THE DEVELOPMENT AND CLINICAL TESTING OF A MOVEMENT QUALITY OUTCOME MEASURE FOR PATIENTS WITH NEUROLOGICAL CONDITIONS: THE LEEDS MOVEMENT PERFORMANCE INDEX

DENISE HELEN ROSS

A thesis submitted to the University of Huddersfield
in partial fulfilment of the requirements for
the Degree of Doctor of Philosophy

The University of Huddersfield

May 2015

Abstract

Background

In modern neurological physiotherapy practice, a patient's neuroplasticity is harnessed, teaching them to develop motor control at 'impairment' level. Consequently, the patient relearns 'normal' movement, which in turn enables them to gain more efficient function and independence that has significant impact on their 'life'. However, there are no outcome measures that capture the patient's quality of movement, or the specific effects of physiotherapy intervention.

Such an outcome measure, the Leeds Movement Performance Index, was developed to fill this gap. It was hypothesised to be a valid, reliable and clinically useful tool.

Methods

A multi-centre, three-part, mixed-methods study was undertaken with three groups of neurological physiotherapists (n=34) and patients with neurological diagnoses (n=42). A range of quantitative and qualitative methods were used: Consensus methods to develop the new outcome measure; psychometric tests to examine reliability and validity against existing outcome measures in the field; focus groups, face-to-face interviews and reflective writing to further explore clinical utility.

Results

The Leeds Movement Performance Index was shown to be a tool with strong measurement properties i.e.: internal consistency (Chronbach's α, overall scale=0.862), inter-rater reliability (ICC=0.959); test-re-test reliability (rho=0.792); and criterion validity compared with the Berg Balance Scale (rho=0.468, SD±2). Thematic analysis demonstrated robust content validity and clinical utility. Furthermore, it un-expectedly revealed that the Leeds Movement Performance Index also supported fundamental aspects of neurological physiotherapy clinical practice, including assessment, analysis and clinical reasoning, and potential usefulness as an education aid.

Conclusion

The Leeds Movement Performance Index makes an important and novel contribution to the field of neurological physiotherapy, both clinically and within research practice. It is the first outcome measure to conceptually map the nature and definition of quality of movement for patients with motor impairment, and it captures the impact of neurological physiotherapy intervention more responsively compared with other outcome measures routinely used within the field.

Table of Contents

Chapter 1: Background

Chapter 2: Outcome measures, set in the context of neurological physiotherapy

Chapter 3: Literature review

Chapter 4: Research design and methodology

Chapter 5: Methods, study 1: the conceptualisation, development and initial field testing of a new outcome measure (the LMPI)

Chapter 6: Results, study 1: the conceptualisation and development of a new outcome measure (the LMPI)

Chapter 7: Methods, study 2: testing the measurement properties of the LMPI

Chapter 8: Results, study 2: the measurement properties of the LMPI

Chapter 9: Methods, study 3: testing the clinical utility, face and content validity of the LMPI

Chapter 10: results, study 3: the clinical utility, face and content validity of the LMPI

Chapter 11: Discussion

List of Figures

List of Tables

List of Boxes

List of Photographs

List of Graphs

Appendices

Final word count: 49 034

Acknowledgements

Publications

Papers

Ross, DH. (2008). Measuring Movement Performance in the Acute Setting: The development of the LEEDS Movement Performance Index. *Synapse Journal of ACPIN, Spring,* 1-4.

Culmer, PR., Brooks, PC., Strauss, DN., Ross, DH., Levesley, M., O'Connor, RJ. & Bhakta, BB. (2012). An Instrumented Walking-Aid to Assess and Retrain Gait.*IEEE/ASME Transactions on Mechatronics, 19*(1), 141-148.

Ross, DH., McLuskey, S., Fletcher-Cook, P. & Stephenson, J. (2014). The reliability of the Leeds Movement Performance Index (LMPI): a new tool for neurological physiotherapy. *Physiotherapy Theory and Practice, 30*(8), 581–587.

Posters

Ross, DH. (October 2010). *Measuring movement performance in the acute setting.The development of the Leeds Movement Performance Index*. Poster presented at Physiotherapy UK (Liverpool, UK)

McLuskey, S. & Ross, DH. (May 2013). *The 'cognitive apprenticeship' model and postgraduate research supervision: mind the gap*. Poster presented at HEA Social Sciences Conference: Teaching research methods (Liverpool, UK)

Ross, DH., McLuskey, S. & Fletcher-Cook, P. (October 2013). *The Leeds Movement Performance Index (LMPI): an exploration of the clinical validity of a new tool for specialist neurological physiotherapy*. Poster presented at Physiotherapy UK (Birmingham, UK)

Ross, DH. (June 2015) *Is it possible to measure the quality of our patients' movement? The development of the Leeds Movement Performance Index (LMPI).*Poster to be presented at The Society for Research in Rehabilitation Summer Meeting (Newcastle UK)

Ross, DH. (October 2015)*An Assessment of the measurement properties of the LMPI (Leeds Movement Performance Index): a new tool for neurological physiotherapy.* Poster to be presented at Physiotherapy UK (Liverpool, UK)

Conference platform presentations

Ross, DH. (June 2012) *The development of an index of movement performance for neurological physiotherapy*. Platform presentation at 'Equinox', University of Huddersfield Research Festival (Huddersfield, UK)

Ross, DH. (January 2014). Come on baby light my fire: the love of a clinician who 'does' research. Key note speech at The Student Occupational Therapy and Physiotherapy Conference, Leeds Metropolitan University (Leeds, UK)

An overview of the thesis

The focus of this thesis lies within the field of neurological physiotherapy. The senior clinicians within this specialism work with patients who have complex movement difficulties, and deliver equally complex interventions that are necessarily individualised according to each person's impairment and functional need.

Within the author's workplace, a gradual iterative process of senior neurological physiotherapist's reasoning resulted in the deduction that there is a clinical need to be able to measure a patient at impairment level. An outcome measure is needed that is sensitive and specific enough to reflect small amounts of change in control of movement.

According to the World Health Organisation's Classification of Function, Disability and Health (WHO 2001) (figure [i] page 34); specific neurological physiotherapy intervention 'sits' within the impairment domain, and has impact on the patient's function and interaction with 'life'. Available outcome measures within this field tend to sit within the 'function' domain and measure movement, but not how 'well' the patient can move, i.e. the quality of their movement.

The clinicians feel that there are no outcome measures that can meet their clinical demand; that reflect their therapeutic approach, and are supportive of the knowledge that underpins this approach. Furthermore, the ability to be able to measure the quality of their patient's movement is considered to be necessary both at base-line and post intervention.

This thesis describes the development of a new outcome measure that is intended to meet a clinical demand within neurological physiotherapy. That is, a tool that can reflect specific intervention to improve the quality of a patient's motor control. The aim of the research is to develop a suitable outcome measure, then to establish its reliability, validity and clinical utility within neurological physiotherapy. The thesis is structured to set out the several stages involved in the research, and is summarised below:

Chapter 1(Background)

This chapter sets the context of modern neurological physiotherapy practice within the healthcare arena, providing an overview of the relevant empirical knowledge. The history and theories of motor control and neuroplasticity are presented along with how this knowledge is related to the concept of 'normal movement', the analysis of movement and movement quality.

Chapter 2, (Outcome measures, set in the context of neurological physiotherapy)

This chapter places the use of outcome measures into the context of physiotherapy practice, presenting: the importance of using outcome measures, the significance of their robust measurement properties, how outcome measures are developed, and some of the difficulties found by physiotherapists when using them within their practice.

Chapter 3 (Literature review)

The aim of this chapter is to review the available outcome measures that could meet the needs of neurological physiotherapists (as described within Chapters 1 and 2). Firstly, a narrative review of the literature presents the number of available outcome measures within the field. Secondly, these outcome measures are reviewed using criteria drawn from Chapters 1 and 2, and, the three most appropriate outcome measures; the Berg Balance Scale (Berg et al 1989), the Trunk Impairment Scale (Verheyden et al 2004) and Goal Attainment Scaling (Kiresuk & Sherman 1968), are critically analysed to assess their suitability. The results of this review helped to inform the development of a new outcome measure.

Chapter 4 (Research design and methodology)

This chapter presents the two research questions that direct both the methodology and research design used within this thesis. That is: -

1. Can a tool be developed that is able to measure movement quality according to the needs of neurological physiotherapists?

2. Is the newly developed tool reliable, valid and functional within modern neurological physiotherapy clinical practice?

To answer these questions, a mixed methods approach is used, and three sequential studies are conducted.

Three groups of neurological physiotherapists are introduced: The Physiotherapist Research Group, the Senior Physiotherapist Participants Group, and the Expert Physiotherapists Group. The knowledge of these Physiotherapists is utilised to guide and examine the conceptualisation and subsequent testing of the measurement properties and clinical utility of the LMPI.

Chapters 5, 6, 7, 8, 9 and 10 present the methods and results of the three studies in a sequential manner.

Chapter 5 (Study 1)

In this chapter, the conceptualisation, development and initial testing of a new outcome measure (the Leeds Movement Performance Index (LMPI)), are described.

Chapter 6 (the results of Study 1)

In this chapter, the results of Study 1 are presented, along with a definition of movement quality derived from the Physiotherapist Research Group.

Chapter 7 (Study 2)

In this chapter, the quantitative methods used to test the measurement properties of the LMPI are described.

Chapter 8 (the results of Study 2)

The measurement properties of the LMPI are presented, along with demographic data from patient participants and the Senior Physiotherapist Participants Group.

Chapter 9 (Study 3)

In this chapter, the qualitative methods used to examine the clinical utility, face and content validity of the LMPI are described; and conducted with the Senior Physiotherapist and Expert Physiotherapist Groups.

Chapter 10 (the results of Study3)

In this chapter, the results of study 3 are presented.

Chapter 11 (Discussion)

This chapter summarises the research and the results found; critically evaluating the strengths, unexpected findings, limitations of the research and recommendations for taking this work forwards. It is concluded that the LMPI has potential to be used as both a clinical support and educational tool.

Chapter 1 Background

1.1 Neurological Physiotherapy

Physiotherapists work in a variety of different streams, i.e. Health, Higher Education, and Research; and in a diversity of clinical settings, ranging from the sports field to the intensive care unit; this is clearly demonstrated in the Chartered Society of Physiotherapy's database (CSP 2014) which contains over 50 specialist clinical interest networks. In order to meet international expectations and requirements, including those of the UK Chartered Society of Physiotherapy (CSP 2014), a physiotherapist is expected to cover the five key steps of:

1) Assessment.
2) Evaluation.
3) Diagnosis.
4) Treatment / Intervention.
5) Recording of outcome.

Neurological physiotherapy is a specialism within Physiotherapy, and within the larger United Kingdom National Health Service there are also specialisations within neurological physiotherapy, i.e. acute stroke, stroke rehabilitation, neuro-surgery, neurology, multiple sclerosis, Parkinson's disease and neurological out-patient clinics. The theoretical and empirical knowledge that necessarily underpins the treatment approach of a neurological physiotherapist is generated and acquired in many different ways and is discussed in more depth in Chapter 4 (Research Design and Methodology), but the four key topics are those of:

- Neurological damage / diseases of the Central Nervous System.
- The theories of motor control.
- Neuroplasticity.
- Normal movement, incorporating quality of movement.

These will be discussed in greater depth in the following passages.

1.2 Neurological damage and diseases of the Central Nervous System

The number of people suffering from a neurological condition in the United Kingdom is large, and the variety of potential conditions along with their associated impairments makes the assessment, treatment and measurement of these people complex. The Health and Social Care Information Centre (hscic2014) publish data related to the number of people admitted into hospital each year with a primary diagnosis or a 'mention' of a neurological condition: of all hospital admissions during 2012/2013, 6.9% had a neurological diagnosis, of these, 43% had a primary diagnosis and 19% of these had a stroke. Unfortunately, up-to-date information on the prevalence and incidence of people with a neurological condition living in the United Kingdom is not readily available. However, although it is possibly out of date, the Neurological Alliance (Neurological Alliance 2003) has published data which gives an overview of the most commonly seen conditions within neurological physiotherapy clinical practice, and is corroborated by more recent data regarding stroke and multiple sclerosis prevalence (Stroke Association 2013; Mackenzie et al 2013).

The most common form of neurological pathology is stroke, followed by; spinal cord injury, traumatic brain injury, multiple sclerosis, and Parkinson's disease. The most common neurological damage to the CNS is upper-motor-neurone damage, with the exceptions of spinal cord injury, muscular dystrophy and some types of dystonia. Motor neurone disease and multiple sclerosis can affect either or both upper and lower motor neurones.

Damage to the central nervous system caused by disease, pathology or direct trauma, has a life affecting impact on a person's body and how they move and interact within their environment. The amount of primary impact is dependent on the location of the damage. The amount of secondary impact is dependent on the person as an individual (their health and the ability of their brain to plastically adapt to change), and the environment in which they are living. Primary and secondary symptoms (impacts) of central nervous system damage are well known, e.g., symptoms of primary damage:-

- Paralysis (loss of or decreased movement).

- Loss of or altered sensation.

- Loss of or decreased perceptual awareness.

- Loss of or decreased cognition.

Symptoms of secondary damage:-

- Compensatory activity such as:

  o Spasticity.

  o Associated reactions.

  o Contra-lateral (or less affected limb/s) over activity.

- Joint contractures.

- Shortened stiff muscles.

- Weakness.

- Pain.

Understanding the damage that can happen to the human body and the implications that this impact has is a science underpinned by motor control theory, which continues to develop as new technologies are invented that can measure and observe activity in the brain and nerves.

1.3 The theories of motor control

The history of the development of the theories of motor control is owed to the pioneering work of many scientists (Bracewell 2010). As scientific techniques have been developed and invented, research methods have also progressed from observational techniques to include more in-detail research such as the use of electron microscopes, positron emission tomography and functional magnetic resonance imaging. Over the last century, as knowledge and understanding has increased, credit has been given to individual scientists; however there have been no major conflicts of interpretation, and the knowledge gained by many has been developed and built into the complex modern theory of motor control.

From the late 19th century to the middle of the 20th century, Sir Charles Sherrington's work (Sherrington 1973) developed the theory that all movement was based on the basic reflex of a 'stimulus producing a response'; he believed that motor control was a complex combination of multiple reflexes. Sherrington based his scientific knowledge on simple animal preparations that could reproduce stereotypical reflex behaviour. Hughlings Jackson's pioneering work of the late 19th and early 20th centuries is considered to be revolutionary (Foerster 1936). He studied and observed in minute detail the impact of disease (in particular epilepsy), electrical stimulation and excision on movement; presenting a map of the human brain based on the results of almost 300 brain operations done mostly under local anaesthetic. The brain geography within this map is recognisable today within our current knowledge base, as are Jackson's theories regarding 1) the anatomy and functions of different parts of the brain, in particular the very specific localisation of hand and finger movement, 2) the multiple repeated representations of body parts within the brain, 3) the brain's capacity to compensate for loss of movement as a result of pathology or trauma by using abnormal muscle synergies, 4) the motor response to a sensory stimulation, and 5) the brains capacity to learn / re-learn movement.

Motor programming theories have developed more recently in the middle and towards the end of the 20th century as the result of the cumulative work of many scientists; the most notable of them is Bernstein (1967). Bernstein observed the complexity of central nervous system control over movement; hypothesising that 'motor programmes' were formed and remembered within the brain and spinal cord for future utilisation on the basis of lived experiences. This contributed to the development of the systems theory (Whiting & Bernshtein 1984), which was intended to be a consideration of all the different systems within the whole body (including the musculo-skeletal system and the cardio-vascular system), enabling the body to move in a complex and coordinated way. Bernstein supported the fact that hierarchical control must still exist to give some control of the infinite variety and variability within the choice of movement, but that central motor patterns and synergies of movement can more easily explain the super-fast responses observed during movement. By 1975, Schmidt (1975) had put forward the Schema theory, proposing that the capacity of the Central Nervous System was not big enough to remember and program every fine nuance and choice of movement at an individual movement level, suggesting the presence of pre-programmed 'movements' that incorporated both sensory information and sensory feedback. A 'movement Schema' or synergy could be triggered according to the required movement which could then be 'fine-tuned' according to the task being performed.

It is clear that as scientific knowledge has progressed throughout the last century, so has the understanding of the theory of movement control. We know that the human body is able to move in both volitional and non-volitional ways as a result of a combined complex interaction of the many different interdependent internal systems which interact within the body's external environment to achieve a desired task or goal.   The historical science that supports this current theory could be considered weak, because it is dependent on observation, nonetheless, it has significant clinical resonance and in the last 20 years, the science to support the theories has become more sophisticated.

'Observation' remains crucial, but the technology that is used to observe has progressed significantly. This is evident in the work of Kelso (1997), who found that movement deteriorated without sensory feedback; suggesting that the presence of two different processes of movement control were necessary, and were dependent on whether the task was planned or not. Research has also been carried out to investigate abnormal, in comparison with normal motor control using positron emission tomography and electromyography. Stenekes et al (2010) established that movement is initiated within the CNS and is dependent on sensory feedback to maintain its integrity.

During its development, the theory and knowledge that underpins our current understanding of motor control has revealed strong evidence that not only is the brain able to adapt and compensate for loss of normal motor control; it is also able to plastically develop in direct response to both inactivity and rehabilitation intervention, the term used to describe this phenomenon is neuroplasticity.

1.4 Neuroplasticity

The word 'neuroplasticity' describes the ability of the central nervous system to learn and it has an important presence within neuro-rehabilitation. It occurs within the central nervous system at many levels, ranging from cellular changes due to learning, to large-scale changes involved in cortical remapping in response to injury (Kandel et al 2000). Neuroplasticity commonly occurs during healthy development, learning, memory, and recovery from brain damage. It is well known that brain-derived neurotrophic factor has been shown to promote neuroplasticity, and that its production can be stimulated by physiotherapy (Frazzitta et al 2014).It is also known that neuroplasticity is not time limited, but is dependent on an individual's 'normal' ability to learn (Chelette et al 2013).

Thus, the brain is able to learn through experience, this is utilised within the field of neurological rehabilitation and very specifically within neurological physiotherapy. During the clinical reasoning process of assessment, diagnosis, analysis and treatment planning; the neurological physiotherapist requires a sound practical and theoretical knowledge of 'normal movement' in order to understand the components of their patient's movement that are impaired as a result of neurological pathology.

1.5 Normal movement and movement analysis

For a neurological physiotherapist, the knowledge of 'normal movement' and the ability to analyse and identify components of movement that may be missing as a result of the primary and secondary effects of neurological damage in their patient is a key competence. This knowledge assists the diagnosis of any specific aspects of movement control that are 'missing', and have a consequent impact on function. Thus, the skill of analysing 'normal movement' is fundamental for the recognition and subsequent analysis of 'abnormal movement' (Bobath and Bobath 1989). This is a major component of both 'in-service' and 'on-the-job', under and post-graduate training; as well as within formally run post-graduate training which can be seen within the courses run by the British Bobath Tutors Association (BBTA 2014). Equally, within the clinical setting, this ability must be utilised without the aid of kinematic and kinetic analyses because of the cost, knowledge and training implications.

Within the available literature there are many studies where the research aims to analyse the components and biomechanics of normal movement, however, without exception, kinematic and kinetic analyses are used, the results of which then need to be extrapolated into clinical practice. A summary of examples of this phenomenon include; Protopapadaki et al (2007), Ebaugh et al (2010) and Fotoohabadiet al (2010).

Protopapadaki et al (2007) used kinematic and kinetic recordings collected from an 8-camera 3-dimensional motion analysis system, and a force platform positioned in the second stair step, to investigate and compare the biomechanics of stair ascent and descent in 11 healthy, neurologically intact individuals. The results reported a very complex detailed analysis of rotations, flexion and extension in all the lower limb joints, with, as would be expected, very small deviations between subjects. Ebaugh et al (2010) compared scapulo-thoracic motion and muscle activity between the raising and lowering phases of an overhead reaching task with kinematic and electromyographic data. The differences between the 19 neurologically intact participants arm raising, reaching and lowering movements were small, and the differences were related to different arm length and height rather than motor control. Fotoohabadi et al (2010) recruited 41 healthy elderly people to examine the sagittal thoracolumbar kinematics and hip-lumbar interaction during the sit-to-stand task. Retro-reflective markers and a 2-dimensional video analysis system were used to evaluate the movement from a 'side facing' view. Again, the movement patterns were similar in all the subjects.

Having knowledge and understanding of normal movement is important, and the above three tasks (stair ascent and descent, overhead reach, sit to stand) are good examples of important functional activities that patients wish to achieve during their rehabilitation. The advantage of using 'in-service', 'on-the-job' training and the post-graduate courses from educational organisations such as the British Bobath Tutors Association (BBTA 2014), is that the 'practical' component of movement analysis without technology can be taught. Importantly, research such as the examples discussed in this section can be directly applied into clinical practice.

In their review, Toro et al (2003) argue that the 'observation' of movement without the use of kinematics in clinical practice is subjective and therefore must be unreliable. However, the work by Pomeroy et al (2003) disagrees; in their study, they ask ten

physiotherapists to rate the videoed movement performed by ten stroke patients and ten age and gender matched controls using a visual analogue scale. No specific 'quality of movement' criteria were used and the physiotherapists were asked to use their clinical judgment to rate the movements. The researchers found that inter-rater reliability was low but intra-rater reliability was found to be acceptable; reflecting that inter-rater reliability may have been better if the physiotherapists had been asked to rate the same characteristics of 'movement quality'.

When a patient has been judged to have 'normal' movement, this is generally perceived to be of good quality. Nevertheless, gaining an understanding of what 'quality of movement' truly means is important when analysing and assessing the patient's 'base line', and then the effects of physiotherapy intervention.

1.6 The concept of movement quality

Understanding the notion of movement quality is challenging because little evidence can be found that specifically explains the concept. In his blog, Robertson (2015) defines movement quality by writing that:

"it's not just about moving more; it's about moving better." (Robertson n.d.)

Within the context of the complexities of the analysis of movement and the application of the knowledge of 'normal movement' within neurological physiotherapy practice, this is a simplistic statement. It is intended that this concept will be expanded within the course of the research within this thesis.

Research within the area of movement quality spans the sport, physiotherapy and dance literature. In 2003, Skjaerven et al examined the perceptions of quality of movement and the corresponding therapeutic interventions of one highly experienced neuro-physiotherapist. The results found three basic elements which were presented as critical to the phenomenon of the quality of movement, that is; postural stability, free breathing and body / movement awareness. In 2010 the same authors (Skjaerven et al 2010) interviewed 15 physiotherapists to understand how they promoted quality of movement within their treatment interventions. Three key themes emerged:

- Movement awareness, i.e. the therapist needed to be aware of their own movement.

- Platform for promoting movement quality, i.e. this was considered to be the potential of the patient to acquire a better quality of movement in combination with the therapy environment.

- Action strategies such as: how to learn movement awareness, the learning cycle, guidance versus correction, the use of language, and internal and external movement reference points.

In these studies, although a vague understanding of how movement quality is promoted or gained, on a pragmatic level it remains difficult to understand what 'quality of movement' actually means.

Within the field of dance, research to evaluate the quality of a ballet dancer's movement performance led to the development of the Radell Evaluation Scale for Dance Technique (Radell, et al 2011). The items within the scale contain terms such as:

- Rhythmic accuracy and smooth, uninterrupted ease and flow of movement.

- Mastery of steps, creating a clear and accurate performance of steps and rhythm.

- Alignment of the body, specifically, a well aligned spine and appendages.

With the exception of initial inter-rater reliability, the measurement properties of the Radell Evaluation Scale for Dance Technique have not been tested. However, these terms appear to have professional resonance within the field of dance, are considered to represent good quality dance movements by the authors, and are corroborated within the examination system of the Royal Academy of Dance (RAD 2013). The Royal Academy of Dance has a well-developed system of evaluation that includes terminology such as; tempo, timing, rhythmical accuracy and harmonious relationship of body parts. Again, there is no empirical research evidence to support these evaluations which are based on experience, professional knowledge and skills. These descriptions of good quality movement, although related to dance, may have clinical relevance for neurological physiotherapists.

Within neurological physiotherapy clinical practice; when intervention is focussed on the patient's movement impairment in order to improve their movement quality, their functional ability also improves. The content of a variety of published literature can be extrapolated and used to support this statement, examples of which are found in literature from the specialities of musculoskeletal physiotherapy (Alricsson et al 2003), sports physiotherapy (McDonnell et al 2005), and neurological physiotherapy (Smedal et al 2006).

Alricsson et al (2003) recruited 20 elite cross country skiers (ten in an intervention and ten in a control group). The aim of the investigation was to evaluate the effect of dance training on joint mobility and muscle flexibility and also on speed and agility, that is, their movement quality. The results suggested that strength, flexibility, speed and agility can be increased within elite cross country skiers using dance training focussed at these specific components of movement control. Interestingly, the outcome measures used were either focussed on deconstructed components of movement such as joint range, or on function such as speed of skiing. No consideration was able to be given to

the concept of change of movement quality and efficiency during the skiing, and the small sample size has an impact on the ability to generalise the findings; especially into neurological physiotherapy clinical practice.

Within musculoskeletal physiotherapy, McDonnell et al (2005) describe a single case study about a man suffering from severe cervicogenic headaches. His muscle strength, alignment and selective movement within his cervical, thoracic and lumbar spines were treated very specifically to improve his alignment, motor control and thus his movement quality during function.   At discharge the patient's symptoms were either completely improved or manageable with a home exercise programme. Again, although it could be suggested that improving the components of this patient's normal movement resulted in improved movement quality and efficiency; and thus reduced his pain; there was no outcome measure used that could quantify the observed improved movement quality.

Smedal et al (2006) used a single subject study design to see whether physiotherapy directed towards specific movement impairment could improve the quality of gait pattern and balance for two patients with multiple sclerosis. The interventions were tailored to each patient's needs and although the treatment interventions were different for each patient, the outcome measures used at baseline, treatment, early and late follow up were similar. An explicit problem within this study was that although both patients and their therapists reported significant and positive effects of intervention, the outcome measures used (although considered to have strong measurement properties) were not sensitive enough to discriminate clinically important improvement in either patient's quality of motor control.

This last section has focussed on movement quality, and how physiotherapy intervention directed towards impairment is claimed to improve the patients function.   In their 'point

of view' paper, Levin et al (2009) describe the reasonable assumption that neurological injury leads to the loss of skilled motor behaviour, and that appropriate neuro-physiotherapy intervention can lead to full or part recovery of skilled movement or adaptation. They also state that no intervention can lead to the patient learning to adapt, compensate or substitute movement in an endeavour to achieve the task they are attempting.

The neurological physiotherapy approach sits within a larger holistic bio psychosocial model of treatment intervention; The World Health Organisation's International Classification of Function Disability and Health (WHO-ICF) (WHO 2001).

1.7 The World Health Organisation's Bio-Social, International Classification of Function, Disability and Health (WHO-ICF)

Within rehabilitation medicine it is important to be able to consistently harness and apply: 1) the knowledge and understanding of motor control, and 2) the brain's capacity to adapt and recover according to the sensory information that it receives (neuroplastic ability). The international rehabilitation community (Doctors, Nurses and Therapists) set this knowledge into the framework of the WHO-ICF (WHO 2001) so that appropriate patient focussed rehabilitation could be organised, standardised and coordinated. This model (Figure [i]) is applied into the context of each patient's individual requirements.

The WHO defines 'impairment', within the body functions and structures domain as: problems with joint mobility, muscle power, muscle tone, involuntary movements and pain. Its definition of the 'activity and participation' domains include: lifting and carrying objects, fine hand use (e.g. writing and cooking), walking, driving, self-care and domestic life. Those of the 'environment' and 'personal factors' domains include;

products, technology services, personal attitudes and beliefs, support and relationships from others (WHO 2001 p3-4).

In an attempt to apply the WHO-ICF model into physiotherapy practice, Mittrach et al (2008) demonstrated that their physiotherapy interventions could be categorised according to ICF codes within the 'body functions' (impairment) domain, and that their treatment goals could be focussed within the 'activity and participation' domain. Although the authors felt that using this technique could quantify and standardise physiotherapy intervention by demonstrating the 'fit' of potential interventions into the ICF domains of body functions and activity, this conceptual approach to physiotherapy intervention would necessitate the deployment of instruments that could measure at both the patient's 'base line' and post intervention.
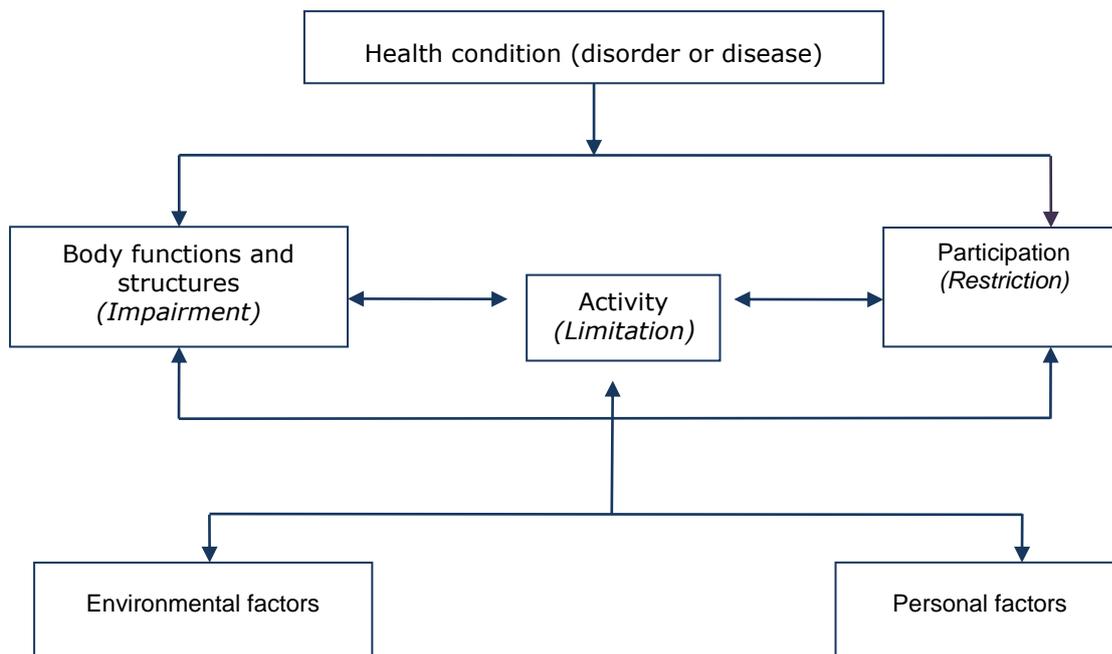
Figure [i]: Interactions between components of the WHO- ICF (WHO 2001 p9)

In order to simply express how the seemingly reductionist interventions employed by a neurological physiotherapist 'fit' within the WHO-ICF model, Shumway-Cook and Woollacott (2012) present a simple model, where 'movement' is considered in relationship to the 'task' that is being performed, the 'individual' (in terms of their impairments and personal factors) and the 'environment' in which the task is being executed (see Figure [ii]).

T
Task (dressing, standing up)

Movement
(Arm and hand movement)

M

I
Individual
(stroke, upper extremity weakness, scapula instability)

E
Environment
(at home, in preparation for going to work)
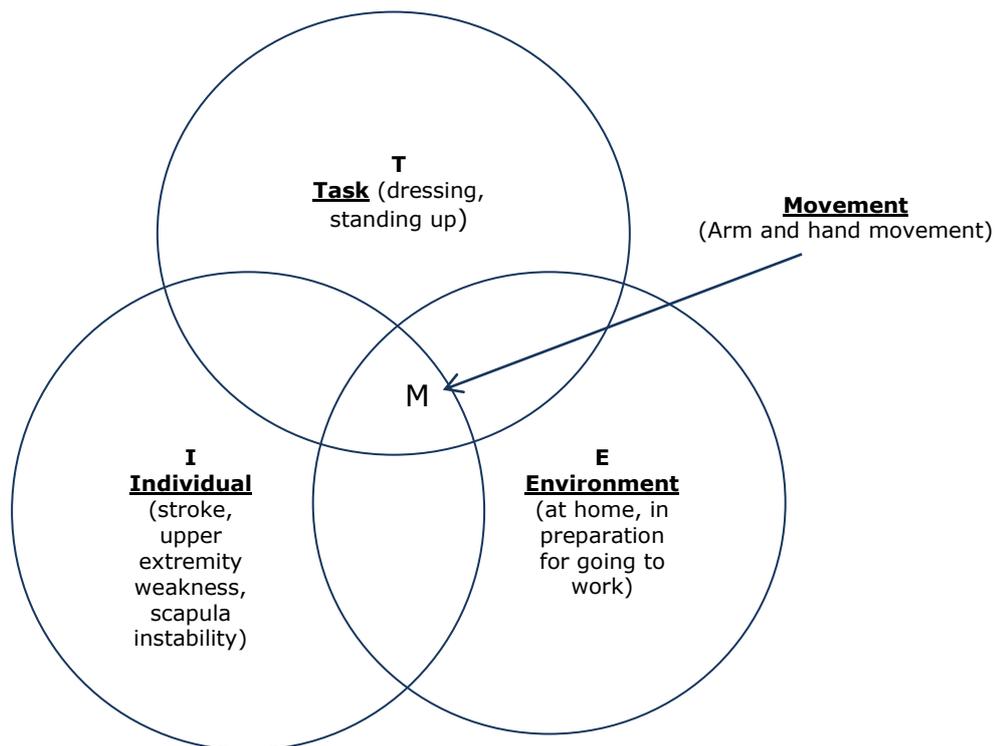
Figure [ii]: Movement emerges from an interaction between the individual, the task, and the environment (Shumway-Cook and Woollacott 2012, p4)

To place this within the specific context of neurological physiotherapy clinical practice (Ross et al 2014), a 'stroke' patient may have an inability to stabilise their scapula on their thorax and therefore suffer from impaired upper limb function and be dependent on carer support during dressing. The impairment (scapula stability) is treated specifically before enabling activity (arm movement) within the context of meaningful function (dressing). The patient then becomes more functionally independent and is able to

interact within their environment with less support from others or from technology, and potentially may feel less disabled. The goal that underpins the focus of the physiotherapist's treatment approach, is to improve the ability, efficiency and therefor the quality of their patient's movement.

1.8 Summary

The paradigm of neurological physiotherapy intervention has been described; in which the complex cycle of patient focussed assessment, diagnosis, clinical reasoning, prognosis, and treatment is 1) underpinned by theoretical and practical knowledge, 2) focussed at impairment level, and 3) impacts at all other levels within the WHO-ICF (WHO 2001).

In order to meet both international expectations and requirements (WCPT 2013), and those of the UK Chartered Society of Physiotherapy (CSP 2014), it is suggested that a physiotherapist is expected to measure the patient at 'base-line' and at intervention outcome. Chapter 2 will present the outcome measurement tools used within neurological physiotherapy in more depth, and Chapter 3, will describe and report the results of a literature review that is intended to identify and critique the available outcome measures that could potentially meet the clinical demands of neurological physiotherapy.

Chapter 2: Outcome measures set in the context of neurological physiotherapy

2.1 Introduction

Chapter 1 has presented the clinical paradigm within which neurological physiotherapists work. In Chapter 2, the use of outcome measures will be placed in the context of neurological physiotherapy including: how they are developed, how it is known if they are reliable and valid for use, guidance as to which tool should be used within the clinical setting, and the constraints and difficulties of using outcome measures in clinical practice.

The United States of America Department of Health and Human Sciences; National Quality Measures Clearinghouse (NQMC 2014) define a clinical outcome as:

"..a health state of a patient resulting from health care..….an outcome measure thus requires data about health states, i.e., states occurring within the body of a patient"

(NQMC 2014)

In 2010, the Chartered Society of Physiotherapy published a document (CSP 2010) that used a panel of 60 expert members to prioritise research topics within neurological physiotherapy. Out of 16 key themes, 11 identified effectiveness of intervention as a topic; the topic subjects covered included stroke, multiple sclerosis, spinal cord injury and ataxia. Out of the 43 specific topics identified, 17 require the use of outcome measures that can measure the effects of very specific interventions. Therefore, in this case, the outcome measures required by both researchers and clinicians need to possess

the appropriate measurement properties that can discriminate the effects of the very specific interventions identified.

2.2 The development of outcome measures

The European Organisation for Research and Treatment of Cancer has developed guidelines for the development of patient completed questionnaires (Johnson et al 2011). Although these are patient reported outcome measures, the developmental process is rigorous and the process can be applied in other settings. Four key phases are described and simplified below (Table [i]). The two important factors of this process are that;1) the users of the outcome measure are involved in the developmental process from the beginning to the end, and 2) it is underpinned with academic resources and knowledge; enabling the measurement properties of face and content validity to be firmly established.

Table [i] : The European Organisation for Research and Treatment of Cancer guidelines for the development of patient completed questionnaires
(Johnson et al 2011)

Phase 1 **Literature** searches
Interviews with **patients**
Review of provisional list of issues
Interviews with **health care professionals**
Amendments of the list
Creation of the list

Phase 2 **Transforming the list into items**
All items related to functioning should be scored in a **positive** direction

Phase 3 **Pre testing**…administration to patients in the target population,
analysis, retention or deletion of items

Phase 4 **Field testing of measurement properties**
Patient sample – should be representative of the target population

During development, or once an outcome measure has been developed, it is important to test its measurement properties to ascertain reliability and validity.

2.3 Establishing the validity and reliability of outcomes measures

The establishment of the measurement properties of an outcome measure requires the use of both qualitative and quantitative methodology. It is important for both clinicians and scientists to know that an outcome measure is both reliable and valid for use in the setting in which it is to be used. That is, they need to know that the tool is trustworthy in that it:-

- Can be used by one or several physiotherapists to measure their patient's movement, with the confidence that they will score in very similar ways (internal reliability).

- Can be transferred between therapists as part of the clinical information that follows the patient along their rehabilitation pathway, with the confidence that they will score in very similar ways (external reliability).

- Can measure the changes to the patient's movement control that occurs during a treatment session or course of treatment (sensitivity to effects of treatment).

- Can measure people with large complex movement control difficulties e.g. someone with significant paralysis (low floor effects).

- Can measure people with a small amount of movement control difficulty, e.g. someone with a small amount of weakness (high ceiling effects).

- Is clinically useful and meaningful for both the patient and their physiotherapist.

2.4 The measurement properties of outcome measures

In an attempt to concisely present the different measurement properties, their clinical impact, how the properties can be tested and useful parameters that are clinically relevant; guidance has been extrapolated from several sources, including within the patient reported outcome measurements world, and combined in Table [ii].

Table [ii]: Psychometric tests and criteria used in the evaluation of reliability[1] and validity[2] for outcome measurement instruments - 1

Property	Definition	Clinical relevance	How it can be tested	Expected outcome
Clinical utility	An outcome measure should be appropriate, accessible, practicle and acceptable for use in clinical practice.	If an outcome measure does not have these properties, it is unlikely that it will be used.	Qualitative methods, e.g.- interview, focus groups, observation	Description of qualities.
Reliability[1]	The degree to which the measurement is free from measurement error. There are 2 aspects of reliability: 1) internal consistency and 2) reproducibility (test re-test and intra-rater reliability)			
Internal consistency	*"individual items should highly correlate with each other and with the summed score of the total of items in the same scale"* Fitzpatrick et al 1998	The items within the scale are all necessary	Cronbach's alpha coefficient, applied to the entire scale and to each item	excellent = alpha ≥ 0.8 good = alpha ≥ 0.7 inadequate = alpha < 0.7
Reproducibility / External reliability	Can therapists use the scale consistently by themselves or within a group of therapists, i.e. 1) the same therapist can use the scale on the same patient repeatedly and expect it to measure without error, and 2) different therapists can measure the same patient and expect to agree with each other. Thus if the score changes, an assumption can be made that the patient has changed.			
Test re-test reliability	When an instrument yields the same results on repeated applications, when neither the respondents nor the domain being measured has changed. Sometimes called intra-rater reliability (Horner & Larmer 2006)	The scale can be used on the same patient over time, with knowledge that any changes in score are due to the patient and not the scale's unreliability. That is the tool is clinically stable	Spearman's rank correlation coefficient A variance components analysis: between-patient, between therapist, between testing variability Re-test between 2 and 14 days	almost perfect: > 0.8 substantial: 0.6 to 0.8 moderate: 0.41 to 0.6 poor: < 0.4 clinical recommendations to measure progress: individuals - ICC > 0.9 large group - ICC > 0.7
Inter-rater reliability	The level of agreement when two or more raters complete the same measurement on the same patient where there is no evidence of any change in condition	The scale can be used on the same patient by different physiotherapists, with the knowledge that any changes in score are due to the patient and not the scale's unreliability.	Intra-class correlation coefficient (ICC) for total scores and individual items Percentage agreement between raters Kappa and weighted Kappa	ICC Excellent: > 0.75 Adequate: 0.40 to < 0.74 Poor: < 0.40 Kappa values 0.00-0.20 = slight 0.21-0.40 = fair 0.41-0.60 = moderate 0.61-0.80 = substantial 0.81-1.00 = almost perfect

Table [ii]: Psychometric tests and criteria used in the evaluation of reliability[1] and validity[2] for outcome measurement instruments - 2

Property	Definition	Clinical relevance	How it can be tested	Expected outcome
Validity[2]	An instrument measures what it purports to measure.			
Construct / criterion	The degree to which the scores of the instrument are consistent with another instrument. i.e. with regard to internal relationships, relationships to scores, or differences between relevant groups. This is based on the assumption that the instrument being compared validly measures the construct	The scale is correlated / compared with an outcome measure (s) that are recognised as 'gold standard'.	Spearmans rank correlation coefficient. Correlation between the averages and the differences of the pre and post intervention scores (Bland & Altman 2010) Pearson's correlation coefficient	See above Standard Deviation ± 2 0.00-0.19 ="very weak" 0.20-0.39 = "weak" 0.40-0.59 = "moderate" 0.60-0.79 = "strong" 0.80-1.0 = "very strong"
Floor and ceiling effects	Floor effects occur when a measure's lowest score is unable to assess a patient's level of ability Ceiling effects occur when a measure's highest score is unable to assess a patient's level of ability	When an outcome measure is used with patients who have very good or very poor ability, it may not be able to demonstrate change / effect of intervention.	Excellent: No floor effects, Adequate: Floor effects < 20%, Poor: Floor effects for > 20% Excellent: No ceiling effects, Adequate: Ceiling effects < 20%, Poor: Ceiling effects > 20%	
Face validity **Content validity**	What an item appears to measure based on its content How well a measurement tool covers the important parts of the health components to be measured How extensively individuals with relevant clinical or health status methodology expertise participated in generating the content	It is essential for clinicians to know that the outcome measurement tool measures what it is supposed to measure. The items need to be relevant and comprehensive. This is a key property to establish, particularly due to the number of outcome measures developed for one purpose then used for another.	Items should be judged by experts Qualitative methods e.g.: - The development process Interview Focus group Questionnaire Observation	

Table [ii]: Psychometric tests and criteria used in the evaluation of reliability[1] and validity[2] for outcome measurement instruments – 3

Name of the test	Definition	Clinical relevance	How it can be tested	Expected outcome
Predictive Validity	Indicates that the outcomes of an instrument can predict a future state or outcome.	Within the healthcare setting, predictions can be of length of stay, discharge destination and risk of falls.	Spearmans rank correlation coefficient. Receiver Operating Characteristic (ROC) analysis - area under the curve.	See above Excellent: > 0.9 Adequate: 0.7 to 0.89 Poor: < 0.7
Responsiveness	**Effect size**	The ability of a scale to detect clinically significant change following treatment of known efficacy.	Cohen's d statistic. Within patient change scores before and after treatment. Calculating an effect size statistic (mean change score divided by standard deviation of pre-treatment scores)	≥0.80 = Large 0.50 = Moderate 0.20 = Small
	Measurement error The Standard Error of Measurement (SEM) is a reliability measure that assesses response stability.	The SEM estimates the standard error in a set of repeated scores	Limits of agreement (LoA) and Smallest detectable change (SDC)	Measured in units of the outcome measure
	Minimal or Smallest Detectable Change (MDC/SDC)	A statistical estimate of the smallest amount of change that can be detected by a measure that corresponds to a noticeable change in ability important to the patient	$1.96 \times \sqrt{2} \times SEM$.	Measured in units of the outcome measure

Andresen (2000);Bland& Altman (2002; 2010);de-Vet et al (2006);Evans et al (1996); Fitzpatrick et al (1998); Goreki et al (2013); Horner& Larmer (2006); Johnson et al (2011); Kazis et al (1989); Landis& Koch (1977); Messick (1995); Rehabilitation Measures Database (2010); Wade (2004).

It is important that neurological physiotherapists and researchers, providers and purchasers of physiotherapy services, and national organisations such as the UK Rehabilitation Outcomes Collaborative (UK-ROC 2014) should have clear criteria when selecting an outcome measure for use, in order to ascertain that the results of patient measurement are scientifically credible and trustworthy. Nonetheless, for clinicians, the issues of which outcome measure to use can be problematic.

2.5 Recommended outcome measures for use within neurological physiotherapy practice

Nearly 20 years ago, in her review paper, Greenhalgh (1998) recognised that whilst outcome measures are widely used within research so that the effectiveness of a 'tested' intervention can be judged; they were not widely used in clinical practice. Given the number of available outcome measures that could potentially be used within clinical practice, the issues that she identified are still relevant today, making the decision by a physiotherapist of which outcome measure to use a complex one. There are several resources that can be accessed by neurological physiotherapists to support them in this choice: The British Society of Rehabilitation Medicine (BSRM 2005), The UK Department of Health (DOH 2001; 2005), The Rehabilitation Measures Database (2010), National Clinical Guideline for Stroke (RCP 2012), the American Physical Therapy Association Neurology Section Task Force (Sullivan et al 2013) and the UK Rehabilitation Outcomes Collaborative (UK ROC 2014).

However, despite this advice, in the UK, the ultimate decision of choice of outcome measure rests with the physiotherapists, who are required to meet the demands and requisites of national organisations, their service managers, their patients and their own professional and clinical need. They also have to ensure that the chosen measurement tool is both valid, reliable, designed to measure impact of intervention and concurs with their patient's neurological pathology.

Thus, although the use of standardised, reliable and validated outcome measures have been encouraged; within the clinical setting, the adoption of this practice has been challenging (Duncan and Murray 2012); encouraging researchers to investigate the reasons why physiotherapists do or do not use outcome measures.

2.6 Using outcome measures within neurological physiotherapy practice

Several authors have published their findings of research into the drivers, facilitators, constraints and difficulties found by physiotherapists regarding the use of outcome measures in their practice; they have utilised a mixture of methodologies: -

- Postal or on-line questionnaire (Chesson et al 1996; Abrams et al 2006; Van Peppen et al 2008; Yoward et al 2008; Jette et al 2009).
- Semi-structured interview (Wedge et al 2012).
- Questionnaire plus semi-structured interview (Swinkels et al 2011).
- Literature review (Wedge et al 2012).

This selection of research papers, methodology, authors, geographical location researched and physiotherapy speciality (general, musculo-skeletal, neurology) have exposed a common set of barriers and facilitators to the use of outcome measures by physiotherapists.

2.7 Barriers to the use of outcome measures within physiotherapy practice

A barrier for a physiotherapist in the use of an outcome measure within their clinical practice would be any factor that provides a reasonable rationale for not using one. The work of Swinkels et al (2011) gives the richest understanding of barriers, feasibly due to the mixture of methodology, these authors found four main 'barrier' themes.

Physiotherapists

The physiotherapists had problems with their levels of competence to use outcome measures, describing: a lack of knowledge regarding the outcome measures available and how to use them appropriately, and also not being experienced at using them in their routine work, although they also stated that they were aware that they should use them. One of their problems was that their intervention had a focus on the diagnosis of patient impairment, and it was difficult to find an outcome measure that met this focus. The physiotherapists attitude towards using outcome measures was also described, in that they had a resistance to changing their practice (being 'fixed' in their normal working methods), they weren't 'convinced' of the value of using outcome measures, they felt overloaded with information, they described the outcome of their intervention in other ways (e.g. within their written clinical records) and didn't feel confident in using the tools that were available to them.

Organisation

The organisational barriers were described as being: time constraints (the mangers did not give the physiotherapists' time to use the outcome measures), there were no financial incentives (although this is not relevant in UK practice); there were also insufficient supportive technology (such as computers) and no organisational mandatory practice or policy. Within colleagues, there was a lack of discussions and meetings to facilitate use, and no compliance with any previous agreements made regarding the use of outcome measures.

Patients

The physiotherapists described their patient's expectations as a barrier because they felt that patients didn't want to spend time being tested - preferring just to be treated. They also found that using patient questionnaires were difficult because of potential language and cognitive difficulties.

Measurement instruments

The measurement instruments themselves were also seen as a barrier to use because of their poor availability, the large amount of choice, poor clinical utility and unclear instructions and interpretation.

2.8 Facilitators to the use of outcome measures within physiotherapy practice

A facilitator for a physiotherapist in the use of an outcome measure within their clinical practice would be any factor that provides reasonable rationale and thus motivation for using one. Facilitators to the use of outcome measures in clinical practice emerged into three main themes: communication, mandatory / policy requirements, physiotherapist attitude and clinical drivers.

Communication

Providing patients with information related to their change in status and patient related discussion with colleagues were found to be enhanced with the use of outcome measures (Chesson1996; Jette et al 2009).

Policy

The changing policy requirements both within the physiotherapy profession and within the organisations in which they are employed have created a strong driver for changing clinical practice.

Attitude and clinical drivers

The physiotherapist's attitudes towards using outcome measures seem to be very positive despite the difficulties previously described. Some respondents felt that using outcome measures could: 1) demonstrate intervention effectiveness (Yoward et al 2008), 2) help direct a treatment plan and determine progress (Jette et al 2009), and 3) improve quality of treatment (Swinkels et al 2012).

The barriers facing physiotherapists trying to use outcome measures within their clinical practice appear to be similar in the UK, Australia, Holland and the USA, and they do not appear to have changed over the years. Similar problems were being faced in 1996 (Chesson et al 1996) as in 2012 (Wedge et al 2012), however, despite this, it appears that the use of outcome measures has increased (Yoward et al 2008; Swinkels 2012,) even though the difficulties remain. It is possible that this is due to the Physiotherapists professional values and motivation, plus increased professional and managerial mandatory requirements.

To summarise; in his editorial, Duncan (2011) wrote:

"Outcome measures are more likely to be used in practice if they are developed to be brief, straightforward and meaningful. Therapists are more likely to use measures in practice when they are easily available; they have choice over their selection and feel skilled in their use. And a supportive culture is required at an organisational level to successfully embed routine outcome measurement into practice" (Duncan 2011, p221)

Although this statement is directed towards the Occupational Therapy profession, it is clearly relevant for neurological physiotherapists.

2.9 Summary of Chapter 2

There are significant potential problems within neurological physiotherapy research and clinical practice, in that:

- There is no clinical or scientifically accepted 'gold standard' outcome measure that can be used within neurological physiotherapy, although a confusing array of many different outcome measures are recommended for use (DOH 2001; DOH 2005; BSRM 2005; The Rehabilitation Measures Database 2010; RCP 2012; Sullivan et al 2013; UK ROC 2014).

- An intervention being tested could be effective but the outcome measure being used doesn't reflect a clinically meaningful 'base line' of impairment or a change in the patients quality of movement, possibly because:
  - The measurement tools are not sensitive enough to assess the 'base line' or measure the intervention that is focussed on the patient's impairment (Janssen et al 2012; Wang et al 2005).
  - The items in the scale are not clinically relevant or functionally meaningful to the patient or therapist (Barak & Duncan 2006).
- An intervention being tested could be ineffective (i.e. could be teaching the patient to abnormally compensate for their movement deficit) and therefore the patient may appear to have improved in terms of for example gait speed, or balance, but has actually learnt to efficiently and abnormally compensate for their lack of motor control. Of course, this judgement is very dependent on the focus of the patient's treatment goals, which may be to learn how to compensate for loss of movement. It should be argued however, that the goal of learning to compensate as 'efficiently' as possible still requires an outcome measure that is clinically sensitive and meaningful.

To gain an understanding of the outcome measures that are currently available for neurological physiotherapists to use with their patients, that 1) meet the requirements of International and National professional bodies (WCPT 2013, CSP 2005) and2) meet the clinical demand; a review of the available literature was conducted.

Chapter 3: Literature review

The goals of this literature review were to:

- Identify which outcome measures are being used or developed within neurological physiotherapy or neurological rehabilitation research and clinical practice.

- Ascertain which outcome measures fit specific inclusion and exclusion criteria extrapolated from within the contexts of both neurological physiotherapy clinical practice (Chapter 1) and the relevant measurement properties of outcome measurement tools (Chapter 2).

- Subject the selected outcome measures to in-depth review.

3.1 The literature review methods

This narrative review of the literature falls into three clear phases (two literature searches and an in-depth appraisal); in Phase 1, the literature will be searched for research papers describing the conception and development of specific outcome measurement tools, the search will be refined by the use of explicit inclusion and exclusion criteria in order to find a range of outcome measures that are fit for modern neurological physiotherapy use. In Phase 2, a literature search related to each of the emergent outcome measures will result in a selection of research papers pertaining to each tool. In Phase 3, an in depth appraisal of each outcome measure will be made, using the collection of research papers found for each tool that were identified in Phase 2.

To maximise simplicity within such a complex strategy, the results of each phase are presented following a description of the methods, and figure [iii] gives an over-view of all three phases and their steps, along with how they are connected.

Phase 1: Literature review
- Search for papers on outcome measures
- Synthesis and selection of three key outcome measures

Phase 2: Literature review of three outcome measures
- Search for papers describing each of the three outcome measures
- Selection of pertinent articles for in-depth analysis

Phase 3: In-depth analysis
- In-depth analysis of the Berg Balance Scale
- In-depth analysis of the Trunk Impairment Scale
- In-depth analysis of Goal Attainment Scaling

Figure [iii]: An over-view of all three phases of the literature review

3.2 Phase 1

Methods

Box [i] (Search 1) gives an overview of the methods that will be followed during the first search of this literature review. The questions that underpin the search goals are intended to focus the findings. Firstly (Step 1), a search for research papers was carried out within:-

- The electronic databases appropriate to health care and rehabilitation.
- The Cochrane database of systematic reviews and clinical trials.
- A hand search of reference lists and personal literature collection.
- Specialist websites.

The search terms were kept broad ('Physiotherapy' AND 'Outcome Measure') to ensure a maximum number of results; as were the search limits (Step 1b) of: 'adult', 'human', 'English language' and 'no age limit'. Specific inclusion and exclusion conditions (Step 2b) drawn from Chapters 1 and 2 established selection criteria which were also then used:-

- Within Step 2 - the initial title and abstract screen of research papers related to outcome measurement tools; so that papers could be rejected or collated.

- Within Step 3 - the subsequent full text screen of the surviving source research papers; again, the criteria enabled rejection or collation.

It was expected that this inclusion and exclusion process would identify a selection of source research papers describing outcome measurement tools that may meet the needs of neurological physiotherapists within their clinical practice.

Box [i]: Search 1: The search and review method to identify source research papers of outcome measurement tools

Questions to guide the search goals

1. What outcome measures are being used in Neurological Physiotherapy research?

2. Have any outcome measures been developed that are not being used in research?

3. What other available measures are there?

Step 1a) Literature search

Search terms: *Physiotherapy*
                AND
                Outcome Measure

a) Electronic databases: AMED, EMBASE, MEDLINE, PsycINFO, CINAHL, Web of Science, Global Health, Pub Med, Science direct, PEdro, Evidence search, Scopus, TRIP, EThOS

b) Cochrane database of Randomised controlled Trials; Cochrane database of systematic reviews

c) Hand search of reference lists

d) Specialist web sites:
- Rehabilitation Measures database
- Clinical Measurement Instruments database
- Stroke Engine Assess
- The Neurology Section
- American Physical Therapy Association
- Chartered Society of Physiotherapy (UK)
- Australian Physiotherapy Association
- Canadian Stroke Network
- UK National Clinical Guidelines

Step 1b) Limits
- Adult.
- Human.
- No age limit of publication.
- English language

Step 2) Title and abstract screen

Inclusion and exclusion criteria applied

4334 Papers related to outcome measures rejected

30 source papers of outcome measurement tools selected for full text screen.

Step 3) Full text screen Inclusion and exclusion criteria applied to source papers of outcome measurement tools

Step 4) Outcome

3 outcome measures selected

Progress to Phase 2 of literature review

Step 2b) Selection criteria

Inclusion	**Exclusion**
• Could be used within clinical practice. • Therapist completed. • Adults. • Validated for use with more than one neurological pathology. • Measures more than one element of movement. • Measurement properties tested.	• Non-neurological. • Measures function. • Not free. • All standing / ambulation tests. • Obvious floor/ceiling effects. • Patient completed questionnaires. • Kinematics. • Activities of daily living (ADL) scales.

52

Results

For simplicity, Search 1 was sub-divided into four more detailed steps.

Step 1a: Electronic databases were accessed via the libraries of the Universities of Huddersfield and Leeds, and personal reference databases were searched using the search terms of 'Physiotherapy' AND 'Outcome Measure'. The Cochrane databases were browsed by:

   I.   Topic; 'Neurology'.

  II.   Within each specific neurological pathology category (e.g. head injury, multiple sclerosis).

 III.   Within 'rehabilitation' section or further pathology / disease sub-category.

Specialist websites were accessed via personal internet access and searched for specific outcome measures that met the inclusion and exclusion selection criteria within Step 2b, from Box [i]. This process resulted in over 4300 research papers; Table [iii] presents the extent of the search results.

Table[iii] : The results of Literature Search 1

Electronic database	Search terms	Refined by or with additional limits	Number of records
TRIP	Physiotherapy AND Outcome measure	clinical area -(neurology) & 'guidelines'	23
CINAHL – from 1960	Physiotherapy AND Outcome measure (In abstract)		129
SPORTdiscus	Physiotherapy AND Outcome measure		373
PEDro – from 1929 Systematic reviews Clinical trials	Physiotherapy AND Outcome measure (in abstract & title)		926
Scopus – from 1960	Physiotherapy AND Outcome measure (in title, abstract & keyword)	Subject area –(neurology) Limit – human & physiotherapy	184
EMBASE – from 1947	Physiotherapy AND Outcome measure (In keyword)		645
PsycINFO from 1806	Physiotherapy AND Outcome measure (In keyword)		37
Ovid Medline from 1946	Physiotherapy AND Outcome measure (In keyword)		199
AMED from 1995	Physiotherapy AND Outcome measure (In keyword)		113
PubMed	Physiotherapy AND Outcome measure (In title & abstract)		202
Science Direct – from 1823	Physiotherapy AND Outcome measure (In title, abstract & keyword)		511
Web of Science from 1900	Physiotherapy AND Outcome measure	Neuroscience & neurology, English	802
Global Health	Physiotherapy AND Outcome measure		3
Cochrane library from 2005. Database of systematic reviews	Browsed by topic - neurology	Head injury Motor neurone disorders MS Stroke	30 17 48 176
Cochrane library from 2005, Register of controlled trials	Physiotherapy AND Outcome measure	Stroke group Movement disorders MS and rare diseases of the CNS	86 0 12
Total			**4366**

Step 2

After duplicate papers were removed, the title and abstracts of these research papers were screened using specific inclusion and exclusion selection criteria shown in Step 2a of Search 1 shown in Box[i]. Research papers were rejected if they did not pass this initial screening process. A total of 4366 citations were reviewed, of which 4334 were excluded and 30 source research papers were assessed as potentially relevant. Full text of these papers was obtained for further scrutiny.

Step 3

The full text of these 30 selected source research papers of outcome measurement tools (Table [iv], were evaluated using the inclusion and exclusion criteria shown in Step 2a of search 1 shown in Box [i]. Twenty-seven source research papers of outcome measures were rejected because they did not meet the criteria. Three source research papers of outcome measures were retained.

Table [iv]: Thirty outcome measures selected for review - 1

	The outcome measure	Reference	Inclusion criteria not met
1	Activities-specific Balance Confidence Scale	Powell, LE. &Myers, AM. (1995). The Activities-specific Balance Confidence (ABC) Scale. *Journals of Gerontology. Series A, Biological Sciences and Medical Sciences, 50A*(1), M28-34.	Patient completed level of confidence
2	Activity Measure Post-acute Care	Haley, SM., Coster, WJ., Andres, PL., Ludlow, LH., Ni, P., Bond, TL., Sinclair, SJ. &Jette, AM. (2004). Activity outcome measurement for post-acute care. *Medical Care, 42*(1 Suppl), I – 49.	Not free

Measures ADL |
| 3 | Ashworth Scale / Modified Ashworth Scale | Bohannon, RW. & Smith, MB. (1987). Interrater reliability of a modified Ashworth scale of muscle spasticity. *Physical therapy, 67*(2), 206-7. | Measures spasticity not movement |
| 4 | Barthel Index | Wade, DT. (1992). *Measurement in Neurological Rehabilitation*. New York: Oxford University Press. | Measures ADL |
| 5 | Balance and Mini Balance Evaluation Systems Test / Brief Balance Evaluation Systems Test | Horak, FB., Wrisley, DM. & Frank, J. (2009). The Balance Evaluation Systems Test (BESTest) to differentiate balance deficits. *Physical Therapy, 89*(5), 484-498. | Not free

Obvious floor effects |
| 6 | Berg Balance Scale | Berg, K., Wood-Dauphinee, S., Williams, JJ. & Gayton, D. (1989). Measuring balance in the elderly: preliminary development of an instrument. *Physiotherapy Canada, 41*(6), 304-11. | To review in more detail |
| 7 | Canadian Neurological Scale | Cote, R., Hachinski, VC.,Shurvell, BL., Norris, JW. &Wolfson, C. (1986). The Canadian Neurological Scale: a preliminary study in acute stroke. *Stroke, 17*(4), 731-7. | Tool for medical assessment

Acute stroke only |
| 8 | Chedoke-McMaster Stroke Assessment Measure | Gowland, C., Stratford, P., Ward, M., Moreland, J., Torresin, W., Van Hullenaar, S., Sanford, J., Barreca, S., Vanspall, B. &Plews, N. (1993). Measuring physical impairment and disability with the Chedoke-McMaster Stroke Assessment. *Stroke, 24*(1), 58-63. | Stroke only |
| 9 | Community Balance and Mobility Scale | Howe, J., Inness, E., Venturini, A., Williams, JI. &Verrier, MC. (2006). The Community Balance and Mobility Scale: A balance measure for individuals with traumatic brain injury. *Clinical Rehabilitation, 20*, 885-95. | Measures ambulation

Obvious floor effects |
| 10 | Dynamic Gait Index / Functional Gait Assessment | Marchetti, GF. & Whitney, SL. (2006). Construction and validation of the 4-item dynamic gait index. *Physical Therapy, 86*(12),1651-60. | Measures ambulation

Obvious floor effects |

	The outcome measure	Reference	Inclusion criteria not met
		Table [iv]: Thirty outcome measures selected for review - 2	
	The outcome measure	**Reference**	**Inclusion criteria not met**
11	Dynamometer scores	Wiles, CM. & Karni, Y. (1983). The measurement of muscle strength in patients with peripheral neuromuscular disorders. *Journal of neurology, Neurosurgery, and Psychiatry, 46*(11), 1006-13.	Not free
12	Emory Ambulation Profile; / Modified Functional Ambulation Profile	Wolf, SL., Catlin, PA., Gage, K., Gurucharri, K., Robertson, R. & Stephen, K. (1999). Establishing the reliability and validity of measurements of walking time using the Emory Functional Ambulation Profile. *Physical Therapy, 79*(12), 1122-1133.	Stroke only Measures ambulation, Obvious floor effects
13	Fugl-Meyer Assessment of Motor Recovery after Stroke	Gladstone, DJ.,Danells, CJ. & Black, SE. (2002). The Fugl-Meyer Assessment of Motor Recovery after Stroke: A critical review of its measurement properties. *Neurorehabilitation and Neural Repair, 16*(3), 232-240.	Stroke only
14	Function in Sitting Test	Gorman, SL., Radtka, S., Melnick, ME., Abrams, GM. & Byl, NN. (2010). Development and validation of the function in sitting test in adults with acute stroke. *Journal of Neurologic Physical Therapy 34(*3), 150-160	Validated for acute stroke only
15	Functional Assessment Measure (FAM)	Donaghy, S. & Wass, PJ. (1988). Interrater reliability of the Functional Assessment Measure in a brain injury rehabilitation program. *Archives Physical and Medical Rehabilitation,79*(10),1231-6.	Not free
16	Functional Independence Measure (FIM)	Keith, RA., Granger, CV., Hamilton, BB. & Sherwin, FS. (1987). The functional independence measure: a new tool for rehabilitation. *Advances in Clinical Rehabilitation,1*, 6-18.	Not free, measures ADL
17	Functional Axial Rotation	Schenkman, M., Hughes, MA., Bowden, MG. & Studenski, SA. (1995). A clinical tool for measuring functional axial rotation. *Physical Therapy, 75*(2),151-6.	Limited to rotation in sitting, PD only, not free,
18	Functional Reach test & Modified Anterior Functional reach	Duncan, PW., Weiner, DK., Chandler, J. & Studenski, S. (1990). Functional reach: a new clinical measure of balance. *The Journals of Gerontology, 45*(6), M192-7.	Obvious floor effects
19	GAS Goal Attainment Scaling	Kiresuk, TJ. &Sherman, RE. (1968). Goal attainment scaling: A general method for evaluating comprehensive community mental health programs. *Community Mental Health Journal, 4*(6), 443-53.	To review in more detail

	The outcome measure	Reference	Inclusion criteria not met
		Table [iv]: Thirty outcome measures selected for review - 3	
20	Motor Assessment Scale (MAS)	Carr, JH., Shepherd, RB., Nordholm, L. & Lynne, D. (1985). Investigation of a new motor assessment scale for stroke patients. *Physical Therapy, 65*(2),175-80.	Stroke only
21	Motor Function Measure	Berard, C., Payan, C., Hodgkinson I. & Fermanian, J. (2005). A motor function measure scale for neuromuscular diseases. Construction and validation study. *Neuromuscular Disorders,15*(7), 463-470.	Neuromuscular diseases only
22	Motricity Index	Collin, C. & Wade, D. (1990). Assessing motor impairment after stroke: a pilot reliability study. *Journal of Neurology Neurosurgery and Psychiatry, 53,* 576-579.	Stroke only
23	Rivermead Mobility Index (RMI)	Collen, FM., Wade, DT., Robb, GF. & Bradshaw, CM. (1991). The Rivermead Mobility Index: a further development of the Rivermead Motor Assessment. *International Disability Studies, 13,* 50-54.	Patient completed questionnaire
24	Stroke Impact Scale	Duncan, PW., Wallace, D., Lai, SM., Johnson, D., Embretson, S. & Laster, LJ. (1999). The stroke impact scale version 2.0. Evaluation of reliability, validity, and sensitivity to change. *Stroke, 30*(10), 2131-40.	Patient completed Stroke only
25	Stroke Rehabilitation Assessment of Movement Measure (STREAM)	Daley, K., Mayo, N. & Wood-Dauphinée, S. (1999). Reliability of scores on the Stroke Rehabilitation Assessment of Movement (STREAM) measure. *Physical Therapy, 79*(1), 8-19.	Stroke only
26	Tardieu Scale/Modified Tardieu Scale	Haugh, AB., Pandyan, AD. & Johnson, GR. (2006). A systematic review of the Tardieu Scale for the measurement of spasticity. *Disability and Rehabilitation*, *28*(15):899-907.	Measures spasticity and muscle tone using stretch
27	Tinetti Performance Oriented Mobility Assessment	Tinetti, ME., Williams, TF. & Mayewski, R. (1986). Fall Risk Index for elderly patients based on number of chronic disabilities. *American Journal of Medicine,* 80(3), 429-34.	Obvious floor effects
28	Trunk Control Test	Collin, C. & Wade, D. (1990). Assessing motor impairment after stroke: a pilot reliability study. *Journal of Neurology, Neurosurgery and Psychiatry, 53*(7), 576-579.	Stroke only
29	Trunk Impairment Scale	Verheyden, G., Nieuwboer, A., Mertin, J., Preger, R., Kiekens, C. & De Weerdt, W. (2004). The Trunk Impairment Scale: a new tool to measure motor impairment of the trunk after stroke. Clinical Rehabilitation, 18(3), 326-334.	To review in more detail
30	Wolf Motor Function Test	Wolf, SL., Catlin, PA., Ellis, M., Archer, AL., Morgan, B. & Piacentino, A. (2001). Assessing Wolf motor function test as outcome measure for research in patients after stroke. *Stroke, 32*(7), 1635-9.	Upper limb only

Step 4

Three outcome measures emerged that met the requirements of the selection criteria:-

1) The Berg Balance Scale (Berg et al 1989) (BBS).

2) The Trunk Impairment Scale (Verheyden & Nieuwboer 2004) (TIS).

3) Goal Attainment Scaling (Kiresuk & Sherman 1968) (GAS).

3.3 Phase 2

Methods

The selection of source outcome measurement instrument papers that were identified within Search 1 of this literature review were the foundations of Search 2, and Box [ii] gives an overview of the methods followed.

Each outcome measure was reviewed separately, so a literature search related to each outcome measure was carried out, using a similar stepwise process to Search1.

Again, a question was used to underpin the search aims and help focus the findings. Firstly (Step 1a), a search for research papers was carried out within:-

- The electronic databases appropriate to health care and rehabilitation.

- A hand search of reference lists and personal literature collection.

- The accessing and searching of specialist websites.

Again, the search terms were kept broad (the 'name' of the outcome measure being reviewed) to ensure a maximum number of results, as were the search limits (Step 1b) of: 'adult', 'human', 'English language' and 'no age limit'. Note that for this search, databases containing systematic reviews and randomised controlled trials were not included because research papers that examined the properties of outcome measures

are not relevant for this methodology. Specific inclusion conditions were again drawn from within the context of neurological physiotherapy clinical practice and also included research papers related to the testing of measurement properties (Step2b). These selection criteria were used:-

- Within Step 2 - the initial title and abstract screen, so that papers could be rejected or collated.

- Within Step 3 - the full text screen so that further papers could be rejected or collated.

The resulting selection of research papers pertaining to each of the surviving outcome measures were then reviewed in depth in Phase 3.

Box [ii]: Search 2: The search and review method to identify research papers related to each outcome measurement tool; the Berg Balance Scale, the Trunk Impairment Scale and Goal Attainment Scaling

Questions to guide the search

1. What measurement properties of this outcome measurement tool (the Berg Balance Scale, Goal Attainment Scaling and the Trunk Impairment Scale) have been established?

Step 1a): Literature search

Search terms:
   "name of selected outcome measure"

1) Electronic databases: AMED, EMBASE, MEDLINE, PsycINFO, CINAHL, Web of Science, Global Health, Pub Med, Science direct, Scopus, TRIP, EThOS.

2) Hand search of reference lists.

3) Specialist web sites:
   * Rehabilitation Measures database.
   * Clinical Measurement Instruments database.
   * Stroke Engine Assess.
   * The Neurology Section.
   * American Physical Therapy Association.

Step 1b): Limits

   * Adult.
   * Human.
   * No age limit of publication.
   * English language.

Step 2) Title and abstract screen

Selection criteria used

Research papers rejected

Step 2b): Selection Criteria

   * Validated for use with more than one neurological pathology.

   * Measures more than one element of movement or body part.

   * Research set within neurological physiotherapy.

   * Research paper related to one or more measurement properties OR clinical utility.

Research papers selected for full text screen

Step 3) Full text screen

Selection criteria used

4) Outcome

A selection of research papers specifically related to each outcome measure:

Progress to in-depth full text review using a critical appraisal checklist (Box [iii]) within Phase3.

Results

Box [ii] gives an overview of the process followed for each of the three outcome measures, and again, for simplicity the process is sub-divided into four steps.

Step 1

Electronic databases were accessed via the libraries of the Universities of Huddersfield and Leeds, and personal reference databases were searched using the search terms of the name of the outcome measure (Table [v]).

	Table [v]: The results of Literature Search 2 using electronic databases		
	Search terms &number of records		
Electronic database	*"Berg Balance Scale"*	*"Trunk Impairment Scale"*	*"Goal Attainment Scaling"*
TRIP	320	8	114
CINAHL – from 1960 (in abstract)	522	20	132
SPORTDiscus	329	17	47
Scopus – from 1960	816	27	235
EMBASE – from 1947 (title)	80	10	136
PsycINFO from 1806	12	2	126
Ovid Medline from 1946	53	8	104
AMED	35	6	39
PubMed	851	33	231
Science Direct – from 1823	272	5	54
Web of Science from 1898 – in title	103	15	151
Global Health from 1910	4	0	4
Total	**3097**	**302**	**1270**

Step 2

After duplicates were removed, the title and abstracts of these research papers were screened using the selection criteria shown in Box [ii], Search 2, Step 2b. Research papers were rejected if they did not pass this initial screening process.

Step 3

The full text of selected research papers were screened using the same inclusion and exclusion criteria as Step 2 above, and then rejected or retained for progression into Step 4.

- For the BBS, a total of 3097 citations were reviewed, of which 3053 were excluded and 43 research papers were assessed as potentially relevant. Full text of these papers was obtained for further scrutiny.

- For the TIS, a total of 302 citations were reviewed, of which 289 were excluded and 13 research papers were assessed as potentially relevant. Full text of these papers was obtained for further scrutiny.

- For GAS, a total of 1270 citations were reviewed, of which 1258 were excluded and 11 research papers were assessed as potentially relevant. Full text of these papers was obtained for further scrutiny.

Step 4

A selection of research papers specifically related to each outcome measure, were carried forward into Phase 3 of the literature review.

3.4 Phase 3

Methods

A critical appraisal checklist was used to review each of the papers emerging from Search 2, so that a full in depth evaluation of both the measurement properties and

clinical utility of each outcome measure could be achieved. This checklist (Box [iii]) has been created with initial guidance from Greenhalgh (1998) and Wade (2004), and then updated and developed to meet the needs of this review, by incorporating derivations from several sources previously discussed within this thesis:

1)   The presence of modern measurement properties necessary to ensure appropriate reliability and validity of an outcome measure (table [ii]).

2)   The developmental process of the outcome measure, enabling strong face and content validity (Table [i], (Johnson et al 2011).

3)   The barriers and facilitators that have been found for physiotherapists using outcome measures within their clinical practice (Chapter 1).

4)   The phenomenon of neurological physiotherapy clinical practice (Chapter 1).

The rationale of using this checklist to support the evaluation of each outcome measure is to find a tool that is fit for purpose within modern neurological physiotherapy clinical practice.

Box [iii]: The critical appraisal checklist used for each outcome measurement tool

Background

- The aims and design of the instrument, the rationale behind its design, domains and items within the scale, training required, normative data, face and content validity.

Internal consistency

- The items within the scale are all necessary and correlate both with each other and with the whole scale.

Clinical utility

- Clinically useful, meaningful for both therapist and patient, focus on impairment, quick to use, help to direct a treatment plan, improve quality of treatment.

Test re-test reliability

- The scale can be used on the same patient over time, with knowledge that any changes in score are due to the patient and not the scale's unreliability.

Inter-rater reliability

- The scale can be used on the same patient by different physiotherapists, with the knowledge that any changes in score are due to the patient and not the scale's unreliability.

Construct validity

- In the classical model of validity, construct validity is one of three main types of validity evidence, alongside content validity and criterion validity. For the purposes of this review, the terms are grouped together because they are interrelated both operationally and logically.

Floor and ceiling effects

- Useable with patients who have either very good or very poor ability.

Responsiveness

- Can demonstrate treatment effectiveness.

Other relevant research specific to the scale

Summary

- The settings and applications / neurological diagnoses that it has been tested to be used in
- Overall impressions of the scale, it's strengths and weaknesses.

Results

The set of research papers related to each outcome measure were reviewed in depth using the critical appraisal checklist (Box [iii]) and the results are presented separately below.

3.5 A review of the Berg Balance Scale (BBS)

The BBS was developed in 1989 by Berg et al, as an evaluative outcome instrument to measure preparatory and reactive response to balance perturbations in elderly patients; the focus being on assessment of performance as opposed to that of impairment. The rationale behind its design was to meet a clinical need because at the time, there were no other outcome measures that could easily be used within the healthcare setting that were: easy to use, required little equipment and were able to provide a quantitative score for recording purposes. In their paper (Berg et al 1989), the authors describe the process of the scale's development; 38 patients and 32 heath care professionals were recruited to develop the content and structure, and then to test internal and external reliability.

Utilising the opinions of patients and health care professionals during the development of the BBS ensured that it had both good face and content validity. Although the authors stated that no training was needed to complete the scale; an assumption should be made that a professional health worker with knowledge related to neurological rehabilitation would be able to use the BBS, as the raters within this and all the studies discussed in this section have these pre-requisite skills.

Box [iv] (The items within the Berg Balance Scale) presents the items of the scale for clarity, and Appendix 1 (The Berg Balance Scale) the full version - including instructions.

Box [iv]: The items within the Berg Balance Scale (Berg et al 1989)

Name: … … … … … …   Date: … … … … … …

Location: … … … … … …   Rater: … … … … … …

Item description   score (0-4)

1) Sitting to standing   … … …
2) Standing unsupported   … … …
3) Sitting unsupported   … … …
4) Standing to sitting   … … …
5) Transfers   … … …
6) Standing with eyes closed   … … …
7) Standing with feet together   … … …
8) Reaching forward with outstretched arm   … … …
9) Retrieving object from floor   … … …
10) Turning to look behind   … … …
11) Turning 360 degrees   … … …
12) Placing alternate foot on stool   … … …
13) Standing with one foot in front   … … …
14) Standing on one foot   … … …

                                    Total   … … …

This 14 item scale assesses a patient's balance through direct observation of their performance, it requires 10 to 20 minutes to complete and measures the patient's ability to maintain their balance either statically or whilst performing specific movements. The items are scored from 0 to 4; a score of 0 represents an inability to complete the movement or task and a score of 4 represents independent item completion. An overall score is calculated out of 56 possible points and using it requires minimal equipment (chair, stopwatch, ruler and step), space and no specialised training.

Appendix 1 presents a summary of the available literature that has been full text reviewed, using the critical appraisal checklist framework previously described (Box [iii]). It is clear from these results that the BBS is widely used within research and within clinical practice, the measurement properties will now be critiqued in more detail.

3.5.1 Internal consistency

The BBS has been consistently found to have strong internal consistency (Berg et al 1995;Frangionini et al 2005; Steffen & Senney 2008); with Chronbach's alpha for total scores ranging from 0.83 (Berg et al 1995) to 0.95 (Franchignoni et al 2005), and individual items ranging from 0.41 to 0.64 (Berg et al 1998). This measurement property has been tested in different neurological patient populations: Stroke (Berg et al 1995; Liston & Brouwer 1996; Mao & Hsueh 2002; Conradsson et al 2007; Hiengkaew et al 2012), acquired brain injury (Farlow et al 1997), traumatic brain injury (Newstead et al 2005), adults with learning disability plus neurological impairment (Sackley et al 2005) and Parkinson's disease (Steffen & Seney 2008; Leddy et al 2011). Although these results suggest that the BBS has internal consistency when used within these patient populations; the potential for variability between the different raters in terms of their skills, knowledge and experience has not been examined, and may be a source of bias causing misleading results. Rasch analysis (La Porta et al 2012), found that if the static sitting and standing balance items (Items 3 and 2) were removed a good uni-dimensional 'fit' was found; thus firmly establishing strong internal consistency.

3.5.2 Clinical utility

With the exception of the original study (Berg et al 1989), clinical utility has not been widely examined, although evidence suggests that within clinical practice the BBS is widely used (Yoward et al 2008) so an assumption could be made that it has good utility. However, Datta et al (2009; 2012) concluded that although the BBS appeared to be clinically useful at the lower or upper end of the scale, in general, it had limited use for the incomplete spinal cord injury patient population who appeared to require an outcome measure that was more dynamic and sensitive. These findings are in some conflict with the work by Lemay and Nadeau (2010), who found strong correlations between outcome measures already validated for the incomplete spinal cord injury patient population;

suggesting that if the BBS were to be used for either physiotherapy clinical or research purposes, consideration should be made in order to meet the needs of the patient population, the therapists intervention and the researcher's methods.

3.5.3 Test re-test reliability

During and since its conception in 1989 (Berg et al 1989), the BBS has been tested repeatedly for test re-test reliability within varied populations of adults with a neurological diagnosis, that is: Stroke, acquired brain injury, traumatic brain injury, adults with learning disability plus neurological impairment and Parkinson's disease. The consistently strong results (Spearman's rho above 0.91) suggest that the BBS has excellent stability, despite the risk of biased results from small sample size (Newstead et al 2005) and ceiling effects (Mao & Hsueh 2002; Newstead et al 2005).

3.5.4 Inter-rater reliability

As with test re-test reliability, inter-rater reliability of the BBS has been extensively tested (Berg et al1995;Farlow et al 1997;Sackley et al 2005; de Figueiredo et al 2009;Leddy et al 2011) within elderly, stroke, Parkinson's disease, adults with learning disability, and acquired brain injury patient populations; and has been consistently found to be strong. Video was also used to reduce the risk of difference in scores being due to patient change as opposed to consistency in the rater (Farlow et al 1997).

Within these studies, the raters have all been described as senior and experienced, suggesting that there may be an element of knowledge required, however, de Figueiredo et al (2009) examined the inter-rater reliability of the BBS between novice and experienced physiotherapists, and no statistical differences were found. Nonetheless, in terms of 'novice' or 'experienced' skills of physiotherapists, whose baseline post graduate

ability to complete the BBS would be expected to be sound, the strong ICC found in this study should not be surprising.

3.5.5 Construct / criterion validity

In the absence of any 'gold standard' outcome measure within neurological rehabilitation, the BBS has been compared with many different outcome measures focussing on balance (Liston & Brouwer 1996), movement (Mao & Hsueh 2002), functional activities of daily living (Berg et al 1992;Feld et al 2001) and gait (Data et al 2009; Lemay & Nadeau 2010; Whitney et al 2003); in conjunction with different patient cohorts such as incomplete spinal cord injury (Lemay & Nadeau 2010), Huntington's disease (Rumpf et al 2010), multiple sclerosis (Fjeldstad et al 2009), Parkinson's disease (Qutubuddin et al 2005) and stroke (Mao & Hsueh 2002). The BBS was been found to correlate moderately to strongly within these studies, suggesting that balance is a significant component of gait, movement and function, and that the BBS is a valid instrument to use within the neurological patient populations.

3.5.6 Floor and ceiling effects

Ceiling effects have been found in studies that include patient populations who are mainly ambulant (Newstead et al 2005; Nilsagård et al 2009; Lemay & Nadeau 2010; Leddy et al 2011). However, both significant ceiling (32%) and floor (35%) effects were found by Mao & Hsueh (2012) suggesting that the patient's motor control status should be carefully considered before the BBS is used.

3.5.7 Responsiveness / Effect size / Standard Error of Measurement / Minimal Detectable Change

Because responsiveness of the BBS has been assessed and measured in several different ways, it is difficult to compare both the results of the different studies, and the responsiveness of the BBS in comparison with other outcome measures.

The results found by Wood-Dauphinee et al (1997) and Mao and Hsueh (2002)presented effect size and were in agreement (effect size ranged up to 1.11), although the results from the Mao et al group were stronger, reflecting the greater range of patient abilities. However, the results from the study by Amusat (2009) disagree, finding very low effect size for the BBS (0.22) which should nonetheless be interpreted with caution because the scale was 'capped' at item 3 (sitting) and therefore was used in a constrained non-valid manner. In an intervention study, Hackney and Earhart (2009) found a strong effect size of 0.83, which was in agreement with the Unified Parkinson's Disease Rating Scale (Goetz et al 2003) and stronger than the timed up and go (Podsiadlo & Richardson 1991) and 6 minute walk test(Wade 1992). These results suggest that effect size calculations of BBS used to measure treatment effects within the Parkinson's disease population may be reliable and are comparable to effect sizes found in larger populations such as stroke (Mao & Hsueh 2002).

The Standard Error of Measurement and Minimal Detectable Change values for the BBS have been calculated in a number of studies. Donaghue et al (2009) found a Standard Error of Measurement between '1' and '2' and a Minimal Detectable Change between '3' and '6', both values being dependent on the low, middle or high score range with high scores having less potential variability. This study used a non-neurological population so could be considered representative of normative values but is not in agreement with the non-symptomatic / pre-manifest Huntington's disease patient group in the study by

Quinn et al (2013). Studies using neurological patient groups (Stevensen 2001; Hiengkaew et al 2012; Godi et al 2013; Quinn et al 2013) are in general agreement that for the BBS, a Standard Error of Measurement value falls between '2' and '3', whereas a Minimal Detectable Change value falls between '5' and '6'.

Thus, the implications are that:-

- When measuring the effect of treatment interventions and programmes; researchers and clinicians should account not only for the potential variability in their patients, but also in the Minimal Detectable Change value range.

- Effect size, Standard Error of Measurement and Minimal Detectable Change values vary according to the patient population being tested and the intervention administered.

3.5.8 Predictive Validity

Tests of prediction have been examined using the BBS within two main areas: 1) that of destination on discharge from hospital, length of stay and functional ability on discharge, and 2) of risk of falling.

Predictive validity related to discharge from hospital

Wee et al (1999; 2003), Feld et al (2001) and Wirz et al (2010)found that a BBS score on admission was only moderately related to discharge destination and length of hospital stay, due to the bias of:

- Family support.
- Whether the person was living alone pre-morbidly.
- The necessity of waiting for placement in nursing and residential homes.

Nonetheless, admission scores of more than '28' were found to predict discharge home, around '22' predicted discharge to a residential home and around '8' predicted discharge to nursing home; so whilst only moderately strong, these values may have clinical

resonance when planning the level of care and rehabilitation facilities appropriate for this patient population.

Predictive validity of falls

Whilst it is accepted that the risk of falling is multi-factorial, i.e., it is related to reduced balance ability, weakness, vision impairment, low blood pressure, pain, environment, use of a walking aid etc. Significant work has been done in attempts to find cut-off scores of the BBS that can predict risk of falling. Bogle and Newton (1996) found participants with a BBS score of more than '45' were less likely to fall than those with a score of less than '45', but also conversely, that decreased scores did not predict an increased frequency of fall. The participants who fell most frequently were those with BBS scores between '31' and '45', maybe because: -

- A score of less than '31' would indicate either an inability to be ambulant, or a need for assistance from another person to walk; and therefore have less risk of falling.
- A score of '45' and above would indicate a higher level of balance ability and therefore less risk of falling.

Using a stroke population recruited from an acute hospital setting, Maeda et al (2009) found that the 'fallers' had lower BBS scores on admission (mean16.9; SD17.9) than 'non-fallers' (mean 40.4; SD16.2). However, the degree of variation is large, and may account for other factors (such as infection, altered blood pressure) often found within a patient acutely admitted to hospital. The difference in the BBS scores that are suggestive of prediction of falls within these two studies are different, which could be expected, because of the difference in the patient populations tested. That is; Bogle and Newton (1996) recruited a stable population, with only 17% of patients having a neurological diagnosis and who were generally more mobile, whereas Maeda et al (2009) recruited a cohort of patients who were neurologically unstable, with new, unknown difficulties with their balance, and who were in general less stable.

When recruiting people with multiple sclerosis for studies to ascertain cut off scores in the BBS to identify risk of falls for the greater multiple sclerosis population, methodological care has to be taken in order to recruit patients that are representative of the many variations of motor control, sensory and cognitive difficulties. Two groups of researchers (Cattaneo et al 2006; Nilsagård et al 2009), found that the BBS could not predict falls or reliably discriminate between fallers and non-fallers. This is likely due to the complexity and unpredictability of motor control and motor and sensory processing impairment that this patient group has, which consequently increases the number of variables causing risk of falling.

On the other hand, within a stable population such as incomplete spinal cord injury, where prediction of falling could be expected to be more reliable, Wirz et al (2010) found no correlation between falls and BBS scores. A possible reason may be that although the patients were at risk of falling, if an assumption is made that the participants were cognitively intact, it may be that they were able to 'manage' the risk of falling more successfully than a population who have pathological or traumatic brain damage.

3.5.9 Summary of the BBS

Despite the risk of insufficient methodological strength in some of the research discussed in this section; the levels of agreement between them and the number and variety of studies (Appendix 1), participants and raters all serve to strengthen and establish the internal and external reliability and validity of the BBS for use both within clinical practice and in research related to neurological patient populations (specifically: stroke, multiple sclerosis, Parkinson's disease, incomplete spinal cord injury, Huntington's disease and adults with a learning disability plus neurological impairment).

This review has discovered that within the population of people suffering from neurological damage, the BBS was found to have strong internal and external reliability; its content validity is also strong, as is its construct and criterion validity. However, the BBS may be better suited for use with patients who have acute neurological conditions to reduce the risk of ceiling effects and paradoxically in this population, care also needs to be taken to avoid floor effects, e.g. Mao & Hsueh (2002) initially tested their patients two weeks post stroke. The BBS may also be limited in use in patients with Parkinson's disease to those in the middle stages because of the ceiling effects found in less disabled patients and floor effects found in more disabled patients (Leddy et al 2011).

It has been suggested that the BBS has only a low to moderate ability to predict falls in medically stable populations and a poor ability in unstable populations; probably due to the multi factorial component of falls risk.

The effect size, Standard Error of Measurement and Minimal Detectable Change of the BBS has also been shown to be comparable or better than other similar outcome measures. Interestingly, the agreement between patient and clinician judgement of ability to balance with the BBS is only moderate (Berg et al 1992) suggesting that the BBS may have elements of low clinical utility.

Nonetheless, despite the overall established strengths of the BBS, it has not been designed to measure the quality of patient's movement, and it is not clinically useful for patients who require physiotherapy intervention and are either very disabled (low floor), or have small levels of impairment (high ceiling).

3.6 A review of the Trunk Impairment Scale (TIS)

There are two outcome measures called the 'Trunk Impairment Scale', both developed in 2004: 1) by Verheyden et al (2004) and 2) by Fujiwara et al (2004). The latter was rejected during the inclusion and exclusion criteria review of full text within this current review of the literature, because it has been validated for stroke only. The former has been included for further in-depth discussion because it has been validated within the stroke, traumatic brain injury, multiple sclerosis and Parkinson's disease patient populations.

The TIS was developed and published by Verheyden et al (2004), in response to a clinical need; at that time there were no outcome measures that could capture the 'observation' of impaired trunk activity. The authors intended that the TIS would be able to monitor clinical progress, predict treatment outcome and measure the effect of intervention. There are three subscales within the TIS: 1) static sitting balance, 2) dynamic sitting balance and 3) co-ordination. Each subscale contains between three and ten items, and the TIS total score ranges from a minimum of 0 to a maximum of 23. Within each subscale, items are designed to test the ability of the trunk to maintain stability and to describe the presence of specific compensatory strategies. The full data sheet including test instructions and score criteria are available in Appendix 2

Appendix 2 presents a summary of the available literature that has been full text reviewed using the critical appraisal checklist framework previously described (Box [iii]).No information is available regarding the process of development of the TIS, i.e. how it was developed and by whom, although there are strong similarities and author link to the work by Nieuwboer et al (1996) where the initial development of a scale that was intended to measure the quality of trunk movement was presented. Qualitative methods of interview and patient observation were used to develop a 12 item scale that, on face value, was intended to test: postural adjustments during volitional movement,

the quality of posture, and the ability to perform selective movements of the trunk. This scale was found to have moderate inter-rater reliability for all items pertaining to the ability to balance or not, but poor reliability for items that attempted to measure quality of movement. The authors (Nieuwboer et al 1996) suggested that one of the reasons for poor reliability may have been due to the difference in experience of the raters. An assumption could be made that this scale was developed into the TIS but this is neither clearly stated nor claimed.

Training needs of personnel aiming to complete the TIS are not presented, but in the source paper (Verheyden et al 2004) raters were physiotherapists and the language within the scale is technical suggesting that physiotherapists may be qualified to complete it.

Since 2004, further work has been published concerning: internal consistency, test re-test reliability, inter-rater reliability, construct validity, predictive validity, floor and ceiling effects and the standard error of measurement. A small amount of research that establishes the correlation between recovery of the components of movement post stroke (Verheyden et al 2008), lung function post stroke (Jandt et al 2011), and testing the effects of a specific physiotherapy intervention (Verheyden et al 2009) have also been published.

3.6.1 Internal consistency

Using Cronbach alpha coefficients, Verheyden et al (2004) found internal consistency to range from inadequate to excellent(0.65 to 0.89). Rasch analysis (Bond & Fox 2001) has also been used to test the internal validity of the TIS (Verheydenk & Kersten 2010), finding that the 'static sitting balance' sub-section of the TIS should be removed because it demonstrated large ceiling effects, and that both the dynamic sitting balance and

coordination sub-scales adequately fitted the Rasch model. The authors suggest that ceiling effects may have been reached because the majority of patients were three weeks or more post stroke, and once the 'static sitting balance' sub-scale was removed, the authors presented version 2.0 of the TIS. No other research has been published related to the TIS 2.0; therefore this critique will focus on the original version.

3.6.2 Test re-test reliability

Within their original paper, Verheyden et al (2004) found test re-test reliability to be strong (ICC=0.96). These results are supported in further research by the same authors within different patient diagnostic populations (Verheyden et al 2006b; Verheyden et al 2006c), including a Bland-Altman plot for test re-test agreement, which demonstrates TIS values falling between 2 Standard Deviations of the mean across the range of the scale. These results firmly demonstrate that the TIS has strong test re-test reliability when used with stroke, multiple sclerosis and Parkinson's disease patient populations.

3.6.3 Inter-rater reliability

Strong inter-rater reliability has been established, with ICC's of above 0.93 (Verheyden et al 2004; Verheyden et al 2006b; Verheyden et al 2006c); the patient populations also varied, to include stroke, multiple sclerosis and traumatic brain injury.

3.6.4 Construct / criterion validity

In the absence of any 'gold standard' outcome measure within neurological rehabilitation, the TIS has been compared with several different outcome measures focussing on balance (Verheyden et al 2006a), movement (Verheyden et al 2006b), functional activities of daily living (Verheyden et al 2004; Verheyden et al 2006c) and gait (Verheyden et al 2006a); in conjunction with different patient cohorts such as:

multiple sclerosis (Verheyden et al 2006b), Parkinson's disease (Verheyden et al 2007b), traumatic brain injury (Verheyden et al 2006c) and stroke (Verheyden et al 2004; Verheyden et al 2007a; di Monaco et al 2010). The TIS was been found to correlate moderately to strongly with other outcome measures used within these studies, suggesting that trunk control is a significant component of gait, movement and function, and that the TIS is a robust tool with which to measure it.

3.6.5 Predictive Validity

Three research studies have been published (Verheyden et al 2007a; Verheyden et al 2008; Di Monaco et al 2010), which strongly suggest that trunk activity measured by the TIS shortly after an acute stroke attack, is a prediction of functional outcome on discharge home and after six months as assessed by the Functional Independence Measure (Keith et al 1987).

3.6.6 Floor and ceiling effects

Although floor and ceiling effects within the TIS have not been formally examined, in one of their studies Verheyden et al (2006a) stated that the TIS had no ceiling effect, however the study by Verheyden et al (2005) showed that 45% of neurologically unimpaired adults could not achieve full scores so this is not surprising. Interestingly, in their Rasch study Verheyden and Kersten (2010) discarded the 'static sitting balance' sub-scale of the TIS because ceiling effects within this item made analysis impossible; although this could have been a reflection of the ability of the patients that were recruited.

3.6.7 Responsiveness

The sensitivity of the TIS in relation to effect size and Minimal Detectable Change values have not been published, however, the results found by Verheyden et al (2006b) indicate that the Standard Error of Measurement for total TIS scores of people with multiple sclerosis (1.23 for inter-rater reliability and 1.58 for test-retest reliability) are comparable to other outcome measures such as the BBS (Stevenson 2001). It is difficult to establish a reliable understanding of responsiveness for the TIS because there have been relatively few studies published; and as previously discussed, effect size, Standard Error of Measurement and Minimal Detectable Change values vary according to the patient population being tested and the intervention administered.

3.6.8 A summary of the TIS

Although on face value the TIS appears to have been vigorously tested; face and content validity, and clinical utility have not been established, and the small variability in publishing authors (three groups) would suggest that the TIS is not widely used either in research or clinical practice. Despite these issues, Van Veppen et al (2007), based on the consensual opinion of clinicians, advise that the TIS should be used as a 'specific optional' outcome measure within stroke rehabilitation.

3.7 A review of Goal Attainment Scaling (GAS)

Goal Attainment Scaling (GAS) was originally developed in response to clinical demand within the psychology field (Kiresuk& Sherman 1968), because at the time, there was a tendency to use a fixed battery of outcome measures regardless of each individual's characteristics or problems. Clinicians (psychologists) argued that the use of these batteries did not represent their therapy aims or interventions, thus, GAS was conceived.

However, at the time, despite this face validity; content validity was not established as there is no information related to how GAS was developed or by whom.

GAS was originally designed to be sensitive to change found in patients as a response to psychological intervention, to enable comparison of treatment interventions within a group, and to be able to evaluate psychological rehabilitation programs. The process of setting appropriate goals and scaling them occurred in a two part process:

Firstly:

- A realistic set of mental health goals were set by a committee.
- A scale for each goal was composed of a graded series of likely treatment outcomes.
- These likely treatment outcomes were given points and assigned numerical values:- -2, -1, 0, +1, +2 (a minimum of 2 are needed), where:
  - -2 is considered to be baseline.
  - 0 is considered to be the most likely outcome.
  - +1 and +2 are considered to reflect 'better than expected' outcomes.
- 'Weights' could be set for goals of higher importance.

Secondly:

- The patient was assigned to a treatment therapist (psychologist).
- The patient was re-assessed by the committee after a pre-determined intervention interval.
- The standardised composite goal attainment score was calculated (see Figure [iv]).

$$T = 50 + \frac{10\Sigma(w_i x_i)}{\sqrt{[1-r\Sigma W i^2 + r(\Sigma Wi)^2]}}$$

Figure [iv]: GAS calculation (Doig et al 2010)

It should be noted that this complex GAS calculation is facilitated and freely accessible alongside practical guidance via the Kings College London website (GAS n.d.).

At the time of the conception of GAS (Kiresuk & Sherman 1968), there were potential issues regarding: 1) possible bias of the person or committee who selected the patient's goals, 2) the goals were not chosen by the patient, 3) a suggestion by the authors that GAS goals shouldn't even be known to the therapist, and 4) in its original format GAS was considered to be individualised but not patient focussed. Since its creation, GAS has subsequently been used in partnership between patients and their therapists in a number of areas relating to rehabilitation. These include: cognitive (Jones et al 2006; Bouwens et al 2009), elderly care (Stolee et al 1999; Gordon et al 1999), neurological (Joyce et al 1994; Reid & Chesson 1998; Ponsford et al 1999; Turner-Stokes 2009) and amputee rehabilitation (Rushton & Miller 2002). Within the field of paediatric rehabilitation, several papers have been published which evaluate measurement properties of GAS (e.g. Steenbeek et al 2005; 2007; 2010). However, this review will focus on the change of use of GAS within modern adult neurological physiotherapy rehabilitation.

Appendix 3 presents a summary of the available literature that has been full text reviewed using the critical appraisal checklist framework previously described (Box [iii]). During the analysis of the available literature pertaining to GAS, there was found to have been no studies that discuss training requirements prior to use, however, Khan et al (2008) comment on the training needed to use GAS; not in actually applying the scale to the patient, but having the clinical skill and experience to be able to prognose or predict outcome following intervention.

Although no formal examination of content validity have been undertaken, the study by Joyce et al (1994) initiates its establishment, by comparing the goals set by and with the patients, with the then current literature.

3.7.1 Internal consistency

No studies have formally investigated internal consistency, although Tennant (2007) published the results of a comprehensive Rasch analysis, and suggested that GAS did not meet the basic mathematical requirements across the range of scores, and the risk of either under or over misinterpretation was present across the spectrum. He advised that although the development of an 'item bank' of potential GAS items would be challenging to create, the result could satisfy sound mathematical principals, enabling cross patient and group comparisons; and therefore allowing sound scientific measurement within research trials of intervention.

3.7.2 Clinical utility

Several studies and literature reviews have discussed and reflected on the strong clinical utility of GAS (Joyce et al 1994; Reid & Chesson 1998; Khan et al 2008; Turner Stokes et al 2010; Stevens et al 2013). Within the neurological rehabilitation literature, the consistent and overwhelmingly strong opinion is that although GAS has been found to be complex to calculate, difficult and time consuming to use (especially for patients with cognitive difficulties), it also:

- Can facilitate patient focussed goal-setting.
- Is a feasible and practical method to evaluate outcomes following rehabilitation intervention.
- Encourages communication and collaboration between multidisciplinary team members and patients.

Turner-Stokes and Williams (2010) attempted to address the complexity of the rating method, by examining alternate methods, such as introducing half scores to reflect partial achievement of a goal. They found significant impact on the calculation method, with score outcomes being underestimated, but no evidence was provided to demonstrate improved reliability or validity.

3.7.3 Test re-test reliability

No studies were found within the available literature related to the testing of test re-test reliability within the population of adults with neurological motor control disability.

3.7.4 Inter-rater reliability

Two papers have been published reporting inter-rater reliability of the GAS (Joyce et al 1994; Bovend'Eerdt et al 2011). Joyce et al, using different members of the rehabilitation team to rate the patients, found strong inter-rater reliability (ICC = 0.92 on admission and 0.94 on discharge). However, Bovend'Eerdt et al, using a second rater blinded to the patient, found only adequate results (ICC 0.48) suggesting that scoring a patient using GAS should be done by a rater who is familiar with the patients movement control difficulties. These results are in agreement with the study by Steenbeek et al (2010), and although the study investigates the inter rater reliability of the GAS within the cerebral palsy paediatric population, reliability was shown to be strong (r=0.82) when used by therapists familiar with the child's treatment and progress, but less so when measured by independent raters unfamiliar with the child (r=0.64).

The results of these three studies suggest that for maximum inter-rater reliability, GAS requires the collaborative involvement of both the patient and their treating team, and that exclusion of one of these elements does not deliver the same strength.

3.7.5 Construct / criterion validity

In the absence of any 'gold standard' outcome measure within neurological rehabilitation, GAS has been compared with many different outcome measures focussing on movement (Khan et al 2008; Turner-Stokes et al 2009), functional activities of daily living (Joyce et al 1994;Ashford & Turner-Stokes 2006; Turner-Stokes et al 2009), spasticity (Turner-Stokes et al 2010) and clinical judgement (Joyce et al 1994;Khan et al 2008); in conjunction with different patient cohorts such as traumatic brain injury (Joyce et al 1994), acquired brain injury (Ashford & Turner-Stokes 2006), multiple sclerosis (Khan et al 2008) and complex neurological disability (Turner-Stokes & Williams 2010). GAS was been found to correlate moderately to strongly with outcome measures that reflected patient or clinician judgement; e.g. the Clinical Global Impression scale (Busner & Targum 2007), but weakly against outcome measures that measure function (Turner-Stokes et al 2009). Testing the validity of GAS is likely to be difficult because of its individual application to patients, therefore it should be expected that GAS scores will correlate weakly or moderately with the more 'standard' outcome measures such as the Barthel Index (Wade 1992) or the Functional Independence Measure (Keith et al 1987); interestingly GAS correlates strongly with clinician global impressions.

3.7.6 Predictive Validity

Predictive validity of response to intervention has been demonstrated by Ashford and Turner-Stokes (2006). However, as Khan (2008) suggests, although specific training is not required prior to using GAS, clinical skill and experience to be able to prognose or predict outcome following intervention is necessary. Therefore it should be expected that a study that investigates the ability of GAS to predict outcome has strong results.

3.7.7 Floor and ceiling effects

No studies have been found within the available literature that have tested or commented on floor and ceiling effects within GAS, this is probably due to the fact that individualised goals are agreed with the patient therefore restricting this phenomenon.

3.7.8 Responsiveness

Effect size, using Cohen's d statistic, has been used in two studies (Khan et al 2008; Turner-Stokes et al 2009), both of which found GAS more responsive than the Barthel Index (Wade 1992) or the Functional Independence Measure (Keith et al 1987). Turner-Stokes et al (2010) found strong agreement between GAS with measures of clinician and patient perceived benefit of intervention (r= 0.46 and 0.41 respectively) and although when they were correlated against the Modified Ashworth Scale (Bohannon & Smith 1987) they were good (r=0.35), but as time progressed, GAS scores continued to improve whereas the Modified Ashworth Scale scores remained constant, suggesting that GAS was more sensitive to change. It is difficult to establish a reliable understanding of responsiveness for GAS because there have been relatively few studies published; and as previously discussed, effect size values vary according to the patient population being tested and the intervention administered.

3.7.9 A summary of GAS

Turner-Stokes (2009) captured the essence of the difference of using GAS in comparison to other standardised outcome measures, when she wrote:

"This approach is conceptually different from standardized measures. If interval measures may be described as measuring with 'a straight ruler', and ordinal measures as 'a piece of string', then this method is the equivalent of measuring with a set of elastic bands!" (Turner-Stokes 2009, p368)

However, in agreement with Tennant (2007) she concludes with the suggestion that mapping of goals onto the WHO-ICF framework could give added value, validity and reliability. No research has yet been published that examines this technique.

There appear to be clear strengths, limitations and cautions to using GAS. The literature agrees that GAS takes goal setting and achievement a step further, because it allows a 'calibration' of 'degree of success', recognising partial achievement, it also allows a baseline measurement which is then able to be compared to the patients post intervention measurement. However, using GAS successfully depends on two key facts: the patient has to have the potential and ability to change and the clinician has to have the experience and skill to be able to accurately predict the change; hence limiting its use. It is also open to bias, because clinicians both set the goals and 'rate' the outcomes; therefore caution should be applied when using it.

GAS has been found to have strong clinical utility, face and content validity, and to be very useful within the patient focussed intra-disciplinary rehabilitation team approach (Ertzgaard et al 2011). Nonetheless, there are clear difficulties when using GAS within intervention studies, because any scales that are used within research of clinical practice should be supported by psychometric evidence to demonstrate appropriate measurement properties such as reliability and validity. Although, as Turner-Stokes et al (2010) suggest, it can be used as a secondary outcome measure to describe the more qualitative aspects of treatment effects. GAS falls into the category of individualised, as

opposed to standardised scales in that the patient and/or therapist devise the item content. Using scales that are scientifically standardised and tested is important because of the risk of misinterpretation of change scores i.e. patients may be judged as having failed to reach a clinically significant change, when in reality they have, and vice versa (Tennant 2007).

Patient focussed outcomes such as GAS are important, and are attractive to both patients, because they can determine their own outcomes, and professionals, because the GAS can be a useful clinical management tool. Goals can be made to be very specific for particular interventions, for example, a patient with multiple sclerosis may have a goal to become functionally independent when using the lavatory. In this instance, the very specific physiotherapy goals could be to improve: 1) pelvic stability during sit to stand, and / or 2) foot interaction with the floor for balance, and / or 3) selective scapular stability on the thorax for hand function. However, GAS cannot measure or record these very specific physiotherapy interventions; i.e. it does not have the capacity to measure the quality of pelvic stability, foot interaction or scapula stability on the thorax.

Nonetheless, GAS has strong clinical resonance, and it appears to be widely used (Yoward et al 2008) but there are very few research papers that can be directly related to neurological physiotherapy intervention. Even so, within their clinical practice, therapists providing the intervention, who are familiar with the patient's actual abilities can score reliably; but, independent assessors cannot have that advantage, indicative of weak inter-rater reliability.

In conclusion, GAS in its original format (Kiresuk & Sherman 1968) was intended for both patient and programme evaluation, however the strength of its use within the

neurological rehabilitation clinical setting has been clearly demonstrated in the literature and despite questions regarding its reliability and validity, the sustained use of GAS is a testimony to its clinical resonance (Yoward et al 2008). However, although GAS can be used and focussed at the individual patient's goals during therapy, and reflects to some extent the way neurological physiotherapists work; especially within an inter-disciplinary team in terms of goal setting and prognosis of potential for change as a result of intervention. GAS does not reflect quality of movement, neither does it focus within the impairment domain of the WHO-ICF, understandably so because it was adapted to elucidate individual patient functional rehabilitation goals.

3.8 A summary of the review of the BBS, the TIS and GAS

The BBS is an extensively researched outcome measure and has well established measurement properties; its clinical utility is also sound and is used widely within both clinical practice and research. However it does not consider movement quality and cannot be used to assess impairments of movement that occur after damage to motor control caused by neurological pathology.

In comparison to the BBS, although its measurement properties have been studied, the TIS appears to be a less well used outcome measure both in clinical practice and research. However during development whilst there was an attempt to identify and measure components of trunk impairment and movement quality, the depth with which this was achieved does not meet the clinical demand of neurological physiotherapists.

GAS has been clearly shown to be a clinically useful measurement tool that encourages patient and intra-disciplinary team collaboration towards the achievement of individualised goals. However GAS can really only be used as a secondary instrument

because of its weak measurement properties, and no specific recognition is made in relation to quality of movement.

In conclusion, functional outcome measures enable the physiotherapist to assess performance of activities of daily living at the activity level, and quantify whether a task is performed within the constraints specified by the test (e.g., BBS, TIS), within these outcome measures though, no attention is paid to how well the movement is performed. Thus, the problem encountered by neurological physiotherapists when attempting to assess both their patient's 'base line', and the efficacy of their treatment intervention is the lack of tools sensitive to the movement parameters they specifically want to change. Therefore, there is often little choice but to use qualitative assessment (i.e. written description within clinical records) to describe movement impairment and improvement, making it difficult to transfer information reliably between therapists.

3.9 Conclusion

With the exceptions of Levin et al (2004) and Horak et al (2009), there are no impairment scales that are based on movement analysis and that can also reflect the complex components of movement that are required to achieve a task. This means that within the available literature, it has been difficult to relate quality of movement to function. On the other hand, the lack of a clear relationship between quality and function is partly due to the lack of appropriate outcome measures. For several reasons, it would be useful for neurological physiotherapists to have a scale that measures the quality of movement performance specific to a task and which can also reflect the patients impairments, or elements of the task that are missing:

- To measure the patient at 'baseline' assessment.
- To enable the identification of missing elements of a task or movement.

- To track recovery.

- To provide evidence that normal movement can recover.

Several authors have published evidence to suggest that scientific and empirical knowledge are progressing towards achieving this goal (Tyson and Desouza 2003; Levin et al 2004; Tyson & Connell 2009).

Using focus group methodology to investigate how 27 experienced neurological physiotherapists assessed posture and balance in people who had suffered a stroke, Tyson and DeSouza (2003) found that the therapists asked themselves three key questions 1) what can the patient do?, 2) how do they do it?, and 3) why do they do it in that particular way? The authors developed a clinical model that used observation (alignment and movement of body segments) and palpation (of muscle activity), with the intention of informing a new outcome measure; this has not been published.

Levin et al (2004) describe the development of a scale (The Reaching Performance Scale) that attempts to meet this need. Underpinned by previous research completed by the group (Cirstea & Levin 2000; Michaelsen et al 2001; Levin et al 2002), consensus group methods using experienced neurological physiotherapists and occupational therapists; defined scale items to assess forward reach in a hemiparetic upper limb. Components of the outcome measure included: smooth or fluid movement, appropriate direction, appropriate alignment of trunk and shoulder, and it was focused on the degree of compensation at trunk, shoulder and elbow. The therapist was asked to visually decompose 'reaching' into the elements of movement, that is, trunk displacement, movement smoothness, shoulder displacement, elbow displacement, and quality of prehension. Initial tests of measurement properties found that good intra rater and inter rater reliability were likely to be dependent on the skill of the rater's visual analysis of movement, and more work was planned to refine the scale. This has not been published.

In 2009, Tyson and Connell (2009) published a systematic review aiming to identify outcome measures that were 1) psychometrically robust and 2) clinically feasible to measure balance within the neurological patient population. Whilst 19 outcome measures met their criteria, including the TIS and the BBS, the authors concluded that future outcome measure development should consider scale sensitivity and the underpinning theoretical construct of neurological physiotherapy.

Clearly, the contents of existing scales that purport to measure a patient's movement that is impaired as a result of neurological pathology; do not sufficiently reflect clinical practice, or provide enough detail to meet the requirements relevant to neurological physiotherapists.

Therefore, this study will attempt to meet these demands of measurement within modern neurological clinical practice. An instrument will be developed to measure movement quality according to the clinical needs of neurological physiotherapists and their patients: the Leeds Movement Performance Index (LMPI). The reliability, validity and clinical utility of the LMPI will then be established in a multi-centre, mixed methods study.

Chapter four: Research design and methods

4.1 Introduction

This chapter presents the research design, methods and methodology adopted in order to address the following research questions:

1. Can a tool be developed that is able to measure movement quality according to the needs of neurological physiotherapists?

2. Is the newly developed tool reliable, valid and functional within modern neurological physiotherapy clinical practice?

Epistemological and ontological issues that are focussed within the context of neurological physiotherapy as a profession will be discussed, in conjunction with the knowledge generated and utilised within this research. A multi-centre mixed methods research design will be described, along with the different styles of analysis that will be used to interpret the results.

4.2 The Epistemological and Ontological framework supporting this thesis

Crotty (1998) describes 'ontology' as the study of being, and 'epistemology' as the study of knowledge. These philosophical concepts are embedded within this research, directing both the conception and then the investigation of the measurement properties and clinical utility of the newly developed measurement tool; the Leeds Movement Performance Index (LMPI) (Ross et al 2014).In order to answer the research questions and meet the aims of this research study, a mixed methods approach was used (Johnson & Onwuegbuzie 2004; Creswell & Piano-Clark 2011; Shaw et al 2010) as a pragmatic

style, that is able to utilise the phenomenon, culture and epistemology of the Physiotherapy profession. Three studies will be utilised in a sequential manner exploiting the strengths of both qualitative and quantitative methods. The use of different methodology is expected to achieve triangulation (O'Cathain 2010), gaining reliable, valid, rich and informative answers.

Higgs and Titchen (1995) present a model (Figure [v]) that consolidates and applies epistemological and ontological perception, neatly into both neurological physiotherapy clinical practice and this research design.

Propositional knowledge
Discursive knowledge
Research knowledge
Declarative knowledge

Insights
Abstract
conceptualisations
Theoretical knowledge
Empirical knowledge

Theoretical knowledge
Empirical knowledge

Influences
Existing knowledge base
Frames of philosophy
Values
Beliefs

**Personal
Knowledge**
Affective, cognitive,
spiritual & aesthetic
awareness
Interpersonal knowledge
Knowledge of being

Intuitive knowledge
Tacit knowledge
Experiential knowledge
Ethical knowledge

**Professional craft
knowledge**
Practical knowledge
Procedural knowledge
Theory-in-use

Figure [v]: Types of knowledge and internal influences on knowledge generation (Higgs & Titchen 1995 p526)

Personal knowledge

This is very individual and pertains to the clinician's professional and life experience; it includes values, spirituality, perception and self-understanding. Reflexivity and 'knowing' oneself is critical in this area of knowledge. This type of knowledge is developed during the physiotherapist's career pathway, and is influenced by: -

- Interaction with colleagues within the profession and with other members of the inter-disciplinary team, with patients and with their families.
- Personal development during life experiences with family, friends and other life contacts.
- Developing spirituality and values within the context of lives both at home and at work.

Professional craft knowledge

This type of knowledge describes the practical neurological physiotherapy expertise and skills which are built up over time, that guide day to day clinical practice. The 'knowledge' is reported and reflected upon within patient's physiotherapy clinical records; Higgs and Titchen (1995) describe it as 'tacit' and 'intuitive', used in partnership with analytical clinical reasoning; they state that:

"The depth of clinical judgement demonstrated by an expert clinician is, we argue, born of a wealth of personal experience of clinical practice in combination with a processing of prior learning". (P 527)

Propositional knowledge

This type of knowledge is developed and publicised academically; having a solid base of science and theory, in contrast with both professional craft knowledge and personal knowledge, which are developed with experience, primarily in clinical practice.

All three types of knowledge are amalgamated within a neurological physiotherapist, being implicitly part of each individual therapist's 'lived' professional and personal life experiences.

The history of the development of the culture within the Physiotherapy profession combined with expectations from both patients and inter-disciplinary colleagues have ensured that professional craft knowledge and personal knowledge have a well-established and strong foundation in comparison with propositional knowledge. As a group of people who are educated to degree level (with strong depths of personal knowledge), once qualified, very few neurological physiotherapists specialise within the research arena to gain propositional knowledge; and it could be reasonably argued that once they do, they lose professional craft knowledge (Murray et al 2014). Conversely, Higgs and Titchen (1995) support the notion that society is 'unreasonably dominated' by academic knowledge and that other forms of knowledge are considered less important, they propose that in reality there should be a balance between the clinical and academic settings, with each extreme feeding and supporting the other.

Within this research, the knowledge of three groups of physiotherapists was utilised, namely; a Physiotherapy Research Group, a Senior Physiotherapist Participant Group and an Expert Physiotherapist Group. The geographical locations of these groups are presented in Figure [vi].

4.3 The Physiotherapy Research Group

This is a group of senior neurological physiotherapists, employed by a large teaching hospital in Yorkshire (Leeds Teaching Hospital NHS Trust: Centre 1). Within the group:

- Members have knowledge and skills representative of the major clinical specialist areas within neurological physiotherapy (neuro-surgery, acute neurology, stroke

rehabilitation, acute stroke unit, neurological out-patients, neurological rehabilitation, multiple sclerosis and neuro-oncology).

- As well as being 'senior' within the clinical field, the group also manage clinical physiotherapy teams, deliver treatment interventions to patients and provide in-service and 'on the job' education for more junior physiotherapists and physiotherapy students.

- Number of years post graduate experience ranges from 16 year to 49 years with an average of 25 years and a total of 222 years.

- All members have completed a three week Bobath course, 6 members (60%) have completed one or more advanced courses, one member recently retired as a Bobath tutor

- Throughout this research project, the group also provided on-going clinically related guidance, expertise and support to the researcher.

4.4 The Senior Physiotherapist Participants Group

This group of senior neurological physiotherapists were recruited from three other participating organisations (Centres 2, 3 and 4) within Yorkshire (Leeds Community Health Care Trust, Airedale NHS Foundation Trust and Mid Yorkshire NHS Foundation Trust). Group members worked in a variety of clinical areas: acute stroke, stroke rehabilitation, neurological rehabilitation, community stroke team, community neurological rehabilitation team, community brain injury team and neurological out-patients. This group of physiotherapists used the LMPI in Study 2: Phases 2 and 3 and then reflected on these experiences in Study 3: Phase 2.

4.5 The Expert Physiotherapists Group

This group of physiotherapists are widely considered to be national and international experts within neurological physiotherapy. They are all members of a non-NHS

organisation; The British Bobath Tutors Association (BBTA) (BBTA 2014), and although work clinically within the NHS, higher education and the private sector; are also in demand to organise and teach on internationally respected and demanded clinically focused courses specifically for specialist neurological physiotherapists and occupational therapists. This group's headquarters are in Yorkshire (Centre 5) and they agreed to participate within Study 3: Phase 1; using the LMPI within their clinical practice then discussing the experience within two Focus Groups.

An epistemological and ontological balance is thus created in this research design, by encompassing the strengths of all three knowledge bases, i.e.: -

- The use of an academic framework supported by relevant published research.
- The use of senior neurological physiotherapist's individual perceptions, clinical experience and knowledge.
- The judgements and opinions of acknowledged clinical experts.
- The support and challenge achieved by rigorous academic supervision.

4.6 The research design used within this thesis

In order to answer the research questions stated above, this study adopted a multi-centre, three-part, mixed-methods design. Using both qualitative and quantitative methods allowed the specifics of both measurement properties and clinical utility to be investigated. Multiple research centres were also used in-order to maximise the generalisability of the results (Figure [vi]). Because of the nature of mixed methods research, this study's design is complex and inter-related over time. Figures [vii] and [viii] present a clear overview of the research process.

The methods used for creating a new outcome measure (Study 1) were guided by Johnson et al (2011) (Table [i]), using the qualitative techniques of consensus group and

Delphi rounds with members of the Physiotherapy Research Group. In Study 2, quantitative psychometric tests were used to examine the measurement properties of the new outcome measure using the Senior Physiotherapist Participants group and patient participants who have neurological diagnoses. The psychometric tests used, were guided by a significant amount of research (Andresen 2000; Bland & Altman 2010, 2002; de-Vet et al 2006; Evans et al 1996; Fitzpatrick et al 1998; Goreki et al 2013; Horner & Larmer 2006; Johnson et al 2011; Kazis et al 1989; Landis & Koch 1977; Messick 1995; Rehabilitation Measures Database 2010; Wade 2004.) previously described in table [ii]. Further examination of face and content validity with clinical utility will be investigated in Study 3 using qualitative methods and participation from both the Senior Physiotherapist Participants Group and the Expert Physiotherapists Group.
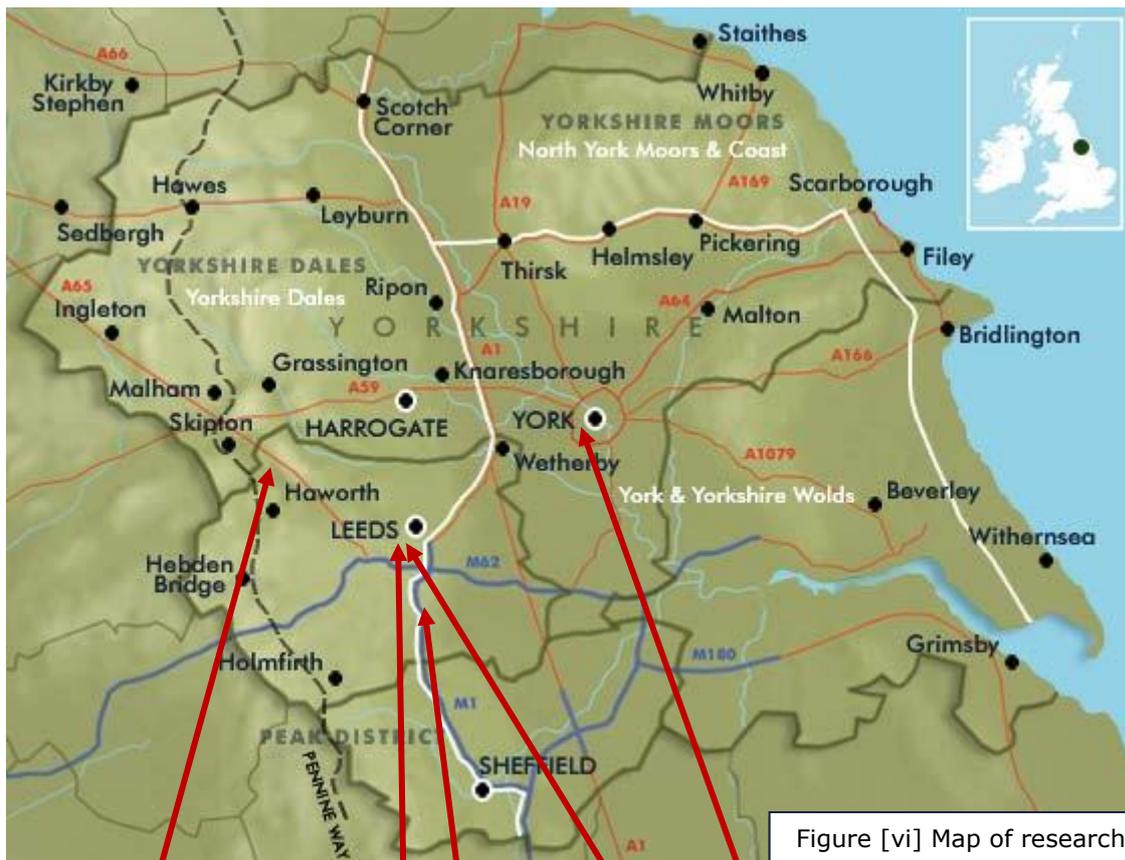
Figure [vi] Map of research centres

Centre 4:
Airedale NHS Foundation Trust

Centre 5:
British Bobath Tutors Association Headquarters, York

Centre 1:
Leeds Teaching Hospitals NHS Trust

Centre 2:
Leeds Community Health Care Trust

Centre 3:
Mid Yorkshire Hospitals NHS Foundation Trust

99
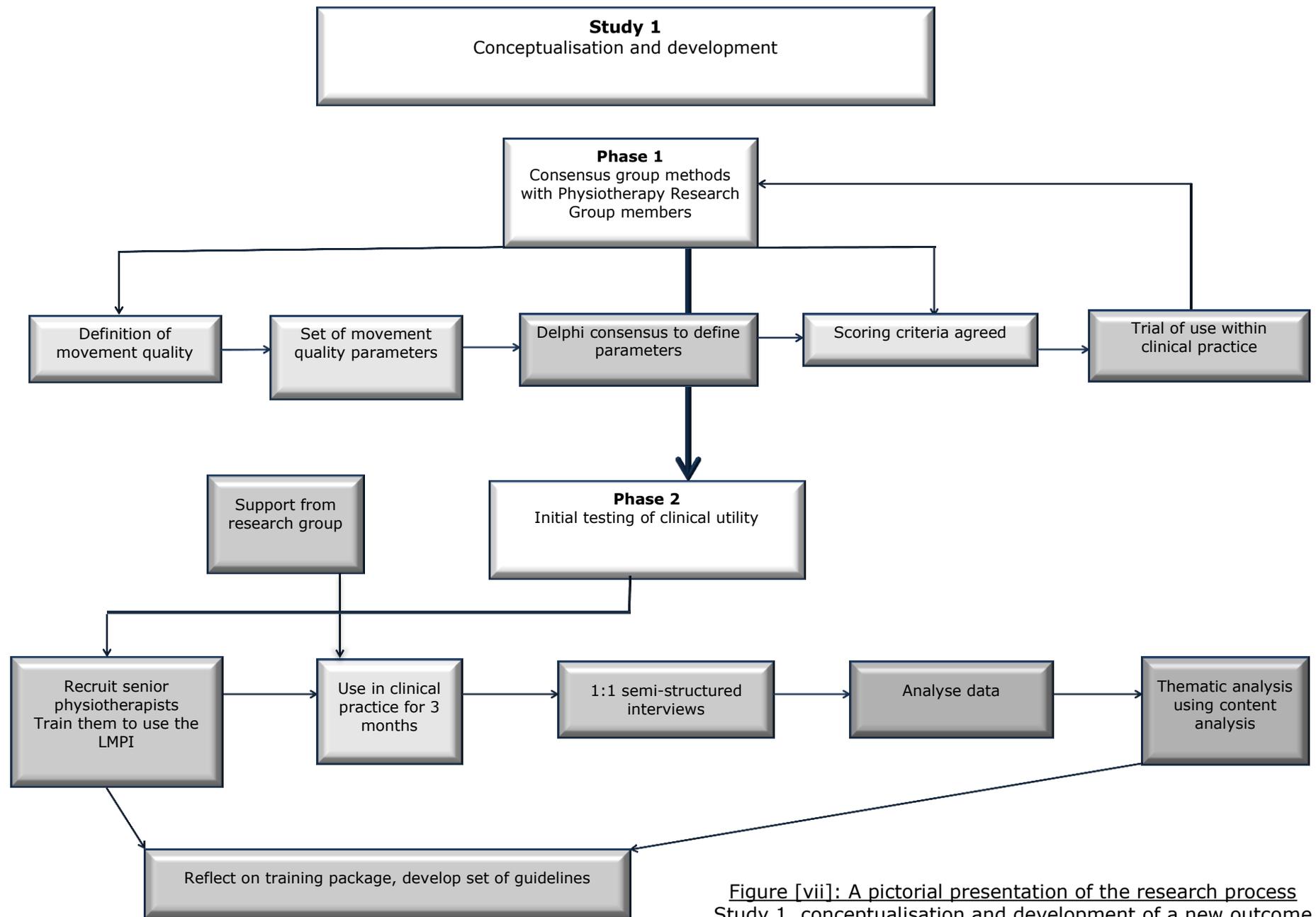
Figure [vii]: A pictorial presentation of the research process Study 1, conceptualisation and development of a new outcome measure

Study 2 Measurement properties

Phase 1 Preparation of research tools

Phase 2 Test measurement properties internal & external reliability, measurement error, content validity

Phase 3 Test criterion validity& responsiveness

Recruit patients from centre 1

Take video recordings

Design training package & teaching materials

Recruit senior neurological physiotherapists from centres 2, 3 & 4 (Senior Physiotherapists Group)

1. Train physiotherapists
2. Test LMPI
3. Gather data

Recruit patients from centres 2, 3 & 4

Analyse data SPSS

Measure pre & post treatment intervention with LMPI and BBS Gather data

Examination of the combined results from study 1 and 2

Rich note taking by researcher

Build questions for Focus Groups

Transcribe verbatim

Cross case Template Analysis

Study 3 Clinical utility

Phase 1(centre 5) Clinical utilisation & Focus Groups, (Expert Physiotherapists Group) Gather data

Emergent themes

Build structure to support reflective writing

Phase 2 Clinical utilisation & reflective writing, (Senior Physiotherapists Group) Gather data

Figure [viii]: A pictorial presentation of the research process Studies 2 and 3, testing measurement properties & clinical utility

101

4.7 The ethical considerations for this research and its participants

Ethical issues were addressed in line with the International Conference on Harmonisation Good Clinical Practice guidelines (ICH-GCP 2000) (Appendix 4). Although these guidelines have been developed for clinical trials, the principles should be applied to all research studies.

4.7.1 NHS patient participants

The patient participant group consisted of people who had a neurological diagnosis (e.g. stroke, traumatic brain injury, multiple sclerosis). These people were potentially vulnerable (because they had difficulty in moving, and because they were receiving physiotherapy treatment from the person recruiting them into the study) and could have had cognitive, communication and/or emotional problems as a result of their neurological damage. To address this issue both patients and their spouses or carers were given verbal and written study information to enable informed consent. There are special considerations regarding the recruitment and gaining of informed consent from adults who do not have capacity. That is, in the clinical population, patients may have decreased conscious levels or have cognitive impairment as a result of their neurological condition. It is possible to assess the measurement properties and clinical utility of the LMPI using patients who did not have capacity to consent, since the instrument testing requires clinical observation which could be undertaken irrespective of cognitive function. However, using guidance from the International Conference on Harmonisation Good Clinical Practice guidelines (ICH-GCP 2000), this study did not recruit patients who did not have, or who were perceived not to have capacity to consent to participate in this research (as decided by their physiotherapist).

The patient's physiotherapy treatment was not be affected by this study; however information regarding their movement, diagnosis, age and gender were recorded. Anonymity was ensured by the removal of personal information from data collected, and this was made clear in both verbal and written information.

Video of patient's movement was used in part of this study. It was not possible to disguise the identity of the patient by digitally obscuring part of their faces, because the alignment and relationship of their facial features to their head, and their head to their neck and trunk can be an important part of their physiotherapy assessment. This issue was made explicit in specific written and verbal information so that informed consent was clear. All patient video was kept on an encrypted lap-top computer; the videos were only watched by the Physiotherapy Research Group (during the preparation of the training package), the physiotherapy participants as part of the training and reliability testing and the academic supervision team.

In order to ensure that the patient's medical care was not affected during their involvement with the study, the relevant multi-disciplinary team members working with the patient were informed (with the patient's permission) via a letter to the lead clinician (their Consultant if they were resident in hospital, or their GP if they were an outpatient or treated in the community setting).

4.7.2 NHS physiotherapist participants

Only senior physiotherapists were eligible for recruitment into the study if they predominantly treated patients with neurological diagnoses. These therapists carried full-time clinical caseloads and taking part in this study may have added burden on their clinical commitments. However, involvement within this research is expected to support and enhance a physiotherapist's assessment and clinical reasoning skills so there may be

an overall benefit of impact on service delivery. This issue was both discussed verbally and included in participant information sheets.

4.7.3 All Physiotherapists within this thesis

Therapist participants may have felt that they were under professional and clinical scrutiny (by their peers, managers or the researcher) because the study introduced an outcome measure that was alleged to support their assessment and clinical reasoning skills. Confidentiality was assured by the removal of all information that could identify the participant and this issue was also discussed during training. This risk was also reduced by 1) blinding during Study 2, Phase 2 testing protocol, and 2) Focus Group 'rules' (see Appendix 5) during Study 3, Phase 1.

In accordance with national research guidance, all data gathered and stored during the course of this research will be destroyed after five years of study completion.

4.8 Ethical approval and research governance

Ethical approval for the study was granted by: Leeds Central Research Ethics committee on 09/04/2008 (REC Reference: 08/H1313/23), The University of Huddersfield School of Human and Health Sciences School Research Ethics Panel on 28/09/2010, and Bradford NHS Research Ethics Committee on 24/11/2010 (REC reference number 10/H1302/82).

Local Research and Development approval was also obtained from Leeds Teaching Hospitals NHS Trust, Leeds Community Health Care Trust, Mid Yorkshire Hospitals Foundation Trust and Airedale NHS Foundation Trust. Approval dates and references are as follows:-

- Leeds Teaching Hospitals NHS Trust reference NE10/9497, approval received 14/01/2011.

- Leeds Community Health Care Trust received 06/01/2011.

- Mid Yorkshire Hospitals Foundation Trust reference JS/vd/N:R&D(10/700), approval received15/12/2010 .

- Airedale NHS Foundation Trust reference EPS: 0506 CSP, approval received 29/11/2010.

Appendix 4 contains all letters confirming ethical approval.

4.9 Summary

This chapter has described and presented the research design and methodology that was used to answer the research questions and meet the research objectives. Chapters 5 to 10 will firstly present the methods, then the results of each of the three studies in a sequential manner, i.e. the methods and results of the first study, followed by the methods and results of the second study, and finally the methods and results of the third study. The nature of mixed methodology research is complex and inter-related, which although gives richness and depth to the research, can also cause difficulty in following the flow of information. To address this issue, Figure [ix] is presented for clarity.
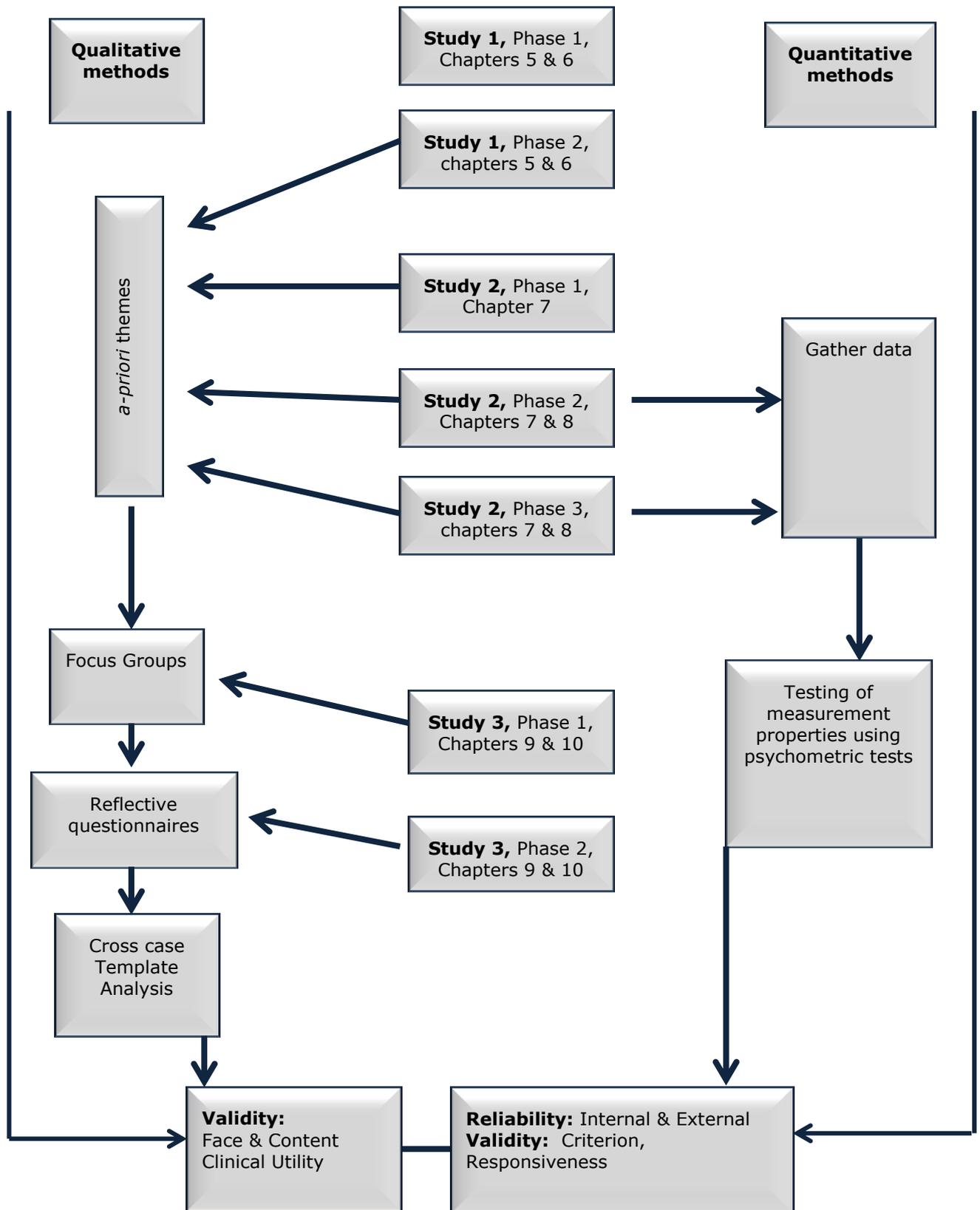
Figure [ix]: A summary of the mixed methods design used throughout Studies 1, 2 and 3

Chapter 5: Methods, Study 1: The conceptualisation, development and initial field testing of a new outcome measure (the LMPI)

5.1 Introduction

The aim of this study was to create a new outcome measure that encompasses movement quality. In order to achieve this, several objectives were set: -

1. To explore the meaning of and develop a definition for 'quality of movement '.
2. To define parameters / factors within the 'quality of movement'.
3. To establish a means of scoring or recording movement quality.
4. To run a small pilot study to investigate the clinical utility of the new outcome measure.

Within the course of this study, it was expected that: 1) an understanding of face and content validity and clinical utility would be gained, and 2) the foundation of a set of a-priori themes would be established in preparation for use in Study 3.

5.2 The design of Study 1

This study ran sequentially through two phases. Phase 1 focussed on the conceptualisation and creation of the LMPI; and Phase 2 used a qualitative pilot study in order understand whether the LMPI had face and content validity, and could be a clinically useful and meaningful way to record the movement difficulties of people who were receiving treatment from neurological physiotherapists.

5.3 Study 1, Phase 1: The conceptualisation and creation of the LMPI

The aim of this study was to define 'movement quality' and define the parameters within this term.

This study used consensus group methods described by Jones and Hunter (1995).

1. Firstly, nominal group technique to gather and organise information and knowledge.
2. Secondly, a Delphi process to anonymously refine terminology and reach agreement.

5.3.1 Nominal group meetings

Three structured meetings were used:

Meeting 1:   Initial meeting to define 'quality of movement' and identify key parameters within the resulting definition.

Meeting 2:   To agree score criteria.

Meeting 3:   To prepare research material for Phase 2 of Study 1.

5.3.2 The Delphi process

Three rounds of Delphi were utilised using e-mail within a secure internal server, and a space of one month was applied between rounds. Delphi methods were used, not as a method for creating new knowledge, but for accessing the knowledge of the Physiotherapist Research Group members in a quick un-biased manner and to help structure and organise group communication without the risk of influence (Mokkink et al 2006).

5.3.3 Nominal and Delphi Group members

This is a group of ten senior neurological physiotherapists previously described, known as the Physiotherapy Research Group.

5.3.4 Data collection

The results of the consensus group methods were collected over the course of ten months, and the data that emerged were used to inform the progression of the research process within this phase. Whilst an overview of this process is presented within the context of the full research study (Figure [vii]), the micro-detail of this process is described in Figure [x], i.e. the data gathered from nominal group meeting 1 informed the first Delphi round; the consensus from the Delphi study was used to form the draft LMPI; nominal group meeting 2 further developed the LMPI; nominal group meeting 3 analysed the results from Study 1 Phase 2.

```
[Nominal group meeting 1] → [1st Delphi round] → [2nd Delphi round] → [3rd Delphi round]
                                                                              ↓
                          [Draft LMPI] ←────────────────────────────────────┘
                              ↓
[Nominal group meeting 2] → [Further development of the LMPI] → [Study 1 Phase 2]
        ↓
[Nominal group meeting 3] → [Analysis of study 1 Phase 2 results]
```
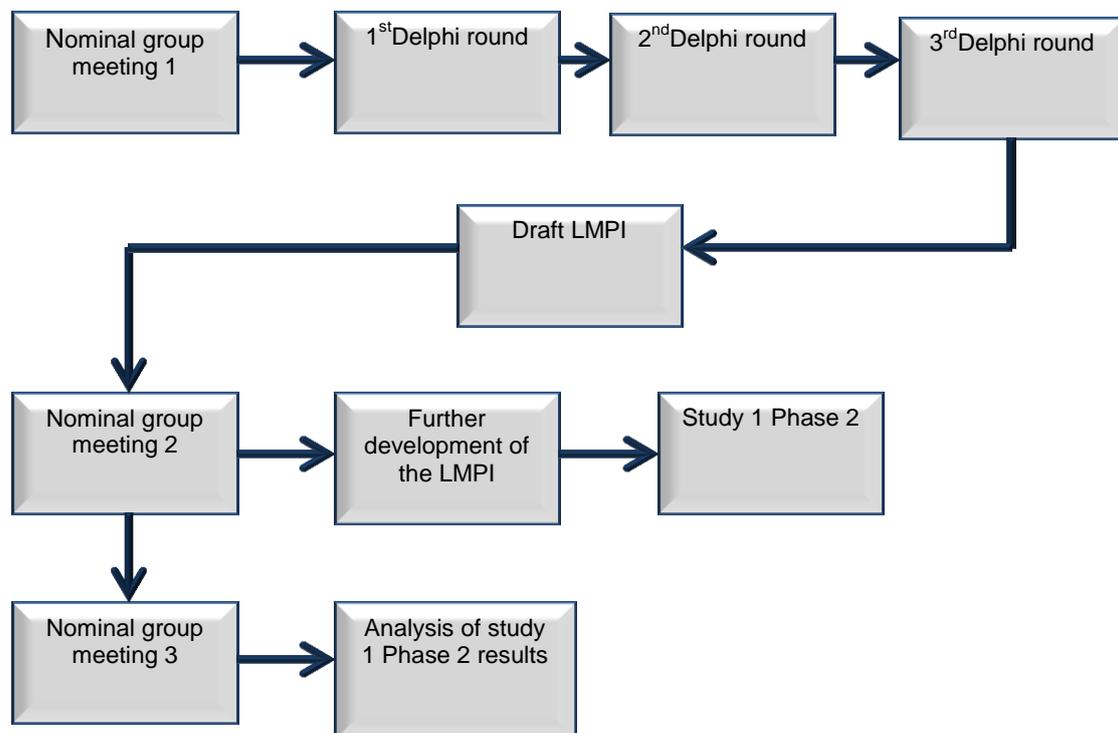
Figure [x]: The micro-detail of the research process within Study 1 Phase 1

5.3.5 Nominal group meetings

Meeting 1

The meeting was facilitated by the lead researcher. The ten group members spent several minutes writing down their views about their own interpretations of what 'the 'quality of movement' meant to them. Each member in turn contributed one idea to the facilitator, who recorded it on a flip chart, the 'turns' continued until no further ideas were left. The group then discussed the phenomenon of 'movement quality' and agreed a definition. The flip chart was re-visited and the 'ideas' were grouped together, where appropriate to form agreed components of movement quality.

Meeting 2

The draft LMPI was presented to the group members, who then spent several minutes writing down their views about how the LMPI should be scored. This was then discussed, and agreement was achieved.

Meeting 3

Group members discussed and agreed a training programme that would be used in Phase 2 of Study 1. A Microsoft PowerPoint presentation would be prepared containing information related to 1) how the LMPI was developed and 2) how to apply the use of the LMPI into routine clinical practice. Simple guidelines were written to support the training session(Appendix 6: LMPI guidelines). During the planning of the pilot study, the group members also agreed to provide supervision and support to participants, and to work as a group to analyse the data that were generated.

5.3.6 Delphi rounds

Round 1

Using secured e-mail, the lead researcher sent each nominal group member 1) the definition of movement quality that had been agreed and 2) the agreed set of components. Each member was asked to write a definition that encompassed their understanding of each component of movement quality using a proforma designed for the process (Figure [xi]).

Parameter	Description
Alignment	Your definition…
Interaction	Your definition…
Timing	Your definition…
Speed	Your definition…
Selective movement	Your definition…

Figure [xi]: The proforma sent to consensus group members, for individual completion

Round 2

The ten definitions for each component were collated and group members were asked to rank their agreement of each definition.

Round 3

The ranked definitions of each component were reviewed and where full agreement had been reached, were removed from the Delphi. The remaining components were collated, and members were asked to re-rank them.

5.4 Study 1, Phase 2: Pilot study; initial investigation of clinical utility

The aim of this study was to investigate the clinical utility, face and content validity of the LMPI.

A pilot study was run using a small group of senior physiotherapists, who were firstly trained to use the LMPI, and then secondly used it within their clinical practice for two months. During this time, the participants could access any support they felt they required from a member of the Physiotherapy Research Group. After two months, semi-structured interviews were used to gather thoughts, impressions and opinions regarding the clinical utility, face and content validity of the LMPI

5.4.1 Participant eligibility

Senior Physiotherapists who worked for the NHS and who met the inclusion criteria below were recruited into the study.

5.4.2 Inclusion criteria

- Majority of caseload spent treating patients who had a neurological diagnosis; in order to ensure familiarity and confidence working with patients who had neurologically related movement difficulties.

- Working as a senior physiotherapist. This staff group were chosen because their work pattern allowed continuity for the research project, i.e. junior grades of staff rotate through different clinical specialities four monthly; senior grade staff are either non-rotational or rotate six monthly or yearly.

- Permission from their manager to participate.

- Currently working in a clinical area that ensured support from a member of the Physiotherapy Research Group.

5.4.3 The recruitment of participants and the consent process

Physiotherapy mangers were approached and permission was gained for the researcher to approach physiotherapists working within the organisation who met the inclusion criteria. Both verbal and written information (Appendix 4) about the study were given to prospective physiotherapist participants by the researcher prior to the gaining of informed consent. Written information was sent to prospective participants four weeks previously with the invitation to attend a meeting. At the meeting, verbal information was given prior to an invitation to attend a follow on training event.

5.4.4 Data collection

Training protocol

A half day training event took place in the participant's workplace within their normal working hours. The history of the development of the LMPI was explained to the participants, they were then taught how to apply it within the clinical setting. During their use of the LMPI, the participants received on-going supervision, support and advice from members of the Physiotherapy Research Group.

Use within clinical practice

Participants used the LMPI within their routine practice of clinical record keeping for two months, any thoughts, reflections and opinions related to the use of the LMPI were recorded on the data-sheets which were anonymised for patients and participant details and collected by members of the Physiotherapy Research Group.

Semi-structured interviews

Participants were interviewed face to face using the following semi-structured questions:

- How did you use the LMPI?

- Was the LMPI easy to use?

- Did the LMPI affect your clinical reasoning?

- Did the LMPI affect your handover of clinical information?

- Was the LMPI useful?

- Were there any times when it wasn't appropriate to use the LMPI? And why couldn't you use it?

- Is there anything that you would like to change about the LMPI?

- Is there anything that you would like to add to this interview?

Rich note taking was used to record the interviews and all data were transcribed into Microsoft word documents.

5.4.5 Data analysis

Data from the anonymised LMPI data sheets and the transcribed semi-structured interviews were analysed using thematic content analysis guided by Boyatzis (1998) and Howitt & Cramer (2008) (Figure [xii]).
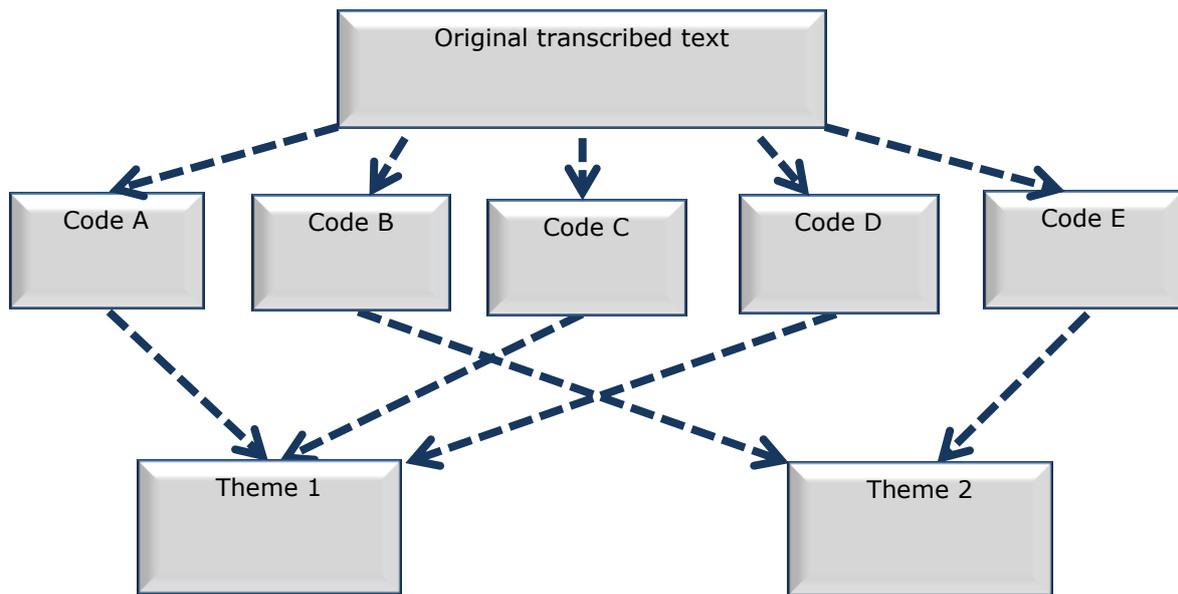
Figure [xii]: The process of thematic content analysis used during Study 1,
Phase 2   (Howitt & Cramer 2008 p344)

The Physiotherapy Research Group met to analyse the data; initially familiarising themselves with it, then as a group, identifying codes and themes using 'post it' notes onto a blank wall. As the meeting progressed, themes were refined until full agreement related to the emerging themes was reached.

All data were stored securely.

Chapter 6: Results, Study 1: The conceptualisation and development of a new outcome measure (the LMPI)

6.1 Introduction

This chapter presents the results of Study 1, the conception and pilot testing of clinical utility of a new outcome measure. The study was organised into two phases, each phase will be presented separately: -

Phase 1: The conceptualisation and development of the new outcome measure. This will include the results of consensus group and Delphi methods, producing:

- A definition of the term 'movement quality'.
- Definitions of the parameters which were then used to form the items within the new outcome measure.
- The agreed scoring criteria.
- The naming of the new outcome measure.

Phase 2: The results of the pilot study used to explore potential clinical utility and content validity.

Results presented in this study have been previously published in SYNAPSE (Ross 2008), a national quarterly journal published by the Association of Chartered Physiotherapists Interested in Neurology (ACPIN) (Appendix 7).

6.2 Study 1, Phase 1: The conceptualisation and creation of the new measurement tool

6.2.1 Nominal and Delphi group members

The Physiotherapist Research Group previously described, worked in a consensual manner using nominal group and Delphi methods.

The outcomes of nominal group meetings and Delphi rounds will be presented in the chronological order in which they occurred (see Figure [x]) because the information generated flows and develops between the two techniques, i.e.: nominal group meeting one→ first Delphi round→second Delphi round→ third Delphi round→ nominal group meeting two, and then nominal group meeting three.

6.2.2 Nominal group meeting 1

Two main themes emerged during the course of this three hour meeting, helping to focus 1) the definition of the phrase: 'quality of movement' and 2) the understanding of where and how 'quality of movement' fits within the context of neurological physiotherapy intervention:

Theme 1:   The quality of a patient's movement at an impairment level is a key part of their Physiotherapy assessment, analysis and treatment planning.

Theme 2:   The quality of a patient's movement within their normal functional daily activity is personalised in terms of the patient as an individual, their environment in which they exist, the task they are performing, their pathology, their age, their motor control deficit and prognosis.

The meeting was split into three steps: step 1) brainstormed the concept of movement quality, step 2) produced two definitions of 'movement quality', and step 3) used discussion to agree on specific components of observable quality of movement and posture.

Step 1

The key parameters that emerged from the brainstorm session within this section are presented in Figure [xiii]. The session worked well as an exercise to promote thinking and discussion in preparation for the creation of a definition of movement quality within Step 2.
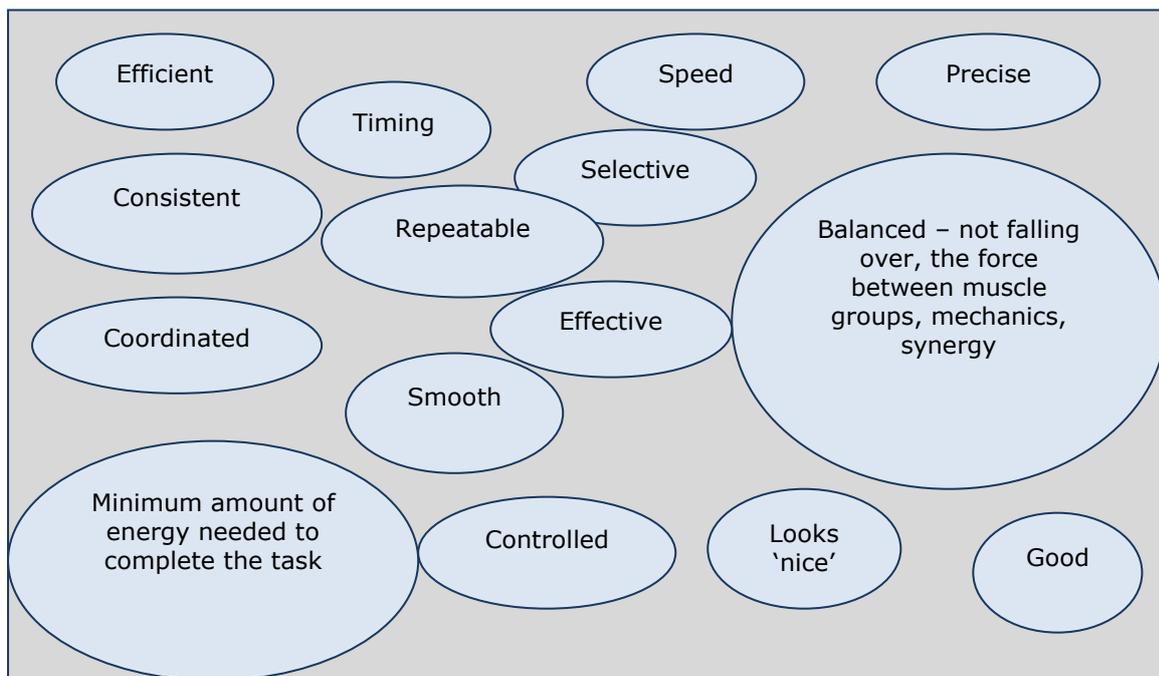
Figure [xiii]: The results of the 'brainstorm' exercise to define the parameters within quality of movement

Step 2

Within this section, because of the size of the group (ten participants) it was agreed that there were too many people to be able to have an inclusive conversation. Therefore, for

one hour, the members split into two sub-groups of five. Each sub-group used the parameters to produce a definition of their understanding of the meaning of 'movement quality'; these two definitions are presented in Figure [xiv].

"As Physiotherapists we define a high quality movement as an efficient way to achieve a desired outcome or goal. This would be with the least effort, timely, smooth and precise; within the context of the individual, task and environment"

"Good quality movement is efficient, effective and seemingly effortless. It is performed in a controlled and timely manner to achieve a precise outcome. Quality of movement must be evaluated within the context of the individual; i.e., their age, the environment, and is dependant on the task"

Figure [xiv]: The two different definitions of 'movement quality' defined by the Physiotherapy Research Group

Step 3

During this section of the meeting, the group used their newly formalised understanding of movement quality, and re-visited the work within Step 1. The group felt that there were too much overlap and meaning of the terms (see Figure [xiii]) and the consensus of opinion was that the parameters should be re-looked at and be made more explicit and focussed. The results are presented in Figure [xv]; technical 'jargon' has been used by the group to create condensed and specific terms.
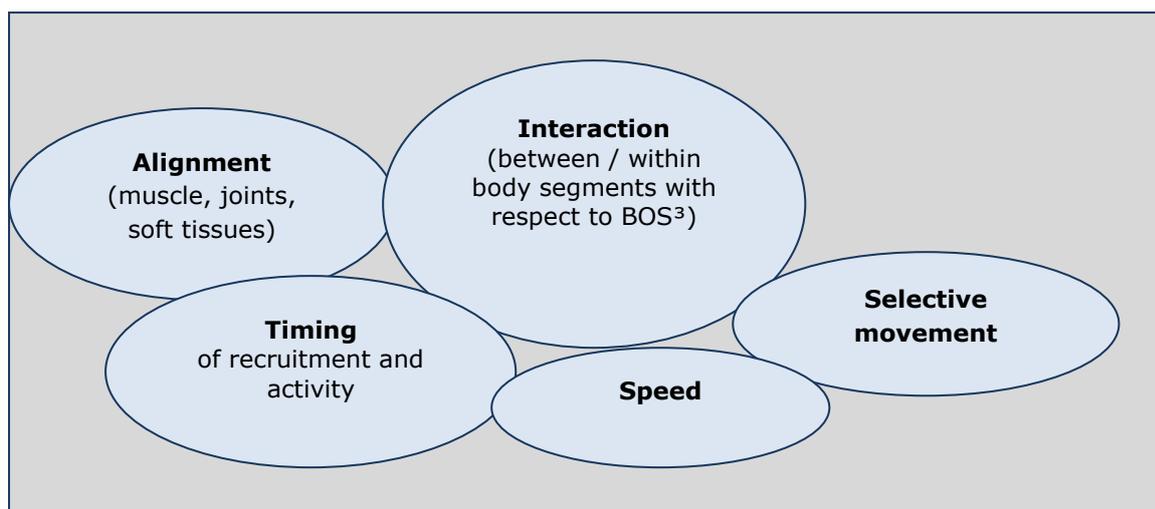
Figure [xv]: The five parameters of movement quality within posture and movement.
BOS³ = Base of Support

The next stage of the process was to agree definitions of these parameters of movement quality, and for this, Delphi methods were used.

6.2.3 Delphi rounds: 1, 2 and 3

Round 1

Each group member was electronically sent the designed proforma (Figure [xi]) using secured e-mail, which was completed and then returned to the researcher.

With the inclusion of the researcher, all group members participated, resulting in ten definitions of each parameter (see Appendix 8).

Round 2

After one month, the full list of ten definitions for each parameter was sent to group members, who were asked to select their 'top three' favoured definitions. After this Delphi round, there were clear favourites identified for: 'Alignment', 'Interaction' and 'Speed'. These parameters were removed from the subsequent Delphi round.

Round 3:

After another month, group members were re-sent all ten definitions for 'Timing' and 'Selective Movement'. On their return, the clear favourites had been chosen (Figure [xvi]).

Parameter	Description
Alignment	The position/posture of muscles, joints and body parts from which movement/activity is most anatomically correct and therefore efficient and effective
Interaction	The on-going adjustment between body parts within a posture or during movement with respect to its BOS[3]; that allows the maintenance of the posture on a background of balance correction, strength and endurance.
Timing	The appropriate sequence of activation and de-activation of automatic and selective movement in order to complete a task.
Speed	How fast or slowly a movement can occur. An optimum speed would be one which allows coordination, control, use of minimal energy and allow an effective goal to be achieved
Selective movement	Ability to achieve an isolated, specific and desired movement on a background of stability

BOS[3]= Base of Support

Figure [xvi]: The definitions of the parameters of quality within posture and movement: post Delphi technique

6.2.4 Nominal group meeting 2

The definitions of the parameters were reviewed and formally agreed upon. A discussion took place about how these defined components of movement could potentially be used as an outcome measure by neurological physiotherapists to score or measure a patient's quality of movement. A simple scoring system was devised, which ranged from zero to three; where 0 = severe, 1 = moderate, 2 = mild and 3 = normal. The group defined what they meant by normal, mild, moderate and severe (see Box [v]).

Box [v]: The scoring criteria of the new measurement tool	
3 = Normal	"Based on what the person's theoretical optimum normal should be"
2 = Mild	"The **ability** to meet more than half OR the <u>majority</u> of the components of the item, based on what the person's theoretical optimum normal should be"
1 = Moderate	"The **inability** to meet more than half OR the <u>majority</u> of the components of the item, based on what the person's theoretical optimum normal should be"
0 = Severe	"An **inability** to meet <u>any</u> of the components of the item, based on what the person's theoretical optimum normal should be"

The group then agreed that when to measure should be at the discretion of the clinician. For example, a patient could be measured:

- Pre and post treatment session or course of treatment to measure the effect of intervention.

- Post and pre-intervention to measure the carryover effect between treatments or courses of treatment.

- Once per week, or month etc. to measure progress.

The group also agreed that what to measure should also be at the discretion of the clinician and be appropriate to the patient, the treatment, and the objectives of the treatment e.g., sitting posture, sit to stand, leg on pelvis alignment, resting hand alignment. The nominal group members then used the new measure within their clinical practice for two months in order to assess its clinical usefulness.

6.2.5 Nominal group meeting 3 – the naming of the LMPI

During this group meeting the physiotherapists discussed their experiences of using the LMPI within their clinical practice, they felt that it: -

- Was more sensitive in comparison with other outcome measures

- Was easier and quicker to use in comparison with other outcome measures

- Had low floor and high ceiling effects

- Could be applied individually according to the patient's rehabilitation goals

The group members then agreed on a name for the outcome measure; The Leeds Movement Performance Index (LMPI), and prepared a training programme in readiness for phase 2. The data sheet for the LMPI can be seen in Appendix 6.

6.3 Study 1, Phase 2: The pilot study, an initial investigation of clinical utility

6.3.1 A description of the participants

A total of 21 senior neurological physiotherapists were recruited from NHS Centre 1 (see Figure [vi]), three participants withdrew from the study (one stopped working for the organisation, and two withdrew because their managerial duties prevented their continuation). Of the 18 remaining participants, 13 rotated within different specialities related to neurological rehabilitation, i.e. stroke, community, medical wards, neurosurgery, and neurological rehabilitation. The remainder had 'static' senior specialist posts within different specialities, i.e. neurological rehabilitation unit, acute neurology and out-patient clinics. The participants were considered to be representative of both a variety of clinical areas and of grade and experience within neurological physiotherapy.

All participants had clinical and research support from a member of the Physiotherapy Research Group. After the participants had used the LMPI within their clinical practice for at least three months they participated in a semi-structured interview with the researcher.

Eighteen interviews were held, rich note taking was used to record the conversation and each participant was asked to read the notes that had been taken to ensure: validity of the notes that were taken; that their intended meaning was captured and opportunity to add any information. All data were transcribed into Microsoft word documents and stored securely.

6.3.2 Content analysis of the data gathered

The 'Physiotherapy Research Group' met to analyse the data; initially familiarising themselves with the content of the transcribed interviews by reading, then re-reading them. Within the group, initial coding was facilitated by using 'post it' notes stuck on a wall (see Photograph [i]). Themes were then developed, based on the initial coding, then reviewed and organised into three main themes. Figure [xvii] demonstrates the flow and development of the three main themes from the initial coding stage.

Photograph [i] The initial identification of codes; thematic content analysis: Study 1, Phase 2
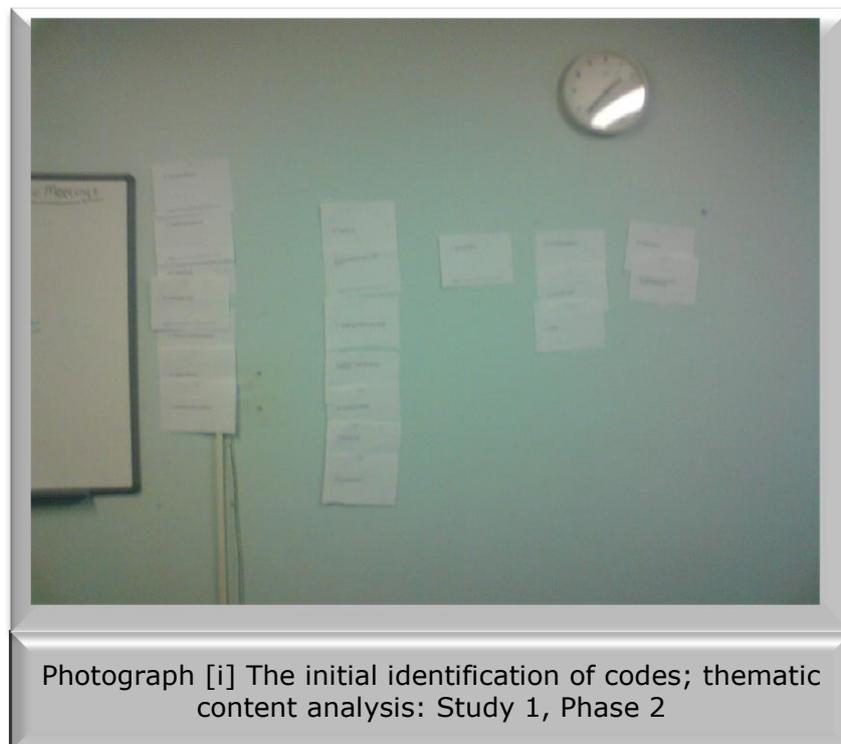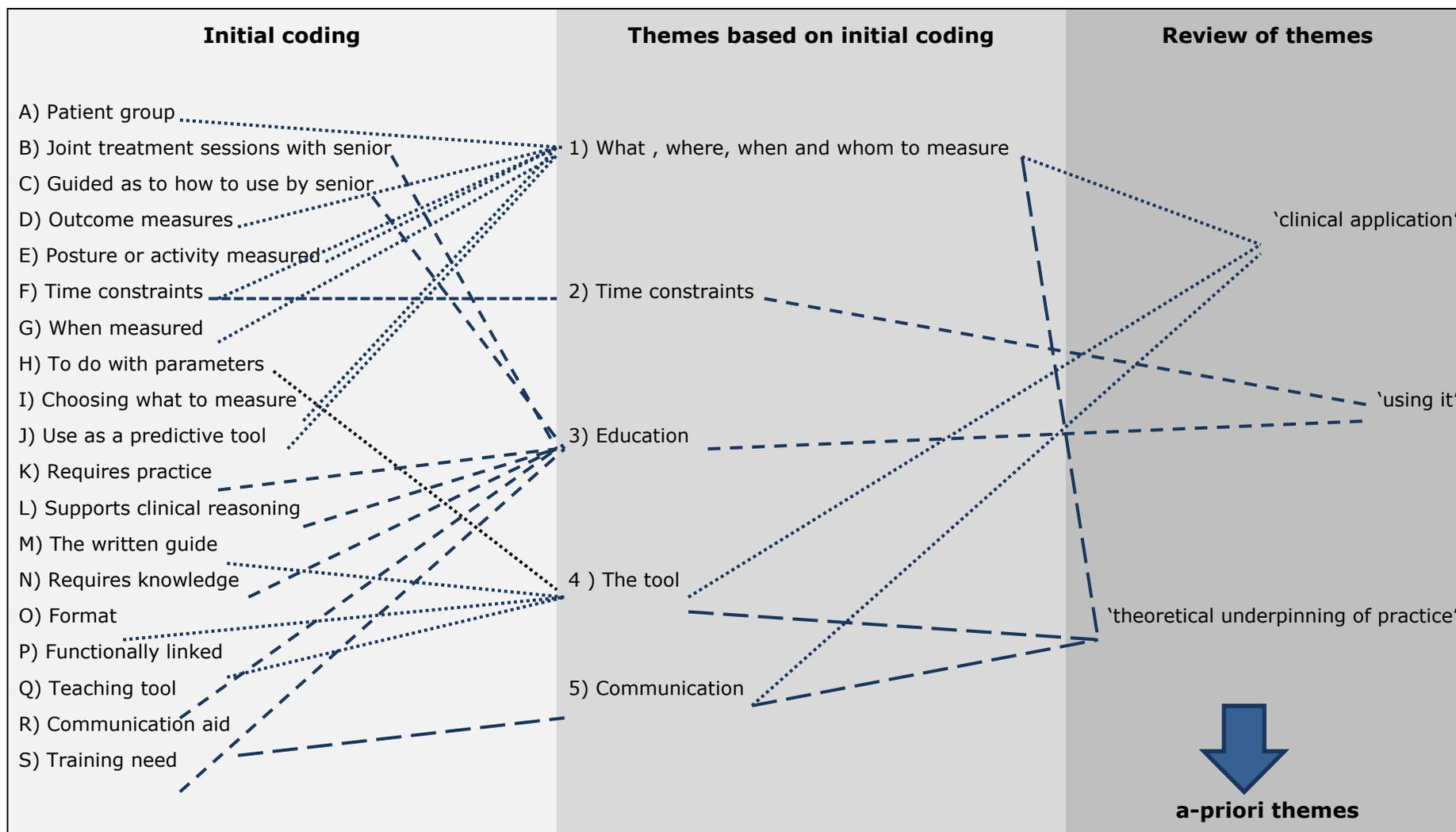
Figure [xvii]: The thematic content analysis of clinical utility. Study 1, Phase 2

6.3.3 The initial codes

As the transcribed texts were read by the Physiotherapy Research Group members, common themes emerged, and these were designated to a 'code'. As new themes emerged, new codes were identified, until no more data were left to be analysed. Nineteen initial codes were identified, and they are now described in more detail.

Code A) Patient group

All participants found that within the clinical setting in which they were based; as long as the patient required a rehabilitation approach, the LMPI could be used. For example:

- When a patient was critically ill, the physiotherapy intervention was directed towards life support as opposed to the re-learning of normal motor control.
- For adults with a learning difficulty, their behaviour was a limiting factor. The participants also commented that using the LMPI with patients who had very complex neurological movement problems helped organise a treatment plan.

Code B) Joint treatment sessions with senior clinician

The participants found that when they used the LMPI in conjunction with joint treatment sessions with a member of the Physiotherapy Research Group; it helped them to think and vocalise more deeply about their assessment, diagnosis and clinical reasoning.

Code C) Use guided by senior clinician

It was generally felt that having the guidance and support of a member of the Physiotherapy Research Group made applying the LMPI into their clinical practice easier. More senior participants also reported that they had to be able to understand how to analyse normal movement before using the LMPI; reflecting that teaching non-specialist physiotherapists to use the LMPI may be difficult.

Code D) Outcome measures

Many of the participants reported that the LMPI could be incorporated into the treatment session as opposed to being used separately, such as with the BBS. Also, that they found no 'floor' or 'ceiling' effects when using the LMPI. One participant commented that she had not come across anything that measured quality of movement before.

Code E) Posture or activity measured

There was no consistency related to postures or movements that were measured, but participants mostly measured at impairment level e.g. hand orientation to a flat surface during contralateral limb activity.   One participant said that measuring impaired movement quality helped him to appreciate how much it had changed and impacted on the patient's function.

Code F) Time constraints

Time was a significant factor, with participants finding that although the LMPI took some time to 'set up' it was then quick to use, although one participant commented that using the LMPI was time consuming because she had to think more.   Other participants reported that using any outcome measures were difficult because of general time constraints within clinical practice.

Code G) When measured

Several of the participants gave indications as to when in the treatment session the LMPI was used, and one of them requested that a 'key' should be included on the data sheet to indicate when it was used, giving the example of: pre and post treatment, best performance during the treatment or post and pre-treatment to measure carryover effects.

Code H) To do with parameters

The participants felt that although 'tricky' to understand due to their knowledge base, the parameters helped them to focus on their patient's motor control difficulties.

Code I) Choosing what to measure

Generally, the participants found choosing what to measure challenging, because it made them think about their assessment and treatment plan. One participant described the process of thinking about the 'global' movement, then measuring a specific impaired part of the movement that was being performed. Although the score criteria and technical language generated discussion, no changes were indicated or suggested.

Code J) Use as a predictive tool

Participants felt that the LMPI helped them to think about which impaired movements were feasible to change; being useful when setting reasonable targets or making decisions about their patient's rehabilitation potential or progress.

Code K) Requires practice

Initially the more junior grade participants (i.e. the rotational senior staff) found the LMPI difficult to use, but by the end of the project, because of practice and support, they were able to use it independently. The more senior participants were quickly able to use the LMPI successfully, with one commenting that she would be happy to use it for every patient within her specialty (neurological out-patient clinic).

Code L) Informs / challenges clinical reasoning

Throughout the semi-structured interviews, the participants frequently commented on the impact that the LMPI had on their clinical reasoning, this was especially so with the more junior grade staff; they found that using the LMPI made them really think about how they analysed their patient's movement during assessment.

Code M) The written guide

In general, not many participants referred to the 'LMPI guidelines' (Appendix 6), mainly because they had good support from the Physiotherapy Research Group members. However, one participant felt that the guidelines should be developed to include language with less jargon, to ease use for less experienced physiotherapists.

Code N) Requires knowledge

Although this was not mentioned specifically, it was clear that in order to use the LMPI appropriately and with confidence, users required a good standard of clinical skill; i.e. they needed to be able to assess and analyse normal movement in relation to their patient's impaired movement and motor control.

Code O) Format

Issues related to the format of the data sheet were few, but suggestions were made: to give space to record when the LMPI was used, and to use 'half' scores. Interestingly, participants also found that the use of the LMPI made their written clinical records quicker and easier to complete.

Code P) Functionally linked

The more senior participants (non-rotational senior specialist neurological physiotherapists) consistently made links between their patient's impairment and functional abilities; noting that the measurement of movement quality can help the therapist appreciate how much it can change and impact on the patient's function.

Code Q) Teaching tool

This code was formulated because of the number of comments, particularly from the more junior participants, related to how much they learnt about their patient's movement from their supervising Physiotherapy Research Group member when using

the LMPI. The more senior participant's comments tended to relate to the usefulness of the LMPI within clinical peer review.

Code R) Communication aid

Communication (writing clinical records, discussing patients with physiotherapy team colleagues and giving confidence to clinical discussions within multi-disciplinary team meetings) was all described as being enhanced and simplified with the support of the LMPI.

Code S) Training need

Possibly due to the novel way of measuring and recording movement, the majority of participants commented on the training required to be able to use the LMPI with confidence. They felt that whilst both the training package and guidelines were helpful, the support of the Physiotherapy Research Group were also valuable, and suggested that video recordings of patient's movement during the training session may have been beneficial.

6.3.4 The overarching themes

All participants felt that the LMPI items, wording and scoring criteria should not be altered; they also felt that the LMPI met a clinical need.

Participants discussed: the movements they measured in their patients, when they measured them and the types of patients they measured. Participants who were experienced needed little support in this area, those who were less experienced needed support before they become independent and confident in using the LMPI.

All participants felt that training was needed before using the LMPI, and that the tool itself provided education in terms of promoting and supporting their clinical reasoning. They also thought that the LMPI could potentially be used to help educate junior staff and students within the areas of assessment, analysis, diagnosis, goal setting and treatment planning.

Time constraints regarding the actual time taken to use the LMPI were identified, however, this theme was consistently accompanied by general time constraints within clinical practice, and that all outcome measures took time to complete.

Participants felt that the tool helped communication between therapists in terms of treatment planning and continuity, handover of clinical care, and discussion with other members of the multi-disciplinary team.

Only two of the participants had used the guidelines, the rest had sought support via the Physiotherapy Research Group. It was noted that simpler language and less jargon ought to be used.

To summarise; three important and popular ideas that could be used as a-priori themes within future qualitative research methodology emerged from this work: -

- 'Clinical application' – the application of the LMPI into clinical practice.
- 'Using it' – related to the mechanics of using an outcome measure.
- 'Theoretical underpinning of practice' – related to the culture and concept of the modern neurological physiotherapy treatment approach.

6.3.5 Key actions identified from the themes

Within an organised Physiotherapy Research Group meeting, following discussions related to the results of this pilot study, the following actions were decided: -

- Some alterations should be made to the demographic patient information area and the format of the front page of the LMPI data sheet.

- The development of a standardised training package designed by the Physiotherapy Research Group members, including patient video, should precede any future study.

- The guidelines accompanying the LMPI should be reviewed and modified, using feedback and advice from the participants from within this study.

No action would be taken to solve the problems of time constraints, because this was: 1) considered to be a service issue and not specifically related to the LMPI, and 2) the use of outcome measures was an important standard of clinical practice, and it was acknowledged within the qualitative data that all outcome measures were time consuming to use.

6.4 Summary of Chapters 5 and 6

Using consensus methods, a new outcome measure, the LMPI, was developed during the course of this study. The methods used suggest good face and content validity and also potentially good clinical utility. However, there are clear issues of possible bias because: 1) the Physiotherapy Research Group and study participants work together within the neurological physiotherapy team for the same NHS organisation, and 2) the Physiotherapy Research Group members could have strongly influenced the participants within Study 1 Phase 2. Nonetheless, scientifically sound ground work has been instigated and achieved in preparation for more objective testing within Studies 2 and 3 of this thesis.

Chapter 7: Methods, Study 2: Testing the measurement properties of the LMPI

7.1 Introduction

The aims of this study were to explore the measurement properties of the LMPI, specifically:-

- Internal consistency.

- External reliability.

- Criterion validity.

- Scale responsiveness.

During the course of the study, it was also intended to gain an understanding of face and content validity, and to further build on the three a-priori themes in preparation for the qualitative methods within Study 3.

This study ran sequentially through three Phases. Phase 1 focussed on the preparation of research tools, Phase 2 examined internal and external reliability and Phase 3 examined the criterion validity and responsiveness of the LMPI.

Rich note taking and reflexivity throughout this study further established a-priori themes which were used for preparation of the Focus Groups in Study 3.

7.2 Study 2, Phase 1: Preparation of the research tools

The aim of this Phase was to develop a training package for use in the training of Physiotherapists and the testing process of Phase 2 of this study.

7.2.1 The design of Study 2, Phase 1

Short (from 7 to 48 seconds) video recordings of patients were made, with each patient performing a simple task. The video recordings were: 1) incorporated into a training package to train physiotherapists to use the LMPI or 2) incorporated into a testing process to test the LMPI during Phase 2 of this study. The available literature related to the use of video for testing the measurement properties of outcome measures varies widely in both the number of raters and number of videos. For example: Mosely et al (2003) used 20 videos and three raters; Carr et al (1985) used five videos and 20 raters; Whitall et al (2006) used 10 videos and three raters. Therefore, a pragmatic decision (based on resources available, experience of teaching and statistical guidance) was made by the author and the Physiotherapy Research Group to use three patient videos to help teach the physiotherapists how to use the LMPI, and five videos within the test protocol. The use of video is also considered a useful method to reduce the risk of change in the patient's motor control between testing sessions (Pomeroy et al 2003).

7.2.2 Participant eligibility

Patients who were resident on the acute and rehabilitation wards or attending out-patient appointments at research Centre 1, the Leeds Teaching Hospitals NHS Trust (Figure [vi]) were eligible to be recruited if they met the following criteria.

7.2.3 Inclusion criteria

- Over 18 years of age.
- Neurological diagnosis having an impact on motor control.
- Receiving treatment from a neurological physiotherapist.
- Deemed (by their Physiotherapist) to be cognitively able to consent to being videotaped whilst performing a simple functional task.

7.2.4 The recruitment of participants and the consent process

Patients identified by their Physiotherapist as meeting the inclusion criteria were approached by the researcher, who verbally explained the research process and provided supporting written information sheets (Appendix4). Patients were included if they provided written informed consent to be videotaped whilst performing a short functional task during their physiotherapy treatment session.

7.2.5 Data collection

Fifteen patients were recruited, and the researcher recorded a short episode of movement from each patient using a single hand held digital camera, so that only one viewpoint was seen. The recording was stored securely in a jpeg file format.

Nine men and six women were recruited (see Table [vi]). Their ages ranged from 28 to 91 years with a mean age of 55 years (SD 16). Nine patients had suffered a stroke, two had multiple sclerosis and the others presented with peripheral neuropathy or retro-spinal craniectomy or subarachnoid haemorrhage or traumatic brain injury. This range of pathologies is typically seen within neurological physiotherapy, as is the range of post neurological insult recovery stages. The tasks videoed varied, and included: walking, sit to stand, forward reach to grasp cup, in supine - elbow flexion with active grasp, supine to sit on edge of bed and two handed reach and place hands. The majority of the tasks were functional and all were chosen by the patient and their physiotherapist, reflecting their treatment plan and functional goals.

Table [vi]: Study 2, Phase 1 participants – video recording of movement	
Gender	9 males, 6 females
Age range	from 28 to 91 years mean age = 53 years SD 16 years
Diagnosis	• Stroke (3 haemorrhagic / 1 brain stem / 5 infarcts) 9 • Multiple Sclerosis 2 • Peripheral neuropathy 1 • Retro-spinal Craniectomy 1 • Subarachnoid Haemorrhage 1 • Traumatic brain injury 1
Recruited from	• Neuro-physiotherapy out-patients 8 • Neuro-rehabilitation (ward) 4 • Acute stroke (ward) 1 • Neurosurgery (ward) 1 • Stroke rehabilitation (ward) 1
Functional task recorded	• Walking 7 • Sit to stand 3 • Forward reach to glass 2 • In supine, elbow flexion with active grasp 1 • Supine to sit on edge of bed 1 • 2 handed reach and place 1

Once all the videos had been recorded and stored, they were reviewed by the Physiotherapist Research Group who allocated videos for either training physiotherapist participants in the use of the LMPI, or testing the LMPI measurement properties, based on the following criteria.

7.2.6 The videos allocated for training

Based on their experience of providing clinically based education to less experienced physiotherapists, the Physiotherapy Research Group considered that between three and four videos would give a sufficient variety of motor control difficulties on which the LMPI could be applied. The criteria used for allocating the videos for the training package were that: -

- A variety of problems should be presented so that physiotherapists could learn to apply the concepts of the LMPI to different movement problems. But at the same time, the number of videos used should be as small as possible so that the process could be kept as simple as possible.

- The patient's movement / motor control difficulties should be sufficiently complex to initiate discussion about their motor impairments; so that the principles of the use of the LMPI could be applied.

- The motor control difficulties that the patient presented should be fairly typical of movement difficulties commonly observed in clinical practice.

- The videos chosen to support the training should look at different aspects of movement.

The videos allocated were:

Training video 1: A 68-year-old man who had had a stroke that affected the movement on the left side of his body three months previously. The video was of him seated, reaching forwards across a table to grasp a glass of water with his left hand (9 seconds).

Training Video 2: A 50-year-old woman who had had a stroke that affected the movement on the right side of her body two years previously. The video was of her standing up from a treatment plinth and stepping

round to sit in her wheelchair using a quad stick to help her balance (20 seconds).

Training video 3:   A 48-year-old man who had had a stroke in his brain stem that affected the movement throughout his body 14 years previously. The video was focussed on his lower legs and feet during stand up from sitting (17 seconds).

Training video 4:   A 51-year-old woman who had multiple sclerosis that affected her core strength and balance, diagnosed two years previously. The video was of her walking down the corridor in the physiotherapy department without any walking aid or assistance (28 seconds).

It was intended that discussion related to all or any parts of the patients motor control difficulties and the appropriate application of the LMPI would occur during the training process.

7.2.7 The videos allocated for testing

Because the available literature related to the use of video for testing the measurement properties of outcome measures varies widely, a pragmatic decision was made to use five videos within the test protocol.

The criteria used for selecting the videos to be used during the testing protocol were similar to those for the training package, but directed towards an individual viewer as opposed to group viewing with discussion: -

- The motor control difficulties that the patient presented were fairly typical of what would commonly be observed in clinical practice.

- The videos chosen should focus on different aspects of motor control problems to each other.
- That patient's movement should be clearly visible; normally, physiotherapists observe their patient's movement difficulties in three dimensions, but for the purposes of the testing of the LMPI they were asked to make judgements in only two dimensions.

The patient videos allocated were:-

Test Video 1:   A 68-year-old man who had had a stroke that affected the movement on the left side of his body three months previously. The video was of a side view of him rising into a standing position from seated in his wheelchair (7 seconds).

Test Video 2:   A 55-year-old woman who had had a bi-lateral radiculopathy affecting her lower limbs following radiotherapy for cervical cancer one year previously. The video was of a side view of her rising into a standing position from seated in her wheelchair (8 seconds).

Test Video 3:   A 62-year-old man who had had a stroke in his brain stem that affected the movement on the right side of his body two months previously. The video was of him walking up and down the corridor, from one stationary view point, so that both front and rear views could be observed (48 seconds).

Test Video 4:   A 65-year-old man who had had a stroke that affected the movement on the left side of his body over two years previously. The video was of a front view of him seated, reaching forwards across a table to grasp a glass of water with his left hand, and then lifting it towards his mouth (8 seconds).

Test Video 5;   A 65-year-old woman who had a complex history of sub-arachnoid haemorrhage and aneurysms with a prolonged hospital admission including several weeks on the intensive care unit with artificial life support. She had general body weakness and deconditioning, combined with a significant right arm weakness. The video was of her laying supine in bed, then rolling onto her right side to sit on the edge of her bed. The video was shot from the bottom of her bed at the side that she was moving towards (30 seconds).

7.2.8 The training and testing package

A Microsoft PowerPoint presentation (see Appendix 9) was prepared by the researcher incorporating the background and history of the development of the LMPI and the video material previously described. It was intended that the presentation be used: 1) to train then test the Senior Physiotherapists Participant Group; and 2) to train the Expert Physiotherapists Group.

7.3 Study 2, Phase 2: Internal consistency and external reliability

7.3.1 Introduction

The aim of Study 2 Phase 2 was to examine the internal consistency and external reliability of the LMPI in order to establish confidence that:

- The five different items were all necessary parts of the measurement tool.

- The LMPI could be used by the same physiotherapist to reliably score change over time.

- The LMPI could be used by a team of therapists treating the same patient, or during transfer between therapists as part of the clinical information that follows the patient along their rehabilitation pathway.

7.3.2 The design of Study 2, Phase 2

Senior Physiotherapists (Senior Physiotherapists Participant Group) were trained to use the LMPI, and then followed a testing protocol designed to examine its internal and external reliability. Five video recordings were watched and rated using the LMPI. Two weeks later, the video recordings were re-watched and re-rated. The viewing order remained the same.

7.3.3 Participant eligibility

Senior Physiotherapists (Senior Physiotherapists Participant Group) who worked for the NHS and who met the inclusion criteria below were recruited into the study.

7.3.4 Inclusion criteria

- Majority of caseload spent treating patients who had a neurological diagnosis; in order to ensure familiarity and confidence working with patients who had neurologically related movement difficulties (see Study 1).
- Working as a senior therapist; Study 1 results had found that newly qualified or junior grade physiotherapists needed to be taught how to analyse movement before they could use the LMPI
- Permission from their manager to participate.

7.3.5 The recruitment of participants and the consent process

Neurological physiotherapy service managers from three participating NHS organisations were approached and permission was gained for the researcher to approach physiotherapists working within their organisations who met the inclusion criteria (Appendix4). The managers identified eligible physiotherapists who agreed to meet with the researcher. Both verbal and written information about the study were given to prospective physiotherapist participants by the researcher prior to the gaining of informed consent (Appendix 4). This written information was sent four weeks previously to prospective participants, with the invitation to attend a meeting. At the meeting, verbal information was given about the research study, prior to an invitation to attend a follow-on training event; during which, the participants learnt how to use the LMPI.

7.3.6 Data collection

Training protocol

In groups of three or four, the Senior Physiotherapist Participants were trained to use the LMPI, using the research material developed during Phase 1. The half day training event took place in participant's workplaces within their normal working hours. Problem solving discussions about each patient's videoed movement enabled the physiotherapist participants to apply the LMPI to clinical problems and use the clinical reasoning process to underpin observational assessment and analysis of the patient's movement. Once the physiotherapist participants expressed verbally that they understood how to use the LMPI, they progressed to the testing protocol.

Testing protocol

After a short break, participants were shown five further video recordings of patients. Each video was played repeatedly, while the physiotherapist participants used

a paper datasheet of the LMPI to 'rate' each patient's movement. The physiotherapists were told specifically what to measure i.e.:-

Test video 1   The actions of the patient's left leg (pelvis, hip, thigh, lower leg, ankle and foot).

Test video 2   The actions of the patient's right hip, knee and foot.

Test video 3   The patient's 'whole body' walking quality.

Test video 4   The patient's left shoulder, arm and hand from the start of the movement up to the grasp of the glass.

Test video 5   The patient's 'whole of body' movement.

Two weeks later, the use of the LMPI was reviewed with the participants, who then re-watched the same videos and re-rated each patient's movement. A time gap of two weeks is consistent with similar research (Carr et al 1985; Mosely et al 2003; Whitall et al 2006) and was considered a long enough period for participants to have poor recall of their previous assessment results. On both occasions the participants were blinded to their own and the scores made by other participants; this was done to minimise both professional scrutiny and potential bias. All data were gathered together and stored confidentially and securely by the researcher prior to the analysis of reliability.

7.3.7 Sample size estimations

No examples of sample size estimation methods for the evaluation of the measurement properties of outcome measures were identified in the literature. Therefore, literature related to the development of quality of life in cancer rating scales was used (Johnson et al 2011); here, a 'rule of thumb' of five to ten participants for every item in a questionnaire is recommended. A sample size of five patients and 20 Senior

Physiotherapist Participants was expected to provide a sufficient number of completed assessments to assess the internal consistency and external reliability of the LMPI.

7.3.8 Data analysis

Data were analysed using SPSS (version 20.0).

7.3.9 Internal consistency

This was assessed using Cronbach's alpha coefficient, applied to the overall scale and to each individual item.

7.3.10 External (inter-rater) reliability

This was assessed by calculation of the Intraclass Correlation Coefficient (ICC) for the scores awarded by multiple raters, appropriate for the analysis of numerical data (Armitage et al 2008).

7.3.11 External (test-retest) reliability

This was assessed by calculation of Spearman's rank correlation coefficient for total scale scores obtained on two testing occasions.

7.3.12 Measurement error

Measurement error was assessed by evaluation of the Smallest Detectable Change (SDC). This statistic is a function of the ICC and Standard Deviation (SD).

7.3.13 Variance components analysis

This procedure estimates the contribution of each random effect to the variance of the dependent variable. Hence in the current context, variance in LMPI score is partitioned into components arising from between-patient variability, between-therapist variability and between-testing variability; as well as from residual variability; to assess the proportion of variability in LMPI score that might arise from instability of the instrument when applied by multiple physiotherapists or across multiple measurement occasions. Thus the procedure determines where attention should be focussed in order to reduce the variability. In this process it is assumed that both the practitioners and the patients featured in the sample represent random selections from larger populations.

7.4 Study 2, Phase 3: Criterion validity and responsiveness

7.4.1 Introduction

The Senior Physiotherapist Participants group from Study 2 Phase 2 were trained to recruit NHS patients for purposes of this research using the International Conference on Harmonisation – Good Clinical Practice Guidelines (ICH-GCP 2000). These guidelines were developed with international agreement, and although were intended for use with multi-centre pharmaceutical trials, the principles of good research practice are transferable.

The aims of this study were to investigate the criterion validity and the responsiveness of the LMPI.

7.4.2 The design of Study 2, Phase 3

The physiotherapists were asked to recruit appropriate patients from their clinical caseloads and then measure their movement performance using the LMPI and the BBS (Berg et al 1989) prior to; and at the end of a course of treatment, or after six weeks (whichever was the soonest). Site visits were carried out by the researcher in line with ICH-GCP guidelines and also:

- To support the Senior Physiotherapist Participants group in their recruitment of participants and use of the LMPI.
- To gather 'rich' notes, perceptions, reflections about how members of the Senior Physiotherapist Participants group found using the LMPI in clinical practice.

All data were gathered together and stored confidentially and securely by the researcher prior to analysis.

7.4.3 Participant eligibility

Patients who were resident on the acute and rehabilitation wards, or attending out-patient appointments at participating NHS organisations, or who were receiving intervention in their own homes by members of the Senior Physiotherapist Participants Group; were eligible to be recruited if they met the following criteria.

7.4.4 Inclusion criteria

- Over 18 years old.
- Neurological diagnosis having an impact on motor control.
- Receiving treatment from a member of the Senior Physiotherapist Participants Group.
- Considered (by their Physiotherapist) to be cognitively able to consent to be included in the research.

7.4.5 The recruitment of participants and the consent process

The Senior Physiotherapist Participants who had been trained to use the LMPI and to recruit patients to research studies identified their patients who met the inclusion criteria. They then approached their patients, verbally explained the study process and supported their explanation with written participant information sheets (Appendix4). Patients were included if they met the eligibility criteria and provided written consent.

7.4.6 Data assessments

Physiotherapists measured their patient's movement using the LMPI and the BBS and recorded it on the appropriate data sheets (Appendices6 and 1 respectively). The data sheets were then stored in the patients clinical records. After a course of treatment (or after six weeks, whichever was the sooner) the physiotherapists re-recorded their patient's movement. They were not blinded to their baseline assessment. The data sheets were then photocopied by the physiotherapist and collected by the researcher during a site visit. The data collected were stored securely in a locked office on NHS premises ready for analysis. The original documents remained in the patient's physiotherapy clinical records.

7.4.7 The Berg Balance Scale

This scale was chosen to be used in Study 2 Phase 3, because it is a well-known, widely used outcome measure (see Chapter 3.5), validated for use within several diagnostic patient phenotypes (Blum& Korner-Bitenski 2008; Kornetti et al 2004; La Porta et al 2012; Qutubuddin et al 2005). The BBS is a measure of balance, it was expected that the construct of the LMPI would correlate moderately well with the BBS because

successful balance requires a significant element of efficient good quality movement and motor control (see Box [iv] andAppendix1).

7.4.8 Sample size estimations

Again, no examples of sample size estimation methods for the evaluation of the measurement properties of outcome measures were identified in the literature. Therefore, the 'rule of thumb' guidance by Johnson et al (2011) was again applied. A sample size of between 25 and 50 patients was expected to provide a sufficient number of completed assessments to assess the criterion validity and responsiveness of the LMPI. Similar published work that tests the criterion validity of the BBS have used comparable numbers of participants: Berg et al (1989) used 38 patients, Berg et al (1992) used 31 patients, Liston and Brouwer (1996) used 22 patients, Bennie et al (2003) used 20 patients, Qutubuddin et al (2005) used 38 patients, Lemay & Nadeau (2010) used 32 patients. The recruitment of more patients than the estimated requirements were deemed to be unnecessary because of ethical reasons and study constraints.

7.4.9 Data analysis

7.4.9.1 Criterion validity

Criterion validity was assessed by evaluation of the correlation between the BBS and LMPI pre and post intervention scores; and by construction and evaluation of the corresponding Bland-Altman plots (Bland& Altman 1986); which facilitate a visual representation of the relationship between averaged and difference scores evaluated from pre and post intervention data.

7.4.9.2 Clinical responsiveness

This was assessed by calculating mean within patient change scores in the BBS and the LMPI pre and post intervention, so that the responsiveness of the LMPI can be compared with the BBS when the variables of both the physiotherapists and the patients are unchanged.

The magnitude of the effect of the intervention measured by both the LMPI and the BBS was also calculated, using a Cohen's d statistic.

7.5 Field notes

The technique of rich note taking and reflexivity by the researcher throughout this study further established the a-priori themes that emerged during Study 1 Phase 2 which were used within the Focus Groups in Study 3. Template analysis (King 2014; King & Brooks 2014) was used within Study 3, providing a framework to interpret the data.

Chapter 8: Results, Study 2: The measurement properties of the LMPI

8.1 Introduction

This chapter presents the results of the testing of measurement properties of the LMPI. Phase 1 of this study focusses on the preparation of research tools which have been previously discussed in Chapter 7.3. The results from Phase 2 will include a description of the participants recruited (the Senior Physiotherapist Participants Group) and a presentation of the results of the data analysed to test internal consistency, external (inter-rater and test-retest) reliability, and a variance components analysis. Results presented in this study have been previously published in Physiotherapy Theory and Practice (Ross et al 2014), an internationally peer reviewed journal (Appendix10).

Phase 3, will present the results of the testing of criterion validity and the responsiveness of the LMPI, including a description of the patient participants recruited and a presentation of the data analysed to test criterion validity and clinical sensitivity in comparison with the BBS.

8.2 Study 2, Phase 2: Internal consistency and external reliability

Study 2 Phase 2 investigated the internal consistency and external (inter-rater and test re-test) reliability (see Chapter 7.3).

8.2.1 A description of the participants

A total of 12 participants were recruited to the Senior Physiotherapist Participant Group from three NHS centres (see Figure [vi]). Appendix 11 presents the demographics of the members of the Senior Physiotherapist Participants Group. Five members were recruited from Centre 2, The Leeds Community Health Care Trust (two separate groups were recruited to reduce participant burden), three members were recruited from Centre 3; The Mid Yorkshire Hospitals NHS Foundation Trust, and four members were recruited from Centre 4; The Airedale NHS Foundation Trust. The physiotherapists worked in a variety of clinical areas, representative of those found within neurological physiotherapy. The physiotherapists were all senior grade, and all had been qualified for more than five years. The group's postgraduate education was also varied: some had completed Masters' degree modules (n=4) or a full Masters' degree (n=1), all were active within in-service training programmes and one was enrolled on a Professional Doctorate program. Most of the participants had trained within the Bobath concept (BBTA 2014) (n=11), and two had motor re-learning backgrounds (Carr & Shepherd 2003).

8.2.2 Sample size

After being trained to use the LMPI using the material developed during Study 2 Phase 1 (Chapter 7.2), the 12 Senior Physiotherapist Participants used the LMPI to assess the movement of the five patients previously recorded with video. The physiotherapists re-assessed the same patient videos two weeks later. Appendix 12 contains the full data gathered during this phase of the study.

No data is missing.

8.2.3 Data analysed

8.2.3.1 Internal consistency

Table [vii] summarises the values of Cronbach's Alpha Coefficient calculated for both the overall scale and to each individual item. The alpha value for all items (0.862) indicates high overall reliability; the alpha values of the scale with individual items removed is also strong (range from 0.795 to 0.892), implying that the reliability of the scale decreases with the removal of all scale items except Alignment. However, the removal of the Alignment item results in only a very small increase in scale reliability, which would not justify the loss of information resulting from the removal of this item.

Table [vii]: Internal consistency of the LMPI		
Cronbach's Alpha, overall scale	0.862	
	Cronbach's Alpha if Item removed	Item to total correlation
Alignment	0.892	0.401
Interaction	0.833	0.681
Timing	0.811	0.773
Speed	0.816	0.745
Selective Movement	0.795	0.821

8.2.3.2 External (inter-rater) reliability

Table [viii] summarises the assessment of the consistency of the scores made on different measurement occasions, and by different physiotherapists using the ICC. Overall, external reliability was high (0.959), with individual item reliabilities ranging from 0.874 to 0.968. The p values demonstrate statistical significance of all items, implying that the LMPI has strong inter-rater reliability.

Table [viii]: External (inter-rater) reliability of the LMPI		
	Intraclass Correlation Coefficient	p-value
Average measures all items	0.959	<0.001
Alignment	0.874	<0.001
Interaction	0.931	<0.001
Timing	0.957	<0.001
Speed	0.935	<0.001
Selective Movement	0.968	<0.001

Table [ix] presents the percentage agreement between raters for each item; five items plus twelve raters gives a total number of possible agreements for each item to be sixty. The percentage agreements between total scores for each patient by each rater are also given.

Table [ix]: The percentage agreement between raters when rating individual item and total scale values			
Item	Number of agreements between raters for each item (n=60)	Percentage agreement between raters for each item	Percentage agreement between raters for all items (n=300)
Alignment	37	62%	71%
Interaction	50	83&	
Timing	42	70%	
Speed	39	65%	
Selective Movement	44	73%	
Total scores	21	35%	

The apparently large levels of disagreement represent only small departures from perfect agreement and are not necessarily large discrepancies (Appendix 12).

8.2.3.3 External (test-retest) reliability

Table [x] summarises the results of an item-total rank correlation analysis to assess test-re-test reliability; the value of the correlation coefficient for the full scale is high (0.792) with values of individual items ranging from 0.397 to 0.674; indicating effects of medium size or greater. Furthermore, the corresponding correlation coefficients for individual items of the scale were all statistically significant ($p<0.002$ in all cases).

Table [x]: External (test re-test) reliability of the LMPI		
	Spearman's rho rank Correlation Coefficient	p-value
All items	0.792	<0.001
Alignment	0.397	<0.002
Interaction	0.674	<0.001
Timing	0.516	<0.001
Speed	0.655	<0.001
Selective Movement	0.655	<0.001

8.2.3.4 Measurement error

From the values of the ICC and SD previously obtained, the SDC was calculated to be 1.16, using the method described by Ries et al (2009).

8.2.3.5 Variance components analysis

Table [xi] summarises a variance components analysis that was used to examine the variability of the results, to partition variance into components arising from between-patient variability, between-therapist variability and between-testing variability; as well as from residual variability. The low proportions of variability between therapists and between measurement occasions calculated from this procedure (7.8% and 2.8% of total variability respectively) provide further evidence of the stability of the scale; with, as

might be expected, the largest component of variance arising from natural between-patient variability. This component represents 55.2% of the total variance and 83.2% of all accountable variance.   The high variance between patients reflects the variety of different patient presentations.

Table [xi]: Variance components analysis of the LMPI		
Component	Variance Estimate	% of total
Variance between Physiotherapists	0.467	7.8%
Variance between Patients	3.317	55.2%
Variance between replicate measurement occasions	0.170	2.8%
Residual variance	2.056	34.2%

8.3 Study 2, Phase 3: Criterion validity and clinical sensitivity

8.3.1 Introduction

As previously described (Chapter 7.4), in order to compare scores between the LMPI and the BBS, the Senior Physiotherapist Participants Group was trained, using guidance from ICH-GCP guidelines (ICH-GCP 2000) to recruit NHS patients into Phase 3 of this study.

8.3.2 A description of the participants

Twenty seven patients were recruited; their movement performance was measured by the Senior Physiotherapist Participants using the BBS and the LMPI pre and post course of physiotherapy treatment intervention.   Appendix 13 displays patient demographic data. Age in years of participants recruited ranged from 19 to 76, with a mean age of 49 years and a median age of 62 years. Sixty-six percent of participants were women. Fifty percent were recruited from home, 33% from neurological-physiotherapy outpatient

clinics and 14% from a hospital ward. Fifty-nine percent of participants had suffered

from a stroke; the other participants' diagnoses were of neurological pathology.

8.3.3 Test results pre and post intervention

Appendix 13 displays the results of the Senior Physiotherapist Participants assessment of

their patient's data gathered pre and post physiotherapy intervention. The majority of

patient scores improved. In two cases (patients 4 and 7) the BBS score did not change

post treatment when the LMPI score did, and in three cases (patients 22, 25 and 27),

the LMPI score did not change post treatment when the BBS score did. In one case

(patient 10) neither the BBS nor the LMPI scores changed post treatment. No patient

participants withdrew from the study, and all were able to complete their course of

treatment. Patient participant 12 had the only incomplete set of data. Appendix 13

contains the complete results from this phase of the study, including patient

demographic information and test results.

8.3.4 Data Analysis

8.3.4.1 Criterion validity

Bivariate Spearmans correlation calculation

Tables [xii], [xiii] and [xiv] present the results of the Spearmans correlation calculations

between the LMPI and the BBS:-

- Between the total scores of the BBS and the LMPI pre physiotherapy intervention

   - Table [xii].

- Between the total scores of the BBS and the LMPI post physiotherapy intervention

   - Table [xiii].

- Between the change in scores of the BBS and the LMPI pre and post

  physiotherapy intervention - Table [xiv].

Table [xii]: A Bivariate Spearmans correlation calculations between BBS and LMPI measured pre physiotherapy intervention		
		LMPI pre
	BBS pre	0.468
	p value	0.014

Table [xiii]: A Bivariate Spearmans correlation calculation between BBS and LMPI measured post physiotherapy intervention		
		LMPI post
	BBS post	0.461
	p value	0.015

Table [xiv]: A Bivariate Spearmans correlation calculation between BBS change in scores pre and post physiotherapy intervention and LMPI change in scores pre and post physiotherapy intervention		
		LMPI change
	BBS change	0.473
	p value	0.013

In each case, a moderate correlation is evident between the BBS and the LMPI. All correlations are statistically significant ($p < 0.05$ in all cases). When these results were plotted onto scatter plots (Graph[i]), the variability in correlation is clear.
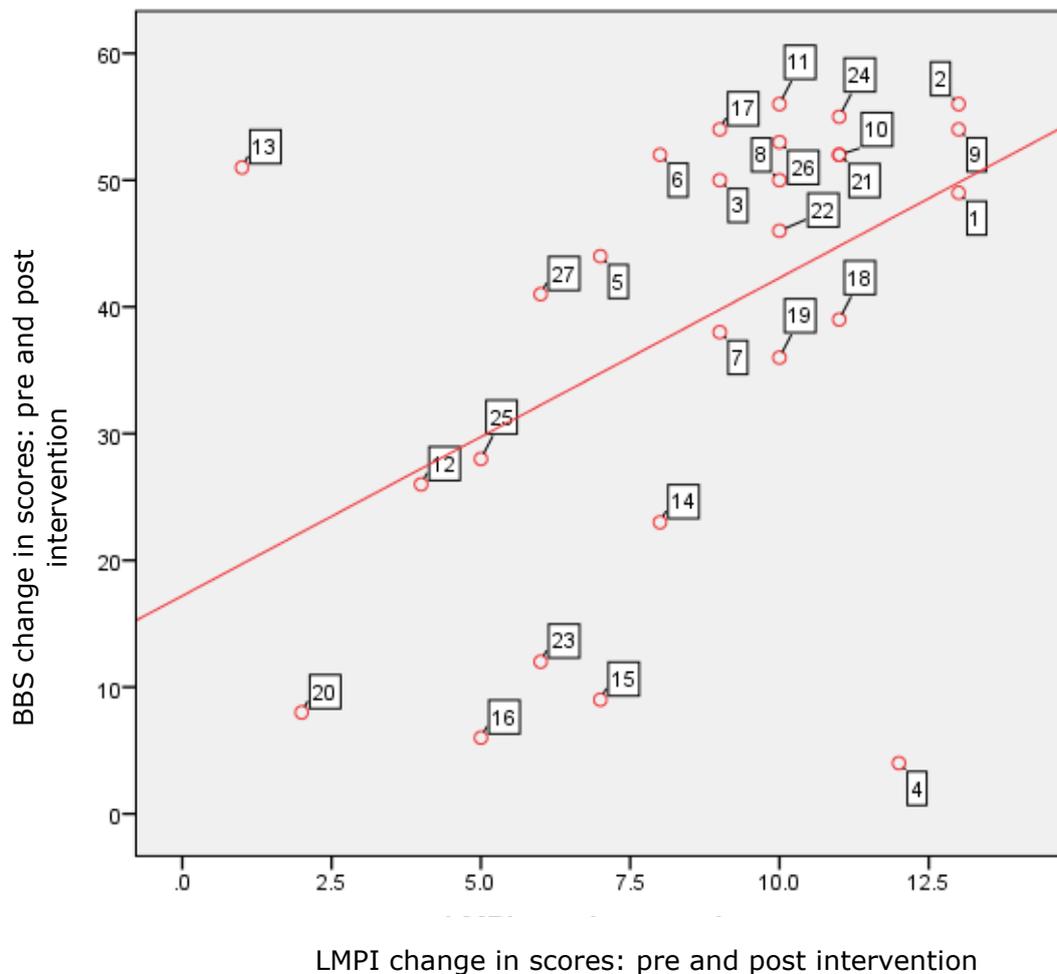
Graph [i] A scatter plot illustrating the linear relationship between BBS change in scores pre and post physiotherapy intervention and LMPI change in scores pre and post physiotherapy intervention

Bland Altman scatter plot

When correlating two tools that measure similar items, in this case the patient's changing movement and balance ability; it is highly probable that the two measures will agree with each other. A Bland-Altman scatter plot (Bland & Altman 1986) was therefore carried out after the results had been standardised (see Graph [ii]).
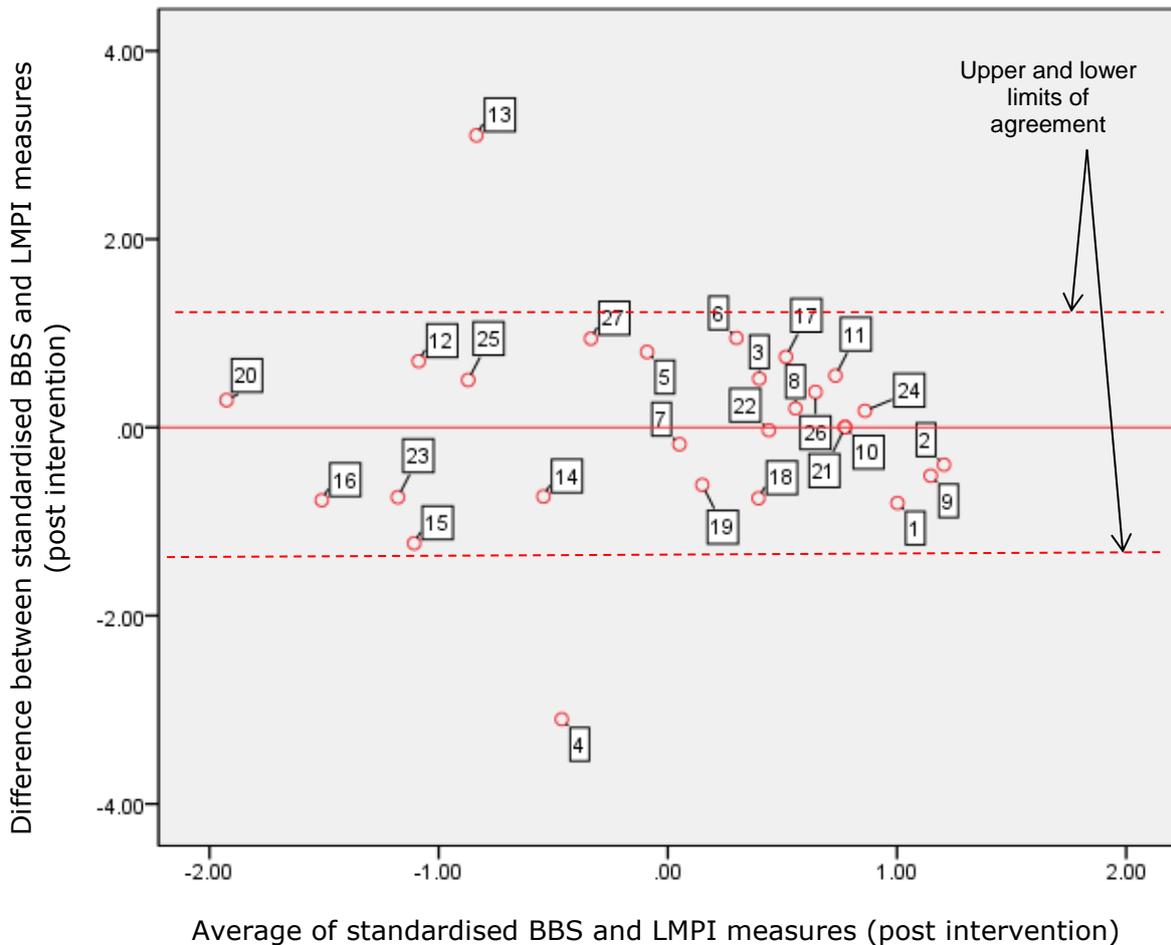
Graph [ii] A Bland-Altman scatter plot between the difference and average of LMPI and the BBS post intervention

There are only two points which lie beyond the upper and lower limits of agreement (defined as 2 Standard Deviations either side of the mean). This is within expectations for a data set of this size and indicates that there is good consistency between the measures.

There is no obvious pattern in the data as you look from left to right, the points seem to be randomly scattered about the zero line. This indicates that agreement is constant over large and small values; i.e. that the level of agreement seen between the BBS and the LMPI does not depend on whether the scores are high or low.

159

This demonstrates: 1) moderate correlation (Graph [i]), 2) consistency whether the patient has a low or high score (Graph [ii]), and 3) a repeatable coefficient of only 2 Standard Deviations (Graph [ii]) (Petrie& Sabin 2009; Bland &Altman 1986) for 93% of the plots. This suggests that a physiotherapist could confidently use this scale with a patient who has major (low score) or mild (high score) movement difficulties.

It is interesting that the scores of patients 4 and 13 do not fit with the trend, and their removal improves both reliability and consistency.

8.3.4.2 Clinical sensitivity

The clinical sensitivity of the BBS and LMPI measures was tested using the 27 patients measured pre and post treatment (see Table [xv]). The mean total BBS score pre-treatment was 31.1; the mean post treatment score was 38.7, demonstrating an improvement in balance. Hence a mean difference of 7.6 was recorded on the BBS measure. This was significant at the 5% level ($p < 0.001$; 95% confidence interval). The mean total LMPI score pre-treatment was 5.78; the mean post-treatment score was 8.56, demonstrating an improvement in movement performance. Hence a mean difference of 2.78 was recorded on the LMPI measure. This was also significant at the 5% level ($p < 0.001$; 95% confidence interval).

Table [xv]: Clinical sensitivity of the LMPI and the BBS		
	BBS	LMPI
Mean total pre treatment	31.1	5.78
Mean total post treatment	38.7	8.56
Mean difference	7.6	2.78

Effect size

The effect size using a Cohen's d statistic (table [xvi]) was calculated as the difference in means divided by the standard deviation of pre and post treatment data measured on 27 patients. This was found to be 0.99 for BBS and 1.52 for LMPI.

Table [xvi]: Effect size, comparison between the BBS and the LMPI		
	BBS	LMPI
Cohen's d statistic	0.99	1.52

Whilst both these effects might be considered to be large in magnitude, the higher value obtained by the LMPI suggests that this measure may have greater sensitivity in the assessment of improvements following treatment than the BBS.

8.4 Summary

Twelve raters were used to test the measurement properties of internal and external reliability, the results are consistently strong, suggesting that the measurement properties are good, and furthermore; because of the number of raters tested, it is suggested that the confidence of the results having a low risk of error is good.

The correlation between the LMPI and the BBS is good, but does not definitively prove consistency; however, the Bland-Altman plot provides evidence that there is good consistency across a range of scores.

Chapter 9: Methods, Study 3: Testing the clinical utility, face and content validity of the LMPI

9.1 Introduction

Study 3 investigated the clinical utility (see Table [ii]) and meaning of the LMPI when used within clinical practice by: 1) The Expert Physiotherapist Group of senior neurological physiotherapists; and 2) the Senior Physiotherapists Participants Group recruited into study 2. The qualitative data that were generated in this study was analysed using Template Analysis as described by King (2014) and King and Brooks (2012).

9.2 Study 3, Phase 1: Clinical utility, face and content validity: Focus Groups with Expert Physiotherapist Group

9.2.1 Design: Focus Groups with national experts

National Expert Physiotherapists (British Bobath Tutors) were recruited to the study, and trained to use the LMPI, using the same training package as the participants in Study 2 Phase 2 (Appendix 9). The participants were asked to use the LMPI during their clinical and teaching practice for six months. At the end of six months, they were asked to attend one of two Focus Group meetings.

9.2.2 Focus Groups

Focus group methodology was specifically chosen so that the group's interactions, discussions and challenges could be used as data (Kitzinger 1994; Smithson 2000). This group of therapists knew each other very well within both work and social contexts, and they naturally discussed and challenged each other's thoughts and perceptions regarding subjects such as the utility of the LMPI.

The Focus Groups were organised using guidance from Kitzinger (1994; 1995) and White and Thomson (1995), it was intended that the Focus Groups would: -

- Have between four and eight participants.

- Have agreed rules e.g. confidentiality (see Appendix 5).

- Be conducted in an informal style.

- Be run for one hour.

- Be audio recorded.

- Use note taking (onto a flip chart) of key themes for immediate validation of the Focus Groups member's important issues.

- Have minimal input from the researcher, other than to introduce specific questions, to request clarification, or urge debate. This was so that participants could be facilitated to move the discussion outside the researcher's knowledge limits, and to ensure all participants had a voice.

9.2.3 Participant eligibility

The British Bobath Tutors Association (BBTA 2014) is a nationally and internationally renowned group of expert neurological physiotherapists who work both: 1) clinically within the NHS, higher education and the private sector, and 2) organise and teach on internationally respected and demanded clinically focused courses, specifically for

specialist neurological physiotherapists and occupational therapists. The headquarters of the British Bobath Tutors Association is based in York.

The British Bobath Tutors Association has 17 members in the UK and Ireland, and all available group members who met the following inclusion criteria below were invited to participate in the research study.

9.2.4 Inclusion criteria

- A member of the British Bobath Tutors Association.

- A Physiotherapist.

- Spends the majority of work time spent treating patients who have a neurological diagnosis, or teaching Physiotherapists to treat patients with movement difficulties caused by neurological impairment.

- Able to complete the study.

- Able to agree to use the LMPI within their clinical and / or teaching practice.

9.2.5 The recruitment of participants and the consent process

The BBTA hold business meetings at the British Bobath Tutors Association headquarters in York twice per year. After approaching the chairperson of the British Bobath Tutors Association, the researcher was invited to attend a business meeting to present the research protocol and to invite British Bobath Tutors Association members who met the inclusion criteria to participate. Both verbal and written information in the form of participant information sheets were given prior to the recruitment of participants (Appendix 4).

9.2.6 The training protocol

The Expert Group Physiotherapists were trained to use the LMPI using the research material developed during Study 2 Phase 1 (Chapter 7) using the same training protocol as the Senior Physiotherapists Participants Group received in Study 2 Phase 2 (Chapter 8). The training was delivered by the researcher and took place within an allocated session during the 'May' business meeting of the British Bobath Tutors Association. Problem solving discussions about the patient's videoed movement enabled the expert physiotherapist participants to apply the LMPI to clinical problems and use the clinical reasoning process to underpin observational assessment and analysis of patient's movement. Once the Expert Physiotherapist Group participants expressed verbally that they understood how to use the LMPI, they were asked to use the LMPI within their clinical and teaching practice.

9.2.7 Use within clinical and teaching practice

The Expert Physiotherapist Group members work in a variety of clinical, academic and private settings throughout the UK (England, Scotland, Ireland and Wales); teaching on National and International courses. They were not asked to recruit their patients to the study, but to use the LMPI for six months within their routine professional practice, in a similar way to how they would use other available outcome measures.

9.2.8 Data collection

Those who provided consent, attended one of two Focus Groups of six participants each, held within allocated sessions during the 'November' business meeting of the British Bobath Tutors Association. The Focus Group structure included the a-priori themes gathered during Studies 1 and 2, that is; 'clinical application, 'ease of use', and 'theoretical underpinning to clinical practice'.

The groups were facilitated by the researcher and at the same time, key observational notes were taken by an assistant (a physiotherapist from the Physiotherapist Research Group) and written onto a flip chart that was visible to the participants. In this way, the participants could give immediate validation of key or important issues. The Focus Group meeting was audio-recorded from start to finish. Each meeting lasted for approximately one hour. The audio-tapes were stored securely.

9.2.9 Sample size estimations

Kitzinger (1994; 1995) and White and Thomson (1995), state that focus groups should have between four and eight participants. Based on 17 potential participants recruited from the British Bobath Tutors Association, it was envisaged that two focus groups would be run, with a third group planned if all British Bobath Tutors Association members consented to participate in the study.

9.2.10 Analysis

The audio tapes were transcribed verbatim into line numbered Microsoft word documents. Cross case Template Analysis was carried out, as described by King (2014). This is described in greater depth later in this section.

9.3 Study 3, Phase 2: Clinical utilisation and reflective writing, Senior Physiotherapist Participants Group

9.3.1 Introduction

The aim of this study was to 1) investigate the clinical utility of the LMPI in greater depth, and 2) to expose the researcher and the LMPI to peer-review, securing the

judgements of the Senior Physiotherapist Participants Group who had been recruited into Study 2 Phase 2.

9.3.2 Design: reflective writing by Senior Physiotherapist Participants Group.

The physiotherapists had been using the LMPI and the BBS within their clinical practice during Study 2 Phase 3 (this phase ran for approximately six months). When this phase came to an end, they were asked to write a piece of reflective work related to their clinical and professional impressions of the LMPI. Guidance in the form of prompts was used in order to focus the participant's responses (see Appendix 14). These prompts were formed by both the a-priori themes and the emergent themes from the Focus Groups and included: 'clinical application', 'ease of use', 'theoretical underpinning to clinical practice'.

Written reflection as opposed to focus groups methods or interviews was decided for this group of participants so that the burden of participation was minimised, this group of therapists worked in different NHS organisations, did not know each other and may not have felt comfortable in disagreeing with or challenging each other or the LMPI.

9.3.3 Eligibility, inclusion criteria, recruitment of participants and consent process

These physiotherapists had previously been identified for eligibility and inclusion criteria, and had consented to participate during Study 2 Phase 2 (Chapter 7) of this research.

9.3.4 Data collection

Once the physiotherapists had written their piece of reflective work, they sent it either by royal mail or e-mail to the researcher. All identifiable information was removed by the researcher, then transcribed or copied and saved into a line numbered Microsoft word document. All data were stored securely.

9.4 Cross case Template Analysis

King (in Cassell & Symon 2004) describes template analysis as a *'varied but related group of techniques'* (p256), as opposed to a distinct methodology that can be used for the thematic analysis of textual data. Using template analysis within this study allowed a pragmatic and flexible means of developing and organising the themes emerging from several textual sources of data, i.e. from the:

- A-priori themes, rich notes taken by the researcher in Studies 1 and 2.
- The two Focus Groups with the Expert Physiotherapists Group.
- The 12 sets of reflective writing from the Senior Physiotherapist Participants Group.

The advantages of using Template Analysis in this study is that it is highly flexible but keeps a structured approach, can be easily understood and followed by an independent observer, different sets of data can be compared and the process can result in a clear description of its results. King (in Cassell & Symon 2004) states that one of the disadvantages of using Template Analysis is that there is only a small amount of literature supporting the method; this could cause potential insecurity for the novice researcher in this study. King (in Cassell & Symon 2004) also warns of the problems of over *'simplification'* or *'complication'* of themes and codes arising as a result of inexperience. To reduce the risk of this, The Physiotherapist Research Group was involved in the analysis of the data, which was then reviewed and audited by the

Doctoral supervision team. With this support, the researcher attempted to create a balance between the need to be open to the data with the need to be structured and organised, because as King advises, novice researchers *"more often suffer from too much openness than too little"* (Cassell & Symon 2004, p269). Although the template analysis will start formally and be a structured and organised process, it is envisaged that this analytical and reflexive process will continue through to the writing up, reporting and discussion of the results. There is little guidance as to the appropriate sample size for achieving saturation point during the analysis of qualitative data; however Guest et al (2006) demonstrated that meaningful themes can typically be identified after the analysis of approximately six sets of data. In this study there are nine sets of semi-structured questionnaires plus two Focus Group transcripts and rich notes taken by the researcher during Studies 1 and 2, it was therefore expected that a good level of saturation would be achieved.

9.4.1 Creating the initial template

An initial template was set up using three a-priori themes: -

- Clinical application theme.
- Quick and easy theme / using the LMPI.
- Theoretical underpinning to practice theme.

These themes were derived during the original conceptualisation and development of the LMPI (Study 1) and the reflexive writing kept during Study 2. Questions that could fit around and develop these themes were agreed during a Physiotherapist Research Group meeting (box [vi]), and used to structure the two Expert Physiotherapist's focus groups in Study 3 Phase 1.

Box [vi]: The emergent a-priori themes from Studies 1 and 2, used to create a framework for questions

Clinical application theme	Quick and easy theme	Theoretical underpinning to practice theme
Does the scale recognise the individual nature of your patient's movement? (content validity)	Does it take long to use? (clinical utility)	Do you think the items in the scale are hierarchical in nature? (content validity)
Can you use it for all of your patients? (clinical utility)		
What patient phenotypes did you use it with? (clinical utility)		How does it compare to other outcome measures that you use or have used? (clinical utility)
What clinical settings have you used the LMPI in? (clinical utility)	Within the patient treatment process, when do you complete it? (clinical utility)	
Is the scale sensitive enough to measure change? (content validity)		Does it underpin your approach to clinical practice? (content validity)
Can the LMPI be related to function? (content validity)		
Are there any missing items in the scale (related to movement only)? (content validity)		
What are its strengths? (content validity & clinical utility)		

Initial emergent themes arising from the Focus Groups were added to this template, which was then used as a basis for the Senior Physiotherapist Groups reflective questionnaire used in Study 3 Phase 2 (Appendix14). Questions were further generated within the Physiotherapist Research Group around these themes:-

- Clinical application.

- Ease of use.

- Theoretical underpinning of clinical practice.

- Would you change the LMPI?

- Any problems using it?

- Your involvement in the research process.

- The training package.

- The testing process.

In this way, the a-priori themes were added to so that the initial template was developed before the formal analysis of the textual data.

9.4.2 Organisation into higher order and lower order codes

Once completed, all auditory data were transcribed verbatim into line numbered word documents and stored electronically. All handwritten documents were transcribed into line numbered word documents and stored electronically. The researcher then 'immersed' herself in the data by:

- Reading the text several times.

- Reading the text whilst listening to the audio-recorded Focus Group meetings.

- Noting the a-priori themes and codes by underlining and highlighting text.

- Noting further issues of relevance in the test, and inserting them into the template. New codes were devised for these emerging themes.

- Using the original template to organise and record the themes and codes as they emerged.

- Grouping themes (lower order codes) into higher order codes (which describe broader themes).

- Changing the scope of the codes if it became apparent that they had greater significance or breadth than was originally intended.

- Changing the classification of the lower or higher order codes or moving them to different groups as appropriate.

- Recording the process clearly and stepwise, using photographs of the data as it was coded, and saving progressive versions of the Template as it developed.

Alongside this analytical process, validation of the researcher's analysis was sought and established in four different ways:

1) During a Physiotherapist Research Group meeting, where the transcribed anonymised reflective questionnaires were thematically analysed within the group.

2) A senior neurological physiotherapist not previously involved with the research study but who followed the analytical process described above using one of the Focus Group transcripts.

3) An academic supervisor with appropriate published experience of using Template Analysis (McCluskey et al 2011) independently analysed one of the Focus Groups and three anonymised reflective questionnaires.

4) Discussion of the process, a-priori themes, emerging themes and codes with the supervision team.

Using Physiotherapists in this way, gave insight and understanding into the potential 'meanings' and language of statements and reflections. Using the supervision team in this way, gave scientific knowledgeable guidance and direction throughout the process.

9.5 Summary

In this study, it was intended that clinical utility would be examined. A multi-centre mixed methods research design has been used in order to gather the a-priori themes to initiate Template Analysis. Figure [ix] 107) summarises and demonstrates the interaction between all aspects of the study.

Chapter 10: Results, Study 3: The clinical utility, face and content validity of the LMPI

10.1 Introduction

This section of the results will present the analysis of the qualitative data gathered throughout this study (Figure [xviii]), i.e.: -

- A-priori themes that emerged during the analysis of the qualitative data gathered during the pilot work during Study 1.

- Field notes taken by the researcher during Study 2.

- Two Focus Group transcripts.

- Eleven semi-structured questionnaires.

A cross case template analysis (King 2014) method was chosen to allow the a-priori themes to be used to develop an initial coding template; applying an inductive organised process of analysis that focussed on the real life experiences of using the LMPI within clinical practice. The field notes, Focus Group transcripts and semi-structured questionnaires data were then mapped onto the initial code template, modifying it until all relevant data were coded satisfactorily. Although the data were combined for the purposes of analysis, the themes emerging from both groups and each senior physiotherapist participant were coded so that comparisons, agreements and oppositional relationships could be seen and discussed.
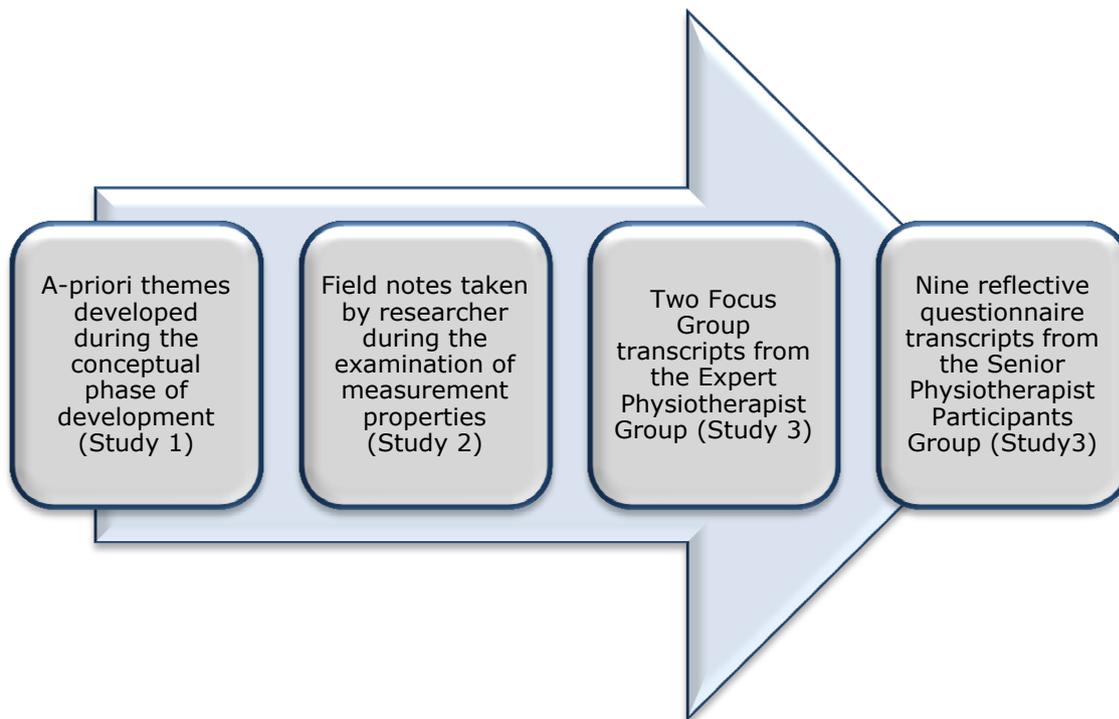
10.2 A-priori themes

The a-priori themes were identified during the analysis of the results that emerged during the conception of the LMPI, and were discussed within a Physiotherapist Research Group meeting, the key a-priori themes were agreed as: -

- 'Clinical application'   The application of the LMPI into clinical practice

- 'Using it'   Related to the mechanics of using an outcome measure

- 'Theoretical underpinning of practice'   Related to the culture and concept of neurological physiotherapy treatment approach

10.3 Field notes

The field notes taken throughout all three phases of Study 2 were analysed by reading and re-reading them, highlighting, and then extracting key themes; these themes enriched the a-priori themes and were used to develop a framework of questions for the

Focus Groups. Questions and prompts were identified to be used within the two Focus Group meetings and a table format (Box [vi]) was designed in order to facilitate the balance required between the need to create a relaxed informal atmosphere whilst ensuring that similar questions were asked to both groups.

10.4 Study 3, Phase 1: Clinical utilisation and Focus Groups with Expert Physiotherapists Group

10.4.1 A description of the participants

Twelve of 17 British Bobath Tutors Association members were recruited to the study then trained to use the LMPI using the same training package that was used in Study 2. The participants were then asked to use the LMPI during their routine clinical practice for six months. At the end of this time, they were asked to attend one of two Focus Group meetings and all participants agreed. One participant was unable to attend the Focus Group meeting, therefore Focus Group One contained six participants, the other contained five, the memberships were chosen randomly just prior to the meetings, which were run consecutively. The clinical and professional experience of these participants was extracted from the British Bobath Tutors Association website (BBTA 2014) to establish their expert standing. Within this group, the participants had been working as physiotherapists between 15 and 41 years; had been qualified as Bobath tutors between 8 and 27 years; 42% of them were 'advance' tutors' and 58% of them had a professionally related MSc.Most of the participants worked within a combination of roles, e.g. private practice, physiotherapy team leader, strategic roles within neurological physiotherapy and higher education. The participants were geographically located throughout all of the UK, and were considered to be strongly representative of expert opinion, having significantly greater experience than the members of both the Senior Physiotherapist Participants and the Physiotherapy Research Groups.

10.4.2 A description of the Focus Groups

Both Focus Groups ran for approximately one hour, the conversations were audio-recorded and notes were taken onto a flip chart by a research assistant (a member of the Physiotherapy Research Group) for immediate validation by the group members. As soon as the Focus Group meeting had finished, the flip chart notes were reviewed and agreed by members. Both sets of audio recordings and flip chart notes were transcribed into line numbered Microsoft word documents.

10.4.3 The preparation of the semi-structured questionnaires

An initial review of the transcribed data revealed six emerging themes which were used to structure the reflective questionnaires planned for use in Study 3 Phase 2. The initial emergent themes were that the LMPI appeared to: -

- Be sensitive to clinical demands.

- Be able to be focused on the individual patient.

- Be able to be used for any patient with a motor control difficulty.

- Underpin the physiotherapist's theoretical concept towards their treatment approach.

- Reflect and / or support clinical reasoning.

- Be of potential educational value.

10.5 Study 3, Phase 2: Clinical utilisation and reflective writing, Senior Physiotherapist Participants Group

10.5.1 A description of the participants

As previously discussed in Chapter 8, 12 senior physiotherapists were recruited to this study. Their experience of using the LMPI was:-

1) During the reliability and validity testing within Study 1 Phase 2.

2) During Study 1 Phase 3 where they recruited a small sample of their patient caseload, then measured their patients using the LMPI and the BBS pre and post intervention.

Once Phase 3 of Study 2 was completed, the physiotherapists were asked to complete a reflexive, semi-structured questionnaire based on the initial emergent themes from Study 3 Phase 1 (above), once they were completed, the participants sent them to the researcher via royal mail or e mail.

10.5.2 Sample size

Table [xvii] presents the proportion of data received from each participant. Eight participants recruited a small proportion of their patient caseload into the study; ranging from one to six patients. Nine participants returned the questionnaires (two non-respondents gave no reason, the third reported that their workload was too high to justify on-going participation), the completed and returned data were transcribed into line numbered word documents, then analysed using cross case template analysis.

Table [xvii] : Number of patients recruited during Study 2 Phase 3, and number of returned reflective questionnaires by the Senior Physiotherapist Participants Group

Senior Physiotherapist Participant number	Recruited patient number		Returned reflective questionnaire
1	1 2 3	13 21	No
2	none		Yes
3	none		Yes
4	14 15	18	Yes
5	16 17	20 27	Yes
6	19		Yes
7	12 22		No
8	none		Yes
9	10 11		Yes
10	none		Yes
11	4 6 23	24 25 26	Yes
12	5 7	8 9	Yes

It was questioned whether there was a relationship between the number of patients recruited and the number of year's post-graduate experience of the physiotherapy participants; this was investigated using a correlation coefficient. No relationship was found ($r = 0.069$) and the correlation was non-significant ($p = 0.830$) (Graph [iii]). There were no other quantifiable variables recorded regarding the physiotherapists except gender, and this cannot be used because the members of Senior Physiotherapist Participant Group were female except one.
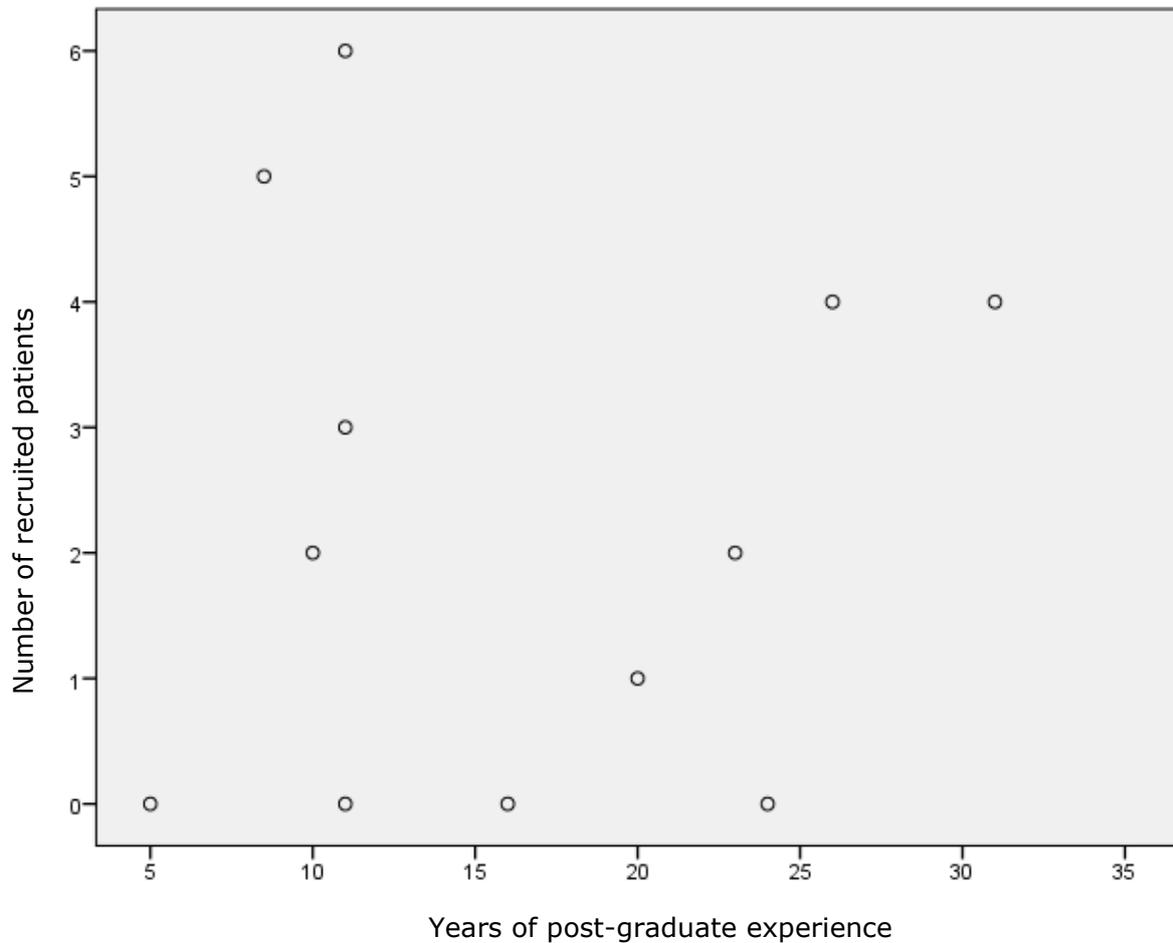
Graph [iii]: A Correlation Coefficient to examine a possible relationship between number of years post-graduate experience (of the Senior Physiotherapist Participant Group) and number of patients recruited

Appendix 11 presents the demographics of the members of the Senior Physiotherapist Participants Group, and as previously discussed, the population of this group is representative of the clinical population of senior neurological physiotherapists employed by the participating organisations within Yorkshire.

10.6 Template analysis

Field notes, Focus Group transcripts and semi-structured questionnaires data were mapped onto an initial code template (made up of the a-priori themes), modifying it until

all relevant data were coded satisfactorily. In order to maximise quality and validity, the process was recorded so that an audit trail was clear (Figure [xiv]).

10.6.1 Template Analysis validity

Independent scrutiny was accessed, providing validity of the interpretation of the data:

1. By the Physiotherapist Research Group who reviewed and discussed the completed reflective questionnaires (from the Senior Physiotherapist Participants Group).

2. By an independent senior neurological physiotherapist (not previously involved with the research), who reviewed and discussed one of the Focus Group transcripts with the researcher.

3. Samples of the qualitative results were independently reviewed by an experienced member of the supervisory team, and then a joint review with the researcher provided an element of clinical interpretation.

Figure [xix]: Thematic analysis process using cross case template analysis

1) 'Noted' a-priori themes

2) 'Noted' additional themes that emerged as a result of reflexivity and rich note taking during study 1

3) Read Focus Group transcripts & questionnaire transcripts several times, highlighted themes

4) Used 'post it' notes to organise a-priori themes and emerging themes into codes

8) Based the organisation of the data on a template used by Atwal et al (2011)

9) Resulted in coding template – Figure [xv]: final code template

10.6.2 The overarching themes emerging from the data

Once the template analysis process was complete, the a-priori themes and emergent themes were examined in more detail. As described by King (2014) the reflexive nature of template analysis continues throughout all the stages of reading the data, recognising the emergent themes, organising the themes into codes and then writing the report. King suggests the benefit of pragmatic reasoning to support the timing of the decision about when to halt the analysis, so that the conflicting priorities of maximising the validity and depth of analysis, with the time constraints of Doctoral research can be met.

Two overarching main themes have emerged from the data:

1. Related to a theoretical context.
2. Related to the clinical utility of the LMPI.

One lesser main theme emerged from the data:

3. Related to the research process.

A report of the findings is now presented using the 'Final Code Template' (Figure [xv]) as a framework structured around the main themes and sub themes, supported by illustrative quotes taken from the data.

Overarching themes	Main sub-themes	Sub-themes

Theoretical context

Clinical application
- Teaching tool
  - Junior staff
  - Course participants
  - Teaching the patient
- Clinical reasoning

Theoretical underpinning of practice
- Quality of movement
- Individual nature of movement
- Related to function / goals / patient specific

Outcome measures
- Comparison with other outcome measures
  - GAS
  - BBS
- Outcome measures in general
- About the LMPI as an outcome measure
  - Items in the scale,
  - Score criteria
  - Novel use of the LMPI

Clinical utility
- Ease of use
  - Difficult to use
  - Easy to use
  - General issues of use
- Strengths / weaknesses
- Time it takes to use
- When did you use it?
- What pathologies it was used with
- Sensitivity
- Subjectivity

About the research process
- During Study 2, Phase 2, testing of measurement properties
- Involvement in the research process
- Ethics
- The training / video

Figure [xx]:
Final Code Template

183

10.6.3 The 'key' for data source

Table [xviii] presents a reference key to the sources of the data presented to support each of the themes described below.

Table [xviii]: The source of data extracted from the results of the Template Analysis	
Study 1 field notes = S1line…	
Focus Group One= FG1, line…	
Expert Physiotherapist Participant 1 = EP1	Senior Physiotherapist Participant 2 = P2line…
Expert Physiotherapist Participant 2= EP2	Senior Physiotherapist Participant 3 = P3line…
Expert Physiotherapist Participant 3= EP3	Senior Physiotherapist Participant 4 = P4line…
Expert Physiotherapist Participant 4= EP4	Senior Physiotherapist Participant 5 = P5line…
Expert Physiotherapist Participant 5= EP5	Senior Physiotherapist Participant 6 = P6line…
Expert Physiotherapist Participant 6= EP6	Senior Physiotherapist Participant 8 = P8line…
Focus Group Two = FG2, line….	Senior Physiotherapist Participant 9 = P9line…
Expert Physiotherapist Participant 7= EP7	Senior Physiotherapist Participant 10 = P10line…
Expert Physiotherapist Participant 8= EP8	Senior Physiotherapist Participant 11 = P11line…
Expert Physiotherapist Participant 9= EP9	Senior Physiotherapist Participant 12 = P12line…
Expert Physiotherapist Participant 10= EP10	
Expert Physiotherapist Participant 11= EP11	

Ten themes are presented, three of which stem from the a-priori themes: 'clinical application', 'using it' and 'theoretical underpinning to clinical practice', the remainder have emerged through the process of data analysis. Appendix 15 contains the complete results.

10.6.4 A report of the overarching themes

There are three overarching themes

- 'Theoretical context' which is further divided into three main sub-themes of 'Clinical application', 'theoretical underpinning of practice' and 'outcome measures'.
- 'Clinical utility'.
- 'About the research process'.

10.6.4.1 Theoretical context

Clinical application

This is a main sub-theme, containing the two further sub-themes of: 'teaching tool', and 'clinical reasoning'. Within the sub-theme of 'teaching tool', there are three further themes of 'junior staff', 'course participants' and 'teaching the patient'.

Teaching tool

Teaching tool for Junior staff:

A key theme emerging from the data of the Focus Groups was the interest in using the LMPI as a tool to develop less experienced staff, namely: 1) the junior physiotherapists who work with the Expert Physiotherapists within their clinical practice and 2) the physiotherapists who attend Bobath courses run by the Expert Physiotherapists:

> EP5: *"if you were working with junior staff it could be really useful because you could actually be very specific you would say "when we are looking at alignment of the leg these are the things we are look for"* (FG1,line 48)

> EP3: *"In the end the categories are really good so the delineation in the different areas is great because they are things that you actually want to get across about how people move so that is why I definitely think that as*

185

a teaching tool a training tool for junior / staff grades it is very useful because it really homes in on the key things you want people to look at in movement rather than - can they can't they? - sit to stand? – tick" (FG1, line 60)

EP8: "*It has a feel that it could be a good nurturing tool in a teaching situation for supervision, and looking at the components - and you have picked your 16 components; your junior has three ....what components were they missing? - and I think it could be a good teaching tool for supervision in that respect."* (FG2, line 223)

In contrast, only one Senior Physiotherapist Participant commented on the use of the LMPI as a teaching tool for junior staff:

P5: "*Some of our team are now using the LMPI and finding it quick and easy to use and a good way of teaching junior staff and students. Also it is useful for the senior staff to bring us back to the 'bread and butter' analysis of human movement"* (P5, line 75).

This may be because the Senior Physiotherapist Participants had limited experience of developing more junior staff, whereas the expert group all had considerable and on-going experience of teaching within their clinical work setting and on organised post graduate courses, or, that during the research window they did not have junior staff working with them so did not have the opportunity to consider using the LMPI in a teaching context.

The Expert Physiotherapists all felt that there was potential for the LMPI to be used as a teaching tool both within clinical and teaching practice:

> EP7:   *"We need as many tools on the course as we can to get the course participants to be able to see what we see and understand what we understand"* (FG2, line 267)

> EP7:   *"it makes the less skilled practitioner to look more closely at what they are doing, then they could use it at the beginning of the course – a three week basic course or an advanced course – maybe it is a better tool for the advance course for themselves or with their partner - scored the patient on day one and then rescored the patient on day five"* (FG2, line 282)

Teaching tool for the patient:

The same Senior Physiotherapist Participant described above (P5) also thought that the LMPI was useful to help educate their patients:

> P5:   *"Using the LMPI meant that an explanation was given to the patient about quality of movement, …….. therefore it was useful as a teaching aid"* (P5, line 37)

Clinical Reasoning

This was a very popular theme; it emerged from the data numerous times, Although the phrase 'clinical reasoning' was not always specifically mentioned, discussions about movement analysis, the underlying reasons for the patient's movement difficulties, and

linking treatment plans to assessment are all recognisable topics beneath the umbrella of 'clinical reasoning'. During a site visit in Study 2, the researcher noted that the LMPI:

S1   *"…promoted discussion around movement analysis"* (S1, line 31).

The Expert group found that:

EP6   *"….I wonder in relation to those points the challenging aspect of it is because actually when you are clinically reasoning in practice. And I agree I think that categories are really nice categories and really pertinent categories to consider but when you are working with a patient you are kind of considering them in relation / together / as a whole. to each other so if we are going to improve the interaction between body parts or body segments you are considering in relation to alignment in relation to background activity.* (FG1 line71)

EP3   *"… it actually DOES reflect the complexity of movement in that it throws up a lot of questions for me …that is what I felt about it"*. (FG1,line 57).

Examples of how the Senior Physiotherapist Participants felt included:

P12   *"The biggest impact I felt personally, was on my clinical reasoning and treatment planning/implementation, using the tool I felt clarified/justified my reasoning and made my treatments much more goal specific. (P12line30)*

P11   *"Helped tailor analysis and treatment plan and remind me it's OK to focus on one part during a treatment session e.g. arm and that can influence the whole patient and their movement patterns more effectively sometimes than spending a little time on the whole of them"* (P11line23)

P10   *"I felt the LMPI does recognise the individual nature of patient's movement. It makes you look more specifically"* (P10, line 1)

Theoretical underpinning of practice

This theme links very closely with the 'clinical reasoning' theme because it is related so closely to clinical practice; however, they are separated because of these specific differences:

- 'Clinical reasoning' occurs during and within clinical practice.

- 'Underpinning an approach to clinical practice' relates to the phenomenon and the paradigm of practice.

In general, all physiotherapists felt that the LMPI underpinned their approach to clinical practice and the sub-themes of this section fall into three separate categories: 'Quality of movement', 'Individual nature of movement' and 'Related to function'. The focus of the Senior Physiotherapist Participants tended to lean towards the analysis of movement and clinical reasoning aspects of the theory underpinning their intervention. Whereas the focus of the Expert Group Physiotherapists trended towards the analysis of movement and the teaching of the analysis of movement:

Quality of movement

During site visits, the researcher noted that:

S1   *"the LMPI was good because it's not just that they* (the patients) *can perform the function, but how well they can perform it".* (S1, line 89).

Physiotherapist P5 noted that:

P5:   *"It is easy in community* (meaning; working with patients in their own homes) *to become quite functionally focused and using the LMPI has been a good reminder to look at quality of movement first"* (P5, line 41)

The Expert Physiotherapists also discussed the quality of movement with reference to the LMPI:

EP1   *"What has come up with in my mind for what it is worth is it is a bit like ice dancing and standing up with high performance - 6 technical merit - and 5.8 for artistic impression rather than it being in the Olympics - it would be the timed race - the outcome measure would be the timed race it is who is first at the post it is a quantitative measure - where this is much more the ice dancing of the measure."*

EP6   *"But that is a very good analogy"* (FG1, line 226)

Individual nature of movement

The ability to recognise and reflect the movement performed by individual patients appeared to be very important within both groups of participants. The bio-mechanics of movement are very personal and can be influenced by age, gender, body mass, previous injury and illness, occupation, and the environment and culture in which the individual lives.

> EP9: *"The fact that it is very individual and it is subject to someone, sometimes it's very helpful, for some of our patients, to support, to show the changes that they have."* (FG2, line 218)

> P10: *"I felt the LMPI does recognise the individual nature of patient's movement. It makes you look more specifically"* (P10, line 1)

An Expert Physiotherapist in Focus Group One thought that:

> EP6: *"in essence it DOES recognise an individual nature"* (FG1, line 15),

An Expert Physiotherapist in Focus Group Two thought that not only was the LMPI able to recognise the individual nature of movement, it was also able to manage the complexity of movement by simplifying it.

> EP7: *"a strength of it is it breaks movement down into components"* (FG2, line 447).

> EP10: *"It prompts you to break things down into components. The measure itself does not break them down. It prompts the clinician to"* (FG2, line 466).

A Senior Physiotherapist thought that the LMPI was the:

> P11: *"only outcome measure I have come across that looks at each component of normal movement, measuring quality rather than just ability"* (P11, line 5).

Related to function and the patient's treatment goals

In general, there was agreement that the LMPI could be related to function, a Senior Physiotherapist Participant thought that the LMPI:

> P6   *"Could be related to patients function and goals, for example, for patient to be able to stand up from wheelchair……..look at:*
>
> - *weight bearing through affected LL* (lower limb)
>
> - *adaptability of foot during movement*
>
> - *trunk and UL* (upper limb) *alignment during movement"* (P6, line 16)

An Expert Physiotherapist thought that:

> EP6: *"it was those patients where you inherently know they are not going to look hugely different but they can FEEL different but that can be very relevant to them in their overall function"* (FG1, line 375).

In contrast to this statement, there was also a feeling in the Focus Groups that the LMPI was not related to function:

EP1: "*I was looking at a particular alignment issue with regard to a very small body part I was not relating it to function but I thought it might work out that way but it did not*" (FG1, line 104).

Outcome measures

Comparison with other outcome measures

Both groups of Physiotherapists compared the LMPI to either other non-specific outcome measures, or to other specific popular ones. One Senior Physiotherapist Participant wrote that she*:*

P6   "*could use LMPI for all patients, but more likely to use it for patients where other OM's* (outcome measures) *do not fit. For example, low level patients who may score '0' on Trunk Control Test on admission and discharge, but may actually demonstrate improvement in posture, head control, etc. This would be detected on LMPI but not necessarily on TCT* (Trunk Control Test)*. Could also be used for patients with bilateral deficit, for example GBS* (Guillain-Bare Syndrome) *or TBI (*Traumatic Brain Injury*) where OM's such as MAS* (Motor Assessment Scale) *do not fit. Also useful for UL (*upper limb*) changes, which may not be functional but may demonstrate an improvement in posture, alignment or hand contactual responses."*(P6,line1).

This Physiotherapist indicated that the LMPI could: 1) be patient focused, and 2) be generalisable across different pathologies; whereas other available outcome measures are constrained by floor and ceiling effects, insufficient depth of analysis and are often validated for patients who have specific pathologies.

The Expert Physiotherapists compared the LMPI with GAS

EP7: *"For me it* (the LMPI) *is almost quite subjective like the GAS goal where you can choose and you can fit it to your patient population because you can choose any aspect of movement to look at different components and then allocate it so it should fit to any patient"* (FG2, line 24).

The Expert group also stated that:

EP8: *"This is looking at the qualitative normal movement aspect but on the GAS score you can only have one or two variables – one variable really – so you can have lots more variable with this measure"* (FG2, line 161).

Although the LMPI is compared favourably with GAS, within their clinical practice, the Expert group appeared to prefer to use GAS because it was an established outcome measure. The Senior Physiotherapist Participants group did not compare the LMPI with GAS.

In comparison with the BBS

The Senior Physiotherapist Participants compared the BBS to the LMPI, probably because they were using it in conjunction with the LMPI during the research of Study 2 Phase 3:

P9: *"The patient was often unaware that I was using the measure. In contrast, the BBS or timed walk etc. needs the patient to cooperate which can have an effect on the outcome"* (P9, line 45).

Physiotherapist 12 noted that:

> P12: *"The Berg Balance is a very objective outcome measure which lots of patients like as they can see clear measures taking place (involving stopwatches and tape measures etc.) however I feel it is a superficial measure looking only at tasks and not the quality of movement involved in achieving them"* (P12, line 22)

Outcome measures in general

Focus Group Two participants had a short discussion about the use of outcome measures in general:

> EP7: *"We at Xxxxxxx (a three week Bobath course that was being run at an NHS hospital in the UK) last week we were trying to get relatively skilled practitioner's to use GAS but it was difficult very difficult.*
>
> EP9: *I think it is the time*
>
> EP8: *They had the time on the course – they had the time.*
>
> EP7: *Lack of experience was a big excuse. There is a huge lack of experience no matter how much we talk about this health service and the fact that every practitioner should be measuring change on their patient. We found amongst 18 course members last week we found quite considerable lack of ability to do that"* (FG2, line 294)

About the LMPI as an outcome measure

As an outcome measure, the LMPI was liked because of its association with movement quality; and a good example of this is Focus Group One's discussion of this topic:

EP1: *"What has come up with in my mind, for what it is worth, is it is a bit like ice dancing and standing up with high performance - 6 technical merit - and 5.8 for artistic impression rather than it being in the Olympics - it would be the timed race - the outcome measure would be the timed race it is who is first at the post it is a quantitative measure - where this is much more the ice dancing of the measure.*

EP4: *But that is a very good analogy"* (FG1, line 226)

The Senior Physiotherapist Participants also found that:

P2: *"LMPI was clinically useful and more individual to patient".* (P2, line 26)

And that:

P2: *"the LMPI acknowledges grades of deficits rather than an individual movement patterns"* (P2, line 2).

Sub-themes within this main theme were related to 'items in the scale' and the 'score criteria'.

<u>Items within the scale</u>

There was discussion within the Expert Physiotherapist Focus Groups and reports from the Senior Physiotherapist Participants about the words and terms used within the LMPI. During Study 1 the researcher noted that one of the Senior Physiotherapists Group thought that:

S1:   "*Different terms / jargon would be easier*" (S1, line 6).

However, the consensus appeared to be that all participants liked the items within the LMPI

EP8:   "*the interaction with the base of support*" is also a huge strength of it *because it gets missed in a lot of measures it is important to the concept that I practice" (*FG2, line 215).

EP7:   "*I liked the fact that it has alignment in it because that is where we often start and I think that is useful with all of the patients we looked at because you are looking at an optimal alignment to underpin the other things so an optimal alignment will underpin the on-going interaction of the patient with gravity and their supporting surface and the on-going - the alignment will underpin the timing, the sequence of movement, the speed and the selectivity. That I think is a strength - it really, that it facilitates the person who is doing the measure to look critically at the alignment and not just function – the task*" (FG2, line 207).

The 'speed' item was considered by one Focus Group member to be:

EP1:   "*very difficult to deal with because you say the ability to choose how fast or slowly - well it depends and that made it very hard to categorise - put a number to that*" (FG1, line 107).

None of the Senior Physiotherapist Participants commented on the 'speed' item

When asked if they thought that anything was 'missing' from the scale, the Focus Groups thought not:

EP8: *"From a movement component perspective – I don't think so, it covers all bases"* (FG2, line 305),

EP7: *"it is comprehensive and appropriate"* (FG2, line 334).

In contrast, two of the Senior Physiotherapist Participants thought that changing the score system may be useful:

P5: *"Sometimes it is hard to pick a score from 0-3 and wonder whether allowing ½ scores would be useful"* (P5, line 53);

P4: *"could be more sensitive with 5 scores allowed, to help distinguish between scores of 2 and 3"* (P4, line 9).

Score criteria

Within both Focus Groups, there were considerable lengthy discussions around what was meant by the phrase 'theoretical optimum' within the score criteria.

EP10: *"I found that extremely difficult because I did not know whether if I was looking that the theoretical optimal performance of that person before their injury or after"* (FG2, line 91).

Both Focus Groups discussed the issue and came to similar conclusions. Focus Group One concluded that the theoretical optimum could be related to the prognosis as a result of assessment and analysis:

EP4: *"There could never be a '3' because they were never going to have enough recovery to be back to their previous level it was the theoretical optimal performance and I was not clear on that whether I should be judging them against : prior to their assault or the best I thought they could be post lesion".*

EP3: *"Your best prognosis."*

EP6: *"Which is what I was doing"* (FG1line122)

Focus Group Two also related prognosis to the theoretical optimum, along with a reflection related to the patient's pre-morbid ability:

EP7: *"So how did you score optimal how did you score his theoretical optimal performance?"*

EP11: *"Against what I thought he might be able to achieve"*

EP7: *"With his diagnostic"*

EP11: *"Yeh along with the patient's diagnosis. But obviously I had no idea of where he might be able to go to - and this is a guy who declined in terms of his functional ability over a period of time so I was trying to move him back.*

EP7: *"To where it was. To where his optimal was"* (FG2, line 344).

Interestingly, in contrast, only one of the Senior Physiotherapist Participants commented on the 'theoretical optimum':

P6:   *"Scale somewhat subjective. Quite difficult at times to consider patients "theoretical" normal* (P6, line 11).

P6:   *"What if patient surpasses their theoretical normal? Is there a ceiling effect? Or does it mean we have scored wrong previously?"* (P6, line 14)

Focus Group One questioned what should be done with the score:

EP6:   *"for example measuring sit to stand - well yes I could get a different set of scores as part of the overall sit to stand - but it is a bit like what Xxxxx* (another Focus Group member) *says - I am not quite sure what we do with them at this stage do you add them up, do you highlight, that is where the score changed, that is where the score did not change, and the aspect of sit to stand that you are actually recording change of very much impairment level aspects - you see what I mean?"* (FG1, line 206).

In contrast, none of the Senior Physiotherapist Participants noted that this was a problem or a weakness of the LMPI.

Neither the Expert nor the Senior Physiotherapists thought that the LMPI was hierarchical, commenting that:

EP2:   *"I was working with a patient who needed to improve his selective planter-flexion in terms of terminal stance and sit to stand so I was working very specifically on his selective movement of his planter-flexors so that was the most important aspect, because that was effecting everything else and strength was an issue, so in that respect the most important thing for him was... the hierarchy did not even come into it".* (FG1, line 315).

The Senior Physiotherapist Participants were in agreement:

> P12: *"The importance" of the items in the scale varied with each individual patient, for example; in some patient's selective movement was the key limiting factor, in others it was alignment and in some patients all items were equally affected."* (P12, line 34)

Novel use of the LMPI

Both Focus Groups and the Senior Physiotherapist Participants all discussed using the LMPI not only as a measure of outcome, but also: -

1) To support their clinical reasoning.

2) To teach more junior staff within the clinical setting, i.e. 'on the job' training.

3) To teach Bobath course participants (senior neurological physiotherapists attending an organised course) how to analyse and assess movement control.

4) To help patients to understand their movement control difficulties.

10.6.4.2 Clinical utility

Ease of use

This sub-theme includes discussions within the Focus Groups and thoughts from the Senior Physiotherapists related to: 'difficult to use', easy to use' and 'general issues of use'.

Difficult to use

In general, the Expert Physiotherapists Group found the LMPI quite challenging to use, one member in particular found it difficult, stating:

EP3: "*and I thought it would be straight forward and I actually found it much more difficult than I expected to*" (FG1, line 7*).*

EP5: "*I would have to say when I started using it - and I did a couple - I thought I had missed the point I thought I was getting something fundamentally wrong because I was feeling so challenged by it. I found that quite difficult*" (FG1, line 28).

EP7: "*but I felt that I did not understand what I was doing fully and I still think I do not understand what I am doing fully.*" (FG2, line 77)

Easy to use

In contrast, when three of the Focus Group Two members were using the LMPI together in a patient treatment session, they reported that:

EP8: "*It was very fast it gave us a good score and showed big change*" (FG2, line 34*).*

EP7: "*there were flashes of greater understanding through discussion with my colleagues that I had not had when I had done it on my own*" (FG2, line 85).

In contrast, the Senior Physiotherapist Participants consistently found it easy to use and due to the nature of this research, had only used the LMPI as sole practitioners:

P5 "*quick and easy tool to try and bring quality of movement back into a busy workload*" (P5, line 5)

Problem solving discussions with Senior Physiotherapist Participants during the site visits of Study 1 Phase 3 were noted by the researcher to be helpful in supporting the use of the LMPI.

S1:   *"I found myself teaching and advising successfully; I make this judgement from their interaction with me, and their reception of what I said"* (S1, line 80)*.*

General Issues of use

One Senior Physiotherapist Participant felt that:

P9:   *"I wasn't always sure what to measure and often tended to use functional activities rather than specific muscle activity"* (P9, line 23)

Strengths and weaknesses

The Focus Groups were not specifically asked about the strengths or weaknesses of the LMPI, whereas the Senior Physiotherapist Participants were; there was strong agreement with the comments about the strengths of the LMPI:

P9:   *"Easy to complete, Quick to complete, Focuses on normal movement, Appropriate for patients with neurological problems"* (P9, line 70)

P5:   *"aids analysis and observation of movement. It is quick and easy to use and adaptable and sensitive"* (P5, line 55)

P12: *"easy to use, facilitates treatment planning and goal setting, I found it a sensitive measure"* (P12, line 44)

P6: *"same thought process we use every day, looks at quality"* (P6, line 46)

There were differing opinions about the weaknesses of the LMPI:

P9: *"Not always sensitive enough, would reflect negatively on patients with progressive disorders, Limited to therapists with neurological interest"* (P9, line 75)

However, it could be argued that this would be the case with any outcome measure used for a person with a degenerative neurological condition:

P5: *"the items feel a little repetitive as there is a blurring of meaning between some of them. For instance, alignment is similar to interaction and timing is similar to selective movement. Sometimes it is hard to draw a distinction between items that are only subtly different"* (P5, line 58).

P12: *"Not always as easy for the patient to understand what we were measuring (compared to say the Berg)"* (P12,line 46).

P6: *"not well enough known yet, unable to compare patients (if we wanted to!), Use of jargon (wordy, for junior staff)"* (P6, line 49).

Time it takes to use

The Senior Physiotherapist Participants also found it quick to use:

> P5:   *"The LMPI tool itself does not take long to use and because of this it will be very useful clinically and more likely that clinicians will use it"* (P5, line 24).

But deciding what to measure could take some time, reporting that the LMPI was:

> P6:   *"Quick to use, although deciding on what to measure, why and how takes a little longer."* (P6, line 24)

In contrast, the Expert Physiotherapists found that the tool took too long to use:

> EP3:   *"I think that in real world people increasing under pressure with time it that would be pursued as a negative I think even if it was useful it would be take too long I think"* (FG1, line 424),

Even though they also reported that when using it with two fellow participants within a patient treatment:

> EP8:   *"It was very fast it gave us a good score and showed big change"* (FG2, line 34).

When did you use it?

This question was used in an attempt to understand 'when'; within the treatment session or during clinical record keeping the LMPI was used. For example pre-treatment and post treatment to measure effects of intervention, post treatment to record 'best performance' during the treatment session, or post treatment and pre-treatment to measure carry-over of treatment effects from one treatment session to the next. The Expert group reported:

> EP5:   *"I thought I quite liked the idea of best performance"* (FG1, line 195),

Whilst a Senior Physiotherapist Participant stated:

> P5:   *"When using the LMPI, I generally scored from memory during the record keeping and the patient usually had no awareness of the process other than the initial consent"* (P5, line 34).

This again indicates flexibility of the LMPI towards the requirements of the patient and the therapist.

What pathologies it was used with

This question was asked, because one of the aims during the development of the LMPI was to be able to use it to measure across the spectrum of neurological conditions and it was clear that the LMPI was used successfully with several pathologies, Focus Group One discussed:

EP2:   *I think it could be used for any condition. I think you could use it with any*

         condition

ALL: agreeing

EP5:   *not just neurological conditions -ANYTHING about movement and the*

         indicators and categories apply to any bodies' movement   - for anyone,

         any area.

EP2:   *Yes. I think so.*" (FG1line 353)

Senior Physiotherapist Participant 3 reflected that:

P3:   "*all types of neuro pathologies and all levels of impairments. The types of*

         pathologies I used were: stroke, MS (multiple sclerosis),*brain tumour but I*

         could see its use in other neuro pathologies. (P5, line 10).

However, in contrast, Physiotherapist 10 found:

P10:   "*I could not use it for all my patients as many of our patients are very*

         early strokes….It was more suitable for patients who were a few weeks

         into their rehab and outpatients" (P10, line 3).

So although the LMPI was adaptable to be used for different pathologies, there appeared
to be some constraining factors to its use which were dependent on the physiotherapy
intervention that the patient was receiving.

Sensitivity

There were mixed reports within the area of sensitivity, from:

> P5:   *"very specific to each patient and this means that it can be sensitive"* (P5, line 4);

To:

> P2:   *"possibly not good to use for severely neurologically impaired patients as may not be sensitive enough to small changes. This may also apply to high level patients who may also have subtle changes"* (P2, line 36),

And:

> EP7:   "*… I found the high level patient I could not get a reasonable picture of the high level patients using the scale so it was more useful with the complex patient who had more serious alignment, impairment, movement dysfunction issues than the high level patient who made, for me in respect of their goals for the weeks treatment, made significant changes but were difficult to record. I needed something that was more sensitive"* (FG2, line 6).

In contrast, Physiotherapist 12 thought that the:

> P12:   "*… LPMI reflected not only the treatment goal but considered how the goal was achieved, by measuring the various components involved such as; timing / interaction etc. which are often over looked in other tools, this I thought made it quite a sensitive measure"* (P12, line 4)

Subjectivity

Both groups thought that the LMPI was subjective:

EP8:   *"when I did it in combination with two of my tutors it felt like you could pick something and you could quickly go through it but it was slightly subjective"* (FG2, line 31).

One Senior Physiotherapist Participant quantified her statement:

P12:   *"intrinsically it is a subjective measure (which could be a weakness), but because of the items in the framework which are very clear and specific this makes it as objective as possible"*

10.6.4.3 About the research process

The Senior Physiotherapist Participants group was asked how they felt about being part of a Physiotherapy research project, they commented on several factors:

During Study 2, Phase 2, testing of measurement properties

During Phase 2 the researcher noted that:

S1:   *"they cannot remember their scores from the first set of tests and they thought they would"* (S1, line 19).

And also that at the re-test session:

> S1: "*Participants felt they were being quicker with their scoring, they felt more confidant, they were just 'going for it'. Felt they were being harsher with scores. Reported that using the LMPI felt easier*" (S1, line 60).

These observations are interesting, considering the suggested strength of the LMPI's internal consistency and external reliability.

Involvement in the research process

The Senior Physiotherapist Participants group were asked how they felt being part of physiotherapy focussed research project:

> P9: "*Initially I felt some reluctance to take part due to limited time and extra demands to fill in forms and attend meetings. However I found the research of particular interest as it was specifically designed for neuro-patients. The support and encouragement given to me by the lead, and other colleagues provided motivation*" (P9, line 80)

> P12: "*I found the whole process very interesting especially as the research had a very clear remit, physiotherapy focus, and clinically of great professional interest*" (P12, line 51)

During their participation in Study 2, testing the measurement properties of the LMPI, there was some trepidation of how they would perform:

P5: *"This was a bit challenging in that there was some anxiety as to whether the results might vary widely, but it was a good task to do from a personal development aspect"* (P5, line 73)

P12: *"The re-testing was absolutely fine, less threatening than anticipated"* (P12line65)

P2: *"The test re-test was good, I had no recollection of what I'd recorded in the 1st session so it was planned in a timely manner"* (P2, line 55)

Ethics

Although the Physiotherapists within Senior Physiotherapist group had been trained how to recruit patient participants using the International Conference on Harmonisation – Good Clinical Practice Guidelines (ICH-GCP 2000), they found it time consuming, and therefore restricted the number of patients that they potentially could have recruited:

P9: *"The project would have been easier if patients had not needed to agree to taking part"* (P9, line 85)

This is probably due to the fact that these physiotherapists were not active researchers, and were recruiting patients without additional resource to their caseload.

The training / video

In general, the Senior Physiotherapist group enjoyed this process, although some of them also found it challenging:

P2:   *"The training was really good, the video clips were useful and doing the training in groups where discussion was possible helped to gain understanding of the assessment"* (P2, line 50)

10.7 An overview of the results from Studies 2 and 3

A strength of using mixed methods research is that both qualitative and quantitative results can be presented together to provide a richer insight of the research outcomes. This section will present the data gathered from Senior Physiotherapist Participants 5, 11 and 12, namely that of; intra-rater reliability (Study 2 Phase 2), the patient participants they recruited (Study 2 Phase 3) and their written semi-structured reflections from Study 3. These physiotherapist's data were chosen because they:

- Attended the training provided.

- Completed study 2 Phase 3.

- Recruited the most number of patients.

- Returned their written reflections.

This section of analysis was framed around the main sub-themes within the final code template (Figure [xv]) with reference to the quantitative results so that a more in-depth analytical interpretive style could be used.

10.7.1 Senior physiotherapist participant 5

This Physiotherapist works in a neurological specialist community rehabilitation team and at the time of the research had been qualified for 27 years, alongside on-going informal and formal in-service training she had completed a post-graduate certificate in adult neurology, a basic (three week long) Bobath course and a Professional Diploma in MS.

When testing the LMPI, this Physiotherapist's intra-rater reliability, as measured using Spearman's rank correlation coefficient, was 0.918. This is greater intra-rater reliability than the corresponding value for the entire group (r=0.792). That is, Physiotherapist 5 is probably better than the overall group, but this cannot be certain, because although the value is higher, it is only based on five pairs of readings, and hence is less trustworthy than the lower value of 0.792 which applies to the whole group.

This Physiotherapist recruited three men and one woman (patient numbers: 16, 17, 20 and 27), aged 19, 56, 72 and 76 (respectively), and provided their physiotherapy intervention within their own homes. Their diagnoses causing neurological impairments were traumatic brain injury, cerebral meningioma and stroke. The Physiotherapist used the LMPI to measure movement during standing in all four of the participants and recorded change in both the LMPI and the BBS (Appendix 13). When the correlation was observed between the LMPI and the BBS scores for these patients (Graph [i]) it would appear that these patient's scores had a weaker correlation, however when the same patients are observed in graph [ii], it is clear that the results are consistent with the rest of the group. There are no indications within either the qualitative or quantitative data that would suggest why this participant was able to recruit more patients.

10.7.2 Senior Physiotherapist Participant 11

This participant works in a combined role: 1) within a neurological physiotherapy out-patients clinic, and 2) on an acute and rehabilitation stroke and neurology unit. At the time of the research, had been qualified for 11 years and alongside on-going informal and formal in-service training had completed a basic (three week long) Bobath course.

This Physiotherapist's intra-rater reliability, as measured using Spearman's rank correlation coefficient (r = 0.782), was comparable to the rest of the group.

This Physiotherapist recruited three men and two women into Study 1 Phase 3 (patient numbers: 4, 6, 24, 25 and 26), aged 58, 74, 59, 49 and 64 (respectively), and they received physiotherapy on the hospital ward (one patient) or in the neurological physiotherapy out-patient clinic (four patients) settings. Their diagnoses causing neurological impairments were sub-arachnoid haemorrhage (four patients: - three resulted in moderate impairment and one with severe impairment) and stroke (one patient). The Physiotherapist used the LMPI to measure movement during sit to stand (two patients), sitting (one patient with leg activity, one patient with arm activity), and walking (one patient). All but one patient demonstrated change in the LMPI, all but one patient demonstrated change in the BBS (Appendix 13). The patient who had unchanging LMPI scores (patient 25) only changed by one point with the BBS, despite having 17 weeks of treatment intervention between tests. Interestingly, the patient who had unchanging BBS scores (patient 4) showed a significant effect of treatment when the LMPI was used, patient four's results also demonstrated a significant variance within the scatter plot illustrating the linear relationships between the LMPI and the BBS (Graph [i]) and the Bland Altman scatter plot (Graph [ii]).

There are no indications within either the qualitative or quantitative data that would suggest why this participant was able to recruit more patients.

10.7.3 Senior Physiotherapist Participant 12

This participant works in a combined role: 1) as a specialist neurological clinical team manager, and 2) within a neurological physiotherapy out-patients clinic. At the time of the research, the participant had been qualified for 31 years and alongside on-going informal and formal in-service training had completed a basic Bobath course and a Masters module for the administration of botulinum toxin for spasticity. This

Physiotherapist's intra-rater reliability, as measured using Spearman's rank correlation coefficient (r = 0.761), was comparable to the rest of the group.

This Physiotherapist recruited one man and three woman (patient numbers: 5, 7, 8 and 9), aged 62, 41, 52 and 62 (respectively), they were recruited and received physiotherapy on the hospital ward (three patients) or in the neurological physiotherapy out-patient clinic (one patient), their diagnoses causing neurological impairments were multiple sclerosis (one patient) and stroke (three patients). The Physiotherapist used the LMPI to measure movement during sit to stand (two patients), walking (one patient) and during a transfer from treatment plinth to chair (one patient). All participants demonstrated change in the LMPI, all but one participant demonstrated change in the BBS (Appendix 13). The patient who had unchanging BBS scores (patient 7) showed a moderate effect of treatment when the LMPI was used, but did not show significant variance within the scatter plot illustrating the linear relationships between the LMPI and the BBS (Graph [i]), and the scores were consistent within the group (Graph [ii])

There are no indications within either the qualitative or quantitative data that would suggest why this participant was able to recruit more patients; however, she worked in the same department as Senior Physiotherapist Participant 11 which may have given a motivational element to them both.

An assumption could be made that all Senior Physiotherapist Participants had similar work pressures related to working for the NHS, with the focus on maximising efficiency within their caseloads. The differences in recruitment levels may be due to motivation to be research active, availability of patients who were able to consent to participation, or high level skills of workload prioritisation.

10.8 Summary

The analysis of the quantitative data gathered Study 2 suggests that the LMPI; when used by senior neurological physiotherapists is a reliable and internally consistent measurement tool which is more clinically responsive and has greater effect size than the BBS when used within this study.

The data that emerged during the thematic analysis of the transcribed data from Study 3, gathered from a representative group of senior NHS physiotherapists and internationally acknowledged expert physiotherapists suggests that the LMPI has been found to be clinically useful in that:

1. It underpins neurological physiotherapy approach to observational assessment.
2. It supports the clinical reasoning process.
3. It could potentially be useful as a teaching or educational tool.
4. Although is quick to use would need support and training to be used most effectively.

However, some issues were identified in relation to the language of the score criteria, especially in respect to the phrase "theoretical optimum".

A combined overview and analysis of both the qualitative and quantitative data enabled a more in-depth and richer examination of the results from three members of the Senior Physiotherapist Participants Group. Within this research, the homogenous representation of: 1) patients, in terms of their pathology and treatment location, and 2) physiotherapists, in terms of their clinical speciality (within neurological physiotherapy), experience and skills would suggest that these results could be generalised within the profession. As a consequence of the methodology used within the development and testing of the LMPI, strong face and content validity has also been achieved.

Chapter 11: Discussion

11.1 Summary

The results of this research indicate that the LMPI can be reliably and validly used to measure the movement quality status of people with neurological conditions causing motor control impairment, irrespective of their age, gender, pathology or movement difficulties. It can be applied to any component of movement that is affected, at any point during the rehabilitation pathway, irrespective of the severity with which the motor control is impaired, and can also be directly associated to the patient's functional rehabilitation goals. Most importantly, the LMPI has also been found to fill a 'gap' in knowledge: all three groups of Physiotherapists involved in testing the measurement properties found that the LMPI could capture the quality of their patient's movement. Furthermore, during the course of this research, it also emerged that the LMPI is a tool that: supports clinical reasoning and intervention, can potentially be used as a framework for the education and development of less experienced physiotherapists, and reflects the theoretical knowledge that underpins both senior and expert physiotherapist's approach to assessment, analysis and prediction of treatment outcome. The use of the LMPI can be directed towards the measurement of a 'status' or 'snap shot' of the condition of a patient's movement quality, both during baseline assessment and analysis at outcome, thus making it a novel tool within this field.

Within modern neurological physiotherapy practice, there are no outcome measures that capture the patient's quality of movement, or the specific effects of physiotherapy treatment. Through intervention, neurological physiotherapists intend to harness their patient's ability to neuro-plastically change, teaching them to develop motor control at

'impairment' level. Consequently the patient relearns 'normal' movement, which in turn, according to the WHO model (WHO 2001), enables them to gain more efficient function and independence, having significant impact on their 'life'. Thus, there is a gap within clinical practice: neurological physiotherapists and their patients can both see and feel a difference in quality of movement pre and post intervention, but with the exception of kinematic techniques, there are no outcome measures that can capture this change in quality of movement (Paci 2003). It was hypothesised that the Leeds Movement Performance Index (LMPI) would be a more valid, reliable and clinically useful tool for use in modern neurological physiotherapy practice than other available existing outcome measures. At the outset, it was understood that a measurement instrument could not just be 'made up'; and as a consequence of this, the conception, development and testing of the LMPI were subject to rigorous, evidence based procedures (Table [ii]).

Figures [vii], [viii] and [ix] (pages 99, 100 and 105 respectively) give pictorial presentations of the research process, but to briefly re-cap: a multi-centre, three-part mixed methods study was undertaken. Study 1 (Chapters 5 and 6) describes the creation and pilot testing of a new outcome measure using the qualitative methods of nominal group, Delphi and semi-structured face-to-face interviews. Study 2 (Chapters 7 and 8) uses psychometric techniques to illustrate the measurement properties of the LMPI, namely; internal consistency, external reliability, criterion validity and responsiveness. Study 3 (Chapters 9 and 10), using the qualitative method of Template Analysis, further explores the content validity and clinical utility of the LMPI.

11.2 Strengths

A Strength of this research, is that the development and testing of the measurement properties of the LMPI were theoretically driven using a gold standard, conceptual, development and testing framework, adapted and designed around key literature from

within the field of patient reported outcome measurement (Table [ii]; Johnson et al 2011). Furthermore this is the first within the field to do this. A global approach was employed, requiring a combination of quantitative and qualitative methodological paradigms as described by Johnson and Onwuegbuzie (2004).

Since the design and completion of this research, new evidence has been published that enables the rating of the methodological quality of the development and testing of patient reported outcome measures. The COnsensus based Standards for the selection of health Measurement Instruments (COSMIN) (Mokkink et al 1010; Terwee et al 2012) were developed within the international arena using the knowledge of international experts. Although the LMPI is a clinical outcome measure, and not patient reported; it was felt that the rigour of the concepts of COSMIN were a thorough method of evaluation of the methodological quality of both development and testing, and could be appropriately applied to the LMPI. The COSMIN framework was used to assess the properties of the LMPI alongside the BBS, the TIS and GAS; this evaluation is available within Appendix 16.

11.2.1 The use of mixed methodology

Employing a mixed methods design has created strength within this study. Using a scientific, experimental and reductionist approach to Study 2 (Chapters 7 and 8), and using a holistic, descriptive, phenomenological and illuminative approach to Studies1 and 3 (Chapters 5, 6, 9 and 10 respectively); has resulted in the investigation and analysis of the properties of the LMPI, and gained 'real life' insights into the professional practical use of a unique way of measuring movement performance by different groups of physiotherapists. This knowledge can be generalised within the profession because of both the range of clinical settings that participants (both physiotherapists and patients)

were recruited from, and their respective range of levels of clinical skills, experience, expertise, pathology and impairment.

Furthermore, as figure [ix] demonstrates (reproduced on page 224 from page 107); the qualitative and quantitative methods were not compartmentalised, but used iteratively to inform the research progression, enhancing the validity of the results.

- Content validity was examined using focus groups and reflective questionnaires. It was also established within the testing of the measurement properties. Firstly, the movement of patients suffering from neurological damage receiving neurological physiotherapy intervention was videoed. Secondly, the patient's movement was rated by neurological physiotherapists.

- Rich reflective field notes were recorded by the researcher during the quantitative phases of Study 2, and then used to inform and build on the a-priori themes that had emerged in Study 1. The a-priori themes provided the initial source of questions for the focus groups and reflective questionnaires, and established the initial template for the analysis of the qualitative data.

- During the analysis of the qualitative data, quantitative information (such as individual physiotherapist's intra-rater reliability) was used to enrich possible explanations to the impressions and reflections given by the Senior Physiotherapist Participants group.
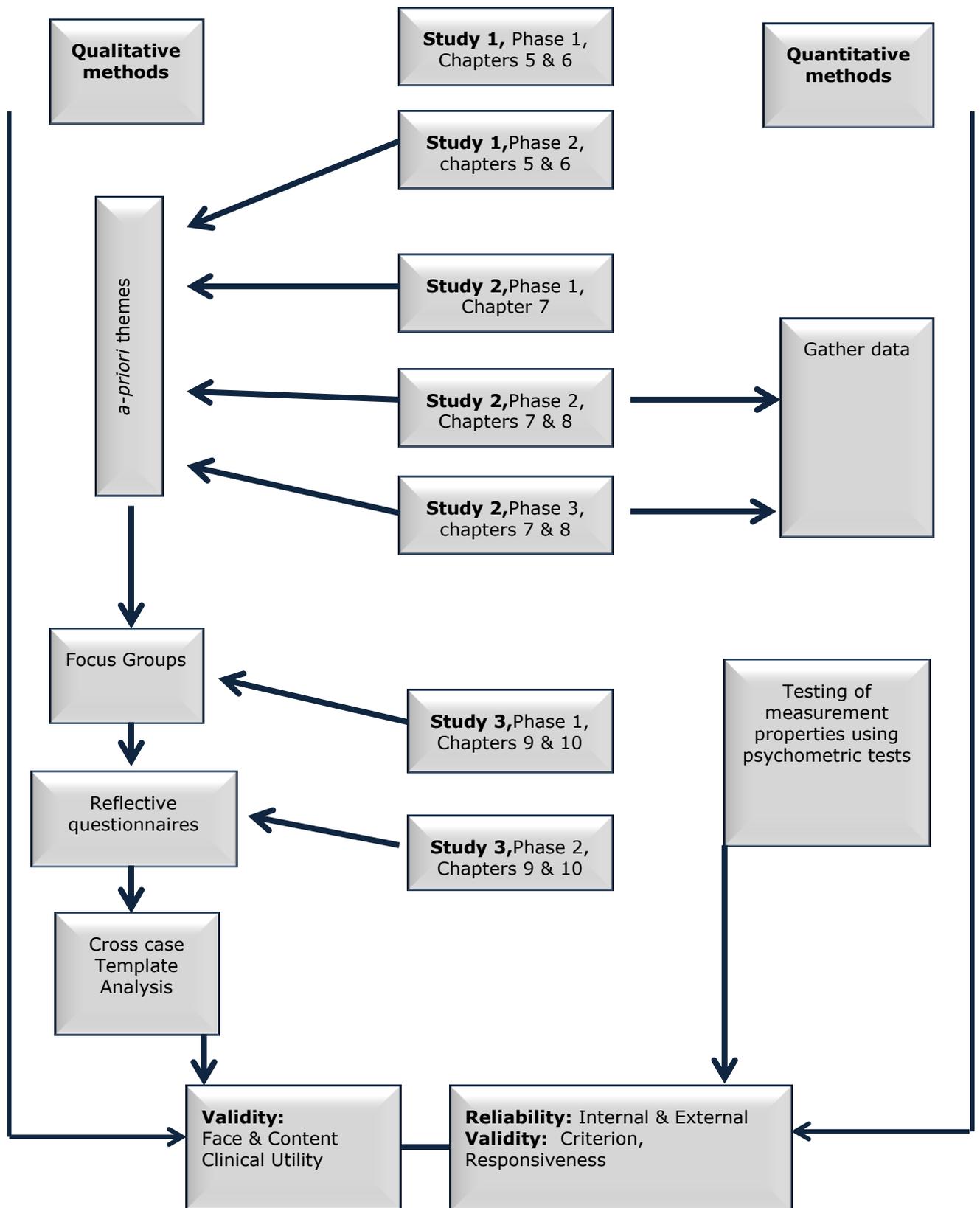
Figure [ix] – re-produced from page 106: A summary of the mixed methods design used throughout Studies 1, 2 and 3

Therefore, using a mixed methods design worked well, giving the research an interlacing of both quantitative and qualitative processes and analysis, this design gave the results depth and validity which could not have been achieved with the individual use of either methodology (Rauscher & Greenfield 2009).

The concept of using mixed methods research within the Physiotherapy profession is interesting. Culturally, physiotherapists are scientific and are generally pragmatic by nature, however, within clinical practice, there is a strong drive to treat patients as individuals. Hence, treatment plans are individualised to help patients to manage their movement difficulties within their physical and social environment, thus reflecting the bio-social model of the World Health Organisation's International Classification of Function Disability and Health (WHO-ICF) (WHO 2001) (Figure [i]). Consequently, the LMPI will not be accepted if it is not found to be clinically useful. Being accepting of both methodological paradigms and so finding a third paradigm that suited the requirements of this research project enabled the convergence and corroboration of evidence (Rauscher & Greenfield 2009) to provide both a scientific validation and a practical endorsement of a novel way of assessing, analysing, measuring and possibly teaching these skills to less experienced physiotherapists.

11.2.2 Content validity

Once the LMPI had been designed (Study 1, Chapters 5 and 6), the need to scientifically establish its reliability and validity became clear. To further support both initial face and content validity, patients with neurological pathology and senior neurological physiotherapists (the Senior Physiotherapist Participant Group) with no connection to its origin, were recruited to investigate internal and external reliability and validity (Study 2, Chapters 7 and 8). To understand the clinical utility of the LMPI, both the Senior Physiotherapist Participant Group and internationally acknowledge experts (the Expert

Physiotherapist Group) were invited to critique its use after they had experience of applying it within their practice (Study 3, Chapters 9 and 10).

The face to face interviews used within the pilot work of Study 1 (Chapters 5 and 6) may have been influenced by 'personal interest' researcher bias; but this risk was foreseen and contained because similar information was gathered from both the Senior Physiotherapist Participants and the Expert Physiotherapists Groups.   Johnson et al (2011) advocate the use of clinicians in these ways, so that good face and content validity is assured; and similar methods were also utilised by Berg et al (1989) and Horak et al (2009) during the development of the BBS and the Balance Evaluation Systems Test. The use of these methods and the resulting findings suggest robustness of the LMPI and comparability with other work within the field.

The use of focus group methods within Study 3 (Chapters 9 and 10) using the Expert Physiotherapists Group, was intended as the ultimate test of clinical utility and content validity of the LMPI; thus meeting the methodological requirements within figure [ii] and the COSMIN framework (Terwee et al 2012). The clinical skills and experience of the participants were similar to each other (Krueger et al 2000), and greater than those of the researcher; thus increasing the quality of the information gathered potentially outside her knowledge base. It was expected that the participants would openly discuss, disagree if necessary, and explore their knowledge in depth and how the LIMP may relate to their practice. It was not feasible to bring together a group of experts within this clinical field who did not know each other, and so, potential bias was managed in other aspects of this method (FocusGroupTips.com (n.d.) by:-

- Minimising moderator bias:

  The moderator did not offer opinions.

- Avoidance of biased questions:

The questions and topics were pre-prepared; general prior to specific questions, and positive prior to negative questions were asked.

- Avoidance of biased answers:

The moderator created a calm atmosphere, recording independent notes in conjunction with audio-recording; challenging discussions were responded to in a tactful and honest way.

- Minimised biased reporting:

More than one individual / group of analyst(s) were used; independent notes on a flip chart were kept during the Focus Groups, and then shared with participants for immediate validation.

Again, focus group methods fulfil the suggestions of Johnson et al (2011) and this approach is seen within the literature (Table [iv]), for example, other researchers have used focus group methods, but much earlier in the process (Howe et al 2006); or other types of consensus group methods (Horak et al 2009; Daley et al 1999) or interview (Berg et al 1989; Gorman et al 2010) in order to gain feedback during the development of instruments. No other researcher groups within the field of outcome measures aimed at patients with movement impairment have used focus groups similar to those used within this thesis, suggesting that the clinical utility of the LMPI has been tested more robustly, and to greater depth than others within the field.

11.2.3 Measurement properties

Using the COSMIN framework; the LMPI was critiqued alongside the BBS, the TIS and GAS (Appendix 16); the findings suggest that the properties of the LMPI are comprehensive, meeting the requirements of Table [ii], and stronger than those of the BBS, the TIS and GAS because mixed methodology was used.

Internal consistency of the LMPI was rated as "excellent" according to table [ii], comparable to the BBS (Berg et al 1989; Mao & Hsueh 2002), and stronger than the TIS (Verheyden et al 2004).

Test re-test reliability of the LMPI was rated as "substantial" according to table [ii], but not as strong as those found for the BBS (Berg et al 1989; Berg et al 1995; Liston & Brouwer 1996; Farlow et al1997; Mao & Hsueh 2002; Hiengkaew et al 2012) or the TIS (Verheyden et al 2004; Verheyden et al 2006b; Verheyden et al 2006c). However, assuming the perceived greater clinical judgement required to use the LMPI, together with its perceived greater sensitivity (given the floor and ceiling effects of both the BBS and TIS, and emergent themes from the Template Analysis in Study 3, Chapter 10); it should be expected that the test re-test reliability of the LMPI should not be exceptionally strong, and that it should perform differently to other less sensitive scales. Nonetheless, it is still within acceptable levels.

Inter-rater reliability was found to be "excellent" according to Table [ii] and compares well to the BBS (Berg et al 1989; Berg et al 1995; Farlow et al1997; Bennie et al 2003; de Figueiredo et al 2009; Leddy et al 2011), the TIS (Verheyden et al 2004; Verheyden et al 2006c) and GAS (Joyce et al 1994), the latter of which was interestingly only found to be strong if the raters were familiar with the patient being tested. The testing of the LMPI using patient videos enabled blinding of the raters, thus overcoming this potential issue.

The measurement error using the Smallest Detectable Change (SDC) of the LMPI is small in comparison to the SDC of the BBS which has been found to have a range of values from 4 to 6.2 according to the study being reported (Stevenson 2001; Steffen & Seney 2008; Donoghue & Stokes 2009; Hiengkaew et al 2012; Quinn et al 2013; Godi et al

2013). This would suggest that the LMPI has greater sensitivity than others within the field, and could thus have significant impact both within the clinical and research arenas.

Criterion validity of the LMPI was tested by comparing and correlating LMPI and BBS scores for a group of patients' pre and post intervention. The results demonstrate only moderate agreement, which should be expected because although similar constructs were being measured, i.e. movement; the items within the scales measure different components of motor control. There is argument within the COSMIN group (Mokkink et al 2010), that criterion validity should not be tested against a scale that is not of 'gold standard'. However, there are no gold standard outcome measures available within this field. In this study, the use of the BBS for comparison with the LMPI is justified on the grounds that it:-

- Has strong clinical resonance.
- Has strong concurrent validity with other measurement instruments and rigorously tested measurement properties (Appendix 1)
- Meets the requirements of Table [ii] better than any other within the field.

In practice, the LMPI is unlikely to have strong criterion validity with any of the outcome measures currently in use, because it assesses and measures a different construct of movement i.e. quality of movement.

Interestingly, studies examining the agreement between patient and clinician perceptions of change with an 'outcome measure' have been carried out for both the BBS during its development (Berg et al 1989); and more recently within the field of neurological rehabilitation with GAS (Joyce et al 1994; Khan et al 2008). Testing the agreement between the LMPI and patient and / or clinician perceptions of change seems an area worthy of future exploration with the LMPI.

11.2.4 Clinical utility

The COSMIN group (Terwee et al 2102), do not rate or include clinical utility within their framework; but it was included in this study because it was present in Table [ii] and also perceived to be an important barrier or facilitator for the use of outcome measures within neurological physiotherapy clinical practice (Chapter 2). Within the literature associated with the BBS, the TIS and GAS, some work has been published that relates to this concept. For example, two groups of researchers within the incomplete spinal cord population (Datta et al 2009; Lemay & Nadeau 2010; Datta et al 2012) have considered clinical utility for the BBS, but they did not use qualitative methods and their results did not agree: one group felt that the BBS was clinically useful (Lemay & Nadeau 2010) whilst the other did not (Datta et al 2009; Datta et al 2012). Several studies have reported the clinical utility of GAS: Joyce et al (1994) used clinical observations of the authors; Reid & Chesson (1998) used two case studies; Khan et al (2008) used quantitative methods, comparing GAS with other outcome measures; and Turner Stokes et al (2010) used quantitative methods to compare the sensitivity of GAS with other outcome measures. No previous studies have used a mixed methodology to explore clinical utility. This research has used a combination of quantitative and qualitative methods indicating that the LMPI is robust, and further strengthened by 'real life' insights from a range of clinical settings, conditions and levels of clinical skills, experience, expertise, pathology and impairment.

Responsiveness

Within this thesis, responsiveness has been reported in terms of measurement error and effect size, it also emerged from the Template Analysis, that the physiotherapists suggested that the LMPI was able to assess very specific improvement after physiotherapy intervention. When assessing clinical responsiveness and effect size of an outcome measure, the results to some extent must be dependent on the variability of

the patients (their diagnosis, prognosis and neuroplasticity) and the expertise of the physiotherapist. In Study 2 (Chapter 6), when the LMPI and BBS were administered pre and post intervention by the same physiotherapist (i.e. neither the patients nor the physiotherapists varied); the LMPI was compared favourably with the BBS demonstrating greater responsiveness and larger effect size; and whilst the BBS and LMPI results were both above 0.80 (the suggested criteria for 'large' within Table [ii]), the LMPI's were greater. Furthermore, the effect size of the BBS found within this study is comparable to those found by Wood-Dauphinee et al (1997), Amasut (2009), Hackney and Earhart (2009), and Mao & Hsueh (2000), thus re-enforcing the reliability of results. No comparisons can be made with the TIS because no data is available; however, the effect size of GAS is comparable to that of the LMPI (Ashford & Turner- Stokes 2006; Kahn et al 2008; Turner- Stokes et al 2009; Turner-Stokes & Williams 2010).

Respondent burden and ease of use

This quality, although considered by the COSMIN group (Mokkink et al 2010), was not included within the contributors to Table [ii], is nonetheless important because of the factors that can inhibit or facilitate the use of outcome measures within neurological physiotherapy clinical practice (Chapter 2).

Swinkels et al (2011) found that one of the main contributions to the low use of outcome measures within physiotherapy clinical practice, was that those available did not address the area to which intervention was directed, that is, the patient's impairment; another was that the patients preferred to be 'treated' as opposed to 'tested'. Yoward (2008), Jette et al (2009) and Swinkels et al (2012) found that outcome measures might be utilised more if they could demonstrate treatment effectiveness, direct a treatment plan and improve quality of treatment. The emergent themes from within Study 3(Chapter 10) of this thesis suggest that the LMPI can meet these demands because:

- It has been found to be quick and easy to use once the decision about what aspect of the patient's movement to be measured has been decided.

- It has to be directed towards both the patient's impairments and their rehabilitation goals.

- It is best completed during routine clinical record keeping.

Therefore in summary; in comparison with other outcome measures in the same field, a significant methodological strength of the measurement properties of the LMPI is that not only have they been developed and tested using a robust framework (Table [ii]); but are also favourably judged according to COSMIN.

11.3 Unexpected benefits

A major strength of this study is the use of both quantitative and qualitative data; firstly, to conceptualise and develop an outcome measurement instrument, then secondly, to establish its robust measurement properties. It was not anticipated that the LMPI would be perceived as a clinical support tool or would have the potential to be used as a tool for educational purposes.

11.3.1 Clinical support tool

The aims of Study 1 Phase 2 (Pilot study; initial investigation of clinical utility) were to initially test the LMPI for clinical utility within neurological physiotherapy clinical practice. Although the results indicate good clinical utility, a strong emerging theme indicated that the clinicians felt that the LMPI underpinned their therapeutic approach, and supported their clinical knowledge.   This theme also clearly emerged during the cross case analysis of the focus groups and reflective written data, strongly suggesting that the clinicians perceived that the LMPI aided their clinical reasoning. This was especially so for the less

experienced Senior Physiotherapist Participants Group. Therefore the clinicians perceived that the LMPI could help the clinicians to assess, clinically reason and treat their patients.

There is an interesting difference between the ability of the LMPI to assess outcomes and it's potential ability to also assess clinically and thus guide intervention. This may imply that using the LMPI within clinical practice could help to: firstly, standardise an individual patient's intervention and secondly, standardise practice across a team of neurological physiotherapists.

11.3.2 Education support tool

The data analysed specifically from the Expert Physiotherapists Group suggested that the participants perceived that the LMPI could be used as a framework for the education and development of the observational and analytical skills of both experienced and less experienced physiotherapists. That is, the LMPI could be used as a tool to teach physiotherapists to treat their patients. This perception should be judged to be valid because of the educational element of the Expert Group's teaching roles within their organisation (the British Bobath Tutors Association).

Furthermore, it is suggested that the use of the LMPI can be directed towards the measurement of a 'status' or 'snap shot' of the condition of a patient's movement quality, both during assessment and analysis at outcome, therefore making it a unique tool within this field.

11.4 Limitations

Using the COSMIN group criteria for the assessment of the quality of measurement properties of patient reported outcome measures (Terwee et al 2102) (Appendix 16): helped demonstrate the robustness of the development of the LMPI in comparison to other outcome measures in the same field (the BBS, the TIS and GAS); and also provided useful indicators for future work. However, the three criteria assessed by Terwee et al (2012) which were not met within this thesis were the use of Rasch analysis to determine ordinal scale structure (Bond & Fox 2001), the use of specific sample size of participants to ensure low risk of interpretation error, and the testing of floor and ceiling effects.

Rasch analysis was not appropriate in this study because the sample size required for this method was unachievable within the constraints and resources of a Doctoral study. It is also suggested that Rasch methods were not appropriate, because the items of the LMPI were not hierarchical in nature, and the ranking of importance of the items within the LMPI were dependent on each individual patient's motor control impairments.

Although the sample size used to test internal consistency was appropriate, the rule of thumb estimate being for approximately five patients per item (Nunnally and Bernstein 1994). Terwee et al (2012) advise that when testing scale external reliability and validity: an adequate sample size should consist of more than 100 patients; a good sample size should consist of between 50 and 99 patients; a moderate sample size should consist of between 30 and 49 patients; and a sample size is considered small when less than 30 patients are recruited. Between 25 and 50 patients were expected to be recruited into Study 2 Phase 3 (Chapters 7 and 8) and although 27 were recruited, four of the Senior Physiotherapist Participants did not take part in patient recruitment, creating a significant impact on patient access. It was not appropriate to extend the

window of time for recruitment because of the ethical issues of physiotherapist participant burden and PhD study time constraints. However, the results from Study 2 also indicate that findings are free from type I (error in detecting reliability) or type II errors (failure to detect reliability); suggesting that although the sample sizes used were considered 'small', they were able to meet the requirements of this research. The sample sizes used within the many different studies relating to the testing of the measurement properties of the BBS, the TIS and GAS are largely comparable to those used within this thesis; that is, they are considered small by the standards advocated by Terwee et al (2012).

Similar to GAS (Turner-Stokes et al 2009); floor and ceiling effects are not relevant for the LMPI, because the movement being measured is focussed on the individual patient's impairment and is directly related to the criteria within the items i.e.:

- Alignment of the relevant body parts, soft tissues and muscles.
- Interaction between the relevant body parts and the patient's base of support.
- Timing of motor control.
- Appropriate Speed of movement.
- The ability to achieve the task being performed using Selective Movement.

Nonetheless, despite the decision of not to quantitatively investigate the floor and ceiling effects for the LMPI, there is qualitative evidence of the lack of effects in different parts of the results. During Study 1 Phase 1 (Chapter 6), the Physiotherapy Research Group felt that the LMPI did not have floor or ceiling effects. Within Study 1 Phase 2 (Chapter 6), the physiotherapists participating in the pilot study (an initial investigation of clinical utility) reported that they found no floor or ceiling effects. Physiotherapist 6 (Study 3, Chapter 10), when comparing the LMPI to another outcome measure, indicated that some patients may score '0' on both admission and discharge when rated with the Trunk

Control Test (Collin and Wade 1990) yet would demonstrate change if the LMPI were to be used. The findings throughout the results may have emerged because floor and ceiling effects found in other outcome measures (e.g. the BBS) constrain their use within clinical practice. Since the LMPI can be used with people who have large or small levels of impairment, floor and ceiling effects are not an issue of concern. In contrast; the BBS was found to have both floor and ceiling effects (Mao et al 2002), and whilst its authors claim no such effects within the TIS (Verheyden et al 2006a), a study by Verheyden et al (2005) showed that 45% of neurologically unimpaired adults could not achieve full scores.

It is important to acknowledge other inherent limitations in the methodological approaches used in this study.

Whilst the consensus methods employed in Study 1 (Chapters 5 and 6) were designed to be as rigorous as possible, and a 'strength' of nominal group methods is considered to be a useful way of harnessing collective knowledge from group members, there is also a risk of 'collective ignorance' (Murphy et al 1998). However, the results from the face to face interviews used during the pilot work within Study 1 (Chapter 6) and the themes arising from the semi-structured questionnaires and Focus Groups in Study 3 (Chapter 10) established the reliability of the results, and thus re-enforce the content validity of the LMPI. The Delphi methods used in Study 1 (Chapters 5 and 6) also helped to support the strength of the findings by enabling independence of opinions without the bias of potentially stronger members of the group inhibiting the opinions of others.

The thematic analysis techniques used within Study 1 (Chapters 5 and 6) may have been influenced by both researcher and consensus group 'personal interest'; however this risk was removed, because similar findings from the results of the Template Analysis used in

Study 3 (Chapter 10). Furthermore, these results were also independently scrutinised in order to manage potential 'personal interest' bias of the researcher and Physiotherapy Research Group. Template Analysis was used so that the a-priori themes emerging during Studies 1 and 2 (Chapters 5, 6, 7 and 8) could be utilised to initially organise and ultimately strengthen the final code template created within Chapter 10 (Figure [xiv]). Thus, it is suggested that using the method of Template Analysis and accessing independent scrutiny was an effective way of organising qualitative data to gain an understanding of the LMPI, enabling the employment of the a-priori themes developing during both the quantitative and qualitative approaches.

There was a concern that the videos prepared for both the training and testing sessions within Study 2 (Chapters 7 and 8) were not representative of a typical neurological physiotherapy patient caseload; because a large number of the 'normal' patient population have impairments related to comprehension, expression or cognition. This was considered unavoidable because the ethical approach required consent to participate and these patients were excluded. However, in practice, it was found within the qualitative data, that the LMPI was a tool that enabled neurological physiotherapists to assess, analyse and plan intervention by supporting the clinical reasoning and theory that underpins practice. In other words, using the LMPI was not considered to be dependent on the patient's ability to communicate, but on the physiotherapists ability to analyse movement and motor impairment. Furthermore, within clinical practice the observational assessment skills of neurological physiotherapists are transferable between clinical areas and the patient's neurological pathology and complexity. The recruitment of patients within Study 2 Phase 3 was also limited to those who were able to give informed consent; again, for the reasons explained above this was deemed not to be a significant constraint of the research findings.

Within Study 2 (Chapters 7 and 8), the risk of contamination between raters was managed by organising the training and testing sessions within small groups of Senior Physiotherapist Participants, and requesting that participants did not confer either during or after testing the LMPI. This practice also helped to reduce physiotherapist participant burden because the sessions were organised during both their normal working hours and at their places of work.

Because all the physiotherapists and physiotherapist participants contributing to this research are either experienced or expert clinicians, the validity of the results are maximised. On the other hand, the findings cannot be generalisable throughout the profession as a whole. It is therefore not known whether the LMPI could be used by less experienced physiotherapists, student physiotherapists, or physiotherapists from within different specialisms, e.g. musculoskeletal, haemophilia, respiratory medicine or paediatrics. Nonetheless, a clear argument can be made for the implementation of this tool for use by senior neurological physiotherapists. Patients who have motor control difficulties because of neurological damage are complex, they therefore require treatment from senior clinicians; the LMPI can thus be used by these clinicians both to support and reflect their intervention, and possibly also to support the education of less experienced physiotherapists. No actions were taken to reduce or manage this potential limitation, although future work would be indicated to explore these prospective expansions of use.

It could be argued that the language used within the LMPI is technical and therefore not easily understood by a patient or other members of the rehabilitation team. Other outcome measures have used similar technical language to that of the LMPI: that is, the Radell Evaluation Scale for Dance Technique (Radell, et al 2011), the Reaching Performance Scale (Levin et al 2004) and the Balance Evaluation Systems Test (Horak et al 2009) but none of these are satisfactory for use within the neurological patient

population: the former being developed by and for the dance industry; the Reaching Performance Scale is not fully developed and limited to upper limb use; and the latter is not free, and limited to the measurement of movement in standing. It was found in Study 3 (Chapter 10) that the technical language used within the LMPI is meaningful within the context in which it is used, and was designed to be as succinct and as clear as possible.

11.5 Conclusion

The LMPI is a novel and potentially important contribution to the field of neurological physiotherapy, both clinically and within research practice. It is the first outcome measure to conceptually map the nature and definition of quality of movement for patients with motor impairment and captures the impact of neurological physiotherapy intervention more responsively compared with other outcome measures routinely used within the field. Horner and Larmer (2006) state that health outcome measures should sit:

'*within conceptual frameworks and be practical*' (Horner & Larmer 2006, p23).

The developmental process of the LMPI and its resulting face and content validity enables the LMPI to sit within the conceptual framework of modern UK clinical practice. Horner and Larmer also state that measures should be

"*reliable, valid and responsive for a particular purpose in a particular population*"

(Horner & Larmer 2006, p23).

The results of the three studies within this thesis suggest that the LMPI has strong internal and external reliability, clinical utility and validity. Furthermore, unexpected benefits within this research demonstrated that the LMPI was much more than 'just' a measurement instrument and has potential value as a clinical support tool and an educational tool within clinical practice.

The findings from this Doctoral programme of research make an important contribution to the field of neurological physiotherapy, drawing on a wide range of methodologies. The resulting tool, the LMPI, has many potential uses within clinical practice, including:

- The assessment and recording of the patient's quality of movement at base line, monitoring of changes and recording outcome of neurological physiotherapy intervention.

- The support of clinical reasoning, i.e. the identification and prioritisation of motor control difficulties at impairment level according to the WHO-ICF model (figure [i]), presenting a more consistent holistic approach to neurological physiotherapy assessment and intervention.

- The facilitation of: between physiotherapist communication and shared treatment planning.

- Subject to further research findings, the potential of using the LMPI as a framework for training less experienced staff or physiotherapy students to develop the skills of assessment of impairment, analysis of assessment and treatment, and measurement at both baseline and post intervention.

- Within intervention and evaluation research; i.e., the selection of appropriate outcome measures to underpin the meaningful interpretation of study results (data can only be meaningful if the instruments used to collect the data are valid and reliable and appropriate to address the research question).

11.6 Recommendations for taking this work forward

During the analysis, interpretation and discussion of the results of this research, a number of recommendations for further work have been identified.

11.6.1 Further testing of measurement properties

Because of the constraints of this study, sample size was restricted as were further investigations of measurement properties. Further research would be appropriate to examine:-

- Convergent validity with patient perceptions of improvement such as has been published for the BBS (Berg et al 1989) or clinician perceptions of change as has been published for GAS (Joyce et al 1994; Khan et al 2008).
- The effect of larger sample sizes of patient participants to reduce the risk of type I and type II errors, as suggested by Terwee et al (2012).
- The potential of the application of Rasch analysis (Bond & Fox 2001) so that the LMPI could more reliably be used in multi-site interventional studies.

Different grades

This research has focussed on the reliability of the LMPI using senior neurological physiotherapists and could be repeated and results compared with different/more junior grades of physiotherapists working within neurological physiotherapy.

Different specialities

Again, this research has focussed on the reliability of the LMPI using senior neurological physiotherapists. The exploration of the clinical utility, internal and external reliability

and validity of the LMPI within different specialisms of physiotherapy, using similar methods to Studies 2 and 3 may gain generalisability across the profession.

11.6.2 Educational tool

The use of the LMPI as an educational tool was suggested by the Expert Physiotherapist Group, and this could be further explored: within the higher education, organised post graduate course and clinical settings, recruiting student physiotherapists, inexperienced and experienced physiotherapists. It is suggested that the LMPI would be used as an intervention (to teach the analysis of movement), and the effects of the intervention measured using the perceptions of participants and the clinical judgement of their educators.

11.6.3 Clinical support tool

The use of the LMPI as clinical support tool was suggested by both the Expert Physiotherapist and Senior Physiotherapist Participant Groups, and this could be further explored within the clinical and post-graduate course settings. Could clinicians use the LMPI to guide their intervention as well as record the effects of their intervention? Again, it is suggested that the LMPI could be the intervention, acting as a framework for analysis and clinical reasoning alongside outcome measurement. Then used by a group of physiotherapists during their day to day clinical work or during a post-graduate course. The effects of the intervention could then be analysed using the perceptions of both the participating physiotherapists and their patients.

Appendices

Appendix 1

- The Berg Balance Scale data sheet

- A summary of the available literature that has been reviewed in relation to the measurement properties and clinical utility of the Berg Balance Scale

Berg Balance Scale data sheet (Berg et al 1989)

Patient number:

Item	Description	Date 1 score	Date 2 score
1 Sitting to standing	**Instructions**: *Please stand up. Try not to use your hands for support* **4**-able to stand without using hands and stabilise independently **3**-able to stand independently using hands **2**-able to stand using hands after several tries **1**-needs minimal aid to stand or stabilise **0**-needs moderate or maximal assistance to stand		
2 Standing unsupported	**Instructions**: P*lease stand for 2 minutes without holding* **4**-able to stand for 2 minutes **3**-able to stand for 2 minutes with supervision **2**-able to stand for 30 seconds unsupported **1**-needs several tries to stand for 30 seconds unsupported **0**-unable to stand for 30 seconds unsupported **If a subject is able to stand for 2 minutes unsupported, score full points for next item and proceed to item 4.**		
3 Sitting supported	**Instructions**: *Please sit with arms folded for 2 minutes (back supported)* **4**-able to sit safely and securely for 2 minutes **3**-able to sit for 2 minutes under supervision **2**-able to sit for 30 seconds **1**-able to sit for 10 seconds **0**- unable to sit without support for 10 seconds		
4 Standing to sitting	**Instructions**: *Please sit down* **4**-sits safely with minimum use of hands **3**-controls descent by using hands **2**-uses back of legs against chair to control descent **1**-sits independently but has uncontrolled descent **0**-needs assistance to sit		
5 Transfers (arrange as for pivot transfer, using either 2 chairs (1 with and 1 without armrests) or a bed and a chair	**Instructions**: A*sk subject to transfer one way toward a seat with armrests and one way toward a seat without armrests* **4**-able to transfer safely with minor use of hands **3**-able to transfer safely with definite need of hands **2**-able to transfer with verbal cueing and / or supervision **1**-needs 1 person to assist **0**-needs 2 people to assist or supervise to be safe		
6 Standing unsupported with eyes closed	**Instructions**: *Please close your eyes and stand still for 10 seconds* **4**-able to stand for 10 seconds safely **3**-able to stand for 10 seconds with supervision **2**-able to stand for 3 seconds **1**-unable to keep eyes closed but stands safely **0**-needs help to keep from falling		
7 Standing unsupported with feet together	**Instructions**: *Place your feet together and stand without holding* **4**-able to place feet together independently and stand for 1minute safely **3**- able to place feet together independently and stand for 1 min with supervision **2**- able to place feet together independently, but unable to hold for 30 seconds **1**-needs help to attain the position but able to stand for 15 seconds. Feet together **0**- needs help to attain the position but unable to hold for 15 seconds		

Item	Description	Date 1 score	Date 2 score
8 Reaching forward with outstretched arm (ruler placed at fingertips when arm at 90º. Fingers not touching ruler while reaching)	**Instructions**: *lift arm to 90º. Stretch your fingers and reach forward as far as you can. The recorded measure is the distance forward that the fingers reach while the subject is in the most forward lean position. When possible, ask the subject to use both arms when reaching to avoid rotation of the trunk.* **4**-can reach forward confidently 25cm (10 inches) **3**-can reach forward 12cm (5 inches) safely **2**-can reach forward 5cm (2 inches) safely **1**-reaches forward but needs supervision **0**-loses balance while trying / requires external support		
9Pick up object from the floor from a standing position	**Instructions**: *pick up the shoe / slipper placed in front of your feet* **4**- able to pick up slipper safely and easily **3**- able to pick up slipper but needs supervision **2**- unable to pick up but reaches 2-5 cm from slipper and keeps balance independently **1**- unable to pick up and needs supervision while trying **0.-** unable to try / needs assist to keep from losing balance or falling		
10 turning to look behind over left and right shoulders while standing	**Instructions**: *turn to look directly behind you over your left shoulder. Repeat to the right. The examiner may pick an object to look at directly behind the subject to encourage a better twist turn.* **4**-looks behind from both sides and shifts weight well **3**-looks behind one side only. Other side shows less weight shift **2**- turns sideways only but maintains balance **1**- needs supervision when turning **0**-needs assistance when turning		
11 Turn 360º	**Instructions**: *turn completely round in a full circle. Pause. Then turn a full circle in the other direction* **4**-able to turn 360º safely in 4 seconds or less **3**- able to turn 360º safely in 1 direction only in 4 seconds or less **2**- able to turn 360º safely but slowly **1**-needs supervision when turning **0**- needs assistance when turning		
12 placing alternate foot on step or foot stool whilst standing unsupported	**Instructions**: *place each foot alternatively on the step. Continue until each foot has touched the step 4 times.*		
13 standing unsupported 1 foot in front	**Instructions**: (DEMONSTRATE TO SUBJECT) Place 1 foot directly in front of the other. If you fell that you cannot place your foot directly in front, try to step far enough ahead that the heel of your forward foot is ahead of the toes of the other foot. (to score 3 points, the length of the step should exceed the length of the other foot and the width of the stance should approximate the subjects normal stride width) **4**- able to place foot tandem independently and hold for 3 seconds **3**- able to place foot ahead of other independently and hold for 3 seconds **2**- able to take small step independently and hold for3 seconds **1**- needs help to step but can hold for 15 seconds **0**- loses balance while stepping or standing		
14 standing on 1 leg	**Instructions**: stand on 1 leg as long as you can without holding **4**-able to lift leg independently and hold for more than 10 seconds **3**-able to lift leg independently and hold for 5 - 10 seconds **2**- able to lift leg and hold for 3 or more seconds **1**- tries to lift leg unable to hold for 3 seconds but remains standing independently. **0**- unable to try or needs assist to prevent a fall		
TOTAL SCORE	**56 Maximum**		

A summary of the available literature that has been reviewed in relation to the measurement properties and clinical utility of the BBS – 1.

Research paper	Measurement property	Face and content validity	Neurological diagnosis	Sample size	Internal consistency	Test re-test reliability	Inter-rater reliability	Correlated against	Construct / criterion validity	Rasch analysis	Clinical utility	Ceiling effects	Floor effects	Responsiveness	Predictive validity
1) Berg et al 1989		+++	PD Stroke Elderly	38 pts 32 HCP	+++	+++ 14pts 5PTs	+++ 14pts 5PTs	Carer opinion	+++	-	-	-	-	-	-
2) Berg et al 1992		-	Elderly Neuro	31 pts	-	-	-	Tinetti Barthel TUG	+++	-	-	-	-	-	-
3) Berg et al 1995		-	Elderly Stroke	183 pts 32raters	+	+++ 30pts 7raters	+++ 30pts 7raters	-	-	-	-	-	-	-	-
4) Liston & Brouwer 1996		-	Stroke	22 pts	-	+++	-	balance master	+	-	-	-	-	-	-
5) Bogle&Newton 1996		-	Elderly Neuro	66 pts	-	-	-	-	-	-	-	-	-	-	Falls +
6) Wood-Dauphinee et al 1997		-	Stroke	70 pts	-	-	-	-	-	-	-	-	-	ES up to 0.97	-
7) Farlow et al1997		-	ABI	18 pts 4 raters	-	+++	+++	-	-	-	-	-	-	-	-
8) Wee et al 1999		-	Stroke	128 pts	-	-	-	-	-	-	-	-	-	-	LOS ++

A summary of the available literature that has been reviewed in relation to the measurement properties and clinical utility of the BBS - 2.

Research paper	Measurement property / Face and content validity	Neurological diagnosis	Sample size	Internal consistency	Test re-test reliability	Inter-rater reliability	Correlated against	Construct / criterion validity	Rasch analysis	Clinical utility	Ceiling effects	Floor effects	Responsiveness	Predictive validity
9) Salbach et al 2001	-	Stroke	50 pts	-	-	-	-	-	-	-	-	26%	-	-
10) Stevenson 2001	-	Stroke	48 pts	-	-	-	-	-	-	-	-	-	MDC SEM	-
11) Feld et al 2001	-	ABI	40 pts	-	-	-	FIM	-	-	-	-	-	-	D/C ++
12) Mao et al 2002	-	Stroke	112 pts 2 OTs	+++	+++	-	FM PASS	+++	-	-	28%	35%	ES up to 1.11	-
13) Bennie et al 2003	-	Neuro rehab	20 pts	-	+++	+++	TUG FR	++	-	-	-	-	-	-
14) Wee et al 2003	-	Stroke	313 pts		-	-	-	-	-	-	-	-	-	D/C++
15) Whitney et al 2003	-	PD	70 pts	-	-	-	DGI	+++	-	-	-	-	-	-
16) Kornetti et al 2004	-	Neuro Elderly	100 pts	-	-	-	-	-	+	-	-	-	-	-
17) Wang et al 2004	-	Stroke	70 pts	-	-	-	PASS	++	-	-	-	-	-	-
18) Franchignoni et al 2005	-	PD	70 pts	++	-	-	FFM PCS	++	-	-	-	-	-	-

A summary of the available literature that has been reviewed in relation to the measurement properties and clinical utility of the BBS - 3.

Research paper	Measurement property	Face and content validity	Neurological diagnosis	Sample size	Internal consistency	Test re-test reliability	Inter-rater reliability	Correlated against	Construct / criterion validity	Rasch analysis	Clinical utility	Ceiling effects	Floor effects	Responsiveness	Predictive validity
19) Newstead et al 2005		-	TBI	5 pts 2 raters	-	+++	-	-	-	-	-	40%	-	-	-
20) Qutubuddin et al 2005		-	PD	38 pts	-	-	-	UPDRS H&Y SE-ADL	+++	-	-	-	-	-	-
21) Sackley et al 2005		-	ADL	47 pts 2 raters	-	+++	+++	--	-	-	-	-	-	-	-
22) Cattaneo et al 2006		-	MS	51 pts	-	-	-	-	-	-	-	-	-	-	Falls +
23) Conradsson et al 2007		-	Stroke Elderly	45pts 1rater	-	+++	-	-	-		-	-	-	-	-
24) Steffen & Seney 2008		-	PD	37 pts	-	+++	-	-	-	-	-	-	-	SEM MDC	-
25) Hackney & Earhart 2009		-	PD	14 pts	-	-	-	UPDRS TUG 6MWT	-	-	-	-	-	ES 0.83	-
26) Amasut 2009		-	Stroke	51 pts	-	-	-	-	-	-	-	-	-	ES 0.22	-
27) Datta et al 2009		-	ISCI	97 pts	-	-	-	6MWT 10mWT SCFAI	-	-	+	-	-	-	-

A summary of the available literature that has been reviewed in relation to the measurement properties and clinical utility of the BBS - 4.

Research paper	Measurement property	Face and content validity	Neurological diagnosis	Sample size	Internal consistency	Test re-test reliability	Inter-rater reliability	Correlated against	Construct / criterion validity	Rasch analysis	Clinical utility	Ceiling effects	Floor effects	Responsiveness	Predictive validity
28) Donoghue & Stokes 2009		-	Elderly	118 pts	-	-	-	-	-	-	-	-	-	SEM MDC	-
29) Fjeldstad et al 2009		-	MS	14 pts	-	-	-	Lab tests	-	-	-	-	-	-	-
30) de Figueiredo et al 2009		-	Elderly	12pts 18PTs	-	-	+++	-	-	-	-	-	-	-	-
31) Maeda et al 2009		-	Stroke	72 pts	-	-	-	-	-	-	-	-	-	-	Falls ++
32) Nilsagård et al 2009		-	MS	76 pts	-	-	-	-	-	-	-	17%	-	-	+
33) Lemay& Nadeau 2010		-	ISCI	32 pts	-	-	-	2MWT 10mWT WISCII SCI-FAI	+++	-	++	37%	-	-	-
35) Wirz et al 2010		-	Stroke	128 pts	-	-	-	-	-	-	-	-	-	-	D/C ++
36) Leddy et al 2011		-	PD	80pts 3 raters	-	+++	+++	-	-	-	-	10%	-	-	Falls++
37) Datta et al 2012		-	ISCI	124 pts	-	-	-	-	-	-	++	-	-	-	-

A summary of the available literature that has been reviewed in relation to the measurement properties and clinical utility of the BBS - 5.

Research paper	Measurement property	Face and content validity	Neurological diagnosis	Sample size	Internal consistency	Test re-test reliability	Inter-rater reliability	Correlated against	Construct / criterion validity	Rasch analysis	Clinical utility	Ceiling effects	Floor effects	Responsiveness	Predictive validity
39) Flansbjer et al 2012		-	Stroke	50pts	-	-	-	-	-	-	-	-	-	SEM	-
40) Hiengkaew et al 2012		-	Stroke	61 pts 2 PTs	-	+++	-	-	-	-	-	-	-	MDC	-
41) La Porta et al 2012		-	Neuro rehab	217 pts	-	-	-	-	-	+	-	-	-	-	-
44) Godi et al 2013		-	Neuro rehab	93 pts	-	-	-	-	-	-	-	-	-	SEM MDC	-
43) Quinn et al 2013		-	HD	75 pts	-	-	-	-	-	-	-	-	-	MDC	-

KEY: Strong = **+++**; Moderate = **++**; Weak = **+**; Not tested = - .

Abbreviations & references: **2MWT**= 2 minute walk test; **6MWT**=6 minute walk test; **10mWT** = 10 metre walk test (Wade 1992); **BI**= Barthel Index (Wade 1992);**D/C** = discharged; **DGI**- Dynamic Gait Index (Rehabilitation Measures database 2010); **EDS**S = Expanded Disability Status Scale,(Kurtzke 1983); **FIM**= functional Independence Measure (Wright 2000);**FM** = Fugl-Meyer (Gladstone et al 2002); **FR** = functional reach (Duncan et al 1990);**H&Y**= Hoehn and Yahr Staging Scale (Hoehn&Yahr 1967); **HD**= Huntington's Disease**; ISCI** = Incomplete Spinal Cord Injury; **LD**= Adults with Learning Disability; **MDC** = Minimal Detectable Change; **MS** = Multiple Sclerosis; **Neuro rehab** = Neurological Rehabilitation; **OTs**=occupational therapists; **PD** = Parkinsons Disease; **pt**s= patient; **PTs**= physiotherapists; **PASS**= Postural Assessment Scale for Stroke (Benaim et al 1999); **SCI-FAI**= Spinal Cord Injury Functional Ambulation Inventory (Field-Fote et al 2001);**SE-ADL**= Modified Schwab and England Capacity for Daily Living Scale (EPDA n.d.); **SEM**= Standard Error of Measurement ; **Tinetti**(Abbruzzese 1998); **TUG**=timed up and go (Podsiadlo & Richardson 1991); **UHDRS-TM**= Unified Huntington's Disease Rating Scale Total Motor Score (UHDRS n.d.); **UPDRS**= Unified Parkinson's Disease Rating Scale (Goetz et al 2003); **WISCII** = Walking index for spinal cord injury (Dittuno et al 2001)

Appendix 2

- The Trunk Impairment Scale data sheet

- A summary of the available literature that has been reviewed in relation to the measurement properties and clinical utility of the Trunk Impairment Scale

Trunk Impairment Scale data sheet (Verheyden et al 2004)

The starting position for each item is the same. The patient is sitting on the edge of a bed or treatment table without back and arm support. The thighs make full contact with the bed or table, the feet are hip width apart and placed flat on the floor. The knee angle is 908. The arms rest on the legs. If hypertonia is present the position of the hemiplegic arm is taken as the starting position. The head and trunk are in a midline position. If the patient scores 0 on the first item, the total score for the TIS is 0. Each item of the test can be performed three times. The highest score counts. No practice session is allowed. The patient can be corrected between the attempts. The tests are verbally explained to the patient and can be demonstrated if needed.

Item			
Static sitting balance			**Score**
1	Starting position	Patient falls or cannot maintain starting position for 10 seconds without arm support	0
		Patient can maintain starting position for 10	2
		If score = 0, then TIS total score = 0	
2	Therapist crosses the unaffected leg over the hemiplegic leg	Patient falls or cannot maintain sitting position for 10 seconds without arm support	0
		Patient can maintain sitting position for 10 seconds	2
3	Patient crosses the unaffected leg over the hemiplegic leg	Patient falls	0
		Patient cannot cross the legs without arm support on bed or table	1
		Patient crosses the legs but displaces the trunk more than 10cm backwards or assists crossing with the hand	2
		Patient crosses the legs without trunk displacement or assistance	3
		Total static sitting balance	**/7**
Dynamic sitting balance			
1	Starting position Patient is instructed to touch the bed or table with the hemiplegic elbow (by shortening the hemiplegic side and lengthening the unaffected side) and return to the starting position	Patient falls, needs support from an upper extremity or the elbow does not touch the bed or table	0
		Patient moves actively without help, elbow touches bed or table e 1	1
		If score = 0, then items 2 and 3 score 0	
2	Repeat item 1	Patient demonstrates no or opposite shortening/lengthening	0
		Patient demonstrates appropriate shortening/lengthening	1
		If score = 0, then item 3 scores 0	
3	Repeat item 1	Patient compensates. Possible compensations are: (1) use of upper extremity, (2) contralateral hip abduction, (3) hip flexion (if elbow touches bed or table further then proximal half of femur), (4) knee flexion, (5) sliding of the feet	0
		Patient moves without compensation	1
4	Starting position Patient is instructed to touch the bed or table with the unaffected elbow (by shortening the unaffected side and lengthening the hemiplegic side) and return to the starting position	Patient falls, needs support from an upper extremity or the elbow does not touch the bed or table	0
		Patient moves actively without help, elbow touches bed or table	1
		If score = 0, then items 5 and 6 score 0	
5	Repeat item 4	Patient demonstrates no or opposite shortening/lengthening	0
		Patient demonstrates appropriate shortening/lengthening	1
		If score = 0, then item 6 scores 0	

Dynamic sitting balance - continued			
6	Repeat item 4	Patient compensates. Possible compensations are: (1) use of upper extremity, (2) contralateral hip abduction, (3) hip flexion (if elbow touches bed or table further then proximal half of femur), (4) knee flexion, (5) sliding of the feet Patient moves without compensation	0 1
7	Starting position Patient is instructed to lift pelvis from bed or table at the unaffected side (by shortening the unaffected side and lengthening the hemiplegic side) and return to the starting position	Patient demonstrates no or opposite shortening/lengthening Patient demonstrates appropriate shortening/lengthening **If score = 0, then item 8 scores 0**	0 1
8	Repeat item 7	Patient compensates. Possible compensations are: (1) use of upper extremity, (2) pushing off with the ipsilateral foot (heel loses contact with the floor) Patient moves without compensation	0 1
9	Starting position Patient is instructed to lift pelvis from bed or table at the unaffected side (by shortening the unaffected side and lengthening the hemiplegic side) and return to the starting position	Patient demonstrates no or opposite shortening/lengthening Patient demonstrates appropriate shortening/lengthening **If score = 0, then item 10 scores 0**	0 1
10	Repeat item 9	Patient compensates. Possible compensations are: (1) use of upper extremities, (2) pushing off with the ipsilateral foot (heel loses contact with the floor) Patient moves without compensation	0 1
		Total dynamic sitting balance	**/10**
Co-ordination			
1	Starting position Patient is instructed to rotate upper trunk 6 times (every shoulder should be moved forward 3 times), first side that moves must be hemiplegic side, head should be fixated in starting position	Hemiplegic side is not moved three times Rotation is asymmetrical Rotation is symmetrical **If score = 0, then item 2 scores 0**	0 1 2
2	Repeat item 1 within 6 seconds	Rotation is asymmetrical Rotation is symmetrical	0 1
3	Starting position Patient is instructed to rotate lower trunk 6 times (every knee should be moved forward 3 times), first side that moves must be hemiplegic side, upper trunk should be fixated in starting position	Hemiplegic side is not moved three times Rotation is asymmetrical Rotation is symmetrical **If score = 0, then item 4 scores 0**	0 1 2
4	Repeat item 3 within 6 seconds	Rotation is asymmetrical Rotation is symmetrical	0 1
		Total co-ordination	**/6**
		Total Trunk Impairment Scale	**/23**

A summary of the available literature that has been reviewed in relation to the measurement properties and clinical utility of the TIS – 1.

Research paper	Measurement property	Face and content validity	Neurological diagnosis	Sample size	Internal consistency	Test re-test reliability	Inter-rater reliability	Correlated against	Construct / criterion validity	Rasch analysis	Clinical utility	Ceiling effects	Floor effects	Responsiveness	Predictive validity	Other
1) Nieuwboer et al 1996		**++** **3** pts, 5 PTs	-	-	-	-	**++**27 pts, 2PTs	-	-	-	-	-	-	-	-	-
2) Verheyden et al 2004		**-**	Stroke	28 pts 2 PTs	**+++**	**+++**	**+++**	BI TCT	**++**	-	-	-	-	-	-	-
3) Verheyden et al 2005		-	Stroke 'normal'	40 pts 40 ctrls	-	-	-	-	-	-	-	**++**	-	-	-	Norm.
4) Verheyden et al 2006a		-	Stroke	51 pts 1 rater	-	-	-	TCT Tinetti FAC 10mWT TUG FIMm	**+++**	-	-	none	-	-	-	-
5) Verheyden et al 2006b		-	MS	30 pts 2 PTs	-	**+++**	**+++**	FIM EDSS BI	**++**	-	-	-	-	SEM	-	-
6) Verheyden et al 2006c		-	TBI	30 pts 2 PTs	-	**+++**	**+++**	BI	**++**	-	-	-	-	-	-	-
7) Verheyden et al 2007a		-	Stroke	102	-	-	-	BI FIM	-	-	-	-	-	-	D/C function **++**	-

A summary of the available literature that has been reviewed in relation to the measurement properties and clinical utility of the TIS – 2.

Research paper	Measurement properties	Face and content validity	Neurological diagnosis	Sample size	Internal consistency	Test re-test reliability	Inter-rater reliability	Correlated against	Construct / criterion validity	Rasch analysis	Clinical utility	Ceiling effects	Floor effects	Responsiveness	Predictive validity	Other
8) Verheyden et al 2007b		-	PD	26 pts 26 ctrls	-	-	-	UPDRS	++	-	-	-	-	-	-	-
9) Verheyden et al 2008		-	Stroke	32 pts	-	-	-	FM arm BI	-	-	-	-	-	-	recovery	-
10) Verheyden et al 2009		-	Stroke	33	-	-	-	Tinetti FAC	-	-	++	-	-	-	-	Rx effect
11) Di Monaco et al 2010		-	Stroke	60 pts	-	-	-	BI PASS FIM	-	-	-	-	-	-	D/C function ++	-
12) Verheydenk & Kersten 2010		-	-	162 pts	-	-	-	-	-	++	-	yes	-	-	-	-
13) Jandt et al 2011		-	Stroke	21 pts	-	-	-	Resp function	+++	-	+	-	-	-	-	-

KEY: Strong = **+++**; Moderate = **++**; Weak = **+**; Not tested = **-**.
Abbreviations & references: **10mWT** = 10 metre walk test (Wade 1992); **ctrls**= controls; **BI**= Barthel Index (Wade 1992); **D/C** = discharged; **EDSS** = Expanded Disability Status Scale(Kurtzke 1983); **FMa** = Fugl-Meyer-arm (Gladstone et al 2002); **FAC** = Functional Ambulation Category (Holden et al 1984); **FIM** =   functional Independence Measure (Wright 2000);**FIMm**= functional Independence Measure-motor (Wright 2000);**Norm** = normal; **pts**= patients; **PD** = Parkinson's Disease; **PTs**= physiotherapists; **PASS**= Postural Assessment Scale for Stroke (Benaim et al 1999); **Resp** = respiratory; **Rx** = treatment; **SEM**= Standard Error of Measurement; **TUG** = timed up and go (Podsiadlo & Richardson 1991); **Tinetti =** (Abbruzzese 1998);**TBI** = Traumatic Brain Injury; **TCT** = Trunk Control Test (Collin & Wade 1990); **UPDRS**= Unified Parkinson's Disease Rating Scale (Goetz et al 2003).

Appendix 3

- A summary of the available literature that has been reviewed in relation to the measurement properties and clinical utility of Goal Attainment Scaling

A summary of the available literature that has been reviewed in relation to the measurement properties and clinical utility of GAS – 1.

Research paper	Measurement property	Face and content validity	Neurological diagnosis	Sample size	Internal consistency	Test re-test reliability	Inter-rater reliability	Correlated against	Construct / criterion validity	Rasch analysis	Clinical utility	Ceiling effects	Floor effects	Responsiveness	Predictive validity	Other
1) Kiresuk& Sherman 1968		+	None	-	-	-	-	-	-	-	-	-	-	-	-	-
2) Joyce et al 1994		+++	TBI	16 pts Team raters	-	-	+++	CGI RDR MEDLS KELS IADL	+++ +++ ++ + +	-	+++	-	-	-	-	-
3) Reid &Chesson 1998		-	Stroke	-	-	-	-	-	-	-	+++			-	-	-
4) Ashford & Turner-Stokes 2006		-	ABI	18 pts	-	-	-	BI	-	-	-	-	-	++	-	-
5) Tennant 2007		-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
6) Khan et al 2008		-	MS	24 pts	-	-	-	BI FIM CGI	+ + +++	-	+++	-	-	ES	-	Training need

254

A summary of the available literature that has been reviewed in relation to the measurement properties and clinical utility of GAS – 2.

Research paper	Measurement property	Face and content validity	Neurological diagnosis	Sample size	Internal consistency	Test re-test reliability	Inter-rater reliability	Correlated against	Construct / criterion validity	Rasch analysis	Clinical utility	Ceiling effects	Floor effects	Responsiveness	Predictive validity	Other
7) Turner-Stokes et al 2009		-	Neuro	164 pts	-	-	-	FIM FAM BI	+ + +	-	-	-	-	ES	-	-
8) Turner-Stokes et al 2010		-	Neuro	90 pts	-	-	-	MAS	-	-	-	-	-	++	-	-
9) Turner-Stokes & Williams 2010		-	ABI ISCI Neuro	243 pts	-	-	-	GAS version 2	-	-	++	-	-	-	-	-
10) Bovend'Eerdt et al 2011		-	Neuro	29 pts 1PT 1IR	-	-	+	-	-	-	-	-	-	-	-	-
11) Stevens et al 2013		-	-	-	-	-	-	-	-	-	++	-	-	-	-	-

KEY: Strong = **+++**; Moderate = **++**; Weak = **+**; Not tested = -

Abbreviations &references:**ABI** = Acquired Brain Injury; **BI**= Barthel Index (Wade 1992); **CGI**= Clinical Global Impression (Busner&Targum 2007); **FAM**= Functional Assessment Measure (Donaghy et al 1988); **FIM**= functional Independence Measure (Keith et al 1987); **GASv2** = GAS version used by Steenbeek et al 2005;**ES** = Effect Size; **IADL** = Instrumented Activities of Daily Living; **IR**= independent rater; **KELS**= Kohlman Evaluation of Living Skills (Burnett et al 2009); **MAS**= Modified Ashworth Scale (Bohannon & Smith 1987); **MEDLS**= Milwaukee Evaluation of Daily Living Skills (Leonardelli 1988);**MS** = Multiple Sclerosis;**Neuro** = patients with neurological diagnoses; **OAIADL**= Older Americans Resources Survey Instrumental Activities of Daily Living Index (Lawton &Broday 1969); **pts**= patient; **PT**= physiotherapist; **RDRS**= Rappaport Disability Rating Scale (Rappaport et al 1982);**SEM**= Standard Error of Measurement; **TBI** = Traumatic Brain Injury

Appendix 4

- GCP certification
- All letters confirming ethical approval
    - National Research Ethics Study 1
    - National Research Ethics Study 2
    - University of Huddersfield, School Research Ethics Panel
    - Leeds Teaching Hospitals NHS Trust
    - Airedale NHS Foundation Trust
    - Mid Yorkshire Hospitals NHS Trust
    - NHS Leeds
- Study 1, Phase 2: Participant information sheet and consent form
- Study 2, Phase 1: Participant information sheet and consent form
- Study 2, Phase 2: Physiotherapy manager information sheet and consent form
- Study 2, Phase 2: NHS physiotherapist participant information sheet and consent form
- Study 2, Phase 3: Patient participant information sheet and consent form
- Study 3: Expert physiotherapist participant information sheet and consent form

The Faculty of Pharmaceutical Medicine has accredited this course for 9 Continuing Professional Development credits.

GCP web–based training course
designed and developed by

INFONETICA

Ashford and St. Peter's Hospitals **NHS**
NHS Trust

Certificate Of Achievement

This is to certify that
Denise Ross
Leeds Teaching Hospitals NHS Trust

has successfully passed a web–based examination covering all aspects of the
International Conference on Harmonisation – Good Clinical Practice Guideline Course

02 July 2010

(Recommended renewal date: 02 July 2012)

Certificate No: 11332–1–13101

Course Director
Dr Isaac John, Hon Lecturer
Royal Holloway, University of London
Assistant Director Research & Development
Ashford & St Peter's Hospitals NHS Trust

Royal Holloway
University of London

Endorsed by
Professor George Dickson
Head, School of Biological Sciences
Royal Holloway, University of London

Room 5.2, Clinical Sciences Building
St James's University Hospital
Beckett Street
Leeds
West Yorkshire
LS9 7TF

Telephone: 0113 2065652
Facsimile: 0113 2066772

9 April 2008

Ms Denise H Ross
Clinical Specialist Physiotherapist
Physiotherapy Department
Lincoln Wing
St James University Hospital
Beckett Street
Leeds
LS9 7TF

Dear Ms Ross

Full title of study:	**Measuring Movement Performance: A study to develop the Leeds Movement Performance Index within the clinical setting**
REC reference number:	**08/H1313/23**

Thank you for your letter of 19 March 2008, responding to the Committee's request for further information on the above research and submitting revised documentation.

The further information was considered at the meeting of the Sub-Committee of the REC held on 7 April 2008. A list of the members who were present at the meeting is attached.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised.

Ethical review of research sites

The Committee has designated this study as exempt from site-specific assessment (SSA). There is no requirement for other Local Research Ethics Committees to be informed or for site-specific assessment to be carried out at each site.

Conditions of approval

The favourable opinion is given provided that you comply with the conditions set out in the attached document. You are advised to study the conditions carefully.

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document	Version	Date	
Application		03 March 2008	
Investigator CV		05 February 2008	
Protocol	2	31 January 2008	
Letter from Sponsor		25 February 2008	
Participant Information Sheet	2	25 March 2008	
Participant Consent Form	2	19 March 2008	
Response to Request for Further Information		19 March 2008	
The LEEDS Movement Performance Index	1	31 January 2008	

R&D approval

All researchers and research collaborators who will be participating in the research at NHS sites should apply for R&D approval from the relevant care organisation, if they have not yet done so. R&D approval is required, whether or not the study is exempt from SSA. You should advise researchers and local collaborators accordingly.

Guidance on applying for R&D approval is available from
http://www.rdforum.nhs.uk/rdform.htm.

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees (July 2001) and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

After ethical review

Now that you have completed the application process please visit the National Research Ethics Website > After Review

Here you will find links to the following
  a) Providing feedback. You are invited to give your view of the service that you have received from the National Research Ethics Service on the application procedure. If you wish to make your views known please use the feedback form available on the website.
  b) Progress Reports. Please refer to the attached Standard conditions of approval by Research Ethics Committees.
  c) Safety Reports. Please refer to the attached Standard conditions of approval by Research Ethics Committees.
  d) Amendments. Please refer to the attached Standard conditions of approval by Research Ethics Committees.
  e) End of Study/Project. Please refer to the attached Standard conditions of approval by Research Ethics Committees.

We would also like to inform you that we consult regularly with stakeholders to improve our service. If you would like to join our Reference Group please email referencegroup@nationalres.org.uk .

| 08/H1313/23 | **Please quote this number on all correspondence** |

With the Committee's best wishes for the success of this project

Yours sincerely

Dr Margaret L Faull
Chair

Email: ann.prothero@leedsth.nhs.uk

Enclosures:	List of names and professions of members who were present at the meeting and those who submitted written comments
	Standard approval conditions
Copy to:	Dr Derek Norfolk, Leeds Teaching Hospitals NHS Trust

Members of the Sub-Committee which reviewed the response:

Mrs Dee Alton, Nurse
Dr Richard Baker, Consultant Renal Physician

National Research Ethics Service

Bradford Research Ethics Committee

Yorkshire & Humber REC Office
Millside
Mill Pond Lane
Meanwood
Leeds
LS6 4RA

Telephone: 0113 305 0128

24 November 2010

Ms Denise H Ross
1 Oakwood Cottages
Lady Lane
Bingley
West Yorks
BD16 4AS

Dear Ms Ross

Study Title:	**The development and clinical testing of an index of movement performance (the Leeds Movement Performance Index) for neurological physiotherapy: a mixed-methods study**
REC reference number:	**10/H1302/82**

Thank you for your letter of 23 November 2010, responding to the Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Ethical review of research sites

The favourable opinion applies to all NHS sites taking part in the study, subject to management permission being obtained from the NHS/HSC R&D office prior to the start of the study (see "Conditions of the favourable opinion" below).

Conditions of the favourable opinion

The favourable opinion is subject to the following conditions being met prior to the start of the study.

Management permission or approval must be obtained from each host organisation prior to the start of the study at the site concerned.

For NHS research sites only, management permission for research ("R&D approval") should be obtained from the relevant care organisation(s) in accordance with NHS research

governance arrangements. Guidance on applying for NHS permission for research is available in the Integrated Research Application System or at http://www.rdforum.nhs.uk.

Where the only involvement of the NHS organisation is as a Participant Identification Centre (PIC), management permission for research is not required but the R&D office should be notified of the study and agree to the organisation's involvement. Guidance on procedures for PICs is available in IRAS. Further advice should be sought from the R&D office where necessary.

Sponsors are not required to notify the Committee of approvals from host organisations.

It is the responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document	Version	Date
Protocol	1	11 May 2010
Response to Request for Further Information		23 November 2010
Participant Information Sheet: Patient study 1c	2	23 November 2010
Investigator CV		
Participant Consent Form: Physiotherapist study 2a	2	23 November 2010
Supervisor CV - Dr Serena McCluskey		
Study Process Diagram	1	01 August 2010
Participant Information Sheet: Patients study 1a	2	23 November 2010
Participant Information Sheet: Physiotherapist studies 1b, 1c, 2b	2	23 November 2010
Evidence of insurance or indemnity		08 October 2010
Covering Letter		29 October 2010
Letter from Sponsor		28 September 2010
GP Letter	1	21 July 2010
LMPI Data Sheet		
LMPI Guidelines for Users		
REC application		05 October 2010
Participant Information Sheet: Physiotherapists study 2a	2	23 November 2010
Participant Consent Form: Patients study 1a	2	23 November 2010
Participant Consent Form: Physiotherapists studies 1b, 1c, 2b	2	23 November 2010
Participant Consent Form: Patients study 1c	2	23 November 2010

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees (July 2001) and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

After ethical review

Now that you have completed the application process please visit the National Research Ethics Service website > After Review

You are invited to give your view of the service that you have received from the National Research Ethics Service and the application procedure. If you wish to make your views known please use the feedback form available on the website.

The attached document *"After ethical review – guidance for researchers"* gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Adding new sites and investigators
- Progress and safety reports
- Notifying the end of the study

The NRES website also provides guidance on these topics, which is updated in the light of changes in reporting requirements or procedures.

We would also like to inform you that we consult regularly with stakeholders to improve our service. If you would like to join our Reference Group please email referencegroup@nres.npsa.nhs.uk.

10/H1302/82	Please quote this number on all correspondence

With the Committee's best wishes for the success of this project

Yours sincerely

Professor Alan Roberts
Chair

Email: Sinead.audsley@leedspft.nhs.uk

Enclosures: "After ethical review – guidance for researchers",

Copy to: Prof Nigel King, University of Huddersfield
                  Anne Gowing, Leeds Teaching Hospitals NHS Trust

28 September 2010

Ms Denise Ross
Professional Doctorate Student
School of Human and Health Sciences
University of Huddersfield

Dear Denise

School Research Ethics Panel (SREP) Submission
Title of Study: "The development and clinical testing of an index of
movement performance for neurological physiotherapy: a mixed-
methods study"

I confirm that your project, as titled above has received ethical approval from
the School of Human and Health Sciences Research Ethics Panel, University
of Huddersfield.

I also confirm that indemnity for this project will be covered by the insurance
policy held by the University of Huddersfield, as it falls within the normal range
of research activity.

With best wishes for the success of your research.

Yours sincerely

Prof Nigel King
Chair, SREP
School of Human and Health Sciences

Direct Tel: +44 (0)1484 472812
Email: n.king@hud.ac.uk

The Leeds Teaching Hospitals **NHS**

NHS Trust

Ref: Amanda Burd

14/01/2011

Research & Development

Leeds Teaching Hospitals NHS Trust
34 Hyde Terrace
Leeds
LS2 9LN

Tel: 0113 392 2878
Fax: 0113 392 6397

r&d@leedsth.nhs.uk
www.leedsth.nhs.uk

Ms Denise H Ross
Clinical Specialist Physiotherapy
Leeds Teaching Hospitals NHS Trust
Physiotherapy Department
Chapel Allerton Hospital
Chapeltown Road, Leeds
Leeds
LS7 4SA

Dear Ms Denise H Ross

Re: NHS Permission at LTHT for: The Development and clinical testing of an index of movement performance (the Leeds Movement Performance Index) for neurological physiotherapy: a mixed-methods study
LTHT R&D Number: NE10/9497
REC: 10 H1302 82

I confirm that *NHS Permission for research* has been granted for this project at The Leeds Teaching Hospitals NHS Trust (LTHT). NHS Permission is granted based on the information provided in the documents listed below. All amendments (including changes to the research team) must be submitted in accordance with guidance in IRAS. Any change to the status of the project must be notified to the R&D Department.

Permission is granted on the understanding that the study is conducted in accordance with the *Research Governance Framework for Health and Social Care*, ICH GCP (if applicable) and NHS Trust policies and procedures available at http://www.leedsth.nhs.uk/sites/research_and_development/.

This permission is granted only on the understanding that you comply with the requirements of the *Framework* as listed in the attached sheet "Conditions of Approval".

If you have any queries about this approval please do not hesitate to contact the R&D Department on telephone 0113 392 2878.

Indemnity Arrangements
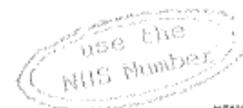
The Leeds Teaching Hospitals NHS Trust participates in the NHS risk pooling scheme administered by the NHS Litigation Authority 'Clinical Negligence Scheme for NHS Trusts' for: (i) medical professional and/or medical malpractice liability; and (ii) general liability. NHS Indemnity for negligent harm is extended to researchers with an employment contract (substantive or honorary) with the Trust. The Trust only accepts liability for research activity that has been managerially approved by the R&D Department.

The Trust therefore accepts liability for the above research project and extends indemnity for negligent harm to cover you as investigator and the researchers listed on the Site Specific Information form. Should there be any changes to the research team please ensure that you inform the R&D Department and that s/he obtains an appropriate contract, or letter of access, with the Trust if required.

Yours sincerely
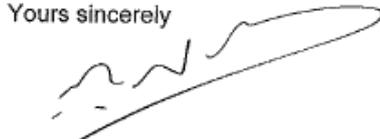
Dr D R Norfolk
Associate Director of R&D

Approved documents
The documents reviewed and approved are listed as follows

Document	Version	Date of document
NHS R&D Form	3.0	22/12/2010
SSI Form	3.0	29/09/2010
Directorate Approval		01/10/2010
Sponsor Signature		28/09/2010
Insurance Letter		08/10/2010
Protocol		Not Dated
Study Diagram		01/08/2010
REC Letter confirming favourable opinion		24/11/2010
Patient Information Sheet and Consent - 1C (REC Approved)		23/11/2010
Patient Information Sheet and Consent - 1A (REC Approved)		23/11/2010
Patient information sheet and Consent - 1B,1C, 2B (REC Approved)		23/11/2010
Patient Information Sheet and Consent - 2A (REC Approved)		23/11/2010
GP Letter - 2A (REC Approved)		21/07/2010

29th November 2010
Ref. EPS: 0506
CSP:

Research & Effectiveness
Fleming House
Airedale General Hospital
Steeton
KEIGHLEY
W Yorks
BD20 6TD

Tel. 01535 294655
Fax. 01535 294655

Ms Denise H Ross
1 Oakwood Cottages
Lady Lane
Bingley
West Yorkshire
BD16 4AS

Dear Ms Ross

Re: The development and clinical testing of an index of movement performance (the Leeds Movement Performance Index) for neurological physiotherapy: a mixed methods study.

I have received details of the above research project and after consideration am pleased to confirm that this has received Research Management approval.

Please note that this approval is conditional on compliance with the following requirements.

- That all research activity should comply with the requirements of the Research Governance Framework. It is your responsibility to ensure that Health and Safety and Data Protection policies are adhered to where appropriate.

- That you submit a progress report annually and that we are notified of the completion or early termination of the study.

- That you consent to project audit.

- That payment of project funding (where applicable) is made to Airedale NHS Foundation Trust.

- That ethics approval has been obtained from the relevant NHS Research Ethics Committee, http://www.nres.npsa.nhs.uk/.

267

I hope all goes well with the study and look forward to hearing about your progress.

Yours sincerely

Carole Paley
Senior Research Manager

On behalf of:
Dr R Pope
Research & Effectiveness Director

Copy to: Julie Buckley, ANHST

The Mid Yorkshire Hospitals **NHS**

NHS Trust

If you need this correspondence in a larger font size please contact: 01924 543175

Research & Development Office
Decant Village
Pinderfields General Hospital
Aberford Road
Wakefield
WF1 4DQ

JS/vd/N:R&D(10/700)

Tel: 01924 543174
Fax: 01924 214932
jane.shewan@midyorks.nhs.uk

15 December 2010

Ms Denise Ross
Physiotherapy Department
Chapel Allerton Hospital
Chapeltown
Leeds
LS7 4SA

Dear Ms Ross

Re: The development and clinical testing of an index of movement performance for neurological physiotherapy: a mixed-methods study
R&D ref: 10/700

Your research study has been approved by the Trust's Research and Development Committee. This approval applies to you; as named in your application. This refers to Protocol version 1 and associated documents.

There are some conditions to this approval:

- The study may only begin after appropriate Research Ethics Committee approval has been received. I confirm receipt of the latest REC approval letter dated 24 November 2010.

- To comply with the Research Governance Framework (DOH, 2001), the Local Investigator/Researcher should ensure that the study is conducted in accordance with the approved protocol. Informed consent must be obtained in accordance with the protocol and a copy given to the participant, a copy kept in the medical record, where appropriate, and a copy kept by the investigator in their research file. The Trust may audit these requirements.

- Research activity must be monitored by the Trust. A copy of letters or reports received following monitoring visits or inspections relating to the conduct of this study, at this site, must be sent to this office.

- Research involving radiation exposures must comply with local Trust policies and procedures, including authorisation by a named local Practitioner.

- Annual progress reports will be required, and a copy of the final report. A copy of your report to the appropriate Research Ethics Committee will satisfy this requirement.

- Any researchers not employed by this organisation who will be conducting research on Trust premises may require a research passport, an honorary contract, or a letter of access. If you require help with this, in the first instance, contact myself.

- For research within the scope of the Medicines for Human Use (Clinical Trials) Regulations 2004, investigators must provide evidence of appropriate ICH-GCP training. The Trust may audit this requirement.

If you agree with the terms stated, please will you sign the copies of this letter overleaf and return one copy to myself.

May I take this opportunity to wish you every success with your research.

Yours sincerely

Jane Shewan
HEAD OF RESEARCH AND EFFECTIVENESS

I agree with the terms of approval stipulated by the Trust's Research and Development Committee.

Signature of Local Investigator/Researcher .... Date ....

Cc: Mr Peter Creegan
       Head of Physiotherapy
       DDH

Telephone enquiries, please contact: Linda Dobrzanska
Phone: 0113 203 3473 / 07958066828
Email: linda.dobrzanska@nhsleeds.nhs.uk

6th January 2011

Ms Denise Ross
1 Oakwood Cottages
Lady Lane
Bingley
Bradford BD16 4AS

Stockdale House
Headingley Business Park
Victoria Road
Leeds
LS6 1PF

www.nhsleeds.nhs.uk

Ref: NP/0062

Dear Ms Ross

Re: The development and clinical testing of an index of movement performance (the Leeds Movement performance Index) for neurological physiotherapy: a mixed-methods study

Thank you for your recent submission to NHS Leeds requesting governance approval for the above study.

Following consideration of your submission I am pleased to confirm that research management and governance approval has been granted by NHS Leeds for the above research to take place as described in your application and accompanying documentation.

Conditions of approval

You should be aware that approval is granted subject to the conditions specified below:

- In undertaking this research you must comply with the requirements of the Research Governance Framework for Health and Social Care (2nd edition 2005) which is mandatory for all NHS employees.

- Consent for NHS Leeds to audit your project, which is implicit in your acceptance of approval.

- Where any amendments, substantial or non substantial are made throughout the course of the study these should be notified to NHS Leeds.

- A copy of the final study report should be forwarded to NHS Leeds.

- Should any serious adverse event(s) occur throughout the course of the study these should be notified to NHS Leeds using the contact details set out above.

- You comply with NHS Leeds Policies on the handling of data. These policies are available from the research manager.

Chair: Linda Pollard OBE

Chief Executive: John Lawlor

Should you require any clarification regarding any of the points raised above, or have any further queries in relation to approvals and post approval study management process then please do not hesitate to contact me on 0113 2033473.

Finally, may I take this opportunity to wish you well with your study and look forward to hearing about your progress in due course.

Yours sincerely
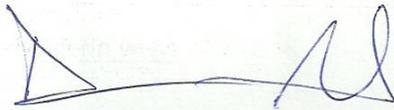
Damian Riley
Director of Primary Care / Medical Director

Approved documents

The documents reviewed and approved by NHS Leeds are listed as follows

Document	Version	Date of Document
REC Form	3.0	
SSIF	3.0	
Participant Information Sheet: Physiotherapist study 1b,1c,2b	2.0	23 November 2010
Patient study 1c	2.0	23 November 2010
Consent Form: Physiotherapist study 1b,1c,2b	2.0	23 November 2010
Patient study 1c	2.0	23 November 2010
Protocol:	1.0	11 May 2010
CV of researcher		Document reviewed
CV of academic researcher (if appicable)		Local collaborator reviewed
Sponsor identified		University of Huddersfield
Indemnity identified		University of Huddersfield

Cc:
Mrs Kirsty Forrester
Clinical Manager Community Stroke Tteam
Leeds Community Healthcare
Community Rehabilitaiton Unit
St. Mary's Hospital
Greenhill Road
Leeds LS12 3QE

Measuring Movement Performance: A study to develop the Leeds Movement Performance Index within the clinical setting

You are being invited to take part in a research study. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully. Talk to others about the study if you wish.

Part 1 tells you the purpose of this study and what will be expected of you if you take part.

Part 2 gives you more detailed information about the conduct of the study

Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

PART 1

What are the purposes of this study?

Over the last 18 months Neuro Training Group 1 has been developing a measure of movement performance. It is called 'The Leeds Movement Performance Index'.

We now want to refine the measurement tool, by asking senior Bobath trained Physiotherapists to use it during their routine record keeping

Why have I been chosen?

You have been chosen to take part in this study, because you meet the inclusion criteria for potential participants, that is: -

Senior Physiotherapists band 6 or above.

Eligible to attend Neuro Training Group 2 (a current specialist training programme for Physiotherapists employed by LTH)

Access (within their current clinical setting) to a member of the research team

Do I have to take part?

No, it is up to you to decide whether or not to take part.

You will be given this information sheet and asked to attend a training session. You can then decide whether or not you would like to be involved in the project; if you do, you will be asked to sign a consent form.

You are still free to withdraw at any time.

What will be expected of me if I take part?

You will be asked to routinely complete a Leeds Movement Performance Index (Leeds MPI) data sheet during your routine clinical record keeping process. This will mean that you will need to identify key aspects of the components of your patient's movement and record them on a specific form.

If you have any thoughts, problems or suggestions about the practical use of the Leeds MPI within your clinical practice, you will be asked to make a note of these on the data sheet.

Towards the end of the research project, the lead researcher will meet with you and ask you about your experience of using the Leeds MPI.

The lead researcher will record your comments, and take copies of the notes you have written on the Leeds MPI data sheet.

How long the research will go on for?

You will be asked to use the Leeds MPI within your clinical practice, for all appropriate patients that you work with, for 2 months.

What support will I get during the research project?

You will get written support in the form of this information sheet.

You will receive a comprehensive in-service training session on the development and use of the Leeds MPI.

You will receive support within your clinical practice from the member of the research team that works within your clinical area.

Also, should you wish to read it, a copy of the research protocol is available from the lead researcher.

Are there any disadvantages to taking part in this study?

Yes, you may find that there is a small time commitment during your record keeping process, when you are recording your clinical observations onto the Leeds MPI data sheet.

Are there any advantages to taking part in this study?

Yes, you will gain valuable experience in taking part in and learning about an aspect of research. You will have the opportunity to be directly involved in the development of a measure of physiotherapy intervention.

Will my taking part in the study be confidential?

Yes, all the information about your participation in this study will be kept confidential.

During the meeting you will have with the lead researcher (when you will be giving feedback about your experiences of using the Leeds MPI), direct quotes from you may be recorded and used in future publications. Any quotes used will be anonymous.

Any data that you complete will have your name removed from it to ensure your anonymity.

The data will be kept for a minimum of 5 years; this is in line with current CSP requirements (in a locked filing cabinet, in a locked room)

How do I contact the lead researcher?

Denise Ross is the lead researcher, her contact details are: Physiotherapy Department, Lincoln Wing, St James University Hospital, ext 64375, bleep 6551

Which members of staff are in the research team?

Alan Bass	Physiotherapy Department, Chapel Allerton Hospital, ext 24523
Jill Hall	Physiotherapy Department, Chapel Allerton Hospital, ext 24571
Maddy Kenny	Ward 10, Chapel Allerton Hospital, ext 24510
Liz Walker	Ward 34, St James University Hospital, ext 65734
Kate Warner	Physiotherapy Department, Leeds General Infirmary, bleep 2036
Cat Williams	Physiotherapy Department, Leeds General Infirmary, bleep 1544
Karen Wood	Ward 1, Chapel Allerton Hospital, ext 24582

PART 2

What will happen if I don't want to carry on with the study?

Your decision will be respected, any information that you have already collected will be anonymised, used to refine the Leeds MPI, and stored in a secure and confidential manner as per CSP guidelines.

What will happen to the results of the research study?

The results of the study will be written up in 3 main ways: -

1. In thesis format, for a Doctor of Physiotherapy.

2. As a research paper for publication in a Physiotherapy related journal.

3. Presentations regarding this research will also be submitted for physiotherapy and rehabilitation conferences.

If the research can successfully demonstrate that the LMPI is an appropriate way to measure people who are receiving neurological physiotherapy then it can be used within clinical practice and for future research projects.

Who is organising and funding the research?

The research is being organised by Denise Ross, she is a Clinical Specialist Physiotherapist in Neurology, and works for Leeds Teaching Hospitals NHS Trust. Denise is being supported academically by the University of Huddersfield

There is no funding for the research

Who has reviewed this study?

Leeds (Central) Research Ethics Committee

Research Ethics Panel, School of Human and Health Sciences, University of Huddersfield

If I have any concerns or complaints regarding this study, who should I contact?

If you have any concerns or complaints about anything related to the study, please contact:

Dr Serena McCluskey,
Research Fellow,
Centre for Health & Social Care   Research,
University of Huddersfield,
Queensgate,
Huddersfield,
HD1 3DH
Telephone: 01484 422 288

Ms Denise Ross,
Physiotherapy Department,
Chapel Allerton Hospital,
Chapeltown Road,
Leeds,
LS7 4SA. .
Telephone: 01133924523

You will be given a copy of this information sheet, and should you wish to become a research participant, a copy of your signed consent form.

Thank you for taking the time to read this information and for considering taking part in this research study

Centre number………………………..................

Physiotherapist ID number………………………..

Staff ID number…………….............................

Research team member......................................

Consent Form

Title of project: **Measuring Movement Performance: A study to develop the Leeds Movement Performance Index within the clinical setting**

Name of lead researcher   **Denise Ross MCSP MSc**

1. I confirm that I have read and understood the information sheet dated March 2008 (version 2) for the above study. I have had the opportunity to consider the information, ask questions and have these answered satisfactorily

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason

3. I understand that direct quotes that I give during my reflective practice may be used verbatim in future publications, although they will remain anonymous.

4. I agree to take part in the above study

	Name	Signature	Date
Participant			
Researcher			

NHS Physiotherapist participant information sheet and consent form Study 1 phase 2. When completed, 1 copy for participant, 1 copy for researcher (to be kept in research file) March 2008

Patient Participant Information Sheet Study 2, phase 1

The development and clinical testing of an index of movement performance for neurological physiotherapy: a mixed-methods study

You are being invited to take part in the above research study. Your physiotherapist has discussed this and explained what we would like you to do. However, it is important for you to understand why the research is being done and what it will involve before you decide whether or not to take part. Please take time to read the following information carefully. You are free to talk to others, for example your family, about the study if you wish.

- Part 1 of this sheet tells you the purpose of this study and what will be expected of you if you take part.
- Part 2 gives you more detailed information about the conduct of the study

Please ask if there is anything that is not clear or if you would like more information.

Take time to decide whether or not you wish to take part.

PART 1

What are the purposes of this study?

The purpose of this study is to psychometrically and clinically test the properties of the Leeds Movement Performance Index (LMPI). This is a way of measuring the effects of physiotherapy treatment. The LMPI has been developed within the clinical setting, and the neuro-physiotherapists who have developed it feel that it reflects their assessment, clinical reasoning and treatment planning processes.

What does this mean?

Psychometric tests are mathematical tests that can be done using a computer software package; they can help us to understand if measurement tools, tests and questionnaires actually measure what they are supposed to. They can also tell us if therapists score and test to the same standards and in a consistent way.

Outcome measures are used to find out how people change. In this case we are using a measure to define how someone moves, and to see if the physiotherapy that they are receiving is having an effect on their ability to move. Sometimes it is important to prove that physiotherapy is effective and necessary and we hope that this research will help us to be able to do that.

Neurological physiotherapy intervention is a specialist branch of physiotherapy and it involves assessing a patient's movement difficulties, then planning what treatment will be most effective in helping that person to improve or maintain their functional abilities and independence.

Why have I been chosen?

You have been chosen to take part in this study, because you meet the inclusion criteria for potential participants, that is: -

- You have been diagnosed with a neurological condition that makes it somewhat difficult to move
- You are receiving a course of neurological physiotherapy from a senior physiotherapist.

Do I have to take part?

No it is up to you to decide whether or not to take part.

You are free to withdraw at any time.

What will be expected of me if I take part?

Your physiotherapist has asked you if you would consider consenting to an aspect of your movement being videoed and has given you this information sheet.

If you are agreeable, the lead researcher, a senior physiotherapist, will video record an aspect of your movement during your normal physiotherapy session.

Personal information regarding your age, gender, neurological diagnosis, movement difficulties and current physiotherapy treatment goals will also be recorded. All of this information will be kept strictly confidential and will be anonymised, i.e. your name and date of birth will be removed. All of this information will also be stored in a secure place that is only accessible by the lead researcher.

What will be videoed?

Your Physiotherapist will discuss this with you, but it will probably be a movement that you are practicing in your physiotherapy sessions. It is likely that your face will be visible on the video tape; this means that the people who watch the video could recognise you. The only people who will watch your video will be those that are directly involved with this study.

How long will the video be?

Between 20 seconds and a minute

What will my video be used for?

Your video will: -

- Either be used to help teach senior neurological physiotherapists in Yorkshire how to use the LMPI, by showing them how to measure YOUR movement using the scale.
- Or, it will be used to test whether several neurological physiotherapists (from Yorkshire) measure movement in the same way. The therapists will observe your movement, and then score it using the LMPI, and then the researcher will determine

whether they agree with each other. There are several tests that can be done to see if therapists use the LMPI in the same way and this is an important process to go through when a new measurement scale is being developed.

- Your video will be stored on an encrypted computer that only the lead researcher has access to.
- The people who see your video will be:
  - The physiotherapists who prepare the teaching material
  - The physiotherapists who are being taught to use the LMPI
  - The physiotherapists who will be tested to see how they use the LMPI

How long will the research go on for?

No, for the purposes of this study, you can only use the LMPI if you have been trained to use it by the lead researcher.

How long the research will go on for?

Your part in the research project will be for a very short time (the time it takes to video you move during your physiotherapy session). But the full length of the project will last for 2 years. Your video will be used during the first 6 months of the project.

What support will I get during the research project?

You will receive support from your physiotherapist and the lead researcher.

What will happen to my video and personal information when the research is completed?

When the research is completed, your video and personal information will be stored securely within Leeds Teaching Hospitals NHS Trust, and will not be accessible to anybody other than the lead researcher. After 3 years, all confidential information from this research project will be destroyed.

Are there any disadvantages to taking part in this study?

No, your physiotherapy treatment will not be affected in any way, whether you decide to take part in the study or not.

However, your movement difficulties will be recorded and used to help develop the LMPI. This means that other neurological physiotherapists working in Yorkshire will observe how you currently move and will score how you move, but you will not be identified.

Are there any advantages to taking part in this study?

Yes, you will be helping neurological physiotherapists to measure the effects of their treatment.

In future research this could be important to see whether more neurological physiotherapy input has an impact on a patient's recovery of movement.

Will my taking part in the study be confidential?

Yes, all the information about your participation in this study will be kept confidential.

Any information about you will have your name removed from it to ensure your anonymity. However the physiotherapists watching your video will see your face.

If you agree, your Doctor and other members of the medical or rehabilitation teams who are currently working with you will be informed about your participation in this study.

How do I contact the lead researcher?

Denise Ross is the lead researcher, her contact details are:

Physiotherapy Department, Chapel Allerton Hospital, Chapeltown Road, LEEDS, LS7 4SA.e-maild.h.ross@leeds.ac.uk

PART 2

What will happen if I change my mind after the video has been made, and I decide that I don't want to carry on with the study?

Your decision will respected, your video and personal information will not be used in this study, your video and personal information will be destroyed.

What will happen to the results of the research study?

The results of the study will be written up in 3 main ways: -

1.   In thesis format, for a Doctor of Physiotherapy.

2.   As a research paper for publication in a Physiotherapy related journal.

3.   Presentations regarding this research will also be submitted for physiotherapy and rehabilitation conferences.

If the research can successfully demonstrate that the LMPI is an appropriate way to measure people who are receiving neurological physiotherapy then it can be used within clinical practice and for future research projects.

Who is organising and funding the research?

The research is being organised by Denise Ross, she is a Clinical Specialist Physiotherapist in Neurology, and works for Leeds Teaching Hospitals NHS Trust. Denise is being supported academically by the University of Huddersfield

There is no funding for the research

Who has reviewed this study?

Local NHS Research Ethics Committees

Research Ethics Panel, School of Human and Health Sciences, University of Huddersfield

If I have any concerns or complaints regarding this study, who should I contact?

If you have any concerns or complaints about anything related to the study, please contact:

Dr Serena McCluskey,
Research Fellow,
Centre for Health & Social Care   Research,
University of Huddersfield,
Queensgate,
Huddersfield,
HD1 3DH
Telephone: 01484 422 288

Ms Denise Ross,
Physiotherapy Department,
Chapel Allerton Hospital,
Chapeltown Road,
Leeds,
LS7 4SA. .
Telephone: 01133924523

You will be given a copy of this information sheet, and should you wish to become a research participant, a copy of your signed consent form.

Thank you for taking the time to read this information and for considering taking part in this research study

Patient ID number...............................

<u>Patient Participant Consent Form Study 2 phase 1</u>

Title of project: **The development and clinical testing of an index of movement performance for neurological physiotherapy: a mixed-methods study**

Name of lead researcher   **Denise Ross MCSP MSc**

1. I confirm that I have read and understood the information sheet dated 17/09/2010 for the above study. I have had the opportunity to consider the information, ask questions and have these answered satisfactorily
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason
3. I understand that a small piece of video recording my movement will be taken and used by the lead researcher to either: -
   a) Help in the training of senior neurological physiotherapists to use the Leeds Movement Performance Index (LMPI)
   OR
   b) To test that senior neurological physiotherapists use the LMPI to a similar standard in a consistent way.
4. I understand that personal information such as: -
   a) My age
   b) My gender
   c) My neurological diagnosis
   Will be used in this research study, and may be used within future physiotherapy and rehabilitation publications and professional conferences but all the information about me will remain confidential and anonymous.
5. I agree to take part in the above study, and I agree that my Doctor and other members of the medical or rehabilitation teams who are currently working with me can be told that I am participating in this study

	Name	Signature	Date
Participant			
Researcher			

Patient participation information sheet and consent form final version study 1 phase 1. When completed, 1 copy for participant, 1 copy for Physiotherapist (to be kept in patient's medical notes), 1 copy for lead researcher. 17/09/2010

The Leeds Teaching Hospitals **NHS**

NHS Trust

<u>Physiotherapist Participant Manager Information Sheet</u>

The development and clinical testing of an index of movement performance for neurological physiotherapy: a mixed-methods study

Denise Ross, the lead researcher for this study, would like your consent for neurological physiotherapists who deliver your local physiotherapy service to be approached by her and asked if they would like to participate.

Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully.

- Part 1 tells you the purpose of this study and what will be expected of your local neuro-physiotherapists if they take part.
- Part 2 gives you more detailed information about the conduct of the study

Please ask if there is anything that is not clear or if you would like more information.

Take time to decide whether or not you wish for your local neuro-physiotherapists to take part.

<u>PART 1</u>

What are the purposes of this study?

The purposes of this study are to psychometrically and clinically test the properties of the Leeds Movement Performance Index (LMPI). This is an outcome measure that reflects neurological physiotherapy intervention. It has been developed within the clinical setting, and the neuro-physiotherapists who have developed it feel that it reflects their assessment, clinical reasoning and treatment planning processes; this means that the measure is clinically meaningful and potentially useful to be used in both clinical practice and research.

What would you like me to do?

The lead researcher would like you to give her permission to approach potential research participants that meet the inclusion criteria, i.e. those that:

- Are employed as band 6 Physiotherapists or above
- Have had post-graduate training within neurological physiotherapy either formally at M level or equivalent, within the Bobath concept or equivalent, or informally via in-service or on the job training.
- Work predominantly with patients who have neurological diagnoses

Once you have identified potential participants, the lead researcher would like you to give them a participant information sheet. The therapists will then be approached by the lead researcher, and be invited to attend a training session. If they attend the training session, they will then need to decide whether or not they would like to be involved in the project; if they do, they will be asked to sign a consent form.

They are free to withdraw at any time.

Where will the training session take place?

The training session will take place in a place convenient to your therapists, if possible on your local Trust premises.

Do the neuro-physiotherapists who work for me have to take part?

No, it is up to them to decide whether or not to take part.

What will be expected of them if they take part?

After the training session, they will be asked to take part in a short study to test the agreement between and within users (or raters) of the LMPI. This means that they will be asked to watch 6 videos of patients' movements, and complete the LMPI. After two weeks, they will be asked to again watch the 6 videos of patients' movements, and complete the LMPI. The results will be tested for inter and intra rater and test re-test reliability using a computer software package (SPSS)

After the above tests are complete: -

1. The therapists will be asked to complete a LMPI data sheet for all appropriate patients during their routine clinical record keeping practice. This will mean that they will need to identify key aspects of the components of the movements of each of their patients and record them on a specific form, alongside patient information such as age, gender, diagnosis, and the specific movement that they are recording. They will then be asked to re-score the same movement, using the LMPI, 6 weeks later, or on discharge from treatment/hospital if this occurs earlier. They will also be asked to complete a Berg Balance Scale (BBS) each time they complete a LMPI data sheet. The analysis of this information is part of the validity testing of the LMPI.

2. They will be asked to gain informed consent from their patients to become participants in this research study. In order for them to do this in such a way that conforms to good research practice requirements, initial training and on-going advice will be given by the lead researcher. In practice, they will find that gaining full informed consent from their

3. When the research is complete, the lead researcher will send the therapists a reflective practice form and ask that they complete it and send her a copy. This is so that she can understand how using the LMPI has impacted on their clinical practice – both personally and professionally, and whether they found it useful and meaningful.

How much time will this study take out of my staffs' clinical obligations?

The researcher expects that a full half day will be needed to complete the training and the initial testing of the LMPI. The re-testing (after 2 weeks) should take between 30 and 45 minutes.

The on-going use of the LMPI within routine clinical practice should take minimal time in comparison to other measures of outcome that are generally used

Can anybody else use the LMPI?

No, for the purposes of this study, only therapists can use the LMPI if they have been trained to use it by the lead researcher.

How long the research will go on for?

The neuro-physiotherapists will be asked to use the LMPI within their clinical practice, for all appropriate patients that they work with, until at least 100 data sheets (in total for the whole study) have been collected. There will be several neuro-physiotherapists who have given consent to be recruited into this study, and who will also be collecting data sheets.

What support will the therapists get during the research project?

They will get written support in the form of an information sheet similar to this one.

They will receive a comprehensive in-service training session on the development and use of the LMPI.

They will receive a copy of the LMPI guidelines

They will receive training on the gaining of full informed consent from their patients, who will be research participants and will also be provided with written information.

They will be able to contact the researcher for advice and guidance via e mail.

The researcher will visit your staff during the data gathering period, in order to provide support and solve any issues that arise, and to ensure that research ethical requirements are being met.

Are there any disadvantages to taking part in this study?

Yes, there is a half day of time that your neuro-physiotherapists will need to commit to in order to be trained to use the LMPI and participate in study 1b.

They may also find that there is a small time commitment during their record keeping process, when they are recording their clinical observations onto the LMPI data sheet.

Are there any advantages to taking part in this study?

Yes, they will gain potential valuable experience in taking part in and learning about an aspect of research.

They will have the opportunity to be directly involved in the development of a measure of neurological physiotherapy intervention.

They will receive training in gaining informed consent for research purposes.

They will be able to use this experience to provide evidence to meet some of their KSF requirements.

Will taking part in the study be confidential?

Yes, all the information about your staff's participation in this study will be kept confidential.

Any data that is completed will have their names removed from it to ensure anonymity.

During the research study, written comments that are made (via e mail or from the reflective practice sheet) regarding the use of the LMPI may be used verbatim within future publications. However, any quotes will remain anonymous

All data gathered during the course of this study will be kept in a secure place, only accessible by the lead researcher.

The data will be kept for a minimum of 3 years; in a locked filing cabinet, in a locked room.

How do I or my staff contact the lead researcher?

Denise Ross is the lead researcher, her contact details are: Physiotherapy Department, Chapel Allerton Hospital, Chapeltown Road, LEEDS, LS7 4SA.

e-maild.h.ross@leeds.ac.uk

PART 2

What will happen if the therapists don't want to carry on with the study?

Their decision will be respected. Their decision will not affect any future or current working relationships with the lead researcher. Any information about them that has already been gathered by the lead researcher will be destroyed and will not be used in the study.

What will happen to the results of the research study?

The results of the study will be written up in 3 main ways: -

1.   In thesis format, for a Doctor of Physiotherapy.

2.   As a research paper for publication in a Physiotherapy related journal.

3.   Presentations regarding this research will also be submitted for physiotherapy and rehabilitation conferences.

If the research can successfully demonstrate that the LMPI is an appropriate way to measure people who are receiving neurological physiotherapy then it can be used within clinical practice and for future research projects.

The researcher will offer to return to your Trust, in order to give feedback regarding the progress and results of the research.

Who is organising and funding the research?

The research is being organised by Denise Ross, she is a Clinical Specialist Physiotherapist in Neurology, and works for Leeds Teaching Hospitals NHS Trust. Denise is being supported academically by the University of Huddersfield.

There is no funding for the research

Who has reviewed this study?

Local NHS Research Ethics Committees

Research Ethics Panel, School of Human and Health Sciences, University of Huddersfield.

If I have any concerns or complaints regarding this study, who should I contact?

If you have any concerns or complaints about anything related to the study, please contact:

Dr Serena McCluskey,
Research Fellow,
Centre for Health & Social Care   Research,
University of Huddersfield,
Queensgate,
Huddersfield,
HD1 3DH
Telephone: 01484 422 288

Ms Denise Ross,
Physiotherapy Department,
Chapel Allerton Hospital,
Chapeltown Road,
Leeds,
LS7 4SA. .
Telephone: 01133924523

Thank you for taking the time to read this information and for considering that the neurological physiotherapists who work for you may be approached by the lead researcher for inclusion in this research project.

University of
HUDDERSFIELD
Inspiring tomorrow's professionals

Physiotherapy Manager Consent

Title of project   **The development and clinical testing of an index of movement performance for neurological physiotherapy: a mixed-methods study**

Name of lead researcher   **Denise Ross MCSP MSc**

1. I confirm that I have read and understood the information sheet dated 26/09/2010 for the above study. I have had the opportunity to consider the information, ask questions and have these answered satisfactorily ☐

2. I understand that the participation of the neuro-physiotherapists who work for me is voluntary and that they are free to withdraw at any time, without giving reason ☐

3. I understand that direct quotes that my staff given during their written communication with the lead researcher, or within their reflections for study 2b may be used verbatim within future publications, although they will remain anonymous. ☐

4. I agree that the lead researcher may approach staff who meet the inclusion criteria to take part in the above study ☐

	Name	Signature	Date
Manage			
Researcher			

Physiotherapy Manager information sheet and consent form final version. When completed, 1 copy for Manager, 1 copy for lead researcher. 26/09/2010

NHS Physiotherapist Participant Information Sheet

The development and clinical testing of an index of movement performance for neurological physiotherapy: a mixed-methods study

You are being invited to take part in a research study but before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully. Talk to others about the study if you wish.

- Part 1 tells you the purpose of this study and what will be expected of you if you take part.
- Part 2 gives you more detailed information about the conduct of the study

Please ask if there is anything that is not clear or if you would like more information.

Take time to decide whether or not you wish to take part.

PART 1

What are the purposes of this study?

The purposes of this study are to psychometrically and clinically test the properties of the Leeds Movement Performance Index (LMPI). This is an outcome measure that reflects neurological physiotherapy intervention. It has been developed within the clinical setting, and the neuro-physiotherapists who have developed it feel that it reflects their assessment, clinical reasoning and treatment planning processes.

Why have I been chosen?

You have been chosen to take part in this study, because you meet the inclusion criteria for potential participants, that is: -

- You are a senior Physiotherapist band 6 or above
- You have attended post-graduate training within neurological physiotherapy (at M level, in-service or on the job training)
- You work predominantly with patients who have neurological diagnoses
- You work within Yorkshire

Do I have to take part?

No, it is up to you to decide whether or not to take part.

You will be given this information sheet and asked to attend a training session. You can then decide whether or not you would like to be involved in the project; if you do, you will be asked to sign a consent form.

You are still free to withdraw at any time

.

What will be expected of me if I take part?

After the training session, you will be asked to take part in a short study to test the agreement between and within users (or raters) of the LMPI. This means that you will be asked to watch 6 videos of patients' movements, and complete the LMPI. After two weeks, you will be asked to watch the 6 videos of patients' movements again and complete the LMPI. The results will be tested for inter and intra rater and test re-test reliability using a computer software package (SPSS).

After you have been trained: -

1. You will be asked to complete a LMPI data sheet for all appropriate patients during your routine clinical record keeping. This will mean that you will need to identify key aspects of the components of the movements of each of your patients and record them on a specific form, alongside patient information such as age, gender, diagnosis, and the specific movement that you are recording. You will then be asked to re-score the same movement, using the LMPI, 6 weeks later, or on discharge from treatment/hospital if this occurs earlier. You will also be asked to complete a Berg Balance Scale (BBS) each time you complete a LMPI data sheet. The analysis of this information is part of the validity testing of the LMPI.

2. You will be asked to gain informed consent from your patients to become participants in this research study (to give permission for their personal information to be sent to the lead researcher for statistical analysis). In order for you to do this in such a way that conforms to ethical approval and good research practice requirements, initial training and on-going advice will be given by the lead researcher. In practice, you will find that gaining full informed consent from your patients for treatment is a similar process to that of gaining full informed consent for research activities.

3. When the data sheets are complete, the researcher asks that you return the data sheets to her. This is so that concurrent, construct, internal consistency validity and scale sensitivity can be tested. This will be done using SPSS

4. When the research is complete, the researcher will send you a reflective practice form, with some guidance questions, and ask that you complete it and send her a copy. This is so that she can understand how using the LMPI has impacted on your clinical practice – both personally and professionally - and whether or not you found it useful and meaningful.

How much time will this study take out of my clinical obligations?

The researcher expects that a full half day will be needed to complete the training and the initial testing of the LMPI.

The re-testing (after 2 weeks) should take between 30 and 45 minutes.

The on-going use of the LMPI within routine clinical practice should take minimal time in comparison to other measures of outcome that are generally used.

Can anybody else use the LMPI?

No, for the purposes of this study, you can only use the LMPI if you have been trained to use it by the lead researcher.

How long the research will go on for?

You will be asked to use the LMPI within your clinical practice, for all appropriate patients that you work with, until at least 100 data sheets (in total for the whole study) have been collected. There will be several neuro-physiotherapists who have given consent to be recruited into this study, and who will also be completing data sheets.

What support will I get during the research project?

You will get written support in the form of this information sheet.

You will receive a comprehensive in-service training session on the development and use of the LMPI.

You will receive a copy of the LMPI guidelines.

You will receive training on the gaining of full informed consent from your patients, who will be research participants and will also be provided with written information.

You will be able to contact the researcher for advice and guidance via e-mail.

The researcher will visit you during the data gathering period, in order to provide support and solve any issues that arise.

Are there any disadvantages to taking part in this study?

Yes, there is a half day of time that you will need to commit to in order to be trained to use the LMPI and participate in study 1b.

There is also a small time commitment during your record keeping process, when you are recording your clinical observations onto the LMPI data sheet.

Are there any advantages to taking part in this study?

Yes, you will gain potentially valuable experience in taking part in and learning about an aspect of research.

You will be directly involved in the development of a measure of neurological physiotherapy intervention.

You will receive training in gaining informed consent for research purposes.

You will be able to use this experience to provide evidence to meet some of your KSF requirements.

Will my taking part in the study be confidential?

Yes, all the information about your participation in this study will be kept confidential.

Any data that you complete will have your name removed from it to ensure your anonymity.

During the research study, written comments that you make (via e mail or from the reflective practice sheet) regarding the use of the LMPI may be used verbatim within future publications. However, any quotes will remain anonymous

All data gathered during the course of this study will be kept in a secure place, only accessible by the lead researcher.

The data will be kept for a minimum of 3 years; in a locked filing cabinet, in a locked room.

How do I contact the lead researcher?

Denise Ross is the lead researcher, her contact details are: Physiotherapy Department, ChapelAllertonHospital, Chapeltown Road, LEEDS, LS7 4SA.

e-maild.h.ross@leeds.ac.uk

PART 2

What will happen if I don't want to carry on with the study?

Your decision will respected. Your decision will not affect any future or current working relationships with the lead researcher. Any information about you that has already been gathered by the lead researcher will be destroyed and will not be used in the study.

What will happen to the results of the research study?

The results of the study will be written up in 3 main ways: -

1.   In thesis format, for a Doctor of Physiotherapy.

2.   As a research paper for publication in a Physiotherapy related journal.

3.   Presentations regarding this research will also be submitted for physiotherapy and rehabilitation conferences.

If the research can successfully demonstrate that the LMPI is an appropriate way to measure people who are receiving neurological physiotherapy then it can be used within clinical practice and for future research projects.

The researcher will offer to return to your Trust, in order to give feedback regarding the progress and results of the research

.

Who is organising and funding the research?

The research is being organised by Denise Ross, she is a Clinical Specialist Physiotherapist in Neurology, and works for Leeds Teaching Hospitals NHS Trust. Denise is being supported academically by the University of Huddersfield

There is no funding for the research

Who has reviewed this study?

Local NHS Research Ethics Committees

Research Ethics Panel, School of Human and Health Sciences, University of Huddersfield

If I have any concerns or complaints regarding this study, who should I contact?

If you have any concerns or complaints about anything related to the study, please contact:

Dr Serena McCluskey,
Research Fellow,
Centre for Health & Social Care   Research,
University of Huddersfield,
Queensgate,
Huddersfield,
HD1 3DH
Telephone: 01484 422 288

Ms Denise Ross,
Physiotherapy Department,
Chapel Allerton Hospital,
Chapeltown Road,
Leeds,
LS7 4SA. .
Telephone: 01133924523

You will be given a copy of this information sheet, and should you wish to become a research participant, a copy of your signed consent form.

Thank you for taking the time to read this information and for considering taking part in this research study

Centre number………………………..................

Physiotherapist ID number……………………..

Number of years post graduate...........................

Post graduate training within neurology (include M level, IST, on the job training)
....
....

NHS Physiotherapist Consent Form

Title of project: **The development and clinical testing of an index of movement performance for neurological physiotherapy: a mixed-methods study**

Name of lead researcher   **Denise Ross MCSP MSc**

1. I confirm that I have read and understood the information sheet dated 26/09/2010 for the above study. I have had the opportunity to consider the information, ask questions and have these answered satisfactorily
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason
3. I understand that direct quotes that I give during my reflective practice may be used verbatim in future publications, although they will remain anonymous.
4. I agree to take part in the above study

	Name	Signature	Date
Participant			
Researcher			

NHS Physiotherapist participant information sheet and consent form Studies 2 & 3. When completed, 1 copy for participant, 1 copy for researcher (to be kept in research file) 26.09.2010

University of
HUDDERSFIELD
Inspiring tomorrow's professionals

<u>Patient Participant Information Sheet Study 2, phase 3</u>

The development and clinical testing of an index of movement performance for neurological physiotherapy: a mixed-methods study

You are being invited to take part in the above research study. Your physiotherapist has discussed this and explained what we would like you to do. However, it is important for you to understand why the research is being done and what it will involve before you decide whether or not to take part. Please take time to read the following information carefully. You are free to talk to others, for example your family, about the study if you wish.

- Part 1 of this sheet tells you the purpose of this study and what will be expected of you if you take part.
- Part 2 gives you more detailed information about the conduct of the study

Please ask if there is anything that is not clear or if you would like more information.

Take time to decide whether or not you wish to take part.

<u>PART 1</u>

What are the purposes of this study?

The purpose of this study is to psychometrically and clinically test the properties of the Leeds Movement Performance Index (LMPI). This is a way of measuring the effects of physiotherapy treatment. The LMPI has been developed within the clinical setting, and the neuro-physiotherapists who have developed it feel that it reflects their assessment, clinical reasoning and treatment planning processes.

What does this mean?

Psychometric tests are mathematical tests that can be done using a computer software package; they can help us to understand if measurement tools, tests and questionnaires actually measure what they are supposed to. They can also tell us if therapists score and test to the same standards and in a consistent way.

Outcome measures are used to find out how people change. In this case we are using a measure to define how someone moves, and to see if the physiotherapy that they are receiving is having an effect on their ability to move. Sometimes it is important to prove that physiotherapy is effective and necessary and we hope that this research will help us to be able to do that.

Neurological physiotherapy intervention is a specialist branch of physiotherapy and it involves assessing a patient's movement difficulties, then planning what treatment will be most effective in helping that person to improve or maintain their functional abilities and independence.

296

Do I have to take part?

No it is up to you to decide whether or not to take part.

You are free to withdraw at any time.

What will be expected of me if I take part?

Your physiotherapist has asked you if you would consider to consent to your movement difficulties being recorded by the LMPI. This means that the physiotherapist will record your movement difficulties (as they normally would) and also score them using the LMPI. They will also score your movement using the Berg Balance Scale (BBS); this is something that they may already routinely do. The BBS measures your balance and your ability to do movements such: sit on the edge of a bed, stand up, sit down, turn and look over your shoulder.

Your physiotherapist will score your movement using the LMPI and the BBS; once, at or near the beginning of your course of treatment, and then again 6 weeks later or when you leave hospital, or finish your course of physiotherapy (whichever is the sooner).

Personal information regarding your age, gender, neurological diagnosis, movement difficulties and current physiotherapy treatment goals will also be recorded.

All of this information will be kept strictly confidential, and will be anonymised i.e. your name and date of birth will be removed.

All of this information will then be used to test the LMPI using a computer software statistics package.

How long the research will go on for?

Your part in the research project will be for a very short time (the time it takes to video you move during your physiotherapy session). But the full length of the project will last for 2 years. Your video will be used during the first 6 months of the project.

What support will I get during the research project?

You will receive support from your physiotherapist.

What will happen to my personal information when the research is completed?

When the research is completed, your personal information will be stored securely within Leeds Teaching Hospitals NHS Trust, and will not be accessible to anybody other than the lead researcher. After 3 years, all confidential information from this research project will be destroyed.

Are there any disadvantages to taking part in this study?

No, your physiotherapy treatment will not be affected in any way, whether you decide to take part in the study or not.

However, your movement difficulties and personal information will be recorded and used to help develop the LMPI.

Are there any advantages to taking part in this study?

Yes, you will be helping neurological physiotherapists measure the effects of their treatment.

In future research this could be important to see whether more neurological physiotherapy input has an impact on a patient's recovery of movement.

Will my taking part in the study be confidential?

Yes, all the information about your participation in this study will be kept confidential.

Any information about you will have your name and date of birth removed from it to ensure your anonymity.

If you agree, your Doctor and other members of the medical or rehabilitation teams who are currently working with you will be informed about your participation in this study.

How do I contact the lead researcher?

Denise Ross is the lead researcher, her contact details are:

Physiotherapy Department, Chapel Allerton Hospital, Chapeltown Road, LEEDS, LS7 4SA.e-mail d.h.ross@leeds.ac.uk

<u>PART 2</u>

What will happen if I change my mind after the video has been made, and I decide that I don't want to carry on with the study?

Your decision will be respected and your personal information will not be used in this study. Any information that has already been sent to the lead researcher will not be used in the study and will be destroyed.

What will happen to the results of the research study?

The results of the study will be written up in 3 main ways: -

1.   In thesis format, for a Doctor of Physiotherapy.

2.   As a research paper for publication in a Physiotherapy related journal.

3.   Presentations regarding this research will also be submitted for physiotherapy and rehabilitation conferences.

If the research can successfully demonstrate that the LMPI is an appropriate way to measure people who are receiving neurological physiotherapy then it can be used within clinical practice and for future research projects.

Who is organising and funding the research?

The research is being organised by Denise Ross, she is a Clinical Specialist Physiotherapist in Neurology, and works for Leeds Teaching Hospitals NHS Trust. Denise is being supported academically by the University of Huddersfield

There is no funding for the research

Who has reviewed this study?

Local NHS Research Ethics Committees

Research Ethics Panel, School of Human and Health Sciences, University of Huddersfield

If I have any concerns or complaints regarding this study, who should I contact?

If you have any concerns or complaints about anything related to the study, please contact:

Dr Serena McCluskey,   Ms Denise Ross,
Research Fellow,   Physiotherapy Department,
Centre for Health & Social Care   Research,   Chapel Allerton Hospital,
University of Huddersfield,   Chapeltown Road,
Queensgate,   Leeds,
Huddersfield,   LS7 4SA. .
HD1 3DH   Telephone: 01133924523
Telephone: 01484 422 288

You will be given a copy of this information sheet, and should you wish to become a research participant, a copy of your signed consent form.

Thank you for taking the time to read this information and for considering taking part in this research study

The Leeds Teaching Hospitals **NHS**

NHS Trust

Centre number…………………………

Physiotherapist ID number……………………..

Patient Participant Consent Form Study 2 phase 1

Title of project: **The development and clinical testing of an index of movement performance for neurological physiotherapy: a mixed-methods study**

Name of lead researcher   **Denise Ross MCSP MSc**

1. I confirm that I have read and understood the information sheet dated 17/09/2010 for the above study. I have had the opportunity to consider the information, ask questions and have these answered satisfactorily
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason
3. I understand that personal information such as: -
   a) My age
   b) My gender
   c) My neurological diagnosis
   d)The results of the Berg Balance Scale and Leeds Movement Performance Index
   Will be used in this research study, and may be used within future physiotherapy and rehabilitation publications and professional conferences but all the information about me will remain confidential and anonymous.
4. I agree to take part in the above study, and I agree that my Doctor and other members of the medical or rehabilitation teams who are currently working with me can be told that I am participating in this study

	Name	Signature	Date
Participant			
Researcher			

Patient participation information sheet and consent form final version study 1 phase 1. When completed, 1 copy for participant, 1 copy for Physiotherapist (to be kept in patient's medical notes), 1 copy for lead researcher. 17/09/2010

Physiotherapist Participant Information Sheet Study 3

The development and clinical testing of an index of movement performance for neurological physiotherapy: a mixed-methods study

You are being invited to take part in a research study but before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully. Talk to others about the study if you wish.

- Part 1 tells you the purpose of this study and what will be expected of you if you take part.
- Part 2 gives you more detailed information about the conduct of the study

Please ask if there is anything that is not clear or if you would like more information.

Take time to decide whether or not you wish to take part.

PART 1

What are the purposes of this study?

The purposes of this study are to psychometrically and clinically test the properties of the Leeds Movement Performance Index (LMPI). This is an outcome measure that reflects neurological physiotherapy intervention. It has been developed within the clinical setting, and the neuro-physiotherapists who have developed it feel that it reflects their assessment, clinical reasoning and treatment planning processes.

Why have I been chosen?

You have been chosen to take part in this study, because you meet the inclusion criteria for potential participants, that is: -

- You are a member of the British Bobath Tutors Association (BBTA)

Do I have to take part?

No, it is up to you to decide whether or not to take part.

You will be given this information sheet and asked to attend a training session. You can then decide whether or not you would like to be involved in the project; if you do, you will be asked to sign a consent form.

You are still free to withdraw at any time.

What will be expected of me if I take part?

You will be asked to routinely complete a LMPI data sheet during your routine clinical record keeping practice. This will mean that you will need to identify key aspects of the components of your patient's movement and record them on a specific form. You should keep the data sheets within your clinical records, these will not be used within the research.

After six months, the lead researcher will ask you to participate in one of two focus groups. Your focus group will last for about an hour, and will take place at some point during a BBTA meeting.

The focus groups will be centred around how you used the LMPI and whether it was useful and meaningful to you in your clinical practice. Before the focus groups are run, ground rules will be agreed with all participants.

The focus groups will be audio taped, the content will then be transcribed. If you wish, you may review the transcription from your focus group for accuracy; this means that you will also have the opportunity to review and request removal of information pertaining to you from the transcript.

Once the transcripts have been agreed, they will be analysed by the lead researcher.

The lead researcher requests that all focus group participants maintain confidentiality regarding the views of other participants.

The audio tapes and transcripts will be kept in a secure location, accessible only to the lead researcher.

What happens if I become distressed during the focus group?

If this happens, there will be someone that you know available to support you. Should you wish to remove yourself from the group, your decision will be respected and if you wish it, all the evidence that you have contributed will not be used in the study and will be destroyed.

How much time will this study take out of my clinical obligations?

The researcher expects that approximately 1 hour will be needed to complete the training to use the LMPI.

The on-going use of the LMPI within routine clinical practice should take minimal time in comparison to other measures of outcome that are generally used.

Can anybody else use the LMPI?

No, for the purposes of this study, you can only use the LMPI if you have been trained to use it by the lead researcher.

How long will the research go on for?

You will be asked to use the LMPI within your clinical practice, for six months (between BBTA meetings).

What support will I get during the research project?

You will get written support in the form of this information sheet

You will receive a comprehensive training session on the development and use of the LMPI.

You will receive a copy of the LMPI guidelines

You will be able to contact the researcher for advice and guidance via e mail.

Are there any disadvantages to taking part in this study?

Yes, you may find that there is a small time commitment during your record keeping process, when you are recording your clinical observations onto the LMPI data sheet.

There is a time commitment of one hour whilst you participate in the focus group. During the focus group you will be asked to be positively critical and open during a discussion about the clinical use and efficacy of the LMPI

Are there any advantages to taking part in this study?

Yes, you will gain potentially valuable experience in taking part in and learning about an aspect of research. You will have the opportunity to be directly involved in the development of a measure of physiotherapy intervention.

Will my taking part in the study be confidential?

Yes, all the information about your participation in this study will be kept confidential. The information will be kept in a secure location and only accessible to the lead researcher.

Any information about you will have your name removed from it to ensure your anonymity.

Written comments you make, via e mail regarding the use of the LMPI, may be used verbatim within future publications. However, any quotes from you will remain anonymous

Your contribution to the focus group discussion will be kept confidential.

During the focus groups, verbal comments you make regarding the use of the LMPI, may be used verbatim within future publications. However, any quotes from you will remain anonymous

How do I contact the lead researcher?

Denise Ross is the lead researcher, her contact details are: Physiotherapy Department, Chapel Allerton Hospital, Chapeltown Road, LEEDS, LS7 4SA. e mail d.h.ross@leeds.ac.uk

PART 2

What will happen if I don't want to carry on with the study?

Your decision will respected. Your decision will not affect any future or current working relationships with the lead researcher. Any information about you that has already been gathered by the lead researcher will be destroyed and will not be used in the study.

What will happen to the results of the research study?

The results of the study will be written up in 3 main ways: -

1.   In thesis format, for a Doctor of Physiotherapy.

2.   As a research paper for publication in a Physiotherapy related journal.

3.   Presentations regarding this research will also be submitted for physiotherapy and rehabilitation conferences.

If the research can successfully demonstrate that the LMPI is an appropriate way to measure people who are receiving neurological physiotherapy then it can be used within clinical practice and for future research projects.

The researcher will offer to return to your Trust, in order to give feedback regarding the progress and results of the research.

Who is organising and funding the research?

The research is being organised by Denise Ross, she is a Clinical Specialist Physiotherapist in Neurology, and works for Leeds Teaching Hospitals NHS Trust. Denise is being supported academically by the University of Huddersfield

There is no funding for the research

Who has reviewed this study?

Local NHS Research Ethics Committees

Research Ethics Panel, School of Human and Health Sciences, University of Huddersfield

If I have any concerns or complaints regarding this study, who should I contact?

If you have any concerns or complaints about anything related to the study, please contact:

Dr Serena McCluskey,   Ms Denise Ross,
Research Fellow,   Physiotherapy Department,
Centre for Health & Social Care   Research,   Chapel Allerton Hospital,
University of Huddersfield,   Chapeltown Road,
Queensgate,   Leeds,
Huddersfield,   LS7 4SA. .
HD1 3DH   Telephone: 01133924523
Telephone: 01484 422 288

You will be given a copy of this information sheet, and should you wish to become a research participant, a copy of your signed consent form.

Thank you for taking the time to read this information and for considering taking part in this research study

Physiotherapist Participant Consent Form Study 3

Title of project: **The development and clinical testing of an index of movement performance for neurological physiotherapy: a mixed-methods study**

Name of lead researcher   **Denise Ross MCSP MSc**

1. I confirm that I have read and understood the information sheet dated 17/09/2010 for the above study. I have had the opportunity to consider the information, ask questions and have these answered satisfactorily
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason
3. I understand that verbatim quotes that I give during the focus group or during written communication may be used in future publications, although they will remain anonymous.

4. I agree to keep the discussion within my focus group confidential

5. I agree to take part in the above study

	Name	Signature	Date
Participant			
Researcher			

Physiotherapist participant information sheet and consent form Study 3

When completed, 1 copy for participant, 1 copy for researcher (to be kept in research file) 17/09/2010

Appendix 5

- The themes and structure for the Focus Groups

Themes and structure for focus groups

(18th November 2011)

Prior to Focus group starting, discuss:

- Focus group rules
  - Confidentiality
    - For me - talk amongst yourselves but not outside BBTA
    - For participants – anonymised transcripts of this audio-recording
  - Feel free, unconstrained and comfortable to speak as you feel
  - My role is to put questions to you, possibly probe, and guide you
  - The assistant's role is to time keep, and to scribe key points that you discuss. You will have opportunity to correct / expand / alter these points for 10 minutes at the end of 45 minutes.
- Length of time it will run
  - 45 minutes of discussion
  - 10 minutes of feedback from the flip chart key points that Alan will make during your discussion
  - 5 minutes for change over
  - STRICT timekeeping by assistant
- This will be hard work, because we only have 1 hour, I would like you to make sure that you have discussed everything that you need to, and to try not to become side tracked….. you don't need to repeat points - - everything is recorded.
- Typed out verbatim and anonymised
- Analysed
- Feedback of research findings

Clinical application theme	Quick and easy theme	Theoretical underpinning to practice theme
Does the scale recognise the individual nature of your patient's movement?	Does it take long to use?	Do you think the items in the scale are hierarchical in nature? - (but I'm not psychometrically testing this, this will be on face value only)
Can you use it for all of your patients?	Is it achievable, realistic and timely? I.e. does it take a reasonable length of time to complete	
What patient phenotypes did you use it with?		How does it compare to other outcome measures that you use or have used?
What clinical settings have you used the LMPI in?	Within the patient Rx process, when do you complete it?	
Is the scale sensitive enough to measure change?		Does it reflect your conceptual approach to clinical practice?
Can the LMPI be related to function?		
Have you found it to be a meaningful and useful outcome measure?		
Is there anything missing (don't include cognition or sensation, i.e. movement only)?		
What are it's strengths?		

Appendix 6

- LMPI guidelines
- LMPI data sheet

Leeds Movement Performance Index: Guidelines for use

July 2010

Physiotherapy Department

LMPI

The Leeds Teaching Hospitals **NHS**
NHS Trust

LMPI Scoring guidance

Alignment: The position / posture of muscles, joints and body parts from which movement / activity is most anatomically correct and therefore efficient and effective.

3 = **Normal**_Able to appropriately align all muscles, joints and body parts for the movement or posture that is being measured.

2 = **Mild**_Able to achieve a good amount of alignment of the muscles, joints or body parts for the movement or posture that is being measured.

1 = **Moderate**_Able to achieve a small amount of alignment of the muscles, joints or body parts for the movement or posture that is being measured.

0 = **Severe**_Unable to achieve any appropriate alignment of muscles, joints or body parts for the movement or posture that is being measured.

Interaction: The ongoing adjustment between body parts within a posture or during movement with respect to its BOS; that allows the maintenance of the posture on a background of balance correction, strength and endurance.

3 = **Normal**_Able to appropriately interact and adjust between the body parts that are being measured within the posture or movement.

2 = **Mild**_Able to achieve a good amount of interaction and adjustment between the body parts that are being measured within the posture or movement.

1 = **Moderate**_Able to achieve a small amount of interaction and adjustment between the body parts that are being measured within the posture or movement.

0 = **Severe**_Unable to achieve any interaction or adjustment between the body parts that are being measured within the posture or movement.

Timing: The appropriate sequence of activation and de-activation of automatic and selective movement in order to complete a task.

3 = **Normal**_Able to access the appropriate sequence and timing of activity within the movement.

2 = **Mild**_Able to access a good amount of the appropriate sequencing and timing of activity within the movement.

1 = **Moderate**_Able to access a small amount of the appropriate sequencing and timing of activity within the movement.

0 = **Severe**_Unable to access any of the appropriate sequencing and timing of activity within the movement.

Speed: The ability to choose how fast or slowly a movement can occur. An optimum Speed would be one which allows coordination, control, use of minimal energy and allow an effective goal to be achieved.

3 = **Normal**_An ability to move appropriately through the range being measured, and to move with a choice of different speeds.

2 = **Mild**_An ability to produce movement within the range being developed and the ability to move with a limited choice of different speeds.

1 = **Moderate**_An ability to produce movement within the range being developed but with a single choice of speed

0 = **Severe**_An inability to produce any movement at any speed.

Selective movement: The ability to achieve an isolated, specific and desired movement on a background of stability.

3 = **Normal**_An ability to move selectively on an appropriate background of stability.

2 = **Mild**_An ability to achieve a moderate amount of selective movement and / or recruit a moderate amount of appropriate postural activity.

1 = **Moderate**_An ability to achieve a small amount of selective movement and / or recruit a small amount of appropriate postural activity.

0 = **Severe**_An inability to move selectively or recruit appropriate postural activity.

Introduction

The **Leeds Movement Performance Index has been developed for senior neuro-physiotherapists in order to:** -

- Support clinical communication & continuity between therapists
- Enable record of specific changes as a direct outcome of therapy intervention
- Demonstrate carryover
- Support clinical reasoning, decision making & treatment planning.

F.A.Q's

How do I know what to measure?
- Consider the patients problem list, treatment plan, hypothesis and goals. Decide what you want to change and therefore measure.
- Keep what you are measuring simple and specific
- E.g. "hip extensor activity in single leg stance", "alignment in standing", "the ability to accept a base of support"

How do I know when to measure?
This needs to reflect your patients progress, and will depend on their pathology, your treatment intensity and their individual circumstances, you could measure: -
- Pre and post treatment
- Post and pre treatment to capture carry-over.
- Once per week or month.

Do I need to use all the items on the scale?

In some circumstances you may not need to use all the items of the scale, i.e. if you are measuring alignment of the body in double leg stance, this is a still posture so you may not need to measure speed or selective movement, but you might measure timing of adjustment and interaction. If you decide not to measure a particular item put "n/a" in the score box.

How do I interpret the results?

Because the construct validity of this scale is under investigation it is not appropriate to add up the total scores, however comparison of sequential scores are clinically meaningful.

What other factors should I consider?

Consider what the patients 'optimum normal' should be i.e. an elderly rheumatoid female's 'normal' is very different to a young male athlete's 'normal'.

Item guidance

Alignment: 'The position / posture of muscles, joints and body parts from which movement / activity is most anatomically correct and therefore efficient and effective'
Consider things that could effect alignment e.g. tone, strength, activity, soft tissue changes, orientation:

Interaction: 'The ongoing adjustment between body parts within a posture OR during movement with respect to its BOS; that allows the maintenance of the posture on a background of balance correction, strength and endurance.'
The patients base of support (BOS) depends on what you are measuring, e.g. the BOS for selective hand movement may be the wrist, the

BOS for trunk posture in sitting would include the patients' bottom and feet.

Timing: 'The appropriate sequence of activation and de-activation of automatic and selective movement in order to complete a task.'
This is about the building up and the scaling down of activity within movement and posture, it is reciprocal and should be in a specific order.

Speed: 'the ability to CHOOSE how fast or slowly a movement can occur. An optimum speed would be one which allows coordination, control, use of minimal energy and allow an effective goal to be achieved'
You could only measure this when you are utilising different aspects of speed during the treatment session

Selective movement: 'Ability to achieve an isolated and specific movement on a background of stability'
This is dependent on the combined elements of alignment, interaction, timing and speed, but may not be maintained throughout the range of the task.

LMPI

Physiotherapy Department

The Leeds Teaching Hospitals **NHS**
NHS Trust

The LEEDS Movement Performance Index

<table>
<tr><td>PAS LABEL</td><td>Name:

Hospital number:</td></tr>
</table>

- Age …………   Gender …………
- Diagnosis …………………………………..
- Time since onset ……………………………………..
- Other factors affecting the patients theoretical normal (e.g. PMH, bariatric etc)

  …………………………………………………………………..
- Environment (on hospital bed, type of chair, treatment plinthetc)

  …………………………………………………………………..
- Location (at home, out-patient department etc) ..…………………..
- What is being measured ……………………………………………

  ………………………………………………………………………..

  ………………………………………………………………………..

  ………………………………………………………………………..

  ………………………………………………………………………..

  ………………………………………………………………………..

  ………………………………………………………………………..

  ………………………………………………………………………..
- Comments ……………………………………………………………

  ………………………………………………………………………..

  ………………………………………………………………………..

  ………………………………………………………………………..

  ………………………………………………………………………..

  ………………………………………………………………………..

  ………………………………………………………………………..

  ………………………………………………………………………..

  ………………………………………………………………………..

The LEEDS Movement Performance Index

Score	Definition of score
3 = Normal	Based on what the person's theoretical optimum normal should be
2 = Mild	The **ability** to meet more than half OR the majority of the components of the item, based on what the person's theoretical optimum normal should be
1 = Moderate	The **inability** to meet more than half OR the majority of the components of the item, based on what the person's theoretical optimum normal should be
0 = Severe	An **inability** to meet any of the components of the item, based on what the person's theoretical optimum normal should be

DATE	Score 1	Score2
Alignment 'The position / posture of muscles, joints and body parts from which movement / activity is most anatomically correct and therefore efficient and effective'		
Interaction The ongoing adjustment between body parts within a posture or during movement with respect to its BOS; that allows the maintenance of the posture on a background of balance correction, strength and endurance.		
Timing 'The appropriate sequence of activation and de-activation of automatic and selective movement in order to complete a task.'		
Speed 'The ability to choose how fast or slowly a movement can occur. An optimum speed would be one which allows coordination, control, use of minimal energy and allow an effective goal to be achieved'		
Selective movement The ability to achieve an isolated, specific and desired movement on a background of stability		

Appendix 7

- Ross, DH. (2008). Measuring Movement Performance in the Acute Setting: The development of the LEEDS Movement Performance Index. *Synapse Journal of ACPIN, Spring*, 1-4.

Name of author: Denise Ross MCSP, PGDip, MSc.

Address of author: Physiotherapy Department,
Lincoln Wing,
St James University Hospital,
Beckett St.,
LEEDS, LS7 9TP.

Email of author: denise.ross@leedsth.nhs.uk

Names of Consensus group members: Alan Bass, Sally Bowes, Jill Hall, Maddie Kenny, Gill Lether, Denise Ross, Liz Walker, Kate Warner, Cat Williams, Karen Wood,

Introduction

Within the field of neurological rehabilitation, a Bobath trained physiotherapist assesses and treats the underlying impairments that constrain function and participation, for example the patient may have an inability to stabilise their scapula on their thorax and therefore suffer from impaired upper limb function, and be dependent on carer support during ADL. The impairment is treated specifically before enabling activity within the context of meaningful function. In other words, the 'micro detail' is changed during treatment to give more efficient bio-mechanics of the movement which alters the efficiency of the 'macro' detail of function (IBITA 2006, Edwards 2002, Shumway-Cook & Woollacott 2001, Stokes 1998).

There is an abundance of validated outcome measures that measure movement and function currently available for neurological physiotherapists to use, for example the Berg Balance Scale (Berg et al 1992), the Ten Metre Walk (Wade 1992) the Trunk Control Test (Frangignoni et al 1997), the Postural Assessment Scale for Stroke (Benaim et al 1999), the Modified Rivermead Mobility Index (Lennon, Johnson 2000), the Motor Assessment Scale (MAS) (Carr et al 1985) and TELER (Le Roux 1993, Mawson 1995, 2002). However, it is difficult to find a tool that measures change affected during physiotherapy intervention at component or impairment level.

Boyce et al (1993) developed a scale that measured the quality or performance of the cerebral palsied child's movement, which could be used in conjunction with a previously developed scale of motor function. In practical terms, the resulting measurement tool could be used to measure change over time, compare change to intensity of input, and compare change to surgical intervention. The tool could also be used to support clinical reasoning for physiotherapy treatment planning and the demonstration of treatment effectiveness.

Within the last thirteen years there has been a significant amount of research within the field of balance and postural control in adult neurology focusing on the measurement of outcome at impairment rather than at functional level. Nieuwboer et al (1995) developed a scale, based on the visual observation of balance posture and trunk activity in sitting, for stroke patients. The tool was designed to be used by physiotherapists for the monitoring of clinical progress, treatment outcome, effect of intervention and to be quick, easy, reliable and valid for use. This study found that the items which **did not** measure the quality of the movement or posture had good reliability, whereas the items which **did** measure the quality of the movement (assessment of selective and symmetrical movement) only achieved moderate or slight reliability, possible due to the variance of clinical knowledge and experience between the testers, resulting in measurement error. ,

During a more recent study by Verheyden, Nieuwboer et al (2004) the Trunk Impairment Scale was developed by removing some items of poor reliability and redefining other items.

The authors state that this scale could be used as a guide for physiotherapy treatment, but it only looks at trunk control in sitting. It could be that the measurement of the quality of trunk control in sitting is generalisable and a predictor to the patients' overall quality of their postural control, but this isn't claimed in the study.

Mawson (1995) developed a set of movement indicators for use by physiotherapists when treating neurologically damaged patients. The movement indicators were developed to fit with the TELER technique of measurement. They were developed during a two-year project, using the clinical experience of a group of senior neurological physiotherapists. The indicators were given face validity by the British Bobath Tutors Association, and given concurrent validity when compared with the MAS (Mawson 2002). On face value, these indicators appear to be applicable to individual patients and sit well within the Bobath concept, however, although clinical standards of 'normal movement' were specifically addressed, they do not consider the quality or performance of the patients' movement and postural control.

Daley et al (1999), Wang et al (2002) and Ahmed et al (2003) have demonstrated the Stroke Rehabilitation Assessment of Movement Measure (STREAM) to be a psychometrically strong outcome measure for stroke, for use in research and clinical practice. The STREAM measures a mix of selective motor activity and function that may be appropriate for use in clinical practice. The scoring criterion although initially appearing to be complex; assesses and scores depending on whether the movement is complete, normal or deviated. This outcome measure therefore recognises the necessity of measuring the quality of movement in clinical practice.

It is important to measure change in the patients' ability and performance of movement as a result of physiotherapy intervention. The measures of change that are available are, in general, function orientated and are not specifically related to neuro physiotherapy clinical practice, which is: -

- analysis of movement and posture

- problem identification

- functional goal setting

- treatment planning

- 'hands on' facilitation of movement and postural activity

There is a need to support current subjective observation of our patients' ability pre and post treatment in order to validate physiotherapy intervention.

Because quality or performance of posture and movement is important, the understanding of what is meant by 'quality', and what components of this are needed in order to achieve a successful performance, is essential.

The purpose of this study was to establish:-

- What Bobath trained therapists mean by 'quality of movement and posture'.

- The parameters of quality that are referred to in clinical practice.

- The potential to develop a measurement tool that could quantify these qualitative observations.

Methodology

The senior neuro training group within Leeds Teaching Hospitals NHS Trust Physiotherapy Department worked together as a consensus group, facilitated by one of the clinical specialists. The membership of the group is diverse in terms of specialist knowledge, representing a broad clinical spectrum within neurology (acute neurosurgery, acute neuro rehabilitation, stroke unit, community stroke rehabilitation, community neuro rehabilitation

unit, neuro out-patients and MS specialist service). Its membership consists of ten experienced clinicians, with a range of between four and twenty five years experience of working at band seven levels or above in neurological rehabilitation. A series of consensus group meetings and Delphi type methodology was used to develop 'The LEEDS Movement Performance Index'. (figurei)

Results

During their first meeting in July 2006, the consensus group identified and agreed two definitions of what 'quality of movement and posture' meant to them. They then identified different components of quality of movement, and agreed on five key components.

A Delphi type methodology was used within the group, in order for individuals to anonymously define and describe the five key components of quality of movement and posture.

In November 2006, the consensus group met again. A simple scoring system based on what the patients 'theoretical optimum normal' should be was agreed, and the resulting measure was named 'The LEEDS Movement Performance Index' (LEEDS MPI).

Each group member was randomly allocated two items of the index and used it during their routine physiotherapy record keeping process for two months. There were no constraints placed on how or when the measure should be used, only that it should be at the clinical judgment of each group member. During this trial period, the groups' facilitator visited each of the group in their clinical setting and gathered information and knowledge about how clinically useful the performance index was in practice.

A consensus group meeting in March 2007 resulted in the decision to trial and use all five items in clinical practice. This was done during June and July 2007.

Discussion

During their year of research, the consensus group developed a measure that could support their qualitative analysis of selective components of movement and posture during the assessment, which underpinned the functional goal setting and treatment of their patients. There were no floor or ceiling effects as the index could be used to analyse a part of, or the whole of, a pattern of movement. It was unanimously agreed that the index was supportive of the clinical reasoning process, and was closely related to patients' treatment goals and treatment plan.

During consensus group meetings it was recognised that the LEEDS MPI could also be developed for use as a tool to support the development of less experienced physiotherapists.

The group has developed a measure of intervention of treatment of neurologically impaired adults, based on a sound research structure, thus achieving robust face and content validity.

The consensus group recognizes that there may be an element of bias within this study, as all group members are very specifically Bobath trained and work at specialist level. The LEEDS MPI could be observed to be very technical, in terms of ease of use and language, by non-Bobath trained therapists. It would also be impossible to use the index for comparison between groups of patients due to the variety and individualized nature of physiotherapy treatment goals and plans.

Future work and dissemination

It is intended by the researcher and the consensus group participants, that the LEEDS MPI be further developed, in order to: -

- Explore reliability during use by senior Bobath trained therapists.
- Explore the validity for use by senior Bobath trained therapists, as an objective tool to measure intervention.

- Support the more subjective descriptions currently used during the documentation of neurological therapy clinical practice.
- Explore the development of use as a training aid for less experienced therapists or therapy students.

It is intended that dissemination of the work will be via presentation and publication, in order to gain peer review and feedback.

Acknowledgements

Reference list

Benaim, Perennou, Villy, Pelissier (1999) Validation of a standardised assessment of postural control in stroke patients: the postural assessment scale for stroke patients (PASS) Stroke 30 (9) 1862-8

Berg et al (1992) Measuring Balance in the Elderly: Validation of an instrument Can Journal Public Health supplement 2 p7-11

Boyce, Gowland, Russell, Goldsmith, Rosenbaum, Plews, Lane (1993) Consensus methodology in the development of a gross motor performance measure Physiotherapy Canada Spring 1993, vol. 45, no. 2, 94-100

Carr. Shepherd. Nordholm. Lynne. (1985). Investigation of a Motor Assessment Scale for Stroke Patients .Physical Therapy. Vol 65.No. 2.February. P 175 – 180.

Frangignoni et al (1997) Trunk Control Test as an early predictor of stroke rehabilitation outcome Stroke 28, 1382 – 85

IBITA. (2006) Theoretical assumptions and clinical practice 2006, The Bobath Concept www.ibita.org

Edwards 2nd ed. (2002) Neurological Physiotherapy, A problem solving approach Churchill Livingstone, London

Lennon, Johnson (2000) The Modified Rivermead Mobility Index: validity and reliability Disability and Rehabilitation 22(18) p833-39

Le Roux (1993) TELER the concept Physiotherapy 79, 11, 755-65

Mawson (1995) TELER Normal Movement Indicators. The Cromwell Press, Wiltshire

Mawson (2002) TELER versus MAS; Validating TELER indicator definitions for use in the measurement of physiotherapy outcomes in acute stroke rehabilitation. Physiotherapy 88 (2) p67-76

Nieuwboer et al (1995) Developing a clinical tool to measure sitting balance after stroke: a reliability study. Physiotherapy 81 (8) 439-45

Shumway-Cook, Woollacott (2001) Motor Control Theory and Practical Applications (2nd Ed) Lippincott Williams and Wilkins. Maryland USA

Stokes (1998) Neurological Physiotherapy Mosby, London

Verheyden, Nieuwboer, Mertin, Kiekens, De Weerdt (2004) The trunk impairment scale: a new tool to measure motor impairment of the trunk after stroke Clinical Rehabilitation 18, 326-34

Wade (1992) Measurement in Neurological Rehabilitation Oxford University Press. Oxford

Figure (i): research process
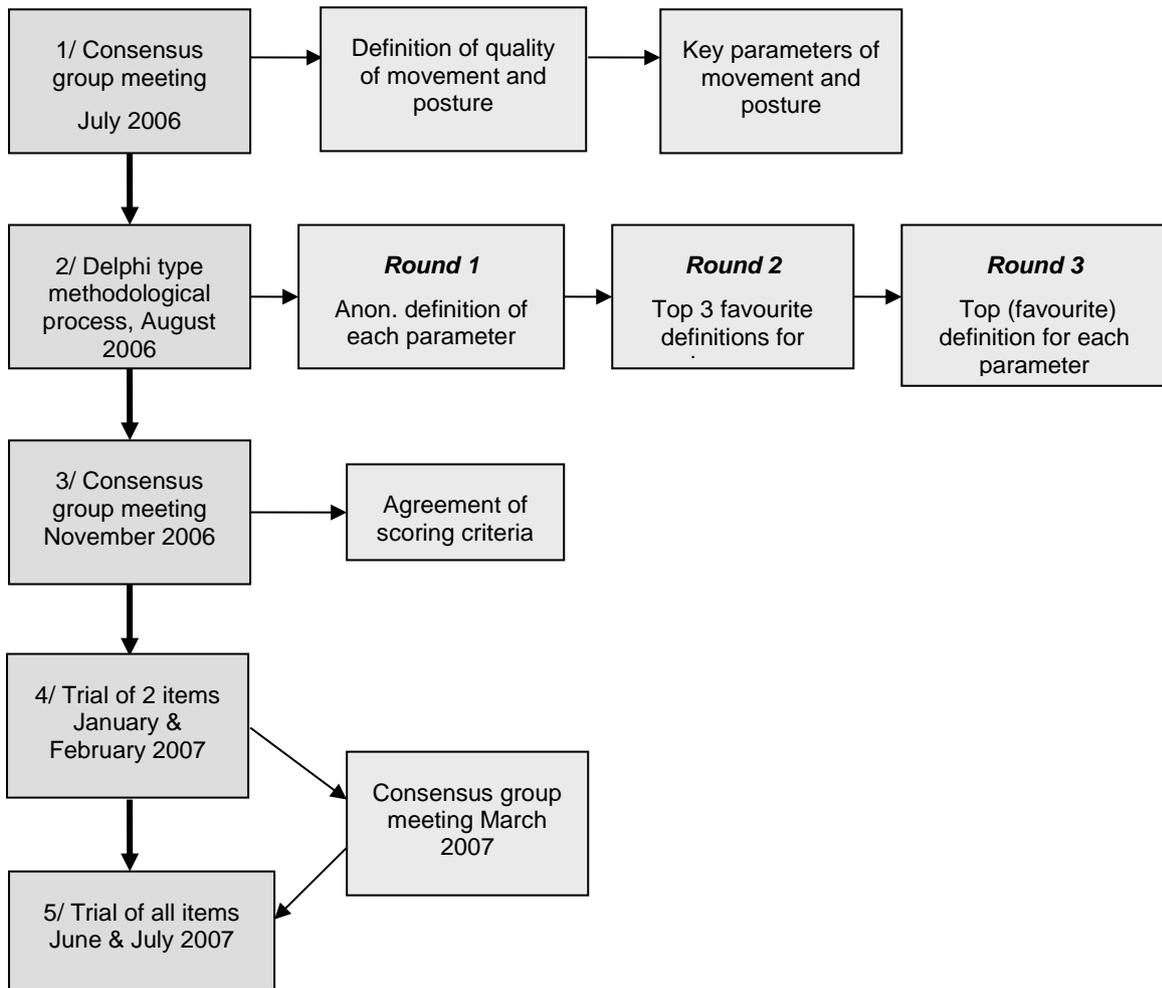
Appendix 8

- All ten definitions of each item within the LMPI

All ten definitions of each item within the LMPI

Alignment

1   The way in which one body segment or joint is actively 'stacked' or line up with each other in different postures and during activities.

2   Alignment of key body parts in a specified posture. Something being positioned correctly over or next to something else (muscles, joints etc).

3   The anatomical position of body parts in relation to each other.

4   The position/posture of muscles, joints and body parts from which movement/activity is most anatomically correct and therefore efficient and effective.

5   Alignment must take into consideration joint, ligament, muscle and tendon i.e. there is a mechanical aspect to alignment. But crucially, for function to occur there must be muscle activity. Appropriate muscle activity is intrinsically linked with alignment.

6   The correct / optimum position of body parts to each other to allow normal function. Alignment means correct muscle length and joint positions so allowing proper proprioception from muscles and joints and efficient muscle activation i.e. correct timing and recruitment of stabilizer, mobiliser muscle groups.

7   The relationship between joints, soft tissues and muscles, in respect to the posture and movement of the whole body, is recognisable within the variability of what is commonly accepted as 'normal'.

8   The optimum position of body segments including the skeleton and soft tissues.

9   The relationship between body parts.

10 The arrangement of body segments/parts to one another within 3 planes which have a dynamic interaction with each other via the neuro-musculo-skeletal system.

Interaction

1   How well a person relates to the given environment.

2   Ability to receive sensory information, integrate it and produce a motor output as a response. In relationship to body parts (alignment), base of support and environment.

3   The ability of body segments to move, and be in awareness of each other- also to include an awareness of the related contact surfaces.

4   The ongoing adjustment between body parts within a posture or during movement with respect to its BOS; that allows the maintenance of the posture on a background of balance correction, strength and endurance.

5   The ability of body segments to cooperate with each other or with a supporting surface to produce, sustain or limit a movement.

6   This is the way in which the body is dynamic and changeable in different postures to allow movement to occur.

7   A mutual or reciprocal action between body parts which enhances or allows selective movement to occur.

8   a/ with the BOS, the ability for the part of the body in contact with the supporting surface to adapt to it.

b/ of the body parts with each other, the ability of 1 body part to adapt and allow another to work and for body parts to move in relation to each other.

9   Interaction occurs between the supporting surface and the body parts in contact with that supporting surface i.e. a base of support is the outcome of that interaction. Interaction is the active working relationship within and between body segments with respect to the base of support.

10 How a body part moves or aligns with another and its response to the environment around it.

Timing

1   The initiation, speed and coordination of muscle and joint activity.

2   Smooth and harmonious muscle activity for function is linked to the timing of recruitment of muscle fibre. This is governed by the Heinemann Recruitment Principle. Timing of recruitment occurs within a muscle and between muscle groups.

3   Appropriate sequential movement relevant to the task being performed.

4   That the appropriate recruitment of activity occurs in the accepted order to achieve smooth and accurate movement.

5   Correct timing ensures sequential firing of specific muscles to produce coordinated, efficient movement.

6   Coordinated sequenced recruitment of muscle activity for efficient movement.

7   The interval between key components of a movement or action.

8   The way in which the body works in an order or sequence so to produce an efficient movement. The way in which the body must gain stability at a joint or body segment before movement can occur.

9   The ability to switch muscle activity on and off appropriately. ie stabilizers switch on before mobilisers. Also, the grading of agonist / antagonist activity.

10 The appropriate sequence of activation and de-activation of automatic and selective movement in order to complete a task.

Speed

1   The speed of a person's movement should be appropriate to the task and to the environment, within this movement there should be an appropriate degree of variability and choice of speed.

2   Varying dependent on the movement being performed, timely to allow the movement to be appropriate.

3   To include an awareness of rate, pattern and frequency.

4   Appropriate velocity for the sequencing and recruitment of muscle activity for efficient movement.

5   The time taken to achieve the required goal indicates efficiency and precision of movement and is easily measurable.

6   Speed should be able to be variable without losing efficiency of movement.

7   The speed of a movement should appear appropriate for the movement being performed. It should not appear too fast or too slow to allow for a safe and smooth movement or pattern.

8   How fast or slowly a movement can occur. An optimum speed would be one which allows coordination, control, use of minimal energy and allow an effective goal to be achieved.

9   Speed is a variation in the timing of recruitment. For efficiency there will be an optimum (or a range of optimum) speeds, i.e. a natural timing of recruitment that will result in effortless function.

10   The rate at which an action occurs.

Selective movement

1   This movement is a product of good alignment between interaction and body parts. It is precise efficient movement performed with appropriate timing.

2   Movement that has all the above components - correct timing, speed and varying interaction between joints, muscles etc. to allow a task to be performed with as little effort as possible.

3   The movement of a body part that can occur freely, and that can be appropriately independent of other body parts, this could be: During functional movement / During selective limb activity.

4   The way in which the body provides a background of control so the limbs or one body part can move freely against another, and can be ready to work if demanded by the individual.

5   Ability to achieve an isolated, specific and desired movement on a background of stability

6   Movement performed using the correct components for a particular activity.

7   Selective movement is the ability to isolate movement to one body part or to one limb. Appropriate selection of movement is determined by the function to be achieved. Stability of an associated body part is essential for the agonist and antagonist to work harmoniously together for selective movement.

8   Recruitment of the appropriate muscle groups working in synergy to efficiently achieve the desired outcome.

9   A movement which is precise and free from interference from reflex activity, abnormal fixation, compensation or movement of other body parts. The ability to select one movement to the exclusion of others. To be able to pick out or choose a specific, discrete movement. Requires correct postural background activity. It is not possible to have selective movement with a background of low or high muscle activity; it requires synergic control and reciprocal innervation.

10   Isolated, specific movement of one joint or joints based on stability through appropriate muscle activity.

Appendix 9

- The Microsoft PowerPoint presentation used to teach Studies 2 and 3 participants how to use the LMPI

The LMPI training and testing package

Slide 1

Testing of the measurement properties of the Leeds Movement Performance Index (LMPI)

Denise Ross

University of HUDDERSFIELD · The Leeds Teaching Hospitals NHS

Slide 2

Plan

- So what's this research all about then?
  - Review your participant information sheet and consent form
- What is the LMPI?
  - Background
  - The research project
  - How to use the LMPI
- Invitation to participate in the research project
- Tea break
- Test
- Time plan
  - Re-test in 2 weeks time

Slide 3

Handouts

1. LMPI data sheet
2. LMPI guidelines
3. Your participant Information Sheet and consent forms

Slide 4

Review of your participant information sheet

- What are the purposes of this study?
- Why have I been chosen?
- Do I have to take part?
- What will be expected of me if I take part?
- How much time will this study take out of my clinical obligations?
- How long the research will go on for?
- Are there any advantages or disadvantages to taking part in this study?
- Will my taking part in the study be confidential?
- How do I contact the lead researcher?
- What will happen if I don't want to carry on with the study?
- What will happen to the results of the research study?
- Who is organising and funding the research?
- Who has reviewed this study?
- If I have any concerns or complaints regarding this study, who should I contact?

Slide 5

What is the Leeds Movement Performance Index (LMPI)?

Slide 6

NTG1 – the research team

Slide 7

Background

- MSc project
  - Correlation of quality of movement parameters with PASS
  - Good but interesting variants
- What do we mean by 'quality' of movement?

Slide 8

We produced a definition

- "Quality movement is an efficient way to achieve a desired outcome or goal. This would be with the least effort, timely, smooth and precise; within the context of the individual, the task and the environment."

Slide 9
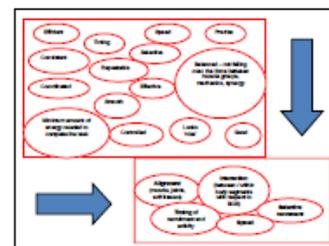
Slide 10

Defined parameters

- Alignment
  - The position / posture of muscles, joints and body parts from which movement / activity is most anatomically correct and therefore efficient and effective
- Interaction
  - The ongoing adjustment between body parts within a posture or during movement with respect to its BOS; that allows the maintenance of the posture on a background of balance correction, strength and endurance
- Timing
  - The appropriate sequence of activation and de-activation of automatic and selective movement in order to complete a task
- Speed
  - How fast or slowly a movement can occur. An optimum speed would be one which allows coordination, control, use of minimal energy and allow an effective goal to be achieved
- Selective movement
  - Ability to achieve an isolated, specific and desired movement on a background of stability

Slide 11

Score criteria

- 3 = Optimal
  - Based on what the person's theoretical optimum performance should be
- 2 = Mild
  - The ability to meet more than half OR the majority of the components of the item, based on what the person's theoretical optimum performance should be
- 1 = Moderate
  - The inability to meet more than half OR the majority of the components of the item, based on what the person's theoretical optimum performance should be
- 0 = Severe
  - An inability to meet any of the components of the item, based on what the person's theoretical optimum performance should be

Slide 12

Slide 13

Our next steps were

- We used it in different clinical areas
  - Acute & Rehab stroke units
  - General neurological rehab
  - Neuro-surgery
  - MS service
  - Neuro-out patients
  - Community stroke team
- No changes made
- BUT we thought we could be biased

Slide 14

Refinement study Spring 2008

- NTG 2
- Used within their clinical practice for three months
- Semi-structured interview to find out what they thought of the LMPI
- Did we need to change anything?
- Developed the guidelines (see handout)

Slide 15

PhD research project
The development and clinical testing of an index of movement performance for neurological physiotherapy: a mixed-methods study

Slide 16

Abstract

The proposed research concerns the role of movement performance in maintaining and improving function in people with neurological disorders.

A provisional index of movement performance has been previously developed by this researcher; the Leeds Movement Performance Index (LMPI), to facilitate and support the assessment, clinical reasoning, goal and intervention planning, and the measurement of outcome within specialist neurological physiotherapy. The LMPI was developed to meet the clinical demand for measures of outcome that reflect clinical practice, and was driven by clinical need.

Both quantitative and qualitative methodology will be used to establish 1) the reliability and 2) the clinical validity of the LMPI, with the overall aim being to produce a rigorously tested movement performance index for use in clinical practice.

This will make the tool unique, in that it will be appropriate for use both in clinical practice and in research in order to assess the treatment effects of physiotherapeutic interventions for people with neurological disease.

Slide 17

This study

- Reliability study
- Test the measurement properties of the LMPI
- Quantitative methodology

Slide 18

Testing of:-

- Internal reliability - Cronbach's alpha coefficient, applied to the entire scale and to each individual item
- External (inter-rater) reliability - Intraclass Correlation Coefficient for the scores awarded by multiple raters
- External (test-retest) reliability - Spearman's rank correlation coefficient between scores obtained on two testing occasions
- Variance components analysis - to partition variance into components arising from between-patient variability, between-therapist variability and between-testing variability; as well as from residual variability.

UNIVERSITY OF HUDDERSFIELD   The Leeds Teaching Hospitals NHS

Slide 19

What is the LMPI and how do I use it?

See guidelines

Slide 20

Slide 21

Clinical example 1

(video, plus diagnosis, age and gender, movement that is being measured)

2

Slide 22

Clinical example 2
(video, plus diagnosis, age and gender, movement that is being measured)

Slide 23

Clinical example 3
(video, plus diagnosis, age and gender, movement that is being measured)

Slide 24

Discussion

Slide 25

Invitation to participate

- Inclusion criteria
  - Work in Yorkshire
  - HPC registered Physiotherapist
  - Band 6 or above
  - Post graduate training within neuro-physiotherapy (formal or informal)
  - Work predominantly with patients who have neurological diagnoses
  - Managers consent
- Exclusion criteria

Slide 26

Participant Information Sheet

- Contents of the Participant Information Sheet
- Any questions?
- The consent form
  - 1 with Doctors letter to go to GP or Consultant or medical records
  - 1 copy for patient
  - 1 copy of consent form to Denise Ross

Slide 27

Your consent form

- I confirm that I have read and understood the information sheet dated 23/11/2010 for the above study. I have had the opportunity to consider the information, ask questions and have these answered satisfactorily
- I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason
- I understand that direct quotes that I give during my reflective practice may be used verbatim in future publications, although they will remain anonymous.
- I agree to take part in the above study

Slide 28

Practice video

Slide 29

Videos to score using the LMPI "Test 1"

- Video 1
- Video 2
- Video 3
- Video 4
- Video 5

Slide 30

Date set for 2 weeks time

- Plan
  - practice video to refresh memory of how to use the LMPI
  - Re-test - "Test 2"
    - Video 1
    - Video 2
    - Video 3
    - Video 4
    - Video 5

Appendix 10

- Ross, DH., McLuskey, S., Fletcher-Cook, P. & Stephenson, J. (2014). The reliability of the Leeds Movement Performance Index (LMPI): a new tool for neurological physiotherapy. *Physiotherapy Theory and Practice, 30*(8), 581–587.

The Reliability of the Leeds Movement Performance Index (LMPI): A New Tool for Neurological Physiotherapy.

ABSTRACT

Background: Measuring movement performance in people with neurological damage requires a tool that reflects physiotherapy assessment and clinical reasoning. The LMPI was previously developed by a group of neurological physiotherapists to fulfil these requirements. Objective: to assess the reliability of the LMPI for use in neurological physiotherapy practice. Methods: Twelve senior neurological physiotherapists were trained to use the LMPI, and then asked to measure the movement performance of 5 patients whose movement had been previously video-recorded for this purpose. A retest session was completed after 2 weeks. Data were analysed to establish internal and external reliability. Results: Internal reliability was assessed using Cronbach's alpha coefficient, applied to the entire scale (0.862) and to each item (range 0.795 - 0.892). External (inter-rater) reliability was assessed by a calculation of the intraclass correlation coefficient for scores awarded by multiple raters (0.959), with individual item reliability ranging from 0.874 - 0.968. External (test-retest) reliability was assessed by calculating the Spearman's rank correlation coefficient between scores obtained on 2 testing occasions (0.792) with values of individual items ranging from 0.397 - 0.674. A variance components analysis partitioned variance into components arising from between-patient variability (83.3%) between-therapist variability (7.8%), and between-testing variability (2.8%). Conclusions: Results indicate that the LMPI is a reliable measurement tool when used by senior neurological physiotherapists.

BACKGROUND

The use of outcome measures is strongly advised within neurological physiotherapy clinical practice (Hammond 2000), but the literature consistently illustrates that they are not well used (Van-Peppen et al 2008; Wedge et al 2012). A possible reason for this is that available outcome measures that are appropriate for use within neurological physiotherapy practice (Berg Balance Scale (Berg, Wood-Dauphinee, Williams, Gayton1989); Ten Metre Walk (Wade 1992); Goal Attainment Scale (Turner Stokes 2009); Motor Assessment Scale (Carr, Shepherd and Nordholm 1985); TELER (Le Roux 1993; Mawson 1995; 2002)) measure that the patient can perform a movement e.g., stand up, roll over in bed, sit down etc., but not how *well* they can perform it. These ways of measuring outcome all largely represent the 'activity' domain of the World Health Organisation's bio psychosocial model that classifies Impairment, Function, Disability and Health (ICF) (WHO 2001) (see figure 1). This paper examines the measurement properties of a new outcome measure, which reflects neurological physiotherapy assessment and treatment, and is focussed on how *well* a

patient can move. The emphasis is on the physiotherapy intervention, which is centred within the 'body functions and structures' domain.

figure 1: Interactions between components of the ICF (WHO 2002 p9)
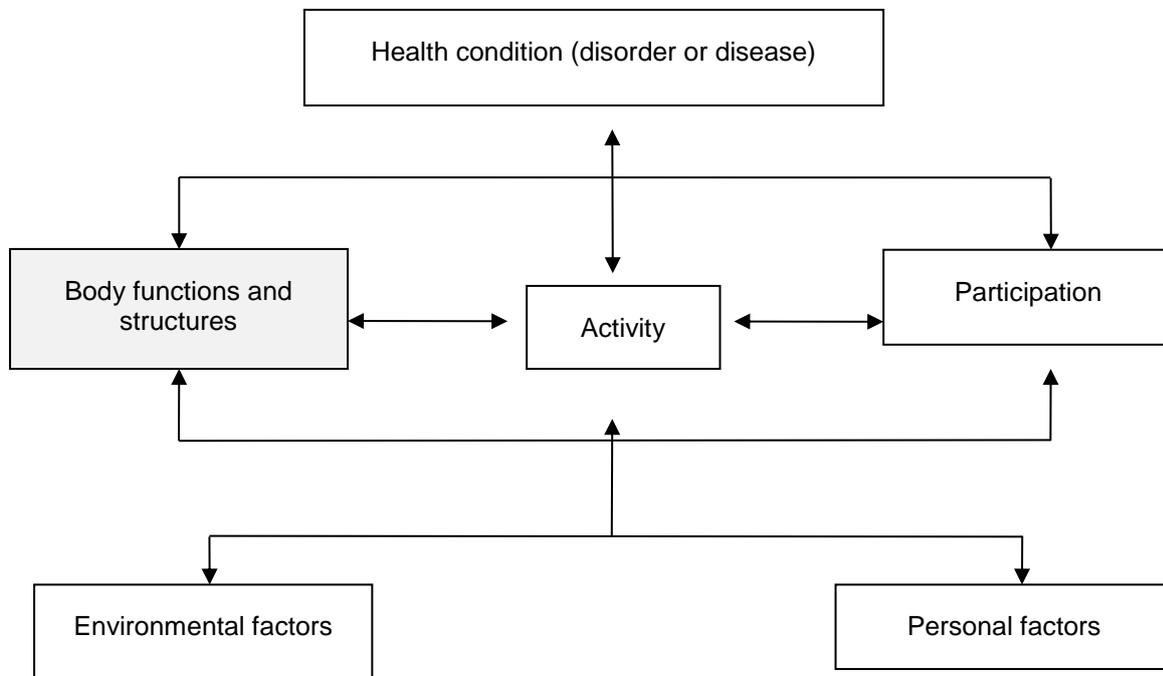
The World Health Organization (WHO) define 'impairment' as: problems with joint mobility, muscle power, muscle tone, involuntary movements and pain. Its definition of the 'activity and participation' domains include: lifting and carrying objects, fine hand use (e.g. writing and cooking), walking, driving, self-care and domestic life. Those of the 'environment' and 'personal factors' domains include products, technology services, attitudes, support and relationships (WHO 2003 p3-4).

Shumway-Cook and Woollacott (2012) perfectly demonstrate how the WHO's ICF can be applied into physiotherapy practice, where movement has to be considered in relationship to the task that is being performed, the individual (in terms of their impairments and personal factors) and the environment in which the task is being performed (see figure 2).
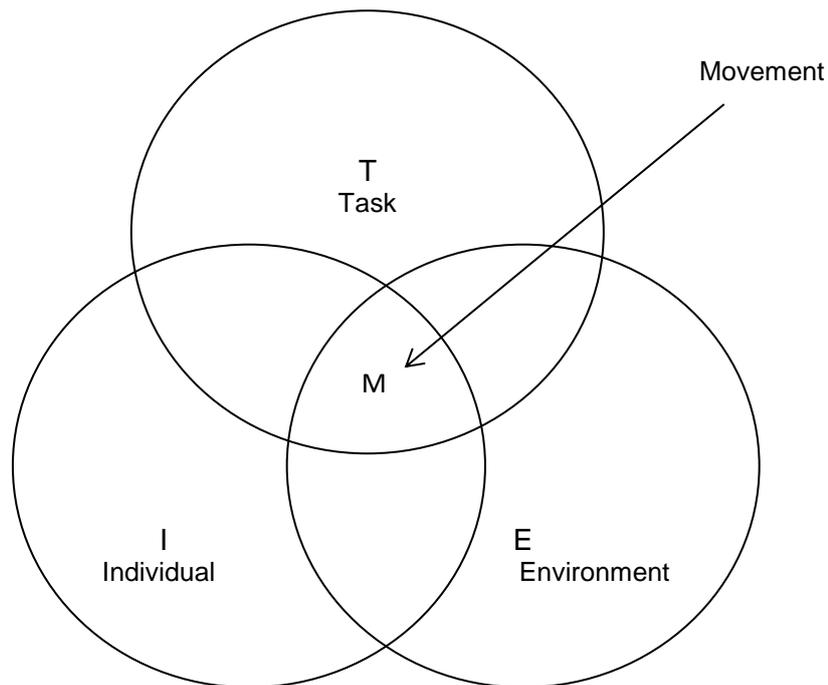
Figure 2: Movement emerges from an interaction between the individual, the task, and the environment. Shumway-Cook and Woollacott (2012, p4)

To place this within the specific context of neurological physiotherapy clinical practice, a stroke patient may have an inability to stabilise their scapula on their thorax and therefore suffer from impaired upper limb function and be dependent on carer support during dressing. The impairment (scapula stability) is treated specifically before enabling activity (arm movement) within the context of meaningful function (dressing). There are no available measurement tools that can: 1) measure the patient's improved movement performance and change of their quality of movement achieved as a result of physiotherapy intervention; and 2) also reflect the process of observational assessment and clinical reasoning used within practice.

In order to address this need, an outcome measure entitled the Leeds Movement Performance Index (LMPI) (appendix 1: The LMPI data sheet), was developed by a Physiotherapist Research Group (a group of senior neurological physiotherapy clinicians who work in an acute hospital setting) (Ross 2008a, 2008b). The group wanted to develop a measurement tool that could capture the 'quality' of their patients' movement. Consensus group and Delphi methods were used to: 1) define their understanding of the term 'movement quality' and 2) identify and define the key components of 'movement quality' that they felt were important within their clinical practice. Movement quality was defined as "an efficient way to achieve a desired outcome or goal with the least effort, timely, smooth and precise; within the context of the individual, the task and the environment." (Ross 2008b).

The 5 key components of movement within this definition were: "Alignment, Interaction, Timing, Speed and Selective Movement" (Ross 2008b), forming the basis of the 5 scale items within the LMPI. A unique premise of the LMPI is that it enables deconstruction of movement into these 5 different but inter-related scale items, allowing a more in-depth and meaningful assessment of movement performance compared to existing outcome measures.

The LMPI is used to assess the patient's quality of movement during a specific task or movement and is generally completed post-treatment during the physiotherapist's routine record keeping process. With familiarity of use it has potential to become part of the clinical reasoning process, both during and post-treatment. Any aspect of the patient's movement can be chosen to be measured (e.g. "foot on floor during the stance phase of gait", "the pelvis during sit to stand", "the hemi-paretic arm during walking") but it should be related to the patient's and therapist's treatment goals. The ordinal score system (see appendix 1) of the LMPI, where: 0 = severe, 1 = moderate, 2 = mild and 3 = normal, was designed by the Physiotherapy Research Group in an attempt to reflect the prognostic element of the physiotherapist's assessment (Ross 2008b). Shumway-Cook and Woollacott describe a similar score criteria (2012, p124) when they discuss Schmitz's non-equilibrium tests used to diagnose specific pathology in the cerebellum.

Although the LMPI scoring system involves a subjective clinical judgement, it is important, is supported by the experience, knowledge and skill of the physiotherapist and is used to guide realistic goals for the patient. No intentional hierarchy is given to the scale items, and the LMPI is intended to be applied to any movement or functional activity that is appropriate to the patient's rehabilitation and their physiotherapy intervention. It is intended that the LMPI be used within teams of physiotherapists (e.g. the team of physiotherapists working on an acute stroke rehabilitation unit) or singly (e.g. a lone practitioner in an out-patient department or in a patient's home).

The measurement tool sits within the conceptual framework of modern UK clinical practice, which is a need identified by Horner and Larmer (2006) who support this need when they state that health outcome measures used within the health setting should be practical and "responsive for a particular purpose in a particular population" (p23). Although during its development, preliminary face and content validity has been established; further, more robust examination of the measurement properties of the LMPI is now required in order to establish its reliability, validity and clinical utility within neurological physiotherapy practice.

This paper presents the methods used to investigate the internal and external (inter-rater and test-retest) reliability of the LMPI and the results.

<u>Ethical issues:</u> Ethical approval for this research project was granted by the UK National Health Service (NHS) research ethics committee (reference number: 10/H1302/82) and permissions were obtained by all 4 of the participating organisations.

<u>METHODS</u>

<u>Research Design</u>

Video recordings of patient's movements were observed and scored using the LMPI by senior neurological physiotherapists. The data gathered were analysed using standard psychometric tests to determine internal and external reliability. This study ran sequentially through 2 phases. Phase 1 focussed on the preparation of research tools; phase 2 examined internal and external reliability of the LMPI.

<u>Phase 1: preparation of research tools</u>

Short (from 7 to 48 seconds) video recordings of patients were made, with each patient performing a simple movement. The video recordings were: 1) incorporated into a training package to train physiotherapists to use the LMPI or 2) incorporated into a testing process, to test the LMPI during phase 2 of this study.

The available literature related to the use of video for testing the measurement properties of outcome measures varies widely in both the number of raters, and number of videos. For example: Mosely et al (2003) used 20 videos and 3 raters; Carr et al (1985) used 5 videos and 20 raters; Whitall et al (2006) used 10 videos and 3 raters. Therefore, a pragmatic decision (based on resources available, experience of teaching and statistical guidance) was made by the authors and the Physiotherapy Research Group to use 3 patient videos to help teach the physiotherapists how to use the LMPI, and 5 videos within the test protocol.

<u>Eligibility and inclusion criteria</u>

Patients who were resident on the acute and rehabilitation wards or attending out-patient appointments at a large teaching hospital were eligible to be recruited if they met the following criteria: over 18 years of age, neurological diagnosis having an effect on motor control, receiving treatment from a neurological physiotherapist and considered (by their physiotherapist) to be cognitively able to consent to being videotaped whilst performing a simple movement (e.g. stand up, walk etc.).

<u>Recruitment and consent</u>

Patients identified by their physiotherapist as meeting the inclusion criteria were approached by the researcher, who verbally explained the research process, and provided supporting written information sheets. Patients were included if they provided written informed consent

to be videotaped whilst performing a simple movement during their physiotherapy treatment session.

Data collection

Fifteen patients were recruited, and the researcher video-recorded a short episode of movement from each patient using a single hand-held digital camera, so that only 1 viewpoint was seen.

Data analysis

Nine men and 6 women were recruited; their ages ranged from 28 to 91 years with a mean age of 55 years (SD 16 years). Nine patients had suffered a stroke, 2 had multiple sclerosis and the others presented with peripheral neuropathy or retro-spinal craniectomy or subarachnoid haemorrhage or traumatic brain injury. The movements videoed varied, and included: walking, sit to stand, forward reach to grasp cup, in supine - elbow flexion with active grasp, supine to sit on edge of bed and 2-handed reach and place hands. The majority of the tasks were functional. All were chosen by the patient and their physiotherapist and reflected their goals and treatment plan.

Once the videos had been recorded and stored, they were reviewed by the Physiotherapist Research Group who allocated videos for either training physiotherapist participants in the use of the LMPI, or testing the LMPI measurement properties based on the following criteria: -

- A variety of problems should be presented so that physiotherapists could learn to apply the concepts of the LMPI to different movement problems.
- The patient's movement / motor control difficulties should be sufficiently complex to initiate discussion around the concepts of their bio-mechanical impairments; so that the principals of the use of the LMPI could be applied.
- The motor control difficulties that the patient presented should be fairly typical of movement difficulties commonly observed in clinical practice
- Patient movement should be clearly visible (normally physiotherapists observe their patient's movement difficulties in 3 dimensions: for the purposes of the testing of the LMPI they were asked to make judgements in only 2 dimensions).

Phase 2: Testing the measurement properties of internal and external reliability

Aim: to examine the internal reliability and external reliability of the LMPI in order to establish confidence that: 1) the 5 different components were all necessary parts of the scale, 2) the LMPI can be used by the same physiotherapist to reliably measure pre- and post-treatment, or course of treatment; and 3) the scale can be used by a team of therapists treating the

same patient, or during transfer between therapists, as part of the clinical information that follows the patient along their rehabilitation pathway.

Design

Physiotherapists were trained to use the LMPI, and then followed a testing protocol designed to examine its internal and external reliability. Five video recordings were watched and rated using the LMPI. Two weeks later, the video recordings were re-watched and re-rated.

Eligibility and inclusion criteria

Physiotherapists who worked for the participating organisations and who met the following inclusion criteria were recruited into the study: majority of caseload spent treating patients who had a neurological diagnosis, working as a senior therapist, permission from their manager to participate.

Recruitment and consent

Neurological physiotherapy service managers from 3 participating organisations were approached; they identified eligible physiotherapists who agreed to meet with the researcher. Both verbal and written information about the study were given to prospective physiotherapist participants by the researcher prior to the gaining of informed consent.

Data collection

Training protocol: In groups of 3 or 4, the physiotherapist participants were trained to use the LMPI by the researcher using the research material developed during phase 1. The training took place in participants' workplaces within their normal working hours. Group work and problem solving discussions about the patients' videoed movement enabled the physiotherapist participants to apply the LMPI to clinical problems and use the clinical reasoning process to underpin observational assessment and analysis of patient movement. Once the physiotherapist participants expressed verbally that they understood how to use the LMPI, they progressed to the testing protocol.

Testing protocol: Participants were shown 5 further video recordings of patients. Each video was played repeatedly, while the physiotherapist participants each used a paper datasheet of the LMPI to 'rate' the patient's movement, until they expressed that they had completed each component and were satisfied with the score. Two weeks later, the use of the LMPI was reviewed with the participants, who then re-watched the same videos and re-rated the patient's movement. On both occasions the participants were blinded to each other's scores. All data were gathered together and stored confidentially and securely by the researcher prior to the analysis of reliability.

Data analysis: Based on the recommendations of Fitzpatrick, Davey, Buxton and Jones (1998), the most appropriate standardised psychometric tests were used to establish the LMPI's internal reliability, its external reliability (inter-rater reliability and test-retest reliability), and an analysis of the components of variance of the data (Kirkwood, Sterne 2003; Norusis 2003; Kinnear, Gray 2009).

- Internal reliability was assessed using Cronbach's alpha coefficient, applied to the entire scale and to each individual item
- External (inter-rater) reliability was assessed by calculation of the intraclass correlation coefficient (ICC) for the scores awarded by multiple raters, appropriate for the analysis of numerical data
- External (test-retest) reliability was assessed by calculation of Spearman's rank correlation coefficient for scores obtained on 2 testing occasions
- A variance components analysis was also undertaken. This procedure estimates the contribution of each random effect to the variance of the dependent variable. Hence in the current context, variance in LMPI score is partitioned into components arising from between-patient variability, between-therapist variability and between-testing variability; as well as from residual variability; to assess the proportion of variability in LMPI score that might arise from instability of the instrument when applied by multiple physiotherapists or across multiple measurement occasions. Thus the procedure determines where attention should be focussed in order to reduce the variance. In this process it is assumed that the practitioners and patients featured in the sample represent random selections from larger populations.

All analyses were undertaken using SPSS Version 20.0.

RESULTS

Internal reliability: Table 1 summarises the values of Cronbach's Alpha Coefficient calculated for both the overall scale and for each individual item. The alpha value for all items (0.862) indicates high overall reliability; the alpha values of the scale with individual items deleted also indicates high reliability (range from 0.795 to 0.892), implying that the reliability of the scale decreases with the deletion of all scale items except Alignment; the deletion of which is associated with a very small increase in reliability.

table 1: Internal reliability

Cronbach's Alpha, overall scale	0.862
Cronbach's Alpha if Item Deleted	
Alignment	0.892
Interaction	0.833
Timing	0.811
Speed	0.816
Selective Movement	0.795

External (inter-rater) reliability: Table 2 summarises the assessment of the consistency of the scores made on different measurement occasions, and by different physiotherapists using the intraclass correlation coefficient (ICC). Overall external reliability was high (0.959), with individual item reliabilities ranging from 0.874 to 0.968; implying that the LMPI has strong inter-rater reliability. The corresponding p-values (<0.001 in all cases) demonstrate statistical significance of all items.

table 2: External reliability

Intraclass Correlation Coefficient		p-value
Average measures all items	0.959	<0.001
Alignment	0.874	<0.001
Interaction	0.931	<0.001
Timing	0.957	<0.001
Speed	0.935	<0.001
Selective Movement	0.968	<0.001

Test-retest reliability: Table 3 summarises the results of an item-total rank correlation analysis to assess test-retest reliability; the value of the correlation coefficient for the full scale is high (0.792) with values of individual items ranging from 0.397 to 0.674. Furthermore, the corresponding correlation coefficients for individual items of the scale were all statistically significant ($p<0.002$ in all cases), with effects of medium size or greater being observed in the majority of cases.

Spearman's rho Rank Correlation Coefficient		p-value
All items	0.792	<0.001
Alignment	0.397	<0.002
Interaction	0.674	<0.001
Timing	0.516	<0.001
Speed	0.655	<0.001
Selective Movement	0.655	<0.001

Table 4 summarises a variance components analysis that was used to examine the variability of the results, to partition variance into components arising from between-patient variability, between-therapist variability and between-testing variability; as well as from residual variability. The low proportions of variability between therapists and between measurement occasions calculated from this procedure (7.8% and 2.8% of total variability respectively) provide further evidence of the stability of the scale; with, as might be expected, the largest component of variance (83.3%) arising from natural between-patient variability.

table 4: Variance components analysis

Component	Variance Estimate	% of total
Variance between Physiotherapists	0.467	7.8%
Variance between Patients	3.317	55.2%
Variance between replicate measurement occasions	0.17	2.8%
Residual variance	2.056	34.2%

DISCUSSION

The results of this study indicate that the LMPI is a reliable measure of movement performance, potentially providing a unique measurement tool for use in neurological physiotherapy practice, both by individual physiotherapists or teams of physiotherapists over time. The internal and external reliability of the LMPI were examined in order to establish confidence that:-

1) All 5 scale items were necessary components of the scale. It has been recognised that redundant items could "artificially inflate a score", thus reducing clinical usefulness and wasting "time and effort" for both the patient and the therapist (Tyson and Connell, 2009, p836).

2) The LMPI can be used by the same physiotherapist to reliably score pre- and post-treatment, or course of treatment.

3) The scale can be used by a team of therapists treating the same patient, or during transfer between therapists as part of the clinical information that follows the patient along their rehabilitation pathway.

The results of the internal reliability tests were strong (Jorstad, Hauer, Becker and Lamb 2005; Pallant 2007; Field 2009), with alpha values of 0.862 for all items and a range from 0.795 to 0.892 for individual items. Hence such items may be considered to add value in terms of scale reliability. Furthermore, on clinical grounds, the small decrease in reliability arising from the exclusion of the Alignment item does not merit the deletion of this item from the scale results.

External (inter-rater) reliability of the LMPI was high (0.959) (Pallant, 2007; Field, 2009) indicating that a team of physiotherapists can use the scale on the same patient with high confidence of agreement. Individual item reliabilities ranged from 0.874 to 0.968, inferring that during the analysis of movement dysfunction, the individual items could also be used in a 'stand-alone' manner and scored with good confidence of agreement.

The test re-test reliability of the LMPI, using a Spearman's rank correlation coefficient on all items is high (0.792) with the corresponding correlation coefficients for individual items of the scale being statistically significant ($p < 0.002$ in all cases). Lone practitioners can therefore use this scale with confidence that any changes in the patients' scores would be due to changes in their movement performance as opposed to scale error. Clinicians with an interest in the score of a particular item (e.g. 'timing' of the pelvic movement during sit to stand) may also be confident that significant variation in scoring of that item between repeated measurement occasions is likely to be low; i.e., any change noted in the patient's movement quality is likely to be due to the patient, as opposed to the scale's instability.

The findings of the variance components analysis underpin and reinforce the findings of the reliability assessments. Furthermore, it has been shown that variability between therapists and between measurement occasions is low compared to natural between-patient variability. Between-patient variability (83.9%) accounts for more than 5 times as much variance in the outcome as all other known sources of variance.

Clinical utility: In their study, Skjaerven, Kristoffersen and Gard (2010) used a phenomenological approach to gain a rich understanding of how physical therapists perceive and teach or re-educate movement quality. The results found that there are 3 key areas that are imperative to the promotion of movement quality: 1) the therapist's awareness and knowledge of their own movement, 2) the creation of learning situations that are meaningful

for the patient, and 3) strategies for promoting movement quality. The development of the LMPI adds to this field, because: -

- it can be reliably used to measure the quality of movement
- it could potentially be used within clinical practice to underpin the therapists awareness and knowledge of movement
- it could potentially be used flexibly to suit the patients' goals
- it could potentially be used to enhance the patients' awareness of their own quality of movement.

Concurrent research will investigate these potential applications further (Ross, McCluskey 2013).

A particular strength of this study was the use of video recordings. They minimised the stress for patient participants because patients only needed to perform their movement task once for the physiotherapy participants to observe and score with the LMPI in different locations and at different times. This is supported by Carr, Shepherd and Nordholm (1985); who also found that video avoided variability in the presentations of the patient's movement. Videos were also effective in teaching the physiotherapist participants how to understand and use the LMPI by ensuring a standardised, consistent training protocol, therefore improving reliability, as was found by Mazzone et al (2009).

Another particular strength of the study was that research reflected a 'real-life' setting. In the UK, physiotherapists work within clinical teams' e.g. acute neuro-surgery and stroke rehabilitation. Teams are 'skill mixed' to include specialist, senior and junior grade staff to meet the needs of complex patient presentation and efficient financial service delivery. Junior staff are educated and developed via support and supervision without having direct responsibility for assessment and analysis. To become a skilled analyst, it is necessary for a physiotherapist to gain clinical skills from both within their job and through specialist training. Therefore, physiotherapist participants who all worked at senior grades were recruited, whereby patient participants were recruited from various clinical settings in an attempt to gain a variety of clinical diagnoses so that the results were more generalizable. It is interesting to note that the gender representations in this study are similar to those found by Skjaerven, Kristoffersen and Gard (2010), reflecting the higher proportion of women working within this clinical field compared to men.

However, it is acknowledged that the patient participants recruited were only representative of the then current caseload. Another limitation of this study is that the LMPI has been tested for reliability using senior physiotherapists only; but these are representative of the staff who will be ultimately using it. Hence, while the LMPI is a highly reliable instrument

when used by senior physiotherapists, reliability may be lower amongst other members of the profession, such as undergraduate physiotherapy students. However, it would be expected that in the majority of cases, the LMPI will be used by senior professionals, in whom reliability has been well demonstrated. Within clinical practice, not only do outcome measures need to be meaningful for the patient and their therapist, they also need to be interpretable for the rest of the multi-disciplinary team in order to support clinical decisions (Fitzpatrick, Davey, Buxton and Jones 1998). Because of its technical language and specialist application it is unlikely that the LMPI will meet this requirement. It is therefore suggested by the authors that the LMPI be used by physiotherapists for the benefit of their patients and themselves; *in conjunction* with an outcome measure that is meaningful to their colleagues, e.g. the 10 metre walk test (Wade 1992).

It could also be argued that the LMPI is biased towards the Bobath concept of treatment (Shumway-Cook and Woollacott 2012; Edwards 2002; BBTA 2013; Raine, Meadows and Lynch-Ellerington 2009; Vaughan-Graham et al 2009), because the physiotherapists who developed the tool work within this concept and the majority of therapists recruited to test the tool have postgraduate Bobath educational backgrounds. However, 2 of the physiotherapists recruited into this study do not have a 'Bobath' background, and the data suggest that their results are comparable.

CONCLUSION

The results presented in this paper indicate that the LMPI is a reliable measure of movement performance, when used by senior neurological physiotherapists, potentially providing a unique measurement tool for use in neurological physiotherapy practice, both by individual physiotherapists or teams of physiotherapists over time.

IMPLICATIONS FOR PHYSIOTHERAPY PRACTICE

This research suggests that the LMPI is a new outcome measure which more accurately reflects and supports the assessment and treatment approaches of neurological physiotherapists. Future research will focus on the validity and clinical utility of the LMPI.

KEY WORDS

Physiotherapy, outcome measurement, reliability, Bobath concept

ACKNOWLEDGEMENTS

DECLARATIONS OF INTEREST

The authors report no declarations of interest

REFERENCE LIST

BBTA Current assumptions underlying the Bobath concept. http://www.bbta.org.uk/current-assumptions-underlying-bobath-conceptdate accessed 10/09/2013

Berg K, Wood-Dauphinee S, Williams J, Gayton D 1989 Measuring balance in the elderly: preliminary development of an instrument' Physiotherapy Canada 41: 304-11.

Carr J H, Shepherd R B. 2003 Stroke Rehabilitation; guidelines for exercise and training to optimise motor skill. China, Butterworth Heineman

Carr J H, Shepherd R B, Nordholm L 1985 Investigation of a new motor assessment scale for stroke patients. Physical Therapy 65: 175-80

Edwards S 2002 Neurological Physiotherapy, A problem solving approach, 2nd edition. London, Churchill Livingstone

Field A 2009 Discovering Statistics using SPSS, 3rd edition. London, Sage publications

Fitzpatrick R, Davey C, Buxton MJ, Jones DR 1998 Evaluating patient-based outcome measures for use in clinical trials. Health Technology assessment 2: 22-24

Hammond R 2000 Evaluation of Physiotherapy by Measuring the Outcome .Physiotherapy 86: 170-172

Horner D, Larmer PJ 2006 Health outcome measures. New Zealand Journal of Physiotherapy 34: 17-24

IBITA Theoretical Assumptions and Clinical Practice. http://www.ibita.org/home.htm date accessed 02/04/2009

Jorstad EC, Hauer K, Becker C, Lamb S 2005 Measuring the Psychological Outcomes of Falling: A Systematic Review. Journal of the American Geriatric Society 53: 501-510

Kinnear PR, Gray CD 2009 SPSS Made Simple. Psychology Press. Hove
Kirkwood BR, Sterne JAC 2003 Essential Medical Statistics. Blackwell. Oxford
Le Roux B 1993 TELER the concept Physiotherapy 79:755-765

Mawson S 1995 TELER Normal Movement Indicators. Wiltshire. The Cromwell Press.

Mawson S 2002 TELER versus MAS; Validating TELER indicator definitions for use in the measurement of physiotherapy outcomes in acute stroke rehabilitation. Physiotherapy 88: 67-76

Mazzone ES, Messina S, Vasco G, Main M, Eagle M, D'Amico A, Doglio L, Politano L, Cavallaro F, Frosini S, Bello H, Magri F, Corlatti A, Zuccchini E, Brancalion B, Rossi F, Ferretti M, Motta M, Cecio MR, Berardinelli A, Alferi P, Mongini T, Pini A, Astrea G, Battini R, Comi G, Pegaoraro E, Morandi L, Pane M, Angelini C, Bruno C, Villanova M, Vita G, Donati MA, Bertini E, Mercuri E 2009 Reliability of the North Star Ambulatory Assessment in a multicentric setting. Neuromuscular Disorders 19: 458-461.

Moseley AM, Yap MC 2003 Interrater reliability of the TEMPA for the measurement for the measurement of upper limb function in adults with traumatic brain injury. Journal of Head Trauma Rehabilitation 18: 526-31,
Norusis MJ 2003 SPSS Statistical Procedures Companion. PrenticeHall. Upper Saddle River.
Pallant L 2007 SPSS Survival Manual, 3rd Edition. Maidenhead, Berkshire Open University Press

Raine S, Meadows L, Lynch-Ellerington M (eds) 2009 Bobath Concept: Theory and Clinical Practice in Neurological Rehabilitation. Chichester, Wiley-Blackwell

Ross DH, McCluskey S 2013 The Leeds Movement Performance Index (LMPI): an exploration of the clinical validity of a new tool for specialist neurological physiotherapy. In: Physiotherapy UK 2013, 10-11 October 2013, Birmingham, UK

Ross DH 2008a Measuring Movement Performance in the Acute Setting: The development of the LEEDS Movement Performance Index. Synapse Journal of ACPIN Spring: 1-4

Ross, DH 2008b Measuring Movement Performance in the Acute Setting: The development of the LEEDS Movement Performance Index: In: Physiotherapy UK 2008, 10-11 October 2008, Liverpool, UK

Shumway-Cook M, Woollacott M H 2012 Motor Control Translating Research into Clinical Practice 4th Edition. Baltimore, Philadelphia, USA, Wolters Kluwer Health / Lippincott, Williams and Wilkins

Skjaerven L, Kristoffersen K, Gard G 2010 How can movement quality be promoted in clinical practice? A phenomenological study of physical therapist experts. Physical Therapy 10: 1479-1492

Turner Stokes 2009 'Goal attainment scaling (GAS) in rehabilitation: a practical guide' Clinical Rehabilitation 23: 362-370

Tyson SF, Connell LA, 2009 How to measure balance in clinical practice .A systematic review of the psychometrics and clinical utility of measures of balance activity for neurological conditions. Clinical Rehabilitation 23: 824-840

Van der Lee JH, De Groot V, Beckerman H, Wagenaar R C, Lankhorst G J, Bouter L M 2001 The intra- and interrater reliability of the action research arm test: a practical test of upper extremity function in patients with stroke. Archives of Physical Medicine and Rehabilitation 82: 14-9

Vaughan-Graham J, Eustace C, Brock K, Swain E, Irwin-Carruthers S 2009 The Bobath Concept in Contemporary Clinical Practice. Topics in Stroke Rehabilitation 16: 57-68

Van Peppen RPS, Maissan FJ, Van Genderen FR, Van Dolder R, Van Meeteren NL 2008 Outcome measures in physiotherapy management of patients with stroke: a survey into self-reported use, and barriers to and facilitators for use. Physiotherapy Research International13: 255-270

Wade 1992 Measurement in Neurological Rehabilitation. Oxford. Oxford University Press.

Wedge FM, Braswell-Christy J, Brown CK, Foley KT, Graham C, Shaw S 2012 Factors influencing the use of outcome measures in physical therapy practice. Physiotherapy Theory and Practice28: 119-133

Whitall J, Savin DN, Harris-Love M, Waller S M 2006 Psychometric properties of a modified Wolf Motor Function test for people with mild and moderate upper-extremity hemiparesis Archives Physical Medicine Rehabilitation 87: 5656-60

World Health Organisation (WHO) 2001 International Classification of Functionhttp://www.who.int/classifications/icf/en/date accessed 26/07/2013

WHO 2003 ICF checklist version 2.1a
http://www.who.int/classifications/icf/training/icfchecklist.pdfdate accessed 27/08/2013

Appendix 11

- The Senior Physiotherapist Participants Group demographic data.

The Senior Physiotherapist Participants Group demographic data

Physiotherapist number	Gender	Clinical work area	NHS Centre	Number of years post-graduate	M level study	D level study	On the job training	In Service Training	Introductory Bobath course	3 week Bobath course	Motor re-learning programme	ACPIN courses	Sensory integration course	Various other courses	Posture & balance course	Orthotics workshop
									Post-graduate training							
1	F	Community stroke team	LCHCT 1	8 ½	yes		yes	yes		yes						
2	F	Community Rehabilitation Unit	LCHCT 1	5			yes	yes	yes					yes		
3	M	Community Neurology Team	LCHCT 1	11	yes	yes	yes							yes	yes	yes
4	F	Community Neurology Team	MYHNHSFT	11			yes	yes	yes	yes		yes				
5	F	Community Neurology Team	MYHNHSFT	26	yes		yes			yes	yes					
6	F	Neurological Rehabilitation Unit	MYHNHSFT	20			yes	yes	yes			yes		yes		
7	F	Community Stroke Team	LCHCT 2	10			yes	yes	yes	yes						
8	F	Community Neurology Team	LCHCT 2	16	yes		yes		yes	yes		yes				
9	F	Neurology Out-patients	ANHSFT	23			yes	yes	yes	yes		yes		yes		
10	F	Stroke Rehabilitation Unit	ANHSFT	24			yes	yes		yes			yes			
11	F	Neurological Out-Patients	ANHSFT	11			yes	yes		yes		yes				
12	F	Neurological Out-patients	ANHSFT	31	yes		yes	yes		yes						
				Total	5	1	12	9	6	9	1	5	1	4	1	1
					41%	8%	100%	75%	50%	75%	8%	41%	8%	33%	8%	8%

The Leeds Community Health Care Trust (LCHCT 1 = group 1, LCHCT 2 = group 2), The Mid Yorkshire Hospitals NHS Foundation Trust (MYHNHSFT), Airedale NHS Foundation Trust (ANHSFT).

Appendix 12

- Data from Study 2, Phase 2: testing the measurement properties of internal consistency and external reliability of the LMPI

Data from Study 2, Phase 2: testing the measurement properties of internal consistency and external reliability of the LMPI – 1.

NHS site: The Leeds Community Health Care Trust group 1   **Test 1 = 01/04/11**   **Re-Test =18/04/2011**

	Patient 1 scores		**Patient 2** scores		**Patient 3** scores		**Patient4** scores		**Patient5** scores	
	Test	Re-Test	Test	Re-Test	Test	Re-Test	Test	Re-Test	Test	Re-Test
Physiotherapist 1										
Item										
Alignment	2	1	2	1	**2**	**2**	1	0	**2**	**2**
Interaction	**1**	**1**	**1**	**1**	**2**	**2**	**1**	**1**	**0**	**0**
Timing	**1**	**1**	1	2	1	2	**1**	**1**	**0**	**0**
Speed	**1**	**1**	**2**	**2**	1	2	**1**	**1**	**0**	**0**
Selective movement	0	1	1	2	1	2	**0**	**0**	**0**	**0**
Total	5	4	7	8	7	10	4	3	**2**	**2**
Physiotherapist 2										
Item										
Alignment	**1**	**1**	2	1	**1**	**1**	1	0	1	2
Interaction	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**0**	**0**
Timing	**1**	**1**	**2**	**2**	**1**	**1**	**1**	**1**	**0**	**0**
Speed	**1**	**1**	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**
Selective movement	**1**	**1**	**1**	**1**	**1**	**1**	1	0	**0**	**0**
Total	**5**	**5**	8	7	**4**	**4**	4	2	1	2
Physiotherapist 3										
Item										
Alignment	**1**	**1**	**2**	**2**	1	2	**1**	**1**	0	1
Interaction	2	0	**2**	**2**	0	1	0	1	**0**	**0**
Timing	**1**	**1**	**1**	**1**	1	2	**1**	**1**	**1**	**1**
Speed	**1**	**1**	**2**	**2**	1	2	**1**	**1**	0	1
Selective movement	**1**	**1**	1	2	1	2	**0**	**0**	**0**	**0**
Total	6	4	8	9	4	9	3	4	1	3

NB: numbers in **bold** font highlight scores in agreement

Data from Study 2, Phase 2: testing the measurement properties of internal consistency and external reliability of the LMPI – 2.

NHS site: The Mid Yorkshire Hospitals NHS Foundation Trust: **Test 1 = 21/06/11   Re-Test =05/07/2014**

	Patient 1 scores		**Patient 2** scores		**Patient 3** scores		**Patient4** scores		**Patient5** scores	
	Test	Re-Test	Test	Re-Test	Test	Re-Test	Test	Re-Test	Test	Re-Test
Physiotherapist 4										
Item										
Alignment	**1**	**1**	**2**	**2**	1	2	**1**	**1**	1	2
Interaction	**1**	**1**	**1**	**1**	**2**	**2**	0	2	**0**	**0**
Timing	**1**	**1**	2	1	1	2	**1**	**1**	**0**	**0**
Speed	**1**	**1**	2	1	**1**	**1**	**1**	**1**	**0**	**0**
Selective movement	**1**	**1**	**1**	**1**	1	2	0	1	**0**	**0**
Total	**5**	**5**	8	6	6	9	3	6	1	2
Physiotherapist 5										
Item										
Alignment	**1**	**1**	**1**	**1**	**2**	**2**	1	0	2	1
Interaction	**1**	**1**	**1**	**1**	**2**	**2**	0	1	**0**	**0**
Timing	**1**	**1**	**1**	**1**	2	1	**0**	**0**	1	0
Speed	1	2	1	2	1	2	0	1	**1**	**1**
Selective movement	**1**	**1**	**1**	**1**	1	2	**0**	**0**	**1**	**1**
Total	5	6	5	6	8	3	1	2	5	3
Physiotherapist 6										
Item										
Alignment	**1**	**1**	**1**	**1**	2	1	**1**	**1**	0	1
Interaction	**1**	**1**	**1**	**1**	**2**	**2**	**1**	**1**	**1**	**1**
Timing	0	1	**1**	**1**	2	1	**1**	**1**	**0**	**0**
Speed	**0**	**0**	**1**	**1**	2	1	0	1	**0**	**0**
Selective movement	0	1	**1**	**1**	**2**	**2**	**0**	**0**	**0**	**0**
Total	2	4	**5**	**5**	10	7	3	4	1	2

NB: numbers in **bold** font highlight scores in agreement

Data from Study 2, Phase 2: testing the measurement properties of internal consistency and external reliability of the LMPI – 3.

NHS site: The Leeds Community Health Care Trust group 2:   Test 1 = 28/06/11   Re-Test =13/07/2014

	Patient 1 scores		Patient 2 scores		Patient 3 scores		Patient4 scores		Patient5 scores	
	Test	Re-Test	Test	Re-Test	Test	Re-Test	Test	Re-Test	Test	Re-Test
Physiotherapist 7										
Item										
Alignment	0	1	**1**	**1**	**1**	**1**	1	0	**1**	**1**
Interaction	**0**	**0**	**0**	**0**	0	1	**0**	**0**	0	1
Timing	1	0	0	1	1	0	**1**	**1**	**0**	**0**
Speed	**0**	**0**	0	1	**0**	**0**	1	0	**0**	**0**
Selective movement	1	0	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**
Total	2	1	2	4	**2**	**2**	3	1	1	2
Physiotherapist 8										
Item										
Alignment	2	1	2	1	**1**	**1**	1	0	**1**	**1**
Interaction	**1**	**1**	0	1	**1**	**1**	**1**	**1**	**0**	**0**
Timing	**1**	**1**	**1**	**1**	**1**	**1**	0	1	**0**	**0**
Speed	**1**	**1**	0	1	0	1	0	1	**0**	**0**
Selective movement	**1**	**1**	**1**	**1**	**1**	**1**	1	0	**0**	**0**
Total	6	5	4	5	4	5	**3**	**3**	**1**	**1**

NHS site: Airedale NHS Foundation Trust: Test 1 = 29/06/11   Re-Test = 13/07/2014

	Patient 1 scores		Patient 2 scores		Patient 3 scores		Patient4 scores		Patient5 scores	
	Test	Re-Test	Test	Re-Test	Test	Re-Test	Test	Re-Test	Test	Re-Test
Physiotherapist 9										
Item										
Alignment	**1**	**1**	**2**	**2**	**1**	**1**	1	0	**1**	**1**
Interaction	**1**	**1**	**1**	**1**	**1**	**1**	0	1	**0**	**0**
Timing	**1**	**1**	**1**	**1**	**1**	**1**	1	0	**0**	**0**
Speed	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**0**	**0**
Selective movement	**1**	**1**	**1**	**1**	**1**	**1**	0	1	**0**	**0**
Total	**5**	**5**	**6**	**6**	**5**	**5**	**3**	**3**	**2**	**2**

NB: numbers in **bold** font highlight scores in agreement

NHS site: Airedale NHS Foundation Trust   (continued)

	Patient 1 scores		Patient 2 scores		Patient 3 scores		Patient4 scores		Patient5 scores	
	Test	Re-Test	Test	Re-Test	Test	Re-Test	Test	Re-Test	Test	Re-Test
Physiotherapist 10										
Item										
Alignment	**1**	**1**	**1**	**1**	**1**	**1**	1	0	1	0
Interaction	**1**	**1**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**
Timing	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**0**	**0**
Speed	**1**	**1**	**1**	**1**	2	1	**1**	**1**	**0**	**0**
Selective movement	**1**	**1**	**1**	**1**	**1**	**1**	1	0	**0**	**0**
Total	**5**	**5**	**5**	**5**	6	5	4	3	2	0
Physiotherapist 11										
Item										
Alignment	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Interaction	**1**	**1**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**
Timing	**1**	**1**	**1**	**1**	**1**	**1**	2	1	**0**	**0**
Speed	**1**	**1**	2	1	**1**	**1**	2	1	**0**	**0**
Selective movement	**1**	**1**	**1**	**1**	**1**	**1**	1	0	**0**	**0**
Total	**5**	**5**	6	5	**5**	**5**	6	3	**1**	**1**
Physiotherapist 12										
Item										
Alignment	2	1	**1**	**1**	**1**	**1**	**0**	**0**	**1**	**1**
Interaction	1	2	**1**	**1**	**1**	**1**	**1**	**1**	**0**	**0**
Timing	**1**	**1**	2	1	2	1	2	0	**0**	**0**
Speed	**1**	**1**	1	2	2	1	2	1	**0**	**0**
Selective movement	**1**	**1**	**1**	**1**	2	1	**0**	**0**	**0**	**0**
Total	**6**	**6**	**6**	**6**	8	5	5	2	**1**	**1**

NB: numbers in **bold** font highlight scores in agreement

Appendix 13

- Data from study 2, Phase 3: Patient participant demographic information and test results

Patient participant demographic information and data gathered during Study 2 Phase 3 – 1.

Patient number	Age	Gender	Diagnosis	Location	PT number	What the therapists chose to measure using the LMPI	LMPI		BBS		Number of weeks between pre & post intervention
							pre Rx	post Rx	pre Rx	post Rx	
1	65	F	Stroke,L hemiplegia	Home	1	L leg during sit to stand - from own chair	8	13	40	49	5
2	49	M	Stroke, L hemiplegia	Home	1	L leg during gait – in living room	10	13	52	56	9
3	60	F	Stroke, R sided weakness	Home	1	Whole body during gait – in kitchen	5	9	45	50	7
4	59	M	SAH, EDH drained, aneurysm clipped, VP shunt, L hemiplegia	Ward	11	Trunk during movement of placing L foot onto foot plate of wheelchair (R foot already on foot plate)	6	12	4	4	7
5	52	F	MS	Clinic	12	Transfer from treatment plinth to chair	6	7	42	44	5
6	49	F	BG haemorrhage	Clinic	11	Hemiplegic arm during reach from table to mouth and back with polystyrene cup	5	8	44	52	4
7	62	F	Stroke, R hemiplegia	Ward	12	R leg during swing phase of walking	6	9	38	38	4
8	41	F	Fronto-parietal haemorrhage, L hemiplegia	Ward	12	Pelvis during sit to stand from treatment plinth	7	10	38	50	6
9	62	M	PCA infarct	Ward	12	Position of pelvis over feet during sit to stand, from treatment plinth @ 53cm	8	13	28	54	4
10	44	M	Cerebella Ataxia	Clinic	9	Walking	11	11	52	52	8

Patient participant demographic information and data gathered during Study 2 Phase 3 – 2.

Patient number	Age	Gender	Diagnosis	Location	PT number	What the therapists chose to measure using the LMPI	LMPI		BBS		Number of weeks between pre & post intervention
							pre Rx	post Rx	pre Rx	post Rx	
11	62	M	Fall, ICH, L hemiplegia, Stroke 9 years ago secondary to myocarditis	Clinic	9	L arm during walking	6	10	56	56	8
12	76	M	Haemorrhagic stroke R sided weakness, bronchiolitis, pneumonia L lung	Home	7	L leg during sit to stand from perching stool	1	4	19	26	incomplete
13	39	M	Stroke, L hemiplegia	Home	1	L upper limb in sit to stand from wheelchair	0	1	49	51	7
14	62	M	R acute on chronic SDH, evacuation and mini-craniotomy, #C7	Home	4	Sit to stand from wheelchair, whole movement without verbal prompts	6	8	9	23	5
15	51	M	MI, triple CABG and valve replacement, stroke, polio as child	Home	4	Walking in living room on carpet, whole movement but with help from 2 therapists	5	7	5	9	4
16	76	F	Stroke, R hemiplegia, dementia	Home	5	R foot, knee and hip in symmetrical stand, holding onto a ZF, no support	4	5	4	6	6)
17	19	M	Traumatic Brain Injury	Home	5	L Pelvis hip and knee and foot whilst moving L foot on and off the bottom step	7	9	50	54	3

Patient number	Age	Gender	Diagnosis	Location	PT number	What the therapists chose to measure using the LMPI	LMPI		BBS		Number of weeks between pre & post intervention
							pre Rx	post Rx	pre Rx	post Rx	
18	73	M	Stroke – infarct L frontal lobe	Home	4	Ascending stairs with handrail on the L	7	11	16	39	6
19	36	M	Moyamoya disease	Ward	6	Alignment of R lower limb during sit to stand from a raise plinth (24")	8	19	25	36	2
20	72	M	Stroke, L hemiplegia	Home	5	L hip/knee and ankle foot in step through of walking with a Z/F and no facilitation	0	2	5	8	6
21	63	M	Stroke, pontine infarct	Home	1	Sit to stand from wheelchair – whole body	6	11	28	52	7
22	48	F	MS	Clinic	7	Ability to stand from sitting on a plinth	10	10	47	46	4
23	63	M	Stroke, R hemiplegia	Clinic	11	R Foot during sit to stand	0	6	4	12	4
24	64	F	SAH	Clinic	11	R leg during swing phase	7	11	40	55	9
25	74	M	Thalamic stroke 2006, L sided weakness	Clinic	11	Left leg sit to stand from plinth	5	5	27	28	17
26	58	M	SAH	Clinic	11	L pelvis over L foot on sit to stand from chair	6	10	40	53	5
27	56	M	Excision of recurrent parasagittal meningioma, L hemiparesis	Home	5	In standing, lifting left hand on and off kitchen worktop without therapists help, hand and arm measured	6	6	33	41	4

PT= Physiotherapist, L= left, R= right, SAH= Sub-Arachnoid Haemorrhage, EDH= Extra-Dural Haematoma, VP= ventriculo-peritoneal, BG= Basal Ganglia, PCA= Posterior Cerebral Artery, ICH= intra-cerebral haemorrhage, MI= Myocardial Infarct, CABG= Coronary Artery Bypass Graft, SDH= Sub-Dural Haematoma, #= fracture, C7= 7th Cervical vertebrae, Z = zimmer frame, MS= Multiple Sclerosis, Rx= course of treatment.

Appendix 14

- The reflective questionnaire Study 3, Phase 2.

Reflective thoughts and comments regarding your experiences of using the LMPI within your clinical practice.

THE CAPITAL TYPE WRITTEN WORDS ARE THE SUBJECT AREAS THAT I WOULD LIKE YOU TO WRITE ABOUT.

The more you write the better! It will mean that I will have more information to analyse about the LMPI

The text in italics is there to give you some prompts

Please could you type directly into the blank boxes, they will just expand if you need extra space.

Don't worry about formatting the document

CLINICAL APPLICATION

- *Does it recognise the individual nature of your patient's movement, if yes, how does it? If no, why doesn't it?*
- *Could you use it for all of your patients?*
- *What sort of patients have you used it with? (clinical area, patient diagnosis)*
- *Were there patients you couldn't use it for, and why?*
- *Did the research project constrain your use of the LMPI?*
- *Does the scale measure change sensitively; did it measure the change that you had made to your patient's movement control?*
- *Could you relate the scale to your patient's function? Or their goals? Could you give an example?*

Write here:

EASE OF USE

- *Does it take long to use?*
- *Could you compare using the BBS (and / or other outcome measures) to the LMPI? And discuss strengths, weaknesses, clinical usefulness,*
- *Did your patients like you using the outcome measures?*
- *When did you complete the LMPI? Beginning of treatment session? End? During record keeping?*
- *Did using the LMPI have any impact on your communication with your patient? Or with other members of your team?*

Write here:

THEORETICAL UNDERPINNING OF CLINICAL PRACTICE

- *Did using the LMPI have any impact on, or affect or reflect your assessment, clinical reasoning, and treatment planning process?*
- *Do you feel the items within the scale are hierarchical in nature?*
- *Do you think that using the LMPI underpinned your approach to clinical practice?*
  - *If yes, how did it?*
  - *If no, why didn't it?*

Write here:

WOULD YOU CHANGE THE LMPI?

- o *If yes, how would you change it?*
- o *Is there anything missing?*
- o *What are its strengths?*
- o *What are its weaknesses?*

Write here:

ANY PROBLEMS USING IT?

If yes, how did you deal with the problems?

Write here:

YOUR INVOVLEMENT IN THE RESEARCH PROJECT

- o *How did it feel to be involved in a clinically focused physiotherapy research project?*
  - □ *What would have made it easier?*
- o *Have you been involved in other research projects?*
  - □ *If yes, were there any comparisons?*
- o *Were there any problems during the recruitment of your patients*

Write here:

THE TRAINING PACKAGE

Do you have any thoughts about the training package for the LMPI?
Was it useful / helpful?

Write here:

TESTING EXPERIENCE

What did you think of the experience of the testing part of the research project?

Write here:

Do you wish to add anything else?

Write here:

Thank you very much for the time and effort that you have put into this piece of work.

With very best wishes

Denise

Appendix 15

- The complete results of the Template Analysis described within Chapters 9 and 10

The complete results of the Template Analysis described within chapters 9 and 10

ANONYMISED CODE TEMPLATE

Process

Coding template from interviews with therapists	Additional codes that were identified	Additional codes that were excluded	Final coding template that was used for analysis

Atwal, Wiggett and McIntyre (2011)

The process that was followed

1   read several times – all documents – FG transcripts and reflective transcripts
2   highlighted 'interesting things' identified themes
3   grouped the themes around the priori codes
4   identified new codes
5   used post its and fridge door / kitchen walls to extract all the themes and codes and try to organise them
6   Resulted in a confusingly large amount of information with a very real risk of not seeing the important issues and becoming inappropriately 'stuck' on the less important issues (King)
7   Reflected on the problem and:
    a. Acknowledged position of knowing the transcripts well
    b. re-visited the literature (King – refs, other papers/authors that have used template analysis)
    c. reflected on the need to re-visit and re-look at the transcripts with a fresh pair of eyes, based this work on the coding template used by Atwal, Wiggett and McIntyre 2011

a-priori themes that emerged during the development of the LMPI	additional themes that emerged as a result of my reflexivity during study 1	Initial emergent themes from the focus groups	Additional themes that emerged during the analysis of the reflective questionnaires
		Teaching tool if you were working with junior staff it could be really useful because you could actually be very specific you would say "when we are looking at alignment of the leg these are the things we are look for" (FG1/ EP5/ line48) And maybe that is why I was thinking about it too much, over worrying about it too much, what is the right timing? In the end the categories are really good so the delineation in the different areas is great because they are things that you actually want to get across about how people move so that is why I definitely think that as a teaching tool a training tool for junior / staff grades it is very useful because it really homes in on the key things you want people to look at in movement rather than - can they can't they?- sit to stand? - tick (FG1/ EP3/ line60) as a reflection - I think it would still have great value and I think that would be useful <u>particularly</u> in education in developing it, but if you had categories already then it would be easier to score it. (FG1/ line/ EP1/ 411) We have done one with the junior, and they liked the working out of the problems and help them clinically reason the main things they are looking at the main things of the patient. (FG2/ EP9/ line220) It has a feel that it good be a good nurturing tool in a teaching situation for supervision and looking at the components - and you have picked your 16 components your junior has three ....what components were they missing - and I think it could be a good teaching tool for supervision in that respect.(FG2/ EP8/ line223) it does have a feel of being a nurturing tool (FG2/ EP7/ line236) that it could be a tool that has a use on the course but to fit in with my way of teaching and observational analysis of what the patient was doing it would just sit better with me if it was alignment interaction selective movement timing speed. (FG2/ EP7/ line238) Working with the junior staff it was nicer to work through those elements of speed alignment timing for them to work with and to look at it.(FG2/ EP9/ line250) We need as many tools on the course as we can to get the course	Some of our team are now using the OM and finding it quick and easy to use and a good way of teaching junior staff and students. Also it is useful for the senior staff to bring us back to the 'bread and butter' analysis of human movement. P3Lline75)

		participants to be able to see what we see and understand what we understand and to get to the point that Claire was making in that her junior saw 3 components and she had six components and we want our course participants - if we saw six components we want the course participants to see six components - and this does break movement down into components, so we are asking the person to look at different components of movement like alignment like timing like selectivity, so I think there is a scope there for it to be used in BBTA - as opposed to me as an individual.(FG2/ EP7/ line267) it makes the less skilled practitioner to look more closely at what they are doing, then they could use it at the beginning of the course – a three week basic course or an advanced course – maybe it is a better tool for the advance course for themselves or with their partner - scored the patient on day one and then rescored the patient on day five.(FG2/ EP7/ line282) Woman Maybe its best points are that - it fosters and nurtures learning then - I think that is great and I think take those things from it but I am not sure then that it is a measure. Woman It is showing a change then it will be a measure Woman Yes if it is showing a change. Yes (FG2/ EP9&10/ line289)	
			Teaching the patient Using the LMPI meant that an explanation was given to the patient about quality of movement, and also to junior staff. Therefore it was useful as a teaching aid.(P5 line37) I found I was able to use the measure to engage successfully with one of my patients', who has ataxia, The joint goal was to be able to transfer from bed to chair safely and with control. The patient was aware this was the outcome being assessed and during treatment the specific components, timing, speed of the movement etc were broken down for her and she went away and practised between therapy sessions and achieved an excellent result.(P12line11)
Clinical application	**Clinical reasoning** promoted discussion about movement analysis (S1line31) the LMPI is best done during record	The fact that it is very individual and it is subject to someone, sometimes its very helpful, for some of our patients, to support, to show the changes that they have. (FG2/ EP9/ line218) We took two aspects of movement we took sitting alignment on	When the LMPI was discussed with other team members it helped to identify problems and focus treatment objectives. As with all outcome measures time constraints often limit their use. (P9line51)

	keeping, where you can reflect on the pts movement and own clinical reasoning (S1line94)	one patient who was very asymmetrical and who became much more symmetrical and she was seen on two consecutive days and then another patient we were looking at sit to stand where you can put in lots of components and all the different categories were applicable and we did that really fast. (FG2/ EP8/ line58) I think it actually <u>does</u> reflect the complexity of movement in that it throws up a lot of questions for me ...that is what I felt about it.(FG1/ EP2/ line57) *Man* I wonder in relation to those points the challenging aspect of it is because actually when you are clinically reasoning in practice. And I agree I think that categories are really nice categories and really pertinent categories to consider but when you are working with a patient you are kind of considering them in relation / together / as a whole to each other so if we are going to improve the interaction between body parts or body segments you are considering in relation to alignment in relation to background activity. *Woman* So you do not put them down to separate things *Man* So it almost seems like a big hurdle.... slightly unnatural to split them up and score each individual one. I think your perception in practice is that it is all so interrelated anyway - that for me to separate the scoring is quite difficult - or that is what it felt like to me, but by the same token I can see very much see the point for some people in some cases.. to actually do that and to highlight the fact that there is these different contributions to movement could be very useful. *Woman* Yes Yes. (FG1/ EP6,3&2/ line71) ... I would score it in relation to sit to stand, but then there was another part of the scoring which in a way needed to be related to the most significant aspect of impairment as part of that sit to stand - so in a way that is how you would use it - and you can have more than one - and I think that there is potential - real usefulness in this - in terms of whether it is analysing, whether its for your own reflection - whether it is only making that definite measurement link if we change this impartment - if we influence this impairment does that impact on the function of the activity - and maybe that was an easier scenario to use than just one component of movement or one aspect of movement control. What ever you want to call it.(FG1/ EP6/ line144) In terms of an outcome measure the other difficulty I had was, when I had my score and it was related to lower limb alignment I could see the score I had my totals I could see the change so it did reflect change. "OK that is great I have made a change and	I felt the LMPI does recognise the individual nature of pts movement. It makes you look more specifically(P10line1) Made me much more specific, looking at one or two particular movements, rather than a more gross functional movement(P10line22) Using the LMPI made me more aware of quality of movement and helped me develop my observational and analytical skills.(P5 line40) The biggest impact I felt personally, was on my clinical reasoning and treatment planning/implementation, using the tool I felt clarified/justified my reasoning and made my treatments much more goal specific. (P12line30) felt use of LMPI supported clinical reasoning and treatment planning but did not alter it.(P6line36) Helped tailor analysis and treatment plan and remind me its ok to focus on one part during a treatment session eg arm and that can influence the whole patient and their movement patterns more effectively sometimes than spending a little time on the whole of them(P11line23)

		the patient has improved but what did that mean?" because in terms fitting in with the other measures that have to be done in my work place it was not a recognised functional outcome measure (FG1/ EP3/ line174)	
			In comparison with other outcome measures The patient was often unaware that I was using the measure. In contrast to the BBS or timed walk etc needs the patient to cooperate which can have an effect on the outcome,(P9line45) Could use LMPI for all patients, but more likely to use it for patients where other OM's do not fit. For example, low level patients who may score 0 on Trunk Control Test on admission and discharge, but may actually demonstrate improvement in posture, head control, etc. This would be detected on LMPI but not necessarily on TCT. Could also be used for patients with bilateral deficit, for example GBS or TBI where OM's such as MAS do not fit. Also useful for UL changes, which may not be functional but may demonstrate an improvement in posture, alignment or hand contractual response. This would not be obvious from other UL OM's(P6line1). Quicker than BBS or MAS**.(** P6**line26)**
			In comparison with the BBS Compared to the Berg Balance Score, the LMPI is quicker and easier to use and requires less additional testing for the patient. However the Berg does allow you to compare one person's functional level to another's and have some idea how a score will relate to function e.g. a score of under x means an increased falls risk. The Berg is not as sensitive to change as the LMPI however and like many OMs, suffers from floor and ceiling effect which the LMPI does not.
		In comparison with the GAS I think if I am honest I would use a GAS goal to give me a change in score for my own measuring, but, because it is more familiar to me so I would find this easier than me having to think and work it out but I think one of the strengths of this is the categorisation (but also it is a weakness) in that you have to understand - and anyone who is using it has to have the same understanding - of the components particularly if you were doing a task like sit to stand or walking or even things like limb alignment (FG1/ EP5/ line156)	

		For me it is almost quite subjective like the GAS goal where you can choose and you can fit it to your patient population because you can choose any aspect of movement to look at different components and then allocate it so it should fit to any patient but it is quite complicated to do - as is GAS. I found then both. I think GAS might give me more if I was choosing it as a measure rather than this in terms of adding some qualitative aspect of movement analysis - for me I felt it was quite subjective (FG2/ EP8/ line24) The GAS you can add up the scores to have a score so it was again looking at how you would use that as a measure of change ongoing. If you like have a score at the end(FG2/ EP3/ line71) This is looking at the qualitative normal movement aspect but on the GAS score you can only have one or two variables – one variable really – so you can have lots more variable with this measure.(FG2/ EP8/ line161) when we had to practice doing the GAS and they had to work out breaking up a problem - but that (*the LMPI*) was more so for them (*the junior staff liked the LMPI more than the GAS in the 'working out a movement problem for a patient situation*) - they liked that.(FG2/ EP9/ line253) It had more movement components in it than the GAS, the GAS has more functional components (FG2/ EP8/ line256)	
		When did you use it? I thought I quite liked the idea of best performance (FG1/ EP5/ line195)	When using the LMPI, I generally scored from memory during the record keeping and the patient usually had no awareness of the process other than the initial consent.(P5 line34) , I tended to complete the paperwork at the end of the session when completing the patient clinical records.(P12line28) Completed LMPI at beginning of treatment, to see if there was any carry over from previous sessions, and occasionally during record-keeping. (P6line31) I completed it when writing my SOAP notes and found it helped formulate my analysis and target my treatment plan more than other OMs which you just use as an adjunct to therapy to show a

			change(P11line14)
		About the LMPI as an outcome measure so yes it has got that capacity to tell me something about movement and the performance of movement in that individual and I absolutely go with the fact that it is very very individual in terms of its orientation - but I am not quite sure it feels like an outcome measure at this stage - but that is maybe more to do with what kind of what outcome measures we are used to and the way that they are framed and the constructs that they are set around, I think that this something quite different (FG1/ EP6/ line 218) What has come up with in my mind for what it is worth is it is a bit like ice dancing and standing up with high performance - 6 technical merit - and 5.8 for artistic impression rather than it being in the Olympics - it would be the timed race - the outcome measure would be the timed race it is who is first at the post it is a quantitative measure - where this is much more the ice dancing of the measure. Man or another woman) But that is a very good analogy(FG1/ EP1&4/ line226) and this is another thing it gets back to in the philosophy of practice and where you are coming from. We probably spend all our time saying we are interested in the individual scores not in the timed race - do you see what I mean - so in that sense we are saying " well actually it is" it is doing that job - to some extent - in kind of thinking about - in given that depth in terms of movement analysis for that very reason. (FG1/ EP4/ line 232) - I am no expert of using TELER but my understanding is that you have your components on a scale at that particular movement it is kind of there - we could all subscribe to that scale and measure from that - whereas this is much more individual. It's up to you. That could be a merit definitely because TELER would not give you the level of analysis of movement performance that this would ,but this to me feels like you do have to work harder to get that and maybe you know.. (FG1/ EP6/ line416) It is just as a score I am not sure what the score means – the bottom line.(FG2/ EP10/ line230) I thought it was quite important (*the LMPI*) because there are a lot of things that you look at in terms of measuring although it is quite subjective (*the LMPI is subjective*) do not reflect the timing and speed (*other outcome measures don't reflect timing and speed*)(FG2/ EP11/ line176)	The LMPI was effective in helping to analyse the nature of movement control. The 5 items allowed me to measure patient's activity in terms of alignment, interaction, timing, speed and selective movement(P9line4) as it enable the clinician to pick from numerous possibilities of movements for measuring.(P5 line2) one's patient's results cannot be compared to another's because you are nearly always measuring something different. Because of this I am not sure how useful it would be as an outcome measure in a research trial, but it would be useful on an individual patient level to show improvement.(P5 line5) We gave a short IST to 2 of our staff – 1 B7 and 1B6. Both were impressed and felt they would like to try using the LMPI. They felt it was good for analysing and looked quick and easy to use. (P5 line79) LMPI clinically useful and more individual to patient. (P6line26) the LMPI acknowledges grades of deficits rather than an individual movement patterns(P2line2)

		What pathologies did you use it with?	For my other patients who had degenerative conditions I found the scores less useful, as the scores didn't change.(P9line21)
		Woman Stroke and TBI are mine	
		Woman Stroke and yes spinal, stroke	
		Man Stroke. I have used it with other neurological conditions one was - I had a lady was chiari malformation, and used it with her - I did not feel constrained by the condition.	I did like the LMPI measuring tool for use with neurology patients. Its focus on the analysis of movement control is unlike any other outcome measure I have used.(P9line95)
		Women Agreeing	
		I think it could be used for any condition. I think you could use it with any condition - not just neurological conditions -<u>anything</u> about movement and the indicators and categories apply to any bodies movement - for anyone, any area.	I could not use it for all my patients as many of our patients are very early strokes. It was more suitable for patients who were a few weeks into their rehab and outpatients(P5 line3)
		Yes. I think so. (FG1/ EP1,2&6/ line 353)	all types of neuro pathologies and all levels of impairments. The types of pathologies I used were: stroke, MS brain tumour but I could see it's use in other neuro pathologies.(P5 line10)
			: a severe head injury with major tonal changes may change subjectively/objectively during a session but they may still have severely altered movement patterns which the scale may not be sensitive enough to record. (P2line9)
		Sensitivity	very specific to each patient and this means that it can be sensitive(P5 line4)
		and I found the high level patient I could not get a reasonable picture of the high the high level patients using the scale so it was more useful with the complex patient who had more serious alignment, impairment, movement dysfunction issues Than the high level patient who made, for me in respect of their goals for the weeks treatment, made significant changes but were difficult to record. I needed something that was more sensitive (FG2/ EP11/ line6) .	possibly not good to use for severely neurologically impaired patients as may not be sensitive enough to small changes. This may also apply to high level patients who may also have subtle changes.(P2line36)
		and found it very difficult using the score to see, first of all to see a snap shot of her ability from the score did not seem to give me a picture of what she was doing or what she could struggle with but it I did not see much change from the start of using it to finishing it. The lady changed but I did not feel the measure gave a good picture of that (FG2/ EP11/ line15)	
Ease of use		It was very fast it gave us a good score and showed big change (FG2/ EP8/ line34)	Once I was familiar with the 5 items I found the LMPI quite easy to use, although I made judgements while working with the patients I could complete the form afterwards while writing up notes. (P9line43)
		we were <u>much</u> faster than I was in my own practice …strongly attracted to using the tool (takes too long) (FG2/ EP7/ line43)	

| | | | The LMPI tool itself does not take long to use and because of this it will be very useful clinically and more likely that clinicians will use it.(P5 line24)

quick and easy tool to try and bring quality of movement back into a busy workload(P5 line50)

Quick to use, although deciding on what to measure, why and how takes a little longer.(P6line24)

LMPI doesn't take long to use at all especially compared to BBS which seemed to take up a lot of the treatment session time(P11line13) |
| | **difficult to use**
found it difficult to judge what the pts optimal would be (S1line70) | and I thought it would be straight forward and I actually found it much more difficult than I expected to (FG1/ EP3/ line7)

because you could not say you are only looking at the alignment of one area you could be very very specific in terms of if you want to look at someone's head position or if you want to look at something big either their walking or shoulder position so you can use it for anything so in one way that makes it very useful because you can use it for any area, but also in a way that gave me variability that gave me another problem because... which one would I do. (FG1/ EP5/ line21)

I would have to say when I started using it - and I did a couple - I thought I had missed the point I thought I was getting something fundamentally wrong because I was feeling so challenged by it. I found that quite difficult. (FG1/ EP5/ line28)

I think I just found it hard because I think it is probably I did not think about that point, I think your point XXXX about dividing it up is what made it difficult. I still think if I was using it with someone junior, you could say now we are looking at sit to stand , now we are going to look at their alignment and we are going to score that, now we are going to look at their interaction, now we are going to look at their timing now their speed of their movement. It would be very useful but I think that for us - when you are working - that actually that dividing tool, your overall picture because you are working on a whole it is the continuum of movement and the continuum of almost clinical reasoning it becomes more chunkeyit takes you back to dechunking - chunking down is probably the word. (FG1/ EP2/ line 90)

More complicated to use for me, more difficult. I know it is new to me but I was taking half an hour to identify what scores I wanted and thinking it through so for me it was more effortful.(FG2/ EP10/ | at times I had to re-read the instructions to remind myself exactly what each item was referring to.(P9line7)

Scoring sometimes felt a little like a stab in the dark!(P6line54) |

		line21) but I felt that I did not understand what I was doing fully and I still think I do not understand what I am doing fully. (FG2/ EP7/ line77) were flashes of greater understanding through discussion with my colleagues that I had not had when I had done it on my own (FG2/ EP7/ line85) I found the timing one difficult - I am sure that was just about my skill level but I found trying to make an objective decision about whether the sequence of activation was correct or not was very difficult. I wonder if I would ever be able to do that.(FG2line183) I did better at using it in a group situation than I did alone (FG2line237) point I feel that I am missing something and feel that it maybe it needs more practice -maybe it needs more training - I think it is both actually – I think need more training and needs more discussion to understand it and needs more practice (FG2/ EP7/ line261)	
			General issues of use I wasn't always sure what to measure and often tended to use functional activities rather than specific muscle activity(P9line23)
		Time it takes to use I think that in real world people increasing under pressure with time it that would be pursued as a negative I think even if it was useful it would be take too long I think.(FG1/ EP3/ line424)	
		Subjective when I did it in combination with two of my tutors it felt like you could pick something and you could quickly go through it but it was slightly subjective(FG2/ EP8/ line31)	intrinsically it is a subjective measure (which could be a weakness), but because of the items in the framework which are very clear and specific this makes it as objective as possible(P12line18) more than ½, less than ½" – quite subjective, and sometimes difficult to call.(P6line52)
Underpins practice	**Quality of movement** For 1 pt the LMPI was good because its not just that they can perform the function, but how well they can perform it. (S1line89)		. It is easy in community to become quite functionally focused and using the LMPI has been a good reminder to look at quality of movement first.(P5 line41) . Only outcome measure I have come across that

			looks at each component of normal movement measuring quality rather than just ability(P11line5)
		Individual nature of movement but I think in essence it <u>does</u> recognise an individual nature (FG1/ EP6/ line15) a strength of it is it breaks movement down into component which is reflective how we teach the "Bobath concept"(FG2/ EP7/ line447) It prompts you to break things down into components. The Measure itself does not break them down. It prompts the clinician to.(FG2/ EP10/ line466)	The LMPI helped to analyse the movement control in terms of the 5 items. This helped to identify where movement was less than the theoretical normal and guided treatment planning.(P9line64) I felt LPMI reflected not only the treatment goal but considered how the goal was achieved, by measuring the various components involved such as; timing / interaction etc which are often over looked in other tools, this I thought made it quite a sensitive measure.(P12line4)
		related to function I think on one person I did just look at the alignment of their leg. Just leg alignment in standing and I could do that, which is fine, I had my scores but then I was left with so I have changed their leg alignment but in the bigger scheme of things what would that lead too (FG1/ EP2/ line40) I was looking at a particular alignment issue with regard to a very small body part I was not relating it to function but I thought it might work out that way but it did not.(FG1/ EP1/ line104) it was those patients where you inherently know they are not going to look hugely different but they can <u>feel</u> different but that can be very relevant to them in their overall function.(FG1/ EP6/ line374)	Could be related to patients function and goals, for example, for patient to be able to stand up from wheelchair, symmetrically, with supervision. Able to look at- - weight-bearing through affected LL - adaptability of foot during movement - trunk and UL alignment during movement (P6line16)
		Items in the scale "the interaction with the base of support" is also a huge strength of it because it gets missed in a lot of measures it is important to the concept that I practice(FG2/ EP8/ line215) I liked the fact that it has alignment in it because that is where we often start and I think that is useful with all of the patients we looked at because you are looking at an optimal alignment to underpin the other things so an optimal alignment will underpin the ongoing interaction of the patient with gravity and their supporting surface and the ongoing - the alignment will underpin the timing, the sequence of movement, the speed and the selectivity. That I think is a strength - it really, that it facilitates the person who is doing the measure to look critically at the alignment and not just function – the task.(FG2/ EP7/ line207) Woman I think if I was in charge of it..... if it was mine I	

		would re write the order I would go alignment interaction selective movement timing speed. Q Why? Woman just because it makes more sense to me. (FG2/ EP7/ line231)	
	About the LMPI Different terms /jargon would be easier (S1line6)	**The Speed** bit very difficult to deal with because you say the ability to choose how fast or slowly - well it depends and that made it very hard to categorise - put a number to that.(FG1/ EP1/ line106)	
		Anything missing from it? From a movement component perspective – I don't think so, it covers all bases. (FG2/ EP8/ line305) It would be nice to have a section on it that was entitled goals(FG2/ EP10/ line307) Most things are covered aren't they - in terms of patients movements are slower more jerky. Usefulness comes in a lot. A lot of those components come in. You don't want to make it more complicated when a lot of things are already there.(FG2/ EP8/ line327) from that point of view (*is there anything missing?*) it is comprehensive and appropriate(FG2/ EP7/ line334)	With most of my patients I chose an activity for which the patients had some ability and so rarely used O score. Likewise I would choose an area where a problem was identified and so a score 3 would not be possible for all items. This meant in most cases I was choosing between 1 moderate and 2 mild. An extra score i.e. 1 ½ may have been useful and more sensitive to change.(P9line24) Sometimes it is hard to pick a score from 0-3 and wonder whether allowing ½ scores would be useful.(P5 line53) reflection I think making it too detailed would make it less objective and in some respects it made me more decisive.(P12line41) Possibly compare to "normal", rather than patients "theoretical" normal, with possibly extra point on scale to reflect this?(P6line43) could be more sensitive with 5 scores allowed, to help distinguish between scores of 2 and 3(P4line9)
		Theoretical optimum Woman They could never be a three because they were never going to have enough recovery to be back to their previous level it was the theoretical optimal performance and I was not clear on that whether I should be judging them against : prior to their assault or the best I thought they could be post lesion. Woman Your best prognosis. Man Which is what I was doing (FG1/ EP3,4 &6/ line123) *Discussion about the optimum…might it be different with different skills of therapist?(FG1/ EP6,2&1/ line 251+)*	Scale somewhat subjective. Quite difficult at times to consider patients "theoretical" normal(P6line11) What if patient surpasses their theoretical normal? Is there a ceiling effect? Or does it mean we have scored wrong previously?(P6line14)

369

		But actually you might say - if you did that - or if you worked on their selective planter flexion they would improve and their heel stroke would be much better. I would think I do not know how to get that. That is my optimal. I think we would have the variability within ourselves as well as the difference seniority level – it is just experience and skill, knowing what you can achieve.(FG1/ EP5/ line398)	
		I think that there are so many variability's but in terms of prognosis it depends on what time frame you are working with. What I did like was the pre and post treatment idea I think that is very useful as a snap shot because once you start and broaden the context then the variables are so huge then it is quite difficult to feel confident that you are also capturing something of use and value.(FG1/ EP4/ line277)	
		- in the first instance have you really defined your optimal as clearly in your own mind as you need to – you see what I mean. To me, this optimal thing - if we have different perceptions of it - then it is quite a crucial thing if you do not define the optimal how do you define your scores underneath it.(FG1/ EP6/ line384)	
		I found that extremely difficult because I did not know whether if I was looking that the "theoretical optimal performance" of that person before their injury or after.(FG2/ EP10/ line91)	
		Woman So if your complex person achieved the best optimum they had ever achieved - if you did may be measuring him over a few months would that new awareness in your mind that he can be that good which you had never seen before does that kind of shift the whole measure because you would not have thought last month that was his optimum but that is what you were asked to measure him against.
Woman But you would have moved to another goal.
Woman You would have moved on because you had achieved that so you would have moved on to something different – that was my understanding
Woman So the "Theoretical Optimal Performance" is based on the changing goal.
Woman Yeh (FG2/ EP11,8&10/ line127)	
		Woman I would have thought that because this is a normal movement indicator you would always have what was normal as you are comparing your post injured patient from your mild / moderate or severe
Woman I am now really confused now really confused (FG2/ EP8&4/ line167)	

| | | One of the things that I liked in the patient I started on one of them - who would never have – the possibility of having what most clinicians would consider as normal movement - so it was quite useful to have a theoretical normal movement or theoretical goal to work towards or think about - rather than perhaps what therapists might think about - would he move like me - and the question - no and he never will - no. So it was worth having that thought.(FG2line337)

Woman   So how did you score optimal how did you score his theoretical optimal performance?
Woman   Against what I thought he might be able to achieve
Woman   With his diagnostic
Woman   Yeh along with the patients diagnosis. But obviously I had no idea of where he might be able to go to - and this is a guy who declined in terms of his functional ability over a period of time so I was trying to move him back.
Woman   To where it was. To where his optimal was.(FG2/ EP7&11/ line344) | |
|---|---|---|---|
| | | **What do you do with the score?** for example measuring sit to stand - well yes I could get a different set of scores as part of the overall sit to stand - but it is a bit like what Catherine says - I am not quite sure what we do with them at this stage do you add them up, do you highlight, that is where the score changed, that is where the score did not change, and the aspect of sit to stand that you are actually recording change of very much impairment level aspects - you see what I mean.(FG1/ EP6/ line207)

The other thing that I felt was hard, to decide if they were meeting half or more than half of the components of the item(FG2/ EP10/ line102) | |
| | | **Is it hierarchical?** I was working with a patient who needed to improve his selective planter flexion in terms of terminal stance and sit to stand so I was working very specifically on his selective movement of his planterflexors so that was the most important aspect, because that was effecting everything else and strength was an issue, so in that respect the most important thing for him was... the hierarchy did not even come into it.   (FG1/ EP2/ line315)

It is basically understanding those relationships between those different factors. Rather than you get one and then you go on to the next and then on to the next.(FG1/ EP3/ line348) | The " importance" of the items in the scale varied with each individual patients, for example; in some patients selective movement was the key limiting factor, in others it was alignment and in some patients all items were equally affected. Therefore there was a hierarchy of sorts(P12line34)

Don't feel items are hierarchical. Some patients demonstrated improvements lower down scale before further up. Also depends on what you are measuring i.e. whole body v specific body part. (P6line38) |

			Strengths Easy to complete Quick to complete Focuses on normal movement Appropriate for patients with neurological problems (P9line70) aids analysis and observation of movement. It is quick and easy to use and adaptable and sensitive. (P5 line55) easy to use, facilitates treatment planning and goal setting, I found it a sensitive measure. (P12line44) same thought process we use every day looks at quality (P6line46)
			Weaknesses Not always sensitive enough Would reflect negatively on patients with progressive disorders Limited to therapists with neurological interest (P9line75) the items feel a little repetitive as there is a blurring of meaning between some of them. For instance, alignment is similar to interaction and timing is similar to selective movement. Sometimes it is hard to draw a distinction between items that are only subtly different (P5 line58) Not always as easy for the patient to understand what we were measuring (compared to say the Berg) (P12line46) not well enough known yet unable to compare patients (if we wanted to!) Use of jargon (wordy, even for junior staff) (P6line49)
	About testing in study 1b they cannot remember their scores 1st time around and they thought they would (S1line 19) Participants felt they were being quicker with their scoring, they felt		

		more confidant, they were just 'going for it'. Felt they were being harsher with scores. Using the LMPI felt easier (S1line60)	
		Inter and intra-rater reliability Man It does wonder about the inter Woman The inter-rator is the problem Man As oppose to the intra Woman That is what I thought would be difficult Woman unless you really clearly defined what your idea of the components were at the initial time you did it. Woman yes -As you as the filler outer had to record that it then becomes onerous it then becomes a chore because you now have to do a lot more writing (FG1/ EP5&6/ line405) Woman Does it always have to be the same person who is doing the measure - presumably. Woman So that then you knew - my perception is that is that the inter-rater reliability might be quite low and therefore – yeh that would be a concern to me. (FG2/ EP11&7/ line113)	I was a little unsure initially, but it was done in a relaxed, pressure free manner. (P9line92) This was a bit challenging in that there was some anxiety as to whether the results might vary widely, but it was a good task to do from a personal development aspect (P5 line73) The re-testing was absolutely fine, less threatening than anticipated. Once I realised my score was only being measure against <u>my</u> previous score. (P12line65) The test re-test was good, I had no recollection of what I'd recorded in the 1st session so it was planned in a timely manner.(P2line55)
		Using outcome measures Woman We at Xxxxxx last week we were trying to get relatively skilled practitioner's to use GAS but it was difficult very difficult. Woman I think it is the time Woman They had the time on the course – they had the time. Woman Lack of experience was a big excuse. There is a huge lack of experience no matter how much we talk about this health service and the fact that every practitioner should be measuring change on their patient. We found amongst 18 course members last week we found quite considerable lack of ability to do that.(FG2/ EP10,7,9&8/ line294)	I think the LMPI, or some similar measure should underpin the therapists approach to clinical practice, but doesn't always because of time constraints and the need sometimes for function and safety within a home environment (P5 line47
			Involvement in the research project Initially I felt some reluctance to take part due to limited time and extra demands to fill in forms and attend meetings. However I found the research of particular interest as it was specifically designed for neuro-patients. The support and encouragement given to me by the lead, and other colleagues provided motivation (P9line80) It was good to be involved with this project and I feel it has helped with my own personal development and in my ability to teach junior staff.

			Compared to a recent research study into how teams work together in intermediate care, this study felt more clinically relevant and interesting. (P5 line66)
			I found the whole process very interesting especially as the research had a very clear remit, physiotherapy focus, and clinically of great professional interest (P12line51)
			I was very pleased to be involved in trialling a sensitive outcome tool with the emphasis on the quality involved in achieving functional goals which has been sadly lacking especially for neurological patients. (P12line69)
			Regular contact and support was invaluable, and encouraged focus, and use of LMPI.(P6line69)
			1 participant did not use it within their clinical practice because of a time constraint – she had 4 other outcome measures that she needed to complete…… participation caused burden (P9)
			Ethics The project would have been easier if patients had not needed to agree to taking part. (P9line85)
			The only problems with recruiting patients were in gaining their consent.(P5 line70)
			about the BBS A less time consuming alternate measure, rather than the BBS would have made it easier. (P9line86)
			The Berg balance is a very objective outcome measure which lots of patients like as they can see clear measures taking place (involving stopwatches and tape measures etc) however I feel it is a superficial measure looking only at tasks and not the quality of movement involved in achieving them. (P12line22)
			The training was really good, the video clips were useful and doing the training in groups where discussion was possible helped to gain understanding of the assessment. (P2line50)

Appendix 16

- The assessment of the LMPI, the BBS, the TIS and GAS using the COSMIN framework (Terwee et al 2012)

The four outcome measures reviewed using the COSMIN method checklist

Using the COSMIN checklist described by Terwee et al (2012), each of the properties for each of the outcome measures were examined for their ability to meet the standards. Constructing this table has enabled comparison of the quality of the methodology of work that has been done to develop and test the LMPI with the best of the other available outcome measures; according to the criteria that were set within the literature review of Chapter 3. Some properties, such as clinical utility were not included within the COSMIN framework and some indicators within the COSMIN framework were not included in any of the research surrounding the BBS, TIS or GAS.

Although only relatively small scale research has been carried out, in some areas, the LMPI stands strongly next to the BBS, TIS and GAS in some areas, further work is identified for the LMPI

The COSMIN checklist categories

Box A - Internal consistency

The LMPI, BBS and the TIS all met the requirements stated by COSMIN and this property was not assessed within any of the GAS studies examined.

Box B – Reliability

All four outcome measures met the requirements of COSMIN, although, with the exception of the BBS studies, small sample sizes were used.

Box C - Measurement error

Measurement error has strongly been tested within the BBS, and only one study has considered this property for the TIS.

Box D - Content validity

All four studies met this COSMIN requirement, although because of the methodology used within the LMPI studies it was established in significantly greater depth than the others. Clinical utility was investigated within the LMPI and to a small extent within the BBS, TIS and GAS. Respondent burden was only investigated within the LMPI.

Box E - Structural validity

This was not considered within any of the papers; however, predictive validity - in terms of prediction in time(was assessed for the BBS and the TIS), but not prediction of scale total score.

Box F - Hypotheses testing

No hypotheses related to the outcome of tests of validity were used within any of the papers.

Box G - Cross-cultural validity

This was not assessed in any of the papers examined, however some research papers may have been excluded because of the criteria within the literature searches limiting to English language.

Box H - Criterion validity

Criterion validity was assessed in a satisfactory manner for all four outcome measures, although the sample size used within the LMPI study was small.

Box I – Responsiveness

Effect size was tested for the LMPI, BBS and GAS but not for the TIS, however with the exception of BBS papers, small sample sizes were used.

This was not generally tested, with the exception of floor and ceiling effects within the BBS and the TIS; however, neither the LMPI or GAS have issues with floor or ceiling effects due to the nature of the measurement tools.

Determining generalisability of the results

Within the BBS, this is good and it can be used with minimal training or equipment. On the other hand, the TIS requires some specialist skills (all the raters used within the TIS studies were physiotherapists). The LMPI and the GAS both require the skills of prediction and prognosis of the patient's ability to change, plus the potential ability of the patient to change according to the intervention and the treatment skills of the physiotherapist.

Comparison of measurement properties between the BBS, TIS, GAS and LMPI, using the 'criteria framework developed in table [ii] Chapter 2, then examined using the COSMIN checklist (Terwee et al 2012)									
	LMPI		**BBS**		**TIS**		**GAS**		**Expected range**
Name of the test	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	
Internal consistency Cronbach's alpha coefficient, applied to the entire scale and to each item	Study 2: 5pts, 12 PTs, rated patients movement using video; re-rated 2 weeks later.	Overall = 0.862, "excellent" with individual items ranging from 0.795 to 0.892. "good to excellent"	Berg et al 1989 14 pts, 5 PTsCronbach's …………….. Berg et al 1995 30pts, 5 raters Cronbach's ……………… Mao et al 2002 112pts,2OTs, Chronbach's ……………… Franchignoni et al 2005 70pts, unknown raters, Chronbach's	Overall = 0.83 to 0.95 "excellent" ……………….. with individual items ranging from 0.41 to 0.64 "inadequate" ……………… 0.92 to 0.98 "excellent" ……………….. 0.62 to 0.81 "inadequate to excellent"	Verheyden et al 2004 28pts, 2PTs Chronbach ……………… Verheyden & Kersten 2010 162 pts, Rasch	0.65 to 0.89 "moderate to perfect" ……………… Removal of static sitting balance subscale improved internal validity	Tennant 2007, Rasch, simulated data	Does not fit Rasch model, unless instrument is altered.	Cronbach's alpha coefficient excellent = ≥ 0.8 good = ≥ 0.7 inadequate = < 0.7
Box A Internal consistency. The absolute percentage of agreement is inadequate, because it does not adjust for the agreement attributable to chance									
1. Was the sample size included in the internal consistency analysis adequate? Rules-of-thumb vary from four to 10 subjects per variable,	Yes		Yes		Yes		No		Cronbach's alpha(s) calculated per dimension AND Cronbach's alpha(s) between 0.70 and 0.95;

Comparison of measurement properties between the BBS, TIS, GAS and LMPI, using the 'criteria framework developed in table [ii] Chapter 2, then examined using the COSMIN checklist (Terwee et al 2012)									
	LMPI		**BBS**		**TIS**		**GAS**		**Expected range**
Name of the test	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	
3. Was an internal consistency statistic calculated for each (unidimensional) (sub)scale separately?	Yes		Yes		Yes		No		
5. for Classical Test Theory (CTT): Was Cronbach's alpha calculated?	Yes		Yes		Yes				
Test re-test reliability Spearman's rank correlation coefficient	Study 2: 5 pts, 12 PTs, rated patients movement using video; re-rated 2 weeks later. ……………….. Study 2: A variance components analysis:	for overall scale = 0.792 and individual items of selective movement (0.655), speed (0.655) and interaction(0.674). "substantial" reliability for timing (0.516) and alignment (0.397). "moderate" ………………… Variance between physiotherapists (7.8%)and between the	Berg et al 1989 14pts, 5PTs, ICC Berg et al 1995 31pts , 7 raters, ICC Liston & Brouwer 1996 20pts, unknown raters ICC Farlow et al1997 18pts, 2 raters, ICC .	for overall scale consistently above 0.91 "almost perfect"	Verheyden et al 2004 ICC ……………….. Verheyden et al 2006b, 30pts, 2PTs, ICC, Bland Altman …………………… Verheyden et al 2006c, 30pts, 2 researchers, ICC	for overall scale = 0.96 "excellent" ………………… 0.95 "excellent" Bland Altman 93% within 2SDs …………………… 0.88 "excellent"	Not tested		Spearman's rank correlation coefficient almost perfect: > 0.8 substantial: 0.6 to 0.8 moderate: 0.41 to 0.6 poor: < 0.4

Comparison of measurement properties between the BBS, TIS, GAS and LMPI, using the 'criteria framework developed in table [ii] Chapter 2, then examined using the COSMIN checklist (Terwee et al 2012)									
	LMPI		BBS		TIS		GAS		Expected range
Name of the test	Methods	Results	Methods	Results	Methods	Results	Methods	Results	
	between-patient, between therapist, between testing variability	replicate measurement occasions (2.8%) were small, whereas the variance between the patients were large (55.2%) as expected	Mao et al 2002 112pts 2 OTs, ICC Bennie et al 2003, 20pts, 2 raters, ICC Newstead et al 2005 5pts, 2 raters, ICC Steffen & Seney 2008 37pts, unknown raters, ICC Hiengkaew et al 2012 61pts, 2 PTs, ICC ………. Conradsson et al 2007 45pts, 1rater, ICC, Bland Altman ……….. Leddy et al 2011 24pts, 2 raters, ICC ………….. Sackley et al 2005 47pts, 2 raters Kappa.	"almost perfect" ………….. ICC 0.97 Bland AltmanSD= 2.7 ……………. 0.8 "excellent" ……………… K 0.63-1.00 "substantial to perfect" ICC - 0.98 "excellent"					

Comparison of measurement properties between the BBS, TIS, GAS and LMPI, using the 'criteria framework developed in table [ii] Chapter 2, then examined using the COSMIN checklist (Terwee et al 2012)									
	LMPI		**BBS**		**TIS**		**GAS**		**Expected range**
Name of the test	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	
Inter-rater reliability	Study 2: 5 pts, 12 PTs, rated patients movement using video; re-rated 2 weeks later. ICC for total scores and individual items	Total scale scores and individual item scores = all above 0.8 "excellent"	Berg et al 1989 ICC Berg et al 1995 ICC Farlow et al1997 18pts, 4 raters, ICC Bennie et al 2003, 20tps, 2 raters, ICC de Figueiredo et al 2009, 12pts, 18PTs, ICC total scores Leddy et al 2011, 15pts, 3 raters, ICC …………... Sackley et al 2005 Kappa ………. Mao et al 2002 112pts 2 OTs, Kappa, ICC	Total scale scores = all above 0.95 "excellent" ………….. k 0.74-1.00 "substantial to perfect" ICC =0.99. "excellent" ………….. k 0.59 to 0.94 moderate to perfect ICC 0.93 to 0.97 "excellent"	Nieuwboer et al 1996, 27pts, 2PTs, Kappa …………….. Verheyden et al 2004, 28pts, 2PTs, ICC Verheyden et al 2006c, 30pts, 2 researchers, ICC, …………… Verheyden et al 2006b, 30pts, 2PTs, ICC	Range "slight to substantial" ……………… ICC all above 0.93 "excellent" ……………… Bland Altman 93% within 2SDs	Joyce et al 1994 16pts, MDT raters, unknown psychometric test …………… Bovend'Eerdt et al 2011; 29pts, 1PT, 1 Independent rater, ICC	"strong" ……………… 0.478 "adequate"	Kappa values 0.00-0.20 = slight 0.21-0.40 = fair 0.41-0.60 = moderate 0.61-0.80 = substantial 0.81-1.00 = almost perfect ICC Excellent: > 0.75 Adequate: 0.40 to < 0.74 Poor: < 0.40

Box B Reliability: relative measures (including test-retest reliability, inter-rater reliability and intra-rater reliability) Terwee 2012 Adequate sample size (<100) Good sample size (50–99) Moderate sample size (30–49) Small sample size (>30) … The Pearson correlation coefficient is inadequate, because systematic differences are not taken into account … and gave a positive rating for reliability when the ICC or weighted Kappa is at least 0.70 in a sample size of at least 50 patients					
3.Was the sample size included in the analysis adequate?	Small	Studies range from small to good	Small	Small	
4.Were at least two measurements available?	Yes	Yes	Yes	No	
5.Were the administrations independent?	Yes	Yes	Yes	Yes	
6.Was the time interval stated?	Yes	Yes	Yes	Yes	
7.Were patients stable in the interim period on the construct to be measured?	Yes	Yes	Yes	Yes	
9.Were the test conditions similar for both measurements? e.g. type of administration, environment, instructions	Yes	Yes	Yes	Yes	
11.for continuous scores: Was an intraclass correlation coefficient (ICC) calculated?	Yes	Yes	Yes	Yes	

382

Comparison of measurement properties between the BBS, TIS, GAS and LMPI, using the 'criteria framework developed in table [ii] Chapter 2, then examined using the COSMIN checklist (Terwee et al 2012)									
	LMPI		**BBS**		**TIS**		**GAS**		**Expected range**
Name of the test	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	
Measurement error	SEM SDC	0.42 1.16	Stevenson 2001 48pts Steffen & Seney 2008 37pts Donoghue & Stokes 2009 118pts Flansbjer et al 2012 50pts Hiengkaew et al 2012 61pts Quinn et al 2013 75pts Godi et al 2013 93pts	MDC SEM SEM MDC SEM MDC SEM MDC MDC SEM MDC	Verheyden et al 2006b, MS, 30pts, 2PTs	SEM 1.23 to 1.58, comparable with BBS			
Box C Measurement error: absolute measures Design requirements									
3.Was the sample size included in the analysis adequate?	Not tested		Small moderate good		Small		Not tested		
4.Were at least two measurements available?			Yes		No				
5.Were the administrations independent?			Yes		Yes				

Comparison of measurement properties between the BBS, TIS, GAS and LMPI, using the 'criteria framework developed in table [ii] Chapter 2, then examined using the COSMIN checklist (Terwee et al 2012)									
	LMPI		BBS		TIS		GAS		Expected range
Name of the test	Methods	Results	Methods	Results	Methods	Results	Methods	Results	
6.Was the time interval stated?			Yes		Yes				
7.Were patients stable in the interim period on the construct to be measured?			Yes		Yes				
8.Was the time interval appropriate?									
9.Were the test conditions similar for both measurements? e.g. type of administration, environment, instructions			Yes		Yes				
11.for CTT: Was the Standard Error of Measurement (SEM), Smallest Detectable Change (SDC) or Limits of Agreement (LoA) calculated?			SEM MDC		SEM				

Comparison of measurement properties between the BBS, TIS, GAS and LMPI, using the 'criteria framework developed in table [ii] Chapter 2, then examined using the COSMIN checklist (Terwee et al 2012)									
	LMPI		**BBS**		**TIS**		**GAS**		**Expected range**
Name of the test	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	
Face / Content validity	Qualitative methods : - Study 1: developed by clinicians, semi-structured interviews with users– thematic content analysis Study 2 : rich note taking Study 3 : 2 focus groups, reflective questionnaires, cross case template analysis	Strong face and content validity	Berg et al 1989, Use of patients and health care professionals during its development	Good face and content validity	Nieuwboer et al1996 interview and observation PT & pt. Nothing published about development of TIS	Good content and face validity	Kiresuk & Sherman1968 developed for pts receiving psychcology intervention .... Joyce et al 1994, TBI	Poor .... Strong	
Box D Content validity (including face validity) Terwee 2012.. A clear description is provided of the measurement aim, the target population, the concepts that are being measured, and the item selection AND target population and investigators OR experts) were involved in item selection;									
1.Was there an assessment of whether all items refer to relevant aspects of the construct to be measured?	Yes		Yes		Yes		Yes		

Comparison of measurement properties between the BBS, TIS, GAS and LMPI, using the 'criteria framework developed in table [ii] Chapter 2, then examined using the COSMIN checklist (Terwee et al 2012)									
	LMPI		BBS		TIS		GAS		Expected range
Name of the test	Methods	Results	Methods	Results	Methods	Results	Methods	Results	
2.Was there an assessment of whether all items are relevant for the study population? (e.g. age, gender, disease characteristics, country, setting)	Yes		Yes		Yes		Yes		
4. Was there an assessment of whether all items together comprehensively reflect the construct to be measured?	Yes		Yes		Yes		Yes		
3. Was there an assessment of whether all items are relevant for the purpose of the measurement instrument? (discriminative, evaluative, and/or predictive)			Predictive and evaluative		Predictive and evaluative				

Comparison of measurement properties between the BBS, TIS, GAS and LMPI, using the 'criteria framework developed in table [ii] Chapter 2, then examined using the COSMIN checklist (Terwee et al 2012)									
	LMPI		**BBS**		**TIS**		**GAS**		**Expected range**
Name of the test	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	
Predictive Validity	Not tested	Not tested	For D/C LOS Feld et al 2001 Wee et al 1999;2003 …………… Falls Bogle& Newton 1996 Cattaneo et al 2006 Maeda et al 2009 Leddy et al 2011 Coote& Hogan (2013) ……………….. Mao et al 2002, 112pts 2 OTs, BBS v MAS Spearman's	Moderate prediction ……………… Weak prediction ↓ ……………… Day 14 - 0.82 Day 30 - 0.84 Day 90 - 0.91 "large"	For D/C function Verheyden et al 2007a, BI …………………. Verheyden et al 2008, FMa, BI ……………… For D/C functionDi Monaco et al 2010, 60pts,	Strong prediction ……………. Recovery or trunk, arm & leg have similar rates ……………….. Strong prediction of D/C function	Not tested		

Box E Structural validity not carried out within any of the studies examined

1. Does the scale consist of effect indicators, i.e. is it based on a reflective model?

Design requirements

2. Was the percentage of missing items given?

3. Was there a description of how missing items were handled?

4. Was the sample size included in the analysis adequate?

5. Were there any important flaws in the design or methods of the study?

6. for CTT: Was exploratory or confirmatory factor analysis performed?

Box F	**Hypotheses testing** not carried out within any of the studies examined

1. Was the percentage of missing items given?

2. Was there a description of how missing items were handled?

3. Was the sample size included in the analysis adequate?

4. Were hypotheses regarding correlations or mean differences formulated a priori (i.e. before data collection)?

5. Was the expected direction of correlations or mean differences included in the hypotheses?

6. Was the expected absolute or relative magnitude of correlations or mean differences included in the hypotheses?

7. for convergent validity: Was an adequate description provided of the comparator instrument(s)?

8. for convergent validity: Were the measurement properties of the comparator instrument(s) adequately described?

9. Were there any important flaws in the design or methods of the study?

10. Were design and statistical methods adequate for the hypotheses to be tested?

Box G	**Cross-cultural validity** not carried out within any of the studies examined

1. Was the percentage of missing items given?

2. Was there a description of how missing items were handled?

3. Was the sample size included in the analysis adequate?

4. Were both the original language in which the HR-PRO instrument was developed, and the language in which the HR-PRO instrument was translated described?

5. Was the expertise of the people involved in the translation process adequately described? e.g. expertise in the disease(s) involved, expertise in the construct to be measured, expertise in both languages

6. Did the translators work independently from each other?

7. Were items translated forward and backward?

8. Was there an adequate description of how differences between the original and translated versions were resolved?

9. Was the translation reviewed by a committee (e.g. original developers)?

10. Was the HR-PRO instrument pre-tested (e.g. cognitive interviews) to check interpretation, cultural relevance of the translation, and ease of comprehension?

11. Was the sample used in the pre-test adequately described?

12. Were the samples similar for all characteristics except language and/or cultural background?

13. Were there any important flaws in the design or methods of the study?

14. for CTT: Was confirmatory factor analysis performed?

Comparison of measurement properties between the BBS, TIS, GAS and LMPI, using the 'criteria framework developed in table [ii] Chapter 2, then examined using the COSMIN checklist (Terwee et al 2012)									
	LMPI		**BBS**		**TIS**		**GAS**		**Expected range**
Name of the test	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	
Criterion / construct	Convergent reliability With BBS Study 2: Senior Physiotherapist Participant Group, recruited patients and tested them pre and post intervention 27pts 1) Spearmans rank correlation coefficient. 2) Correlation between the averages and the differences of the pre and post intervention scores (Bland & Altman 2010)	"medium" correlation (0.468) Standard Deviation ± 2, except for 2 patients whose results lay outside the norm.	Berg et al 1989, criterion with care givers opinion, Spearmans 38pts ………………… Berg et al 1992 Criterion validity with; Tinetti, BI, TUG 31 pts ………………… Mao et al 2002, stroke, BI, Convergent reliability, Spearman's 112pts …………. Bennie et al 2003 TUG; FR, Spearman's 20pts …………….. Whitney et al 2003, 70pts DGI, Spearman's ………………. Qutubuddin et al 2005 UPDRS ; H&Y SE-ADL, Pearson's 38pts	"significant" but no results shown ……………… Tinetti - 0.91 BI – 0.67 TUG - 0.76 "large" ……………… Between 14 & 180 days 0.89 & 0.94 "large" …………….. TUG - 0.47; FR - 0.42 "medium" ……………….. 0.71 "large" ……………… UPDRS - 0.58 H&Y - 0.45 SE-ADL - 0.55	Verheyden et al 2004; BI, TCT, spearmans 28pts ……………….. Verheyden et al 2006a TCT Tinetti FAC 10mWT TUG FIMm 51pts ……………… Verheyden et al 2006b ; MDST, Bland Altman, 30pts ……………… Verheyden et al 2006c ; BI, Spearmans 30pts ……………… Verheyden et al 2007b, UPDRS, Spearman's 25pts ………….. Di Monaco et al 2010 ; PASS, FIM, Spearman's 60pts	BI 0.86 TCT 0.83 "Large" ……………… "strong relationships" …………………… Standard Deviation ± 2 ……………… 0.59 "large" …………….. 0.41 to 0.68 "medium to large" ……………… PASS 0.85 FIM 0.695 "large"	Joyce et al 1994, Pearson's ; GCI, RDRS, MEDLS, KELS, IADL 16pts ……………… Khan et al2008 ; 24pts with MS, Spearman's BI, FIM, CGI ……………… Turner-Stokes et al 2009 FIM, BI. Spearman's 164pts	GCI - 0.80 "very strong" RDRS - 0.61 "strong" MEDLS - 0.52 "moderate" KELS - 0.0039 "very weak" IADL - 0.16 "very weak" ……………… BI - 0.15 "small" FIM - 0.06 "small" CGI - 0.74 "large" ……………….. FIMm – 0.39 BI - 0.37 "medium"	Spearmans rank correlation coefficient. 0.5 = large 0.3 = medium 0.1 = small

	LMPI		BBS		TIS		GAS		Expected range
									Comparison of measurement properties between the BBS, TIS, GAS and LMPI, using the 'criteria framework developed in table [ii] Chapter 2, then examined using the COSMIN checklist (Terwee et al 2012)
Name of the test	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	
Criterion / construct **CONTINUED**			Lemay& Nadeau 2010 10mWT TUG 2MWT Pearson's WISCII SCI-FAI, Spearman's 32pts ……………… Franchignoni et al 2005, FFM, PCS, Pearson's 70pts	2MWT - 0.78 10mWT - 0.79 TUG – 0.81 2MWT- 0.78 "substantial" WISCII - 0.85 SCI-FAI - 0.74 "large" …………… FFM - 0.67 PCS - 0.82 "moderate"					
Box H Criterion validity									
3.Was the sample size included in the analysis adequate?	small		Small 1 Moderate 4 Good 2 Adequate 1		Good 2 Small 2 Moderate 2		Small 2 Adequate 1		

Comparison of measurement properties between the BBS, TIS, GAS and LMPI, using the 'criteria framework developed in table [ii] Chapter 2, then examined using the COSMIN checklist (Terwee et al 2012)									
	LMPI		**BBS**		**TIS**		**GAS**		**Expected range**
Name of the test	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	
4.Can the criterion used or employed be considered as a reasonable 'gold standard'?	Yes		Yes because of variety of Outcome Measures tested against		Yes because of variety of Outcome Measures tested against		Yes because of variety of Outcome Measures tested against		
6.for continuous scores: Were correlations, or the area under the receiver operating curve calculated?	correlations		correlations		correlations		correlations		
Responsiveness	Study 2, 27pts tested pre and post intervention, cohen's d statistic	ES = 1.52 "large"	Study 2, convergent validity with the BBS, tested pre and post intervention ……………… Wood-Dauphinee et al 1997, Kazis 70pts ……………… Amasut 2009 Cohen 51pts ……………… Hackney & Earhart 2009 14pts ……………… Mao et al 2002, range from 14 & 180 days post stroke, Cohen's d 112pts	ES = 0.99 "large" ……………… ES = 0.97 "large" ……………… ES = 0.22 "small" ……………… ES = 0.83 "large" ……………… 90 to 180 ES = 0.40 "small" 14 to 180 ES = 1.11 "large"	Not tested		Ashford & Turner- Stokes 2006, Rx with BTX, BI 18pts ……………… Kahn et al 2008 Effect size, Cohen 24pts ……………… Turner- Stokes et al 2009, ES 164 pts ……………… Turner-Stokes & Williams 2010 243 pts	More sensitive than BI, a GAS change of >10 associated with clinically important change ……………… I - 0.4 FIM - 0.4 GAS - 9.0 ……………… GAS – 3.54 BI – 1.0 FIMm – 0.93 ……………… Found altering score criteria increased sensitivity to change	Cohen's d statistic ≥0.80 = Large 0.50 = Moderate 0.20 = Small

Cohen *d* effect size (mean change/standard deviation [SD] of baseline score) |

	Comparison of measurement properties between the BBS, TIS, GAS and LMPI, using the 'criteria framework developed in table [ii] Chapter 2, then examined using the COSMIN checklist (Terwee et al 2012)								
	LMPI		**BBS**		**TIS**		**GAS**		**Expected range**
Name of the test	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	
Box I Responsiveness Terwee et al 2012 *"Although the Delphi panel wanted to discuss responsiveness as a separate measurement property, the panel agreed that the only difference between cross-sectional (construct and criterion) validity and responsiveness is that validity refers to the validity of a single score, and responsiveness refers to the validity of a change score [5]. Therefore, the panel decided that the standards for responsiveness should be analogue to the standards for construct and criterion validity. Similarly as with criterion validity, it was agreed that no gold standards exist for change scores on HR-PROs, with the exception of change on the original longer version of a HR-PRO that can be considered a gold standard, when it is compared to change on its shorter version"*									
3.Was the sample size included in the analysis adequate?	Poor		Poor 2 Good 2 Adequate 1		Not tested		Poor 2 Adequate 2		
4.Was a longitudinal design with at least two measurement used?	Yes		Yes				Yes		
5.Was the time interval stated?	Yes		Yes				Yes		
6.If anything occurred in the interim period (e.g. intervention, other relevant events), was it adequately described?	Yes		Yes				Yes		

Comparison of measurement properties between the BBS, TIS, GAS and LMPI, using the 'criteria framework developed in table [ii] Chapter 2, then examined using the COSMIN checklist (Terwee et al 2012)									
	LMPI		**BBS**		**TIS**		**GAS**		**Expected range**
Name of the test	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	
7.Was a proportion of the patients changed (i.e. improvement or deterioration)?	Yes		Yes		Not tested		Yes		
For constructs for which a gold standard was not available: 8. Were hypotheses about changes in scores formulated a priori (i.e. before data collection)?	No		No				No		
9.Was the expected direction of correlations or mean differences of the change scores of HR-PRO instruments included in these hypotheses?	No		No				No		
10.Were the expected absolute or relative magnitude of correlations or mean differences of the change scores of HR-PRO instruments included in these hypotheses?	No		No				No		

Comparison of measurement properties between the BBS, TIS, GAS and LMPI, using the 'criteria framework developed in table [ii] Chapter 2, then examined using the COSMIN checklist (Terwee et al 2012)									
	LMPI		BBS		TIS		GAS		Expected range
Name of the test	Methods	Results	Methods	Results	Methods	Results	Methods	Results	
11.Was an adequate description provided of the comparator instrument(s)?	Yes		Yes		Not tested		Yes		
12.Were the measurement properties of the comparator instrument(s) adequately described?	Yes		Yes				Yes		
14.Were design and statistical methods adequate for the hypotheses to be tested?	Yes		Yes				Yes		

Comparison of measurement properties between the BBS, TIS, GAS and LMPI, using the 'criteria framework developed in table [ii] Chapter 2, then examined using the COSMIN checklist (Terwee et al 2012)									
	LMPI		**BBS**		**TIS**		**GAS**		**Expected range**
Name of the test	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	
utility –within the clinical or research setting	Qualitative methods : - Study 1: developed by clinicians, semi-structured interviews with users– thematic content analysis Study 2 : rich note taking Study 3 : 2 focus groups, reflective questionnaires, cross case template analysis	Strong clinical utility, supports conceptual approach to assessment and treatment, considered to be potentially useful as a teaching tool	Lemay & Nadeau 2010 ISCI population, ... Datta et al 2009; 2012 ISCI population	Assessed by examining patient's scores, not clinicians perception .... Moderate utility	Verheyden et al 2009. stroke population, tested ability to measure effects of intervention .... Jandt et al 2011, correlation with respiratory function	Good .... Good	Joyce et al 1994 – TBI, MDT raters Reid & Chesson 1998 – stroke, PT raters Khan et al 2008 – MS, MDT raters Turner-Stokes & Williams 2010 – neuro, adapted score criteria Stevens et al 2013 literature review	Combined themes Complex to calculate, Difficult and time consuming to use facilitates goal setting feasible & practical encourages communication	Not applicable
		Validated for use with all neurological pathology during rehabilitation		Validated for use with PD, stroke, ABI, TBI, ADL,ISCI, MS, HD		Validated for use with stroke, MS, TBI, PD		Validated for use with all neurological pathology	

Comparison of measurement properties between the BBS, TIS, GAS and LMPI, using the 'criteria framework developed in table [ii] Chapter 2, then examined using the COSMIN checklist (Terwee et al 2012)									
	LMPI		**BBS**		**TIS**		**GAS**		**Expected range**
Name of the test	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	
Respondent burden	Study 1: semi-structured interviews with users Study 2: rich note taking Study 3: 2 focus groups, plus reflective questionnaires	See results in Chapter 10	Not tested		Not tested		Not tested		
Floor and ceiling effects	Study 2: Senior Physiotherapist Participant Group, recruited 27pts and tested them pre and post intervention	No floor or ceiling effects were reported	Mao et al 2002 112pts, stroke	Floor effects - day 14 - 35% Ceiling effects - Day 90 - 22% Day 180 - 29%	Verheyden et al 2005 …………….. Verheyden et al 2006a	Ceiling effects in 45% of 'normals' ………………… "no ceiling effect"	Not commented on		Excellent: No floor / ceiling effects, Adequate: Floor / ceiling effects < 20%, Poor: Floor / ceiling effects for > 20%

Box J **Interpretability** not carried out within any of the studies examined. Terwee et al 2012 *"the smallest difference in score in the domain of interest which patients perceive as beneficial"*
Mokkiink et al 2010; 2010b; *"Interpretability is not considered a measurement property but an important characteristic of a measurement instrument"*

3. Was the sample size included in the analysis adequate?

4. Was the distribution of the (total) scores in the study sample described?

5. Was the percentage of the respondents who had the lowest possible (total) score described?

6. Was the percentage of the respondents who had the highest possible (total) score described?

7. Were scores and change scores (i.e. means and SD) presented for relevant (sub) groups? e.g. for normative groups, subgroups of patients, or the general population

8. Was the minimal important change (MIC) or the minimal important difference (MID) determined?

Comparison of measurement properties between the BBS, TIS, GAS and LMPI, using the 'criteria framework developed in table [ii] Chapter 2, then examined using the COSMIN checklist (Terwee et al 2012)									
	LMPI		BBS		TIS		GAS		Expected range
Name of the test	Methods	Results	Methods	Results	Methods	Results	Methods	Results	
Step 4: Determining the Generalisability of the results Was the sample in which the HR-PRO instrument was evaluated adequately described? In terms of:									
1.median or mean age (with standard deviation or range)?	Yes		Yes		Yes		Yes		
2.distribution of sex?	Yes		Yes		Yes		Yes		
3.important disease characteristics (e.g. severity, status, duration) and description of treatment?	Yes		Yes		Yes		Yes		
4.setting(s) in which the study was conducted? e.g. general population, primary care or hospital/rehabilitation care	Yes		Yes		Yes		Yes		
5.countries in which the study was conducted?	Yes		Yes		Yes		Yes		

Comparison of measurement properties between the BBS, TIS, GAS and LMPI, using the 'criteria framework developed in table [ii] Chapter 2, then examined using the COSMIN checklist (Terwee et al 2012)									
	LMPI		**BBS**		**TIS**		**GAS**		**Expected range**
Name of the test	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	**Methods**	**Results**	
6.language in which the HR-PRO instrument was evaluated?	Limited during original literature search for outcome measures in English language only								
7.Was the method used to select patients adequately described? e.g. convenience, consecutive, or random	Yes		Yes		Yes		Yes		
8.Was the percentage of missing responses (response rate) acceptable?	Yes		Yes		Yes		Yes		

Abbreviations & references: 6MWT = 6 minute walk test; 2MWT = 2 minute walk test; 10mWT = 10 metre walk test (Wade 1992); ABI = Acquired Brain Injury; ADL = Activities of Daily Living; BI = Barthel Index (Wade 1992); D/C = Discharge; DGI = Dynamic Gait Index (Rehabilitation Measures database 2010); EDSS = Expanded Disability Status (Scale, Kurtzke 1983); FAC = Functional Ambulation Category (Holden et al 1984) ; FFm = Fugl-Meyer (motor) (Gladstone et al 2002); FIMm = Functional Independence Measure (motor) (Wright 2000); FM = Fugl-Meyer (Gladstone et al 2002); FR = Functional Reach (Duncan et al 1990); GCI = Clinical Global Impression (Busner & Targum 2007); H&Y= Hoehn and Yahr Staging Scale (Hoehn &Yahr 1967); HD = Huntington's disease; IADL = Instrumented Activities of Daily Living; ISCI = Incomplete Spinal Cord Injury; *k* = kappa; KELS = Kohlman Evaluation of Living Skills (Burnett et al 2009); MDC = Minimal Detectable Change; LOS = Length of Stay; MDT = Multi-Disciplinary Team; MDST = Melsbroek Disability Scoring Test (Verheyden et al 2006b); MEDLS = Milwaukee Evaluation of Daily Living Skills (Leonardelli 1988); MS = Multiple Sclerosis; Neuro = patients with a neurological diagnosis; PASS = Postural Assessment Scale for Stroke (Benaim et al 1999); OTs = Occupational Therapists; PTs = Physiotherapists; PD = Parkinsons disease; pts = patient; RDRS = Rappaport Disability Rating Scale (Rappaport et al 1982); SCI-FAI = Spinal Cord Injury Functional Ambulation Inventory (Field-Fote et al 2001); SD = Standard Deviation; SE-ADL= Modified Schwab and England Capacity for Daily Living Scale (EPDA 2014); SEM = Standard Error of Measurement ; TBI = Traumatic Brain Injury; TCT = Trunk control Test (Collin & Wade 1990); Tinetti = (Abbruzzese 1998); TUG =Timed Up and Go (Podsiadlo & Richardson 1991); UHDRS-TM = Unified Huntington's Disease Rating Scale Total Motor Score (UHDRS 2014); UPDRS = Unified Parkinson's Disease Rating Scale (Goetz et al 2003); WISC II = Walking index for spinal cord injury (Dittuno et al 2001).

Appendix 17

- Other publications:
    - o Poster: CSP UK 2010
    - o Poster: HEE conference 2013
    - o Poster: CSP UK 2013.

Measuring Movement Performance in the Acute Setting
The development of the Leeds Movement Performance Index

Denise Ross MCSP, PGdip, MSc

Physiotherapy Department, St James's University Hospital, Leeds, United Kingdom

Introduction

Aims

It is important to measure change resulting from physiotherapy interventions by identifying improved performance of movement. The measures of change that are available are, in general, function orientated (Benaim et al 1999, Carr et al 1985, Lennon & Johnson 2000) and are not specifically related to neurological physiotherapy clinical practice, e.g. analysis of movement and posture, problem identification, functional goal setting, treatment planning, or facilitation of movement and postural activity (IBITA 2006, Boyce et al 1993).

The purpose of this study was to establish what Bobath trained Physiotherapists mean by 'quality of movement and posture'; to gain an understanding of the parameters of quality that are referred to in clinical practice, and to explore the potential to develop a scale that could measure these qualitative observations.

Methodology

Participants

10 clinicians, with experience ranging from 4 to 25 years working at band 7 or above in neurological rehabilitation. Members work with a wide range of patient groups, representing the broad clinical spectrum within neurology.

Methods

Consensus group methodology; with a series of consensus group meetings and Delphi methodology.

Analysis

1) Agreement by consensus during meetings and
2) Analysis of the Delphi method

Results

Results 1 - *Consensus group meeting 1*

2 definitions of 'quality of movement and posture' were agreed.

As Physiotherapists we define a high quality movement as an efficient way to achieve a desired outcome / goal. This would be with the least effort, timely, smooth and precise; within the context of the individual, task and environment.

Good quality movement is efficient, effective and seemingly effortless. It is performed in a controlled and timely manner to achieve a precise outcome. Quality of movement must be evaluated within context of the individual; i.e., their age, the environment, and is dependant on the task.

Five key components within these definitions were identified.

Results 2 - *Delphi methodology*

Delphi methodology achieved definitions for the 5 key components of quality of movement and posture.

Alignment	The position / posture of muscles, joints and body parts from which movement / activity is most anatomically correct and therefore efficient and effective
Interaction	The ongoing adjustment between body parts within a posture OR during movement with respect to its BOS; that allows the maintenance of the posture on a background of balance correction, strength and endurance
Timing	The appropriate sequence of activation and de-activation of automatic and selective movement in order to complete a task
Speed	The ability to CHOOSE how fast or slowly a movement can occur. An optimum speed would be one which allows coordination, control, use of minimal energy and allow an effective goal to be achieved
Selective movement	Ability to achieve an isolated and specific movement on a background of stability

Results 3 - *Consensus group meeting 2*

A simple scoring system, based on what a patient's 'theoretical optimum normal should be' was agreed.

3 = Normal	Based on what the person's theoretical optimum normal should be
2 = Mild	The ability to meet more than half OR the majority of the components of the item, based on what the person's theoretical optimum normal should be
1 = Moderate	The inability to meet more than half OR the majority of the components of the item, based on what the person's theoretical optimum normal should be
0 = Severe	An inability to meet any of the components of the item, based on what the person's theoretical optimum normal should be

Conclusions

A measure was developed by a group of clinicians that supports and reflects their clinical practice (Ross 2008). The measure is called the Leeds Movement Performance Index (MPI).

This study has a number of limitations. The findings of this study may be confounded by the participants' training within the Bobath concept and their work as specialists. The Leeds MPI could be considered to be very technical, in terms of complexity and language, by non-Bobath trained therapists. It would also be impossible to use the index for comparison between groups of patients due to the variety and individualized nature of physiotherapy treatment goals and plans.

The researcher and consensus group participants intend to develop the Leeds MPI further in order to:

- Refine use of the Leeds MPI within the expert clinical practice of the consensus group
- Refine the use of the Leeds MPI and a set of clinical guidelines, within neurological physiotherapy clinical practice within Leeds Teaching Hospitals NHS Trust
- Explore reliability and validity as a measure of intervention for use by senior Bobath-trained Physiotherapists;
- Support subjective descriptions currently in use during the documentation of neurological physiotherapy clinical practice;
- Develop the MPI as a training aid for less experienced physiotherapists or students.

There is a need to support current subjective observation of our patients' ability pre- and post-treatment in order to validate physiotherapy intervention.

Quality of performance of posture and movement is important in neurological physiotherapy (IBITA 2006): The Leeds MPI allows us to understand what is meant by 'quality', and what components contribute to successful performance.

References

- Lennon, Johnson (2000) The Modified Rivermead Mobility Index: validity and reliability Disability and Rehabilitation 22(16) p833-39 Carr.
- Benaim, Perennou, Villy, Pelissier (1999) Validation of a standardised assessment of postural control in stroke patients: the postural assessment scale for stroke patients (PASS) Stroke 30 (9) 1862-8
- Boyce, Gowland, Russell, Goldsmith, Rosenbaum, Plews, Lane (1993) Consensus methodology in the development of a gross motor performance measure Physiotherapy Canada Spring 1993, vol. 45, no. 2, 94-100
- IBITA. (2006) Theoretical assumptions and clinical practice 2006, The Bobath Concept www.ibita.org
- Ross (2008) Measuring Movement Performance in the Acute Setting: The development of the LEEDS Movement Performance Index. Synapse (Journal of ACPIN) Spring.
- Shepherd. Nordholm. Lynne. (1985). Investigation of a Motor Assessment Scale for Stroke Patients. Physical Therapy. Vol 65. No. 2. February. P 175 - 180.

The Leeds Teaching Hospitals **NHS**
NHS Trust

The Leeds Movement Performance Index (LMPI): an exploration of the clinical validity of a new tool for specialist neurological physiotherapy

Authors:

- Ms Denise H. Ross MCSP, MSc, PhD student: Clinical Specialist Physiotherapist, Leeds Teaching Hospitals NHS Trust, Physiotherapy Department, Chapel Allerton Hospital, Chapeltown Road, Leeds, West Yorkshire, UK. LS7 4SA D.H.Ross@Leeds.ac.uk
- Dr Serena McCluskey, Senior Research Fellow, Centre for Health and Social Care Research, University of Huddersfield, Huddersfield, West Yorkshire, HD1 3DH, UK

Aims: To investigate the content validity of the LMPI with an evaluation of scale content acceptability, item appropriateness and clinical usefulness and meaning.

Methods: Participants were trained in the use of the LMPI and were then asked to use it within their clinical practice. In order to understand, explore and interpret the clinician's experiences:

1) Semi-structured questionnaires were completed retrospectively and reflexively by a group of senior specialist physiotherapists.
2) Focus groups were attended by a group expert practitioners.

Interpretive phenomenological analysis was used for the analysis of transcriptions.

Expert group

- "if you were working with junior staff it could be really useful because you could actually be very specific"
- "reflects the complexity of movement"
- "related to function"
- "this does break movement down into components"
- "I think it could be used for any condition"
- "how did you score his theoretical optimal performance?..........against what I thought he might be able to achieve"

Clinician group

- "I wasn't always sure what to measure and often tended to use functional activities rather than specific muscle activity"
- "reflected not only the treatment goal but considered how the goal was achieved"
- "It makes you look more specifically"
- "I was able to use the LMPI on all types of neuro pathologies and all levels of impairments"
- "aids analysis and observation"
- "I found the LMPI quick and easy to use"

Conclusions: These findings suggest that the LMPI has strong content validity and is a measurement tool that seems to support the physiotherapist participant's assessment, analysis, clinical reasoning, goal setting and treatment planning, appearing to underpin and reflect their theoretical approach to neurological physiotherapy intervention. Indicators for future research are focused around: a) the training and experience required to feel confident to use the LMPI, b) wording of the score criteria, and c) the assessment of it's measurement properties

The LEEDS Movement Performance Index

Score	Definition of score
3 = Normal	
2 = Mild	
1 = Moderate	
0 = Severe	

Implications for clinical practice: The LMPI has been found to be a valid measure of movement performance for senior neurological physiotherapists to use.

It has potential to be used as a tool to support and educate physiotherapists within neurological clinical practice.

The Leeds Teaching Hospitals **NHS** Trust

University of **HUDDERSFIELD**

Bibliography

Abbruzzese, LD. (1998).The Tinetti Performance-Oriented Mobility Assessment Tool. *American Journal of Nursing, 98*(12), 16J-16L.

Abrams, D., Davidson, M., Harrick, J., Harcourt, P., Zylinski, M. &Clancy, J. (2006).Monitoring the change: current trends in outcome measure usage in physiotherapy. *Manual Therapy*, *11*(1), 46-53.

Alricsson, M., Harms-Ringdahl, K., Eriksson, K., & Werner, S. (2003) The effect of dance training on joint mobility, muscle flexibility, speed and agility in young cross-country skiers--a prospective controlled intervention study. *Scandinavian Journal of Medicine and Science in Sports,13*(4), 237-43.

Amusat, N. (2009). Assessment of sitting balance of patients with stroke undergoing inpatient rehabilitation. *Physiotherapy Theory and Practice, 25*(2),138-44.

Andresen, EM. (2000) Criteria for Assessing the Tools of Disability Outcomes Research. *Archives of Physical Medicine and Rehabilitation, 81*(2), S15-S20.

Armitage, P., Berry, G. & Matthews, J. (2008).*Statistical Methods in Medical Research*. DOI: 10.1002/9780470773666.fmatter

Ashford, S. & Turner-Stokes, L. (2006).Goal attainment for spasticity management using botulinum toxin. *Physiotherapy Research International, 1*1(1), 24-34.

Atwal, A., Wiggett, C. & McIntyre, A. (2011). Risks with older adults in acute care settings: occupational therapists' and physiotherapists' perceptions. *British Journal of Occupational Therapy, 74*(9).412-18.

Barak, S. & Duncan, PW.(2006), Issues in selecting outcome measures to assess functional recovery after stroke. *The Journal of the American Society for Experimental NeuroTherapeutics, 3*(4), 505-24.

Benaim, C., Pérennou, DA., Villy, J., Rousseaux, M. & Pelissier, JY. (1999). Validation of a Standardized Assessment of Postural Control in Stroke Patients: The Postural Assessment Scale for Stroke Patients (PASS). *Stroke, 30,* 1862-68.

Bennie, S., Bruner, K., Dizon, A., Fritz, H., Goodman, B. & Peterson, S. (2003). Measurements of balance; Comparison of the Timed 'Up and Go' Test and Functional Reach Test with the Berg Balance Scale. *Journal of Physical Therapy Science, 15*(2), 93-7.

Berard, C., Payan, C., Hodgkinson I. & Fermanian, J. (2005).A motor function measure scale for neuromuscular diseases. Construction and validation study. *Neuromuscular Disorders,15*(7), 463-470.

Berg, K., Wood-Dauphinee, S. Williams, JI. & Gayton, D. (1989).Measuring balance in the elderly: Preliminary development of an instrument. *Physiotherapy Canada, 41*(6)*,* 304-11.

Berg, KO., Maki, BE., Williams, JI., Holliday, PJ. & Wood-Dauphinee, SL. (1992). Clinical and Laboratory Measures of Postural Balance in an Elderly Population. *Archives of Physical Medicine and Rehabilitation, 73*(11), 1073-80.

Berg, K., Wood-Dauphinee, S. & Williams, JI. (1995). The Balance Scale: reliability assessment with elderly residents and patients with an acute stroke. *Scandinavian Journal of Rehabilitation Medicine, 27*(1), 27-36.

Bernstein, N. (1967). *The Co-ordination and Regulation of Movements*. Oxford: Pergamon Press.

Bland, JM. & Altman, DG. (1986). Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet, 2*(8), 307-10.

Bland, JM. & Altman, DG. (2002), Validating scales and indexes. *British Journal of Anaesthesia, 324*, 606-7.

Bland, JM. & Altman, DG. (2010), Statistical methods for assessing agreement between two methods of clinical measurement. *International Journal of Nursing Studies, 47*(8), 931-36.

Blum, L. & Korner-Bitenski, N. (2008). Usefulness of the Berg Balance Scale in stroke rehabilitation: a systematic review. *Physical Therapy, 88*(5), 559-66.

Bobath, K. & Bobath, B. (1989) What is Normal Movement? *Physiotherapy, 75*(6), 325.

Bogle TLD. & Newton, RA. (1996). Use of the Berg Balance Test to predict falls in elderly persons. *Physical Therapy, 76*(6), 576-85.

Bohannon, RW., & Smith, MBO. (1987). Inter-rater reliability of a Modified Ashworth Scale of muscle spasticity. *Physical Therapy, 67*(2), 206–207.

Bond, TG. & Fox, CM (2001).*Applying the Rasch Method: Fundamental Measurement in the Human Sciences.* London: Lawrence Erlbaum Associates.

Bouwens, SFM., van Heugten, CM. & Verhey, FRJ. (2009). The practical use of goal attainment scaling for people with acquired brain injury who receive cognitive rehabilitation. *Clinical Rehabilitation, 23*(4),310-20.

Bohannon, RW. & Smith, MB. (1987). Interrater reliability of a modified Ashworth scale of muscle spasticity. *Physical therapy, 67*(2), 206-7.

Bovend'Eerdt, TJ., Dawes, H., Izadi, H. & Wade, DT. (2011). Agreement between two different scoring procedures for goal attainment scaling is low. *Journal of Rehabilitation Medicine, 43*(1), 46-49.

Boyatzis, RE.(1998). *Transforming Qualitative Information Thematic Analysis and Code Development*. London: Sage Publications.

Bracewell, M. (2010).A Brief Historical Review of Motor Control Theory. *Advances in Clinical Neuroscience and Rehabilitation,10(*3), 22-24.

British Bobath Tutors Association (BBTA). (2014). *British Bobath Tutors Association* Retrieved from http://www.bbta.org.uk/bobath-concept

British Society of Rehabilitation Medicine (BSRM).(2005). *Measurement of outcome in Rehabilitation. The British Society of Rehabilitation Medicine. "Basket" of Measures* retrieved from http://www.bsrm.co.uk/publications/BasketOfScoresWithSCIA%20_2_update2005newref9.pdf

Busner, J. & Targum, SD. (2007). The Clinical Global Impressions Scale, applying a research tool in clinical practice. *Psychiatry 4*(7), 28-37.

Burnett, J., Dyer, CB. & Naik, AD. (2009) Convergent validation of the Kohlman Evaluation of Living Skills as a screening tool of older adults' ability to live safely and independently in the community. *Archives of Physical Medicine and Rehabilitation, 90*(11) 1948-52

Carr, JH., Shepherd, RB., Nordholm, L. & Lynne, D. (1985). Investigation of a new motor assessment scale for stroke patients. *Physical Therapy, 65*(2),175-80.

Carr, JH. & Shepherd RB. (2003). *Stroke Rehabilitation, Guidelines for Exercise and Training to Optimize Motor skill.* China: Butterworth-Heinemann.

Cassell, C. & Symon, G. (2004).*Essential Guide to Qualitative Methods in Organizational Research*. London: Sage publications ltd.

Cattaneo, D., Regola, A. & Meotti, M. (2006). Validity of six balance disorders scales in persons with multiple sclerosis. *Disability & Rehabilitation, 28*(12),789-95.

Chartered Society of Physiotherapy (CSP). (2005). *Core Standards of Physiotherapy Practice*. CSP. London.

Chartered Society of Physiotherapy (CSP) (2010) Physiotherapy Research Priority Project 2010 Prioritised research topics – Neurology. Retrieved from http://www.csp.org.uk/documents/physiotherapy-research-priority-project-2010-prioritised-research-topic-neurology

Chartered Society of Physiotherapy (CSP). (2014). *The Chartered Society of Physiotherapy* Retrieved from http://www.CSP.org.uk

Chelette, KC., Carrico, C., Nichols, L. & Sawaki, L. (2013). Long-term cortical reorganization following stroke in a single subject with severe motor impairment. *Neurorehabilitation, 33*(3), 385-9.

Chesson, R., Macleod, M. & Massie, S. (1996). Outcome Measures Used in Therapy Departments in Scotland. *Physiotherapy, 82*(12), 673-79.

Cirstea, CM. & Levin, MF.(2000). Compensatory strategies for reaching in stroke. *Brain, 123*(5), 940–53.

Collen, FM., Wade, DT., Robb, GF. & Bradshaw, CM. (1991). The Rivermead Mobility Index: a further development of the Rivermead Motor Assessment. *International Disability Studies, 13*(2), 50-4.

Collin, C. & Wade, D. (1990).Assessing motor impairment after stroke: a pilot reliability study. *Journal of Neurology, Neurosurgery and Psychiatry, 53*(7), 576-579.

Conradsson, M., Lundin-Olsson ,L., Lindelöf, HL., Malmqvist, L., Gustafson, Y. & Rosendahl, E. (2007). Berg Balance Scale: Intrarater Test-Retest Reliability Among Older People Dependent in Activities of Daily Living and Living in Residential Care Facilities. *Physical Therapy, 87*(9), 115-63.

Cote, R., Hachinski, VC., Shurvell, BL., Norris, JW. & Wolfson, C. (1986). The Canadian Neurological Scale: a preliminary study in acute stroke. *Stroke, 17*(4), 731.

Creswell, JW. & Piano-Clark, V. (2011). Designing and Conducting Mixed Methods Research. *Australian and New Zealand Journal of Public Health, 31*(4), 388.

Crotty, M. (1998).*The Foundation of Social research: Meaning and Perspective in the Research Process*. London: Sage.

Daley, K., Mayo, N. & Wood-Dauphinée, S. (1999). Reliability of scores on the Stroke Rehabilitation Assessment of Movement (STREAM) measure. *Physical Therapy,79*(1),8-19.

Datta, S., Lorenz, DJ., Morrison, S., Ardolino, E. & Harkema, SJ. (2009). A multivariate examination of temporal changes in Berg Balance Scale items for patients with ASIA Impairment Scale C and D spinal cord injuries. *Archives of Physical Medicine and Rehabilitation, 90*(7), 1208-17.

Datta, S., Lorenz, DJ. & Harkema, SJ. (2012). Dynamic Longitudinal Evaluation of the Utility of the Berg Balance Scale in Individuals With Motor Incomplete Spinal Cord Injury. *Archives of Physical Medicine and Rehabilitation, 93*(9), 1565-73.

Department of Health (DOH). (2001) *National Service Framework for Older People* Retrieved from
http://webarchive.nationalarchives.gov.uk/20130107105354/http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/@dh/@en/documents/digitalasset/dh_4071283.pdf

Department of Health (DOH). (2005). *The National Service Framework For Long-Term Neurological Conditions* retrieved from
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/198114/National_Service_Framework_for_Long_Term_Conditions.pdf

Dittuno, PL. & Dittuno Jr, JF. (2001). Walking index for spinal cord injury (WISCI II): scale revision*. Spinal Cord, 39,* 654–56.

Doig, E., Fleming, J., Kuipers, P. & Cornwell, PL. (2010).Clinical utility of the combined use of the Canadian Occupational Performance Measure and Goal Attainment Scaling. *American Journal of Occupational Therapy*, 64, 904 - 914.

Donaghy, S. & Wass, PJ.(1988). Interrater reliability of the Functional Assessment Measure in a brain injury rehabilitation program. *Archives Physical and Medical Rehabilitation,79*(10),1231-6.

Donoghue, D., Stokes, EK. & Physiotherapy Research and Older People (PROP) group. (2009). How much change is true change? The minimum detectable change of the Berg Balance Scale in elderly people. *Journal of Rehabilitation Medicine, 41*(5), 343-6.

Duncan, E. (2011). Routine outcome measurement in practice: overcoming challenges, seeking solutions, demonstrating impact. *Australian Occupational Therapy Journal, 58*(4), 221.

Duncan, E. & Murray, J. (2012). The barriers and facilitators to routine outcome measurement by allied health professionals in practice: a systematic review. *BMC Health Service Research, 12*, 96

Duncan, PW., Wallace, D., Lai, SM., Johnson, D., Embretson, S. & Laster, LJ. (1999). The stroke impact scale version 2.0. Evaluation of reliability, validity, and sensitivity to change. *Stroke, 30*(10), 2131-40.

Duncan, PW., Weiner, DK., Chandler, J. & Studenski, S. (1990). Functional reach: a new clinical measure of balance. *The Journals of Gerontology, 45*(6), M192-7.

Ebaugh, DD. & Spinelli, BA.(2010). Scapulothoracic motion and muscle activity during the raising and lowering phases of an overhead reaching task. *Journal of electromyography and kinesiology, 20*(2), 199-205.

Ertzgaard, P., Ward, AB., Wissel, J. & Borg, J. (2011).Practical considerations for goal attainment scaling during rehabilitation following acquired brain injury. *Journal or Rehabilitation Medicine, 43*(1), 8-14.

European Parkinson's Disease Association (EPDA). (n.d.). European Parkinson's Disease Association. Retrieved from http://www.epda.eu.com/en/parkinsons/in-depth/parkinsonsdisease/rating-scales/schwab-and-england-adl/

Evans, M., Moutinho, L. & Van Raaj, F. (1996).*Applied Consumer Behaviour.* FT Prentice Hall: New Jersey USA.

Farlow, MR., Ferguson, ST., Kerr, LL., Wills, CA., McCulloch, ML. & Gross, MT. (1997). Interrater and test-retest reliability of the Berg Balance Scale for patients with brain injury. *Neurology Report, 21*(2), 50.

Feld, J., Rabadi, MH., Blau, AD. & Jordan, BD. (2001).Berg Balance Scale and Outcome Measures in Acquired Brain Injury. *Neurorehabilitation and Neural Repair, 15*, 239-44.

Field-Fote, EC., Fluet, GG., Schafer, SD., Schneider, EM., Smith, R., Downey, PA. & Ruhl, CD. (2001). The Spinal Cord Injury Functional Ambulation Inventory (SCI-FAI). *Journal of Rehabilitation Medicine, 33,* 177–81.

de Figueiredo, KMO., de Lima, KC., Cavalcanti, MAC. & Guerra, RO. (2009). Interobserver reproducibility of the Berg Balance Scale by novice and experienced physiotherapists. *Physiotherapy Theory and Practice, 25*(1), 30-6.

Fitzpatrick, R., Davey, C., Buxton, MJ. & Jones, DR. (1998).Evaluating patient-based outcome measures for use in clinical trials Standing Group on Health Technology. *Health Technology Assessment, 2*(14).

Fjeldstad, C., Pardo, G., Frederiksen, C., Bemben, D. & Bemben, M. (2009).Assessment of Postural Balance in Multiple Sclerosis. *International Journal of MS Care, 11*(1), 1-5.

Flansbjer, U., Blom, J. & Brogårdh, G. (2012), The Reproducibility of Berg Balance Scale and the Single-Leg Stance in Chronic Stroke and the Relationship Between the Two Tests. *American Academy of Physical Medicine and Rehabilitation, 4*(3) 1656-70.

FocusGroupTips.com. (n.d.).*What is Bias in Qualitative Research?* Retrieved from http://www.focusgrouptips.com/qualitative-research.html

Foerster, O. (1936). The motor cortex in man in the light of Hughlings Jackson's doctrines. *Brain, 59*(2), 135-59.

Fotoohabadi, MR., Tully, EA. & Galea, MP. (2010). Kinematics of Rising From a Chair: Image-Based Analysis of the Sagittal Elderly People Who Are Healthy. *Physical Therapy, 90*(4), 561-71.

Franchignoni, F., Martignoni, E. & Chaiyawatet, P. (2005).Balance and fear of falling in Parkinson's disease. *Parkinsonism Related Disorders, 11*(7), 427-33.

Frazzitta, G., Maestri, R., Ghilardi, MF., Riboldazzi, G., Perini, M., Bertotti, G., Boveri, N., Buttini, S., Lombino, FL., Uccellini, D., Turla, M., Pezzoli, G. & Comi, C. (2014) Intensive rehabilitation increases BDNF serum levels in parkinsonian patients: a randomized study. *Neurorehabilitation and Neural Repair,28*(2),163-8.

Fujiwara, T., Liu, M., Tsuji, T., Sonoda, S., Mizuno, K., Akaboshi, K., Hase, K., Masakado, Y. & Chino, N. (2004). Development of a new measure to assess trunk impairment after stroke (trunk impairment scale): its psychometric properties. *American Journal of Physical Medicine and Rehabilitation, 83*(9), 681-688.

GAS (n.d.) Goal Attainment Scaling in Rehabilitation; Kings College London. GAS Calculation Sheet. Retrieved from http://www.kcl.ac.uk/lsm/research/divisions/cicelysaunders/resources/tools/gas.aspx

Gladstone, DJ., Danells, CJ. & Black, SE. (2002). The Fugl-Meyer Assessment of Motor Recovery after Stroke: A critical review of its measurement properties. *Neurorehabilitation and Neural Repair, 16*, 232-240.

Godi, M., Franchignoni, F., Caligari, M., Giordano, A., Turcato, AM. & Nardone, A. (2013). Comparison of reliability, validity, and responsiveness of the mini-BESTest and Berg Balance Scale in patients with balance disorders. *Physical Therapy, 93*(2), 158-67.

Goetz, C., Poewe, W., Rascol, O., Sampaio, C. & MDS Task Force on the development of Rating Scales for Parkinson's Disease. (2003). The Unified Parkinson's Disease Rating Scale (UPDRS): Status and Recommendations. *Movement Disorders, 18*(7), 738-50.

Gordon, JE., Powell, C. & Rockwood, K. (1999). Goal attainment scaling as a measure of clinically important change in nursing-home patients. A*ge & Ageing, 28*(3),275-81.

Gorecki, C., Brown, J., Cano, S., Lamping, D., Briggs, M., Coleman, S., Dealey, C., McGinnis, E., Nelson, AE., Stubbs, N., Wilson, L. & Nixon, J. (2013). Development and validation of a new patient-reported outcome measure for patients with pressure ulcers: the PU-QOL instrument. *Health & Quality of Life Outcomes, 11*(1), 95.

Gorman, SL., Radtka, S., Melnick, ME., Abrams, GM. & Byl, NN. (2010). Development and validation of the function in sitting test in adults with acute stroke. *Journal of Neurologic Physical Therapy, 34*(3), 150-60.

Gowland, C., Stratford, P., Ward, M., Moreland, J., Torresin, W., Van Hullenaar, S., Sanford, J., Barreca, S., Vanspall, B. & Plews, N. (1993). Measuring physical impairment and disability with the Chedoke-McMaster Stroke Assessment. *Stroke, 24*(1), 58.

Greenhalgh, J., Long, AF., Brettle, AJ. & Grant, MJ. (1998). Reviewing and selecting outcome measures for use in routine practice. *Journal of Evaluation in Clinical Practice, 4*(4), 339-50.

Guest G. (2006). How Many Interviews Are Enough?: An Experiment with Data Saturation and Variability. *Field Methods*, 18(1), 59-82.

Hackney, ME.& Earhart, GM. (2009). Short duration, intensive tango dancing for Parkinson disease: an uncontrolled pilot study. *Complementary Therapies in Medicine. 17*(4),203-7.

Haley, SM., Coster, WJ., Andres, PL., Ludlow, LH., Ni, P., Bond, TL., Sinclair, SJ. &Jette, AM. (2004). Activity outcome measurement for post-acute care. *Medical Care, 42*(1 Suppl), I49-61.

Haugh, AB., Pandyan, AD. & Johnson, GR. (2006). A systematic review of the Tardieu Scale for the measurement of spasticity. *Disability and Rehabilitation, 28*(15), 899-907.

Health and Social Care Information Centre (hscic). (2014). *Compendium of Neurology Data, England – 2012/13* Retrieved from http://www.hscic.gov.uk/catalogue/PUB13776

Hiengkaew, V., Jitaree, K. & Chaiyawat, P. (2012). Minimal detectable changes of the Berg Balance Scale, Fugl-Meyer Assessment Scale, Timed "Up & Go" Test, gait speeds, and 2-minute walk test in individuals with chronic stroke with different degrees of ankle plantarflexor tone. *Archives Physical Medicine and Rehabilitation, 93*(7). 1201-08.

Higgs, J. & Titchen, A. (1995).The Nature, Generation and Verification of Knowledge. *Physiotherapy, 81*(9), 521-30.

Hoehn, M. & Yahr, M. (1967). Parkinsonism: onset, progression and mortality. *Neurology, 17*(5), 427–42.

Holden, MK., Gill K.M., Magliozzi, MR., Nathan, J. & Piehl-Baker, L. (1984). Clinical gait assessment in the neurologically impaired. Reliability and meaningfulness. *Physical Therapy, 64*(1), 35-40.

Horak, FB., Wrisley, DM. & Frank, J. (2009). The Balance Evaluation Systems Test (BESTest) to differentiate balance deficits. *Physical Therapy, 89*(5), 484-98.

Horner, D. & Larmer, PJ.(2006). Health outcome measures. *New Zealand Journal of Physiotherapy, 34* (1), 17-24.

Howe, J., Inness, E., Venturini, A., Williams, JI. & Verrier, MC. (2006). The Community Balance and Mobility Scale: A balance measure for individuals with traumatic brain injury. *Clinical Rehabilitation, 20*, 885-95.

Howitt, D. & Cramer, D. (2008).*Introduction to Research Methods in Psychology* (2nd Ed), Harlow, England: Prentice Hall.

International Conference on Harmonisation – Good Clinical Practice Guidelines (ICH-GCP) (2000).*ICH Quality Guidelines.* Retrieved from: http://www.ich.org/products/guidelines/quality/article/quality-guidelines.html

Jandt, SR., Caballero, RMDS., Junior, LAF. &Dias, AS. (2011) Correlation between trunk control, respiratory muscle strength and spirometry in patients with stroke: an observational study. *Physiotherapy Research International, 16*(4), 218-24.

Janssen, AJWM., Diekema, ETW., van Dolder, R., Kollée, LAA., Oostendorp, RAB. &Nijhuis-van der Sanden, MWG.(2012). Development of a movement quality measurement tool for children. *Physical Therapy, 92*(4), 574-94.

Jette, DU., Halbert, J., Iverson, C., Miceli, E. & Shah, P. (2009). Use of standardized outcome measures in physical therapist practice: perceptions and applications*. Physical Therapy, 89*(2), 125-35.

Johnson, C., Aaronson, N., Blazeby, JM., Bottomley, A., Fayers, P., Koller, M., Kuliś, D., Ramage, J., Sprangers, M., Velikova, G. & Young, T. (2011). *EORTC QUALITY OF LIFE GROUP Guidelines for Developing Questionnaire Modules Quality of Life Group* retrieved from http://groups.eortc.be/qol/sites/default/files/archives/guidelines_for_developing_questionnaire-_final.pdf

Johnson, RB. & Onwuegbuzie, AJ. (2004). Mixed Methods Research: A Research Paradigm Whose Time Has Come*. Educational Researcher, 33*(7), 14-26.

Jones, J. & Hunter, D. (1995).Consensus methods for medical and health services research. *British Medical Journal, 311*(8), 376-80.

Jones, MC., Walley, RM., Leech, A., Paterson, M., Common, S. & Metcalf, C. (2006). Using goal attainment scaling to evaluate a needs-led exercise programme for people with severe and profound intellectual disabilities. *Journal of Intellectual Disabilities, 10*(4), 317-35.

Joyce, BM., Rockwood, KJ. & Mate-Kole, CC. (1994).Use of goal attainment scaling in brain injury in a rehabilitation hospital. *American Journal of Physical Medicine & Rehabilitation, 73*(1), 10-4.

Kandel, ER., Schwartz, JH., & Jessel, TM. (2000) *Principles of Neural Science,* USA: McGraw-Hill Companies.

Kazis, LE., Anderson, JJ. & Meenan, RF. (1989) Effect sizes for interpreting changes in health status. *Medical Care, 27*(3), S178-S189.

Keith, RA., Granger, CV., Hamilton, BB. & Sherwin, FS. (1987). The functional independence measure: a new tool for rehabilitation. *Advances in Clinical Rehabilitation, 1*, 6-18.

Kelso, S. (1977).Motor Control Mechanisms Underlying Human Performance. *Journal of Experimental Psychology, 3*(4), 529-43.

Khan, F., Pallant, JF.& Turner-Stokes, L. (2008). Use of Goal Attainment Scaling in Inpatient Rehabilitation for Persons With Multiple Sclerosis. *Archives of Physical Medicine and Rehabilitation, 89* (4), 652-59.

Kazis, EK., Anderson, JJ. & Meenan, RFM,.(1989). Effect Sizes for Interpreting Changes in Health Status. *Medical Care, 27*(3), s178-189.

King, N. (2014). *Welcome to the Template Analysis website*. Retrieved from http://www.hud.ac.uk/hhs/research/template-analysis/

King, N. & Brooks, J. (2012). Qualitative psychology in the real world: The utility of template analysis. *British Psychological Society Annual Conference,* 1-17.

Kiresuk, TJ. & Sherman, RE. (1968) Goal Attainment Scaling: A General Method for Evaluating Comprehensive Community Mental Health Programs. *Community Mental Health Journal, 4*(6), 443–53.

Kitzinger, J. (1994).The methodology of Focus Groups: the importance of interaction between research participants. *Sociology of Health and Illness, 16*(1), 103-21.

Kitzinger, J. (1995). Qualitative research. Introducing focus groups. *British Medical Journal, 311*(7999), 299-302.

Kornetti, DL., Fritz, SL., Chiu, Y., Light, KE. & Velozo, CA. (2004).Rating Scale Analysis of the Berg Balance Scale. *Archives of Physical Medicine and Rehabilitation, 85*(7), 1128-35.

Krueger, R. A., and M. A. Casey 2000. Focus groups: A Practical Guide for Applied Research (3rd edition.) Thousand Oaks, California: Sage.

Kurtzke, JF. (1983). Rating neurologic impairment in multiple sclerosis: an expanded disability status scale (EDSS). *Neurology, 33*(11), 1444-52.

Landis, JR. & Koch, GG. (1977). The measurement of observer agreement for categorical data, *Biometrics, 33*,159-174.

Lawton, MP. & Broday, EM. (1969) Assessment of Older People: self-maintaining and instrumental activities of daily living. *Journal of Gerontology, 37,* 179-86.

Leddy, AL., Crowner, BE. & Earhart, GM. (2011). Functional gait assessment and balance evaluation system test: reliability, validity, sensitivity, and specificity for identifying individuals with Parkinson disease who fall. *Physical Therapy, 91*(1), 102-13.

Lemay, JF. & Nadeau, S. (2010). Standing balance assessment in ASIA D paraplegic and tetraplegic participants: concurrent validity of the Berg Balance Scale. *Spinal Cord, 48*(3), 245-50.

Leonardelli, CA. (1988). *The Milwauki Evaluation of Daily Living Skills: Evaluation in Long term Psychiatric Care*. New York: McGraw-Hill

Levin, MF., Michaelsen, SM., Cirstea, CM. & Roby-Brami, A. (2002). Use of the trunk for reaching targets placed within and beyond the reach in adult hemiparesis. *Experimental Brain Research, 143*(2), 171–80.

Levin, MF., Desrosiers, J., Beauchemin, D., Bergeron, N. & Rochette, A. (2004). Development and Validation of Compensations Used for Reaching in Patients With Hemiparesis. *Physical Therapy, 84*(1), 8-22.

Levin, MF., Kleim, J. & Wolf, SL. (2009). What do motor "recovery" and "compensation" mean in patients following stroke? *Neurorehabilitation and Neural Repair, 23*(4), 313-9.

Liston, R. & Brouwer, B. (1996). Reliability and validity of measures obtained from stroke patients using the balance master. *Archives of physical medicine and rehabilitation, 77*(5).425-30.

Maeda, N., Kato, J. & Shimada, T. (2009).Predicting the probability for fall incidence in stroke patients using the Berg Balance Scale. *The Journal of International Medical Research, 37*(3), 697-704.

Mackenzie, IS., Morant, SV., Bloomfield, G., MacDonald, TM. & O'Riordan, J. (2013). Incidence and prevalence of multiple sclerosis in the UK 1990-2010: a descriptive study in the General Practice Research Database. *Journal of Neurology, Neurosurgery, and Psychiatry 85*(1), 76-84.

Mao, H. & Hsueh, I. (2002).Analysis and comparison of the psychometric properties of three balance measures for stroke patients. *Stroke, 33*(4), 1022.

Marchetti, GF. & Whitney, SL. (2006).Construction and validation of the 4-item dynamic gait index. *Physical Therapy, 86*(12),1651-60.

McCluskey, S., Brooks, J., King, N. & Burton, K. (2011). The influence of 'significant others' on persistent back pain and work participation: a qualitative exploration of illness perceptions. *BMC Musculoskeletal Disorders, 12*(1), 236

McDonnell, MK., Sahrmann, SA. & Van Dillen, L. (2005). A Specific Exercise Program and Modification of Postural Alignment for Treatment of Cervicogenic Headache: A Case Report. *Journal of Orthopaedic and Sports Physical Therapy, 35*(3), 1-5.

Messick, S. (1995). Standards of Validity and the Validity of Standards in Performance Assessment *Educational Measurement: Issues and Practice, 1* 5-8.

Michaelsen, SM., Luta, A., Roby-Brami, A. & Levin, MF.(2001). Effect of trunk restraint on the recovery of reaching movements in hemiparetic patients. *Stroke, 32*(8),1875–83.

Mittrach, R., Grill, E., Walchner-Bonjean, M., Scheuringer, M., Boldt, C., Huber, EO. & Stucki, G. (2008). Goals of physiotherapy interventions can be described using the International Classification of Functioning, Disability and Health. *Physiotherapy, 94*(2), 150-57

Mokkink, LB., Terwee, CB., Knol, DL., Stratford, PW., Alonso, J., Patrick, DL., Bouter, LM. & de Vet, HCW. (2006). Protocol of the COSMIN study: COnsensus-based Standards for the selection of health Measurement Instruments. *BMC Medical Research Methodology, 6*(2), doi:10.1186/1471-2288-6-2.

Mokkink, LB., Terwee, CB., Patrick, DL., Alonso, J. Stratford, PW., Knol, DL., Bouter, LM. & de Vet, HCW. (2010). The COSMIN checklist for assessing the methodological quality of studies on measurement properties of health status measurement instruments: an international Delphi study. *Quality of Life Research, 19,* 539-49.

Di Monaco, M., Trucco, M., Di Monaco, R., Tappero, R. & Cavanna, A. (2010). The relationship between initial trunk control or postural balance and inpatient rehabilitation outcome after stroke: a prospective comparative study. *Clinical Rehabilitation, 24*(6), 543-54.

Moseley, AM. & Yap, MC. (2003).Interrater reliability of the TEMPA for the measurement for the measurement of upper limb function in adults with traumatic brain injury. *Journal of Head Trauma Rehabilitation, 18,* 526-31

Murray, C., Stanley, M. & Wright, S. (2014). The transition from clinician to academic in nursing and allied health: A qualitative meta-synthesis. *Nurse Education Today, 34,*389-95.

National Quality Measures Clearinghouse (NQMC) (ND) *National Quality Measures Clearinghouse* retrieved from http://www.qualitymeasures.ahrq.gov/

Neurological Alliance (2003) *Neuro numbers: a brief review of the numbers of people in the UK with a neurological condition,* retrieved from
http://www.neural.org.uk/store/assets/files/20/original/NeuroNumbers.pdf

Newstead, AH., Hinman, MR. & Tomberlin, JA. (2005). Reliability of the Berg Balance Scale and balance master limits of stability tests for individuals with brain injury. *Journal of Neurologic Physical Therapy, 29*(1), 18-23.

Nieuwboer, A., Feys, H., De Weerdt, W., Nuyens, G. & De Corte, Els, (1996) Developing a Clinical Tool to Measure Sitting Balance after Stroke : A reliability study. *Physiotherapy, 81*8, 429-45

Nilsagard, Y., Lundholm, C., Denison, E. & Gunnarsson, LG. (2009).Predicting accidental falls in people with multiple sclerosis--a longitudinal study. *Clinical Rehabilitation, 23*(3), 259-69.

Nunnally, JC. & Bernstein, IH. (1994). *Psychometric Theory* (3rd edition). New York: McGraw-Hill.

O'Cathain, A. (2010). Three techniques for integrating data in mixed methods studies. *BMJ, 341*, c4587.

Paci, M. (2003). Physiotherapy based on the Bobath concept for adults with post-stroke hemiplegia : a review of effectiveness studies. *Journal of Rehabilitation Medicine, 35*(1), 2–7.

Van Peppen, RPS., Maissan, FJ., Van Genderen, FR., Van Dolder, R. & Van Meeteren, NL. (2008). Outcome measures in physiotherapy management of patients with stroke : a survey into self-reported use , and barriers to and facilitators for use. *Physiotherapy Research International, 13*(10), 255-70.

Petrie, A. & Sabin, C. (2013).*Medical Statistics at a Glance*. Retrieved from: http://rc4ht3qs8p.search.serialssolutions.com.libaccess.hud.ac.uk/?ctx_ver=Z39.88-2004&ctx_enc=info%3Aofi%2Fenc%3AUTF-8&rfr_id=info:sid/summon.serialssolutions.com&rft_val_fmt=info:ofi/fmt:kev:mtx:book&rft.genre=book&rft.title=Medical+Statistics+at+a+Glance&rft.au=Petrie%2C+Aviva&rft.au=Sabin%2C+Caroline&rft.series=At+a+Glance&rft.date=2013-11-08&rft.pub=Wiley-Blackwell&rft.isbn=9781405180511&rft.externalDBID=n%2Fa&rft.externalDocID=1561073&paramdict=en-US

Podsiadlo, D. & Richardson, S. (1991). The timed "Up & Go": a test of basic functional mobility for frail elderly persons. *Journal of the American Geriatric Society, 39(*2), 142-148.

Pomeroy, VM., Pramanik, A., Sykes, L., Richards, J. & Hill, E. (2003). Agreement between physiotherapists on quality of movement rated via videotape. *Clinical Rehabilitation, 17*(3), 264-72.

Ponsford, J., Olver, J., Nelms, R., Curran, C. & Ponsford, M. (1999).Outcome measurement in an inpatient and outpatient traumatic brain injury rehabilitation programme.*Neuropsychological Rehabilitation, .9*(3-4), 517-34.

La Porta, F., Caselli, S., Susassi, S., Cavallini, P., Tennant, A. & Franceschini, M. (2012). Is the Berg Balance Scale an internally valid and reliable measure of balance across different aetiologies in neurorehabilitation? A revisited Rasch analysis study. *Archives of Physical Medicine and Rehabilitation Medicine, 93*(7), 1209-16.

Powell LE, & Myers, AM. (1995). The Activities-specific Balance Confidence (ABC) Scale. *Journals of Gerontology. Series A, Biological Sciences and Medical Sciences, 50A*(1), M28-34.

Protopapadaki, A., Drechsler, WI., Cramp, MC., Coutts, FJ. & Scott, OM. (2007). Hip, knee, ankle kinematics and kinetics during stair ascent and descent in healthy young individuals. *Journal of Electromyography and Kinesiology, 22*(2), 203-10.

Quinn, L., Khalil, H., Dawes, H., Fritz, NE., Kegelmeyer, D., Kloos, AD., Gillard, JW., Busse, M. & Outcome Measures Subgroup of the European Huntington's Disease Network. (2013). Reliability and minimal detectable change of physical performance measures in individuals with pre-manifest and manifest Huntington disease. *Physical Therapy, 93*(7), 942-56.

Qutubuddin, AA., Pegg, PO., Cifu, DX., Brown, R., McNamee, S. & Carne, W. (2005). Validating the Berg Balance Scale for patients with Parkinson's disease: a key to rehabilitation evaluation. *Archives of Physical Medicine & Rehabilitation, 86*(4), 789-92.

Radell, S., Adame, D., Cole, S. & Blumenkehl, N. (2011). The impact of mirrors on body image and performance in high and low performing female ballet students. *Journal of Dance Medicine and Science, 15*(3), 108-15.

Rappaport, M., Hall, KM., Hopkins, K. & Cope, DN. (1982) Disability rating scale for severe head trauma: Coma to community. *Archives of Physical Medicine and Rehabilitation, 63*(1)*,* 118-123.

Rauscher, L. & Greenfield, BH. (2009) Advancements in Contemporary Physical Therapy Research: Use of Mixed Methods Designs. *Physical Therapy, 89*(1), 91-100.

Rehabilitation Measures Database (2010) *Rehabilitation Measures* retrieved from http://www.rehabmeasures.org/rehabweb/rhaboutus.aspx

Reid, A. & Chesson, R. (1998) Goal attainment scaling. Is it appropriate for stroke patients and their physiotherapists? *Physiotherapy,84* (3), 136-44.

Ries, JD., Echternach, JL., Nof, L. & Blodgett, MG. (2009). Test-Retest Reliability and Minimal Detectable Change Scores for the Timed ''Up & Go'' Test, the Six-Minute Walk Test, and Gait Speed in People With Alzheimer Disease. *Physical Therapy, 89*(6), 569-79.

Robertson, M. (n.d.).Robertson Training systems. Retrieved from http://robertsontrainingsystems.com/blog/tag/movement-quality/

Ross, DH. (2008). Measuring Movement Performance in the Acute Setting: The development of the LEEDS Movement Performance Index. *Synapse Journal of ACPIN, Spring,* 1-4.

Ross, DH., McLuskey, S., Fletcher-Cook, P. & Stephenson, J. (2014). The reliability of the Leeds Movement Performance Index (LMPI): a new tool for neurological physiotherapy. *Physiotherapy Theory and Practice, 30*(8), 581–587.

Royal Academy of Dance (RAD). (2013). *Royal Academy of Dance: Exams* Retrieved from www.rad.org.uk/examinations

Royal College of Physicians (RCP), (2012) *Intercollegiate Stroke Working Party. National clinical guideline for stroke* (4th edition). Retrieved from https://www.rcplondon.ac.uk/sites/default/files/national-clinical-guidelines-for-stroke-fourth-edition.pdf

Rushton, PW. & Miller, WC. (2002). Goal Attainment Scaling in the rehabilitation of patients with lower-extremity amputations: a pilot study. *Archives of Physical Medicine & Rehabilitation, 83*(6), 771-5.

Sackley, C., Richardson, P., McDonnell, K., Ratib, S., Dewey, M. & Hill, HJ. (2005). The reliability of balance, mobility and self-care measures in a population of adults with a learning disability known to a physiotherapy service. *Clinical Rehabilitation, 19*(2), 216-23.

Salbach, NM., Mayo, NE., Higgins, J., Ahmed, S., Finch, LE. & Richards, CL. (2001). Responsiveness and Predictability of Gait Speed and Other Disability Measures in Acute Stroke. *Archives of Physical Medicine and Rehabilitation, 82*(9), 1204-12.

Schenkman, M., Hughes, MA., Bowden, MG. & Studenski, SA. (1995). A clinical tool for measuring functional axial rotation. *Physical Therapy, 75*(2),151-6.

Schmidt, R. (1975). A Schema Theory of Discrete Motor Skill Learning. *Psychological Review,* 82(4), 225-60.

Shaw, J., Connelly, DM. & Zecevic, A. (2010). Pragmatism in practice: mixed methods research for physiotherapy, *Physiotherapy theory and Practice, 26(8), 510-18.*

Sherrington, CS. (1973). *The integrative action of the nervous system*. New York: Arno Press.

Shumway-Cook, M. & Woollacott, MH.(2012*). Motor Control Translating Research into Clinical Practice* 4th Edition. Baltimore, Philadelphia, USA: Wolters Kluwer Health / Lippincott, Williams and Wilkins.

Skjaerven, L., Kristoffersen, K. & Gard, G. (2003). Basic elements and dimensions to the phenomenon of quality of movement – a case study. *Journal of Bodywork and Movement Therapies, 7*(4), 251-260.

Skjaerven, L., Kristoffersen, K. & Gard, G. (2010). How can movement quality be promoted in clinical practice? A phenomenological study of physical therapist experts. *Physical Therapy, 90*(10), 1479-1492.

Smedal, T., Lygren, H., Myhr, KM., Nilssen, RM., Gijelsvik, O. &Inger, L. (2006). Balance and gait improved in patients with MS after physiotherapy based on the Bobath concept. *Physiotherapy Research International, 11*(2), 104-16.

Smithson, J. (2000). Using and analysing focus groups: limitations and possibilities. *International Journal of Social Research Methodology, 3*(2), 103-19.

Steenbeek, D., Meester-Delver, A., Becher, JG.& Lankhorst, GJ. (2005). The effect of botulinum toxin type A treatment of the lower extremity on the level of functional abilities in children with cerebral palsy: evaluation with goal attainment scaling. *Clinical Rehabilitation 19*(3)*, 274–82.*

Steenbeek, D., Ketelaar, M., Galama, K. &Gorter, JW. (2007) Goal attainment scaling in paediatric rehabilitation: a critical review of the literature. *Developmental Medicine and Child Neurology, 49*(7), 550-6.

Steenbeek, D., Ketelaar, M., Lindeman, E., Galama, K. &Gorter, JW.(2010). Interrater reliability of goal attainment scaling in rehabilitation of children with cerebral palsy. *Archives of Physical Medicine and Rehabilitation, 91*(3), 429-35.

Steffen, T. & Seney, M. (2008). Test-retest reliability and minimal detectable change on balance and ambulation tests, the 36-item short-form health survey, and the unified Parkinson disease rating scale in people with parkinsonism. *Physical Therapy, 88*(6), 733-46.

Stenekes, MW.,Coert, JH., Nicolai, J., Mulder, T., Geertzen, JHB., Paans, M. & de Jong, BM. (2010). Cerebral consequences of dynamic immobilisation after primary digital flexor tendon repair. *Journal of Plastic, Reconstructive and Aesthetic Surgery, 63*(12), 1953-61.

Stevens, A., Beurskens, A., Koke, A. & van der Weijden, T. (2013). The use of patient-specific measurement instruments in the process of goal-setting: A systematic review of available instruments and their feasibility. *Clinical Rehabilitation, 27*(11), 1005-19.

Stevenson, TJ. (2001), Detecting change in patients with stroke using the Berg Balance Scale. *Australian Journal of Physiotherapy, 47*(1), 29- 38.

Stolee, P., Stadnyk, K., Myers, AM. & Rockwood, K. (1999).An individualized approach to outcome measurement in geriatric rehabilitation. *The Journals of Gerontology: Series A: Biological Sciences and Medical Sciences, 54A*(12), M641-M647.

Stroke Association. (2013). *Stroke Association* Retrieved from http://www.stroke.org.uk

Sullivan, JE., Crowner, BE., Kluding, PM., Nichols, D., Rose, DK., Yoshida, R. & Zipp, GP. (2013). Outcome Measures for Individuals With Stroke: Process and Recommendations From the American Physical Therapy Association Neurology Section Task Force. *Physical Therapy, 93*(10), 1383-95.

Swinkels, R., Van Peppen, RPS., Wittink, H., Custers, JWH. & Beurskens, AJHM. (2011). Current use and barriers and facilitators for implementation of standardised measures in physical therapy in the Netherlands. *BMC Musculoskeletal Disorders, 12*(1), 106.

Tennant, A. (2007). Goal attainment scaling: Current methodological challenges. *Disability and Rehabilitation, 29* (20-21), 1583-88.

Terwee, CB., Mokkink, LB., Knol, DL., Ostelo, RWJG., Bouter, LM. & de Vet, HCW. (2012). Rating the methodological quality in systematic reviews of studies on measurement properties: a scoring system for the COSMIN checklist. *Quality of Life Research, 21*(4), 651-7.

Tinetti, ME. (1986). Performance-oriented assessment of mobility problems in elderly patients. *Journal of the American Geriatrics Society, 34*(2),119-26.

Toro, B., Nester, C. & Farren, P. (2003).A review of observational gait assessment in clinical practice. *Physiotherapy Theory and Practice, 19*(3), 137-49.

Turner-Stokes, L. (2009). Goal attainment scaling (GAS) in rehabilitation: a practical guide. *Clinical Rehabilitation, 23*(4), 362-70.

Turner-Stokes, L. & Williams, H. (2010).Goal attainment scaling: a direct comparison of alternative rating methods. *Clinical Rehabilitation, 24*(1), 66-73.

Turner-Stokes, L., Williams, H. & Johnson, J. (2009).Goal attainment scaling: Does it provide added value as a person-centred measure for evaluation of outcome in neurorehabilitation following acquired brain injury? *Journal of Rehabilitation Medicine, 41*(7), 528-35.

Turner-Stokes, L., Baguley, I., De Graff, S., McCrory, P., Katrak, P., Davies, L., McCrory, P. & Hughes, A. (2010). Goal attainment scaling in the evaluation of treatment of upper limb spasticity with botulinum toxin: a secondary analysis from a double-blind placebo-controlled randomised clinical trial. *Journal of Rehabilitation Medicine, 42*(1) 81–89.

Tyson, SF. & DeSouza, LH.(2003). A clinical model for the assessment of posture and balance in people with stroke. *Disability and Rehabilitation, 25*(3), 120-6.

Tyson, SF. & Connell, LA.(2009). How to measure balance in clinical practice. A systematic review of the psychometrics and clinical utility of measures of balance activity for neurological conditions. *Clinical Rehabilitation, 23*(9), 824-40.

Unified Huntingdons Disease Rating Scale; Motor Section (UHDRS) (n.d.) Unified Huntington's disease rating scale (uhdrs) and database. Retrieved from http://endoflifecare.tripod.com/juvenilehuntingtonsdisease/id242.html

UK Rehabilitation Outcomes Collaborative (UK ROC). (2014). *UK Rehabilitation Outcomes Collaborative* retrieved from http://www.csi.kcl.ac.uk/ukroc

USA National Quality Measures Clearinghouse (NQMC). (2014). *USA National Quality Measures Clearinghouse* retrieved from http://www.qualitymeasures.ahrq.gov/tutorial/HealthOutcomeMeasure.aspx

Van Peppen, RPS., Hendriks, HJM., Van Meeteren, NLU., Helders, PJM. & Kwakkel, G. (2007) The development of a clinical practice stroke guideline for physiotherapists in The Netherlands: a systematic review of available evidence. *Disability and Rehabilitation, 29*(10), 767-83.

Verheyden, G., Nieuwboer, A., Mertin, J., Preger, R., Kiekens, C. & De Weerdt, W. (2004). The Trunk Impairment Scale: a new tool to measure motor impairment of the trunk after stroke. *Clinical Rehabilitation, 18*(3), 326-334.

Verheyden, G., Nieuwboer, A., Feys, H., Thijs, V., Vaes, K. & De Weerdt, W. (2005). Discriminant ability of the Trunk Impairment Scale: A comparison between stroke patients and healthy individuals. *Disability and Rehabilitation, 27*(7), 1023-8.

Verheyden, G., Vereeck, L., Truijen, S. , Troch, M., Herregodts, I., Lafosse, C., Nieuwboer, A. & De Weerdt, W. (2006a). Trunk performance after stroke and the relationship with balance, gait and functional ability. *Clinical Rehabilitation, 20*(5), 451-8.

Verheyden, G., Nuyens, G., Nieuwboer, A., Van Asch, P., Ketelaer, P. & De Weerdt, W. (2006b) Reliability and validity of trunk assessment for people with multiple sclerosis. *Physical Therapy, 86*(1),66-76.

Verheyden, G., Hughes, J., Jelsma, J., Nieuwboer, A. & De Weerdt, W. (2006c).Assessing motor impairment of the trunk in patients with traumatic brain injury: reliability and validity of the Trunk Impairment Scale. *South African Journal of Physiotherapy, 62*(2), 23-8.

Verheyden, G., Nieuwboer, A., De Wit, L., Feys, H., Schuback, B., Baert, I., Jenni, W., Schupp, W., Thijs, V. & De Weerdt, W. (2007a). Trunk performance after stroke: an eye catching predictor of functional outcome. Journal of Neurology, *Neurosurgery and Psychiatry, 78*(7), 694-98.

Verheyden, G., Willems, A., Ooms, L. & Nieuwboer, A. (2007b).Validity of the trunk impairment scale as a measure of trunk performance in people with Parkinson's disease. *Archives of Physical Medicine and Rehabilitation, 88*(10), 1304-08.

Verheyden, G., Nieuwboer, A., De Wit, L., Thijs, V., Dobbelaere, J., Devos, H., Severijns, D., Vanbeveren, S. & De Weerdt, W. (2008). Time course of trunk, arm, leg, and functional recovery after ischemic stroke. *Neurorehabilitation& Neural Repair, 22* (2), 173-9.

Verheyden, G., Vereeck, L., Truijen, S., Troch, M., LaFosse, C., Saeys, W., Leenaerts, E., Palinckx, A. & De Weerdt, W. (2009). Additional exercises improve trunk performance after stroke: a pilot randomized controlled trial. *Neurorehabilitation and Neural Repair 23*(3), 281-86.

Verheydenk, G. & Kersten, P. (2010).Investigating the internal validity of the Trunk Impairment Scale (TIS) using Rasch analysis: the TIS 2.0.*Disability and Rehabilitation, 32*(25), 2127-37.

de-Vet, HCW., Terwee, B., Knol, DL. & Bouter, LM. (2006). When to use agreement versus reliability measures. *Journal of Clinical Epidemiology, 59*, 1033-39.

Wade, DT. (1992). *Measurement in Neurological Rehabilitation*. New York: Oxford University Press.

Wade, D. (2004). Assessment, measurement and data collection tools. *Clinical Rehabilitation, 18*(3), 233-37.

Wang, CH., Hsueh, P., Sheu, C., Yao, G. & Hsieh, C (2004). Psychometric Properties of 2 Simplified 3-Level Balance Scales Used for Patients With Stroke. *Physical Therapy, 84*(5), 430-38.

Wang, RY., Chen, HI., Chen, CY. & Yang, YR. (2005). Efficacy of Bobath versus orthopaedic approach on impairment and function at different motor recovery stages after stroke: a randomized controlled study. *Clinical Rehabilitation, 19*(2), 155-64.

Wedge, FM., Braswell-Christy, J., Brown, CJ., Foley, KT., Graham, C. & Shaw, S. (2012). Factors influencing the use of outcome measures in physical therapy practice. *Physiotherapy Theory and Practice, 28*(2),119–133.

Wee, JYM., Bagg, SD. & Palepu, A. (1999). The Berg Balance Scale as a predictor of length of stay and discharge destination in an acute stroke rehabilitation setting. *Archives of Physical Medicine and Rehabilitation, 80*(4), 448-52.

Wee, J., Wong, H. & Palepu, A. (2003). Validation of the Berg Balance Scale as a predictor of length of stay and discharge destination in stroke rehabilitation1. *Archives of Physical Medicine and Rehabilitation, 84*(5), 731-35.

Whitall, J., Savin, DN., Harris-Love, M. & Waller, SM. (2006) Psychometric properties of a modified Wolf Motor Function test for people with mild and moderate upper-extremity hemiparesis.. *Archives of physical medicine and rehabilitation, 87*(5) 656-60

White, G & Thomson AN. (1995). Anonymized Focus Groups as a Research Tool for Health Professionals, *Qualitative Health Research, 5*(2), 256-61.

Whiting, HTA.& Bernshtein, NA. (1984). *Human motor actions: Bernstein reassessed* (edited by HTA Whiting). Amsterdam: North-Holland.

Whitney, S., Wrisley, D. & Furman, J. (2003).Concurrent validity of the Berg Balance Scale and the Dynamic Gait Index in people with vestibular dysfunction. *Physiotherapy Research International, 8(*4), 178-86.

Wiles, CM. & Karni, Y. (1983).The measurement of muscle strength in patients with peripheral neuromuscular disorders. *Journal of Neurology, Neurosurgery, and Psychiatry, 46(*11), 1006-13.

Wirz, M., Muller, R. & Bastiaenen, C. (2010).Falls in persons with spinal cord injury: validity and reliability of the Berg Balance Scale. *Neurorehabilitation and Neural Repair, 24*(1), 70-77.

Wolf, SL., Catlin, PA., Gage, K., Gurucharri, K., Robertson, R. & Stephen, K. (1999).Establishing the reliability and validity of measurements of walking time using the Emory Functional Ambulation Profile. *Physical Therapy, 79*(12), 1122-33.

Wolf, SL., Catlin, PA., Ellis, M., Archer, AL., Morgan, B. & Piacentino, A. (2001).Assessing Wolf motor function test as outcome measure for research in patients after stroke. *Stroke, 32*(7), 1635-9.

Wood-Dauphinee, S., Berg, K., Bravo, G. & Williams, JI. (1997). The balance Scale: Responsiveness to clinically Meaningful changes. *Canadian Journal of Rehabilitation, 10*(1), 35-50.

World Confederation for Physical Therapy (WCPT). (2013). *World Confederation for Physical Therapy* Retrieved from http://www.wcpt.org

World Health Organization (WHO). (2001*). International Classification of Functioning, Disability and Health: ICF*. Retrieved from http://www.disabilitaincifre.it/documenti/ICF_18.pdf

Yoward, LS., Doherty, P. & Boyes, C. (2008). A survey of outcome measurement of balance, walking and gait amongst physiotherapists working in neurology in the UK*. Physiotherapy, 94*(2), 125-32.

Wright, J. (2000). *The FIM(TM).The Center for Outcome Measurement in Brain Injury*. Retrieved from http://www.tbims.org/combi/FIM

Yoward, LS., Doherty, P. & Boyes, C. (2008). A survey of outcome measurement of balance, walking and gait amongst physiotherapists working in neurology in the UK. *Physiotherapy, 94*(2), 125-32.