The perceptions of nurses toward barriers to the safe administration of

medicines in mental health settings:

Abstract

Title. The perceptions of nurses toward barriers to the safe administration of medicines in mental health settings:

This study investigated registered and students nurses' perceptions of barriers to safe administration of medicines in mental health settings. Using a cross-sectional, mixed methods survey. 70 practicing mental health nurses and 41 final-year mental health nursing students, in U.K., who undertook an assessment of medicine administration, completed a questionnaire, comprising 17 closed- and 5 open-response questions.

Seven themes emerged from the data including environmental distractions, insufficient pharmacological knowledge, poorly written and incomplete medication documentation, inability to calculate medication dosage correctly, and work-related pressure. Service user-focused themes comprised poor service user adherence to medication regimens, and cultural and linguistic communication barriers with service users.

Implications: The findings show that registered and student mental health nurses are aware of *latent* conditions that can impair performance to safely administer

1

medication. It is imperative, therefore, that employing and/or training organizations actively support individual nurses to make this complex intervention as risk-free as possible

Introduction

The administration of medicines is the major part of nursing interventions, with some studies estimating 40% of nurses' time in-patient settings is spent on this activity alone [1]; a similar situation occurs with mental health nurses [2-3]. The majority of people diagnosed with a mental health condition in the UK have medicines prescribed either as an inpatient (95%) [4], or in the community [5]. The nurse administering medication is likely to be the last person in a chain of events that contributes to the outcomes of prescribed medication [6]. In this sense, medication administration has been highlighted as the highest risk intervention that most nurses undertake [6-8]. Mistakes in medication administration are the most commonly recorded medicine errors that can have detrimental consequences for patients [8]. An error is a breakdown of an intentional act, which can be considered in two parts: formulating the plan of action, and executing it [9]. It can also be conceived as the consequence of an alignment of conditions and events that combine to cause an error [10].

Prevalence and consequences of medication error

Recorded medicine errors do not reflect the true extent of the problem [11]. In reality, only adverse events resulting from medication errors are reported while those leading to no harm often go unreported in general health settings [12]. This situation is also common in mental health settings [13-15]. The most common type of administration error reported is incorrect dose: improper dose and/or dose omission [13, 16-18]. Depending on the clinical setting, medication errors may contribute from one-third to one-half of serious adverse events in service users [9, 13,19-20].

Swiss cheese model of error

Reason's [1] Swiss cheese model of system failure provides a useful explanatory framework for medication error. Briefly, error can occur at each step in the medication administration process. The perfect system can be equated to slices of Swiss cheese, where each slice provides a defensive layer against error. Holes in the cheese provide the potential for error to occur; however, while an error may happen in one part of the process it is usually contained at the next layer. For a major error to take place, a channel must form which links up the holes at the various levels (slices) of defence. The more defence layers in place, the better, the greater the possibility that errors will be detected or stopped earlier [21]. Most errors are attributable to a breakdown in one or more of four levels — organisational, unsafe supervision, prerequisites for unsafe acts, and actual unsafe acts — each incorporating *active* and *latent failures. Active* failures are

4

"unsafe acts committed by people who are in direct contact with the patient or system. These can be slips, lapses, mistakes, and procedural violations" [21] (p. 769). *Latent* or contextual failures that increase the likelihood of error are "resident pathogens" or structural weaknesses in the system, which have two kinds of adverse effects: (i) they can translate into error provoking conditions in the workplace, and (ii) they can create long-lasting holes or weaknesses in defences against error.

Most studies of medication error have taken place in general health settings; therefore, this study will contribute to the limited body of knowledge of medication error in mental health nursing settings.

METHODS

Aim

The aims of this paper are to identify registered and student mental health nurses' perceptions of barriers to safe administration of medication in mental health settings, and to examine their understanding of why errors occur.

Design

A cross sectional, self-administered survey questionnaire design was used.

Sample and setting

The sample comprised of mental health nurses who were:

- Registered nurses: Employed by South West Yorkshire Partnership Foundation Trust, U.K., and working in a direct clinical care capacity in inpatient and/or community contexts.
- Students: End-of-final-year mental health students from the Bachelor of Science/Diploma in Mental Health Nursing course, University of Huddersfield, U.K.

Ethical considerations

Approval to recruit registered nurses was obtained from the Education and Training sub-group of the Drug and Therapeutic Trust Action Group. Approval to recruit students was given by the University of Huddersfield's School of Health and Human Sciences Research Ethics Panel. Voluntary participation was emphasized and confidentiality was maintained throughout the study.

Data Collection

A questionnaire that contained 17 closed-response items and 5 open-response questions that formed the basis of a larger study [3, 23]. The questionnaire was distributed by email to 827 registered mental health nurses from The South West Yorkshire Partnership Foundation Trust, U.K. and distributed in class to 44 mental health nursing students from the University of Huddersfield, U.K., findings presented in this paper are based on responses to the open-response question: What do you think are the barriers to safe administration of medication? The question comprised seven sub-questions, derived from research literature, that

were identified as barriers to safe administration of medication (Fig. 1). The respondents were asked to tick the respective box of each sub-question that they perceived as a 'barrier' and then provide a written elaboration about each item ticked.

INSERT FIG 1 HERE

Data analysis

Quantitative

Data were analysed using Statistical Package for Social Sciences, Version 18. Analysis was performed using frequencies, percentages, cross tabulations and measures of central tendency, including mean, median, mode and standard deviation and chi-square. Frequencies and percentages are only presented in this paper.

Qualitative.

Written responses to the seven sub-questions were transcribed verbatim, and a content analysis of the data was undertaken. According to Newell and Burnard [24], two approaches can be used in content analysis: (i) examine the answers to pre-set questions deductively, or (ii) allow themes to be developed inductively from the data. Deductive content analysis was used because the analysis was structured on the basis of prior knowledge [25], in this instance, of literature about the seven most common barriers to safe administration of medication. This

approach was also used because the written responses to the sub-questions were more focused and concise than could be obtained from conventional semi-structured, audio-recorded interviews.

Results

A total of 195 mental health nurses and 41 student nurses returned the questionnaire, equivalent to response rates of 24% and 96% respectively. The relatively high response rate for the students may be due to the fact they completed the questionnaire on their last day in university, whereas registered nurses' responses were obtained via email. For this evaluation only 70 registered and 41 student nurses who had undertaken the MwR assessment were included in the sample Chi-square analysis of quantitative responses to the seven sub-question headings indicated that there was no statistical significance difference between registered and student nurses' perceptions of barriers to medication administration.

Categories

From the content analysis, seven themes – five nurse- and prescriber-focused and two service user-focused – were abstracted from written responses to the seven pre-set questions, depicting a range of barriers to safe administration of medicines. Nurse- and prescriber-focused themes included environmental distractions, work-related pressure, insufficient pharmacological knowledge, poorly written and/or incomplete medication documentation, and inability to calculate medication dosage correctly. Service user-focused themes included

poor adherence to medication regimens, and cultural and linguistic communication barriers with service users. These are presented below along with the percentage and number of registered and student nurse responses respectively to each theme.

Nurse- and prescriber-focused themes

Environmental distractions

Seventy percent (n=49) of registered nurses and 59% (n=24) of students reported that environmental distractions were barriers to safe medication administration. Environmental distractions were also manifest in the qualitative data, and ranged from busy wards, to telephone and staff interruptions. These *latent* failures could, in turn, contribute to *active* failures in the administration of medicine. To illustrate, some registered nurses commented that there may be:

"Not enough [physical] space [to administer medication]; phone *interruptions."*

Multiple *latent* conditions were also highlighted:

"Distractions/interruptions from colleagues and other professionals."

"*Noise, poor lighting, interruptions."*

"Distractions and untidiness may cause errors to be made."

These, in turn, can increase the potential for *latent* errors to occur:

"*Environmental noise, needing to concentrate on amount of information on cards and whereabouts of information on cards."*

Students also claimed that environmental distractions were problematic during the administration of medicines: *"Busy wards, distractions, pressure if the patient is waiting (and may become impatient)."*

Work-related pressure

Pressure of work was reported by 59% of registered nurses (n=41) and 61% of student nurses (n=25) as a major *latent* factor. Several *latent* factors were identified in the qualitative analysis that could contribute to errors occurring. First, registered nurses reported concerns about having insufficient numbers of qualified staff on duty:

"*Only one qualified member of staff, and may have to deal with an emergency.*"

"*In addition full beds (bed occupancy), complicated drug regime and non-adherence can extend the length of the drug round.*"

As a consequence of these situations, the potential for *active* errors to occur increased: "*if you are under pressure, it leaves more room for mistakes due to* [low] *levels of staff.*"

Students also commented that inadequate levels of staffing and interruptions while administering medications were barriers to safe administration: "*Being the only qualified on a shift; having to manage time for medication round to be completed safely; and being interrupted.*"

Insufficient pharmacological knowledge

46% (n=32) of registered nurses and 37% (n=15) responded that lack of knowledge of medication was a contributing influence to medication error. Qualitative analysis of registered nurses' supported this finding, indicating that a *latent* deficit in pharmacological knowledge contributed to error: "*Lack of knowledge of drug types, interactions, contraindications and side effects may potentially put service users at risk if nursing staff are not aware of potential*

consequences of taking medication." Registered nurses' concern about insufficient pharmacological knowledge was also associated with the introduction of new medicines: "*This is an often neglected area particularly regarding new medication.*"

Poorly written and incomplete medication charts

More registered (47%, n=33) than student nurses (37%, n=15) indicated that there were problems with medication charts. Qualitative findings also highlighted that vague and poorly written prescriptions were a major contributing factor to medication errors. Registered nurses commented that:

 "*[Prescriptions] can be vague depending on medical staff and how they put [write] down dosage etcetera.*"

"A*t times [the prescription is] written unclearly on the drug card.*"

This lack of attention to the correct procedure for writing prescriptions (*active* failure) increased the likelihood of misinterpretation by registered nurses (*latent* failure). Similarly, omission of important information on the prescription by medical staff increased the likelihood of *active* failure: "*Uncompleted documentation from doctors e.g., stop dates [missing], poorly written prescriptions.*"

Omission also extended to failure to provide clear information about matters that could heighten the possibility of adverse medication events occurring: *"Clarity of allergies not always highlighted appropriately or clearly.*"

Although student participants' written responses were fewer in number

than registered nurses, the former group showed they were aware that if prescriptions were illegible this had the potential to cause errors in interpreting prescriptions and calculating drug dosages:

"Too many alterations on card by medical staff can be confusing."

"*Can be vague depending on medical staff and how they put down [write] dosage.*"

Inability to calculate medication dosage correctly

A markedly higher percentage of student nurses (46%, n=19) than registered nurses (29%, n=20) responded that inability to calculate medication dosage correctly — a *latent* error — contributed to medication error. A registered nurse described the conditions that could cause an error: "*Not knowing how to calculate the correct dose when drawing up an injection; and what was necessary* [to calculate the dose];"

Registered nurses also commented about the need to introduce a requirement for a greater level of competence about drug calculations in preregistration nurse education courses:

"A basic knowledge which should be established during training."

"*More training in drug calculations, definitely.*"

Service user-focused barriers

Poor adherence to medication regimens

A much greater proportion of registered nurses (46%, n=32) than student nurses (29%, n=12) rated poor adherence to medication regimens as a potential barrier to safe administration of medication. Qualitative responses from registered

nurses indicated that a contributing factor to this situation was the mental capacity of the patient to understand the need to take medication.

"*Service users who are acutely unwell are difficult to engage with regarding their medication.*" In addition, intentional non-adherence by service users had the potential to cause adverse implications to other inpatients:

"*Occasionally, patients remove tablets from their mouths when they think that you are not looking. Medication can be harmful to their health if not taken correctly, and harmful to someone else if found and taken by mistake.*"

No written responses were provided by students to this question, perhaps reflecting their lack of experience in the administration of medicines.

Cultural and linguistic influences

Cultural and linguistic influences were considered by registered (14%, n=10) and student (12%, n=5) nurses as contributing factors to medication error, but to a lesser extent than other factors. Patients from different cultural and linguistic backgrounds can present unique challenges that increase the possibility of medication error by registered nurses. Linguistic challenges included difficulties in communicating and understanding between nurses and service users, while cultural challenges included service users' beliefs about medication. At times, linguistic problems were particularly prominent as barriers to safe administration of medication:

"*It is more language barriers that are the issue.*"

Language difficulties could create problems in identifying the correct patient when administering medication:

"identity confusion in names e.g., Asian names, language."

On other occasions, linguistic issues and cultural beliefs combined to increase the likelihood of medication error occurring: "*Language, accents and beliefs all need to be considered and clinical practice formulated to meet these needs.*"

Discussion

This paper reports on registered and end-of-final-year student mental health nurses' perceptions of barriers to safe administration of medication. In comparison to student nurses, registered nurses rated six of the seven barriers to safe administration more highly, and provided more written responses. This difference could have been attributable to the relative lack of experience of student nurses to base their responses. Lack of experience may also explain why a higher proportion of students rated incorrect drug calculations as problematic as they have considerably less experience in calculating doses than registered nurses.

From the content analysis, seven categories – five nurse- and prescriber-focused and two service user-focused – were abstracted from written responses to the seven pre-set questions, depicting a range of barriers to safe administration of medicines. The seven categories that were identified in the content analysis of the written reposes to questions concurred with previous research [3, 26-27] and illustrated how Reason's [21] model can be applied to clinical practice.

Environmental distractions were identified by registered and student nurse

respondents in the present study as a major *latent* cause of administration error. Reason [21] highlights situational and contextual failures that increase the likelihood of error; these "resident pathogens" are also apparent in the findings of our study. Environmental distractions are also mirrored in the nursing literature: Time pressure and understaffing may lead to fatigue and error [13] [28-30]; likewise, noisy environments are distracting [8, 31-32].

Work-related pressure in busy wards was reported in the current study as contributing to medication error. Procedural violations or rule-based errors could be when the nurse administering the medicine deviates from the rules or best evidence [21].Pressure of work and multi-tasking have also been highlighted as reasons why nurses may deviate from safe procedures [7, 30, 32]. Duxbury *et al.* [2] found that nurses on busy acute psychiatric wards were frustrated by their practice environment, which made it difficult for them to remain focused on the task of administering medicine. As such, hospital administrators have a responsibility to ensure that nurses working in environments where system failures are apparent should be given the necessary support to manage in these situations [29, 32-34]. Therefore, errors are not usually attributable to a shortcoming in an individual nurse, but are more likely to take place within the context of a catalogue of events [3, 14, 29]. If these events are not addressed, they are likely to become *latent* or systemic failures [21].

In the present study, a *deficit in psychopharmacological knowledge* was recognized as a major contributor to error. This type of error can occur even if the medication is clearly and accurately written on medication administration charts

[10]. One of the most frequent types of medication administration errors in psychiatric inpatient settings is giving the incorrect drug to the patient [13]. As medicine administration is a complex procedure involving a range of interrelated considerations, such as correct dosage regime, potential hazards, service user's individual health presentation, it is important that nurses are adequately prepared and supported to carry out this crucial role [32,35]. Therefore, it is important to ensure nurses have adequate pharmacological knowledge and are able to transfer this knowledge into clinical practice. These competencies need to be addressed initially in preregistration courses but should be reinforced intermittently throughout a registered nurses' career [2,3,33,36]. It is also the individual nurses' responsibility to keep up-to-date with new medicine regimes [45] and to use education and training opportunities available to be fit for purpose and practice [3,14].

Poorly written and/or incomplete medication documentation, a potential *active* failure, was reported in the present study. Likewise, this has been shown in several other studies, where doctors have been reported as the main contributor to this form of *active* failure; for instance, in writing ambiguous medication orders, particularly with new prescriptions [7,9,13,33]. It has also been claimed that doctors can get up to 1.5% of prescriptions wrong, such as writing the incorrect dose of medication [38]. As nurses have an important role in preventing medication errors, they also have a major responsibility in monitoring for, and correcting, potential doctor-initiated errors [8,13,13,39].

Concern about shortcomings in *nurses' drug calculation skills* is

emphasized in the current study, and is also well-documented problem in nursing literature [40-42]. Respondents in the present study felt that it was necessary to introduce a benchmark for drug calculation skills for nursing students at the point of registration. At an individual practitioner level, poor calculation skills, and inability to calculate medication dosages correctly, are regarded as major causes of medication error [13,16-18]. One approach to addressing this issue with pre-registration nursing students has been undertaken by the University of Huddersfield. It implemented an online medication calculation dosage training programme "Safe Medicate." Even though the program is relatively new, the University has an established evidence base in improving nurses' calculation skills [40,44].

Patient related barriers to safe administration of medication are highlighted in the present study, and have also been reported elsewhere 15 (Procyshyn *et al.* 2010). Examples identified were that some service users omitted to take their medication as prescribed or administered. Omission may have been due to limitations in the capacity of the service user at the time; however, they highlight the range of complexities that nurses' face when administering medication [2, 24].

Cultural and linguistic difficulties with service users were identified in the present study and elsewhere as barriers to safe administration of medication [45-46]. In addition, lack of familiarity with service users is a significant factor that contributes to error [35]. It could be inferred from the findings of the current study that nurses' lack of familiarity could also be attributable to decreased awareness of cultural issues that affect adversely service users' medication taking. This

highlights the need for nurses to be on alert for potential error to occur as a result of confusion or misunderstanding, and to take active measures to ensure service users' identity and understanding of the need to take medications [46].

Study limitations

There are several limitations to this study. The findings are based on a sample of registered nurses from one Mental Health Trust and a single university cohort of end-of-final-year mental health nursing students. However, the themes may be pertinent to registered and student nurses practicing in other mental health contexts [47]. We also sought information about perceived barriers to safe administration of medicines; therefore, no causal link can be made about improved safety outcomes.

Conclusion

Tackling medication administration error is predominantly an organizational rather than individual practitioner responsibility, and this is no different in the mental health nursing context of care. Minimizing medicine errors requires strategic planning and responsible involvement of all key stakeholders in the medication process. Mental health service agencies should seek to prevent *latent* potential of medication errors from becoming *active* mistakes that cause harm to service users who receive psychotropic medication.

18

1) Armitage G, Knapman H. Adverse events in drug administration: a literature review. *Nursing Management* 2003; 1(2); 130-140.

2) Duxbury JA, Wright K, Bradley D, & Barnes P. Administration of medication in the acute mental health ward: Perspective of nurses and patients. Issue. *International Journal of Mental Health Nursing* 2010a; 19 (1); 53e61.

3) Hemingway S, Baxter H, Smith G, Burgess-Dawson R, & Dewhirst K. Collaboratively planning for medicines administration competency: a survey evaluation. *Journal of Nursing Management* 2011; 19; 366–376.

4) Care Quality Commission. Supporting Briefing note: issues highlighted by survey of mental health acute inpatient services 2009; http://www.cqc.org.uk/sites/default/files/media/documents/20120910_mh12_national_briefing_note_final.pdf accessed 9/12/12.

5) Care Quality Commission. Community mental health survey 2012; http://archive.cqc.org.uk/_db/_documents/2009_survey_of_mental_health_acute_inpatient_services_Briefing_note_200909230047.pdf accessed 9/12/12

6) Anderson DJ, Webster CS. A systems approach to the reduction of medication error on the hospital ward. *Journal of Advanced Nursing* 2001; 35(1); 34-41.

7) Shaw M. Health risk and the patient safety agenda 2009. Chapter 9 in: Heyman B, Shaw M, Alaszewski A & Titteron M Risk, Safety, and Clinical Practice Health Care Through the Lens of Risk 2009; London. Oxford, University Press.

8) Unver V, Tastan S, & Akbayrak N. Medication Errors: Perspectives of newly graduated and experienced nurses. *International Journal of Nursing Practice* 2012; 18; 317-324.

9) McDowell S, Ferner HS, & Ferner R. The pathophysiology of medication errors: how and where they arise. British Journal of Clinical Pharmacology 2009; 67(6); 605-613.

10) Armitage G. Human error theory: relevant to nurse management. *Journal of Nursing Management* 2009; 17; 193-202.

11) Williams DJP Medication Errors. Journal of The Royal College of Physicians 2007; 37; 343-346.

12) Ulanimo V M, O'Leary-Kelley C, & Connolly P M. Nurses' perceptions of causes of medication errors and barriers to reporting. *Journal of Nursing Care Quality* 2007; *22*(1); 28-33.

13) Haw CM, Dickens G & Stubbs J 2005 A review of Medication Administration Errors Reported in a Large Psychiatric Hospital in the United Kingdom. Psychiatric Services 2007; 56(12); 1610-1613

14) Bradley EJ, Hynam B, & Nolan P. Nurse Prescribing: Reflections on Safety in Practice. *Social Science and Medicine* 2007; 65(3); 599-609.

15) Procyshyn RM, Barr AM, Brickell T, & Honer WG. Medication errors in Psychiatry: A comprehensive review. *CNS Drugs* 2010; 24; 595-609.

16) Ito H, and Yamazuni S. Common types of medication errors on long-term psychiatric care units. *International Journal for Quality in Health Care* 2003; 15(3), 207-212.

17) Maidment ID, Paton C, Lelliott P. A Review of Medication Errors in Mental Health Care. *Quality & Safety in Health Care* 2006 15; 409-13.

18) Rothschild JM, Klauss K, Keohane CA, Williams DH, Foskett C, Rosen SL, Flaherty L, Chu JA & Bates DW. Medication safety in a psychiatric hospital. *General Hospital Psychiatry* 2007; 29; 156-162

19) White, J., (2004) *Medication Management*. In: Ryan T, Pritchard J, (Eds) (2004). *Good Practice in Adult Mental Health.* London: Jessica Kingsley: 90-107

20) Grasso BC, Bates D, & Shore MF 2007 Medication Errors in Psychiatric Care: Incidence and Reduction Strategies. http://www.medscape.org/viewarticle/558689 2007.

21) Reason JT. Human error, models and management. *British Medical Journal* 2000; 320(7327); 768-770.

22) Gluck PA. Medical Error Theory. *Obstetrics and Gynecology Clinics of North America* 2008; 35; 11-17.

23) Hemingway S, Maginnis R, Baxter H, Smith G, Turner J, & White J. Medicines with Respect (MWR) Phase 1: implementing a pathway toward competency in medicines administration for mental health nurses. *Mental Health Nursing* 2010; 30(3); 12-16.

24) Newell R, Burnard P. (2006). *Research for evidence-based practice.* Oxford, Blackwell.

25) Elo S, & Kyngas H The qualitative content analysis process. Journal of

Advanced Nursing 2008; 62(1); 107-115.

26) Hemingway S, Turner J, White J, Dewhirst K. The Medicine With Respect Project: A stakeholder focus group evaluation. *Nurse Education in Practice* 2012a; 12(6), 310-315.

27) Hemingway S, White J, Baxter H, Smith G, Turner J, & McCann T. '*Implementing a Competence Framework for Administering Medication: Reporting the experiences of Mental Health Nurses and Students'. Issues in Mental Health Nursing* 2012b; 33 (10); 657-664.

28) Mayo AM, Duncan D. Nurse perceptions of medication errors: what we need to know for patient safety. *Journal of Nursing Care Quality* 2004; 19(3); 209-217.

29) Brady AM, Fleming S. A literature review of the individual and systems factors that contribute to medication errors in nursing practice. *Journal of Nursing Management* 2009; 17; 679-697.

30) Fry M, & Dacey C. Factors contributing to incidents in medicine administration Part 1. *British Journal of Nursing* 2007; 16(9); 556-559.

31) Mutsatsa S. *Medicines Management in Mental Health Nursing* 2011; Exeter, Learning Matters.

32) Palese A, Sartor S, Costaperaria G, & Bresadola V. Interruptions during nurses' drug rounds in surgical wards: observational study. *Journal of Nurse Management* 2009; 17; 185-192.

33) Duxbury JA, Wright KM, Hart A, Bradley D, Roach P, Harris N, Carter B. A structured observation of the interaction between nurses and patients during the administration of medication in an acute mental health unit.

Journal of Clinical Nursing 2010b; 19 (1); 1e71.

34) Healthcare Commission (2007) *Talking about Medicines the management of medicines in trusts providing mental health services*. London, Health Care Commission.

35) Eisenhauer L A, Hurley AC, & Dolan N. Nurses' reported thinking during medication administration. *Journal of Nursing Scholarship* 2007; 39 (1); 82-87.

36) Ndosi ME, Newell R. Nurses' knowledge of pharmacology behind drugs they commonly administer. *Journal of Clinical Nursing* 2009; 18; 570-580.

37) Nursing and Midwifery Council. *Standards for medicines management.* 2009; London, NMC.

38) Wright, O. Harmful errors in one in 200 prescriptions. The Times 5TH December 2003.

39) Dimond B. Research shows administration of medicines needs attention. *British Journal of Nursing.* 2003; 12 (7); 397.

40) Coben D, Hall C, Hutton M, Rowe D, Weeks K, & Woolley N 2010. *Research Report: Benchmark Assessment of Numeracy for Nursing: Medication dosage calculation at point of registration.* 2010; Edinburgh, NHS Education for Scotland (NES).

41) Wright K. Student nurses need more math to improve their drug calculating skills. *Nurse Education Today* 2005; 27; 278-285.

42) Preston R. Drug errors and patient safety: the need for a change in practice. *British Journal of Nursing.* 2004; 13 (2); 72-78.

43) Weeks K W, Lyne P, Mosely L, & Torrance C. The strive for clinical

effectiveness in medication dosage calculation problem solving skills: The role of constructivist theory in the design of a computer-based ''authentic world'' learning environment. *Clinical Effectiveness in Nursing.* 2001; 5; 18-25.

44) National Institute of Mental Health Medicines adherence: Involving patients in decisions about prescribed medicines and supporting adherence CG76 2009; http://www.nice.org.uk/cg76, accessed 13/11/12.

45) Nursing and Midwifery Council Standards for medicines management. 2009; London, NMC.

46) Schyve PM. 2007 Language Differences as a Barrier to Quality and Safety in Health Care: The Joint Commission Perspective. *J Gen Intern Med* 22(Suppl 2) 2007; 360–361.

47) Polit DF, & Beck CT 2010. *Generalization in quantitative and qualitative research: Myths and strategies International. Journal of Nursing Studies* 2010; 47; 1451-1458.

.

Fig. 1: What do you think are the barriers to safe administration of medication?

☐ Environmental factors

Comments:

☐ Pharmacology knowledge

Comments:

☐ Complicated documentation

Comments:

☐ Drug calculations

Comments:

☐ Service user adherence

Comments:

☐ Time management

Comments:

☐ Cultural factors

Comments: