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Which alternative communication methods are effective for voiceless patients in Intensive Care Units? A systematic review

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ABSTRACT

Objective

To assess the effectiveness of Augmentative and Alternative Communication (AAC) strategies to enable people who are temporarily voiceless due to medical intervention, to communicate.

Methods

A systematic review informed by a protocol published on an international register. Ten databases were searched from January 2004 to January 2017. Included studies assessed the effect of using AAC strategies on patient related outcomes and barriers to their use. All included studies were quality appraised. Due to the heterogeneity of interventions and outcome measures findings were narratively reviewed.

Results

Twelve studies met the inclusion criteria and were included in the review reporting outcomes from 1981 patient and 454 health professional participants. The quality of included studies were moderate to weak. AAC communication strategies increased the number of communication interactions, improved patient satisfaction with communication and reduced communication difficulties. Barriers to usage were device characteristics, the clinical condition of the patient, lack of timeliness in communication and staff constraints.

Conclusions

There is preliminary, but inconsistent evidence that AAC strategies are effective in improving patient satisfaction with communication and reducing difficulties in communication. A lack of comparable studies precluded the identification of the most effective AAC strategy.

KEYWORDS

Alternative and Augmentative Communication, Communication, Critical Care, Intensive Care, Mechanical Ventilation, Systematic Review

INTRODUCTION

Intensive care units (ITUs) provide treatment and monitoring for patients with life threatening conditions. Respiratory support through intubation and mechanical ventilation is a common intervention received by almost half of all patients admitted to ITUs; a figure that equated to over 69,000 patients in 2012 in the UK alone (Intensive Care National Audit & Research Centre, 2014). Data from other countries indicates that mechanical ventilation is used globally (Rose et al, 2009; Wunsch et al, 2013). Whilst this is lifesaving treatment, patients are rendered temporarily voiceless which can cause psychological distress (Khalaila et al, 2011), frustration (Foster, 2010), and panic (Engström, 2013). Importantly emotional distress experienced in the ITU setting is a predictor of post-traumatic stress disorder during recovery (Wade et al, 2012). Effective communication strategies have the potential to improve long-term health outcomes of ITU survivors but are difficult to implement in clinical practice. Even when communication is possible, via written or non-verbal means, it seldom occurs in a timely fashion, leaving room for improvement (Happ et al, 2007).

The phrase Augmentative and Alternative Communication (AAC) strategies describes a set of tools, technologies and/or approaches (see table 1) used to solve communicative challenges (International Society for Augmentative and Alternative Communication, 2014), and provide a potential solution to communication difficulties for voiceless patients. Although AACs are typically used by patients who have become voiceless due to acquired neurological or neuromuscular conditions, they can also be used to optimise communication for intubated patients in ITU settings. The aim of this systematic review is to identify the most effective AAC strategies and potential barriers to their use in critical care settings.

METHODS

A systematic review of the published literature was conducted as described in the search strategy. Accepted approaches to support the rigour of our methods were adopted, as described in the review protocol (CRD42015014761) which is registered on an international database http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42015014761. These approaches included the independent selection, review and appraisal of studies. The manuscript was structured to reflect the recommendations described in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline (Liberati et al, 2009) to reflect best practice and transparency in reporting of review methods.

Aim and objectives

To assess the effectiveness of Augmentative and Alternative Communication (AAC) strategies in enabling people who are voiceless due to medical intervention, to communicate, with the following objectives:

1. Identify the most effective AAC strategy;
2. Identify the impact of AAC strategies on patient outcomes up to 12 months after implementation;
3. Identify barriers to AAC use in ITU.

Search Strategy

An information technologist assisted the team in the development of a robust search strategy which was piloted, adapted for use and systematically applied across multiple data bases (see appendix 1). Studies published before 2004 were excluded to reflect the recent advances in technology. A search of grey literature was conducted using the Evidence Search database. Initial searches were completed on 7.10.14 and updated on 6.1.17.

Study selection

Titles and abstracts of studies published in English were independently assessed by two reviewers (HC and FA) for eligibility against the pre-determined inclusion and exclusion criteria (see table 2) and categorised as 'possibly relevant' or 'clearly not relevant'. This process was repeated with full text articles (HC and FA or WM) grouping studies as 'relevant', 'definitely irrelevant' or 'unsure'. A third reviewer resolved any disagreements about eligibility for inclusion (WM or FA).

Quality appraisal and data extraction

All relevant papers were quality assessed by two independent reviewers (HC and FA or WM). Guidelines from the *Cochrane Collaboration Handbook for Systematic Reviews* (The Cochrane Collaboration 2008) or the *Quality Assessment tool for Quantitative Studies* (Thomas, 2003) were applied, according to the study design, to systematically appraise included studies. The latter tool uses a 'mixed criteria' approach with specific factual questions about the study design and general judgements on the degree of bias and was identified by Deeks et al (2003) as one of the 'best' tools for the quality appraisal of non-randomised studies. A data extraction tool was developed, piloted and refined to ensure that all relevant results were identified. Disagreement in the quality appraisal and data extraction process was resolved by discussion between at least two reviewers, with the involvement of a third where necessary (WM or FA).

Synthesis of results

The heterogeneity in AAC strategies, patient outcome measures and a lack of RCTs meant that the planned meta-analysis was inappropriate. Accordingly results were narratively synthesised.

RESULTS

Study selection and characteristics of included studies

Figure 1 provides a flow chart of the search which identified 2143 articles. Twelve studies fulfilled the inclusion criteria with a total of 1981 patient participants and 454 health care professional participants. All studies were conducted in critical care settings, the majority in America, with participants intubated for a range of conditions.

Studies used either high or low technology AAC strategies with two studies using both. Table 3 details the AAC interventions with high-technology computer-aided AAC strategies (Happ et al, 2004b; Happ et al, 2005; Happ et al, 2014; Maringelli et al, 2013; Miglietta et al, 2004; Nilsen et al, 2014; Rodriguez & Rowe, 2010; Rodriguez et al, 2012; Rodriguez et al, 2016) used more frequently than low-technology AAC strategies such as communication boards (El-Soussi et al, 2014; Happ et al, 2014; Happ et al, 2015; Nilsen et al, 2014; Otuzoglu & Karahan, 2014). The effectiveness of the intervention was assessed using the following outcome measure: patient satisfaction (El-Soussi et al, 2014; Otuzoglu & Karahan 2014; Rodriguez et al, 2016), ease or difficulties in communication (Happ et al, 2004b; Happ et al, 2005; Happ et al, 2014; Maringelli et al, 2013; Otuzoglu & Karahan, 2014; Rodriguez & Rowe, 2010, Rodriguez et al, 2016), communication success or effectiveness (Happ et al, 2014; Happ et al, 2016), initiation of communication (Happ et al, 2005), staff satisfaction (Maringelli et al, 2013; Miglietta et al, 2004), patient agitation and anxiety (Happ et al, 2016) and barriers to use (Happ et al, 2004b; Happ et al, 2014; Rodriguez et al, 2010; Rodriguez & Rowe, 2012). A variety of study designs were used which included some described as randomised controlled trials (RCT) (El-Soussi et al, 2014), randomised cluster trials (Happ et al, 2015), quasi-experimental (Happ et al, 2014; Otuzoglu & Karahan, 2014, Rodriguez et al, 2016), correlational (Nilsen et al, 2014), time-series (Rodriguez & Rowe, 2010) to pilot/feasibility studies (Happ et al, 2004b; Happ et al, 2005; Maringelli et al, 2013; Miglietta et al, 2004; Rodriguez et al, 2012). The studies described as randomised trials (El-Soussi et al, 2014; Happ et al, 2016) were treated as controlled or cohort analytic trials as the reported randomisation process was unclear.

Quality appraisal

Following a systematic quality appraisal ten studies were rated as weak and two as moderate (inter-rater reliability k=0.75). This may reflect the study design, rather than the quality of included studies. In most cases the design was not an RCTs which reduced appraisal scores. More recent trials (Happ et al, 2015; Rodriguez et al, 2016) were rated as moderate as they addressed this challenge by taking control data from before the intervention was introduced. The likelihood of selection bias was moderate in the trials included in the study. Blinding of outcome assessors and participants was not possible and studies did not control for confounders. Most studies were conducted in a single centre and used researcher-generated outcome measures that were not tested for validity and reliability. Withdrawal and drop-out rates ranged between 0 and 54%, or the reporting was unclear.

Synthesis of results

The included studies used a variety of AAC strategies but a meta-analysis to compare data across studies was not appropriate due to the heterogeneity of study designs and outcomes measures. The AAC strategies that were used were reported to reduce difficulty in communication (Happ et al, 2004b; Happ et al, 2005; Happ et al, 2014; Maringelli et al, 2013; Otuzoglu & Karahan, 2014), improve patient satisfaction in communication (El-Soussi et al, 2014; Miglietta et al, 2004; Rodriguez & Rowe, 2010; Rodriguez et al, 2012; Rodriguez et al, 2016), reduce patient frustration in communication (Rodriguez et al, 2016), increase communication interactions (Happ et al, 2014) and increase positive nurse behaviours such as smiling or giving preparatory information before a procedure (Nilsen et al, 2014).

The effects of low technology AAC

Five studies used low technology AAC strategies for at least one of the intervention groups (El-Soussi et al, 2014; Happ et al, 2014; Happ et al, 2016; Nilsen et al, 2014; Otuzoglu & Karahan, 2014). Comparison between the two different types of AAC strategies was not attempted in Nilsen et al (2014) and although the count of different AAC strategies was positively correlated with positive nurse behaviours ($F = 9.93$, $p = 0.002$), the results cannot be included in any comparison. Happ et al (2014) measured ease of communication using a Likert scale from "not difficult at all" to "extremely difficult" at the end of observed session throughout the same three phase study. Lower proportions of patients reported communication difficulties after receiving AAC strategies and the calculated risk ratio of 0.80 represents small effect, although this was non-significant for both phases ($F=7.67$, $p<0.01$). One unit in this multi-centre study observed a significant increase in the communication interactions when using low technology AAC strategies ($t=4.17$, $p<0.001$).

El-Soussi et al (2014) measured patient satisfaction using the Patient Satisfaction Questionnaire (PSQ) with response scores categorised as “Very dissatisfied” (20-44 points on the PSQ scale); “Dissatisfied” (43-59 points on the PSQ scale); “Satisfied” (60-79 points on the PSQ scale) or “Very satisfied” (80-100 points on the PSQ scale). Patient satisfaction was considered to be represented by a response in the “Satisfied” or “Very satisfied” categories; i.e. by a PSQ score of 60 or above. Otuzoglu and Karahan (2014) measured patient satisfaction using a single dichotomous item, in which patients were requested to report whether or not they were satisfied that appropriate methods had been used by medical staff to communicate with them. Both studies found that patients receiving an AAC strategy had higher proportions of reported satisfaction levels with communication in intervention groups. Medium to large effects were noted in these studies with risk ratios of 2.50 from El-Soussi et al (2014) and 2.11 from Otuzoglu & Karahan (2014).

Happ et al (2015) examined the effect of enhanced communication versus usual care on several patient outcomes including documented pain levels (-0.11, p=0.97), ICU-acquired pressure ulcers (-0.11, p=0.78), physical restraint use (-2.44, p=0.44) and heavy sedation use (1.08, p=0.73) as indicators of effectiveness and anxiety. There was no statistical significant difference reported across the two groups.

The effects of high technology AAC

Nine studies used high technology AAC strategies for at least one of the intervention groups (Happ et al, 2004b; Happ et al, 2005; Happ et al, 2014; Maringelli et al, 2013; Miglietta et al, 2004; Nilsen et al, 2014;Rodriguez & Rowe, 2010; Rodriguez et al 2012; Rodriguez et al, 2016). As discussed previously, Nilsen et al (2014) and Happ et al (2014) used results from the same three phase study although measuring different outcomes. When measuring communication difficulty, Happ et al (2014) reported decreased reports of high difficulty in communication in the third phase when the intervention included high technology AAC strategies and speech language pathologist consultation ($F=7.67$, $p<0.01$). Only one unit in this multi-centre study observed a significant increase in the communication interactions in this third phase ($t=5.27$, $p<0.001$).

Rodriguez & Rowe (2010) assessed ease of communication by the ability to activate at least three of five functions independently; hence communication difficulties were assessed to be failure to activate at least three of five functions independently. Lower proportions of patients reported communication difficulties when using a high technology AAC strategy with the risk ratio of 0.22 indicating a very large effect.

Three further studies measured communication difficulties when using high technology AAC strategies and found positive results (Happ et al, 2004b; Happ et al, 2005; Maringelli et al, 2013). Happ et al (2004b) and Happ et al (2005) used the Ease of Communication scale, in which higher scores indicated higher levels of communication difficulties. Maringelli et al (2013) administered a questionnaire of 5-point Likert items; two of which measured communication ease. All three studies found lower levels of communication difficulties in patients who had received high technology AAC strategies. Study-specific standardised mean differences were significant at $t>2.62$ ($p=0.047$) in the case of Happ et al (2004b). In Maringelli (2013) significant improvements in communication were noted in the following areas; expressing fundamental needs ($z= -3.48$, $p<0.001$), expressing needs and desires ($z= -3.54$, $p<0.001$), answering questions from hospital staff ($z= -3.46$, $p<0.001$) and communication/interaction with family ($z= -3.51$, $p<0.001$). Mean differences were only slightly lower in the intervention group (X=19.8, SD 9.7 compared to X=22.5, SD 11.3) in Happ et al (2005).

Rodriguez et al (2016) measured communication difficulty using the Perception of Communication Difficulty Questionnaire with contradictory results. No statistical significance was discovered between control and intervention groups (-0.06, p=0.14) despite the trend of improved ease of communication over repeated measures. However comparison of mean scores on the Frustration with Communication Tool showed a statistically significant improvement in the intervention groups using the high technology AAC compared to the control group (-2.68, p=<0.001).

Four studies measured patient satisfaction in using high technology AAC strategies (Miglietta et al, 2004; Rodriguez & Rowe, 2010; Rodriguez et al, 2012; Rodriguez et al, 2016). Miglietta et al (2004) found that 94% of patients were in favour of the continued use of the AAC in their evaluation study. Rodriguez & Rowe (2010) measured satisfaction level using a 16-item Satisfaction and Usability Instrument with scores ranging from 1 "not satisfied at all" to 5 "very satisfied". A mean score of 4.18 (SD = 0.76) indicated that participants were quite satisfied with the strategy. A revised versions of this researcher generated measure was used in a later study by the same author (Rodriguez et al 2012) with findings indicating satisfaction with the high technology AAC strategy. The Satisfaction with Communication Method was used in Rodriguez et al (2016) and statistically significant improvements were found in the intervention group (0.59, p=<0.001) compared to control.

Barriers to AAC use in critical care

Barriers to AAC usage were identified in four studies (Happ et al, 2004b; Happ et al, 2005; Rodriguez & Rowe, 2010; Rodriguez et al, 2012). Poor positioning of the device outside patient reach was noted in all studies, with three studies reporting problems of the device being moved following care (Happ et al, 2004b; Rodriguez & Rowe, 2010; Rodriguez et al 2012). Other issues reported included problems due to the medical condition of the participant (Happ et al, 2004b; Rodriguez & Rowe, 2010; Rodriguez et al, 2012), the device not functioning as designed (Happ et al, 2004b; Happ et al, 2005; Rodriguez et al, 2012), communication taking too long to meet needs (Rodriguez & Rowe, 2010), device bulkiness or complexity (Happ et al, 2004b; Rodriguez & Rowe, 2010), and staff time constraints or unfamiliarity with equipment (Happ et al, 2004b; Happ et al, 2005).

The education and skills training required to use AAC interventions during the trials was considered as this could be a perceived barrier to use. Three studies did not describe any education or training provision for staff and patients (El-Soussi et al, 2014; Miglietta et al, 2004; Rodriguez et al, 2016). Other studies reported that training took place pre-operatively if speechlessness and/or ITU care were expected post-operatively (Otuzoglu & Karahan 2014) but the duration of training was omitted. The duration of education and skills training described in other studies was 10-60 minutes (Happ et al, 2004b; Happ et al, 2005; Maringelli et al, 2013; Rodriguez & Rowe, 2010; Rodriguez et al, 2012). The types of training was varied including provision of written instructions (Happ et al, 2005), face to face training (Happ et al, 2004b; Happ et al, 2015; Maringelli et al, 2013), or overviews of the usability of the device (Rodriguez & Rowe, 2010; Rodriguez et al, 2012).

DISCUSSION

The current evidence is rather limited by the variability in study design, a lack of trial evidence and the use of researcher-generated outcome measures with unknown psychometric properties. The lack of RCTs meant that the planned meta-analysis to assess the most effective AAC strategy was not feasible. However although findings were somewhat inconsistent there does appear to be preliminary evidence that both low and high technology AAC strategies significantly increase the number of communication interactions, reduce communication difficulties and increase self-reported satisfaction with communication. The provision of enhanced communication did not appear to translate directly into reductions in patient pain scores, incidence of pressure ulcers, physical restraint use or reduced sedation use. Several significant confounders might explain these findings such as clinical acuity.

Review findings do show that AAC strategies can be used in an ITU setting. It is possible for voiceless patients within ITU, with the support of their nurse, to gain the necessary knowledge, judgement and skills to acquire communication competence as suggested by Light and McNaughton (2014). Potential barriers to using AAC strategies were staff time constraints, unfamiliarity with the equipment, as well as poor repositioning of the device for use following direct care. Despite the potential challenges of using AAC strategies in ITU settings findings suggest that as satisfaction with communication improved, and communication difficulties decreased, then the functionality and adequacy of communication was achieved with relatively little additional training provided to staff and patients. Barriers to optimum use of AAC strategies related to the functionality of communication; such as AAC devices being too bulky with the speed of communication using them reported as too slow. However the barriers to AAC use were not consistently explored across all studies.

The AAC strategies ranged from low-cost and low-technology tools to high cost and high-technology computer-based tools. Conclusions about the cost-effectiveness of AAC strategies could not be made as no economic analyses were reported.

To our knowledge this is the first systematic review investigating the effectiveness of AAC strategies to improve communication for patients admitted to ITU that are temporarily voiceless due to medical intervention. One systematic review on a similar topic, published during the peer review of this manuscript, provided an excellent summary of communication methods for adult mechanically ventilated patients and an algorithm to inform decision making when selecting AAC strategies for use (ten Hoorn et al, 2016). Our findings regarding the positive effects of AAC strategies on communication and patient satisfaction are supported in this earlier review.

As with most reviews there are limitations which should be mentioned. We limited our search to articles published in English, published after 2004, so it is possible that potentially relevant studies using older but relevant AAC strategies may have been omitted. The majority of included studies were conducted in America which highlights the lack of European studies and may affect the generalisablity of findings to other countries.

Further investigations comparing the different types of AAC strategies are necessary to determine which would be most beneficial in this setting. Should low-cost tools be shown to be as effective as high technology AAC strategies, this would have obvious implications on cost effectiveness. Future studies also need to consider the functionality of tools to meet the demands required by patients in ITU. This will ensure that all communication needs are met, involving family members as well and members of the health care team. The importance of effective communication between patients, their family members and health professionals in shared decision-making is central to health policy. AAC strategies offer an effective strategy to optimising such communication in ITU settings worldwide.

CONCLUSION

The most effective AAC strategy for use in ITU settings is unknown. However, results suggest that there is preliminary but inconsistent evidence that AAC strategies are effective in improving satisfaction with communication and reducing difficulties in communication for patients rendered temporarily voiceless due to intubation. The results indicate that communication competence is achievable in ITU despite the difficulties of learning new skills when suddenly voiceless in an anxiety-provoking environment. This suggests that using AAC strategies in ITU are feasible and beneficial to patients. Further research should identify which strategy is most beneficial and cost-effective.

The results of the review indicate that AAC strategies can be implemented in ITU settings to enable voiceless patients to communicate with health care staff and family members. The International Nursing Council (ICN) recognises that communication using information and communication technology is central to person-centred care and has the potential to alleviate suffering and improve well-being (ICN 2014). In particular, the benefits to patients in reducing difficulties in communication and improving satisfaction in communication using AAC strategies has the potential to reduce in-patient psychological distress and long-term psychological morbidity in ITU survivors. The barriers identified indicate that staff training time is required to familiarise nursing staff with the AAC strategy and ITU staff need to be aware of repositioning the device after episodes of care to allow continuity of use. By enabling patients in ITU to communicate more effectively, we will not only be improving the care demonstrated to patients, but also maintain their human right to communicate.

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DECLARATIONS

The authors have no past or present affiliation with any parties who would have an interest in the outcome of this review that could constitute a conflict of interest.

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APPENDIX 1: SEARCH STRATEGY; MEDLINE (EBSCO)

MeSH heading: Communication

Non-speaking OR voiceless OR non-vocal OR communication disorder OR tracheo?tomy OR 'endotracheal tube' OR 'endotracheal intubation' OR laryngectomy OR 'head surgery' OR 'neck surgery' OR speechless* OR mechanical ventilation OR intubated

'communication adj4 technolog*' OR 'communication adj4 tool' OR 'communication aid for disabled' OR 'communication method' OR 'Augmentative and Alternative Communication' OR 'communication strategy' OR 'lip-reading' or 'voice output' OR 'speech output' OR 'speech generating device' OR 'voice output communication aid' OR 'eye gaze' OR 'switch access' OR 'communication intervention' OR 'computer communication' OR 'nonverbal communication' OR 'alternative communication' OR 'augmentative communication' OR 'tablet computer'

#1 AND #2 AND #3

DATABASES

MEDLINE, AMED, CINAHL, PsychINFO, Cochrane Central Register of Controlled Trials (CENTRAL), Web of Science, WileyOnline, TRIP database, and the digital libraries of the Association of Computing Machinery (ACM) and the Institute of Electrical and Electronics Engineers (IEEE). All were searched from 2004 to January 2017.

TABLES & FIGURES

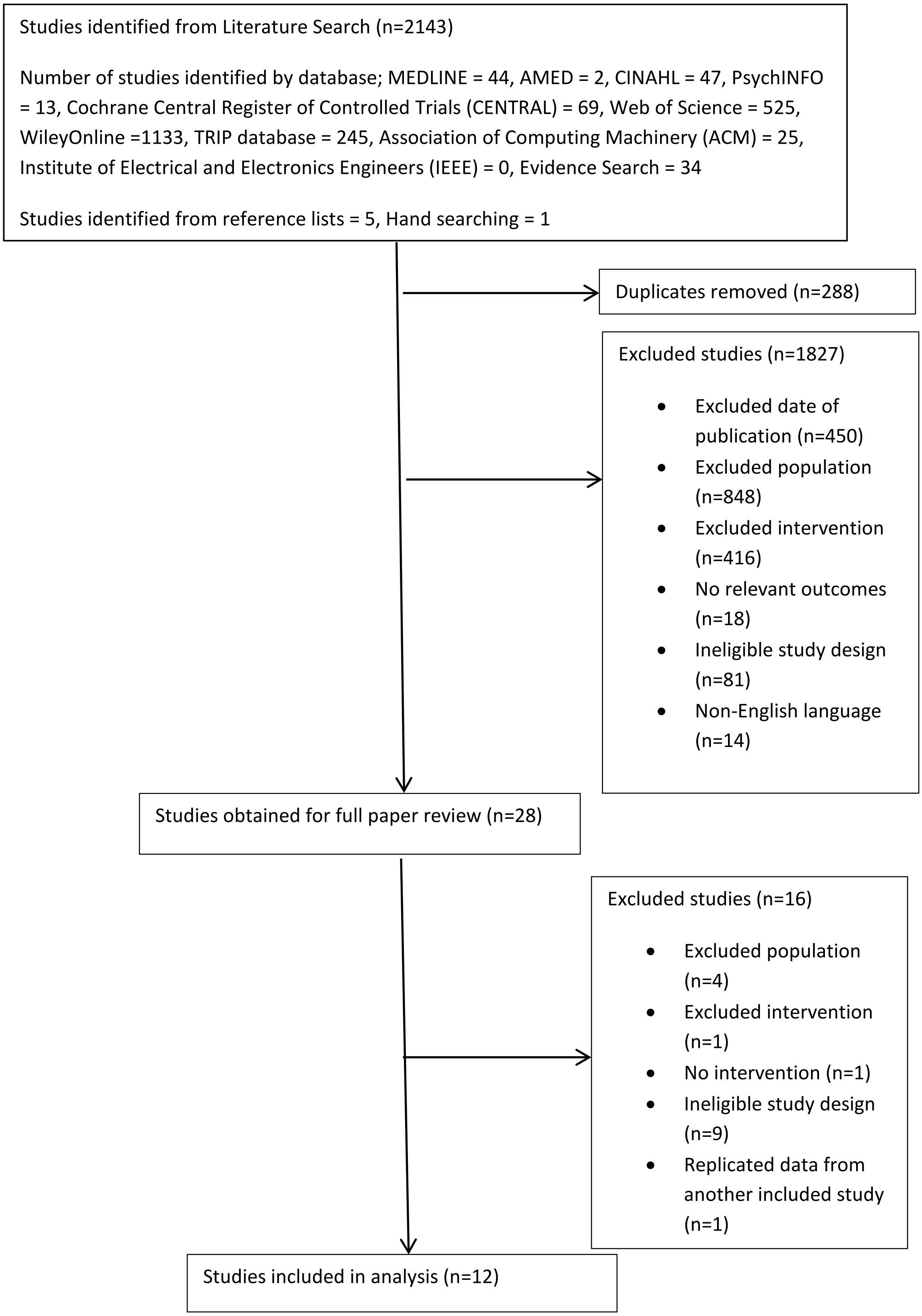
Table 1: Examples of Augmentative and Alternative Communication (AAC) strategies

Low-technology AAC	*High-technology AAC strategies*
• Communication/picture boards or books • Alphabet charts • Symbol charts • Paper and pen	• Speech-generating devices e.g. the DynaMyte and the MessageMate • Mobile technologies using ‘apps’ • Eye controlled assistive technology • TheGrid2 AAC package, Sensory Software International, UK. Running on standard PC integrated with an 'all-in-one' eye tracker and touch screen device • LifeVoice computer communication system (LifeVoice Technologies Inc, NJ).

Table 2: Inclusion Criteria

Study Design • Randomised controlled trials (RCT) including randomised crossover and cluster randomised trials. • Quasi-experimental and observational trials (included due to a low number of RCTs in this area).
Study Participants • Adults (above 18 years old) rendered temporarily voiceless due to medical intervention; including, but not restricted to, tracheostomy, laryngectomy, head and neck surgery, and endotracheal intubation. Studies with paediatric populations or adult populations with pre-existing cognitive impairments, traumatic neurological deficit (e.g. CVA), progressive neurological disease or learning difficulties were excluded, as the pre-existing knowledge, judgement and skills would be different for these populations. Studies using mixed populations were included if it was possible to separate the data between included and excluded populations.
Types of Intervention • Any AAC strategy, technology or tool used to allow communication by the voiceless person defined as ; • AAC strategy: a method of using aids, symbols and/or techniques to facilitate communication; • AAC tool: a device employed to facilitate communication; • AAC technology: a machine or computer used to facilitate communication.
Outcome Measures • Any outcome quantitatively measuring the **quality** (i.e. communication success, ease of use), and **frequency** of communication between a voiceless person and their family members and/or health professional. • Outcomes measuring the **impact** of communication were also considered, including but not restricted to, psychological status (e.g. anxiety, depression, frustration), and satisfaction with care. • Outcomes measurements up to 12 months after the implementation of any AAC intervention were included.

Figure 1: Flowchart for study selection



*inter-reliability between reviewers between reviewers for the selection process was good (k=0.8).

Table 3: Summary of included studies

	Study design	Study setting	Number of participants	Inclusion criteria	Intervention(s)	Outcomes	Follow-up
El-Soussi et al 2014	Controlled Clinical Trial (unclear randomisation)	Pulmonary Critical Care, Egypt	60 patients	Intubated; COPD	Modified communication board and paper/pen	Satisfaction & quality of use questionnaire (author devised)	Not described
Happ et al 2004b	Mixed methods (qualitative and before & after quantitative measures taken concurrently)	Critical Care, US	11 patients	Intubated; responsive to verbal stimuli; able to follow simple commands; able to understand English; able to complete 6/8 Cognitive Linguistic Screening tasks	The DynaMyte with synthesised computer generated voice output The MessageMate	Frequency of usage Ease of Communication Scale Barriers observed	Until extubation or hospital discharge
Happ et al 2005	Mixed methods (qualitative and quantitative measures taken concurrently)	Critical Care, US	20 patients	Intubated; responsive to verbal stimuli; able to follow simple commands; able to understand English; able to complete 6/8 Cognitive Linguistic Screening tasks	The DynaMyte 3100 model device with vital voice The MessageMate	Frequency of usage Ease of Communication Scale Communication initiation observed Barriers observed	Until extubation or hospital discharge
Happ et al 2014	Quasi-experimental three phase cohort study	Medical and Cardiothoracic Critical Care, US	127 patients 42 nurses	*Patients:* Intubated without ability to vocalise; predicted to remain intubated for 2 days; awake and responding to commands; understands English	1) usual care, little to no communication materials available 2) nurse training, communication cart with low tech AAC supplies to ITU	Frequency of usage Ease of usage Likert scale (author devised)	Not described

				<u>Nurses:</u> more than 1 year critical care practice, regularly working 2 consecutive days	3) further nurse training, Speech & Language Pathologist assessment and care, electronic AAC and low tech tools matched to patient	Positive nurse behaviours Success rate	
Happ et al 2015	Randomised crossover cluster	Critical Care, US	1440 patients 323 nurses	<u>Patients:</u> first ITU admission during hospital stay, invasive mechanical ventilation for more than 2 days, awake or alert for at least 1 nursing shift <u>Nurses:</u> all full and part-time staff	One-hour online training including video exemplars for all bedside nurses, included the provision of communication supplies and weekly bedside teaching rounds with Speech and Language Pathologist	Effectiveness measured by pain score documentation, presence of ICU acquired ulcers. Anxiety and agitation measured by ITU days with physical restraint or heavy sedation	Not described
Maringelli et al 2013	Cohort study	Critical Care, Italy	15 patients 8 Physicians 15 nurses	Aged 18-75; Intubation and complete dysarthria; no previous use of AAC technology; normal or corrected to normal sight; absence of severe cognitive deficits	TheGrid2 AAC package, Sensory Software International, UK. Running on standard PC integrated with an 'all-in-one' eye tracker and touch screen device	Patient Satisfaction Likert scale (author devised) Staff Satisfaction Likert scale (author devised)	Not described
Miglietta et al 2004	Prospective Evaluation	Multi-trauma and Neuro-trauma	32 patients 42 staff	Aged 18-65; nonverbal acutely ill trauma patients; intact visual acuity; intact	LifeVoice computer communication	Control system usage	Not described

		Critical Care, US		auditory acuity; English speaking	system (LifeVoice Technologies Inc, NJ). Controlled by eye blinking and/or hand or finger movement	Patient Satisfaction Likert scale (author devised) Staff Satisfaction Likert scale (author devised)	
Nilsen et al 2014	Descriptive correlational	Medical and Cardiothoracic Critical Care, US	38 patients 24 nurses	Aged 60 or older; Intubated and ventilated for >48 hours and expected to continue got 2 days; awake and responding to commands; able to understand English	1) usual care, little to no communication materials available 2) nurse training, communication cart with low tech AAC supplies to ITU 3) further nurse training, Speech & Language Pathologist assessment and care, electronic AAC and low tech tools matched to patient	AAC device usage Correlation with positive nurse behaviours	Not described
Otuzoglu & Karahan 2014	Controlled Clinical Trial	Cardiovascular Surgical Critical Care, Turkey	90 patients	Aged 18 or over; undergone open heart surgery	Author-developed illustrated communication material	Satisfaction scale (author devised)	Until extubation
Rodriguez & Rowe 2010	Time series	Critical Care, US	21 patients	Aged 50 or older; able to verbally communicate at time of consent; read and write English; Mini-Mental	The Springboard programmable speech-generating device	Independency in usage QUEST Satisfaction &	Not described

				Score >24; no previous history of speechlessness; ability to use upper limbs		Usability Instrument	
Rodriguez et al 2012	Time series	Critical Care, US	11 patients	Aged 21 or older; intubated and/or experiencing sudden speechlessness; no delirium; <+-2 in Richmond Agitation Sedation Scale; able to read and speak English	Programmable speech generating device using software on a tablet computer	Usability of Communication Intervention Form Patient Satisfaction & Usability Instrument	Not described
Rodriguez et al 2016	Quasi-experimental four phase cohort repeated measures design	Critical Care, US	116 patients	Sudden speechlessness for more than 8 hours, Aged 21 or older, ability to read English or Spanish, ability to see and use one arm, no permanent speech disability or previous use of communication aid, +1 to -1 in Richmond Agitation Sedation Scale, no delirium	Software associated with a 9.7" touch screen tablet personal computer (included pictorial hot buttons with spoken messages, handwritten messages with stylus, typewriting ability)	Perception of Communication Difficulty Questionnaire Frustration with Communication tool Satisfaction with Communication Method tool Usage	Following transfer from Critical Care