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Abstract

Alert and transiently nonvocal intensive care unit (ICU) patients are dependent on augmentative and alternative modes of communication (AAC). Unfortunately, the literature demonstrates that existent AAC devices have not been widely adopted, and unaided methods are often the primary modalities used despite being insufficient, and frustrating. We present the results of a qualitative semi-structured interview study with 8 ex-ICU patients and 10 ICU-patient relatives and staff exploring their AAC needs and requirements. Participants identified important AAC hardware, software, and content requirements. Salient factors impacting upon AAC adoption in the ICU setting were also highlighted, including the need for staff training and bedside patient assessment. Based on the study results, we propose a series of recommendations regarding the design and implementation of future AAC tools specifically targeted at this group.

Key Words: Augmentative and alternative communication; Communication aid; Critical care; Intensive care; Speech disorder

Communication Aid Requirements of Intensive Care Unit Patients with Transient Speech Loss

More than 200,000 patients are admitted to intensive care units (ICU) in the United Kingdom each year (Health & Social Care Information Centre, 2014). In the critical care environment, transient speech loss due to tracheal intubation or tracheostomy insertion for the purposes of mechanical ventilation is a common scenario (Happ, 2001; Happ et al., 2010). In the absence of sedation intubated patients and those with tracheostomies may be left fully aware of their surroundings but unable to talk. This represents one of the most frequently reported distressing symptoms in this patient group, resulting in feelings of frustration, anxiety, and sleeplessness (Pennock, Crawshaw, Maher, Price, & Kaplan, 1994; Rotondi et al., 2002). Other common causes for difficulties in communication in the ICU setting include trauma, stroke and other neurological conditions, and head and neck surgery.

Transiently nonvocal ICU patients and their communication partners often resort to the use of modalities other than speech in order to communicate (Broyles, Tate, & Happ, 2012) – referred to as augmentative and alternative communication (AAC). Numerous AAC strategies exist and these may be categorized as unaided (for example the use of gesture, body language or mouthing), low-tech communication aids (for example the use of pen and paper or picture boards), and high-tech communication aids (for example the use of devices with pre-recorded speech, or computer based devices with synthesized speech) (Baxter, Enderby, Evans, & Judge, 2012).

While many AAC tools and devices have been designed for use by patients with longterm communication deficiencies, several studies have also evaluated AAC tools created specifically for use in the critical care setting, where speech loss may be sudden, fluctuant, and transient. Patak et al. (2006) demonstrated that use of an ICU-specific communication board reduced

perceived levels of frustration among mechanically ventilated patients when communicating. Use of communication boards has however, also been described as tedious, slow, and limited (Rodriguez et al., 2012).

MacAulay et al. (2002), Miglietta, Bochicchio, and Scalea (2004), and Rodriguez et al. (2012) described and evaluated the feasibility of various speech generating devices (SGD) designed and tailored for use by ICU patients. Although MacAulay et al.'s ICU-talk project (1999-2002) identified many implementation barriers and challenges that have ultimately resulted in a failure of adoption of the technology, Miglietta et al. and Rodriguez et al. demonstrated more favorable results. Patients in the latter studies reported high levels of satisfaction with the SGDs under investigation and felt better able to communicate their needs. Furthermore, use of the tools was reported to have required minimal instruction.

While some centres have managed to successfully implement a variety of AAC devices (Costello, 2000; Hurtig & Downey, 2009), few communication aids have been widely adopted in the critical care setting, despite the aforementioned benefits. The literature highlights that unaided modalities (such as gesturing and silent articulation of speech) are still often the primary mode of communication used by critical care patients, despite evidence showing that they are insufficient, disappointing and frustrating (Broyles et al., 2012; Carroll, 2004; Etchels et al., 2003; Happ et al., 2011). In a prospective observational study of two ICUs, Happ et al. (2011) analyzed more than 900 communication exchanges between intubated transiently nonvocal patients and nursing staff and demonstrated that the predominant AAC strategies used were unaided. The use of low-tech communication aids was relatively rare, with virtually no use of high-tech communication aids reported.

Technology acceptance requires devices to be effective, efficient, and satisfying from an end-user's perspective (Brooke, 1996). A user-centred approach to the design and development of AAC devices is therefore critical. While several studies have investigated the feasibility of using AAC devices in the ICU setting (MacAulay et al., 2002; Miglietta et al., 2004; Rodriguez et al., 2012), little work has been published in the literature specifically exploring the needs and requirements of transiently nonvocal intubated patients and their communication partners from electronic AAC devices, in order to guide development of high-tech communication aids.

With the current mobile device revolution, technologies such as smartphones, tablet computers, and the software applications ("apps") that run on them have become relatively ubiquitous and are increasingly being used in the healthcare context (The Deloitte Consumer Review, 2013; Powell, Landman, & Bates, 2014). An app-based solution may represent a potentially useful and cost-effective means of delivering an AAC tool to ICU patients. Several app-based communication aids are commercially available ("Greenhouse publications", 2010; "Society of Critical Care Medicine patient communicator app for iPad", 2015; "Vidatak: Innovation in patient communication", 2013), though research around their development has not been published and the extent to which end-users were involved in their development remains unclear.

In the work reported in this paper, we present a qualitative interview study of ex-transiently nonvocal ICU patients and their communication partners exploring their AAC device needs and requirements. We also investigate perceptions regarding the feasibility of using mobile technologies (such as tablet computers and apps) to deliver a novel communication aid solution. A qualitative research methodology was adopted because of the exploratory nature of the research. The results of the study are used to generate a series of recommendations with the aim

of guiding future AAC device development specifically for this patient population. The recommendations may also be used as a framework with which to evaluate such devices.

Method

The study was granted ethical approval by the NHS Grampian ethics committee (Ref: 14/NS0065) and all participants provided informed consent prior to their involvement.

Participants, Recruitment, and Sampling

Interviews were undertaken with individuals from stakeholder groups identified from the literature and the authors' experience as key within the ICU communication process: patients who had previously been intubated and transiently nonvocal on ICU, their relatives, and ICU staff members were recruited to the study. Patient and relative participants were recruited through the ICUsteps patient support charity ("ICUsteps – The intensive care patient support charity", 2016) and staff members were recruited from the ICU department of a large London teaching hospital, through a process of opportunistic sampling. The sample size was estimated according to the likely point of data saturation as per previous qualitative studies with similar populations (Happ, Roesch, & Garrett, 2004; Judge & Townsend, 2013) and the available time frame for study completion.

Inclusion and Exclusion Criteria

Only fully competent adults (above the age of 18 years) were enrolled into the study. In order to participate, ex-ICU patients had to have experienced an admission to ICU in the preceding 5 years (from the date of study commencement) in which they experienced a transient inability to speak due to either intubation or the insertion of a tracheostomy tube. In order to take part, relative participants had to have visited an ex-ICU patient participant during their ICU admission at a time when they were unable to communicate vocally. Finally, any ICU doctor,

nurse, or SLT involved in the direct care of ICU patients with transient speech loss was eligible to take part. Any individual under the age of 18, or with pre-existing communication impairment was excluded.

Interview Procedure

In-person and Skype[2] ® based semi-structured interviews were performed by two members of the research team, both with medical backgrounds and trained in the interviewing process. Interviews were based on topic guides devised for each participant group. The guides were designed to explore the range of issues related to communication, and covered the following broad areas; (a) ICU experience, (b) reasons for communication, (c) means of communication, (d) opportunities for communication, (e) AAC user needs and requirements. Prior to use, the topic guides were reviewed by the entire research team and two ICU staff members (distinct from the study cohort) to ensure relevance of wording and content. Interviews were designed to last approximately 60 min and were audio-recorded and transcribed verbatim.

Data Analysis

The data were thematically analyzed using an inductive template analysis approach (Thorpe and Holt, 2008). The entire data analysis was performed by two researchers both of whom had training and experience in qualitative data analysis. Braun and Clarke's (2006) six-step framework and 15-point checklist were used to ensure high-quality thematic analysis throughout. An inductive approach was adopted in order to fully explore the richness of gathered data and to avoid prematurely terminating analysis by limiting this to data related only to preconceived theories or frameworks. An inductive approach ensures that hypotheses and theories are data driven, and avoids the need to fit data into pre-existing models and frameworks and the risk of overlooking important data patterns (Mills, 2010).

Interview transcripts were cross-checked against original audio-recordings for completeness and accuracy. Researchers read and re-read interview transcripts to ensure full immersion in data prior to analysis. The nVivo$^{3\ TM}$ (Version 10.2.1) software package was used to code interview transcripts. Analysis of a subsection of data enabled an initial template of themes to emerge. The topic guide headings were used as a-priori high-level themes within this initial template, however coding was not restricted to these. The template was then used to analyze the whole data set, and was modified as new themes emerged. The process was continued until a final template was established and the entire data set had been coded. Researchers reviewed the coding at regular points throughout the analytic process by jointly discussing representative samples of coded interview transcripts, in order to establish consensus and ensure accuracy of the final codes.

Results

Eighteen participants were recruited into the interview study. The cohort consisted of eight ex-ICU patients, four relatives of ex-ICU patients, and six ICU staff members. The latter group consisted of two senior ICU doctors, two senior ICU nurses, and two speech and language therapists (SLT) working in ICU. (See participant demographics in Tables 1, 2, and 3). Interview duration ranged from 24 – 71 min (M. interview duration = 43 min, SD = 14 min).

The data reported in this paper is a sub-set of the overall data analysis. Specifically, data coded against two higher themes are reported: (a) AAC device specifications, and (b) AAC device adoption considerations. This analysis is presented below and illustrated with verbatim quotations (P=patient, R=relative, D=doctor, N=nurse, S=SLT).

AAC Device Specifications

Patient and relative participants included in this study had no experience of using high-tech AAC devices. As such when exploring their thoughts about an AAC device, patients were asked to imagine a device designed to help them to address the problems they faced when communicating. Thoughts regarding a tablet-based solution were also specifically explored. Participants described a variety of requirements for an AAC device and these related to four separate subthemes that emerged from data analysis: (a) hardware requirements, (b) software/user-interface requirements, (c) content requirements, and (d) accessibility requirements. Each of these subthemes is discussed in depth below.

Hardware requirements. Interview data highlights the importance of an AAC device's size and weight. In light of the prevalence of motor impairment in this patient population, staff explained that any developed AAC device should be lightweight: "Okay so hardware, as I said, tablet device, quite large, and very light." (N1). A clear preference for a larger screen size was also expressed by all participant groups in order to overcome hindrances caused by visual and fine motor impairment: "Big actually. Because being ventilated can affect your eyes… my eyesight was quite fuzzy. So the bigger the better." (P3); "They have to be big enough for a patient to see and big enough for a patient to actually target with their finger." (N2).

Patients and staff pointed out however that an AAC device's screen size should not be so large as to obscure the patient's view, and a tablet-sized device was perceived to offer a good compromise.

> I mean it obviously can't be too big because of everything else that surrounds you. Again you go back to the iPad that is a size that's not huge but it's not too small. I wouldn't have thought it's a size that would get in the way of other things within the hospital, within the bed surroundings. (P6)

Furthermore, while a large screen size and lightweight construction were desirable, the tension existing between these two attributes was articulated by a staff member:

> Again you run into certain problems don't you, the bigger it is the heavier it is. Our patients generally have been wasting away in their beds and lose their muscle tone… and their strength and stamina…. It's got to be small enough to be portable and user friendly in terms of weight, but also it has to be big enough that the patient can actually see it and use it. (N2)

The importance of an AAC device's aesthetics was explored and interview data highlights that this was not a primary concern among any participant group: "I think aesthetics are not so important as robustness and usability." (N2); "When you're in that situation in intensive care, if it worked you wouldn't care what it looked like." (P3).

In general, use of a tablet device for the purposes of AAC was viewed as an attractive proposition by patients, relatives, and all staff groups:

> You look at the iPad and it's a perfect piece of design because it just has no extra bits that do anything else, it's just the screen and that's it. And it's quite difficult to think of something that would be cleaner and simpler than that. (P6)

An SLT participant caveated this however, by explaining that a tablet-based AAC tool would be useful in selected patients who exhibit good cognitive function, dexterity, and vision.

> It depends who we are talking about. If we're talking about someone who has total dexterity, perfect vision, they just can't speak because they've got a tracheostomy then obviously if they had some sort of iPad device or an app… that would be very effective. But it's a very different story if you've got somebody with critical neuropathy or a head injury or acute delirium or all those other things. (S2)

Several benefits of tablets were specifically cited including the technology's simplicity, ease-of-use, and familiarity, which were perceived to negate the need for extensive training. The touch screen capability of tablets was also perceived to be well suited to the task of AAC: "Although an iPad would be easier… To just get the swipe things is so much easier and tap things on the screen is definitely much easier for somebody who is debilitated." (R1); "Because it's only a touch and an immediate response. It's really quite easy to train." (S1).

> I guess so in as much as its, as you said earlier, it's familiar, it's simple. It's a very simple looking device. It doesn't have anything that it doesn't need. (P6)

All participant groups emphasized the importance of offering a mounting mechanism to cater for patients that are unable to hold up the weight of an AAC device. Other described requirements included compliance with infection control policy, high durability, waterproof construction, and a prolonged battery life. It was also important that any developed device did not interfere with other ICU equipment.

> Okay so hardware… Durable and not easy to damage. Has a long battery life because it would forever be forgotten to be plugged in… there is an infection control risk, would it be easy to decontaminate between patients?… it would need to be waterproof, again from an electrical safety point of view. (N1)

Software/user-interface requirements. Interview data highlights that all participant groups generally viewed the prospect of an app-based AAC device positively, though some expressed concerns that this could disadvantage older generations: **"**I mean some sort of app that had words that you could associate with would be probably be the best." (P1).

> You're talking generations here so the older generation might not be so familiar with apps… But I'm sure if it's simple then anyone could use it. (N2)

Both patients and staff explained that an AAC device user-interface must be simple to use in order to minimize the requirement for training.

> I think it just has to be a simple and as clear as it possibly could be. It doesn't have any other use other than getting the attention of the person we need to get the attention of and getting the message across to them that you want. (P6)

> It should require no training because we're not expected to train our patients. So therefore it should be a product which you [the patient] should just, that you can just pick up and use without training. (N2)

Participants desired a variety of different methods for constructing messages. In this regard, image selection, phrase selection, text entry, free drawing (using a stylus and tablet screen in the same way one would use a pen and paper), and eye-gaze technology were specifically mentioned.

> I guess wherever there is a choice you've got the option - if the text works better than the icons for you that's great. If it's the other way round it's great. Whereas you can just go down one route you may be alienating some people. For me icons are part of what I do in my job so it's easier. (P6)

One nurse detailed a possible solution for patients to communicate specifically about pain:

> A thing that I've just thought of, if you're using an app is, when patients are attempting to report symptoms… if you had a diagram of a body and the patient was able to on the screen point to where, say for instance, the pain was that would be a good way. (N1)

Advantages of different methods of message construction were discussed by participants. For example, the use of symbols was perceived to be a useful way of overcoming language barriers in patients who did not speak English as a first language.

> If English isn't your first language, I think symbols are a bit more universal aren't they? And so I guess you wouldn't necessarily have to have something that was multi-lingual if you had symbols that could be easily identified. (P6)

A tension was described between the simplicity of word, phrase, and image selection, which was perceived to only allow limited topics of conversation, versus the freedom of expression and flexibility offered by more arduous text entry: "Maybe both, but definitely icons. Sometimes signs are more obvious. Especially when you're like that. Less so when you get better, you get to do things more normally. But when you're not, the simpler the better." (P5).

> The chances of you having the images that you need in front of you would be pretty slim. So therefore you'd probably be better to just have text…. You'd need thousands of images… So it would be quicker to just use text which you're familiar with anyway. (P4)

In response to direct questioning, patients were willing to make a maximum of 5-10 clicks using an AAC user-interface in order to convey a message. The need for too many clicks was perceived to be a source of frustration and a burden on the user: "As few as possible…. So maybe five and then after that I would have been frustrated." (P2).

The potential of using eye-gaze technology to construct messages was an exciting prospect for some patient and relative participants. Some staff participants however were sceptical explaining that its use in the ICU setting was limited due to patient sedation, orbital edema, calibration needs, and learning barriers.

> I suppose what would have been really nice would be if I could stare at a letter for a certain length of time… Then that would become part of a word. (P4)
>
> Going back to the thing about perhaps not having control over your senses, it might be that you actually cannot look where you want to look. That sounds a bit odd, but it's just

> that frustration of sometimes you're not quite sure what you're looking at. I think certainly in terms of touch, it's easier. But having said that not everybody in that situation can use their hands can they? (P6)

> In very far advanced technology that Steven Hawkins uses for eye tracking, I guess that's attractive but people's eyes, it requires a certain consistency in the patient which we don't have here. So I think simple, self-explanatory, and requiring minimal motor skills. (D1)

SLT participants however, pointed out that in some contexts eye-gaze technology was exactly the method of AAC required by some patients.

> Well I think the ones who would be able to write and use their hands for an app, would not want an app that recognized eye gaze. But the ones who were tetraplegic would have to have an app that was picked up on eye gaze. (S2)

In terms of an AAC device's message output, participants desired both text and voice generation outputs: "If it could yes, that would be ideal [generate audio]." (P1); "…you want it to be perhaps both voice - so the output should be either in voice or in writing." (D2). Difficulties in gaining the attention of communication partners and initiating communication were described by patients, and voice generation output was perceived to be a useful means of overcoming this obstacle.

> But one of the frustrating things, I think, is having a bunch of doctors stood at the end of the bed talking about you, in normal circumstances I would have said, oh excuse me, can you just explain that. But I couldn't. You can't draw their attention… (P6)

Meanwhile, text generation output was perceived by staff to offer greater privacy when communicating.

> So there is always going to be that issue of what's said to somebody in that bed could possibly be heard by somebody in the bed next door. So an electronic device potentially alleviates that if the patient is able to communicate in an electronic written means on a device that somebody else can read. (N1)

Where ICU admission was predictable in advance (e.g., after planned elective surgery), some patient participants felt that prerecording messages with their own voice was a worthwhile feature.

> I think that would be quite helpful actually [pre-recording messages with own voice]. And a voice is very personal isn't it? So maybe if they could hear your voice… (P3)

Several other key requirements of an AAC device's user-interface were highlighted in interviews including the need for users to be able to construct messages reliably, rapidly, and efficiently (i.e., with minimal burden to the user) – these requirements were highlighted by all participant groups: "Well I think reliability of responses has got to be very important…. Well that it's accurate, that they are able to accurately convey their message." (S2).

> It has to be able to produce the result within a reasonable timeframe… There will be a support person with them. And they have to stay with them until they've got the message across. That has to be conveyed within a reasonable time to allow that person, often the nurse, to also fulfil their other duties. (D1)

The importance of these requirements were highlighted by patient participants who recalled that while on the ICU, if they were unable to get their message across reliably on the first attempt they would give up on the communication exchange altogether.

> I wouldn't have made multiple efforts because I just didn't have the strength to do it. If I didn't get the message across first time I just let it go, forget it… (P4)

> I just found that I had no patience for things that just didn't happen straight away… if I couldn't find the right icon or I couldn't find the right symbol I would just give up… (P6)

Content requirements. Throughout interviews participants described many reasons for communicating. Content that should be included on an AAC device can be derived from these reasons for communication, which were broadly categorized into functional, emotional, and social domains.

Functional reasons for communication by patients included the desire to convey a variety of basic needs (e.g., thirst, hunger, sleep, showering, toilet, feeling hot or cold), for orientation (e.g., date and time, to establish who someone is), and for medical purposes (e.g., to talk about symptoms such as pain, for history taking, to understand their diagnosis and reason for ICU admission, to ascertain the medical plan and their medical progress).

> The things that they often want to say is express that they may have pain somewhere. They may want to express that they cannot sleep. That they find it difficult to breathe or difficult to understand what is exactly going on. (D2)

> How you physically are, so whether you're uncomfortable, whether you're in pain… I had this terrible thing with thirst because you couldn't drink… and that was one of the things I wanted to rant at them about. I haven't had a drink for weeks. Don't you understand! (P3)

Communicating to express emotions was described in interviews by patients, relatives, and staff. More specifically, participants described wanting to communicate feelings of fear, sadness, love, and to provide reassurance.

> I watched the doctors speaking to my daughter telling them that I wasn't going to make it. I was trying to shout her to say don't believe them, I'm not leaving you. I'm going to fight, I'm going to come back. (P8)

> For the patient to express emotion as well. Obviously ICU can be a very traumatic experience for patients. I think communication between the two parties, whether it be the patient and a doctor/patient and a nurse is important for that exchange of emotions. (N1)

It was recognized that conveying emotional needs through the use of AAC was a more challenging prospect than communicating for other reasons.

> Predominantly patients feel fear, anger, upset, disorientation and I think it would be quite difficult using a non-traditional verbal method of communication such as an electronic device to convey - for a patient to convey exactly how they are feeling… (N1)

Examples of communication for social reasons included communication with visitors, enquiring about family and friends and the home environment, enquiring about bills and the mortgage, and discussing work and home administration: “Family obviously you want to know what's going on at home, is everyone okay, the children, how are they doing at school etcetera.” (P6).

Aside from the many ascertained functional, emotional, and social reasons for communication, offering simple yes/no functionality in an AAC device was also desired.

> So I mean even if it was just a yes/no reply because you could come up with umpteen questions that could be yes or no. (R2)

The need to express a desire not to communicate was also emphasized by a patient who recalled being pestered by questions all day while on ICU:

> If you didn't want to [communicate] then it's harder to explain. Do you think maybe you could put something on there saying, I'm too tired to talk right now. (P3)

Accessibility requirements. Interview data highlights that a single AAC solution is unlikely to work for every transiently nonvocal ICU patient, due to varying needs and levels of debility – this was emphasized by all staff participants.

> Again I couldn't think of a single solution that would fit everyone. Hence why we have three or four different tools already. (N2)

> It depends who we are talking about. If we're talking about someone who has total dexterity, perfect vision, they just can't speak because they've got a tracheostomy then obviously if they had some sort of iPad device or an app… that would be very effective. But it's a very different story if you've got somebody with critical neuropathy… (S2)

The ability to customize an AAC was seen as a useful way of enabling a single AAC solution to meet the needs of a wider number of patients as well as the changing needs of a given patient. Offering a variety of different input and output methods and the ability to customize icons in terms of their appearance and size were specifically cited examples.

> So the output should be either in voice or in writing. Maybe there should be some common phrases that they can just press one button.… But for some patients it may need to be slightly more advanced than that. So they are fully awake, they know what time of day it is but they want to go through the exact illness… So it's got to be a fairly versatile tool which covers everything from someone that's got basic understanding to someone who wants to almost mimic the conversation we're having in depth and detail. (D2)

Staff participants also emphasized the importance of incorporating accessibility features into an AAC device in order to facilitate use by patients with disability such as visual or hearing impairment. Staff explained that such disability is commonplace on the ICU.

> So perhaps having a single device that taps into all the various things and is flexible and adaptable to the patient's needs to make the letters bigger, make them smaller, can be louder, has a port for an induction loop so people with a hearing aid can listen to it. (D1)

Finally, staff and patient participants expressed a desire for portability, allowing an AAC device to be easily moved and accessed when needed. A tablet-based platform was perceived to be well suited in this regard: "It's got to be small enough to be portable…" (N2).

> Definitely move it around. Because also in intensive care they move you around a lot… So you need to be able to access it all the time. (P3)

AAC Device Adoption Considerations

A number of factors that could potentially hinder or facilitate the adoption of a new AAC device were described in interviews and these were categorized into patient, staff, and technology-related factors.

The need for extensive patient training in order to effectively utilize an AAC device was viewed as a hindrance to adoption. Patient participants emphasized that it would have been very challenging for them to learn new skills while intubated on ICU.

> I don't think I would have been able to do it in the situation I was in. I think mainly because your brain's working on other things… it's busy doing things that it doesn't normally do, thinking about why you're there… I don't think I would have been able to follow somebody explaining to me you have to look at this and however it works. (P6)

Participants emphasized the importance of ensuring that any developed AAC device is simple, user-friendly, and intuitive, thereby reducing the need for such training. Where basic levels of training are required, patients expressed a wish for this to be delivered either through a short video or text-based tutorial within the AAC device software, or by staff: "I suppose if the

nurses were well versed in it they could just put an arm round you and say, look at this Emma this is going to be amazing." (P3); "Probably a short video tutorial would be the best way. Just the basic things so people have got the basic idea of how to use it." (P1).

Some staff participants however, did not feel that training patients to use an AAC device was part of their role and re-emphasized the importance of a device requiring minimal training: "It should require no training because we're not expected to train our patients. So therefore it should be a product which you should just, that you can just pick up and use without training." (N2).

Interview data highlights that patient motor and cognitive function, and psychological and mental well-being were also perceived to impact upon AAC adoption. It was explained that the communication needs of patients vary accordingly and that this in turn will influence the types of AAC that they are capable of utilizing. A couple of patient participants also highlighted that their communication needs varied with time and recovery, particularly in terms of desired topics of conversation and the complexity of communication.

> Yes definitely [my communication needs changed with time]. Because I think I became much more aware of the bigger picture, so what had happened, what was currently happening and where I had to go? So I was able to become involved… (P3)

In this regard, SLT participants described at length the important role that they play in assessing patients' communication needs and matching them to the most suitable AAC tools and devices to support communication and facilitate AAC adoption.

> So if patients are having difficulty communicating we go there to assess them and start with basic things like, figuring out what their comprehension if like. Then trying to determine what's going to help them communicate the most effectively… So you've got to give them some other means of communication. But in order to do that you first have

> to figure out whether they are able to do things like give you accurate yes/no responses… do they have motor control if they are going to use a device… It completely depends on the patient really. So we do the full assessment… (S1)

> So based on an initial assessment… so that the patient's disabilities are taken into account but also their abilities are capitalized on. I think that's the key thing. So you're not giving them an app that makes communication harder, you're finding something that's capitalizing on [the patient's abilities]. (S2)

Several staff-related barriers to the adoption of an AAC device were highlighted in interviews and these were categorized as cultural and training related. A doctor participant highlighted that staff resistance to change and satisfaction with the status quo were important cultural barriers impacting upon AAC adoption.

> Nursing staff are always resistant to change. That's a terrible statement to say but it's true. In fact we all are, as humans aren't we? we're all resistant. (D1)

A nursing participant however explained that these obstacles were easily overcome so long as an AAC tool made the life of staff easier and improved the patient experience: "If it's going to make our life easier and it's going to improve the patient experience then I can't see any resistance from the side of staff." (N2).

Doctor, nurse, and SLT interviewees emphasized that ICU staff education and training was critical to the successful implementation of any new AAC device. Staff had to be aware of the tool, understand its potential benefits, and be appropriately trained in its use.

> The success or failure of any system is how it's implemented, how it's introduced, education that goes along convincing people that they have an interest in this…. I suppose the other thing is awareness, that's the other barrier… There might be a cupboard

> full of communication tools that they could use that they are not aware of or have forgotten about. They'd rather plug away with simple things that they can do at the bedside than go and start trying different devices. (D1)

One staff member explained that delivering training electronically would allow staff to learn in their own time and this was seen as a useful approach when compared with in person training: "If there is a way for somebody to do training in their own time electronically on a computer for instance then you're going to get a much better response." (N1).

In terms of technology-related factors, participants highlighted the importance of an AAC devices ease-of-use and perceived usefulness (among its end-users) in facilitating adoption: "[In response to being asked, 'What do you think would make people more likely to use a new AAC device or technology?'] Well, I guess if it made the patients life easier." (R4); "But if you want to encourage our staff to use it, show them how effective it can be." (N2).

Pre-existing familiarity with an intended AAC platform was another described facilitator to adoption. Given their ubiquity, tablet devices were viewed favorably in this regard, though some patient participants expressed concerns regarding familiarity among older generations: "I think it would work very well for a young person [tablet device] who is familiar with one in the first place yes. But for an old person no it wouldn't have." (P4).

One nurse participant highlighted that cost was another important technology-related factor impacting upon adoption: "Definitely I agree it would be a good idea [tablet device], but bear in mind it depends on the cost." (N2).

Discussion

To the best of our knowledge, this is the first qualitative interview study with intubated transiently nonvocal patients and their communication partners specifically exploring their AAC

device needs and requirements and perceptions regarding the feasibility of using a tablet computer and app as a platform for delivering an AAC tool. Based on the results, we have generated a list of 12 key recommendations relating to the development and implementation of AAC devices targeted at this patient population. These recommendations may further be used as a framework against which to evaluate commercially available AAC devices.

Tablet-based platform. Interview data highlights that tablet computers were perceived to be a useful and effective platform for the delivery of an AAC tool. The size and touch screen capabilities of these devices were looked upon favorably and tablets were viewed as being familiar, lightweight, portable, and relatively inexpensive. Concern was however, expressed around use in older patients, and those with limited motor function and visual impairment.

Mounting. Interview data highlights that some ICU patients will lack the strength to hold up even the weight of a tablet device due to motor weakness and muscle wasting. As such the provision of a mount is imperative and will also help to ensure that devices are maintained in proximity to patients, and are not accidentally dropped or stolen. When evaluating their SGD, Rodriguez et al. (2012) noted that mounting further enabled participants to find the device more easily. As part of the successful Boston model of AAC implementation (Costello, 2000) patients and relatives are taught how to mount their AAC device and are reassured that the devices will be accessible at all times.

Easy-to-clean, waterproof, and durable. Staff highlighted that any developed AAC device must be cleanable and comply with infection control policies . Rodriguez et al. (2012) commented on the need to clean devices and discard screen protectors between patients in their feasibility study of a SGD. Additionally, devices must be resistant to water and physical damage, and offer a prolonged battery life.

Choice of content creation methods and outputs. AAC devices should offer both item selection (e.g., letters, words, symbols) and text-entry inputs for content (message) creation. Interview data highlights that the former method is easier for patients to use but limited in the number of conversational topics, whereas the latter is more arduous but allows for a greater freedom of expression. By offering both, patients can utilize the method that best meets their needs. While some staff participants were skeptical about eye-gaze technology, SLT experts highlighted that this technology is essential in scenarios where patient motor function is absent (e.g., tetraplegia). In a study by Migletta et al. (2004), a small cohort of patients with cervical spine injuries were able to effectively use a SGD in conjunction with specially designed infrared glasses able to detect purposeful blinking, in order to communicate. AAC devices must look to incorporate these technologies if they are to cater for this specific patient population.

In terms of AAC device output, both voice and text generation outputs should be offered as each was felt to be useful in specific scenarios (for example, text output was useful when patients did not want their communication to be overheard).

Communication initiation mechanism. Interview data highlights that initiating communication is incredibly challenging for patients in the absence of a voice. This has also been reported in other works: In an interview study published by Happ (2000) a patient vividly describes taking himself off a ventilator in order to trigger an alarm and gain the attention of nursing staff in order to initiate communication. Consequently it is critical that any AAC device offers an effective means of initiating communication or calling for attention.

User friendly and intuitive. For technology to be accepted it must be both easy to use and perceived as useful (Davis, 1989). There is evidence that more sophisticated and complex communication devices may be rejected by patients and their relatives (Costello, 2000; Fried-

Oken, Howard, & Stewart, 1991). Interview data highlights that an AAC device must be user-friendly and intuitive so that it can be utilized with minimal training. Patients reflected on their ICU stay and explained that it would not have been feasible for them to learn how to use a complex AAC device in their ICU state.

This is consistent with the literature which highlights that the ICU is a suboptimal environment for patient learning due to pain, fluctuations in motor and sensory function, depression, medication effects, emotional status, and sleep deprivation (Costello 2000). Where ICU admission is predictable beforehand, introduction and familiarization with AAC devices prior to admission has been shown to facilitate adoption (Costello, 2000).

Reliable, quick, with minimal burden on the user. Participants emphasized the importance of being able to construct messages quickly, efficiently, and reliably. Although this is more challenging for more complex content, it is suggested that communication of common topics and basic needs should ideally require no more than five actions from the user.

Customizability. It is unlikely that a single AAC device will meet the needs and requirements of all users. Customizability is important in order to enable a device to meet the needs of a wider number of patients, and the varying needs of any given patient during their ICU stay. Allowing users to choose content creation methods and outputs, and the size of icons and fonts may be potentially useful in this regard. However, it should be noted that there will always be a subgroup of patients in whom a communication aid will be unhelpful irrespective of how well designed this is, due to the level of patient debility.

Content. An AAC device should readily allow communication of common functional, emotional, and social needs. The provision of text entry will enable the communication of more complex or less common content.

Voice banking. Some patients expressed a desire to pre-record messages using their own voices where ICU admission was predictable beforehand – a process referred to as voice banking. The benefits of voice banking have been highlighted in the literature, resulting in positive emotional impacts on relatives, and enabling staff to better understand the personalities of patients (Costello, 2000, 2009).

Training and communication environment. Data from staff interviews and the literature highlights that in order for an AAC device to be successfully implemented and adopted it is critical that staff are aware of its existence and appropriately educated and trained in its use (Kalispell et al., 2008). In a three-phase sequential cohort study, Happ et al. (2014) demonstrated that delivery of communication skills training to nurses resulted in a statistically significant increase in the number of positive nurse communication behaviours, and successful communication exchanges about pain and other symptoms when compared to a control group.

Communication needs assessment and AAC matching. It is clear from the results of this study that communication needs vary between patients according to their motor and cognitive function, and any underlying disability. It is also evident that communication needs can fluctuate and alter during a patient's time in the ICU. In this regard, Costello, Patak, and Pritchard (2010) describe 3 phases of recovery in the ICU during which patients' communication needs may change. During the first phase, where patients are first emerging from sedation, the ability to gain attention and provide yes/no responses is crucial. In the second phase patients are more alert and awake and need to be able to "solicit attention, respond, ask questions, express concerns and emotions, make comments, and solicit support, reassurance and encouragement" (Costello et al., 2010, p.293). In the third and final phase there is a need for broad and diverse communication. Different AAC strategies are required as patients progress through these phases.

In light of these varying needs, both our study results and the literature highlight the importance of regular bedside assessment of the communication needs of patients by SLT in order to match them with the most appropriate AAC strategies and access methods (examples include direct selection in patients with intact motor function, switch selection in those with limited motor capabilities, visual scanning in those with no motor function, and auditory scanning in patients with visual impairment) that maximize on patients' abilities (Costello, 2000; Kalispell et al., 2008; Santiago & Costello, 2013). By introducing SLT assessment and the construction of individual communication care plans incorporating AAC modalities matched to patients' needs and abilities, Happ et al. (2014) demonstrated significant increases in successful communication about pain and the ease of communication in comparison to a control group.

Communication breakdowns have been identified as the most common cause of serious adverse incidents affecting patients (Baker et al., 2004; Bartlett, Blais, and Tamblyn, 2008; The Joint Commission, 2005). Consequently, effective communication must be considered an essential pillar of patient safety (Costello et al., 2010). Thus, it is imperative that ICU patients with communication difficulties are provided with the necessary support to facilitate effective communication.

By understanding and incorporating the recommendations listed above, AAC innovators can ensure that developed AAC devices and strategies are relevant and better meet the needs of this patient group and their communication partners. ICUs must also ensure that staff are appropriately trained in communication and AAC, and that SLT are engaged at the earliest opportunity in order to assess and deliver the most appropriate support and AAC to patients with communication difficulties.

Limitations

The sample size of this study was chosen based on the timeframe for study completion and the likely point of data saturation, estimated according to the sample sizes utilized by earlier studies. While saturation was definitively reached in the patient and relative cohorts, further useful insights may have been identified had a larger sample of staff participants been included. It should also be noted that the age of patient participants ranged from 37-77 with a female majority (75%). This is not entirely representative of the ICU population as a whole and could have influenced study results. It may also be true that the hospital site from which staff participants were recruited for this study is not representative of other ICUs – although comparison with the literature from a number of different ICU sites suggests that this is not the case. Finally, it should be noted that some of the opinions and attitudes provided by participants in this study may be related to a lack of opportunity, exposure, and knowledge of certain types of AAC and their successful implementation with patients in the ICU.

Future Research

While our study has made a valuable contribution to the existing body of literature pertaining to communication aid design, and implementation in the critical care setting, we have identified several areas worthy of further investigation. Firstly, in line with the limitations of this study, there is the need for research further exploring the AAC device specification and adoption requirements of ICU staff in order to better understand the perspectives of this group. Studies focusing on patients from specific age demographics (e.g., the pediatric and geriatric populations) may also be warranted in order to explore and identify potential age specific AAC requirements. Second, there is the need to verify and validate the findings of our work. In this regard, future studies should aim to establish whether AAC devices created and implemented in line with our framework of recommendations result in improved patient outcomes, such as a

higher incidence of successful communication and enhanced patient experience. Finally, similar studies focusing on speech loss in other real world contexts both within and outside the ICU environment (e.g. long term rather than transient speech loss) should be considered in order to guide the design and implementation of AAC devices developed for use in these contexts.

Conclusion

Despite a variety of available high-tech AAC strategies, few have been widely adopted in the critical care setting. Unaided means of communication continue to be the most prevalent among transiently nonvocal intubated patients despite evidence showing that such modalities are ineffective and frustrating for patients and their communication partners. Effective communication is an essential cornerstone of patient safety. Consequently every effort must be made to provide nonvocal ICU patients with an effective means with which to communicate.

The results of this interview study have enabled us to devise a series of key recommendations pertaining to patient requirements from AAC, that should be considered by innovators seeking to design and build AAC devices for this patient population in order to ensure that created tools provide users with appropriate and relevant functionality. This in turn will help to facilitate acceptance and adoption. The recommendations may also represent a useful framework against which ICUs can evaluate communication aids when choosing suitable devices for this patient population specifically. In addition to the creation and provision of optimized AAC tools, in order to promote adoption it is imperative that ICU staff are appropriately trained in communicating with nonvocal patients and AAC, and that regular bedside communication needs assessments are undertaken by SLT in order to provide patients with the most suitable AAC strategies and tools to meet their needs and maximize on their abilities.

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End Notes

[1] The iPad is a product of Apple Computers Inc., Cupertino, California, USA. www.apple.com

[2] Skype is a product of Microsoft Corp., Redmond, Washington, USA. www.microsoft.com

[3]nVIVO is a product of QSR International Pty Ltd., Melbourne, Victoria, Australia. www.qsrinternational.com