University of Cincinnati

Date: 6/24/2021

I, Chitrali R Mamlekar, hereby submit this original work as part of the requirements for the degree of Doctor of Philosophy in Communication Sciences and Disorders.

It is entitled:

Using Human-Centered Designs to Support PPC During the COVID-19 Crisis

Student's name: **Chitrali R Mamlekar**

This work and its defense approved by:

Committee chair: Aimee Dietz, Ph.D.

Committee member: Suzanne Boyce, Ph.D.

Committee member: Nancy Creaghead, Ph.D.

Committee member: Carrie Rountrey, Ph.D.

Committee member: Rhonna Shatz, D.O.

40349

Using Human-Centered Designs to Support PPC During the COVID-19 Crisis

A Dissertation Submitted to the

Graduate School

of the University of Cincinnati

In partial fulfillment of the

requirements for the degree of

Doctor of Philosophy

In the Department of Communication Sciences and Disorders

of the College of Allied Health Sciences

By

Chitrali Ramakant Mamlekar

Master of Science Maharashtra University of Health Sciences

May 2014

ABSTRACT

Due to COVID-19, communication between healthcare providers and patients is hampered by isolation requirements, use of personal protective equipment (PPE) and lack of access to patients' family. To address this gap, a novel user-friendly, prototype of a mobile communication app, *Talking About Living with COVID* (TALC©) was developed using human-centered design principles. This dissertation employed a user-centered design approach to develop and test a prototype of a mobile-based communication app that is intended to promote effective communication between the healthcare providers and patients with communication challenges during COVID-19 pandemic and beyond. More specifically, this study aimed to answer two research questions: RQ1: What characteristics of the TALC© prototype do healthcare providers perceive as potentially helpful when interacting effectively with their patients with communication challenges? RQ2: On a well-established reference measure, such as the System Usability Scale (SUS), do healthcare providers rate TALC© as a potentially usable technology in their health setting? Usability was assessed using a think aloud method, where 17 healthcare providers described their interaction with the porotype followed by completion of a System Usability Scale (SUS) and Perceived Satisfaction and User Perceived Value scale. The median score for the SLP group was 77.5 (SUS_1); the median score for the Non-SLP group was 92.5 (SUS_2). On a 6-point Likert scale, eight participants (SLP= 2; Non SLP =6) indicated that they were "very satisfied" with the TALC© prototype, and nine participants (SLP= 5; Non SLP = 4) indicated that they were "moderately satisfied." Qualitative data suggest the healthcare providers responded favorably to the prototype, with the majority commenting that the TALC© would be useful to support communication in their setting and has potential to alleviate communication challenges during—and beyond the COVID-19 pandemic.

ACKNOWLEDGMENTS

Shree Ganeshaya Namah

"It is good to have an end to journey toward; but it is the journey that matters, in the end."

— Ursula K. Le Guin, The Left Hand of Darkness

It has been a great journey from where I have started to where I am today. And there are many people I want to thank for being with me all through my ups and downs. I believe without their knowledge, expertise or simply motivation, it would not have been possible to complete this crucial chapter of my education. First, I would specially like to thank *Dr. Aimee Dietz*, who mentored me in this PhD journey and always believed in me to accomplish the goals we have defined. Her advice, knowledge, and support were invaluable to the development of this study, and as a result, a large part of its quality can be attributed to her. I would also like to thank *Dr. Nancy Creaghead*, for her extensive comments and feedback on this dissertation; *Dr. Suzanne Boyce*, whose eloquent writing skills I am drawn to heavily; *Dr. Rhonna Shatz*, for sharing her expertise in clinical decision-making process *and Dr Carrie Rountrey,* who has provided me with enormous support.

I would like to thank all the healthcare providers who volunteered to participate in this study.

I want to thank my friends, here in the United States and back in India (especially *Priti, Soumya, Amit, Stefanie, Allison, and Dr.Hedieh)* who has been with me throughout these years and with whom I have learned a lot and shared many moments of fun and agony.

A special thanks to my family, namely to my mother, *Smita Mamlekar*, my sister, *Deepali* and brother, *Sameer* and to my father in heaven, *Ramakant Mamlekar*, who always believed in me and tried to do their best to give me a better life. I cannot even express how grateful I am to them in words, but only thank them for their patience during this period. It is to you that I dedicate this work. Finally, I would like to thank my boyfriend, *Dr. Anand Makwana*, who always encourages me to remain a perpetual learner and has supported me at every step of this dissertation.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

Healthcare is a complex system (Donaldson et al., 2000; Glos & Pinet-Peralta, 2021). This is in large part due to the range of tasks involved in the provision of patient care, as well as the diversity of patients, healthcare providers and other staff, the vulnerability of patients and the variation in the physical layout of the clinical environment (Donaldson et al., 2000). In these complex circumstances, patients are at a considerable disadvantage due to lack of knowledge about their diagnoses and health services (Ghosh et al., 2020). Most patients, therefore, must implicitly trust their providers (Caron et al., 2005) to tell them what assessments and treatment will likely best benefit them. As a result, patients are forced to seek out experts who not only have the abilities to manage their health concerns, but also have good communication abilities (Street Jr et al., 2009). Patient satisfaction is multifaceted, and most components are beyond the control of the provider. First, patient age—patients under the age of 65 tend to be less satisfied (Shilling et al., 2003). It has been postulated that elderly patients are more satisfied with their care because they are more familiar with the flaws of the healthcare system, and they are more forgiving of its failings. On the other hand, younger patients value having control over their own healthcare and place a higher importance on the quickness and aggressiveness of their treatment (DeVoe et al., 2009). Second, health status—patients with chronic disease like heart disease and cancer feel less supported (Lin et al., 2014). The conceptual model that underpins the United States' healthcare system is the acute care model, which implies that the system is designed to prioritize preventing, diagnosing, and treating acute medical conditions. Because the healthcare system in the United States is designed primarily to respond to acute problems, it battles to satisfy the requirements of those with chronic illnesses (Priester et al., 2005), leaving them less satisfied with their care (Tinetti & Fried, 2004) Finally, the cost burden—patients facing

financial drain from their healthcare bills are less satisfied (Xu et al., 2018). In 2010, it was estimated that 16% of adults in the United States were underinsured; spending at least 10% of their income on out-of-pocket medical expenses (Schoen et al., 2011). Such financial stress has a negative impact on patient well-being and healthcare quality (Chino et al., 2014). However, healthcare providers do have control over other important factors such as their own communication skills, which can be improved with access to proper resources and training (Baylor et al., 2019).

Effective Communication in Healthcare

Patients who report good communication with their providers are more likely to be satisfied with their healthcare, follow medical advice, and adhere to the prescribed treatment plan (Riedl & Schüßler, 2017). Effective patient-provider communication (PPC) in healthcare refers to exploring patients' illness through spoken speech or other methods of relaying information in order to understand their experience of health and illness (Mead & Bower, 2000). Good PPC allows the provider to better understand patients' needs and expectations (Bredart et al., 2005). On the other hand, patients who feel well-informed are more satisfied with their healthcare (Souza et al., 2011). If either the provider or the patient does not understand the purpose of the information conveyed, communication cannot be effective.

Healthcare providers can establish a trusting environment for patients to share their deepest thoughts and feelings, which may help them to understand the impact of the illness on the patient. Recent studies have shown that effective communication skills of healthcare providers induce psychobiological events that produce measurable change in levels of neurotransmitters (Verghese & Horwitz, 2009). Every patient has an expectation that their provider will assess them in a skilled and respectful manner. If the expectation is satisfied, it

produces positive neurobiological changes (Neumann et al., 2010). If it is not, it might have an unpleasant effect. While this requires the healthcare provider to be proficient at diagnosing and treating the illness, it is also important that they have appropriate and efficient communication skills that allow them to discuss procedures, understand patient needs and pertinent information regarding patients' histories and information. In hospitals, transitions of patient care, also referred to as handoffs, occur when the responsibility for patient care moves from one healthcare provider or hospital unit to another (e.g., during a change of shift from day to evening or when a patient moves from an inpatient unit to an intensive care unit). These handoffs create a particularly vulnerable time for communication failures that can lead to errors and subsequent patient harm (Cheung et al., 2010). In fact, an analysis by the Joint Commission has identified handoff communication failures as a contributing root cause of more than two-thirds of the most serious errors that harm patients, resulting in $1.7 billion in malpractice costs and approximately 1,700 deaths (The Joint Commission, 2017). Medical errors, as a result of ineffective PPC, lead to direct harm and have collateral effects on patient outcomes and satisfaction (Steelman et al., 2016; Thomas & Petersen, 2003). Ratna (2019) outlined four elements that are essential for success during patient-provider interactions. The first relates to patients; more specifically it states that they should be able to communicate information about their health concerns to their healthcare providers. The final three elements pertain to healthcare providers. Specifically, Ratna (2019) outlined that they must be able to: (1) adequately understand and interpret the information in order treat health concerns appropriately, (2) involve the patients in their own healthcare by

conveying adequate treatment information or preventive measures in order to maintain their health, and (3) exchange the information with other team members. This emphasizes that effective communication among the healthcare team members and between the team and patient (see Figure 1.) can contribute to increased communication health. If any of the aforementioned elements are compromised, healthcare delivery becomes ineffective (Ratna, 2019).

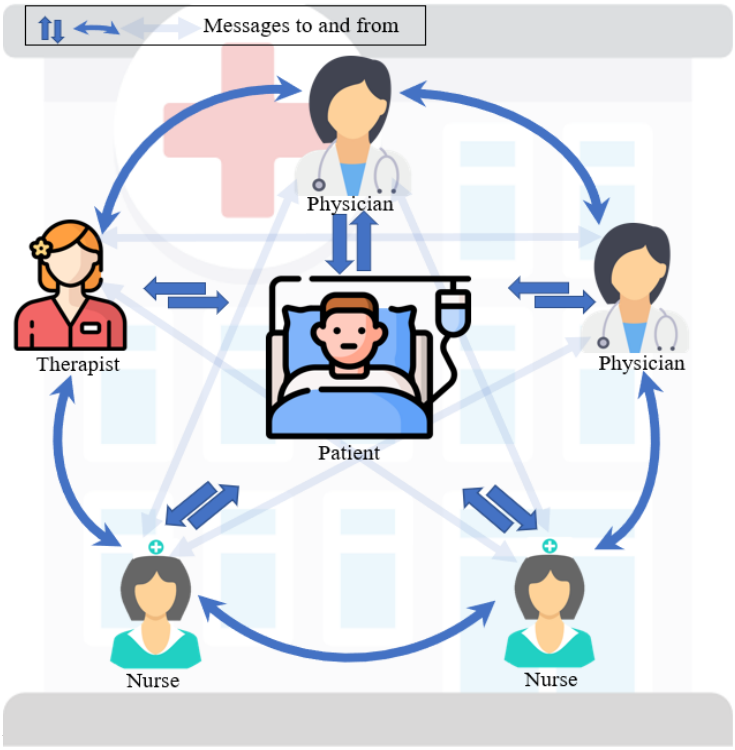


Figure 1 *Schematic Diagram of Communication in Healthcare*

As illustrated in the case of a 50-year-old female diagnosed with rheumatoid arthritis, the healthcare providers administered standard treatment protocol but failed to communicate the dosage instruction. As a result, the patient consumed the medication daily— instead of taking it weekly; this aggravated her symptoms and led to hospitalization (Tiwary et al., 2019). In this example, the healthcare providers used evidence-based knowledge to treat the disease condition appropriately; however, inadequate communication, in terms of medication dosage and frequency, caused a negative impact on the patient's health. This likely could have been prevented if the healthcare providers had effectively communicated the treatment regime to the patient and checked to ensure that the patient understood the treatment plan. Thus, in the absence of effective PPC, patients become particularly vulnerable to adverse events in medical settings

(Forster et al., 2007; O'Neil et al., 1993; Resar et al., 2006). These challenges are exacerbated in the case of patients with communication disorders. Individuals with communication challenges report more difficulties accessing care than those without communication challenges, including difficulty finding a physician, and delaying or abandoning care (Stransky & Morris, 2019).

PPC for Hospitalized Patients with Communication Disorders

Approximately 10% of the population in the United States lives with a communication disability (Morris et al., 2016). Individuals may acquire communication challenges as a result of a variety of medical reasons including – but not limited to – stroke, traumatic brain injuries, oral intubation, tracheostomy, and mechanical ventilation (Grossbach et al., 2011). As such, these individuals are at a high risk for experiencing communication breakdowns with health professionals (Beukelman & Mirenda, 2013; Garrett & Lasker, 2007; Simmons-Mackie et al., 2013). The presence of communication disorders has been linked to higher rates of medical errors, lower satisfaction with healthcare, and reduced accessibility to healthcare compared to patients without communication disorders (Bartlett et al., 2008). This is likely due to the fact that patients with hearing, speech, language, or cognitive impairments have difficulty conveying information about their symptoms, medical histories, or health concerns with the efficiency, clarity, and accuracy that healthcare providers need to make accurate diagnoses and to initiate appropriate treatment. Likewise, the patients with communication disorders may experience challenges in understanding, retaining, and/or executing recommended intervention plans. In a study of the experiences of people with cerebral palsy and amyotrophic lateral sclerosis who used augmentative and alternative communication (AAC) during medical encounters, the participants expressed concerns with being able to communicate effectively with physicians, and

discussed the need for providers to slow down, and to be flexible (and open) to using different methods of communication (Morris, 2011).

The likely increased challenges healthcare providers experience with patients who have communication disorders seems to relate to their lack of training on how to successfully communicate with this population (Bradbury-Jones et al., 2013). Generally speaking, medical practitioners tend to underestimate the comprehension and cognitive abilities of individuals with communication disorders (Yorkston et al., 2015). As a result, they may inappropriately interpret patients' symptoms, which may lead to misdiagnosis (Owolabi & Yakasai, 2011), unnecessary testing and ineffective treatment (Lubarsky & Juncos, 2008). Moreover, patients with dementia may have poor comprehension of medication instructions and regimens, which can lead to unintentional overdosing (Tyson et al., 2012). The absence of verbal communication in some patients creates an obstacle in evaluating and managing patients' concerns thus, putting these individuals at risk to be under- or over-treated in hospitals (Kable et al., 2015; Townend et al., 2010). Communicating with mechanically ventilated patients is another challenging experience for providers since the orotracheal intubation prevents the patients from speaking at all (Thapa et al., 2019). In one qualitative study, waking up on a vent in the intensive care unit (ICU) was described by some patients as frightening, and the inability to communicate effectively made them feel *"...trapped in a dysfunctional body..."* (pp. 174) because they could understand everything they were told, yet they were not provided a way to express themselves (Tembo et al., 2015). Additionally, providers also reported an overall feeling of discomfort when they try to communicate with ventilated patients, and therefore (admittedly) limit their communication with patients to brief interactions regarding clinical procedures (Magnus & Turkington, 2006; Ten Hoorn et al., 2016).

In summary, the reduced ability of patients with communication disorders to interact with their healthcare providers can lead to decreased participation in their own healthcare (Magnus & Turkington, 2006). The Joint Commission has recommended that healthcare organizations *"…make effective communication an organizational priority to protect the safety of patients and to incorporate strategies to address patient's communication needs across the continuum of care"* (Patak et al., 2009, p. 393). Interventions aimed at incorporating communication strategies into hospital policy might only be effective if matched with efforts to increase the communicative competence and confidence of hospital staff and increase their awareness of the broad range of communication needs across patient populations. Frequently, while communicating with non-verbal patients, medical staff are confined to using strategies like yes or no questions, head nods, mouthing of words, communication by a squeeze of the hand or a blinking of the eye (Hurtig & Downey, 2008; Otuzoğlu & Karahan, 2014; Smith, 2006). It is a challenging process for the provider, as well as the patient, to structure an effective communication using these strategies and it can often become a guessing game, where the provider takes on the role of a detective (Rodrigues et.al., 2015). Furthermore, several studies point out that providers were afraid of misinterpreting the patients' non-verbal responses; some providers even felt they lacked competency in this process (Finke et al., 2008; Happ, Garrett, et al., 2014). As such, there is a pressing need to provide staff with information about AAC tools—and how to employ them in a manner that ensures quality communication, care and helps to avoid misunderstandings (Mazzon et al., 2001).

AAC Apps for PPC

> *"Effective patient-provider communication is fundamental to patient-centered care and correlates strongly with better patient outcomes, as well as increased patient safety and patient satisfaction."*
>
> (Wilson-Stonks & Blackstone, 2013, p.69)

Healthcare providers need information from the patient to provide them with the best treatment possible; however, it is difficult to provide appropriate care if the patient is unable to communicate. For patients with linguistic and/or cognitive communication challenges, no-tech communication boards can be helpful; however, the images need to be easy to read and understand, and large enough for those visual deficits. Additionally, communication boards are typically limited in the number of utterances they include. Traditional electronic devices like the text-based keyboards are a great step in the direction of being able to communicate with medical staff. The UbiDuo Face-to-Face Communicator is a keyboard used by Deaf and Hard-of-Hearing individuals to communicate with others by providing two wireless-connected devices to exchange text (sComm, 2008). Even though the UbiDuo is advantageous, it is an arduous communication method, given the time necessary to compose a single message. Moreover, individuals with communication challenges such as anomia or cognitive impairments may not benefit from this device due to the language demands of this approach. Thus, the practicality of using the UbiDuo Face-to-Face Communicator effectively by people with a broad range of communication disorders in a fast-paced medical setting seems questionable. Additionally, there are no options available on the UbiDuo to include pictures to help clarify difficult medical terminology. Finally, if a patient is in a medical setting and has lost the ability to use their hands, this dual keyboard option would not be functional.

Relatively speaking, mobile technologies are more portable and affordable than traditional electronic AAC devices. Therefore, mobile applications (i.e., apps) provide powerful tools for people with communication challenges to support their communication needs. The advantages of mobile apps make communication more accessible and cost-effective for people with communication challenges (AAC-Rehabilitation Engineering Research Center, 2011). Intuitive design strategies used to create communication apps that employ symbols and generate synthesized speech can provide an alternative way to communicate effectively. Over the past few years, there has been an explosion of mobile apps available to support communication (Hershberger, 2011). Mobile AAC apps offer a number of potential benefits for people with communication disorders, including increased awareness about their challenges and social acceptance of the apps and greater functionality (McNaughton & Light, 2013). Like traditional electronic AAC devices, these mobile devices often have touch screens, ample processing power and speech output capabilities. Furthermore, AAC apps have been shown to improve patient knowledge, help patients to become more aware of what matters most to them, and support patients in medical decision-making (Gormley & Light, 2019). One such tool developed by Voxello,® is the Noddle Smart Switch ™ and Noddle-Chat ™ application. The Noddle Smart Switch ™ allows patients to use a voluntary gesture, such as a tongue click, or a minimal movement or head nod or shoulder shrug, to access the nurse call systems and the Noddle-Chat™ tablet to communicate with the providers (Marshall & Hurtig, 2019). Noddle-Chat ™ is a speech-generating tool for hospitals and long-term care facilities that uses a language set with text and picture icons tailored to their needs. It was created in partnership with Saltillo ™ and is intended for use on tablets running the Android operating system (Marshall & Hurtig, 2019). By making these apps accessible at the bedside, healthcare providers can incorporate their use into

patient centered care plans, enhance the interpersonal relationships, provide patients with a platform to take an active role within the care team, and support patients with limited or no verbal communication to interact directly with their caregivers and family.

Various factors influence the adoption of mobile solutions in the healthcare industry. First, smart phones have physical limitations due to their small screens. Second, there are concerns about privacy and security; the risk of storing health-related data on a personal computer device must be properly addressed. Another hurdle is the enormous number of apps available, making it difficult for consumers to choose one that is relevant to them. Finally, because apps are typically meant to produce money for the developer, many applications are affiliated with a certain company, drug, or medical gadget, while fewer applications are focused on the less profitable areas of healthcare. Although PPC is an important and integral part of healthcare, in medical contexts, there are only a few AAC apps built exclusively for patients with limited or no verbal communication (Fager et al., 2020). Furthermore, the apps that are available are often underused in healthcare settings because of lack of personalization (Gormley & Light, 2019). The resistance toward more widespread adoption of AAC apps in medical settings may be due to the lack of user friendliness (Mobasheri et al., 2016).To this end, it is rare to find studies describing how these communication apps were developed, particularly the methods used to involve healthcare providers or patients in the early stages to design and test their usability (Gordon et al., 2020). Knowledge of these steps is crucial if the applications are to meet the needs of target end users: people with communication challenges and their healthcare providers. Undeniably, user-centered design processes can reveal problems that might not otherwise be uncovered, including those related to terminology, navigation, satisfaction, and ease of use (Nilsen et al., 2018).

CHAPTER 2: BACKGROUND

Effective communication is a key and necessary factor for containment of the COVID-19 pandemic (Finset et al., 2020; Hurtig et al., 2020; Knollman-Porter & Burshnic, 2020; Reddy & Gupta, 2020). Accurate and efficient PPC can facilitate how COVID positive patients in medical settings handle uncertainty and fear (Finset et al., 2020), promote better outcomes and satisfaction for both patients and healthcare providers (Hurtig et al., 2020), and foster resilience and sense of safety among the patients in medical settings (Vance & Morganstein, 2020). New challenges created by the COVID-19 pandemic include communicating with patients while utilizing personal protective equipment (PPE) and establishing new ways to connect patients and their family members who are barred from visiting hospitals to help prevent the spread of COVID-19 (Janssen et al., 2020). Given the countless clinical interactions that occur between the patient and their providers, proper social distancing can be difficult (i.e., 6 feet) (Arora et al., 2020). While the pandemic has been a catalyst for widespread use of various AAC tools and strategies (Hurtig et al., 2020; Knollman-Porter & Burshnic, 2020) to facilitate communication, they can be deemed ineffective if not tailored to the needs of the providers or patients in medical settings (Binger et al., 2012; Dietz et al., 2012; Gormley & Light, 2019). This chapter will highlight issues related to PPC in the time of the COVID-19 pandemic; specifically, it will: (a) review how barriers to effective PPC can adversely impact patient outcomes, (b) describe how the implementation of AAC technology in medical settings can alleviate PPC challenges, and (c) discuss how user-centered design can inform and improve AAC technologies in medical settings.

Barriers to Effective PPC for Hospitalized Patients During the COVID-19 Pandemic

Following the first reported case of COVID-19 in the United States on January 20, 2020 (Guan et al., 2020), the healthcare landscape changed considerably, which, in turn, impacted

communication between the providers, patients and families. Based on current data, transmission of the COVID-19 virus is mainly via respiratory droplets and person-person contacts (WHO, 2020). However, recent research has highlighted that airborne transmission of the COVID-19 virus can occur in medical settings (Ong et al., 2020) as well as indoor settings (Morawska et al., 2020). Therefore the World Health Organization (WHO) and Centers for Disease Control and Prevention (CDC) have mandated the use of PPE in healthcare settings (Woolley et al., 2020). The wearing of PPE presents an adverse external influence on speech communication (Hurtig et al., 2020). Investigations of the effect of PPE, in particular face masks, on speech intelligibility has shown that they attenuate the total spectral energy of the speech signal and particularly the aspects of meaning carried in higher frequencies, leading to reduced information about obstruent consonants (i.e., fricatives, affricates and stops) and vowels. Laboratory trials continue to assess the impact of face masks used by healthcare providers (i.e., simple mask Vs, N95 mask Vs, N95 mask with filter) on acoustic signals (Goldin et al., 2020) by measuring voice samples in an anechoic chamber as a function of the type of mask being worn. Using an artificial mouth to play white noise through various types of masks, the acoustic signal output was measured by a microphone at 2 meters distance. The data showed that each mask essentially served as a low-pass filter, attenuating the high frequencies (2000-7000 Hz) spoken by the wearer, with the decibel (dB) level of attenuation ranging from 3 to 4 dB for a simple medical mask and close to 12 dB for the N95 masks. Given the idiosyncrasies of how different types of face masks alter the acoustic speech signal, there is a growing body of work studying the possible differences in how wearing a mask affects speech recognition in presence of background noise (Toscano & Toscano, 2021). In an experiment, the intelligibility of speech produced with a face mask in the presence of two different signal-to-noise ratios (SNR) was assessed. The researchers evaluated a

condition in which no visual cues were available. Sentences were recorded while wearing no mask, a surgical mask, a homemade cloth mask with a fitted design, a homemade cloth mask with a pleated design, or an N95 respirator. Six-talker babble noise was added to the recordings at high (+13 dB) and low (+3 dB) signal-to-noise ratios (SNR). The findings revealed that masks produced little to no effect at the high SNR; some masks (the homemade cloth masks and N95 respirator) had a larger effect at the low SNR. Masks affected speech recognition differently depending on SNR. At the high SNR, accuracy for the no-mask condition (94.3%) was nearly the same as accuracy for speech produced with the surgical mask (93.5%) and N95 respirator (93.1%). Performance was also very high for the pleated cloth mask (91.8%) and somewhat lower for the fitted cloth mask (88.8%). For the low SNR condition, accuracy of perception for speech produced without a mask was considerably lower (45.2%). Performance in the surgical mask condition was similar to the no-mask condition (42.4%). The other masks led to lower accuracy (N95 respirator: 34.6%; pleated cloth mask: 35.1%; fitted cloth mask: 27.0%); this represents an enormous degradation in acoustic signal. Unfortunately, when PPE is worn, visual cues are also not available (Champion & Holt, 2000) during interactions. Even though attempts have been made to create transparent medical-grade masks to facilitate lip reading, designs have not yet met infection prevention and control requirements for use in hospitals (Marler & Ditton, 2021). In the absence of lip reading, neural processing of auditory speech signals is slowed to the detriment of speech perception in normal hearing individuals (Bourguignon et al., 2018). In summary, while masks are undeniably effective in decreasing transmission of the COVID-19, there is clear evidence that face masks reduce speech intelligibility and thereby interfere with effective PPC.

When background noise is present, understanding speech is noticeably more difficult,

making visual cues essential for accurate speech recognition. Noise from certain medical equipment (e.g., portable X-ray machines) exceeds 90 dBA and are comparable to walking next to a busy highway when a large truck passes by (Palmiero et al., 2016). Additionally, the literature has shown that, hospitals generally do not comply with WHO guidelines for noise levels in hospitals (Busch-Vishniac et al., 2005). More recently, healthcare providers are using powered air-purifying respirators (PAPR) to protect themselves from the COVID-19 virus which can have detrimental effects on communication due to loud noise of PAPR (Johnson, et al., 2000). The most critical problem is that healthcare providers experience difficulties in face-to-face communication while wearing PAPR. The speech perception of healthcare providers donning PAPR was affected by the noise of the purifier, the reverberation inside the hood, and the sound of air moving across the microphone. The Human Factors Design Standard (Ahlstrom & Longo, 2003) indicated that ambient noise in operational areas requiring speech communications should not exceed 55 dBA; the PAPRs generate noise is about 75 dBA. Thus, requiring a speaker to raise their voice significantly to be heard over the noise poses significant challenges to communication among hospital staff and with patients (Blomkvist et al., 2005). Background noise causes an acoustic challenge, making the process of understanding speech more difficult. In such cases, intelligibility is aided by being able to see the talker (Brown et al., 2021; Miller et al., 2010). Under everyday listening conditions, successful communication benefits from visual information. In fact, access to visual information speeds-up the cortical processing of auditory signals (Van Wassenhove et al., 2005). Wearing a face mask interferes with the clarity of signal and hides important visual speech cues. Taken together, the presence of PPE, coupled with the hospital equipment noise leads to prolonged, effortful interpretation of PPC exchanges, even without communication challenges. For those with pre-existing, or new

cognitive, communication or hearing impairments, the presence of hospital noise and PPE can have a significant adverse effect on their ability to successfully interact with their providers (Chodosh et al., 2020).

COVID-19 and Vulnerable Populations with Communication Disorders in Medical Setting

Given the importance of intact face recognition in communication, it is imperative to characterize how wearing masks might hamper the abilities to communicate effectively. Since face masks conceal the lower part of the face, including the nose and mouth area, it is anticipated that at least some aspects of holistic facial processing would be interrupted by mask-wearing. In one study, 41 healthy adults were showed a picture of a person whose face was either fully visible or partly covered by a face mask and asked to identify their emotional state from a list of six emotional expressions (i.e., angry, disgusted, fearful, happy, neutral, and sad). The results revealed that the emotional reading was strongly reduced by the presence of a mask (Carbon, 2020). Specifically, confusion was mostly pronounced in the case of misinterpreting disgusted faces as being angry and emotions like happy, sad, and angry as neutral. Given that studies have shown that occlusion of the lower face impedes emotional perception abilities in a heathy population, masking likely has a damaging effect for people with prosopagnosia; common in right hemisphere stroke (Stone & Valentine, 2003). Most of these individuals compensate for their impaired capability of facial perception by using different sources of information such as the gait or gesture (Carbon, 2020). However, even with successful compensation, due to use of mask and other PPE, the processing of these non-verbal cues might be reduced. Due to the high number of active COVID-19 cases in the country, use of masks in hospitals is expected to continue for the foreseeable future. Additionally, in hospitals, wearing a mask results in homogenization of the wide range of healthcare providers; this could result in considerable

confusion for the patients. The inability to recognize a provider may impact upon the extent to which rapport is developed between the patient and the provider (Marler & Ditton, 2021). In a study of over 1,000 patients randomized to be treated by mask-wearing or non-mask-wearing healthcare workers, patients' perceptions of providers' empathy in consultations performed by mask-wearing physicians were found to be significantly lower (Wong et al., 2013). The inability to see the provider's expression hampers the rapport-building with the patient. Specifically, patients may have challenges comprehending provider empathy and trust, which in turn could inhibit their engagement during medical encounters, as well as the outcome of their treatment.

To further complicate the issue, family members are not typically allowed to be at the bedside of the COVID-positive patients (Schlimgen & Frye, 2021). When a person becomes ill, they become physically and/or psychologically dependent on their family and can lose autonomy, which can lead to frustration, anger and could make them more unwell (Mick et al., 2014) .These feelings likely increase in the absence of family members (Tobiano et al., 2013). A family member's presence may be particularly important for patients who are unable to communicate or advocate for their own interests. Primary-care providers need to be cognizant of the specialized needs of patients with communication disabilities. While the needs might be similar to other patient populations, patients with communication disabilities present with unique challenges. Family members of people with communication disabilities who participated in a qualitative interview emphasized that providers could implement three to strategies achieve effective care for the patients with communication disorders. They emphasized the providers should: (1) establish communication preferences, (2) use a guessing strategy, and (3) include family members or caregivers (Morris et al., 2014). In a similar study, the experiences of family members of patients with stroke and traumatic brain injury focusing on the impact of family

presence in the hospital generated three important themes regarding the connection between the family member, the patient, and the connection with the healthcare team. Family members experienced their presence as beneficial for themselves and their loved one. They reported that it helped them understand changing and unpredictable circumstances associated with their loved one's condition and medical care. Family members also viewed themselves as a supporter and an advocate for patients and appreciated being with their loved one when clinicians were rounding or examining the patient. The authors highlighted an urgent need for hospitals to develop new ways to maintain effective PPC and to establish provider-family member communication when restrictive visitation policies are in place, such as during the COVID19 pandemic (Creutzfeldt et al., 2020).

Using Human-Centered Design to Improve PPC

As mentioned above, use of a mask or PPE has known to impair communication; but its benefit to curb the spread of COVID-19 virus has led many providers to accept the communication impairment that is imposed on them due to use of PPE. Although few studies might indicate that masks have relatively little influence on the verbal speech intelligibility for people with normal hearing (Saunders et al., 2021), it is possible that healthcare providers may nonetheless *perceive* them as a communication barrier. Indeed, existing research indicates that nurses in hospitals construed masks as a barrier to audible communication and believed that they struggled to be understood by their patients (Ferrari et al., 2021). Reduced audibility poses its own transmission risk in that the healthcare providers may move closer to the speaker, which is counterproductive to the use of the mask (Lazzarino et al., 2020). As a result, the protective element of social distancing is rendered null and void. To improve intelligibility without changing physical proximity, the clinician must talk loudly, which may increase risk of vocal difficulties in healthcare providers (McKenna et al., 2021), while also and jeopardizing patient confidentiality.

During the COVID-19 crisis, healthcare providers have been using a variety PPC supports, including communication apps to help compensate for the lack of verbal and non-verbal cues in the presence of PPE (Schlossberg, 2021). A recent scoping review recommended that AAC methods should also be considered for non-English speaking patients and those with limited health literacy (Hemsley et al., 2019; Zaga et al., 2020). Additionally, patients with ICU-acquired delirium and intubation should be provided with AAC tools that are user-centered and contain age-appropriate symbols for basic and medical needs (Zaga et al., 2020). Visual scales such as the pain indicator scale can aid in evaluation and treatment of mechanically ventilated patients and facilitate effective communication between the patients and the healthcare providers (Mao et al., 2020). Apps compatible with mobile and tablet devices have been employed by healthcare purposes to provide bimodal presentation of information, with highly positive patient feedback (Marler & Ditton, 2021). Using various forms of AAC strategies adds value to the medical assessment and treatment process and can help providers individualize patients' needs by facilitating more effective PPC, especially in the presences of PPE and with ventilator-dependent patients who are unable to speak. Communication can also be facilitated using no-technology by using AAC tools such as alphabet boards and picture boards.

In recent years, there has been an increased focus on the concept and practice of supported decision-making, as opposed to proxy decision-making, for those with communication disorders (Dinerstein, 2012). The term shared decision-making can be defined as *"...an approach where clinicians and patients share the best available evidence when faced with the task of making decisions, and where patients are supported to consider options, to achieve informed preferences..."*(Elwyn et al., 2010, p. 1361). A systematic review of peer-reviewed journal articles revealed that, in 63% of articles, most patients expressed a wish to actively participate in

decisions around their treatment (Chewning et al., 2012). As mentioned above, the most prevalent and appropriate method to support patients with communication disorders to communicate their needs and participate in the medical decision-making process is to use AAC strategies and tools; however, AAC is often not readily available in the medical setting (D. Downey & M. Happ, 2013) and if available, the design of the mobile AAC apps are not focused on the needs of the patients (Lubas et al., 2014). Instead, the apps are focused too much on the technology and not on the end goal—communication (McNaughton & Light, 2013). With a misdirected emphasis on technology, there is a threat that AAC apps will be purchased without a clear sense of how the technology will be used to support communication in hospitals (Gosnell et al., 2011).

The benefits of mobile-based AAC support can only be achieved if the healthcare providers and the patients accept and intend to fully use them (McNaughton & Light, 2013). Moreover, during the COVID-19 pandemic, healthcare providers must assess and manage ventilator-dependent patients who may not be able to participate in the decision-making process due to critical illness, sudden speechlessness, and cognitive changes. Therefore, it is critical for researchers to understand the intention to use AAC apps for COVID-19 patients. The technology acceptance model (TAM), developed by Davis in 1989, is known as a reliable, robust, and well-known model (Rahimi et al., 2018; Yarbrough & Smith, 2007) which proposes that an individual's acceptance of a technology is determined by two beliefs: perceived helpfulness and ease of use. Helpfulness is defined as the extent to which a person believes that employing the system will enhance his or her personal goals. Ease of use is outlined as the extent to which a person believes that utilizing a technology requires minimal effort. The model suggests that when a person is presented with a particular technology, several factors, notably effectiveness

and accessibility, influence their decision of how and when they will use the technology. Effectiveness is also influenced by ease of use, because the easier the system is to operate, the more valuable it can be to them. The perceived effectiveness and accessibility elements represent the person's cognitive responses to using the technology, which then influences their attitude toward the technology (Burton-Jones & Hubona, 2005).Thus, when developing AAC apps, which are intended to support the patients' participation in the clinical decision-making process and to support effective PPC, it is important to consider its overall usability.

Prior studies on PPC have investigated patients' communication needs and presented various forms of communication tools that assist them in expressing their thoughts or initiating conversations with providers. These tools help facilitate communication between the patient and provider during clinical consultations by providing aids through which patients can communicate their needs; however, these tools often do not take into consideration the providers' specific communication needs and challenges that they encounter while wearing PPE. This study is a step towards addressing this gap in the literature. More specifically, in this dissertation, a user-centered approach is employed to assess an AAC app prototype to alleviate the effect of PPE and enhance the ability of healthcare providers to engage in effective communication with their patients who have communication challenges. Development of effective apps requires involving intended stakeholders throughout the software development process. Often when apps are being developed, the intended stakeholders do not have a role in the design process, which can significantly impair the value of software. Implementing their feedback throughout the software design process can have a positive impact on the stakeholders' comfort level with the technology, attitude toward the technology, and ultimately influence their competency and success. A user-centered design approach is critical for increasing the likelihood of AAC app

acceptance and use. The following section presents an overview of Phase I, of a two-phase user-centered design process and provides a step-by-step example of an AAC app prototype called *Talking About Living with COVID* (TALC©) that was created through this design approach (see Figure 2). Phase I was conducted to understand the needs of the healthcare provider by means of an electronic survey, and the goal was to develop a user-centered mobile-based communication prototype.

Identify the Stakeholders to Inform Initial Design

To understand the experiences of healthcare providers working with patients at risk for or diagnosed with COVID-19, a cross-sectional survey was conducted across a nationwide sample of healthcare providers using a web-based survey during the period between April 3, 2020, to

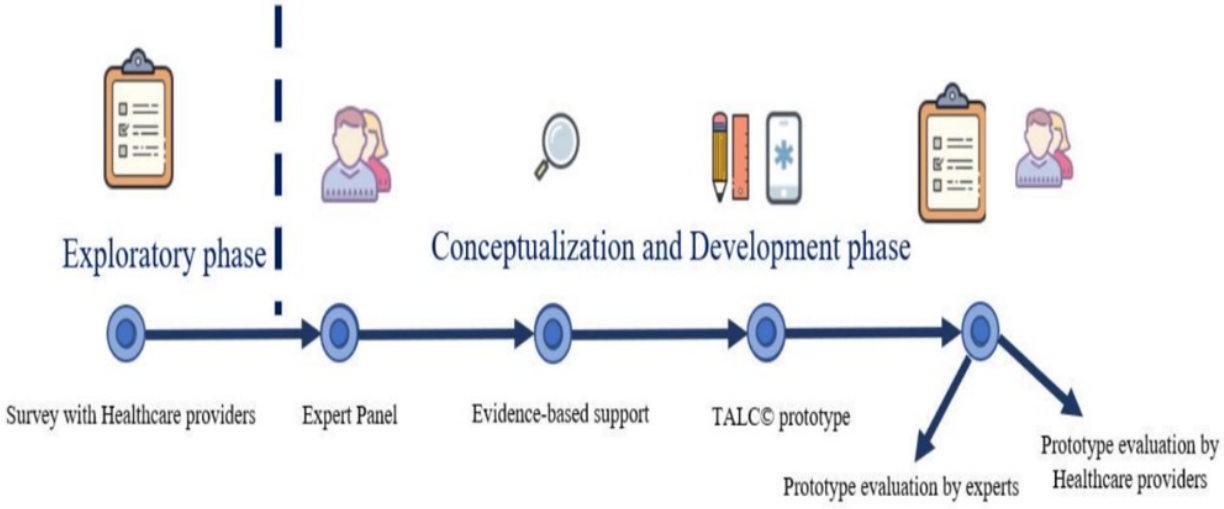


Figure 2 User-centered Design Approach

April 22, 2020 (Mamlekar et.al.; 2020). A total of 73 healthcare providers in the United States of America completed the survey. Around 84 % of the participants (n=61) identified as female, while 15% identified as male (n=11) and 1% identified as non-binary (n=1). Overall, 56% of the participants were nurses, followed by speech-language pathologists (29%), physicians (9%) and others (6%). Other respondents included respiratory therapists, physical therapists, occupational

therapists, and mental health professionals. Among the participants, 87% (n=63) of the healthcare providers had seen at least 20 patients with COVID-19 and 13% (n=10) of the healthcare providers responded of seeing more than 20 patients with COVID-19. When asked, whether they experienced challenges communicating with patients who had COVID-19 and concomitant communication challenges, more than half of the healthcare providers reported "yes" (n=39; 53%), followed by two smaller groups who indicated "somewhat" (n=18; 25%) and "no" (n=16; 22%). The healthcare providers reported challenges gathering information regarding COVID-19 exposure (n=29; 41.40%), details about their symptoms (n=32; 46%), information on their prior medications (n=35; 50%), medical or surgical history (n=37; 53%); social history (n=36; 51.40%) and obtaining consent for medical or non-medical procedure (n=29; 41.40). The respondents also indicated increased difficulty communicating with patients who have COVID-19-related voice/speech concerns (n=35; 53%). They also reported communication barriers specific to COVID-19-related delirium or encephalopathy (n=36; 54.50%). Patients with a history of cognitive disorders (n=34; 51.50%) and aphasia (n=11; 17%) also presented obstacles to successful PPC (on top of COVID-19 challenges. There were also reports of language barriers (n=9; 14%), including the use of American Sign Language (n=3; 4.50%) complicating COVID-19 medical care. Providers also indicated that developmental speech and language impairments (n=8; 12.10%) and COVID-19 related stroke (n=6; 9.10%) created unique communication barriers (See figure 4b) during COVID-19 interactions.

When asked about types of communication tools used to facilitate effective PPC, the majority of the healthcare providers reported using pen and paper (n=41; 56%), followed by communication boards (n=31; 43%), pictures (n= 15; 21%), and/or communication

apps (n=8; 11%) to facilitate successful PPC. Nine participants (13%) reported not using any supports, while 15 (20.50%) indicated that they did not encounter patients with communication disorders. Most importantly, 87% (n=64) of participants indicated that they would be willing to use an intuitive communication app to enhance PPC with their COVID-19 patients.

Conceptualization and Development of the Prototype

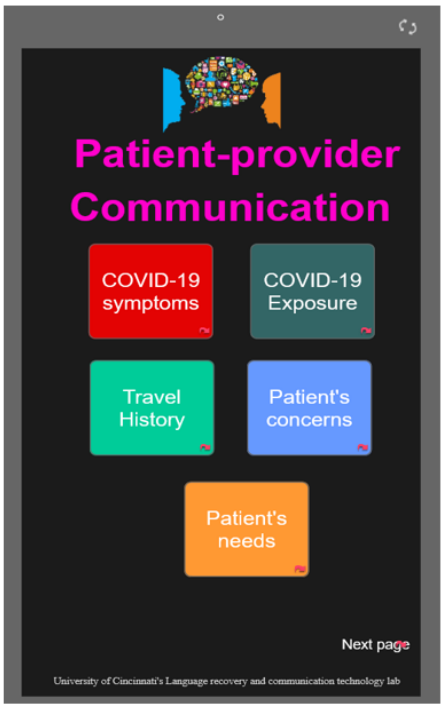


Figure 3 TALC© Home page

The aim of the conceptualization and design step was to develop the flow and content of the prototype. The design and concept development of the TALC© was informed and overseen by an interdisciplinary group of experts from neurology, speech-language pathology, and computer science. The expert panel discussed the survey findings obtained from the healthcare providers and brainstormed ideas to develop a tool for the healthcare providers that can support effective communication in medical settings. These ideas were then drafted to develop an outline for the layout and arrangement of content for the TALC© prototype. The sketches replicated the aesthetics of a digital prototype but not the functional requirements. Next, a final digital prototype was developed using Mockplus™, which was very close to the final product with rich interface details, interactions, animations, and transitions (See Figure 3). It behaved just like the final product and enabled the expert panel to find all the potential usability problems that could impede the successful completion of the prototype by the healthcare providers.

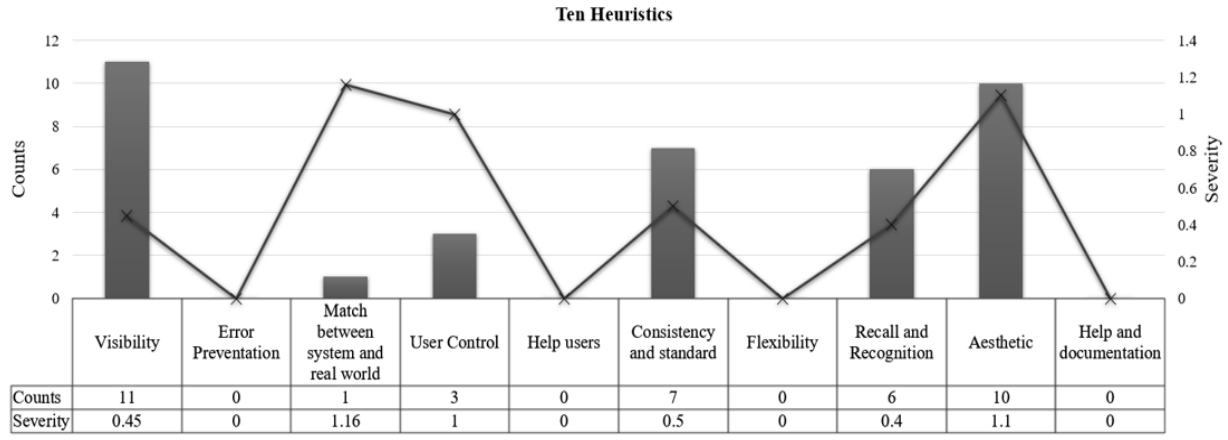
Heuristic Evaluation by Experts. The experts conducted evaluation using the 10 heuristics developed by Jakob Nielsen (See Appendix A). These 10 heuristics include: visibility of system status; match between system and the real world; user control and freedom; consistency and standards; error prevention; recognition rather than recall; flexibility and efficiency of use; aesthetic and minimalist design; help users recognize, diagnose, and recover from errors; and help and documentation. Nielsen's heuristics are widely recognized as the general benchmark for good interface design (Nielsen, 1994). The heuristic evaluation was conducted in two rounds between June 2020-July 2020. During these evaluation rounds, three evaluators with expertise in clinical work in speech-language pathology and novice-level knowledge of human factors assessed the same version of the TALC© prototype for usability issues. In the two rounds, the prototype was viewed on a laptop and smartphone (For instructions, see Appendix B). The goal of heuristic evaluation was to identify usability problems from the perspective of accepted principles of good usability design, and to triangulate these findings with those from the other user-centered approaches to usability evaluations (think aloud and remote usability testing). Overall impact ratings for the 10 heuristics, with problems highlighted, are summarized in Figure 4.

Overall, no severe usability issues were identified within the TALC© prototype. Therefore, the system was considered fit for purpose and able to be used for the purpose it was intended. The three experts identified 38 violations across the 10 heuristics (See Figure 4). Two heuristics, visibility, and aesthetic design were the most frequently violated: 11 (29%) and 10 (26%), respectively. These heuristics, however, received mean severity rating scores of 0.45 (no usability problem) and 1.1 (cosmetic problem only). Consistency and standard and recall and recognition were the next most common violations: 7 (18%) and 6 (16%), respectively. These

four heuristics accounted for 89% of the violations. The heuristic with the fewest violations was match between system and real world: 1 (2%). In terms of mean severity rating scores, two heuristics, error prevention and help, scored highest (0.3, no usability problem), followed by consistency and standard (0.5, cosmetic problem only) and recall and recognition (0.4, cosmetic problem only). All heuristics receiving scores <2 was considered minor usability problems.

Significance of the Study

In an effort to harness the value of an AAC device, but to produce a more convenient and affordable tool, mobile AAC apps are created. AAC apps involve the combination of affordable



	Visibility	Error Preventation	Match between system and real world	User Control	Help users	Consistency and standard	Flexibility	Recall and Recognition	Aesthetic	Help and documentation
Counts	11	0	1	3	0	7	0	6	10	0
Severity	0.45	0	1.16	1	0	0.5	0	0.4	1.1	0

Figure 4 Frequency and Severity of Heuristics Violations

technology with software that can be utilized to assist with communication (Lubas et al., 2014). Smartphones and tablets are types of technology that can be utilized to assist with communication. As technology continues to become more affordable and available, its presence is greatly increasing in society today. This has generated a paradigm shift that has been termed as the democratization of AAC due to the impact of increased choice, lowered costs and raised awareness of AAC (Shane et al., 2012). Despite the increase in available apps for AAC, there is a significant lack of attention given to the process of app development. In particular, it is essential that developers use technology to create new interventions that improve on past work,

and not just re-create past interventions in the form of an app (Light & McNaughton, 2012). A potential response to these obstacles is to develop AAC apps through a user-centered design approach, with the intended users providing feedback throughout the software development process. This dissertation aims to employ a user-centered design approach to developing and testing a mobile-based communication tool that promotes effective communication between the healthcare providers and patients with communication challenges during the COVID-19 pandemic and beyond.

Research Problem

AAC tools that facilitate effective interaction in the medical setting or support the decision-making process have been shown in clinical trials to establish effective patient-provider relationships and help patients become more involved in decisions about their health and be more likely to choose treatments that are consistent with their informed preferences and values (Chebuhar et al., 2013; Holm & Dreyer, 2018; Stacey et al., 2017). However, utilization of these AAC tools in general has been disappointingly low, perhaps because they are typically designed with limited input from the stakeholders and are uninformed by theory. In the field of AAC, evidence-based practice has been defined as *"... the integration of best and current research evidence with clinical/educational expertise and relevant stakeholder perspectives to facilitate decisions for assessment and intervention that are deemed effective and efficient for a given direct stakeholder...*" (Schlosser & Raghavendra, 2004, p. 3). Healthcare providers are the stakeholders who have perspectives relevant to a clinical decision; therefore, as a first step toward developing a user-centered communication app, it is important to solicit their perspectives before and during the formulation of a well-built communication tool. Stakeholder perspectives are deemed especially crucial for making explicit the clinical problem as seen by

stakeholders (Schlosser et al., 2007). User-centered design has been proposed as a way to make communication tools more suitable for clinical implementation (Altman et al., 2018). Even though user-centered design is gaining in popularity in the healthcare environment, usability is infrequently considered as one of the primary goals in many design scenarios (Raza & Capretz, 2015). A very common problem is that the programmers and software developers design an app which is good enough for them to use; but not for the targeted population (Signoretti et al., 2020). Therefore, to improve clinical outcomes and increase successful adoption of AAC apps in medical settings, it is imperative to consider the perspectives of healthcare providers. This will allow the researchers to test their assumptions and biases and develop an app that is successful, acceptable, and feasible to the target population. As such, this dissertation aims to complete Phase II of this two-step process.

Purpose of the Study

The purpose of this mixed method study was to evaluate a prototype version of a mobile app designed to support effective PPC with patients who have communication challenges during the COVID-19 pandemic and beyond. The TALC© prototype includes features that allow communication on a variety of topics such as, basic needs, pain scale, emotions and other information gathering topics such as travel history, exposure information. The TALC© prototype utilizes the benefits of mobile apps, such as touchscreen and portability/mobility (Affordances, 2013), along with a just-in-time self-directed learning video that is intended to help the healthcare providers to navigate the prototype. More specifically, the goals of this dissertation were to (1) evaluate and assess healthcare providers' perceived helpfulness and acceptability of the TALC© prototype and (2) seek their feedback regarding recommended improvements to the TALC© prototype prior launching the final, completely functional app.

Research Questions and Rationale

RQ1: What characteristics of the TALC© prototype do healthcare providers perceive as potentially helpful when interacting effectively with their patients with communication challenges?

> **Rationale:** In the context of a human-centered communication app, understanding the viewpoints of healthcare providers ensures that the necessary elements of person-centeredness, clinician acceptability, and feasibility of using the app in medical settings are taken into account, each of which is critical to ensure the ultimate success of the app.

RQ2: On a well-established reference measure, such as System Usability Scale, do healthcare providers rate TALC© as a potentially usable technology in their health setting?

> **Rationale:** To ensure a high degree of usability, a PPC app should be carefully designed, especially since the end users constitute a multitude of healthcare providers with varying needs and demands. The primary objective of this research question was to measure how the two groups of healthcare providers (i.e., SLPs and Non-SLPs) respond to TALC© in terms of its effectiveness, efficiency, and satisfaction, which together represent its usability.

CHAPTER 3: METHODS

This chapter describes the research methodology used to identify specific areas for iterative improvement of the TALC© from the perspective of target end users. This study employed a remote usability testing technique, an established method that has been demonstrated to be comparable with traditional laboratory-based usability assessment (West & Lehman, 2006). Furthermore, remote usability testing allows sampling of participants from a large geographic area and is often less expensive (Dray & Siegel, 2004).

Research Design and Rationale

This dissertation employed a mixed methods approach to assess the usability of the TALC© prototype. This approach allows for a broad and deep assessment of end user experience (Carayon et al., 2015). The qualitative piece of this study explores a set of acceptance characteristics that may influence the use of TALC© in a healthcare environment. In order to achieve an effective development, it is extremely valuable to understand healthcare providers' acceptance of and satisfaction with TALC© by understanding their thoughts as they interact with it.

Recruitment

The study was approved by the University of Cincinnati Institutional Review Board (IRB Record number: 2020-0335). Multiple methods were used to maximize recruitment; participants were recruited through posting online fliers on social media channels like Facebook, Inc., and Twitter™. Specifically, recruitment flyers were shared on speech-language pathology-focused Facebook groups (i.e., Medical Speech-Language Pathology, AAC for SLPs and Language Recovery and Communication Technology Laboratory). Study fliers were also emailed to various state and national level health sciences professional associations and organizations,

including American Nurses Association®, American Association of Respiratory Care© and American Speech-Language Hearing Association®. The study fliers included a brief introduction to the study design, the eligibility criteria, and the contact details of the researchers.

Participants

Participants were deemed eligible if they: 1) were United States board certified healthcare providers providing direct care to COVID-19 confirmed patients; 2) were able to speak and understand English; 3) had managed at least 5 COVID-19 confirmed patients and 4) were able to attend a single remote usability testing session. For the purposes of this study, healthcare providers were defined as an individual who is licensed, certified, or registered to actively provide healthcare services within their scope of practice to cases with communication challenges secondary to COVID-19 respiratory issues. This includes, but is not limited to physicians, nurses, speech-language pathologist, respiratory therapists, or occupational therapists.

Although, there is no specified pre-set sample size for remote usability studies (Schmettow, 2012); Nielsen (2000) has proposed that five users are sufficient to discern 85% of the usability problems. However, Lewis (2006) asserted that a larger sample size of up to 10 test participants, is necessary for the system to have above average usability. For this dissertation project, a total of 17 healthcare providers were enrolled: 7 speech-language pathologists (SLPs), 5 respiratory therapists, 2 nurses, 2 physicians, and 1 occupational therapist. Reportedly, all participants had assessed or treated at least one patient with communication challenges secondary/independent to COVID-19 issues. For data analysis, the participants were separated into two groups: SLPs and Non-SLPs. A detailed overview of study participants is provided in Table 1 and Table 2, respectively.

Table 1

Characteristics of Group I: SLPs

Participant	Gender	Race	State	Profession	Work environment	No. of COVID-19 Patients
P001	Female	Caucasian	Arkansas	Speech-language pathologist	Outpatient	15
P002	Female	Caucasian	Tennessee	Speech-language pathologist	Inpatient	7
P003	Female	Asian	Virginia	Speech-language pathologist	Inpatient	5
P004	Female	Asian	California	Speech-language pathologist	Inpatient	10-15
P005	Female	Asian	Virginia	Speech-language pathologist	Inpatient	10
P006	Female	Caucasian	Ohio	Speech-language pathologist	Acute	10
P007	Female	Asian	Maryland	Speech-language pathologist	Inpatient	30-35

Note. No. of COVID-19 Patients = Approximate number of COVID-19 confirmed cases seen up until the day of study participation.

Table 2
Characteristics of Group II: Non-SLPs

Participant	Gender	Race	State	Profession	Work environment	No. of COVID-19 Patients
P008	Male	Caucasian	Ohio	Respiratory therapist	Inpatient	>100
P009	Male	Caucasian	Nevada	Respiratory therapist	Inpatient	64
P010	Female	Caucasian	Ohio	Physician	Emergency Room	80
P011	Male	Caucasian	Maryland	Physician	Inpatient	40
P012	Female	African American	Georgia	Occupational therapist	Inpatient	10
P013	Male	Caucasian	Ohio	Nurse	Inpatient	>100
P014	Female	African American	Georgia	Nurse	Acute	>100
P015	Male	Caucasian	Pennsylvania	Respiratory therapist	Acute	>400
P016	Male	Caucasian	Ohio	Respiratory therapist	Acute	20-30
P017	Female	Caucasian	Pennsylvania	Respiratory therapist	Inpatient	12

Note. No. of COVID-19 Patients = Approximate number of COVID-19 confirmed cases seen up until the day of study participation.

Study Setting

In this study, a synchronous remote usability evaluation method was employed. This allowed the healthcare providers to take part in the study from their natural setting. In the synchronous remote testing, the researcher and participant were separated spatially but interacted with one another in real time during testing via video (See Appendix C). Four participants logged into the testing environment from their hospital electronic device, and 13 participants logged in from their home.

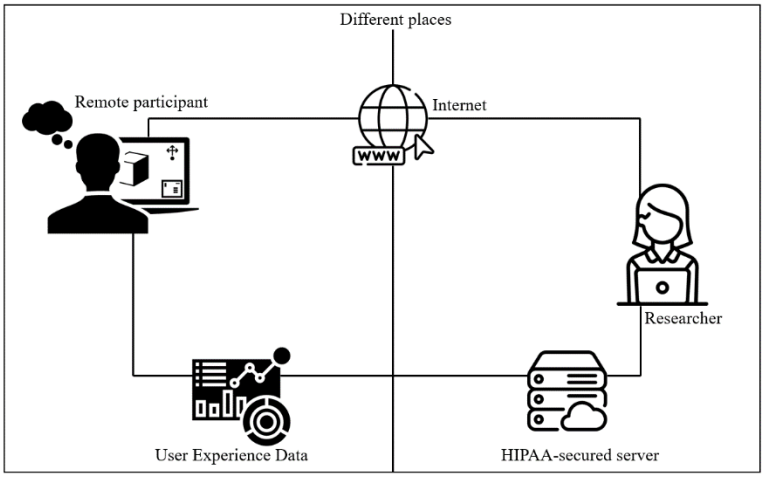


Figure 5 Synchronous remote usability testing design

Materials

Communication App: Talking About Living with COVID (TALC©)

To support healthcare providers in achieving effective communication with their patients who have communication challenges, a mobile-based TALC© prototype (See Figure 3) was created for the usability testing; see Chapter 2 for background and development.

Technology

The participants were required to have a computer with stable Internet connection, the Zoom Video Communications Inc. application, and a connected, functional microphone. The researchers used the same computer with all the participants, which was equipped with Zoom Video Communications Inc. application, Google Chrome™ Internet browser, a microphone, and was connected to the participants through the Internet. A UC HIPAA-secured Zoom account was

used to communicate with the participants, so that they could share their comments and suggestions while interacting with the prototype. During the qualitative data analysis phase, each participant received a Microsoft ® Excel sheet with extracted themes and subthemes with their respective quotes. Member checking Excel Sheets (See Appendix D) were shared via a HIPAA-secure SharePoint ® link.

System Usability Scale

The System Usability Scale (SUS) is a well-known scale in usability practice and research (See Appendix B). The SUS is a ten-question prototype usability scale (See Appendix E) that was created by Brooke (1996) and provides an overview of subjective measurements of usability. The scale has excellent psychometric properties with measures of reliability scoring over .90, a good indicator of validity and sensitivity (Sauro & Lewis, 2009). In addition, several norming studies have presented normative data providing an empirical basis for interpretation of SUS scores. According to such normative data, a SUS score of 72 can be interpreted as a marginally acceptable result (Yuliani & Sulistiadi, 2020)and corresponds to a C+ grade ranging between the adjectives “Acceptable” and “Not acceptable” (See Appendix F).

Perceptual Satisfaction and User Perceived Value

A post-test perceptual satisfaction and user perceived value questionnaire (Appendix G) was developed specifically for this study and was administered to elicit participants’ thoughts about various aspects of the prototype involving functionality and navigation using a Likert scale response. The perceptual satisfaction and user perceived value scale consists of 6 items comprising 6 dimensions:

1. appropriateness of the TALC© to meet communication needs of healthcare provider.
2. accuracy of content with the prototype.

3. learnability.

4. encouragement to use the TALC© in future.

5. confidence in using the TALC©.

6. overall satisfaction.

Items related to dimension 1 were rated on Likert scale 0 (completely inappropriate) to 5 (Perfectly targeted). Item related to dimension 2 were rated on Likert scale 0 (the communication tool is broken) to 4 (all functions worked well). Items related to dimensions 3,4, and 5 were rated on Likert scale 0 (strongly disagree) to 4 (strongly agree). Item related to dimension 6 was rated on Likert scale 0 (very dissatisfied) to 5 (very satisfied). Example items include: "I feel encouraged to use TALC© in my setting" and "I felt comfortable using TALC© in my setting."

Procedures

Figure 6 shows the procedure for the study. Seventeen (17) participants were recruited to conduct the usability assessment. Participants were tested remotely and individually in their

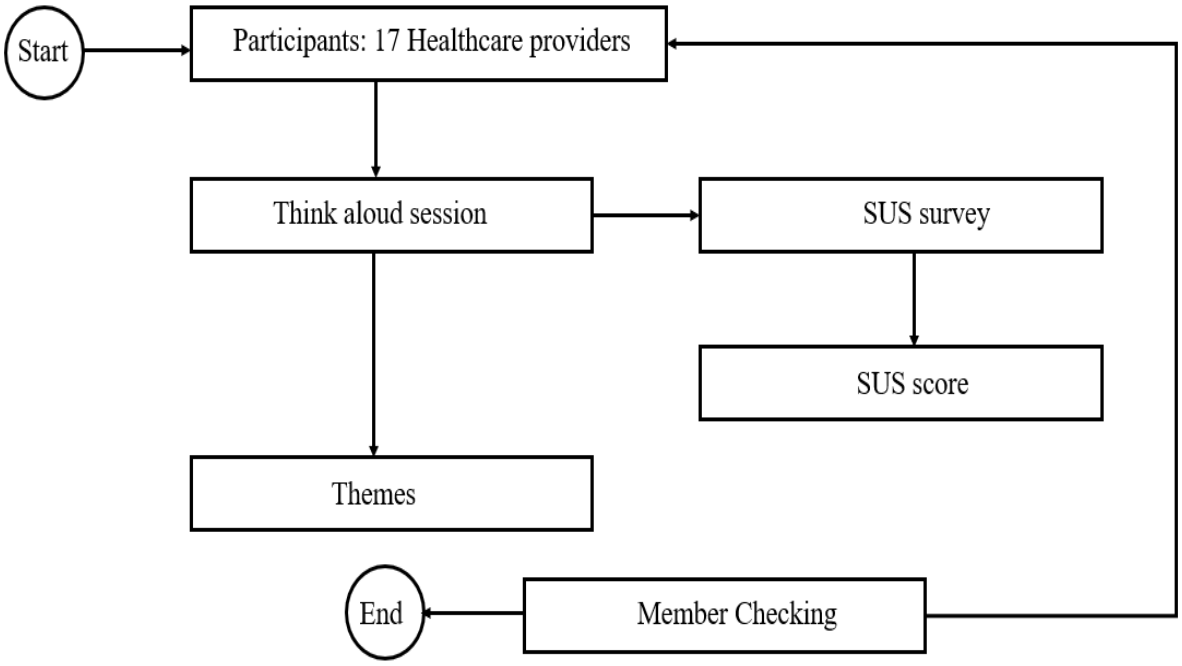


Figure 6 Study events

natural environment using a UC HIPAA-secured Zoom platform. After filling in the demographic questionnaire (age, gender, professional qualification, work experience and number of COVID-19 confirmed patients seen), the participants carried out two tasks on their electronic device (e.g., tablet, smartphone, or laptop—whatever was convenient for them). These consisted of (1) think aloud session and (2) completing remote usability surveys. Each of these tasks are explained in the following section.

Think Aloud Sessions

In this study, think aloud sessions (see Appendix C) were used to expose the healthcare providers to the TALC© prototype while asking them to verbalize their thinking to get their inferences, intuitions, and mental models while interacting with the system. Think aloud sessions were conducted with all 17 participants on an individual basis. The healthcare providers logged in on the online version of the TALC© prototype using their mobile device (smartphone, tablet, or laptop) with a designated personal identification number created for their use at Language Recovery and Communication Technology Lab. During the session, participants were asked to browse through TALC© prototype and try using all the available functions while verbalizing their thoughts. The think aloud session was audio-recorded using the Zoom audio-recording feature to capture their experience while using the prototype.

Remote Usability Survey

After completing the think aloud sessions, the participants were asked to rate the magnitude of their agreement via the SUS scale and perceived satisfaction and user perceived value scale (See Appendix G).

Qualitative Data Analysis

The participants responses during the think aloud sessions were transcribed verbatim from the audio recordings. Transcripts were read and re-read by two research assistants independently to familiarize themselves with the dataset. An initial coding framework was generated manually around emergent themes. In an Excel file, annotations of aspects that were considered meaningful, important, and/or interesting were color coded in the spreadsheet. Following this stage, the two research assistants independently extracted quotes that aimed to summarize the recurrent themes and subthemes. Finally, the codes were checked for consistency and included charting and interpreting the data, which involved defining concepts and finding associations between themes in order to provide explanations for the study's findings. Illustrative quotes for each theme were selected (See Appendix H). No analytic software was used for data analysis.

Member Checking

A member checking involving all the study participants was conducted six weeks following the initial study sessions. The goal of member checking was to (a) validate accuracy of the interpretation of the themes and (b) provide participants with an opportunity to react to the findings (Birt et al., 2016). To this end, the participants received a HIPAA-secured SharePoint® link to an anonymized summary of the qualitative findings. The participants were asked to agree or disagree on their quotes and authors' interpretation of codes. The participants were given opportunities to clarify their reflection, if they did not agree with the authors interpretation.

Inter-Rater Reliability

Cohen's kappa (K) analyses were employed to ensure at least a moderate (i.e.,0.41–0.60) to substantial (0.61–0.80) inter-rater reliability between the two research assistants on all the transcriptions and coded themes and subthemes (Viera & Garrett, 2005).

Quantitative Data Analysis

Group differences were tested non-parametrically (Two-tailed Mann Whitney) due to non-normal distribution of scores between groups (D=0.757; p=0.018). A two-tailed Mann-Whitney test was conducted to detect differences between the usability scores of the SLP and other professionals (non-SLP) groups, using a significance level of 0.05. Finally, central frequencies were calculated to process the participant satisfaction and motivation data.

Reliability and Validity

The transcripts were verified by two research assistants by comparing the typed transcripts to the digital recordings of the think aloud session. To ensure data quality, interrater reliability was calculated on roughly 30% of transcripts (i.e., 5 of 17). This yielded an inter-rater reliability of 94% agreement (Cohen's kappa = 0.86) (Cohen, 1968), and all errors were corrected. The two research assistants coded the transcript for themes and subthemes independently. All the major themes had inter-rater reliability (Cohen's Kappa) of 1.0 and subthemes yielded ratings between 0.65-0.99 suggesting substantial to almost perfect agreement. All disagreements were discussed and resolved as a research team. Finally, to enhance the trustworthiness of the themes and subthemes, the data was returned to participants to check for accuracy. Out of the 17 participants, four participants (1 SLP; 3 Non-SLP) completed the member checking. All of whom reported 100% agreement across all themes and subthemes.

Member Checking

Finally, to enhance the trustworthiness of the themes and subthemes, the data was returned to participants to check for accuracy. Out of the 17 participants, four participants (1 SLP; 3 Non-SLP) completed the member checking. All of whom reported 100% agreement across all themes and subthemes.

CHAPTER 4: RESULTS

This chapter presents the findings of the qualitative and quantitative data for each of the two research questions of this study. As mentioned in Chapter 3, the study involved applying three different techniques for remote usability testing. The results are presented chronologically, with sections about each of the techniques.

Qualitative Findings

A total of 17 healthcare providers participated in the remote think aloud session individually, with one undergraduate research assistant While conducting the thematic analysis, it was clear that themes had emerged consistently across both the groups (SLP and non-SLP group), and there were no themes unique to a particular group. Therefore, the following sections present themes that emerged collectively from the think aloud sessions. The sessions lasted between 18 - 24 minutes (M = 21 minutes).

Theme 1: Ability to Move Easily through the TALC© Prototype

The identified subthemes shown in Table 3 relate to the navigation of the TALC© prototype. Participants assessed the navigation paths and explored whether the TALC© prototype was easy, straight forward, and intuitive to use. Out of the 17 participants, six participants used their smartphones; six participants used their tablet; and five participants used their laptop to explore the TALC© prototype. All of the participants reported that the prototype was simple and easy to use. Participants expressed that the prototype was interactive (n=8), free of jargon (n=11) and intuitive (n=6). They perceived the TALC© interface as streamlined (n=4) and providing sufficient information without instigating information overload (n=14). A few (n=3) commented that all concerns on the “Patients’ concern” page (See Figure 7) should not be shown at the same

time on the same page. They suggested that presenting one concern on a page would help elderly patients identify their symptoms and severity more accurately.

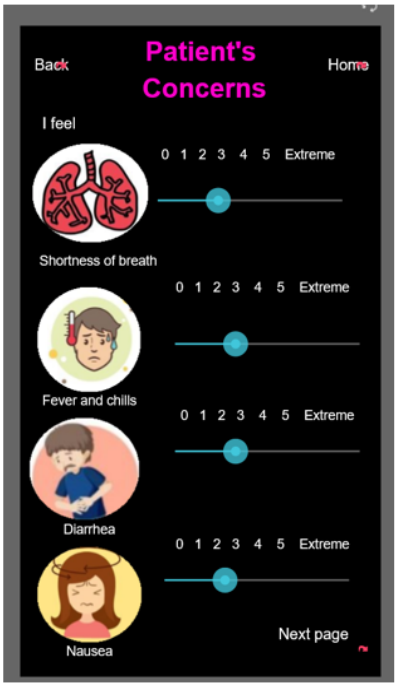


Figure 7 TALC© interface showing the Patient's concern page

All participants commented that it was not hard to find the right information in the prototype. They concluded that the prototype is simple to use. One participant stated,

"It [TALC©]is pretty simple. It just kind of narrows down what you would need to know when you see a patient." [P004—Non-SLP]

Eight participants commented that the system was interactive and would help them to participate effectively in face-to-face interaction with their patient in a collaborative care environment. One participant cited,

> *"I definitely thought that this is an interactive AAC support. I really like that this is actually something that would engage the entire care team."* [P006—SLP]

From the participants' point of view, a communication tool should have user-centered provision of information that can be successfully used by the healthcare providers and the patients. As

such, most participants described having no difficulty understanding the information in the prototype. Eleven participants commented that the prototype was easy to read and understand,

> *"It [TALC©] is clear and free of jargon. I like it. All the concerns [in concern page] are presented clearly"* [P011 –Non-SLP]

A few participants (n=4) appreciated that the prototype is streamlined and recognized the potential of TALC© to make the clinical assessment process more efficient, thus allowing them to understand needs of their patients with communication challenges,

> *"I really liked how streamlined it is. It was very easy to navigate [the tool]. It [the tool] asked a lot of pertinent questions that we [healthcare providers] would like to know from non-verbal patients."* [P007—Non-SLP]

Participants (n=6) also mentioned that they experienced no difficulty while navigating the prototype. They perceived the prototype to be intuitive and easy to use. As expressed by one participant,

> *"It is very simple, it seems very intuitive, it works very similar to other apps"* [P014—Non-SLP]

Overall, healthcare providers reported no issues of cognitive overload, such as difficulty in logging into the prototype or remembering the information on each page. Eleven participants

reported comfort while interacting with the prototype and expressed that all the information on the prototype was easily visible to them. Specifically, one participant endorsed the potential use of TALC© in his medical setting,

> *"I am old, and I think I know what I am doing [when interacting with TALC© prototype] personally for me, I like the app [TALC© prototype]. It is a handy tool. So, I'd probably use it in practice."* [P015 –Non-SLP]

Only one participant indicated impediments related to physical size of his electronic device and difficulty using and figuring-out the back button designed to return to the previous page. This button was placed on the top left corner of each page (see Figure. 8). He commented,

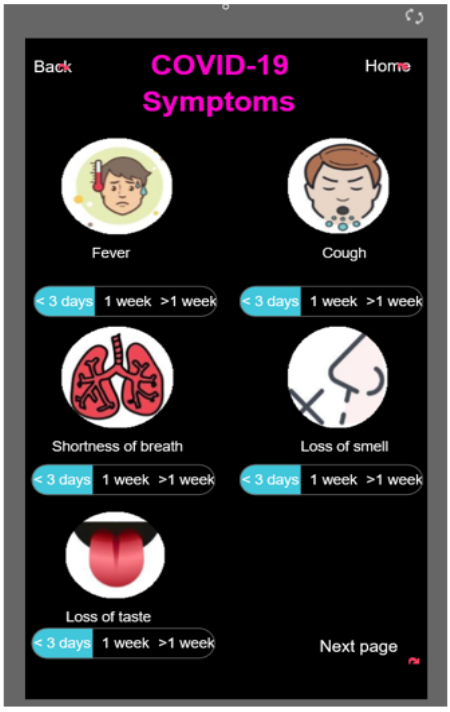


Figure 8 TALC© interface showing the Back button

> *"I see the next button at the bottom of the concern page, but I am repeatedly sliding to right…. this phone is too small... I want to go back [to the previous page], but I can't."* [P016 –Non-SLP]

Table 3

Theme 1: Ability to Move Easily Through TALC©

Subthemes	Cohen's K	Characterization
Easy to use (n=17)	0.80	Overall, the prototype is simple.
Interactive (n=8)	0.76	The prototype allowed the users to interact with the visual information.
Clear (n=11)	0.69	Overall, the prototype was clear and free of jargon
Streamlined (n=4)	0.89	Participants were able to navigate the prototype fluently.
Intuitive (n=6)	0.87	Navigation was perceived to be intuitive.
Minimizing cognitive overload (n=15)	0.65	The options and actions are easily visible so that the user does not have to remember information from one part of the prototype to another.

Note. n= number of participants; Cohen's K=inter-rater reliability

Theme 2: Ability to Quickly Recognize Key Features in the TALC© Prototype

Fifteen of the 17 participants appreciated the visible home page that offered an overview of the TALC© prototype (see Table 4). All participants found the icons to be user-friendly, and a good number (n=8) recognized them from communication boards, other apps, and websites, which seemed to aid in their understanding (For example, see Figure 7 and Figure 8)). The participants also noted that the prototype was free of medical or technical jargon. P011 expressed,

> *"What jumps out to me [in TALC©] is the patients' concerns [page]. We have a communication board in ICU. You know the one with basic needs: Yes-No questions. I am used to that. So, it made it easy [to recognize the icons]"* [P011—Non-SLP]

The healthcare providers highlighted that the user would benefit from the use of the visual aids (e.g., icons) (n=16) that were included in the prototype to assist them in identifying and understanding patient's point of view and the tool during bedside assessment,

> *"The icons make good sense, also the sequence they follow from exposure to concerns is precise. Because it is usually in the order that things actually happen with [COVID confirmed] patients*." [P004—Non-SLP]

The only icon that a few participants (n=3) (See Figure 9) could not associate with its contents was the "concert and beaches" image, located under "travel history"—which was used to capture information if the patient attended a crowded concert for example. One participant suggested to use a different icon,

> *"It is a very nice icon... [it looks] like, 'We are united,' the [associated]text clarifies the icon. I might have thought of a different icon."* [P010 –SLP]

Others (n=5) commented that they found the written description below the icons helpful. One participant commented,

"I think the simplified text helps and the background color is not distracting." [P008—SLP]

Five participants remarked that the prototype was visually appealing, stating specifically that they liked the color scheme of the prototype. As expressed by one participant,

"I think the use of color is neatly done. There are not too many different colors. The contrast seems appropriate with the background colors chosen." [P001—SLP]

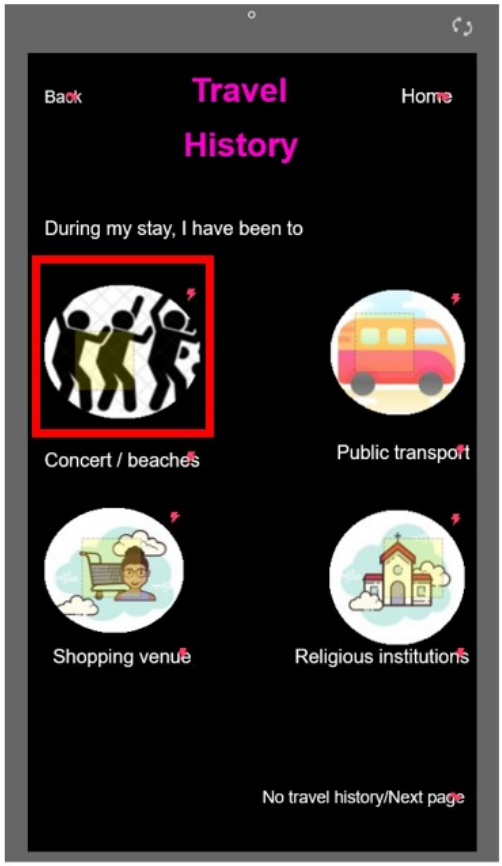


Figure 9 TALC© interface showing the concert/beach icon

Two participants thought that it would be beneficial to have the homepage tabs not only in English and suggested to have the home page in Mandarin and Spanish as well. One participant suggested,

"I see a lot of elderly patients who speak Chinese [Mandarin]. Including different languages in the homepage will help my patients to select their preferred language when the open the app." [P001—SLP]

Table 4

Theme 2: Ability to Quickly Recognize Key Features in the TALC© Prototype

Subthemes	Cohen's K	Characterizations
Familiarity (n=8)	0.97	Experience with other AAC tools
Text (n=5)	0.82	Description of problems and questions in form of texts
Icons (n=16)	1.0	Icons are representative of real world
Color (n=5)	0.85	Effective color combination

Note. n= Number of participants; Cohen's K=inter-rater reliability

Theme 3: Practical Usefulness of the TALC© Prototype

Table 5 includes representative quotes that demonstrated perceived usefulness of TALC©. All participants (n=17) went through the tutorial (See Figure 10) before they started the think aloud session. The tutorial was described as helpful. The participants were able to locate the tutorial without prompting from the researcher. They commented that the information was presented in simple language, and they felt confident about their actions while exploring the prototype. By the end of the usability sessions, when participants had gained some experience with using TALC©, all participants agreed that the just-in-time tutorial helped them get familiar with its features and helped them to use it more efficiently,

> *"The step-by-step guide on how to use the app is great. You go to the homepage, and you know what to do [next]."* [P013—Non-SLP]

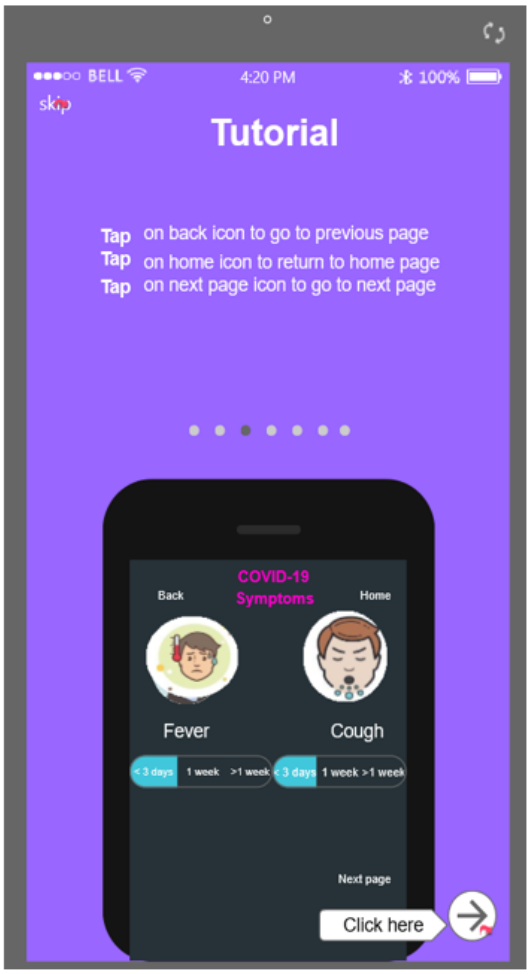


Figure 10 TALC© interface showing the tutorial

Additionally, all participants endorsed the usability of TALC© and stated that they would likely use TALC© regularly to communicate with their patients who have communication challenges in their setting. Two participants expressed,

"It [TALC©] would be really useful, especially for nurses. If the patient needs to go to bathroom, she can hit her call light but then can also let the nurse know their needs." [P006—SLP]

"This would engage the entire care team. It seems like it could be a really nice way to understand patients' concerns and the needs. This could be used throughout a hospital stay. The travel history could be used on the first encounter during admission and, but then you could also use later." [P003—Non-SLP]

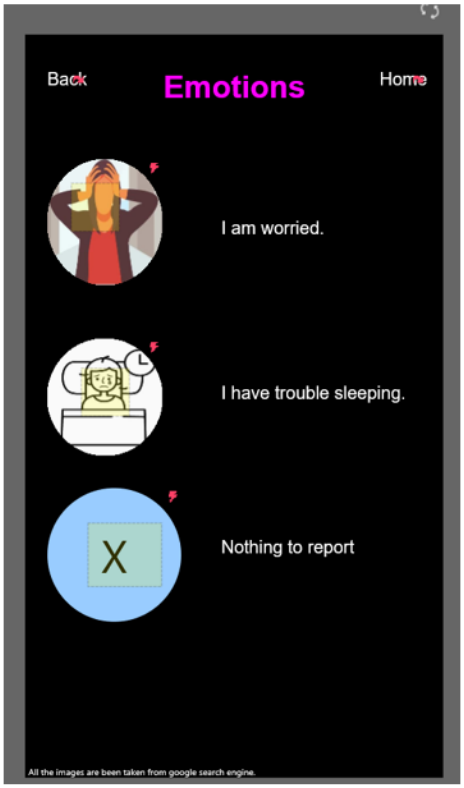


Figure 11 TALC© Interface Showing the Emotions Page

A key feature of the TALC© prototype was the concern tracker page (See Figure 11). The tracker can be used to track the following symptoms: pain, shortness of breath, fever and chills, diarrhea, and nausea. It includes a visual analog scale where "0" indicated absence of symptom to "Extreme" indicates severe symptoms. P001 commented,

> *"I like that you included very simple number scale for the patients. They can scroll sideways to say if they are suffering a lot, or they don't have pain."* [P001—SLP]

Additionally, it includes patients' concerns like "I am worried" and "I have trouble sleeping." (See Figure 11) Tracking of symptoms and concerns was the feature most frequently used during the think aloud activity, and most participants were enthusiastic about using it with patients. Participants provided generally positive feedback regarding the content in the prototype. Additionally, the inclusion of multiple options like the body map (n=6) (See Figure 12) to

describe pain as well as the pages to help understand the needs and concerns of the patients (n=17) were well received. One participant commented about the body map,

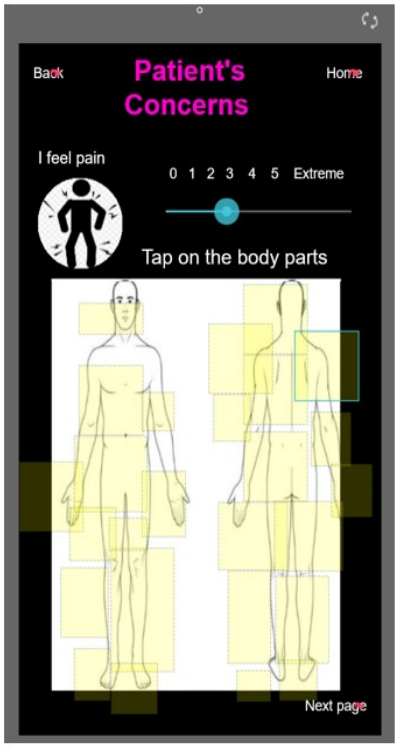


Figure 12 TALC© Interface Showing the Body Map

> *"From an unintelligible [patient,] I would want to know if you [they] are having pain in your [their] throat, if they're intubated."*
>
> [P016—Non-SLP]

Many (n=15) also commented that tracking symptoms and pain would provide a good overview of their patients' symptoms on a given day. They (n=8) noted that the tool can be used with other non-verbal (and non-COVID) patients on their caseload in their medical settings. Several (n=15) indicated that having the tracker and medical symptoms icons next to each other was helpful (see Figure 8 and Figure 12).

Participants also saw positive implications for interdisciplinary care with regards to the possibility of faster communication between the healthcare team and their patients. Two participants discussed the potential of the prototype to support interaction with patients in their hospital units,

> *"In terms of COVID-19 symptoms exposure travel patient concerns. I feel like you've [the tool has] got it and its all great, and basic patient needs are also included."* [P010—SLP]

Another participant commented,

> *"I like how all the options were very relevant to COVID-19 so it was you could tell it was created for that population."* [P005—SLP]

Notably, all 17 of the participants remarked that TALC© prototype can potentially assist them to overcome ongoing PPE-related barriers to communication and support collaborative care planning during the pandemic. Two participants discussed how TALC© may help in alleviating communication challenges due to use of PPE and can be particularly useful in supporting ongoing patient assessment and treatment in their unit,

> *"I've had a lot of patients especially elderly patients who have had trouble hearing me in a mask. So, I really try to speak a lot louder but that does not help. We have iPads installed in the patient room. This app [prototype] can help us ask them [patients] a lot of pertinent history taking questions that we would like to know from patients at regular interval. I think it would be easy for a patient of really kind of any income level or intellectual capacity to navigate and understand [this prototype]"* [P004—Non-SLP]

"When you are in actual unit wearing a PAPR, it is pretty loud, and it isn't always easy to hear what other people are saying. I can use your tool [prototype] to communicate fast and ask practical questions to patients who are on spontaneous breathing trials." [P007—Non-SLP]

"Because of intubation, I had two people [patients] with voice difficulties. Most of the times, I have to end up putting myself at higher risk because you have to be much closer to listen to them [patients]. So, if I am determining their plan of care, then maybe I can use the patients' needs [page]." [P008—SLP]

Table 5

Theme 3: Practical Usefulness of TALC© prototype

Subthemes	Cohen's K	Characterization
Communication (n=17)	0.83	Communication between patients and healthcare providers
Relevant (n=11)	0.81	Relevant to targeted population.
Alleviates PPE-related communication challenges (n=17)	0.89	Ability to communicate effectively with patients while remaining protected.
Tracking scale (n=15)	0.72	The tracking scale was easy and straightforward to use.
Body map (n=6)	0.94	Ability to select more areas of the body while tracking pain.
Concerns (n=17)	0.71	Concern page was helpful.
Just-in-Time tutorial (n=11)	0.99	Just-in-time tutorial was helpful

Note. n= number of participants; Cohen's K=inter-rater reliability

To summarize, all participants found the TALC© prototype clear and pleasantly structured and appreciated the navigation. Six participants gave a positive remark on the TALC© prototype general layout, stating it is logical, convenient, and straightforward. All the participants appreciated the user-interface and engaging graphics. Many (n=11) participants expressed that the interface is easy-to-learn and easy-to-use. All the participants stated they would like to use the TALC© prototype in the future to communicate with their patients who have communication challenges.

Theme 4: Missing Features

The participants highlighted some of the missing features that may help them use TALC© in a more productive way, stating that these features could save them time. For example, during the think aloud test, it became clear that the participants needed the ability to spell words and customize pages for their patients.

> *"Personally, app specific to respiratory care will be useful for me [respiratory therapists]. Something like say hold your breath or I can type take deep breath. Once you customize the app and know how to properly use [the tools], it [will]saves a lot of time and can help me monitor their health."* [P003—Non-SLP]

Many of the participants (n=9) suggested that the patient's needs, and concerns page should include a button to edit and add a new symptom or new concern to the page especially for patients who are non-verbal due to other reasons (e.g., head and neck cancer). The participants, among other things, suggested to add headache, loss of appetite and sore throat to the symptom

tracker, and confused and fear to the concerns page. Three participants noted that when choosing a symptom, it was not possible to proceed without first rating the symptom; however, it might not be relevant at all. The other problem noted by the participants (n=3) was that previously entered data disappeared when the participant moved to the next page on the prototype (See Table 6). One participant suggested adding a "save" button as it would increase the feeling of security with data entered because they were in doubt about what would happen to their data when they pressed the "next" button.

> *"When I press next [button], and go back [to previous page], it [the tool] erases it [information added] all. There should be a save button here."* [P002—Non-SLP]

Table 6

Theme 4: Missing Features

Subthemes	Cohen's K	Characterization
Buttons (n=3)	0.76	Previously entered data disappeared when the next arrow as clicked.
Customizable pages (n=8)	0.83	Discipline-specific Customization
QWERTY Keyboard (n=2)	0.97	Ability to point or spell out words

Note. Non-SLP: Other healthcare provider; Cohen's K=inter-rater reliability

Quantitative Findings

As mentioned in Chapter 3, an online post-test questionnaire consisting of rating scale questions (SUS scale; perceptual satisfaction and user perceived value scale) was used to understand the users' experience with the TALC© prototype. This section presents the results obtained from employing the online post-test questionnaire.

Perceptual Satisfaction and User Perceived Value

The single-item satisfaction scale asked the participants to rate how they feel about the TALC© prototype on a spectrum, with six distinctive adjectives as anchors: (0) very dissatisfied, (2) moderately satisfied, (3) slightly dissatisfied, (4) neutral, (5) moderately satisfied, and (6) very satisfied. Eight participants (Non-SLPs= 6; SLPs=2) indicated that they were "very satisfied" with the TALC© prototype and 9 denoted that they were "moderately satisfied" (Non-SLPs=4; SLPs=5). Because satisfaction is inherently a measure of preference, five additional questions were used to evaluate the participants perceived value of the TALC© prototype. On the item related to appropriateness of the TALC© prototype, eight healthcare providers (Non-SLPs= 7; SLPs=1) agreed that the prototype was "perfectly targeted" to their needs, while nine indicated that the prototype was "well targeted" to their communication needs (Non-SLPs= 3; SLPs=6). On the item related to the accuracy of the TALC© prototype, 13 participants (Non-SLPs=10; SLPs= 3) anticipated that they would be able to communicate "perfectly and timely" with their patients using the prototype and four healthcare providers (SLPs= 4) indicated "some items" in the prototype as valuable for communication with their patients who have voice/speech difficulty. On the item related to learnability, all participants "strongly agreed" that the prototype was easy to learn. Out of the 17 participants, 11 conveyed that they "strongly agree" (Non-SLPs=8; SLPs=3) when asked if they would be interested in using the TALC© in their current setting; the remaining six "agreed" (Non-SLPs= 2; SLPs=4) that they would use the TALC©. Finally, an overwhelming number of healthcare providers chose "strongly agree" (Non-SLPs= 9; SLPs=7), when asked if they felt confident using TALC©, while one (Non-SLP=1) said that they "agree".

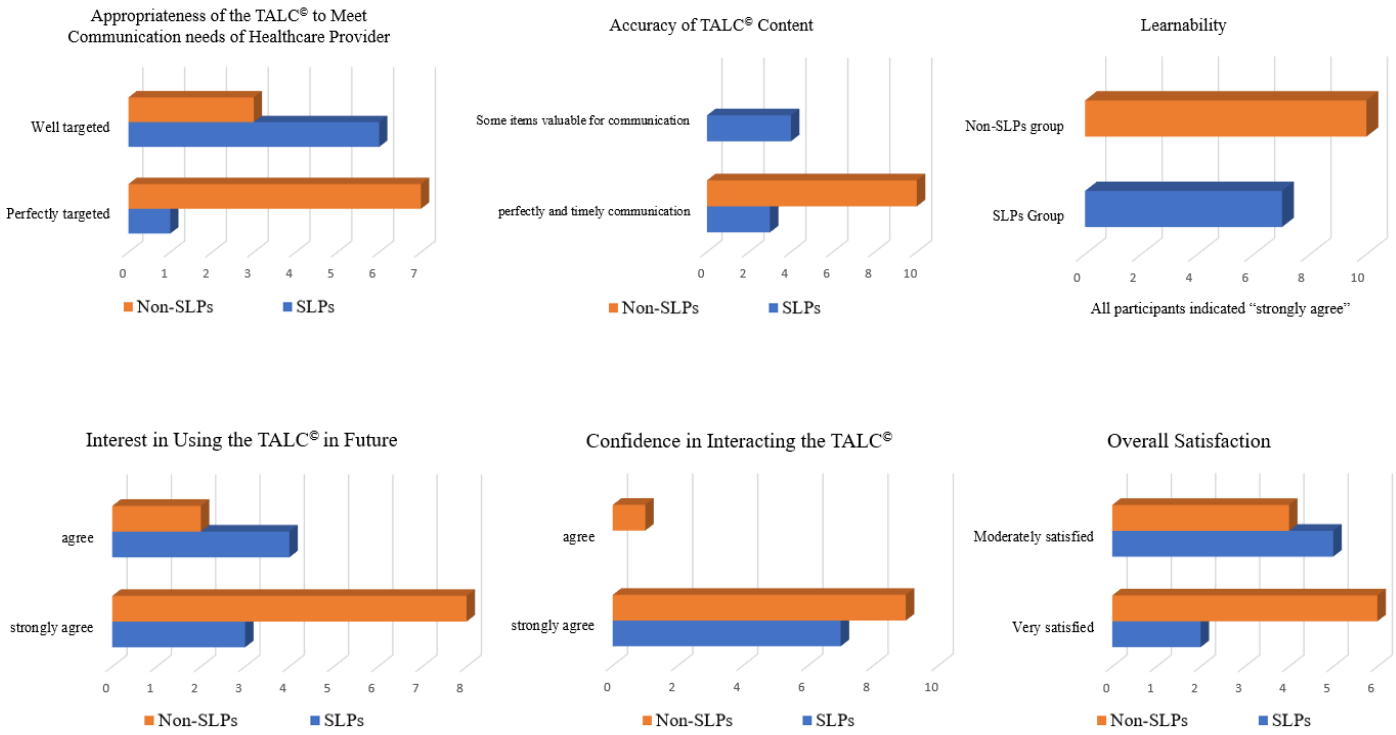


Figure 13 Likert score Average of 17 Participants from Perceptual Satisfaction and User Perceived Value Scale

System Usability Scale (SUS) Analysis

The SUS scores for all participants (n=17) who completed the online questionnaire after trialing the TALC© prototype was calculated. Table 7 lists the SUS score for each participant. SUS scores ranged from 69 to 100. The median score for the SLP group was = 77.5 (SUS_1); the median score for the Non-SLP group was = 92.5 (SUS_2). A Mann-Whitney test was carried out to assess whether there is a difference between SUS scores of the SLP and Non-SLP groups. The result revealed a significant difference between SUS scores of the SLP and Non-SLP groups (U=6.5, z = 2.73, p = .006). However, according to the benchmark for assessing the usability of the prototype (See Appendix F), both groups rated the TALC© prototype usability as "acceptable" (Bangor et al., 2009).

Table 7
Average SUS Score by Participants

Groups	Participants	SUS Composite Score
Non-SLP (Other professionals)	P002	92.5
	P003	100
	P004	95
	P007	92.5
	P011	100
	P013	87.5
	P014	77.5
	P015	85
	P016	85
	P017	100
SLP	P001	80
	P005	77.5
	P006	70
	P008	82.5
	P009	90
	P010	70
	P012	69

CHAPTER 5: DISCUSSION

This dissertation study used a mixed methods design to explore the perspectives of healthcare providers regarding the potential of the TALC© prototype to support PPC in the medical setting. The quantitative phase evaluated the usability and acceptability of TALC©, among healthcare providers working with patients who have communication challenges. The qualitative phase examined the healthcare providers' experience with the TALC© and their perceptions of the TALC©. In this final chapter, the major findings of the dissertation, clinical implications of a fully functional TALC© app as we begin to emerge from COVID-19, as well as how it may be a useful tool beyond the pandemic are discussed. Limitations will be reviewed and opportunities for future research will also be discussed.

Navigating New Challenges in PPC during COVID-19

During the pandemic, the requirement for face masks, as an important protective measure to reduce virus spread, had a significant impact on interpersonal communication in medical settings. Proper application of PPE eliminates non-verbal expression which are necessary for effective communication. In fact, studies have reported that positive facial expression of healthcare providers plays an important role in reducing patient's anxiety (Nobilo, 2020). The healthcare providers who participated in the current study, acknowledged that the increased use of PPE in their setting has created material barriers when communicating with their patients; causing PPC to be disrupted (Mheidly et al., 2020) (Theme 3: Practical Usefulness of TALC© prototype).The degradation of speech quality, combined with the noise in the hospital room and the absence of visual cues, makes speech almost unintelligible for many patients (Mendel et al., 2008). In some instances, as also reported in this dissertation, the healthcare providers resort to talking louder (Theme 3: Practical Usefulness of TALC© prototype ; P004—Non-SLP) or

reiterating the same information (Kilgore et al., 2021). This impact, generally unconscious, may manifest into patronizing communication, causing negative impact on the patients (Cockrell, 2020). As mentioned by the research participants, patients with age-related hearing loss are at greater disadvantage as the visual signs they rely on for lipreading are eliminated due to the use of PPE (Baltimore & Atcherson, 2020)

Additionally, all the healthcare providers caring for suspected or confirmed COVID-19 patients are required to wear PAPR during high-risk or aerosol generating procedures (Howard, 2020). Similar to other studies reporting the disadvantages of PAPR, such as noise from the respirator, participants in the current study expressed concerns (Lenhart et al., 2004). More specifically, participants in the present study reported that PAPR can produce notable levels of background noise and the sound of air moving across the microphone which adversely affects speech perception, causing difficulty communicating with their team, as well as with the patients (Theme 3: Practical Usefulness of TALC© prototype; P007—Non-SLP). Prior research has demonstrated that wearing PAPR hoods creates a loss in speech recognition ability of the wearer, which is comparable to a moderate, to severe hearing loss; thereby causing possible negative effect on communication (Kempfle et al., 2020).

The healthcare providers in this study further recognized the difficulty in interacting with patients who have communication disorders secondary to intubation and noted inadvertently utilizing strategies like standing close to the patient to facilitate better communication with the patients, despite the risk of contracting the COVID-19 virus (Theme 3: Practical Usefulness of TALC© prototype; P008—Non-SLP). Several studies have reported the challenges in implementing social distancing in hospital units (Arora et al., 2020). Lack of patient-centered resources to communicate effectively with these patients further creates a barrier to communicate

effectively with patients who have communication challenges (Wittenberg et al., 2021). As such, healthcare providers are forced to utilize strategies at their disposal such as standing closer to the patients and lip reading, while assessing or treating patients with communication challenges in medical settings and putting themselves at a risk of contracting and transmitting highly communicable diseases (Agarwal et al., 2021). To summarize, the aforementioned findings confirm that PPE and social distancing which are necessary to prevent the spread of the COVID-19 virus, have inadvertently affected the PPC communication in medical settings.

Healthcare Providers Involvement in Designing TALC©

Translating theories of communication from aviation to healthcare is gaining momentum due to common elements in both industries (Leonard et al., 2004; Sexton et al., 2000). According to federal aviation rules, the pilot in command is unequivocally responsible for and has the ultimate authority for the operation of the aircraft. The role of the healthcare provider is identical. The healthcare provider is unequivocally responsible for providing the best possible treatment to the patients and has ultimate authority over the diagnosis and care of the patient. It is the healthcare provider, such as a physician or a therapist, who conducts the first in-depth patient interview. It is the healthcare provider who makes the diagnosis, writes the recommendation and treatment plan, and cares for the patient in the hospital and advises the patient as to the best and most informed treatment options. Consequently, the development process of a communication app that targets effective PPC during medical encounters must involve consultation of healthcare providers (Coulter et al., 2013; Liberati et al., 2015).

A few mobile AAC apps, such as the Society of Critical Care Medicine patient communicator app ™ and VIDATAK: Innovation in Patient Communication® are commercially available. These apps make communication easier by providing pre-determined lists of

communication content from which patients can choose by touching or pointing. However, the research regarding their development is not available, and the extent to which end users were involved is unclear. In a qualitative study, where 80% of the healthcare providers reported using mobile AAC apps, they acknowledged the potential of these tools. However, they indicated that most mobile AAC apps on the market were not designed by healthcare professionals and did not collect desired data for clinical purposes (Wang et al., 2018). As such, despite the growing number of AAC apps, the majority still fail to address the unique needs of healthcare providers. The involvement of healthcare providers in development of AAC technology in the medical setting is not a standard practice (Liberati et al., 2015), which may be, at least in part, due to a lack of information and a framework on how to involve stakeholders in the development process (Lubas et al., 2014). This has resulted in a gap between state of the commercialization and state of scientific practice. The result is a plethora of AAC apps being developed in response to technological innovations, rather than evidence-based knowledge and user needs (Light & McNaughton, 2013). With the rapid expansion of mobile technologies, there is a dire need for more attention on how to develop sophisticated AAC apps that can be helpful to the patients and cater to the needs of the healthcare providers during medical encounters.

In order to close this gap, this dissertation included 17 healthcare providers to evaluate a communication app—the TALC© prototype, with the ultimate goal of to achieving sustainable transfer of this technology in medical settings. The various front-line health professionals considered TALC© as simple to use and interactive (i.e., Theme 1: Ability to Move Easily Through TALC©). In TALC©, communication around pain, emotions, needs and COVID-19 related issues are organized into categories using texts and icons. All the participants responded favorably to the presence of text and pictures to facilitate communication with their patients (i.e.,

Theme 2: Ability to Quickly Recognize Key Features in the TALC© Prototype). One participant offered important input to reduce the prototype complexity and increase its acceptability and make the prototype as user-friendly as possible. The provider suggested putting the scales below the images rather than beside it (see Figure 7). Furthermore, some participants suggested too, that the app include at least one icon per page to help patients attend to one concern, or symptom at a time. Evidence from the literature shows that the organization and layout of representation in AAC systems can either aid or hamper the functional communication in adults who are using the system (Dietz et al., 2014). The design for TALC©, presenting the scales alongside image symbols was intended to improve comprehension of patients and aid them in conveying the severity of their concerns in a timely fashion. However, in patients with limited peripheral vision or with limited attention span, this layout may have a negative impact (Brown et al., 2015). Future studies with patients will help explore whether the presence of more than one icon on the page hinders or helps patients in achieving timely communication. Finally, to the best of our knowledge, this is the first time a communication app focused on COVID-19 concerns has focused on the viewpoint of healthcare providers—an often overlooked stakeholder group (Binger et al., 2012).

Overall, healthcare providers evaluated their experience with TALC© as positive. They also reported that the TALC© has the potential to be helpful and useful (see System Usability Scale (SUS) Analysis for further discussion) for communicating with patients by allowing the patient to express their needs/wishes clearly as well as allowing the healthcare providers to better understand what the patient is trying to say. In general, the healthcare providers involvement engendered frequent conversations around 2 important points: (1) what additional features should be added to the prototype and (2) the advantages of quickly learning to navigate the

prototype. These findings illustrate the importance of engaging healthcare providers early in the design and development process to ensure greater acceptability of the app (Uthoff et al., 2021). Prior research has recommended that AAC researchers should collaborate with stakeholders like physicians, therapists, nursing staff to guarantee adequate healthcare for people with communication challenges (Gibson et al., 2020). The participants also suggested that the prototype should include a wide range of symptoms and conditions, whilst remaining succinct enough to accommodate two or three questions on one page of the app (i.e., Theme 4: Missing Features); which would in turn be beneficial for patients who have short attention spans (Light et al., 2019).

Finally, to ensure effective interaction during PPC, healthcare providers require competence in the operation and implementation of apps. Usually, it takes healthcare professionals a significant amount of time to develop technical competence with AAC apps. Current systems provide few, if any, built in supports for communication partners to facilitate their interactions with patients who have communication challenges. Furthermore, time constraints in the hospitals prevent the providers from learning new AAC technologies. There is also a growing body of research that emphasizes the need for technical development that can help reduce the learning demands of AAC apps in a busy hospital environment (Morris et al., 2013; O'Halloran et al., 2008; Simmons et al., 2019). Consequently, in this study we developed a just-in-time tutorial which provided quick and required minimal training to help the participants navigate TALC©, which reportedly proved helpful to the participants (i.e., Theme 3: Practical Usefulness of TALC©). Based on the current study, the following section highlights the intention for usability testing in the field, which can uncover problems under the context of meaningful use.

Need of Field Testing

AAC researchers with the focus on development of AAC apps will inevitably face technical problems while field testing the new app. Usability testing provides an opportunity for researchers to identify the overt issues during the developmental phase prior to beginning any such trial. Several studies, specifically targeted to healthcare providers, reported that they were able to successfully use AAC systems in an instructional setting but had a hard time transferring those skills to other contexts without specific, intensive training (Downey, 2014). To verify the efficacy of the TALC© prototype, it will be important to rigorously test the prototype in medical settings when healthcare providers are using it while interacting with their patients. Field testing will evaluate not only usability but also usefulness of TALC© in real life situations. One caveat to this recommendation, however, is worth mentioning. The only way to ensure that the TALC© prototype will work in all instances and in all medical units, is to deploy it in those instances and units. Given that resource constraints make this unfeasible, circumstances and situations will arise when certain features do not cater to the needs of healthcare providers or patients. Thus, it is important to test and adapt the app to particular medical unit and stakeholders to manage their expectations, such that they do not expect the communication app will work flawlessly in all situations. Nonetheless, stakeholder involvement throughout this study aided in the development of a communication tool, which will be subsequently significantly updated to ensure its appeal and usefulness among healthcare providers and easy integration into medical encounters. Moving far beyond typical stakeholder engagement, this study involved stakeholders from different medical or allied health backgrounds (see Table 1 and Table 2). Owing to the rich feedback from these participants, we have ascertained that the final product will meet the needs of a variety of healthcare provider groups and provide a communication app that is clinically accurate and

functional; although, based on participants' feedback, we anticipate that a few iterations will be required before the final product is made available.

Usability of the TALC©

Unlike previous research studies that assessed the usefulness and acceptability of communication tools with patients, this study included point-of-care healthcare providers in evaluating the process of developing TALC©. Clinicians' buy-in to the use of AAC apps (or tools) in their hospital unit, as well as their perceptions of system performance and ease of use, are critical factors when selecting AAC apps for patients with communication issues in medical settings (Binger et al., 2012; Dietz et al., 2012). Guided by the TAM, this study provided evidence for the usability and acceptability of the TALC© app prototype. On the SUS (Brooke, 1996), the participants rated the overall usability of TALC© favorably, which reflected perceived usefulness on the TAM. Interestingly, the SLP (SUS_2=77) group rated the overall usability less favorably compared to the Non-SLP group (SUS_1=91.5). The non-parametric test showed a significant difference between two groups. The stark asymmetry in usability rating between the SLP group and Non-SLP group needs further exploration in the future studies. Primarily, all the participants in the SLP group reported seeing patients who had communication challenges secondary to COVID-19 respiratory concerns. The prototype was mainly focused on gathering information pertaining to needs of the patients. While all the SLPs found the tool to be useful in providing communication opportunities to understand the symptoms and needs of the patients, the SLPs were likely expecting an app dedicated to speech-language-swallowing assessment and treatment. It is also noteworthy that both the SLP and Non-SLP group emphasized that the subsequent iteration should provide an opportunity to customize the prototype. To optimize the healthcare communication, it will be crucial to update the TALC© prototype with unit—or

profession-specific communication templates that have been vetted by professional healthcare providers working in those hospital unit. Overall, all the participants were confident and encouraged to potentially use TALC© in their setting. The participants rated that they were satisfied with the TALC© prototype (i.e., 8 participants reporting very satisfied and 9 participants reporting moderately satisfied). Incorporating input from the experts during the prototype development phase (see Chapter 2 for details) allowed development of a convenient, easy to use mobile prototype which likely led to higher rating on perceived value and satisfaction scales.

Mobile AAC apps at the Point of Care

With the current mobile device revolution, technologies such as smartphones and tablets, apps have become fairly widespread and are increasingly being used in the healthcare context (Powell et al., 2014). Initially healthcare environments included portable, wireless mobile information stations such as Computers on Wheels (COWs). The demand for enhanced communication and information resources at the point of care has been a primary driver of widespread use of mobile devices by hospital providers (Moodley et al., 2013). There is a growing body of evidence that the use of mobile communication devices allows providers to monitor patient conditions, while simultaneously enabling individuals to convey their concerns to the health professional (Happ, Walaszek, et al., 2014; Santiago et al., 2019; Von Visger et al., 2016). In the context of the wide adoption of digital technologies in healthcare, an urgent need exists to develop and assess digital tools to facilitate PPC, especially for people with limited verbal communication. An app-based solution may represent a potentially useful and cost-effective means of delivering an AAC tool in the medical setting and facilitating effective communication between the healthcare providers and patients with communication challenges. During the interviews, many participants commented, in passing, that mobile devices were

readily available at their disposal in their hospitals. Mobile devices were perceived to be a potentially useful and effective platform for the delivery of TALC©. In this dissertation, several participants (n=10) interacted with the prototype on their mobile phones, and they identified the size and touch screen capabilities of mobile devices as favorable to use in medical setting. The familiarity, light-weight interface, and portability of mobile devices can be advantageous for using mobile AAC apps in medical settings. One participant indicated that there might be barriers to accessing TALC© on smartphones due to small size of the display screen and poor fine motor dexterity in the elderly (i.e., Theme 1: Ability to Move Easily through the TALC© Prototype; P016—Non SLP). The participant suggested using larger device tablets instead. As designed by the researchers, the TALC© prototype is compatible on electronic devices like smartphones, tablets, and computers. However, exploring healthcare providers' experience of using TALC© on all three electronic devices was beyond the scope of this dissertation. Given the wide assortment of mobile technologies available at the disposal of the healthcare environment, providers must choose a device that is most effective for the patient in terms of accessing the content of the app. For this to happen, barriers to healthcare providers' knowledge, skills, and attitudes must be overcome (Blackstone & Pressman, 2016) and addressing these barriers while developing AAC tools is no exception (Beukelman & Mirenda, 2013). Unfortunately, AAC training is not always a key component of typical healthcare practice due to the busy environment and funding constraints (Downey & Happ, 2013).

The literature has demonstrated that AAC supports and trainings to teach healthcare workers how to use communication methods in medical settings for a number of clinical populations have demonstrated change in skills, knowledge and attitude of the healthcare providers (Radtke et al., 2012; Simmons-Mackie et al., 2007). Completion of such training may

boost healthcare providers' confidence in adopting AAC tools at the point of care. With additional data relating communication programs to better patient outcomes, healthcare systems may be ready to fund more rigorous training, and increased SLP presence, and enhanced electronic AAC device availability in the future.

Optimizing the Layout of the TALC©

To improve the functionality and consequently, the utilization of AAC apps in hospitals, it is important to work directly with healthcare providers and patients. Currently, little-to-no quality control exists to ensure apps used in healthcare environment are user-friendly, accurate in content, evidence-based, or effective (Scott et al., 2018). Over the course of this project, a diverse group of stakeholders were involved to assess usefulness of the prototype. during development (See Chapter 2) and testing of TALC©. Nevertheless, concerns about not including patients in this study were raised by the healthcare providers during the think aloud session. Since this is the first step in assessing the usability of TALC© from the perspective of healthcare providers, the next logical step would be modifying the existing prototype prior to collecting data on patient performance. This information would further strengthen the measurement of the functionality of TALC©. The healthcare providers also conveyed helpful suggestions, during the think aloud session.

Methods of Constructing Message and Output

Participants recommended a variety of different methods for constructing messages. One participant proposed that TALC© should include a page dedicated to medical encounters, as well as preloaded frequently used medical vocabulary and phrases. Another healthcare provider suggested that an onscreen QWERTY keyboard be provided to allow for a greater freedom of expression by the healthcare providers when patients do not understand their messages (as well

as by the patients). This would allow for augmented input which promotes increased active and constructive participation from patients who have difficulty comprehending and following directions (Bourgeois et al., 2001; Wallace et al., 2012). The participant indicated that the ability to customize will allow them to choose and adapt the pages as per their need (i.e., Theme 4: Missing Features; P003—Non-SLP). As currently designed, the TALC© utilizes a direct selection approach. The patient selects a particular page in TALC©, then chooses the desired icon to convey their message to the healthcare provider, while the healthcare provider observes the app. However, direct selection could be problematic for individuals who do not have the ability to isolate fingers to point to the icons in the pages. In that case, the direct selection could be adapted using one of two methods. Adaptive styluses exist in a variety of forms and sizes to make them easier to grasp for patients with poor fine motor skills (Brumberg et al., 2018). Patients who are unable to isolate their fingers to point to the icons on TALC© may be able to hold the stylus and choose the icons with it. The other method involves a universal hand cuff, which requires, an elastic band that is wrapped around the patient's hand and has a pocket for the stylus. If a patient is unable to grasp an adaptable stylus, a universal cuff can be utilized to keep the stylus in place in the patient's hand (Lloyd et al., 2018). In passing, few participants suggested to add the ability to produce digital speech when the patient touches the buttons on the TALC© page. As previous research has pointed out, while visual output is a more private mode of communication (and, in some cases, the only option for people with communication challenges), verbal output is a more acceptable approach to communicate (Fager et al., 2021).

One Size Does Not Fit All

It is not likely that a single AAC app will meet the needs and requirements of all patients with communication challenges. It is also evident that communication needs can fluctuate and

alter during a patient's time in the medical setting. Moreover, the communication needs of patients may change depending on the phases of recovery (Costello et al., 2010). During phase 1, patients are emerging from sedation and regain the attention and the ability respond to yes/no questions. In phase 2, patients are alert and awake. In this phase, the patients should be able to solicit attention and support, ask and respond to questions, express concerns, and emotions. In the final phase, the patients should have the ability to engage in communication about broad and diverse topics related to their healthcare. Consequently, different AAC strategizes are required as the patient progresses through these phases. Considering these evolving needs, it is essential that SLPs perform a regular bedside assessment of the communication needs of patients, with the purpose of matching them with the most appropriate AAC strategies and access methods (Costello, 2000; Mobasheri et al., 2016; Santiago & Costello, 2013). The findings of this study highlighted that customizability of the AAC app is critical to ensure that varying needs of a wider number of patients are met during their hospital stay. Allowing users to choose content creation methods, as well as the size of icons and fonts may potentially be useful in this regard. To summarize, the variety of healthcare provider populations in this study perceived that TALC© has the potential to support communication in a variety of medical settings. The participants also identified few accessibility barriers. This emphasizes the importance of removing such impediments prior to the field testing.

Finally, it is important to acknowledge that people with low socio-economic status generally appear much more reluctant in adopting communication apps (Qualls, 2012). Although elderly people are fairly diverse when it comes to adoption of AAC technology, they may be initially hesitant to use phone- or tablet-based support due to a lack of technical literacy (Shane et al., 2012). Further, while smartphones are widely accessible and used in cities, coverage in rural areas remains significantly lower in comparison, isolating people in these areas (Binger et al., 2012). It therefore

remains questionable whether all groups benefit equally from AAC apps such as TALC©, or if some may not benefit at all. If AAC apps are to be used on a larger scale in hospitals across the United States, it is critical to understand which populations are disadvantaged or whether different groups are affected in different ways, necessitating multiple technology-specific and individual-specific approaches to addressing inequalities.

The TALC© and AAC During COVID-19—and Beyond

The COVID-19 pandemic has brought about dramatic changes to many aspects of the healthcare system (WHO, 2020), including PPC (Belasen et al., 2021). More specifically, an overwhelming number of patients have become ventilator dependent (Hanidziar & Bittner, 2020) and/or suffered neurological disorders (Paterson et al., 2020; Zou et al., 2020) as they battle this virus. Based on current data, COVID-19 is transmitted through respiratory droplet, person-person contacts (WHO,2020), and also via airborne particles (Ram et al., 2021). Currently, the CDC lifted the mask mandate; however, personal PPE, including masks, gowns, gloves, face shields and protective eyewear continue to be used by clinicians and patients to prevent them from acquiring, or acting as a vector in transmission of coronavirus to other staff and patients in medical settings (Woolley et al., 2020). As mentioned previously (Chapter 2), the wearing of PPE presents an adverse external influence on effective communication between the healthcare providers and their patients (Hurtig et al., 2020). During this time, medical SLPs and organizations like the United States Society for Augmentative and Alternative Communication (USAAC) have risen to the challenge and developed resources (see example in Figure 15; courtesy USAAC Disaster Relief Committee) that can be used to communicate with people who

have communication challenges secondary to COVID-19 (Buheji et al., 2020).

This global pandemic offers a unique opportunity to address the past, current, and future challenges in developing and using AAC apps in hospitals. Healthcare providers across the board face stringent productivity standards, with a common expectation to see more patients per unit of paid time (Chandra et al., 2013). These arrangements inevitably put greater constraints on effective PPC, which likely creates an unjust situation that yields less than effective interactions with patients during this unparalleled time. In these situations, embracing user-centered designs for AAC apps may serve the dual-purpose of meeting the demands of hospital productivity and the communication needs of the patient. Effective implementation of AAC apps is contingent

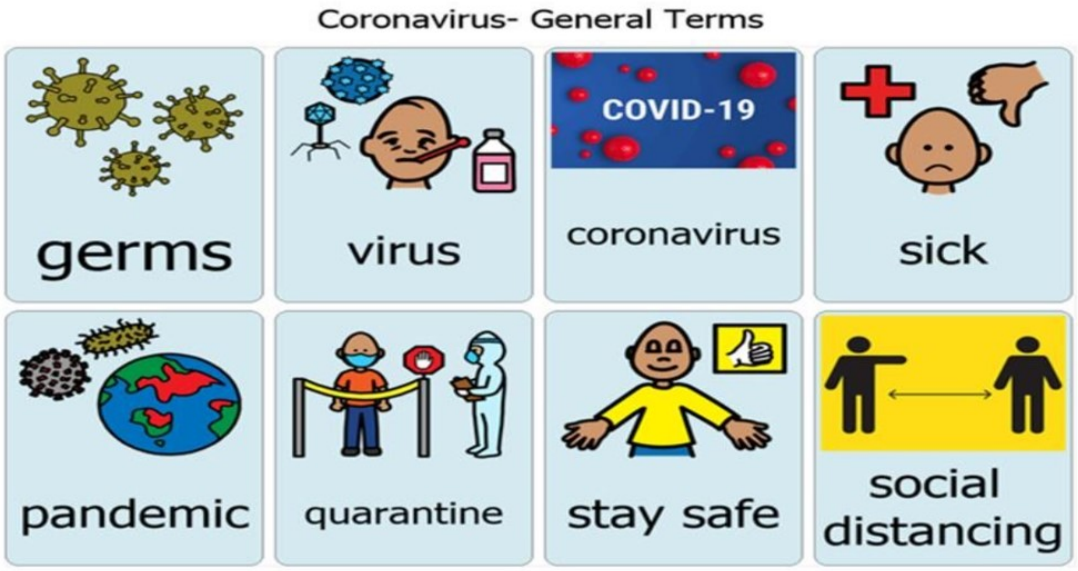


Figure 15 COVID-19 specific Communication Board Distributed by USAAC

upon adequate technological infrastructure such as hardware/software, design and content of the app, and trained personnel in AAC (Gosnell et al., 2011). This dissertation resulted in innovative solution, the TALC© prototype, to potentially support effective communication in the medical setting during the COVID-19 pandemic—and beyond. It is important to note that the TALC© prototype was created for the healthcare providers and was not meant to replace the use of low-

tech AAC, such as those developed by USAAC (see Figure15). Instead, its purpose is to aid in the reduction of communication barriers between healthcare providers and patients, especially when family members are unavailable to assist during these situations.

COVID-19 will eventually be contained, and the world will resume some new form of normalcy. Nonetheless, COVID-19 will likely continue to have long-term effects on how healthcare is practiced, and PPE will likely have a new permanency in the medical setting—even in settings when it was not necessary pre-COVID (see example of PPE policies in Hospital in Nebraska). In a recent survey, a majority of people (59 %) want healthcare workers to continue using PPE at the same frequency as they did during the COVID-19 pandemic even after it has ended (GlobalData, 2021). And thus, would continue to negatively impact communication between patients and their providers (Hampton et al., 2020). The current pandemic has highlighted the need to establish PPC as an institutional priority. It could be argued that PPC is more essential than ever to meet the individual needs of patients during this era of change. The lessons learned during COVID-19, and the increasing need for consideration of patient preferences and values, may help to further the discussion about how to incorporate AAC apps more broadly in hospitals—for those with and without communication challenges. Careful and concerted efforts are needed to incorporate additional inputs from various stakeholders that can address issues like ethical issues like patients' privacy and security while using the apps.

Limitations & Future Directions

To understand more about patients' variables and to inform what adjustment might be needed from the patients' point of view to TALC©, it will be necessary to investigate patients' perspectives and observe interactions between healthcare providers and patients. To achieve this goal, it will be necessary to complete clinical trials of the TALC© to demonstrate the efficacy of

this approach for use by any patient in need of assisted communication with healthcare providers. The usability study of TALC© focused on evaluating the helpfulness of the system and user-satisfaction. It is also imperative to conduct a task-based usability assessment where the users try to accomplish real tasks while using the TALC©. We can quantify the experience using metrics and understand the problems by observing what users do and report. Next, the design of TALC© is focused on healthcare providers and needs of adults who have communication challenges. In order to better serve a younger population, the overall design may need to be adjusted. Future research is planned to conduct a larger-scale study, which will seek to evaluate the capabilities of TALC© during medical encounters in the hospital. The proposed clinical trial will include both patients with communication challenges and healthcare providers. During the study period, patients with communication challenges and healthcare providers will use the TALC© to communicate with each other. In this study, the patients and healthcare providers will evaluate the performance measures of TALC©. Furthermore, the TALC© prototype will be improved based on the feedback from the healthcare providers and patients.

Summary

Patients with communication challenges in healthcare setting often struggle to communicate due to inaccessible or unavailable tools for AAC. Using a human-centered design a novel communication tool, the TALC© was developed for use in medical settings for healthcare providers to help them communicate effectively with their patients. The prototype was evaluated by 17 healthcare providers, and the findings from the think aloud sessions, as well as the SUS surveys suggest that while there is still room for improvement, TALC© has potential to support effective communication in medical settings as we emerge from the COVID-19 pandemic—and beyond. Despite its many challenges, it is clear that this unprecedented period can provide

opportunity to improve the PPC in medical settings. At the time of this writing knowledge, this is one of only two user-centered communication prototypes developed to address PPC challenges during the pandemic. COVID-19 is likely to leave an unpredicted legacy of voice disorders (Piazza et al., 2021), cognitive disorders (Hosp et al., 2021) in a significant number of survivors. An app-based solution could be a potentially useful and cost-effective way to provide an AAC tool to patients in medical settings. This study has demonstrated that this approach is well-suited to identify healthcare providers' communication needs for designing an AAC app. Utilizing human-centered designs, along with AAC training for healthcare providers will increase chances of successful implementation, acceptability, and sustained use of this AAC app by clinicians during COVID-19 and beyond.

REFERENCES

Agarwal, K. M., Sharma, P., Bhatia, D., & Mishra, A. (2021). Concept design of the physical structure for ICU ventilators for COVID-19 pandemic. *Sensors International*, *2*, 100092.

Altman, M., Huang, T. T., & Breland, J. Y. (2018). Peer reviewed: Design thinking in health care. *Preventing Chronic Disease*, *15*.

Arora, V. M., Chivu, M., Schram, A., & Meltzer, D. (2020). Implementing physical distancing in the hospital: a key strategy to prevent nosocomial transmission of COVID-19. *J Hosp Med*, *15*(5), 290-291.

Baltimore, W. J., & Atcherson, S. R. (2020). Helping Our Clients Parse Speech Through Masks During COVID-19. *Leader Live*.

Bartlett, G., Blais, R., Tamblyn, R., Clermont, R. J., & MacGibbon, B. (2008). Impact of patient communication problems on the risk of preventable adverse events in acute care settings. *Cmaj*, *178*(12), 1555-1562.

Baylor, C., Burns, M., McDonough, K., Mach, H., & Yorkston, K. (2019). Teaching medical students skills for effective communication with patients who have communication disorders. *American journal of speech-language pathology*, *28*(1), 155-164. https://doi.org/https://doi.org/10.1044/2018_AJSLP-18-0130

Belasen, A. T., Oppenlander, J., Belasen, A. R., & Hertelendy, A. J. (2021). Provider–patient communication and hospital ratings: perceived gaps and forward thinking about the effects of COVID-19. *International Journal for Quality in Health Care*, *33*(1), mzaa140.

Beukelman, D. R., & Mirenda, P. (2013). *Augmentative & alternative communication: Supporting children and adults with complex communication needs*. Paul H. Brookes Publishing.

Binger, C., Ball, L., Dietz, A., Kent-Walsh, J., Lasker, J., Lund, S., McKelvey, M., & Quach, W. (2012). Personnel roles in the AAC assessment process. *Augmentative and Alternative Communication*, *28*(4), 278-288.

Birt, L., Scott, S., Cavers, D., Campbell, C., & Walter, F. (2016). Member checking: a tool to enhance trustworthiness or merely a nod to validation? *Qualitative health research*, *26*(13), 1802-1811.

Blackstone, S. W., & Pressman, H. (2016). Patient Communication in Health Care Settings: new Opportunities for Augmentative and Alternative Communication. *Augmentative and Alternative Communication*, *32*(1), 69-79. https://doi.org/10.3109/07434618.2015.1125947

Blomkvist, V., Eriksen, C. A., Theorell, T., Ulrich, R., & Rasmanis, G. (2005). Acoustics and psychosocial environment in intensive coronary care. *Occupational and environmental medicine*, *62*(3), e1-e1.

Bourgeois, M., Dijkstra, K., Burgio, L., & Allen-Burge, R. (2001). Memory aids as an augmentative and alternative communication strategy for nursing home residents with dementia. *Augmentative and Alternative Communication*, *17*(3), 196-210.

Bourguignon, M., Baart, M., Kapnoula, E. C., & Molinaro, N. (2018). Hearing through lip-reading: the brain synthesizes features of absent speech. *bioRxiv*, 395483.

Bradbury-Jones, C., Rattray, J., Jones, M., & MacGillivray, S. (2013). Promoting the health, safety and welfare of adults with learning disabilities in acute care settings: a structured literature review. *Journal of Clinical Nursing*, *22*(11-12), 1497-1509.

Bredart, A., Bouleuc, C., & Dolbeault, S. (2005). Doctor-patient communication and satisfaction with care in oncology. *Current opinion in oncology*, *17*(4), 351-354.

Brooke, J. (1996). Sus: a “quick and dirty’usability. *Usability evaluation in industry*, *189*.

Brown, J., Thiessen, A., Beukelman, D., & Hux, K. (2015). Noun representation in AAC grid displays: Visual attention patterns of people with traumatic brain injury. *Augmentative and Alternative Communication*, *31*(1), 15-26.

Brown, V. A., Van Engen, K., & Peelle, J. E. (2021). Face mask type affects audiovisual speech intelligibility and subjective listening effort in young and older adults.

Brumberg, J. S., Pitt, K. M., Mantie-Kozlowski, A., & Burnison, J. D. (2018). Brain–computer interfaces for augmentative and alternative communication: A tutorial. *American journal of speech-language pathology*, *27*(1), 1-12.

Buheji, M., Alhaddad, M., Salman, A., AlShuwaikh, Z., & Jahrami, H. (2020). Hearing the Silent Voices of COVID-19 Patients on Mechanical Ventilators: The Use of Augmentative and Alternative Communication (AAC) Approach. *American Journal of Medicine and Medical Sciences*, *10*(7), 457-461.

Burton-Jones, A., & Hubona, G. S. (2005). Individual differences and usage behavior: revisiting a technology acceptance model assumption. *ACM SIGMIS Database: the DATABASE for Advances in Information Systems*, *36*(2), 58-77.

Busch-Vishniac, I. J., West, J. E., Barnhill, C., Hunter, T., Orellana, D., & Chivukula, R. (2005). Noise levels in Johns Hopkins hospital. *The Journal of the Acoustical Society of America*, *118*(6), 3629-3645.

Carayon, P., Kianfar, S., Li, Y., Xie, A., Alyousef, B., & Wooldridge, A. (2015). A systematic review of mixed methods research on human factors and ergonomics in health care. *Applied ergonomics*, *51*, 291-321.

Carbon, C.-C. (2020). Wearing face masks strongly confuses counterparts in reading emotions. *Frontiers in Psychology*, *11*, 2526.

Caron, C. D., Griffith, J., & Arcand, M. (2005). Decision making at the end of life in dementia: how family caregivers perceive their interactions with health care providers in long-term-care settings. *Journal of Applied Gerontology*, *24*(3), 231-247.

Champion, J., & Holt, R. (2000). Dental care for children and young people who have a hearing impairment. *British dental journal*, *189*(3), 155-159.

Chandra, A., Finkelstein, A., Sacarny, A., & Syverson, C. (2013). *Healthcare exceptionalism? Productivity and allocation in the US healthcare sector*.

Chebuhar, A., McCarthy, A. M., Bosch, J., & Baker, S. (2013). Using picture schedules in medical settings for patients with an autism spectrum disorder. *Journal of Pediatric Nursing*, *28*(2), 125-134.

Cheung, D. S., Kelly, J. J., Beach, C., Berkeley, R. P., Bitterman, R. A., Broida, R. I., Dalsey, W. C., Farley, H. L., Fuller, D. C., & Garvey, D. J. (2010). Improving handoffs in the emergency department. *Annals of emergency medicine*, *55*(2), 171-180.

Chewning, B., Bylund, C. L., Shah, B., Arora, N. K., Gueguen, J. A., & Makoul, G. (2012). Patient preferences for shared decisions: a systematic review. *Patient education and counseling*, *86*(1), 9-18.

Chino, F., Peppercorn, J., Taylor Jr, D. H., Lu, Y., Samsa, G., Abernethy, A. P., & Zafar, S. Y. (2014). Self-reported financial burden and satisfaction with care among patients with cancer. *The Oncologist*, *19*(4), 414.

Chodosh, J., Weinstein, B., & Blustein, J. (2020). Face masks can be devastating for people with hearing loss.

Cockrell, M. D. (2020). Provider–Patient Interaction: Exploring Elderspeak in Simulated Preclinical Chiropractic Student Encounters. *Gerontology and Geriatric Medicine*, *6*, 2333721420923453.

Costello, J. (2000). AAC intervention in the intensive care unit: The children's hospital Boston model. *Augmentative and Alternative Communication*, *16*(3), 137-153.

Costello, J. M., Patak, L., & Pritchard, J. (2010). Communication vulnerable patients in the pediatric ICU: Enhancing care through augmentative and alternative communication. *Journal of pediatric rehabilitation medicine*, *3*(4), 289-301.

Coulter, A., Stilwell, D., Kryworuchko, J., Mullen, P. D., Ng, C. J., & Van Der Weijden, T. (2013). A systematic development process for patient decision aids. *BMC medical informatics and decision making*, *13*(2), 1-7.

Creutzfeldt, C. J., Schutz, R. E., Zahuranec, D. B., Lutz, B. J., Curtis, J. R., & Engelberg, R. A. (2020). Family Presence for Patients with Severe Acute Brain Injury and the Influence of the COVID-19 Pandemic. *Journal of palliative medicine*.

DeVoe, J. E., Wallace, L. S., & Fryer Jr, G. E. (2009). Patient age influences perceptions about health care communication. *Family medicine*, *41*(2), 126.

Dietz, A., Quach, W., Lund, S. K., & MCKeLvey, M. (2012). AAC assessment and clinical-decision making: The impact of experience. *Augmentative and Alternative Communication*, *28*(3), 148-159.

Dietz, A., Weissling, K., Griffith, J., McKelvey, M., & Macke, D. (2014). The impact of interface design during an initial high-technology AAC experience: A collective case study of people with aphasia. *Augmentative and Alternative Communication*, *30*(4), 314-328.

Dinerstein, R. (2012). Implementing legal capacity under article 12 of the UN convention on the rights of persons with disabilities: the difficult road from guardianship to supported decision-making.

Donaldson, M. S., Corrigan, J. M., & Kohn, L. T. (2000). To err is human: building a safer health system.

Downey. (2014). *The effectiveness of AAC training protocols for acute care Nurses: a randomized controlled trial of an instructional on-line medium for clinical skills teaching* University of Iowa].

Downey, & Happ. (2013). The need for nurse training to promote improved patient-provider communication for patients with complex communication needs. *Perspectives on Augmentative and Alternative Communication*, *22*(2), 112-119.

Downey, D., & Happ, M. (2013). The need for nurse training to promote improved patient-provider communication for patients with complex communication needs. *Perspectives on Augmentative and Alternative Communication*, *22*(2), 112-119. https://doi.org/https://doi.org/10.1044/aac22.2.112

Dray, S., & Siegel, D. (2004). Remote possibilities? International usability testing at a distance. *interactions*, *11*(2), 10-17.

Elwyn, G., Laitner, S., Coulter, A., Walker, E., Watson, P., & Thomson, R. (2010). Implementing shared decision making in the NHS. *Bmj*, *341*.

Fager, S. K., Burnfield, J. M., Pfeifer, C. M., & Sorenson, T. (2020). Perceived importance of AAC messages to support communication in rehabilitation settings. *Disability and Rehabilitation: Assistive Technology*, 1-6.

Fager, S. K., Gormley, J. E., & Sorenson, T. L. (2021). Access to AAC for Individuals with Acquired Conditions: Challenges and Solutions in Early Recovery. *Augmentative and Alternative Communication: Challenges and Solutions*, 199.

Ferrari, G., Dobrina, R., Buchini, S., Rudan, I., Schreiber, S., & Bicego, L. (2021). The impact of personal protective equipment and social distancing on communication and relation between nurses, caregivers and children: a descriptive qualitative study in a maternal and child health hospital. *Journal of Clinical Nursing*.

Finke, E. H., Light, J., & Kitko, L. (2008). A systematic review of the effectiveness of nurse communication with patients with complex communication needs with a focus on the use of augmentative and alternative communication. *Journal of Clinical Nursing*, *17*(16), 2102-2115.

Finset, A., Bosworth, H., Butow, P., Gulbrandsen, P., Hulsman, R. L., Pieterse, A. H., Street, R., Tschoetschel, R., & van Weert, J. (2020). Effective health communication–a key factor in fighting the COVID-19 pandemic. *Patient education and counseling*, *103*(5), 873.

Forster, A. J., Rose, N. G., van Walraven, C., & Stiell, I. (2007). Adverse events following an emergency department visit. *BMJ Quality & Safety*, *16*(1), 17-22.

Garrett, & Lasker. (2007). AAC and severe aphasia—enhancing communication across the continuum of recovery. *Perspectives on Neurophysiology and Neurogenic speech and language disorders*, *17*(3), 6-15. https://doi.org/https://doi.org/10.1044/nnsld17.3.6

Ghosh, A. K., Joshi, S., & Ghosh, A. (2020). Effective Patient-Physician Communication-A Concise Review. *The Journal of the Association of Physicians of India*, *68*(6), 53-57.

Gibson, R. C., Dunlop, M. D., Bouamrane, M.-M., & Nayar, R. (2020). Designing clinical AAC tablet applications with adults who have mild intellectual disabilities. Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems,

GlobalData. (2021). *GlobalData poll suggests sustained PPE usage by healthcare workers post-pandemic*. https://www.medicaldevice-network.com/comment/ppt-use-frequency/

Glos, L., & Pinet-Peralta, L. M. (2021). The influence of institutional factors on patient–provider communication and interactions in the US healthcare system. *Journal of Public Health*, 1-12.

Goldin, A., Weinstein, B., & Shiman, N. (2020). Speech blocked by surgical masks becomes a more important issue in the Era of COVID-19. *The Hearing Review*.

Gordon, W. J., Landman, A., Zhang, H., & Bates, D. W. (2020). Beyond validation: getting health apps into clinical practice. *npj Digital Medicine*, *3*(1), 14. https://doi.org/10.1038/s41746-019-0212-z

Gormley, J., & Light, J. (2019). Providing services to individuals with complex communication needs in the inpatient rehabilitation setting: The experiences and perspectives of speech-language pathologists. *American journal of speech-language pathology*, *28*(2), 456-468. https://doi.org/https://doi.org/10.1044/2018_AJSLP-18-0076

Gosnell, J., Costello, J., & Shane, H. (2011). Using a clinical approach to answer "What communication apps should we use?". *Perspectives on Augmentative and Alternative Communication*, *20*(3), 87-96.

Grossbach, I., Stranberg, S., & Chlan, L. (2011). Promoting effective communication for patients receiving mechanical ventilation. *Critical care nurse*, *31*(3), 46-60.

Guan, W.-j., Ni, Z.-y., Hu, Y., Liang, W.-h., Ou, C.-q., He, J.-x., Liu, L., Shan, H., Lei, C.-l., & Hui, D. S. (2020). Clinical characteristics of coronavirus disease 2019 in China. *New England Journal of Medicine*, *382*(18), 1708-1720.

Hampton, T., Crunkhorn, R., Lowe, N., Bhat, J., Hogg, E., Afifi, W., De, S., Street, I., Sharma, R., & Krishnan, M. (2020). The negative impact of wearing personal protective equipment on communication during coronavirus disease 2019. *The Journal of Laryngology & Otology*, *134*(7), 577-581.

Happ, M. B., Garrett, K. L., Tate, J. A., DiVirgilio, D., Houze, M. P., Demirci, J. R., George, E., & Sereika, S. M. (2014). Effect of a multi-level intervention on nurse–patient communication in the intensive care unit: results of the SPEACS trial. *Heart & lung*, *43*(2), 89-98.

Happ, M. B., Walaszek, L., Von Visger, T., Weber, M., Vermillion, B., Chipps, E., Traughber, B., & Patak, L. (2014). 603: Usability and acceptability testing of an iPad communication application in the intensive care unit. *Critical Care Medicine*, *42*(12), A1505.

Hemsley, B., Steel, J., Worrall, L., Hill, S., Bryant, L., Johnston, L., Georgiou, A., & Balandin, S. (2019). A systematic review of falls in hospital for patients with communication disability: Highlighting an invisible population. *Journal of safety research*, *68*, 89-105.

Hershberger, D. (2011). Mobile technology and AAC apps from an AAC developer's perspective. *Perspectives on Augmentative and Alternative Communication*, *20*(1), 28-33.

Holm, A., & Dreyer, P. (2018). Use of Communication Tools for Mechanically Ventilated Patients in the Intensive Care Unit. *CIN: Computers, Informatics, Nursing*, *36*(8), 398-405. https://doi.org/10.1097/cin.0000000000000449

Hosp, J. A., Dressing, A., Blazhenets, G., Bormann, T., Rau, A., Schwabenland, M., Thurow, J., Wagner, D., Waller, C., & Niesen, W. D. (2021). Cognitive impairment and altered cerebral glucose metabolism in the subacute stage of COVID-19. *Brain*, *144*(4), 1263-1276.

Howard, B. E. (2020). High-risk aerosol-generating procedures in COVID-19: respiratory protective equipment considerations. *Otolaryngology–Head and Neck Surgery*, *163*(1), 98-103.

Hurtig, R. R., Alper, R., Altschuler, T., Gendreau, S., Gormley, J., Marshall, S., Santiago, R., & Scibilia, S. (2020). Improving Outcomes for Hospitalized Patients Pre-and Post-COVID-19. *Perspectives of the ASHA Special Interest Groups*, 1-9.

Hurtig, R. R., & Downey, D. (2008). *Augmentative and alternative communication in acute and critical care settings*. Plural Publishing.

Janssen, D. J., Ekström, M., Currow, D. C., Johnson, M. J., Maddocks, M., Simonds, A. K., Tonia, T., & Marsaa, K. (2020). COVID-19: guidance on palliative care from a European Respiratory Society international task force. *European respiratory journal*, *56*(3).

Kable, A., Chenoweth, L., Pond, D., & Hullick, C. (2015). Health professional perspectives on systems failures in transitional care for patients with dementia and their carers: a qualitative descriptive study. *BMC health services research*, *15*(1), 1-11.

Kempfle, J. S., Panda, A., Hottin, M., Vinik, K., Kozin, E. D., Ito, C. J., & Remenschneider, A. K. (2020). Effect of Powered Air-Purifying Respirators on Speech Recognition Among Health Care Workers. *Otolaryngology–Head and Neck Surgery*, 0194599820945685.

Kilgore, B., Harriger, C., Gaeta, L., & Sharpp, T. J. (2021). Unmasking misunderstandings: Strategies for better communication with patients. *Nursing2021*, *51*(1), 56-59.

Knollman-Porter, K., & Burshnic, V. L. (2020). Optimizing effective communication while wearing a mask during the COVID-19 pandemic. *Journal of gerontological nursing*, *46*(11), 7-11.

Lazzarino, A. I., Steptoe, A., Hamer, M., & Michie, S. (2020). Covid-19: important potential side effects of wearing face masks that we should bear in mind. *The BMJ*, *369*.

Lenhart, S. W., Seitz, T., Trout, D., & Bollinger, N. (2004). Issues affecting respirator selection for workers exposed to infectious aerosols: emphasis on healthcare settings. *Applied Biosafety*, *9*(1), 20-36.

Leonard, M., Graham, S., & Bonacum, D. (2004). The human factor: the critical importance of effective teamwork and communication in providing safe care. *BMJ Quality & Safety*, *13*(suppl 1), i85-i90.

Liberati, G., Pizzimenti, A., Simione, L., Riccio, A., Schettini, F., Inghilleri, M., Mattia, D., & Cincotti, F. (2015). Developing brain-computer interfaces from a user-centered perspective: assessing the needs of persons with amyotrophic lateral sclerosis, caregivers, and professionals. *Applied ergonomics*, *50*, 139-146.

Light, J., & McNaughton, D. (2013). Putting people first: Re-thinking the role of technology in augmentative and alternative communication intervention. *Augmentative and Alternative Communication*, *29*(4), 299-309.

Light, J., McNaughton, D., Beukelman, D., Fager, S. K., Fried-Oken, M., Jakobs, T., & Jakobs, E. (2019). Challenges and opportunities in augmentative and alternative communication: Research and technology development to enhance communication and participation for individuals with complex communication needs. *Augmentative and Alternative Communication*, *35*(1), 1-12.

Lin, J. J., Lake, J., Wall, M. M., Berman, A. R., Salazar-Schicchi, J., Powell, C., Keller, S. M., Halm, E. A., Leventhal, H., & Wisnivesky, J. P. (2014). Association of patient–provider communication domains with lung cancer treatment. *Journal of Thoracic Oncology*, *9*(9), 1249-1254.

Lloyd, B., Beck, A. R., & Yacucci, A. L. (2018). Augmentative and Alternative Communication in the Intensive Care Unit: A Service Delivery Model.

Lubarsky, M., & Juncos, J. L. (2008). Progressive supranuclear palsy: a current review. *The neurologist*, *14*(2), 79-88.

Lubas, M., Mitchell, J., & De Leo, G. (2014). User-centered design and augmentative and alternative communication apps for children with autism spectrum disorders. *Sage Open*, *4*(2), 2158244014537501.

Magnus, V. S., & Turkington, L. (2006). Communication interaction in ICU—patient and staff experiences and perceptions. *Intensive and Critical Care Nursing*, *22*(3), 167-180.

Mao, L., Jin, H., Wang, M., Hu, Y., Chen, S., HE, Q., Chang, J., Hong, C., Zhou, Y., Wang, D., Miao, X., Li, Y., & Hu, B. (2020). Neurological manifestations of Hospitalized Patients with COVID-19 in Wuhan, China: a retrospective case series study. *JAMA Neurology*. https://doi.org/https://doi.org/10.1177/1747493020923472

Marler, H., & Ditton, A. (2021). “I'm smiling back at you”: Exploring the impact of mask wearing on communication in healthcare. *International Journal of Language & Communication Disorders*, *56*(1), 205-214.

Marshall, S., & Hurtig, R. R. (2019). Developing a culture of successful communication in acute care settings: Part I. Solving patient-specific issues. *Perspectives of the ASHA Special Interest Groups*, *4*(5), 1028-1036.

Mazzon, D., Mauri, A., & Rupolo, G. (2001). Critical aspects of communication in intensive care. *Minerva anestesiologica*, *67*(11), 819-826.

McKenna, V. S., Patel, T. H., Kendall, C. L., Howell, R. J., & Gustin, R. L. (2021). Voice Acoustics and Vocal Effort in Mask-Wearing Healthcare Professionals: A Comparison Pre-and Post-Workday. *Journal of Voice*.

McNaughton, D., & Light, J. (2013). The iPad and mobile technology revolution: Benefits and challenges for individuals who require augmentative and alternative communication. *Augmentative and Alternative Communication*, *29*(2), 107-116. https://doi.org/10.3109/07434618.2013.784930

Mead, N., & Bower, P. (2000). Patient-centredness: a conceptual framework and review of the empirical literature. *Social science & medicine*, *51*(7), 1087-1110.

Mendel, L. L., Gardino, J. A., & Atcherson, S. R. (2008). Speech understanding using surgical masks: a problem in health care? *Journal of the American Academy of Audiology*, *19*(9), 686-695.

Mheidly, N., Fares, M. Y., Zalzale, H., & Fares, J. (2020). Effect of Face Masks on Interpersonal Communication During the COVID-19 Pandemic. *Frontiers in Public Health*, *8*, 898.

Mick, P., Foley, D. M., & Lin, F. R. (2014). Hearing loss is associated with poorer ratings of patient-physician communication and healthcare quality. *Journal of the American Geriatrics Society*, *62*(11), 2207.

Miller, S. E., Schlauch, R. S., & Watson, P. J. (2010). The effects of fundamental frequency contour manipulations on speech intelligibility in background noise. *The Journal of the Acoustical Society of America*, *128*(1), 435-443.

Mobasheri, M. H., King, D., Judge, S., Arshad, F., Larsen, M., Safarfashandi, Z., Shah, H., Trepekli, A., Trikha, S., & Xylas, D. (2016). Communication aid requirements of intensive care unit patients with transient speech loss. *Augmentative and Alternative Communication*, *32*(4), 261-271.

Moodley, A., Mangino, J. E., & Goff, D. A. (2013). Review of infectious diseases applications for iPhone/iPad and Android: from pocket to patient. *Clinical infectious diseases*, *57*(8), 1145-1154.

Morawska, L., Tang, J. W., Bahnfleth, W., Bluyssen, P. M., Boerstra, A., Buonanno, G., Cao, J., Dancer, S., Floto, A., & Franchimon, F. (2020). How can airborne transmission of COVID-19 indoors be minimised? *Environment international*, *142*, 105832.

Morris, M. A. (2011). *Patient-provider communication: Perspectives of individuals with significant communication disabilities*. University of Washington.

Morris, M. A., Dudgeon, B. J., & Yorkston, K. (2013). A qualitative study of adult AAC users' experiences communicating with medical providers. *Disability and Rehabilitation: Assistive Technology*, *8*(6), 472-481.

Morris, M. A., Meier, S. K., Griffin, J. M., Branda, M. E., & Phelan, S. M. (2016). Prevalence and etiologies of adult communication disabilities in the United States: Results from the 2012 National Health Interview Survey. *Disability and health journal*, *9*(1), 140-144.

Morris, M. A., Yorkston, K., & Clayman, M. L. (2014). Improving Communication in the Primary Care Setting: Perspectives of Patients with Speech Disabilities. *The Patient - Patient-Centered Outcomes Research*, *7*(4), 397-401. https://doi.org/10.1007/s40271-014-0067-y

Neumann, M., Edelhäuser, F., Kreps, G. L., Scheffer, C., Lutz, G., Tauschel, D., & Visser, A. (2010). Can patient–provider interaction increase the effectiveness of medical treatment or even substitute it?—An exploration on why and how to study the specific effect of the provider. *Patient education and counseling*, *80*(3), 307-314.

Nielsen, J. (1994). Heuristic evaluation. Usability inspection methods,

Nilsen, M. L., Morrison, A., Lingler, J. H., Myers, B., Johnson, J. T., Happ, M. B., Sereika, S. M., & DeVito Dabbs, A. (2018). Evaluating the usability and acceptability of communication tools among older adults. *Journal of gerontological nursing*, *44*(9), 30-39.

Nobilo, B. (2020). *Coronavirus Has Stolen Our Most Meaningful Ways to Connect* https://www.cnn.com/interactive/2020/06/world/coronavirus-body-language-wellness

O'Halloran, R., Hickson, L., & Worrall, L. (2008). Environmental factors that influence communication between people with communication disability and their healthcare providers in hospital: a review of the literature within the International Classification of Functioning, Disability and Health (ICF) framework. *International Journal of Language & Communication Disorders*, *43*(6), 601-632.

O'Neil, A. C., Petersen, L. A., Cook, E. F., Bates, D. W., Lee, T. H., & Brennan, T. A. (1993). Physician reporting compared with medical-record review to identify adverse medical events. *Annals of internal medicine*, *119*(5), 370-376.

Ong, S. W. X., Tan, Y. K., Chia, P. Y., Lee, T. H., Ng, O. T., Wong, M. S. Y., & Marimuthu, K. (2020). Air, surface environmental, and personal protective equipment contamination by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) from a symptomatic patient. *Jama*, *323*(16), 1610-1612.

Otuzoğlu, M., & Karahan, A. (2014). Determining the effectiveness of illustrated communication material for communication with intubated patients at an intensive care unit. *International journal of nursing practice*, *20*(5), 490-498.

Owolabi, L. F., & Yakasai, M. M. (2011). Stroke-related Wernicke's Aphasia Mistaken for Psychosis: A Case Report. *J Med Trop*, *14*(1), 83-85.

Palmiero, A. J., Symons, D., Morgan III, J. W., & Shaffer, R. E. (2016). Speech intelligibility assessment of protective facemasks and air-purifying respirators. *Journal of occupational and environmental hygiene*, *13*(12), 960-968.

Patak, L., Wilson-Stronks, A., Costello, J., Kleinpell, R. M., Henneman, E. A., Person, C., & Happ, M. B. (2009). Improving patient-provider communication: a call to action. *The Journal of nursing administration*, *39*(9), 373. https://doi.org/10.1097/NNA.0b013e3181b414ca

Piazza, C., Filauro, M., Dikkers, F. G., Nouraei, S. R., Sandu, K., Sittel, C., Amin, M. R., Campos, G., Eckel, H. E., & Peretti, G. (2021). Long-term intubation and high rate of tracheostomy in COVID-19 patients might determine an unprecedented increase of airway stenoses: a call to action from the European Laryngological Society. *European Archives of Oto-Rhino-Laryngology*, *278*, 1-7.

Powell, A. C., Landman, A. B., & Bates, D. W. (2014). Certification of Mobile Apps for Health Care—Reply. *Jama*, *312*(11), 1156-1157.

Priester, R., Kane, R. L., & Totten, A. M. (2005). How the current system fails people with chronic illnesses. Meeting the challenge of chronic illness,

Qualls, C. D. (2012). Multicultural and international research on communication disorders: Past, present, and future. *Communication*, 296-310.

Radtke, J. V., Tate, J. A., & Happ, M. B. (2012). Nurses' perceptions of communication training in the ICU. *Intensive and Critical Care Nursing*, *28*(1), 16-25.

Rahimi, B., Nadri, H., Afshar, H. L., & Timpka, T. (2018). A systematic review of the technology acceptance model in health informatics. *Applied clinical informatics*, *9*(3), 604.

Ram, K., Thakur, R. C., Singh, D. K., Kawamura, K., Shimouchi, A., Sekine, Y., Nishimura, H., Singh, S. K., Pavuluri, C. M., & Singh, R. (2021). Why airborne transmission hasn't been conclusive in case of COVID-19? An atmospheric science perspective. *Science of The Total Environment*, 145525.

Ratna, H. (2019). The importance of effective communication in healthcare practice. *Harvard Public Health Review*, *23*, 1-6.

Raza, A., & Capretz, L. F. (2015). Usability as a dominant quality attribute. *arXiv preprint arXiv:1508.06195*.

Reddy, B. V., & Gupta, A. (2020). Importance of effective communication during COVID-19 infodemic. *Journal of Family Medicine and Primary Care*, *9*(8), 3793.

Resar, R. K., Rozich, J. D., Simmonds, T., & Haraden, C. R. (2006). A trigger tool to identify adverse events in the intensive care unit. *The Joint Commission Journal on Quality and Patient Safety*, *32*(10), 585-590.

Riedl, D., & Schüßler, G. (2017). The influence of doctor-patient communication on health outcomes: a systematic review. *Zeitschrift für Psychosomatische Medizin und Psychotherapie*, *63*(2), 131-150.

Santiago, C., Roza, D., Porretta, K., & Smith, O. (2019). the use of tablet and communication app for patients with endotracheal or tracheostomy tubes in the medical surgical intensive care unit: A pilot, feasibility study. *Critical Care Nursing*, 17.

Santiago, R., & Costello, J. M. (2013). AAC assessment and intervention in pediatric ICU/acute care: From referral through continuum of care. *Perspectives on Augmentative and Alternative Communication*, *22*(2), 102-111.

Saunders, G. H., Jackson, I. R., & Visram, A. S. (2021). Impacts of face coverings on communication: an indirect impact of COVID-19. *International Journal of Audiology*, *60*(7), 495-506.

Sauro, J., & Lewis, J. R. (2009). Correlations among prototypical usability metrics: Evidence for the construct of usability. Proceedings of the SIGCHI conference on human factors in computing systems,

Schlimgen, J., & Frye, A. (2021). No visitors allowed: How health systems can better engage patients' families during a pandemic. *Patient Experience Journal*, *8*(1), 13-15.

Schlossberg, J. A. (2021). *VidaTalk app gives UCLA Health patients autonomy*. UCLA Health. https://connect.uclahealth.org/2021/04/01/vidatalk-app-ucla-health-patients/

Schlosser, R. W., Koul, R., & Costello, J. (2007). Asking well-built questions for evidence-based practice in augmentative and alternative communication. *Journal of Communication Disorders*, *40*(3), 225-238. https://doi.org/https://doi.org/10.1016/j.jcomdis.2006.06.008

Schlosser, R. W., & Raghavendra, P. (2004). Evidence-based practice in augmentative and alternative communication. *Augmentative and Alternative Communication*, *20*(1), 1-21.

Schmettow, M. (2012). Sample size in usability studies. *Communications of the ACM*, *55*(4), 64-70.

Schoen, C., Doty, M. M., Robertson, R. H., & Collins, S. R. (2011). Affordable Care Act reforms could reduce the number of underinsured US adults by 70 percent. *Health affairs*, *30*(9), 1762-1771.

Scott, I. A., Scuffham, P., Gupta, D., Harch, T. M., Borchi, J., & Richards, B. (2018). Going digital: a narrative overview of the effects, quality and utility of mobile apps in chronic disease self-management. *Australian Health Review*, *44*(1), 62-82.

Sexton, J. B., Thomas, E. J., & Helmreich, R. L. (2000). Error, stress, and teamwork in medicine and aviation: cross sectional surveys. *Bmj*, *320*(7237), 745-749.

Shane, H. C., Blackstone, S., Vanderheiden, G., Williams, M., & DeRuyter, F. (2012). Using AAC technology to access the world. *Assistive Technology*, *24*(1), 3-13.

Shilling, V., Jenkins, V., & Fallowfield, L. (2003). Factors affecting patient and clinician satisfaction with the clinical consultation: can communication skills training for clinicians improve satisfaction? *Psycho-Oncology: Journal of the Psychological, Social and Behavioral Dimensions of Cancer*, *12*(6), 599-611.

Signoretti, I., Salerno, L., Marczak, S., & Bastos, R. (2020). Combining user-centered design and lean startup with agile software development: a case study of two agile teams. International Conference on Agile Software Development,

Simmons, A., McCarthy, J., Koszalinski, R., Hedrick, M., Reilly, K., & Hamby, E. (2019). Knowledge and experiences with augmentative and alternative communication by paediatric nurses: a pilot study. *Disability and Rehabilitation: Assistive Technology*, 1-13.

Simmons-Mackie, N., King, J. M., & Beukelman, D. R. (2013). *Supporting communication for adults with acute and chronic aphasia*. Paul H. Brookes Pub.

Simmons-Mackie, N. N., Kagan, A., O'Neill Christie, C., Huijbregts, M., McEwen, S., & Willems, J. (2007). Communicative access and decision making for people with aphasia: Implementing sustainable healthcare systems change. *Aphasiology*, *21*(1), 39-66.

Smith, C. T. (2006). *An investigation into the impact of a communication pack on mechanically ventilated patients, staff and visitors, on the intensive care unit at the National Hospital for Neurology and Neurosurgery*. University of London, University College London (United Kingdom).

Souza, N. M., Sebaldt, R. J., Mackay, J. A., Prorok, J. C., Weise-Kelly, L., Navarro, T., Wilczynski, N. L., & Haynes, R. B. (2011). Computerized clinical decision support systems for primary preventive care: a decision-maker-researcher partnership systematic review of effects on process of care and patient outcomes. *Implementation Science*, *6*(1), 1-14.

Stacey, D., Légaré, F., Lewis, K., Barry, M. J., Bennett, C. L., Eden, K. B., Holmes-Rovner, M., Llewellyn-Thomas, H., Lyddiatt, A., & Thomson, R. (2017). Decision aids for people facing health treatment or screening decisions. *Cochrane database of systematic reviews*(4).

Steelman, V. M., Williams, T. L., Szekendi, M. K., Halverson, A. L., Dintzis, S. M., & Pavkovic, S. (2016). Surgical specimen management: a descriptive study of 648 adverse events and near misses. *Archives of pathology & laboratory medicine*, *140*(12), 1390-1396.

Stone, A., & Valentine, T. (2003). Perspectives on prosopagnosia and models of face recognition. *Cortex*, *39*(1), 31-40.

Stransky, M. L., & Morris, M. A. (2019). Adults with Communication Disabilities Face Health Care Obstacles: Adults with communication disabilities struggle to access quality health care-significantly more than typical peers. How can we get them needed health information and services? https://doi.org/https://doi.org/10.1044/leader.FTR1.24032019.46

Street Jr, R. L., Makoul, G., Arora, N. K., & Epstein, R. M. (2009). How does communication heal? Pathways linking clinician–patient communication to health outcomes. *Patient education and counseling*, *74*(3), 295-301.

Tembo, A. C., Higgins, I., & Parker, V. (2015). The experience of communication difficulties in critically ill patients in and beyond intensive care: Findings from a larger phenomenological study. *Intensive and Critical Care Nursing*, *31*(3), 171-178.

Ten Hoorn, S., Elbers, P., Girbes, A., & Tuinman, P. (2016). Communicating with conscious and mechanically ventilated critically ill patients: a systematic review. *Critical Care*, *20*(1), 1-14.

Thapa, D., Dahal, A., & Singh, R. (2019). Communication Difficulties and Psychological Stress in Patients Receiving Mechanical Ventilation. *Birat Journal of Health Sciences*, *4*(2), 718-723.

Thomas, E. J., & Petersen, L. A. (2003). Measuring errors and adverse events in health care. *Journal of general internal medicine*, *18*(1), 61-67.

Tinetti, M. E., & Fried, T. (2004). The end of the disease era. *The American journal of medicine*, *116*(3), 179-185.

Tiwary, A., Rimal, A., Paudyal, B., Sigdel, K. R., & Basnyat, B. (2019). Poor communication by health care professionals may lead to life-threatening complications: examples from two

case reports. *Wellcome open research*, *4*, 7-7. https://doi.org/10.12688/wellcomeopenres.15042.1

Tobiano, G., Chaboyer, W., & McMurray, A. (2013). Family members' perceptions of the nursing bedside handover. *Journal of Clinical Nursing*, *22*(1-2), 192-200.

Toscano, J. C., & Toscano, C. M. (2021). Effects of face masks on speech recognition in multi-talker babble noise. *PloS one*, *16*(2), e0246842.

Townend, E., Tinson, D., Kwan, J., & Sharpe, M. (2010). 'Feeling sad and useless': an investigation into personal acceptance of disability and its association with depression following stroke. *Clinical rehabilitation*, *24*(6), 555-564.

Tyson, B. T., Pham, M. T., Brown, N. T., & Mayer, T. R. (2012). Patient safety considerations in the rehabilitation of the individual with cognitive impairment. *Physical Medicine and Rehabilitation Clinics*, *23*(2), 315-334.

Uthoff, S. A., Zinkevich, A., Boenisch, J., Sachse, S. K., Bernasconi, T., & Ansmann, L. (2021). Collaboration between stakeholders involved in augmentative and alternative communication (AAC) care of people without natural speech. *Journal of Interprofessional Care*, 1-11.

Van Wassenhove, V., Grant, K. W., & Poeppel, D. (2005). Visual speech speeds up the neural processing of auditory speech. *Proceedings of the National Academy of Sciences*, *102*(4), 1181-1186.

Vance, M. C., & Morganstein, J. C. (2020). The Doctor-Public Relationship: How Physicians Can Communicate to Foster Resilience and Promote Mental Health During COVID-19. *Journal of general internal medicine*, *35*(12), 3697-3698.

Verghese, A., & Horwitz, R. (2009). In praise of the physical examination. *British Medical Journal Publishing Group*, 339:b5448. https://doi.org/https://doi.org/10.1136/bmj.b5448

Von Visger, T. T., Tate, J. A., Traughber, B., Patak, L., & Happ, M. B. (2016). ICU Nurses Focus Group On Acceptability testing Of Vidatalk™. In *D103. Critical Care: Improving Palliative And End Of Life Care In The Icu* (pp. A7592-A7592). American Thoracic Society.

Wallace, S. E., Dietz, A., Hux, K., & Weissling, K. (2012). Augmented input: The effect of visuographic supports on the auditory comprehension of people with chronic aphasia. *Aphasiology*, *26*(2), 162-176. https://doi.org/10.1080/02687038.2011.628004

Wang, E., Zhou, L., Parmanto, B., Watzlaf, V., & Abdelhak, M. (2018). Clinician's perceptions and expectations on a mHealth platform for supporting patient data integration and clinical service delivery: a case study in evidence-based communication rehabilitation.

West, R., & Lehman, K. (2006). Automated summative usability studies: an empirical evaluation. Proceedings of the SIGCHI conference on Human Factors in computing systems

White paper on mobile devices & communication apps. (2011). *Rehabilitation Engineering Research Center*. http://aac-rerc.psu.edu/index.php/pages/show/id/46

Wittenberg, E., Goldsmith, J. V., Chen, C., Prince-Paul, M., & Johnson, R. R. (2021). Opportunities to improve COVID-19 provider communication resources: A systematic review. *Patient education and counseling*.

Wong, C. K. M., Yip, B. H. K., Mercer, S., Griffiths, S., Kung, K., Wong, M. C.-s., Chor, J., & Wong, S. Y.-s. (2013). Effect of facemasks on empathy and relational continuity: a

randomised controlled trial in primary care. *BMC Family Practice*, *14*(1), 200. https://doi.org/10.1186/1471-2296-14-200

Woolley, K., Smith, R., & Arumugam, S. (2020). Personal Protective Equipment (PPE) Guidelines, adaptations and lessons during the COVID-19 pandemic. *Ethics, Medicine and Public Health*, *14*, 100546.

Xu, X.-M., Vestesson, E., Paley, L., Desikan, A., Wonderling, D., Hoffman, A., Wolfe, C. D., Rudd, A. G., & Bray, B. D. (2018). The economic burden of stroke care in England, Wales and Northern Ireland: Using a national stroke register to estimate and report patient-level health economic outcomes in stroke. *European Stroke Journal*, *3*(1), 82-91.

Yarbrough, A. K., & Smith, T. B. (2007). Technology acceptance among physicians: a new take on TAM. *Medical Care Research and Review*, *64*(6), 650-672.

Yorkston, K., Baylor, C., Burns, M., Morris, M., & McNalley, T. (2015). *Enhancing communication in outpatient medical clinic visits*. Plural Publishing.

Yuliani, P., & Sulistiadi, W. (2020). Effective Communication Improvement in Chemotherapy Services in Hospitals Through the Development of the ChemoCarePlan Application Prototype. International Conference of Health Development. Covid-19 and the Role of Healthcare Workers in the Industrial Era (ICHD 2020),

Zaga, C. J., Pandian, V., Brodsky, M. B., Wallace, S., Cameron, T. S., Chao, C., Orloff, L. A., Atkins, N. E., McGrath, B. A., & Lazarus, C. L. (2020). Speech-language pathology guidance for tracheostomy during the COVID-19 pandemic: an international multidisciplinary perspective. *American journal of speech-language pathology*, *29*(3), 1320-1334.

APPENDIX A

Heuristics and its Definitions

Heuristics	Definitions
Consistency and Standards	Users should not have to speculate whether different words, situations, or actions mean the same thing.
Visibility of System	Users should be informed about what is going on with the system through proper feedback and display of information.
Match Between System and World	The likeness of the system perceived by users should match the model the users have about the system.
Aesthetic and Minimalist	Any extraneous information is a distraction.
Recognition rather than recall	Users should not be required to memorize a lot of information presented in the prototype.
User control and freedom	Users should be free to select options rather than having the system do this for them. Users will need a clearly marked exit to leave the unwanted state without having to go through an extended dialogue
Error prevention	The researchers should prevent problems from occurring in the first place.
Flexibility and efficiency of use	User should be presented with several options when it comes to locating content.
Help and documentation	User should have access to documentation to help them understand how to use prototype.
Recover from error	The error messages should be expressed in plain language.

APPENDIX B

Heuristic Evaluation Instruction

Objective:

- Perform a heuristic evaluation of the following Prototype:

  http://run.mockplus.com/KUOxUwIpfriXrHhx/index.html

Duration: 30 minutes

Heuristics:

Start here:

- Spend a couple of minutes to get an overall impression of the prototype.
- Concentrate on evaluating a single page or a single functionality at a time.
- Inspect areas like navigation, aesthetic etc.
- While inspecting the prototype, complete the heuristic

APPENDIX C

Think Aloud Session

Objective:

- To evaluate the prototype NOT the participants' performance

  http://run.mockplus.com/KUOxUwIpfriXrHhx/index.html

Duration: ~20-30minutes

As you interact with the TALC© prototype, think about your patients and the challenges you are experiencing while communicating effectively with your patients.

Remember:

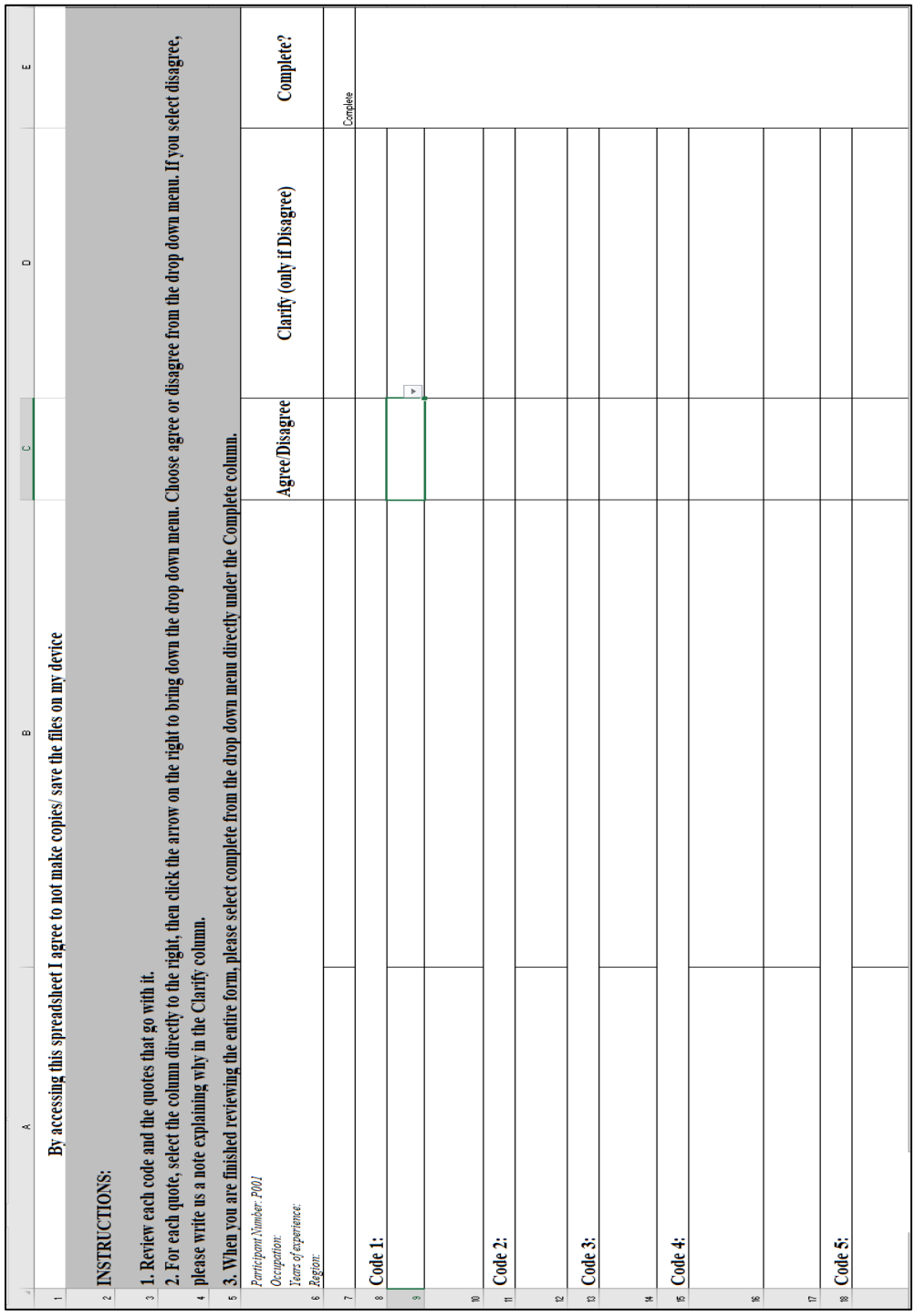
- As you interact with the prototype, voice any confusion or trouble you have.
- As you interact with the prototype, voice what you liked about the prototype and what you do not like about the prototype.

Probes:

- What are you thinking about?
- What did you expect to happen?
- What did you like/dislike about the prototype?
- What customization you would like to see in the prototype that would help you communicate better with your patients?

APPENDIX D

Member Checking Template



By accessing this spreadsheet I agree to not make copies/ save the files on my device

INSTRUCTIONS:

1. Review each code and the quotes that go with it.
2. For each quote, select the column directly to the right, then click the arrow on the right to bring down the drop down menu. Choose agree or disagree from the drop down menu. If you select disagree, please write us a note explaining why in the Clarify column.
3. When you are finished reviewing the entire form, please select complete from the drop down menu directly under the Complete column.

Participant Number: P001
Occupation:
Years of experience:
Region:

	Agree/Disagree	Clarify (only if Disagree)	Complete?
			Complete
Code 1:			
Code 2:			
Code 3:			
Code 4:			
Code 5:			

APPENDIX E

System Usability Survey

		Strongly disagree 1	2	3	4	**Strongly agree** 5
1	I think that I would like to use the prototype frequently.	☐	☐	☐	☐	☐
2	I found the prototype to be simple.	☐	☐	☐	☐	☐
3	I thought the prototype was easy to use.	☐	☐	☐	☐	☐
4	I think that I could use the prototype without the support of a technical person.	☐	☐	☐	☐	☐
5	I found the various functions in the prototype were well integrated.	☐	☐	☐	☐	☐
6	I thought there was a lot of consistency in the prototype.	☐	☐	☐	☐	☐
7	I would imagine that most people would learn to use the prototype very quickly.	☐	☐	☐	☐	☐
8	I found the prototype very intuitive.	☐	☐	☐	☐	☐
9	I felt very confident using the prototype.	☐	☐	☐	☐	☐
10	I could use the prototype without having to learn anything new.	☐	☐	☐	☐	☐

APPENDIX F

SUS Composite Score Interpretation

SUS Score Range	Grade	Percentile Range
84.1-100	A+	Acceptable
80.8- 84	A	
78.9-80.7	A-	
77.2-78.8	B+	
74.1-77.1	B	
72.6-74	B-	
71.1-72.5	C+	Marginal
65-71	C	
63.7-64.9	C-	
51.7-62.6	D	
0-51.7	F	Not Acceptable

APPENDIX G

Perceptual Satisfaction and User Perceived Value

1. Was the communication tool appropriate for your communication needs in your setting?

    0-Completely inappropriate

    1-Mostly inappropriate

    2-Maybe inappropriate

    3-Acceptable but not targeted

    4-Well-targeted, with negligible issues

    5-Perfectly targeted, no issues found language, design

2. How accurately/fast do you perceive you will be able to communicate with your patients who have voice/speech difficulty using this communication tool?

    0-The communication tool is broken

    1-no/insufficient/inaccurate response- had a hard time interacting with the communication tool

    2-Some functions worked well

    3-Most of the functions worked well, some potential to use in my setting

    4-All the functions worked well, potential for perfect/timely communication.

3. I would imagine that most people would learn to use this tool very quickly.

    0-Strongly Disagree

    1-Disagree

    2-Maybe

    3-Agree

    4-Strongly agree

4. I feel encouraged to use this communication tool with my patients who have voice/speech difficulty because of COVID-19 related respiratory concerns using this prototype.

    0-Strongly Disagree

    1-Disagree

    2-Maybe

    3-Agree

    4-Strongly agree

5. I feel confident about using this communication tool

    0-Strongly Disagree

    1-Disagree

    2-Maybe

    3-Agree

    4-Strongly agree

6. Based on your satisfaction, how will you rate this communication tool?

    0-Very dissatisfied

    1-Moderately satisfied

    2-Slightly dissatisfied

    3-Neutral

    4-Moderately Satisfied

    5-Very satisfied

APPENDIX H

Six Step Thematic Analysis Procedure

Phase	Examples of procedure for each step
1. Familiarizing oneself with the data	Transcribing data; reading and re-reading; noting down initial codes
2. Generating initial codes	Coding interesting features of the data in a systematic fashion across the dataset, collating data relevant to each code
3. Searching for the themes	Collating codes into potential themes, gathering all data relevant to each potential theme
4. Involved reviewing the themes	Checking if the themes work in relation to the coded extracts and the entire dataset generate thematic map
5. Defining and naming themes	Ongoing analysis to refine the specifics of each theme; generation of clear names for each theme
6. Producing the report	Final opportunity for analysis selecting appropriate extracts; discussion of the analysis; relate back to research questions or literature; produce results