12-7-2022

An Embodied Conversational Agent to Minimize the Effects of Social Isolation During Hospitalization

Jemma Smith
School of Computer Science, FEIT, University of Technology Sydney, NSW, Australia,
jemmasmith0305@gmail.com

Aashish Bhandari
Department of Computer Science and Engineering, Delhi Technological University, New Delhi, India,
aashish.bhandari2010@gmail.com

Berkan Yuksel
School of Computer Science, FEIT, University of Technology Sydney, NSW, Australia,
berkan.yuksel@alumni.uts.edu.au

Baki Kocaballi
School of Computer Science, FEIT, University of Technology Sydney, NSW, Australia,
Baki.Kocaballi@uts.edu.au

An Embodied Conversational Agent to Minimize the Effects of Social Isolation During Hospitalization

Full research paper

Jemma Smith
School of Computer Science
University of Technology Sydney
Sydney, Australia
Email: jemmasmith0305@gmail.com

Aashish Bhandari
School of Computer Science
Department of Computer Science and Engineering
Delhi Technological University
New Delhi, India
Email: aashish.bhandari2010@gmail.com

Berkan Yuksel
School of Computer Science
University of Technology Sydney
Sydney, Australia
Email: berkan.yuksel@alumni.uts.edu.au

A. Baki Kocaballi
School of Computer Science
University of Technology Sydney
Sydney, Australia
Email: baki.kocaballi@uts.edu.au

Abstract

Social isolation and loneliness contribute to the development of depression and anxiety. Comorbidity of mental health issues in hospitalized patients increases the length of stay in hospital by up to 109% and costs the healthcare sector billions of dollars each year. This study aims to understand the potential suitability of embodied conversational agents (ECAs) to reduce feelings of social isolation and loneliness among hospital patients. To facilitate this, a video prototype of an ECA was developed for use in single-occupant hospital rooms. The ECA was designed to act as an intelligent assistant, a rehabilitation guide, and a conversational partner. A co-design workshop involving five healthcare professionals was conducted. The thematic analysis of the workshop transcripts identified some major themes including improving health literacy, reducing the time burden on healthcare professionals, preventing secondary mental health issues, and supporting higher acceptance of digital technologies by elderly patients.

Keywords Embodied Conversational Agent, Personalization, Mental Health, Social Isolation, Loneliness, Co-design

1 Introduction

Pressures on resources in acute hospitals mean that the focus of attention is the primary illness or condition for which the patient has been admitted, and secondary concerns such as prevention of mental health deterioration may have less priority to be dealt with. Volunteer support workers offer some support but can be limited by the nature of the patient's condition and volunteer availability. Hospital staff generally do not have time to sit with patients and provide companionship, and therefore, there is often no emotional outlet for patients in long-term hospitalisation (Siddiqui et al. 2018). This affects not only the patients but also the staff and the healthcare sector with longer lengths of stay, increased admissions, and the higher level of care needed by socially isolated patients costing the USA Medicare system an extra $6.7USD Billion per year (Shaw et al. 2017). Recently, the COVID-19 pandemic has further compounded social isolation for inpatients due to greatly reduced visitation (Vlake et al. 2021).

Recent studies have analysed potential applications of conversational agent (CA) technology for patients with mental illnesses such as depression, anxiety (Fitzpatrick et al. 2017), and PTSD (Vlake et al. 2021). None of this research has explored the application of CA technology in a preventative capacity for people currently in hospital due to other medical problems. Therefore, the current study focuses on understanding the suitability of using a CA in hospital rooms to minimise the effects of social isolation experienced by the long stay patients.

1.1 The Effects of Hospitalisation on Patients' Mental Health

Walker et al. (2018) conducted a systematic review to analyse the prevalence of depression in general hospital patients and found that the prevalence of depression was between 5% and 34%, with an average of 12. They concluded that screening for depression should therefore occur in all hospitalised patients. (Purssell et al. 2020) in their systematic review found a higher correlation between anxiety (1.28 times higher) and depression (1.45 times higher) in isolated patients compared to non-isolated patients. The findings of these two reviews suggest that social isolation may be a primary contributory factor in mental health decline in hospitalised patients.

Purssell et al. (2020) observed that infectious patients have higher rates of depression and anxiety due to their separation from others. The COVID-19 pandemic has provided an unprecedented amount of data available for analysis due to the high rates of patients requiring isolated hospitalisation and a high degree of post-discharge care. Vlake et al. (2021) found that even three months after discharge, patients were still experiencing decreased mental state, with 13% having probable PTSD, 20% having probable anxiety and 24% having probable depression. While this data is useful in identifying the potential impact of isolated hospitalisation, there exists possible confounding influences on the results, such as social stigma and worry for the safety of close contacts. It is therefore not feasible to only rely on data collected during the COVID-19 pandemic as the healthcare environment differs significantly from pre- and post-COVID-19.

The main cause of mental illness in the older population is existential loneliness and isolation. Sundström et al. (2019) examined the cause of existential loneliness in older people in residential care, palliative care, hospital care and in-home care. They concluded that creating relationships with people in care needs to be an important part of a healthcare professional's role and can mitigate some of the impacts of existential loneliness and decrease the length of stay for the patients. The problem with this conclusion is that it assigns all the responsibility to a healthcare professional who often does not have time to create meaningful relationships with patients, as their primary role is to care for the physical needs of all people in their care.

It has been seen by an early pilot study by Schubert et al. (1992) that the length of stay (LOS) in the hospital increased with higher Geriatric Depression Scale (GDS) scores. This study concluded that depression could delay medical recovery from physical illness and complicate discharge planning. Siddiqui et al. (2018) critically analysed the effect mental illness has on the LOS of patients in hospitals and found that comorbidity of mental illness unfavourably affected the LOS of hospital patients by up to 109%. This not only leads to higher healthcare spending (Shaw et al. 2017) but also increases the risk of mental health degradation. Similar to Sundström et al. (2019), the solutions proposed by the authors to combat the problem rely solely on already-existing systems, such as upskilling healthcare teams and improving LOS reporting, which have proven unhelpful in the past due to high pressures already placed on healthcare staff.

1.2 Conversational Agents used as Mental Health Support

Laranjo et al. (2018) reviewed 17 studies that focused on using unconstrained natural language input CAs for healthcare. They found that the most common conditions were related to mental health, and

CAs have the capability to support health across many application areas. (Laranjo et al. 2018) also found some evidence that using CAs reduced depression symptoms in the users and increased awareness of symptoms and triggers. Fitzpatrick et al. (2017) conducted a randomized controlled trial (RCT) delivering cognitive behavioural therapy (CBT) using a CA to young adults with depression and anxiety symptoms. In this study, the control group only received self-help information from an eBook about depression (Fitzpatrick et al. 2017). The group using the CA experienced significant improvement in their depression symptoms, whereas the control group did not. The authors concluded that CAs could be a "feasible, engaging and effective way to deliver CBT" (Fitzpatrick et al. 2017). These findings are supported by (Gaffney et al. 2019), who reported promising data that CAs can aid in the treatment of mental health problems. Contrary to Fitzpatrick et al. (2017), Gaffney et al. (2019) concluded that current study methods in this area are not robust enough to demonstrate the efficacy and efficiency of CAs. Gaffney recommends further research to demonstrate equivalence to other treatment methods to increase the validity.

To develop a CA for mental health treatment and recovery, it is important to analyse why patients find CA technology helpful. For a CA to appropriately respond to mental health disclosure statements, it may be necessary for these systems to have the ability to display sympathy and empathy towards the user. Liu and Sundar (2018) analysed and compared people's reactions to different kinds of empathic expressions by CAs. They found that users (including those initially sceptical) preferred empathetic and sympathetic responses from an interactive CA over reading text lacking in emotion. These findings support the proposal that a CA with empathetic capabilities could be accepted by hospital patients who are typically older and maybe initially sceptical of CA technology.

In the literature, majority of studies examining the effects of CAs focus on the young adult population. Fitzpatrick's RCT included people aged 18–28 years. Similarly, the studies discussed in the systematic reviews by Laranjo et al. (2018) and Gaffney et al. (2019) and the experiments run by Liu and Sundar (2018) did not report outcomes specific to older people. Bennion et al. (2020) evaluated the usability, acceptability, and effectiveness of CAs to facilitate problem-solving in older adults receiving mental health treatment. Their findings suggest that older adults have a high adherence rate to CA technology, with only 12% of participants discontinuing use during the trial. While this study involved small numbers and no control group, and while no consideration was given to the influence of natural recovery, the high adherence and the high problem-resolution rates observed provide good support for the potential use of CAs by elderly patients and people experiencing long-term hospitalisation.

In a study by Ring et al. (2015), a virtual companion was installed for a week in the homes of 14 elderly people to offer them ongoing social assistance via sympathetic feedback. The results from their study showed significant reductions in loneliness based on self-reported mood. Jegundo et al. (2020) also expressed that embodied conversational agents offer a viable method of delivering support care to senior citizens.

1.3 Conversational Personality and Embodiment of CAs

To improve the acceptability of CA technology, recent research has focused on the impact of human-like characteristics such as personality, tone of voice and visual avatars. Face-to-face interactions allow ECAs to develop an intimate, harmonious relationship with the user that fosters bonding (ter Stal et al. 2020a).

Wolters et al. (2016) found that CAs should be able to change the tone of voice and interaction methods based on the patient's cognitive ability. These new features typify the Embodied Conversational Agent (ECA), a CA with added human-like features such as avatars and gestures. Several prior research supports the adoption of animations of the agent's embodiment, showing that animations favourably impact users' perceptions of the agent and interaction time (ter Stal et al. 2020a).

Valtolina and Hu (2021) created and tested the validity and acceptability of using a customised CA called "Charlie" as a companion for elderly people experiencing social isolation and loneliness in their homes. The study findings show very high acceptability among the elderly users who viewed Charlie as a polite, intelligent, reliable, and helpful companion, and there was a notable decrease in the loneliness experienced by the user. These results provide a basis for future research into companion-type ECAs to mitigate feelings of isolation and loneliness.

Philip et al. (2017) studied using ECAs in patients with major depressive disorders. The participants were all patients at a sleep clinic. They found that ECAs effectively communicate empathy without judgement, which gains the patients' trust and leads to self-disclosure of sensitive information. Ho et al. (2018) showed that CAs could inspire self-disclosure at a similar if not higher rate than humans. Ermolina and Tiberius (2021) found during their Delphi study that current commercial Voice Controlled Personal Assistants (VIPAs) with human-like characteristics are not technologically developed enough

to act as healthcare assistants safely. They did, however, conclude that with further development, VIPA technology can be an effective tool to support staff and patients, especially elderly patients, in a healthcare environment.

1.4 Summary

Increased length of hospital stay can be linked to comorbidity of mental illness (Schubert et al. 1992), which further prolongs recovery. Current strategies for mitigating this effect, such as staff training and reporting, have proven unsuccessful. A more effective and cost-efficient approach is required to address the precursors of mental illness (such as social isolation). Current literature shows supporting evidence for including CAs in mental health treatment, tracking and recovery. Older adults may gain the same, if not more, benefits as younger people from using CAs in a health context (Bennion et al. 2020; Crabb et al. 2012). Older adults have a high adherence rate to CA technology and gain similar emotional, psychological, and relational benefits to younger people. Broadly, some improvement in emotional distress has been demonstrated through CAs.

Although Bickmore et al. (2018) and Kocaballi et al. (2020) warn of the dangers of commercially available technologies in a mental health context, there is emerging evidence that newer ECA technologies can effectively support people in a companionship role (Valtolina and Hu 2021; Wolters et al. 2016) and prevent the development of more serious mental illness.

The rest of this article is organized as follows: The method of the co-design workshop is discussed in section 2. Section 3 provides insights into the results of the workshop. The discussion, including findings, limitations, and future work, has been presented in section 4. Finally, section 5 concludes the study.

2 Method

The study employed a co-design workshop method with healthcare professionals, using a video prototype of an ECA demonstrating some key features. The workshop included a demonstration of the video prototype, construction of a mind map, imagination, and discussion of potential solutions. Thematic analysis was performed to analyse the workshop transcripts. The video prototype was built with an online video production tool called Animaker. Using a video prototype allowed for the demonstration of the functionality of the ECA while eliminating the complexity of developing a fully functional prototype. The following subsections will present each phase in detail.

2.1 Prototype Design

The prototype included four design features: Embodiment, Proactivity, Personalisation and Rehabilitation. In addition, there were some safety considerations.

2.1.1 Embodiment

The CA was designed to be an ECA (Embodied Conversational Agent), which incorporates human-like characteristics in the form of an avatar - named "Jackie". Since no guidelines exist for the appropriate appearances of ECAs (ter Stal et al. 2020b), we selected Jackie and her appearance as generic as possible. By providing the avatar with a human-like resemblance, the interface of our agent feels more connected than a physical device.

Jackie displays emotions through facial expressions and tone of voice. She has a full range of facial expressions, four of which are displayed in Figure 1. She can alter her tone of voice when discussing different subjects to create a human-like interaction. Jackie can also perform basic movements and actions such as waving, sitting, running, and jumping and exercises such as squats and bicep curls. The name "Jackie" was chosen for the sole reason that people tend to trust names that are easy to pronounce and familiar (Newman et al. 2014).

2.1.2 Proactivity

Jackie can “listen” to the sounds in the room and initiate a conversation with the patient if there is no sign of visitors or if the patient is asleep. She begins light conversations with patients with conversation starters.

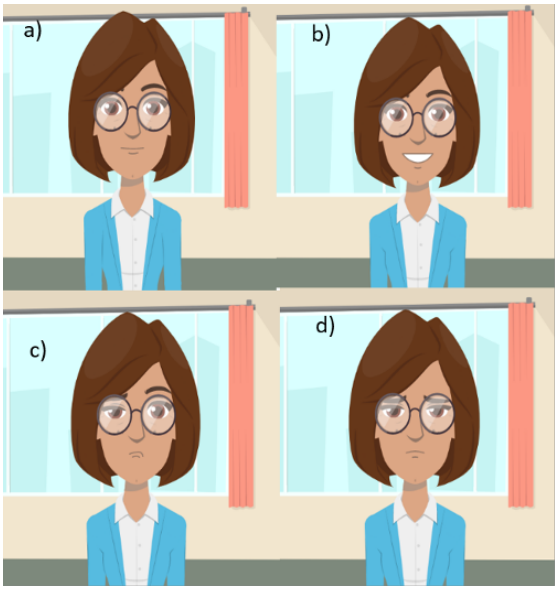

Figure 1: Jackie's facial expression: a) Resting, b) Happy, c) Confused and d) Sad

2.1.3 Personalisation

Jackie can be programmed with personal information about the patient's life, such as the names of family members and friends, their careers, and significant life events. These can be manually input into the system during admission or at an appropriate time when Jackie is being introduced to the patient. Jackie can be programmed with basic information about the patient's condition, if applicable, to aid in health literacy. For example, if a patient has a knee replacement, Jackie can provide the patient with pre-approved generic information about the procedure, the recovery, and the expected outcomes.

2.1.4 Rehabilitation

As some rehabilitation exercises can be done without a healthcare professional's aid, Jackie can motivate and guide the patient through pre-programmed rehabilitation exercises approved by their healthcare staff. She can remind the patient that it is time to do their activities, encourages them through every step, and gathers information about their pain and mobility to be sent to their healthcare professional.

2.2 Sample Conversation

Three short sample conversations were created for the video prototype, and one introduction video would be played for patients when introduced to Jackie. These conversation helps generate further discussion. The three conversations made were:

1. A short casual conversation about a recent visit from a family member, which demonstrates Jackie's ability to remember information told to her regarding specific family members and when they were planning to visit,

2. An instructional conversation that took the patient through their rehabilitation exercises, and

3. A more profound conversation where the patient self-discloses their worries about going home and being isolated. This highlighted how Jackie could encourage patients to talk about emotional topics they may be too embarrassed to initiate with a healthcare staff member.

2.3 Co-design workshop and Survey

A co-design workshop with five healthcare professionals with many years (10-39) of clinical experience from a range of disciplines was conducted to evaluate and envision the design elements of Jackie. Table 1 shows the workshop participants' details. The participants were recruited through personal and professional connections. Eligibility criteria included 5+ years working in a professional healthcare setting and experience caring for patients in long-term hospitalisation. All participants were sent an information sheet about the project and the proposed solution. A short survey was sent out with questions relating to their current job, relevant work experience in healthcare, experience with witnessing social isolation in healthcare settings and initial reactions and reservations to the proposed

ECA solution. The answers to these questions informed other discussion topics in the co-design workshop.

Participant (P)	**Healthcare role**	**Areas of Experience (years of experience)**
P1	Occupational Therapist	Rehabilitation, cardiology, and orthopaedics (35)
P2	Speech Pathologist	Neurology, aged care, and rehabilitation (22)
P3	Registered Nurse	Neurology, palliative care, aged care (10)
P4	General Practitioner	Nursing home and aged care home visits (39)
P5	Registered Nurse	Rehabilitation, Drug health recovery (20)

Table 1. Co-design workshop participants

The co-design workshop was held online through video chat and a collaborative brainstorming tool called Mind Meister. The first mind map aimed to gather information about current social isolation experiences and mitigation strategies that healthcare facilities may have. The workshop then moved into solution ideation, where participants individually provided feedback on the proposed solution and offered solutions to problems identified in the first section. This stage also focused on any negative impacts the ECA may have on patients and any considerations to ensure patient safety. Then, the participants were shown the video prototype and were asked to discuss its features. The workshop was audio recorded. Following the co-design workshop, the audio recording was transcribed and analysed. Thematic analysis (Braun and Clarke 2006) was used to generate sub-themes and themes.

3 Results

Responses to survey questions from the five workshop participants were analysed, along with responses extracted through workshop participation. Inductive coding of themes identified 15 codes from the raw data (survey responses and workshop quotes). The analysis generated three main and 15 sub-themes (Table 2).

3.1 Current healthcare environment

The participants' comments indicated that current isolation mitigation strategies used in hospitals have limited effectiveness. Language barriers, limited visiting hours, busy staff and insufficient volunteer resources were all identified as barriers to success. P3 noted that patients often wander the ward looking for social interaction: "*Visiting hours can be very limiting. So overnight, people can become very isolated. We often have cases of people wandering the hallways trying to talk to people … and there's just no facilities available through a night shift to help someone who …just feels very alone.*" In contrast, P1 noted that some patients will avoid talking to healthcare staff and volunteers: "*Often patients don't want to be "a bother" – so they don't talk, and they don't even talk to the people who are there to listen and help.*" Some participants explained that the only current mitigation strategies are visitors, volunteers, and socialisation between patients. P1 highlighted that visitors are not an option for all patients: *"[It is] hard for rural patients or those without visitors."* P3 described that socialisation between patients is often not possible: "*High doses of medications can make it difficult for patients to mobilise or concentrate.*" Furthermore, P4 stated that none of the mitigation strategies is possible if the patient must be physically isolated: "[*Physical] Isolation [may be necessary] for medical reasons, e.g., infectious disease, immunosuppressed*". Finally, P4 brought up that current admission procedures do not measure a patient's level of loneliness or potential for social isolation: *"[social isolation] is not systematically assessed.*"

3.2 The ECAs' potential impact on patients, staff, and the healthcare system

The participants' comments suggest that a companion tool such as Jackie has the potential to be integrated into some healthcare settings. Although some comments refer to the demonstrated features of ECA including proactivity, personalisation, and rehabilitation, the participants' focus remained mostly on the overall role of such an interactive technology as a new actor.

Current healthcare environment	**The ECAs' potential impact on patients, staff, and the healthcare system**	**Safety and privacy factors to address before implementation**
Medical staff time (1)	Medical staff time (1)	Medical staff time (1)
Shared rooms (2)	Shared rooms (2)	Shared rooms (2)
Issues current patients experience (3)	Features of ECA/Things it could do (9)	Safety concerns of ECA (13)
Current methods to solve issues (4)	Health areas of most help (10)	Data Privacy (14)
Systematic assessment of isolation (5)	Technology (11)	Challenges (15)
Visitors (6)	COVID-19 (12)	
Language (7)	Language (7)	
Shared patient areas (8)		

Table 2. Thematic analysis theme groups

During a discussion about when a patient may instigate a conversation with Jackie, P1 noted that patients often have questions about their condition that they may not ask the healthcare staff: *"… patients don't always ask questions when they are told something about their condition – but they may have questions that they want to ask later – and they don't know who/when to ask."*

Improving physical health was deemed an important factor in shortening the length of stay for people in hospital. P3 noted that this technology could be a positive encouragement and aid rehabilitation for patients: "*Thinking about stroke rehab, there's definitely a place for something like this that's set up by the physio, encourages people, reminds them, tracks their progress.*" P1 added that this technology could also improve patients' health literacy: "*and it will all build health literacy which I just think is a huge potential for this.*" P3 stated that people of all ages can learn to use new technology if they are provided with help and support while they are learning: "*My experience working with people in neuro and aged care settings is that people of all ages can learn to use technology with the right supports.*"

During the workshop, it was found that the acceptability of new technology is high among patients and staff. During a conversation about current technology, P2 stated, "*Allied Health already use iPads.*" To which P3 replied, "*And older people love their iPads.*" Followed by P2 adding, "*They just think they're the coolest thing ever.*" These quotes show an optimistic view of such technologies' potential to positively impact patients, staff, and the health system, by providing as-needed companionship, supporting rehabilitation, and reducing the burden on busy staff.

4 Discussion

Our participants' comments were overall positive about the suitability of ECAs for the patients, staff, and healthcare system. This aligns with data found in the current literature, which shows that, with the introduction of additional safety measures, CAs could help improve the physical and mental health of patients in the hospital, decrease their length of stay, free up nursing staff time, and reduce healthcare spending (Bennion et al. 2020; Fitzpatrick et al. 2017; Gaffney et al. 2019; Shaw et al. 2017; Siddiqui et al. 2018; Vaidyam et al. 2021). Current research suggests that commercial CA technology is not yet safe enough for use in situations where the patient expresses mental health issues or crisis statements (Bickmore et al. 2018; Ermolina and Tiberius 2021; Kocaballi et al. 2020); however, some recent CAs appear to be providing a much safer and more improved experience for the users (Bennion et al. 2020; Gaffney et al. 2019; Philip et al. 2017).

The main aim of hospitalisation (in general medical wards) is to focus on the patient's physical health and get them physically well enough to go home. Mental health tends to be a consideration only once symptoms have emerged. Nurses and other healthcare professionals have limited capacity to meet the companionship needs that could mitigate social isolation and subsequent mental health deterioration. Our literature review and the outcomes of the co-design workshop suggest that psychosocial assessment is not considered at the time of general hospital admission. Nor is there a systematic process for measuring patients' level of social isolation throughout their hospital stay. During the co-design

workshop, the participants were asked to identify measures currently being used to prevent and/or mitigate social isolation and loneliness. Even though healthcare staff is aware that social isolation is a problem, almost nothing is being done to address it.

The purpose of this study was to explore an ECA solution across the "normal" healthcare environment (i.e., pre- and post-COVID-19 pandemic); however, data collected during the pandemic has proven useful in demonstrating the importance of providing alternative companionship methods to isolated patients, with the mental health of patients coming out of hospital after being treated for COVID-19 dangerously low (Vlake et al. 2021). As it was observed by a healthcare professional that patients are reluctant to talk to those who are there to listen and assist, the proactivity feature of the agent can aid in encouraging interaction. In the case of infectious diseases where physical isolation is a must, using a virtual agent can be advantageous.

The participant's feedback on our video prototype is aligned with the outcomes reported by (Valtolina and Hu 2021), (Bennion et al. 2020) and (Wolters et al. 2016) that ECA technology can support people in an emotional capacity and relieve feelings of isolation and loneliness. Therefore, using ECAs in actual hospital settings may prove useful to provide companionship, aid recovery, and shorten the length of stay. However, larger-scale interventions with fully functional ECAs should be conducted to evaluate the efficacy and subjective user experience.

Although none of the co-design workshop participants has experience in hospital or healthcare sector financial management, they agreed that the ECA could shorten the length of stay for hospital patients by targeting social isolation, which would positively impact health sector expenditure. There was also group consensus that the additional features of the ECA, such as education, reminders, and encouragement to perform rehabilitation exercises, could improve health literacy, increase mood and motivation to recover and consequently decrease the length of stay in the hospital.

An important topic of discussion during the co-design workshop was the point at which a medical professional must take over the conversation between the ECA and the patient. Healthcare staff has limited time to interact with patients, so the initial aim was to have the ECA responsible for all mental health conversations, as literature shows that the use of CAs for mental health tracking and recovery can have positive outcomes (Fitzpatrick et al. 2017; Gaffney et al. 2019; Laranjo et al. 2018). Despite this, the participants of the co-design workshop were wary of the technology handling safety-critical conversation topics. To reduce the uncertainty, there was an agreement amongst the participants regarding the disclosure of safety-critical statements; the ECA can notify staff, and a mental health professional can take over. This may help staff identify patients who potentially require additional support.

All the participants in the co-design workshop had questions regarding whether the ECA is safe to use for the patient's physical and mental health. These are the same questions asked in the observational study conducted by Bickmore et al. (2018), which found that commonly available multi-purpose CAs cannot yet be relied on for actionable medical advice. Once the safety and security risks of the technology were discussed in the workshop, the ECAs' potential role switched from a "therapist" providing advice to a hospital companion providing friendship and motivation, with a focus on decreasing social isolation and preventing mental health decline, aligned with the research conducted by Valtolina and Hu (2021), and Wolters et al. (2016).

4.1 Limitations

This study has some limitations. First, the prototype used in the workshop was a video prototype. Although it demonstrated a high-fidelity prototype in action, it did not provide the participants with the first-person experience of using a fully working product. Second, our co-design workshop only included healthcare professionals. Another workshop with patients with prior long-term hospital stay experience and other types of healthcare professionals would complement our study. Third, all the participants were from a similar age group (40 to 60 years old). Therefore, it is possible that this limited variation in technological proficiency and understanding.

4.2 Future work

This study was a proof-of-concept study, obtaining a preliminary understanding of the potential suitability of using ECAs during hospitalisation. Future research can focus on developing a fully working ECA with unconstrained natural language input capabilities for increased accessibility and usability. The ECA should undergo rigorous risk analysis and safety testing before the interventions and should be monitored throughout to ensure the ECA does not give responses that could worsen the physical or mental condition of the patient. To ensure the implementation of the ECA does not hinder the healthcare

staff's ability to provide the necessary care to their patients, future development should ensure that the ECA can be set up easily and the patient's data can be input without posing an imposition to the staff.

While not explored in this study, an opportunity for future development is integrating this technology with Wi-Fi-enabled medical equipment to aid patients' physical health. Voice-activated ECAs could provide an accessibility solution for patients with limited mobility and hand function. This has the potential to create hospital rooms that cater to a much more comprehensive range of conditions and disabilities.

5 Conclusion

The evidence shows that long-term hospital stays can lead to feelings of social isolation and loneliness, significantly contributing to depression and anxiety. Mental health issues such as these have negatively impacted people's physical well-being. Prior studies have investigated if CAs can be helpful for people already experiencing mental illness; however, there has been limited research into the potential application of CAs in a preventative capacity, especially among long-stay patients. Current mitigation methods have limited ineffectiveness, and an additional focus on preventive measures is needed. Our workshop study suggests that ECAs can be helpful technological solutions during hospitalisation. However, privacy and safety remain major concerns similar to other CA applications in healthcare.

6 References

Bennion, M.R., Hardy, G.E., Moore, R.K., Kellett, S., and Millings, A. 2020. Usability, Acceptability, and Effectiveness of Web-Based Conversational Agents to Facilitate Problem Solving in Older Adults: Controlled Study. Journal of Medical Internet Research 22, e16794.

Bickmore, T.W., Trinh, H., Olafsson, S., O'leary, T.K., Asadi, R., Rickles, N.M., and Cruz, R. 2018. Patient and Consumer Safety Risks When Using Conversational Assistants for Medical Information: An Observational Study of Siri, Alexa, and Google Assistant. Journal of Medical Internet Research 20, e11510.

Braun, V., and Clarke, V. 2006. Using thematic analysis in psychology. Qualitative Research in Psychology 3, 77-101.

Crabb, R.M., Cavanagh, K., Proudfoot, J., Learmonth, D., Rafie, S., and Weingardt, K.R. 2012. Is computerised cognitive-behavioural therapy a treatment option for depression in late-life? A systematic review. British Journal of Clinical Psychology 51, 459-464.

Ermolina, A., and Tiberius, V. 2021. Voice-Controlled Intelligent Personal Assistants in Health Care: International Delphi Study. Journal of Medical Internet Research, (23), e25312.

Fitzpatrick, K.K., Darcy, A., and Vierhile, M. 2017. Delivering Cognitive Behavior Therapy to Young Adults with Symptoms of Depression and Anxiety Using a Fully Automated Conversational Agent (Woebot): A Randomized Controlled Trial. JMIR mental health 4, e19.

Gaffney, H., Mansell, W., and Tai, S. 2019. Conversational Agents in the Treatment of Mental Health Problems: Mixed-Method Systematic Review. JMIR Mental Health 6, e14166.

Ho, A., Hancock, J., and Miner, A.S. 2018. Psychological, Relational, and Emotional Effects of Self-Disclosure After Conversations with a Chatbot. The Journal of Communication 68, 712-733.

Jegundo, A.L., Dantas, C., Quintas, J., Dutra, J., Almeida, A.L., Caravau, H., Rosa, A.F., Martins, A.I. and Pacheco Rocha, N., 2020. Perceived usefulness, satisfaction, ease of use and potential of a virtual companion to support the care provision for older adults. *Technologies*, *8*(3), p.42.

Kocaballi, A.B., Quiroz, J.C., Rezazadegan, D., Berkovsky, S., Magrabi, F., Coiera, E., and Laranjo, L. 2020. Responses of Conversational Agents to Health and Lifestyle Prompts: Investigation of Appropriateness and Presentation Structures. Journal of Medical Internet Research 22, e15823.

Laranjo, L., Dunn, A.G., Tong, H.L., Kocaballi, A.B., Chen, J., Bashir, R., Surian, D., Gallego, B., Magrabi, F., Lau, A.Y. and Coiera, E., 2018. Conversational agents in healthcare: a systematic review. Journal of the American Medical Informatics Association, 25(9), pp.1248-1258.

Liu, B., and Sundar, S.S. 2018. Should Machines Express Sympathy and Empathy? Experiments with a Health Advice Chatbot. Cyberpsychology, Behavior, and Social Networking 21, 625-636.

Newman, E.J., Sanson, M., Miller, E.K., Quigley-Mcbride, A., Foster, J.L., Bernstein, D.M., and Garry, M. 2014. People with Easier to Pronounce Names Promote Truthiness of Claims. PLOS ONE 9, e88671.

Philip, P., Micoulaud-Franchi, J., Sagaspe, P., Sevin, E.D., Olive, J., Bioulac, S., and Sauteraud, A. 2017. Virtual human as a new diagnostic tool, a proof-of-concept study in the field of major depressive disorders. Scientific Reports 7, 42656.

Purssell, E., Gould, D. And Chudleigh, J. 2020. Impact of isolation on hospitalised patients who are infectious: systematic review with meta-analysis. BMJ open 10, e030371.

Ring, L., Shi, L., Totzke, K. and Bickmore, T., 2015. Social support agents for older adults: longitudinal affective computing in the home. *Journal on Multimodal User Interfaces*, *9*(1), pp.79-88.

Schubert, D.S.P., Burns, R., Paras, W. And Sioson, E. 1992. Increase of Medical Hospital Length of Stay by Depression in Stroke and Amputation Patients: A Pilot Study. Psychotherapy and Psychosomatics 57, 61-66.

Shaw, J.G., Farid, M., Noel-Miller, C., Joseph, N., Houser, A., Asch, S.M., Bhattacharya, J. And Flowers, L. 2017. Social Isolation and Medicare Spending: Among Older Adults, Objective Social Isolation Increases Expenditures while Loneliness Does Not. Journal of Aging and Health 29, 1119-1143.

Siddiqui, N., Dwyer, M., Stankovich, J., Peterson, G., Greenfield, D., Si, L. And Kinsman, L. 2018. Hospital length of stay variation and comorbidity of mental illness: a retrospective study of five common chronic medical conditions. BMC Health Services Research 18.

Sundström, M., Blomqvist, K., Edberg, A. And Rämgård, M. 2019. The context of care matters: older people's existential loneliness from the perspective of healthcare professionals—A multiple case study. International Journal of Older People Nursing 14, e12234.

ter Stal, S., Broekhuis, M., van Velsen, L., Hermens, H. and Tabak, M., 2020a. Embodied conversational agent appearance for health assessment of older adults: explorative study. *JMIR human factors*, *7*(3), p.e19987.

ter Stal, S., Kramer, L.L., Tabak, M., op den Akker, H. and Hermens, H., 2020b. Design features of embodied conversational agents in eHealth: a literature review. *International Journal of Human-Computer Studies*, *138*, p.102409.

Vaidyam, A.N., Linggonegoro, D. And Torous, J. 2021. Changes to the Psychiatric Chatbot Landscape: A Systematic Review of Conversational Agents in Serious Mental Illness: Changements du paysage psychiatrique des chatbots: une revue systématique des agents conversationnels dans la maladie mentale sérieuse. The Canadian Journal of Psychiatry 66, 339-348.

Valtolina, S. And Hu, L. 2021. Charlie: A chatbot to improve the elderly quality of life and to make them more active to fight their sense of loneliness.

Vlake, J.H., Wesselius, S., Van Genderen, M.E., Van Bommel, J., Boxma-De Klerk, B. And Wils, E. 2021. Psychological distress and health-related quality of life in patients after hospitalisation during the COVID-19 pandemic: A single-center, observational study. PLoS ONE 16.

Walker, J., Burke, K., Wanat, M., Fisher, R., Fielding, J., Mulick, A., Puntis, S., Sharpe, J., Esposti, M.D., Harriss, E., Frost, C. And Sharpe, M. 2018. The prevalence of depression in general hospital inpatients: a systematic review and meta-analysis of interview-based studies. Psychological Medicine 48, 2285-2298.

Wolters, M.K., Kelly, F. And Kilgour, J. 2016. Designing a spoken dialogue interface to an intelligent cognitive assistant for people with dementia. Health Informatics Journal 22, 854-866.