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Evaluating Smart Glasses for Cardiopulmonary Resuscitation

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Abstract. Smart glasses allow care providers to connect to remote experts for consultation and have the potential to improve care. The purpose of this study was to evaluate the user experience with smart glasses in a simulated nursing care environment. We collected data via post-simulation semi-structured interviews and System Usability Scale (SUS) surveys. The median SUS score was 74 (range 57.5 to 90). The qualitative and quantitative findings of our study highlighted the potential benefits of smart glasses for assisting novice nurses in patient care, as well as the technical and workflow challenges that need further investigation.

Keywords. CPR, usability, smart glasses, nursing, simulation

1. Introduction

Smart glasses are head-mounted wearable computerized devices with a near-eye display for presenting three-dimensional information and a video camera for capturing still images and streaming videos. Smart glasses have emerged as a promising technology due to their potential advantages, such as high portability and hands-free operation [8]. Several studies have tested the affordance and feasibility of using smart glasses, to enable real-time sharing of visual medical information in critical care settings. For example, emergency physicians working remotely, can obtain details of patient response to injuries (e.g., facial expression, agitation), that may be difficult to relate verbally [4]. While smart glasses have been increasingly utilized in nursing care and training [5; 6], their effectiveness in improving care provided by novice nurses, through remote access to experts, remain understudied. Hence, the purpose of this study was to evaluate user experience with smart glasses in a simulated nursing care environment.

The study setting simulated performing cardiopulmonary resuscitation (CPR) in an acute care setting. High-fidelity simulations are common in nursing education, and they have been shown to be valid and efficient to recreate high risk events in a low-stakes environment. CPR is an appropriate case to evaluate smart glasses for two primary reasons: 1) During CPR, it's vital for the care provider to have both hands free to

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perform chest compressions and rescue breaths. Smart glasses allow the user to receive instructions without having to use their hands to hold or manipulate a device. 2) Smart glasses can connect the person performing CPR with an expert in real-time, allowing for expert oversight and immediate advice during CPR, which is crucial for patient survival.

2. Methods

We evaluated the user experience with smart glasses after a simulated CPR scenario with 12 nursing students. Students were required to complete American Heart Association (AHA) Basic Life Support (BLS) training as an admission requirement for their undergraduate nursing program. Nine of the students were female, and three were male. Ages ranged from 21 to 33 (median age 25.5). They were recruited on a voluntary basis, and they were not evaluated on their participation or as part of any coursework.

We used Vuzix M400 smart glasses. The device's camera allows for recording and streaming videos. The primary user interface of the device is the near-eye display. The device supports voice-based interaction, where users use simple, pre-defined voice commands to interact with the smart glass system. The simulation scenario was created using the Healthcare Simulation Standards of Best Practice Simulation Design [7]. The scenario was based on a post-operative adult patient experiencing a cardiac arrest, requiring CPR. A high fidelity, adult simulator was used for the simulation-based experience. The patient room was arranged to resemble a realistic acute care environment (Figure 1. Smart glasses are worn by one of the co-authors in the simulation room). Each participant acted as a primary nurse and entered the simulation room independently. However, they were able to request assistance from a volunteer who acted as a clinical nurse assistant (CNA). The CNAs only carried out tasks delegated by the participants. The participant was responsible for making decisions in caring for and administering CPR to the patient. During the pre-briefing phase of the simulation, participants were instructed on how to use smart glasses. From the beginning of the scenario, students could access the CPR trainer through the smart glasses. The connection was initiated by stating “Hi Glass, call remote expert.” At any time during the scenario, participants had the ability to use smart glasses to receive remote support and guidance. The second author (AK) served as the CPR trainer for all participants. After completing the scenario, the participants joined in a debriefing session.

User experience data were collected through semi-structured interviews and a modified version of the System Usability Scale (SUS) questionnaire [2]. The interview

questions aimed to understand the participants' overall experience using smart glasses, their perceived effects on CPR performance, and any encountered challenges. Interviews were conducted by the first author (MO) and lasted an average of nine minutes. The CPR trainer (AK) with whom the participants were connected, was also interviewed. Audio recordings of interviews were transcribed automatically by otter.ai and then reviewed by MO. Transcriptions were analyzed inductively using content analysis.

3. Results

The scenario was planned to last ≤15 minutes. On average, participants stayed connected to the expert through the smart glasses for approximately 6.7 minutes. The SUS score varied between 57.5 to 90, with a median of 74. Qualitative analysis identified seven main themes as described below.

Overall technical and design features of the smart glasses

Two important technical and design aspects were particularly highlighted: audio quality and comfort when wearing the glasses. Most participants reported satisfactory audio quality. Similarly, most of the participants found the glasses to be comfortable, lightweight, and stable: "*It felt integrated, … it didn't feel unnatural*." Fewer respondents reported audio quality unsatisfactory, and uncomfortable to wear.

Challenges of using smart glasses

While the majority of participants had a positive impression, and all recognized the potential of smart glasses, several challenges were identified during their use. First, the initiation of the connection with the remote expert was not seamless (i.e., device not responsive to voice command). Second, some participants reported the need to tilt the camera to provide a better view for the remote expert. However, this adjustment process could be time-consuming and might potentially delay the patient care procedures: "*For something like CPR, where every second counts, it's hard to readjust for the expert*." Third, communication issues between the user and remote expert were also observed. While direct and timely instructions were helpful, delayed guidance could be confusing, resulting in the nurse and expert not always being "on the same page". The fourth challenge was distractions caused by the smart glasses during CPR, since many participants were not accustomed to wearing an additional device while performing critical tasks such as CPR. Lastly, some users mentioned a sense of being overwhelmed, as stated by one user: "*I had to remind myself that where I was looking with my head was where they were seeing*."

Workflow related issues

Workflow issues can affect technology adoption and the benefits derived from it. Participants highlighted several workflow issues. Some mentioned the difficulty of "*having to go find the glasses to get support*" when needed: "*Putting on the glasses [is] not the priority*" in the workflow. Participants also noted the need to perform additional tasks, such as notifying CNA and informing other people in the room about the expert's

instructions. This challenge may have arisen from the fact that the speaker on the device may not have been loud enough to be heard by others who were not close to the smart glass wearer: "*Hearing the person in the glasses might be next to impossible*." Given these issues, participants mentioned that it could be challenging to clearly understand and then follow long and indirect instructions provided by remote experts during real-life scenarios.

Various roles of the expert

The participants identified various roles of the remote expert in this study. The roles include coach, comforter, evaluator, and reminder. In the role of a coach, the expert encouraged the user and provided guidance: "*If [I am] doing something wrong, I can be corrected*." As a comforter, the remote expert provided emotional support, enabling the user to remain calm throughout the scenario, as participants noted: "*It was helpful to have 'someone' in the room*." As an evaluator, the expert provided real-time direct feedback on how CPR was performed. In the reminder role, the expert could provide cognitive support to the user who was overwhelmed. For example, the expert could remind the user to call the CNA and check the patient's vital signs and the sequential steps and interventions to be taken according to the AHA BLS algorithm. These critical tasks must be done on time, and correctly during the scenario.

The effect of smart glasses on CPR

Nearly all participants reported improved performance while using smart glasses. Only two participants had different experiences_one reported negative effect, and the other reported no noticeable impact of smart glasses on their care performance. Improved performance is mainly due to the access to experts. The main reason cited for decreased performance was distraction caused by the smart glasses.

Being more appropriate for some users

Smart glasses may offer greater benefits to certain nurse users compared to others. Some participants highlighted that recently graduated nurses could derive more benefit than their experienced counterparts. Additionally, one participant mentioned that those in team leadership positions could benefit more from smart glasses while seeking consultation from an expert.

Potential new features

Several potential new features were highlighted, including the ability to serve as metronome, a hard start button, camera tilting capability controlled by the expert, the addition of augmented reality to show important vital signs, and incorporating artificial intelligence for measuring compression for real time feedback.

4. Discussion

This pilot study evaluated the use of smart glasses by twelve nursing students, who connected with a remote expert while performing CPR in a simulated setting. The

median SUS score was 74, which is higher than the recommended cutoff of 68 and considered good or acceptable [1; 3]. The qualitative findings identified seven themes that highlighted the potential benefits and challenges of using smart glasses.

The challenges identified can inform the design and implementation of smart glasses for nursing care, education, and training. For example, some technologically feasible suggestions, such as having a hard start button or enabling camera tilting by remote expert, could improve the user experience with smart glasses. Workflow issues, such as the difficulty putting on the glasses, can be addressed by encouraging the nurses to wear them before entering the patient room. Ergonomic issues, such as the comfort of wearing the device and compatibility with existing spectacles (e.g., personal protective equipment), as well as battery issues [8], should be fully addressed by device designers and manufactures to ensure widespread user acceptance and adoption. The implementation of smart glasses should be supported by other workplace and organizational interventions to ensure their effectiveness. For example, policies should be established regarding who should wear smart glasses and under what circumstances. Our analysis suggests that recently graduated or novice nurses in need of consultations from specialties can benefit the most from smart glasses.

Smart glasses can provide more value in clinical settings where experts are necessary and available remotely. Three examples are intensive care units (ICU) that are supported by virtual ICU, clinical settings in rural areas, and nursing homes. These settings utilize experts often on an "as needed basis;" however the timing of the need may not be fully predictable. Smart glasses facilitate faster access to specialists who are critical to manage rapid change in the patient's status. Such access could enable more efficient utilization of remote experts, therefore offering greater flexibility in job and organization design.

The benefit of smart glasses depends on the proficiency of the remote expert's skills. Moreover, it is critical to train experts in the use of smart glasses-enabled telemedicine as such training can increase their awareness of potential challenges in using telemedicine systems, such as distractions and confusing or overwhelming instructions. Experts lacking the necessary competencies and training in smart glasses-powered telemedicine technology could potentially diminish the advantages of adopting such burgeoning technology in nursing practice.

There are three limitations in this study. This study was conducted in a simulated environment; therefore, the actual use of smart glasses in real-world practices cannot be fully captured. All participants were nursing students with no prior experience with smart glasses. Lastly, the author (AK) served as the expert for all participants. Future studies should include multiple experts as expert characteristics may affect the results.

5. Conclusions

Smart glasses can benefit care providers (e.g., novice nurses) by connecting them with remote experts to assist in conducting complex tasks such as CPR. However, many technical and workflow challenges in using smart glasses must be properly addressed to increase the adoption of this technology.

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