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Featured Article

Using Simulation to Conduct a Usability Study of Wearable Technology

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KEYWORDS
head-mounted display;
simulation;
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Abstract

Background: This study had two purposes. First, to assess the usability and perceived ease of use (PEU) of a head-mounted display (HMD) in the health care environment. Second, to assess whether the use of a remote teleconsultant intensivist via a HMD improves the management of a simulated cardiac arrest. The use of technology, specifically HMDs (such as Google Glass™), is becoming more popular, especially in health care. However, the efficacy, usability, and PEU have not been studied to any great extent. Assessing new technology is an important step when considering potential implementation in a patient care setting. Using simulation to assess the usability and the PEU is one method that can provide insight into the viability of new technology.

Methods: Nine teams of internal medicine residents (31 individuals) participated in this study conducted in a simulation center with a high-technology patient simulator. Resident teams were randomized to the availability of a remote intensivist via teleconsultation using a HMD. The residents were asked to provide care to a patient and had the opportunity to activate the HMD for assistance.

Results: The main outcome measure was the PEU and usefulness of the HMD during a cardiac arrest. Although the PEU and perceived usefulness of the HMD were not different between the teams, the team leaders, who used the HMD during the scenario, scored the device as more useful than other team members. The second outcome of proper management of a critical patient was not improved with the use of a HMD.

Conclusions: Real-time video communication via a HMD was seen as potentially useful by the team leaders, but not by team members. In addition, the use of a HMD for communication did not improve the management of a simulated patient. New technologies, including wearable, HMDs may have their role in health care, but must first be tested for efficacy, ease of use, and perceived usefulness in realistic simulated patient environments. Introducing new technology in a simulated environment may aide in their adoption in clinical environments or prevent dangerous and costly missteps.

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Introduction

Cardiac arrest is a serious medical condition affecting more than 209,000 patients in US hospitals every year (Nichol et al., 2008). The survival rate for in-hospital cardiac arrest is less than 25% for adults and less than 50% for pediatrics (Nichol et al., 2008). For adults, best estimates for rate of survival to discharge following in-hospital arrest are about 18%, which slump to 6.6% at one year postevent (Morrison et al., 2013). Organized, cohesive resuscitation programs can improve survival from cardiac arrest by strengthening the links in the chain of survival (Go et al., 2013). The chain of survival includes, immediate recognition and activation of the emergency response system, early cardiopulmonary resuscitation (CPR), rapid defibrillation, effective advanced life support, and integrated postcardiac arrest care. In hospitals, the chain of survival is highly dependent on having an effective cardiac arrest response team.

Key Points

- Simulation should be used to identify the usability of new technology before implementing in patient care areas.
- Head-mounted displays may be more useful for critical tasks than overall event management assistance.
- Usability testing should occur with all new technologies in a simulated environment.

Head-mounted displays (HMDs), such as Google Glass™, can establish audio−video communication between team members at the patient bedside and remote intensivists, thereby leading to a novel method of teleconsultation and advanced support. HMDs offer other unique advantages over traditional telephones, such as the ability to have hands-free use as well as providing the remote intensivist with a first-hand view of the situation.

Telemedicine and teleconsultation have been used previously in emergency departments, where it helped diagnose and treat patients with dermatologic or orthopedic complaints (Chai et al., 2015; Chandhanayingyong, Tangtrakulwanich, & Kiriratnikom, 2007). The use of hands-free wearable displays has been used for limited purposes in highly controlled clinical environments. However, widespread adoption of the technology is still questionable, and to date, few studies of wearable technology taking place in a simulated patient environment have been identified (Drummond et al., 2016; Liu, Jenkins, & Sanderson, 2009). We undertook this study to identify:

a. the perceived usefulness (PU) and perceived ease of use (PEU) of a head-mounted wearable display by cardiac arrest teams and
b. whether teleconsultation improved adherence to American Heart Association (AHA) cardiac arrest guidelines.

Background

There are numerous displays that have been used in everyday life and in health care. They include, head-down displays (HDDs), head-up displays (HUDs), and HMDs. HDDs, such as those placed in the dashboard of cars, negatively affect drivers' visual attention (Ablassmeier, Poitschke, Wallhoff, Bengler, & Rigoll, 2007) because of the need to look away from the area of focus while using the device (Weinberg, Harsham, & Medenica, 2011). From this research, we can extrapolate that the use of cell phones for information gathering or two-way communication in a clinical environment would also negatively affect the attention of the clinician. An alternative display is an HUD, which was first introduced to the automotive industry in 1988 by General Motors (Weihrauch, Meloeny, & Goesch, 1989). User satisfaction and task efficiency research suggests that HUDs are preferred to HDDs or audio-only modes of information transmission. HMDs are worn on the head and are capable of reflecting projected images as well as allowing the user to see through the lens that is in front of one or both eyes. HMDs were studied in the operating room to assess whether anesthesia machine waveforms could be kept in view of the anesthesiologist at all times, by having them displayed on a wearable device (Liu et al., 2009). One example of an HMD is Google Glass™.

One measure of PU and PEU comes from the Technology Acceptance Model (TAM), which is used to predict and explain end-user reactions to new technologies (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989). Studies (Holden & Karsh, 2009) show that the relationship between PU and intention to use or actual use of health information technology is significant. To promote use and acceptance of health information technology, it must be perceived as useful.

Outside of health care, the TAM is a commonly used model to measure technology acceptance (King & He, 2006). Research by Vankatesh and Davis (2000) expanded on the TAM and stated that technology use is dependent on the subject's intention to use technology, which is dependent on subject norm (SN), PU, and PEU. PU is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989, p. 320). PEU is defined as "the degree to which a person believes that using a particular system would be free from effort" (Davis, 1989, p. 320).

Studies call into question subjective norm's role in influencing a person's intention to use technology. Vankatesh and Davis (2000) revealed that SN was a determining factor of initial user acceptance, especially in the mandated setting, but SN was not significant in determining PU and behavioral intention three months postimplementation. As time increases, PU or intention to use technology may be less affected by SN. This is potentially due to the promotion of independent thinking and independent evaluation of the technology, reducing reliance on others'