

Wearable technology to improve education and patient outcomes in a cardiology fellowship program - a feasibility study

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Abstract Graduate medical education (GME) is a balance between providing optimal patient care while ensuring that trainees (residents and fellows) develop independent medical decision making skills as well as the ability to manage serious medical conditions. We used one form of wearable technology (“Google Glass”) to explore different scenarios in cardiovascular practice where fellows can better their education. We specified different scenarios encountered during routine clinical care in the month of July 2013. These scenarios were chosen based on their clinical significance, the difficulty posed to early stage trainees and the possibly deleterious effects of misdiagnosis or treatment. A mock trainee wearing Google glass enacted each scenario. Live video stream from the glass was transmitted via Wi-Fi or Bluetooth which could have been received by a smartphone, tablet or personal computer. In conclusion, wearable technology has the potential to enhance medical education and patient safety once widely available. Medical institutions should work on policies regarding the use of such technologies to enhance medical care without compromising patient privacy.

Keywords Google glass · Medtech · Augmented reality in healthcare · Wearable technology

Graduate medical education (GME) is a balance between providing optimal patient care while ensuring that trainees (residents and fellows) develop independent medical decision making skills and the ability to manage serious medical conditions. Real time and appropriate supervision by experienced faculty is key to reconcile these sometimes diverging interests. Information technology plays an important role by which trainees can provide good patient care while being evaluated and guided by the attending physician. However, real time evaluation of trainees remains challenging. Residents who are not well supervised are more likely to make errors that may harm patients [1]. Wearable technology such as optical head mounted display (OHMD) has the potential to revolutionize medical education and patient safety. We used one form of wearable technology (“Google Glass”) to explore different scenarios in cardiovascular practice where fellows can better their education.

1 Methods

Google glass is optical head mounted display (OHMD) technology which is currently in a development stage and is not available to the general public. Limited numbers of this device have been sold in a beta program of which one of the authors is a participant. GLASS uses advanced technology to enable its user to experience augmented reality. GLASS is composed of the following parts; 1) Bone conduction transducer that is able to transmit audio through the temporal bone and mastoid process. (Sounds transmission varies on the user, the better the contact, the better the sound quality) 2) Microphone: captures voice and allows user to make phone calls, video conferences,

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dictate e-mail and messages, and there are now beta apps like Genie for glass that allows you to dictate notes. 3) Camera: Camera that can take 5 megapixel photographs and 720p HD video. Video can be transferred live via the internet as well as the ability to videoconference. 4) Computer: Gyroscope, GPS, Wi-Fi, Bluetooth, and 12 GB of storage. Connection to the internet is via Bluetooth /hotspot smartphone tethering or just connecting to an available Wi-Fi network. 5) Prism: This is the display for Google GLASS.

We specified different scenarios encountered during routine clinical care in the month of July 2013. These scenarios were chosen based on their clinical significance, the difficulty posed to early stage trainees and the possibly deleterious effects of misdiagnosis or treatment. A mock trainee wearing Google glass enacted each scenario. Live video stream from the glass was transmitted via Wi-Fi or Bluetooth which could have been received by a smartphone, tablet or personal computer. We decided to use a smartphone to receive the feed due to its portable and almost ubiquitous nature at our medical center. We devised 4 scenarios based on real situations encountered by the authors during routine clinical cardiology practice during the month of July 2013. Scenarios included interpretation of electrocardiogram (ECG), assessment for pericardial tamponade, interrogation of a defibrillator and live monitoring of a trainee performing a subclavian vein puncture. None of these scenarios involved patient contact and no patient information was shared. This was also not a “study” in the true sense and was designed to prove that the use of this technology is feasible.

2 Results

The scenarios studied are described below:

2.1 Scenario 1

Chest pain is a common complaint and a missed diagnosis of a myocardial infarction. Electrocardiographic signs can sometimes be subtle. The first scenario consists of a middle aged male with sub sternal chest pain. ECG shows subtle ST elevations in inferior leads and a tall r wave in lead v2 suggestive of a posterior infarct. The trainee wearing the Google Glass studies the ECG with his senior fellow; (Fig. 1a, b) the ECG is interpreted in real time, subtle signs of ischemia are discussed and appropriate treatment is initiated.

2.2 Scenario 2

A first year Cardiology fellow obtains a bedside echocardiogram at 12:00 AM to assess a pericardial effusion in a patient who is short of breath. Echocardiography shows a large



Fig. 1 Posterior Myocardial Infarction

pericardial effusion but the fellow is not sure if the effusion is causing cardiac chamber compression and tamponade. This is a critical decision. If a tamponade is missed, it could have disastrous consequences including death. If a tamponade is falsely diagnosed, the patient may undergo an emergent and potentially dangerous procedure with no clinical benefit. The fellow (Fig. 2a, b) wears the Google glass and contacts his senior fellow who reviews the images and helps him perform additional echo views which confirm that the patient is indeed in cardiac tamponade. Appropriate treatment is initiated.

2.3 Scenario 3

A middle aged woman with an implantable defibrillator (ICD) comes to the emergency room when her device delivers a shock. Defibrillators are often interrogated by representatives of the device manufacturer. On this particular evening the device representative who covers multiple hospitals over a large geographical area is at least 3 h away at a different medical center. Delay in diagnosis may lead to multiple shocks due to arrhythmia. The first year cardiology fellow has been partially trained in device interrogation but is not confident in performing it independently. Using the OHMD device he performs the interrogation while a senior fellow guides him through the various steps. (Fig. 3a, b) They review the events and the correct diagnosis of ventricular tachycardia is made. The patient is admitted and treated without further delay.

2.4 Scenario 4

A cardiology fellow is ready to perform a subclavian vein cannulation in preparation for a pacemaker implantation. He has performed several of them and the senior cardiac electrophysiology attending is comfortable having him start the procedure. However this would be his first attempt without someone physically by his side to assist him. He performs the procedure wearing a Google glass. The faculty member sits outside the lab observing his procedural skills from a first person perspective. (Fig. 4a, b) The procedure is performed

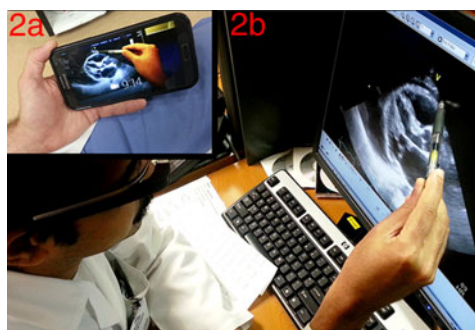


Fig. 2 Cardiac Tamponade

successfully improving the confidence of the trainee and the attending as well. The skill of the performing fellow is documented.

3 Discussion

Technology has revolutionized the practice of medicine. It has permeated all aspects of medicine from innovative medical devices to ready access to data and medical charts. Clinical teaching of residents and fellows largely relies on the apprenticeship model. “See one, do one, teach one” is a common way of acquiring technical skills [2]. However the learning curve to mastering a technique and providing advanced sub-specialty care can be long. This learning curve has patient care implications as well. Though it is beneficial to society when trainees provide direct care to patients; patient safety cannot be ignored. Each patient deserves the best possible care and close supervision of trainees is the key. Teachers in cardiology and medicine in general strive to strike a balance between closely supervising future doctors while providing them independence to practice their skills. Their constant presence can be distracting and can make impair the development of independent decision making skills.

Simulation plays a major role in providing trainees with practice in performing procedures and exposing them to



Fig. 3 Interrogation of Implantable defibrillator

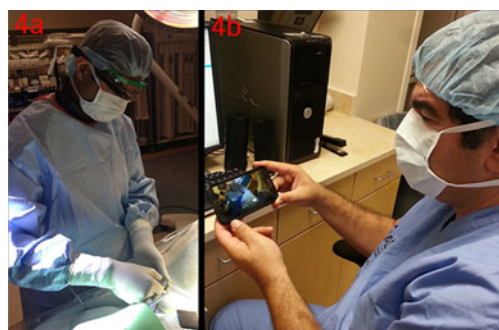


Fig. 4 Subclavian Vein Cannulation for pacemaker implantation

situations such as cardiac arrest. However the drawbacks of simulation are well known [2, 3]. It does not provide training in situational decision making nor does it evaluate the ability to work in a team. Thus while simulation is helpful, trainees benefit from live feedback and guidance while providing clinical care.

Currently, when a trainee encounters an issue, most of the discussion of data occurs by telephone with the attending. The attending physician does not usually have access to the same data that the trainee sees. Using OHMD, there is greater potential for sharing data and evaluation of the trainee’s performance. Wearable technology thus has the potential to bridge these diverging interests of independent training and patient safety. Though it is in its infancy, we believe in its potential and thus performed these simulations to study the feasibility of its use in a cardiology training program. We chose the above scenarios both for the critical nature of the decision making as well as the potential for promoting medical education. Electrocardiograms are often digitally acquired and stored in current medical systems. However electronic medical records rarely talk to each other and the first scenario deals with interpreting a paper copy of the ECG sent over from a different facility. Similarly though echocardiographic images are stored digitally and can be viewed by electronic medical records, real time viewing can be helpful since additional views of the heart can be suggested and feedback can be provided on both the image acquisition and interpretation skills.

Patient privacy and various rules concerning patient information are often cited as examples of why such technology can face hurdles in implementation. In all the above scenarios, data streamed live over a secure hospital network between two physicians who are actively involved in the patient’s care. No data or images were stored. As an additional precaution, data transmitted had no patient identifiers. Using wearable technology in this manner falls under the purview of telemedicine which is an accepted form of providing high quality medical care [4]. In addition availability of this technology also poses an interesting conundrum- is our fear of running afoul of patient privacy laws actually hampering patient care? What would be the reaction of a sick patient when he realizes that his

doctor is afraid to seek help and obtain potentially life-saving advice because of the fear of breaking privacy rules? Clinicians often encounter hurdles in obtaining critical patient data from other hospitals since release of such information is considered to be not compliant with privacy rules unless the patient signs a waiver. This can result in delay of appropriate care. We anticipate similar resistance to the adoption of wearable technology. The key to removing these barriers is to engage patient organizations and lawmakers. Our suggestion would be for individual institutions to develop policies on the use of this technology to enhance patient care. Another critical aspect of the use of such technology is patient acceptance. The almost scientific fiction like appearance of current technology may distract or worry some patients. However as technology becomes more widespread in daily life, we believe patients will perceive the use of such technology to be useful rather than detrimental. In fact, it may increase patient confidence in trainees providing care as has been documented with the use of simulators [5].

There are potentially many other uses of OHMD technology in cardiology. During a complex procedure, cardiologists can instantly seek help from experts anywhere in the world without breaking sterile precautions. One could also envision where the competency of young physician in certain challenging procedures be judged by a group of peers before hospital privileges are granted. Directors of training programs can record the skills of their trainees as a way of assuring competency prior to graduation. For this to happen, secure applications are crucial. It is thus important to foresee that the biggest impact of OHMD in healthcare will not come from simply the use of the camera and microphone alone but the incorporation of these in ‘apps’ created by medical innovators in the field.

Limitations This proof of concept study involves simulated scenarios rather than actual patient encounters. However these scenarios are based on commonly encountered problems in Cardiology. They were also conducted in the hospital setting to demonstrate feasibility and acceptability by other medical

personnel. Most if not all of the medical personnel involved in the scenarios were comfortable with using the technology. Importantly, this is not a study of the use of OHMD rather can a collection of simulations. Only a well designed study can prove the benefits of OHMD in medicine. The purpose of this paper is thus to stimulate interest in this nascent field.

In conclusion, wearable technology has the potential to enhance medical education and patient safety once widely available. Just as smartphones enhanced communication and ease of data access among physicians [6], this technology can be easily embraced by medical professionals once concerns about patient privacy are addressed. Medical institutions should work on policies regarding the use of such technologies to enhance medical care without compromising patient privacy.

Conflict of interest None.

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