1. Introduction

Google Glass is a wearable, without hands, personal computer (PC) with an optical head-mounted display, a 5 MP camera, telephone in a lightweight package with capabilities to text, email, social media—all performed by voice command.

2. Structure and function of glass

The Glass is worn like any other set of reading glasses, but has a prism perched above the right eye that acts as the computer screen (Figs. 1 and 2). The “frames” are actually one contiguous rim of titanium that is lightweight, flexible, and strong. All the equipment is on the right arm of Glass, the battery rests behind the ear, as also a standard ear piece. Along the temple there is a touch-sensitive trackpad that is used to scroll backward, forward, up, and down in order to perform different actions. This area also contains the PC and camera as well. In order to use features other than the camera, e.g. perform Google searches, confer with colleagues using Google Hangout, and receive and send texts/emails, you must be hooked to a WiFi or Bluetooth data connection. The “screen” or display portion of Glass is housed just above the right eye (so that it is out of your field of vision), the display is equal to a 25-inch high-definition screen from eight feet away. The Glass is powered by tilting head back 30° or tapping the track-pad. The Glass works using swiping motions and taps on the track-pad or with a fixed set of voice commands, all prompted from the home screen by saying “Okay, Glass…” Basic requests like “take a picture,” “record a video,” and “send a message” are easily understood and effective. Google Hangout is a kind of video conferencing and can be done with anyone in the Google Circles. Other useful features include the ability to receive and send emails using voice commands, navigation by simply speaking an address, and Google Now.

In clinical settings the Glass can undertake multiple functions: educational, diagnostic, therapeutic or even remote sensing.

3. Educational

One of the greatest potentials for Glass is in medical education. It is game-changing technology wherein audience/students can directly visualize what operator is seeing, and engage with him/her in real time. The Glass could facilitate live broadcasting of cases, where the observers could watch in the comfort of their classroom/theatre and have better eyes on the object of interest than if they were there present in person in cath lab/surgery. Further, they could ask questions of the operator or simply listen to him/her, instructions on anatomy and/or tips to performing the procedure. Finally, they could undertake retrospective review of case feeds which may promote operator self-assessment.

4. Diagnostic

Video capture and storage may be used for effective documentation, while preserving sterility (obviating the need for burden-some hands-on cameras). With the full integration of these devices into contemporary electronic health records, they may be able to interact and relay key reminders and real-time patient-related information to optimize operator workflow.

5. Remote sensing

Remote sensing, electronic consultation, and improved communication and coordination with off-site colleagues/experts may be achieved with these devices.

6. Therapeutic

The Glass opens up the possibility of real-time transfer of data outside of the immediate clinical environments, allowing the consulting expert to visualize the operative field or pathology slide or angiographic finding, and make a recommendation. In other words this technology allows the operator to obtain a second opinion from a far-away consultant who has more experience. Besides this the Glass can help in other ways as well. Instead of transmitting out, the optical head-mounted digital display can transmit in; it can supplement the information directly visualized by operator with virtual extra data displayed by the gadget, for example projection of computed tomography (CT) angiography data sets in a CTO case where distal bed cannot be directly visualized (but the previously obtained information super-imposed on current real information). Thus, the display of 3D CT reconstructions in a mobile application, equipped with a
hand-free voice recognition system and a zoom function may enable the operators to clearly visualize the distal coronary vessel and verify the direction of the guide wire advancement relative to the course of the blocked segment.

7. Limitation of the current technology

Despite several potential advantages and uses at the moment the technology is limited by a number of factors:

1. High-quality data are lacking to validate the expeditious and seamless transmission of information with these innovative devices compared with standard health systems. At present there is a poor operator satisfaction and quality of interpretation of electrocardiograms and angiographic images (particularly left-main) with Google Glass. Finally, secondary data visualization (reprocessing and recapture of primary data) does not appear to be fully effective at this stage of development.

2. Currently, few health-care professionals possess the technological aptitude to be able to assimilate these devices into their practices.

3. Privacy issues are very important; the potential of being recorded without knowledge and the catastrophic consequences this could have on society as a whole. In particular, for patient privacy, using Glass in the hospital without informed consent, and filming of a patient over an insecure network would be a very contentious issue. Practically, for a live-streaming device to be used in clinical scenario, the device would have to run over a health-care-specific, password-protected, encrypted network. Further, other patients and their family members may not be confined to their rooms and may be inadvertently filmed although they may not want to be filmed. Finally, there will be an issue of storing these recording in a privacy protected environment.

4. The rising health-care expenditures preclude the introduction of new technologies that do not add significant value or hold promise in reducing downstream costs. As in many cases of patient-centric wearable health technology, more information may not necessarily be better information and may not translate into improved patient outcomes.

5. This technology will require a significant audiovisual upgrade (and expenditure) and a robust WiFi connection (in a leaded cath lab/operating room), a routine WiFi connection would just not be enough. Even with robust WiFi, it would still be difficult to support video conferencing for an extended period of time.

6. Technical limitations like a short battery life, a sidearm CPU that would get uncomfortably hot are still to be worked out.

8. Conclusions

Wearable health technologies may provide the “smart” technological platform and seem to be future of interventional medicine including cardiology. However, prior to widespread uptake of these wearable devices, a more thorough evaluation of the practicality, feasibility, and clinical implications of their use is mandated.

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