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iMedEd: The Role of Mobile Health Technologies in Medical Education

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Abstract

Mobile health (mHealth) technologies have experienced a recent surge in attention because of their potential to transform the delivery of health care. This enthusiasm is partly due to the near ubiquity of smartphones and tablets among clinicians, as well as to the stream of mobile medical apps and devices being created. While much discussion has been devoted to how these tools will impact the practice of medicine, surprisingly little has been written on the role these technologies will play in medical education. In this commentary the authors describe the opportunities, applications, and challenges of mHealth apps and devices in medical education, and argue that medical schools should make efforts to integrate these technologies into their curricula. By not doing so, medical educators risk producing a generation of clinicians underprepared for the changing realities of medical practice brought on by mobile health technologies.

In the last year, mobile health (mHealth) technologies have experienced a surge in attention because of their potential to transform the delivery of health care[1]. This enthusiasm is partly due to the near ubiquity of smartphones and tablets among clinicians, as well as to the stream of mobile medical apps and devices being created[2]. While much discussion has been devoted to how these tools will impact the practice of medicine, surprisingly little has been written on the role these technologies will play in medical education. In this commentary we describe opportunities, applications, and challenges of mHealth apps and devices in medical education, and argue that medical schools should make efforts to integrate these technologies into their curricula.

mHealth Opportunities

A glimpse at a medical student's smartphone will reveal that students are already using a number of apps in their education, including anatomical atlases, reference tools, and question banks[3]. Though these types of study aids are currently the more popular mHealth

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tools, we are focused on the growing number of mobile apps and "adds" – hardware attachments or wearables – that are capable of collecting *clinically relevant information*. These include smartphone-based scales, thermometers, sphygmomanometers, pulse oximeters, spirometers, breathalyzers, urinalysis, electrocardiography (ECG) monitors, electroencephalography (EEG) headsets, stethoscopes, otoscopes, ophthalmoscopes, and even ultrasound probes[4].

Most of these mHealth tools have been approved by the U.S. Food and Drug Administration and many have been the subject of prospective clinical trials by institutions such as University of California San Francisco School and Medicine and Scripps Research Institute[5]. Some are already being incorporated into the daily workflow by clinicians and patients alike.

To our knowledge, however, few mHealth tools, if any, have entered the realm of medical school education. We argue that these mHealth technologies are currently overlooked opportunities for medical education in three key areas: decreased costs, ease of use, and data mobility.

Decreased costs

Many components of traditional medical devices, such as display screens and batteries, are now built into smartphones and tablets, and these mobile-based devices can be manufactured at a lower cost, making them more accessible to students and institutions for educational purposes.

Consider as an example the otoscope. Traditional otoscopes need a light source and battery, whereas the smartphone-based otoscope does not because the phone itself provides these components via the camera/flash hardware. Thus, one only needs the otoscope adaptor case to use their smartphone as an otoscope. The same functionality also applies to the smartphone-based ECG and ultrasound. Because a large fraction of U.S. medical school students own personal smartphones, the potential cost of adding mHealth apps and devices to the curriculum would be further reduced. Some of these peripheral devices, such as the sphygmomanometer and pulse oximeter, also interface with iPads, which many medical institutions are already providing to their students[6].

Ease of use

Given that many mHealth apps and devices are intended for patients or family members, they are often simple to use. This enables the user to focus on data interpretation instead of data collection. For example, the pulse oximeter and sphygmomanometer are "plug-and-play," meaning that they can be connected to a smartphone or tablet that then automatically opens an app, guiding the user through simple steps leading to a clinically relevant recording. Furthermore, the current generation of trainees is largely familiar with mobile devices and the process of interacting with the various app stores to find helpful tools for daily work or entertainment.

Data mobility

One of the most discussed trends in education, the "flipped classroom," enables *remote* and *asynchronous* learning. mHealth apps and devices may also be used for this purpose. Clinically relevant data collected by the trainee can be stored on the device, sent directly to a preceptor, and/or uploaded to a cloud server, further abstracting the data collection from the data interpretation, and facilitating more efficient learning opportunities.

For example, a group of medical students may be provided with a smartphone-based ophthalmoscope and tasked to collect and transmit optic fundus images of each other the day before an ophthalmology preceptor teaches them how to interpret these findings. The convenience of mHealth technologies may facilitate a return to a day when medical trainees are taught how to perform urinalysis or histology and in doing so, develop an enhanced appreciation and understanding for the diagnostic process and reliability of these exams. It is also important to mention that data mobility and ease of collection may turn patients into their own reliable data collectors, allowing the practicing clinician to focus on data interpretation and management. While this is a very promising opportunity of mHealth technologies, the portability of data also presents unique challenges, which we discuss below.

Applications of mHealth

The potential applications of mHealth technologies closely align to the tripartite goals pursued by academic medical institutions: clinical, research, and educational. The smartphone-based ultrasound, for example, may be applied clinically for the examination and diagnosis of patients; in the research environment to answer both basic and clinical questions; and in the educational setting to allow trainees to have earlier and more frequent access to sonography collection and interpretation[7].

These accessible and "hands-on" tools may appeal to many different learning styles as described by Kolb's Model of Experiential Learning[8]. Kolb's framework divides the learning cycle into two parts: knowing and understanding. Knowledge may come from abstract conceptualization, for example through reading or lectures, as well as concrete experience, such as simulations or real patient encounters. Understanding is the ability to apply such knowledge and can be reached through reflective observation or active experimentation, or "learning by doing."

Within the categories of concrete experience and active experimentation, mHealth technologies can improve preceptor-trainee engagement and increase understanding of clinical data.

Preceptor-trainee engagement

Though one of us (S.M.G) was trained to do an ophthalmic fundus exam by an experienced ophthalmologist at the Wilmer Eye Institute, the exam was difficult to perform and a majority of the students were unable to locate the optic disc, let alone interpret it. Based on observation and anecdotes from trainees at other institutions, this was not an unusual experience. Traditional modes of instruction follow the "see one, do one, teach one" model,

even though the initial step of "seeing one" may not be very clear. In particular this is the case with maneuvers involving asynchronous visualization or auscultation – such as using an ophthalmoscope, otoscope, or stethoscope.

Smartphone- and tablet-based devices allow for the real-time projection or stored recording of images, such as optic fundi and tympanic membranes, as well as sounds, such as respiration or phonocardiograms, thus allowing for enhanced guidance in the collection and interpretation of these findings[9]. As mentioned earlier this teaching could even take place remotely, enabling enhanced and interactive "telemedical education."[10]

Understanding of clinical data

Because mHealth devices and apps are less expensive, easier to use, and highly portable, trainees can use them more frequently and in various settings to develop an increased understanding of clinical data. For example, students may use the smartphone ECG or even EEG to determine how their pulse, heart rhythm, and sleep patterns vary based on factors such as exercise and caffeine consumption. Trainees may also ask their patients for permission to use these devices in order to develop an understanding of normal versus abnormal. For example, the iPhone spirometry app delivers a two-minute test that can be quickly performed at outpatient check-ups, thus providing insight into how indicators such as FEV1 and FVC correlate with gross symptoms and change over time. In this way students may develop a more intimate understanding of clinical data, though collecting data on actual patients is not without potential hurdles, as discussed below.

An additional benefit and, perhaps, responsibility of applying these mHealth tools to medical education is making trainees aware of emerging technologies that may be highly relevant to their future practices. Of course the pace of technology development often exceeds that of validation and thus there are four important areas to address before widespread adoption is possible: Compliance, Accessibility, Reimbursement, and Evidence (CARE).

Challenges of mHealth

Potential hurdles to mobile technologies in clinical practice have been described elsewhere[11] and may include disrupted clinical communication, unclear reimbursement models, social disengagement, and breached confidentiality. Similar challenges around patient privacy, cost, and evidence may arise as these apps and devices are increasingly adopted in the educational setting. In addition to these three shared challenges, there are two other potential challenges specific to medical education: technology dependence and hypochondriasis.

Patient privacy

Security is an issue common to all institutions that allow their employees – or students – to BYOD, or "Bring Your Own Device." Since we are still in the early days of mHealth technologies, it will be important to ensure that apps that store and transmit patient data are HIPAA-compliant. This obstacle may be addressed by ensuring that identifiable patient information is not collected and that the findings are deleted following the encounter.

Cost

While trainees often own personal smartphones, the question remains whether it will be up to the trainee or the institution to purchase apps and devices for educational use. This may not be a significant challenge given that many institutions already purchase iPads and stethoscopes for their students, as well as traditional medical devices for simulation centers. At two medical schools – I cahn School of Medicine at Mount Sinai and the University of South Carolina School of Medicine – each student is provided with pocket ultrasound devices (Vscans) to enhance their ability to perform physical exams at the hospital bedside and in outpatient clinics. With considerable interest of the device manufacturers to get mHealth tools into the hands of the next generation of clinicians, the cost of such educational initiatives is remarkably lower than would be anticipated.

Evidence

As mentioned earlier, many mHealth technologies are undergoing clinical trials to determine if they improve outcomes while reducing costs. It will be important to have similar studies on their efficacy in improving educational outcomes. There also should be detailed reports of the sensitivity and specificity of diagnostic tests using these mHealth apps and devices, so that clinical students may have a solid understanding of when to use which tool.

Technology dependence

Technologies of convenience often become technologies of dependence. How do we ensure that students will still be capable of clinical data collection and interpretation in the absence of these technologies? Others have persuasively argued that overreliance on technology can stunt a trainee's development into a competent and independent clinician, such that he or she cannot practice medicine without the appropriate tools[12]. It will be important to ensure that mHealth apps and devices do not replace but rather augment the acquisition of clinical skills; one additional reason curricula should develop around their appropriate use.

Hypochondriasis

Clinical students are often thought to suffer from recency and confirmation bias, leading to self-misdiagnosis. How may tools that enable on-demand clinical data collection affect this? Research suggests that though "medical studentitis" is a widely held belief it is not one with supporting evidence[13].

As with many other technologies – from social media to reference apps – these mHealth technologies will need to be responsibly integrated into the curriculum and regularly assessed to ensure that the potential obstacles above do not manifest in harmful ways.

Conclusion

Mobile apps and devices present a number of distinct opportunities for medical education, as well as some interesting challenges that must be addressed. Given that these technologies are becoming increasingly relevant in clinical settings, it will be important for medical schools to ensure their trainees are gaining proper exposure, starting with the applications described above. By not doing so, we risk producing a generation of clinicians

underprepared for the changing realities of medical practice brought on by mHealth technologies.

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