The scope of mobile devices in health care and medical education

Devi Prasad Mohapatra, Madhusmita M. Mohapatra, Ravi Kumar Chittoria, Meethale Thiruvoth Friji, Shivakumar Dinesh Kumar

Departments of Plastic Surgery and Pulmonary Medicine, Jawaharlal Institute of Postgraduate Medical Education and Research (JIPMER), Pondicherry, India

ABSTRACT

The use of mobile Internet devices (MIDs), smartphones, and proprietary software applications (also known as “apps” in short) can improve communication among medical caregivers. The utilization of these mobile technologies has further transformed health care, communications, commerce, education, and entertainment, among other fields. Newer technologies have the potential to be adapted for improvement in health care and medical education in general. Mobile technology is one of the latest strings of technological innovations that can be integrated into medical education. M-learning (the use of mobile technologies in teaching/training) has been used as a complimentary resource for interaction between students and instructors for motivation and learning. The main uses described for mobile devices in medical education can be divided into (a) information management (IM), (b) communication, and (c) time management. The field of mobile technology in health-care services and medical education is quite new and throws open ample opportunities for researchers to conduct further studies. Educators in medicine, dermatology, and public health as well as practicing physicians and surgeons need to embrace this new technology, study its further adoption, and assist in the responsible integration of these devices into the art and practice of medicine.

Key words: Applications, medical education, mobile education, smartphones

INTRODUCTION

The use of mobile internet devices (MIDs), smartphones, and proprietary software applications (also known as “apps” in short) can improve communication among medical caregivers. Wani et al. have highlighted the efficacy of communication using WhatsApp in plastic surgery. We would like to elaborate upon a wider scope of usage of these MIDs in improving health care as well as medical education.

There has been an accumulative growth in information technology in the last few decades. The utilization of these mobile technologies has further transformed health care, communications, commerce, education, and entertainment, among other fields. Newer technologies have the potential to be adapted for improvement in health care and medical education for medical sciences in general. Due to this reason, mobile devices are increasingly being used since the past few years, reflecting the growth in technology that has enhanced access to information. Thus, the future of health care, medicine, and medical education depends upon technological innovations as well as the capability of future generations of physicians, medical teachers, and even medical students to adapt to newer technologies.
TERMINOLOGY

Terminologies like smartphones, MIDs, personal digital assistants (PDAs), apps, tablets, mobile operating systems (mobile OSs), cloud computing, etc. have become fairly common parlance among the new generations of technology-driven health caregivers. A brief introduction to the terminology in the context of mobile technology is essential in improving the understanding.

Mobile device
Mobile device is also known as a handheld device, handheld computer, or simply handheld. It is a small, handheld computing device, having a display screen with touch input and sometimes a miniature keyboard. The emergence of technological sophistication has brought about extremely lightweight devices.

MID
A MID is a multimedia-capable mobile device providing wireless Internet access. It allows two-way communication with real-time sharing of data and location-based services.

PDA
A PDA is also known as a palmtop computer or a personal data assistant. It is a mobile device that functions mainly as a personal information manager. With the growing sophistication of mobile devices, these are becoming obsolete.

Mobile phone
Mobile phone is also known as a cellular phone, cell phone, hand phone, or simply a mobile. It is a device that can be used to make and receive telephone calls over a radio link while moving around a wide geographical area. In addition to telephony, modern mobile phones support services such as text messaging/short message service (SMS), multimedia messaging service (MMS), e-mail, Internet access, short-range wireless communications (e.g., infrared, Bluetooth) apart from business applications, gaming, and photography.

Smartphone
Smartphones are mobile phones built on a mobile OS, with more advanced computational capability and connectivity. The first smartphones combined the functions of a PDA with a mobile phone. Newer models perform as portable media players, low-end compact digital cameras, pocket video cameras, and Global Positioning System (GPS) navigation units combined to form one multi-use device. Further, modern smartphones include high-resolution touchscreens and web browsers that display standard web pages as well as mobile-optimized sites. High-speed Internet data access is provided by either Wi-Fi or mobile broadband.

Tablet
A tablet computer, also known as a tablet, is a one-piece mobile computer. These devices have a touchscreen, which can be controlled with finger (or stylus) and supported by the use of one or more physical context-sensitive buttons and are guided by the input from one or more accelerometers. Accelerometers refer to a mobile component that can measure the tilting motion and orientation of the mobile device. These also come equipped with touch-sensitive hideable onscreen keyboards. They are available in a variety of sizes like 7 in and 10 in, which refer to the diagonal screen size.

Mobile OS
Mobile OS, also known as mobile operating system, is an OS software that operates a smartphone, tablet, PDA, or other digital mobile devices. Modern mobile OSs are responsible for the multifaceted performance capabilities of smartphones. At present, multiple OSs for mobile and handheld devices are available [Table 1].

Apps
These are application software, used in handheld computing devices having an OS. They are programs developed to run on the device for a specific purpose.[3] These can be either native apps or web apps. The native apps depend on the OS and can be used offline. The web apps are those applications that are present on the web and can be accessed through the mobile Internet browser (e.g., mobile website versions of a standard website). The web apps need network access and work only when one is online. With the improvement in mobile software technology, “hybrid apps” are becoming more common. The hybrid apps are advanced versions of web apps that are installed on the MID and have the capabilities to use the native apps of the device.

G
G stands for generations of wireless telecom connectivity. Accordingly, there are 1G, 2G, 3G, and 4G technologies, 4G being the most advanced technology in general usage at present. Research for the development of 5G technology is being carried out worldwide.

Cloud computing
Cloud computing is the use of hardware and software resources, which are available in a remote location and accessible over the Internet.

USE OF MOBILE DEVICES IN HEALTH CARE

Recent review studies have highlighted the scope and the future prospects of mobile devices in health management
and health care.[3] Usage of mobile technology in health care can be broadly grouped into two categories, the first being communication and the second, care. Communication could be between physicians and patients, physicians and health-care workers, or among physicians themselves. Communication between physicians and patients would be typically related to appointment scheduling, advice regarding procedures/medications, or adverse effects of the same. Interphysician communication is related to the analysis of patient care or difficult case scenarios or discussion of a treatment plan. The communication could be voice-based or text-based. Voice-based communication is made either through the standard phone calling feature of the mobile device that is facilitated by the use of a subscriber identity module (SIM) card provided by the cellular service provider, or through conversation over the Internet using a software application with (e.g., Skype) or without video calling. Text-based communication is done through SMS and typically consists of appointment schedule reminders or medication and health-care advice as well as reminders. Internet-based text communications can be done using software applications like WhatsApp[3] that also has the advantage of the ability to send pictures for discussion and treatment planning among physicians. These advanced communication capabilities of MIDs have the potential to be utilized for telemedicine services involving patient data transmission from remote areas to a telemedicine center, which could usually be a tertiary hospital. Care of the patient could be provided through newer mobile devices by software applications that:

a. Can provide diagnosis and treatment recommendations through a patient-specific analysis,
b. Maintain patient health records (e.g., MediTouch),
c. Provide access to evidence-based patient-care guidelines (e.g., UpToDate), and
d. Can transform the mobile phone into a medical device with the addition of an attachment [e.g., AliveCor’s AliveECG app, which can convert the mobile phone into an electrocardiogram (ECG) monitor].

Few studies have been carried out for assessing the diagnostic ability of these software and devices.[4] They have shown excellent correlation between the smartphone ECG software recording versus the standard 12-lead ECG recordings.

Utilization of mobile devices for health care in specialties like plastic surgery and dermatology could be for teleconsultations for burns, treatment planning of congenital facial deformities [Figures 1a-c], acute wounds [Figures 1d-f], chronic wounds, lymphedema, limb anomalies, cutaneous lesions, and malformations. Recent studies have shown the use of Internet-based instant messaging applications in communication between physicians.[1] Plastic surgery simulator applications are available for mobile platforms, which are basically photo morphing software apps and can help in counseling the patients about the possible outcomes of a procedure. Studies have demonstrated the use of apps (e.g., OsiriX) to intraoperatively analyze the Digital Imaging and Communications in Medicine (DICOM) images, over a tablet during surgery.[5] Novel uses of smartphones having these apps and hardware attachments have been described in ophthalmology. These apps are being used for visual acuity testing, color blindness testing, and also for fundus photography using a photo adapter device over the smartphone (e.g., iEXAMINER).[6]

Table 1: Comparison of most common mobile OSs in use

| O/Ss   | iOS          | Android                  | Windows phone | BlackBerry OS |
|--------|--------------|--------------------------|---------------|---------------|
| Company| Apple Inc.   | Open Handset Alliance/Google| Microsoft     | BlackBerry    |
| Latest version (as of February 2015) | 8.1.3          | 5.0.2                    | 8.1           | 10.3.1.1565   |
| Licence| Proprietary except for open source components | Free except proprietary components | Proprietary | Proprietary |
| OS family | Darwin | Linux                    | Windows NT8+ | QNX           |
| Applications store | apple.com/itunes | play.google.com/apps | windows.microsoft.com/en-IN/windows-8/apps | appworld.blackberry.com |
| Common devices | iPhone, iPad | Samsung Galaxy Note, Google Nexus | Nokia Lumia, Microsoft Surface tab | Blackberry Z10 |
| Medical applications Type A | √√√√ | √√√√ | √√ | √√ |
| Medical applications Type B | √√√√ | √√√√ | √ | √√ |
| Approximate number of medical applications available | 24,970 apps | 15,965 apps | Data not available | Data not available |

*Android and iOS have dedicated medical apps. BlackBerry has limited medical apps.
specific applications can be produced for guidance of treatment schedules, physiotherapy regimens following reconstructive surgery, or speech therapy regimens for cleft palate patients. These applications can be designed by the physicians themselves, based on their practice and requirements.

USE OF MOBILE DEVICES IN MEDICAL EDUCATION

Mobile technology is one of the latest strings of technological innovations that can be integrated into medical education. M-learning (the use of mobile technologies in teaching/training) has been used as a complementary resource for interaction between students and instructors for motivation and learning.[7] Students view m-learning as having an important supplementary role to e-learning.[8] Studies show that mobile technology creates content generated by the community and a community of learners, and so creates a more communicative or interactive setting rather than a traditional content-based setting.[9] Mobile technologies have been found to be convenient, flexible, and cost-efficient when compared to paper-based technologies.[10]

The main uses described for mobile devices in medical education can be divided into:

a. Information management (IM),
b. Communication,

c. Time management.[10]

We have suggested a classification of medical apps useful in medical education according to their utility [Table 2].

| Type A (Apps with additional medical/educational uses) | Type B (Medical apps (apps with specific medical uses)) |
|--------------------------------------------------------|--------------------------------------------------------|
| Note taking                                            | Medication guides                                      |
| Evernote                                               | Epocrates                                               |
| Skitch                                                 | Omnio                                                  |
| S Note                                                 | Clinical handbooks and textbooks                       |
| File organising                                       | Washington Manual Handbook                             |
| AndroZip                                               | Harrison’s Textbook of Medicine                        |
| Imaging                                                | Speciality-specific reference                          |
| Camera                                                 | Neurology reference app                                 |
| Voice recording                                        | iRadiology                                              |
| Voice recorder                                         | Discipline-specific reference                          |
| Video player                                           | Netter’s Anatomy Atlas                                  |
| YouTube                                                | CME apps and question banks                            |
| Cloud storage                                          | Medscape CME                                           |
| Dropbox                                                | USMLE question bank                                     |
| OneDrive                                               | Clinical examination apps                              |
| SkyDrive                                               | Visual acuity test                                     |
| Web browser                                            | Color blindness test                                   |
| Opera                                                  | Medical calculators                                     |
| Google Chrome                                          | MedCalc                                                |
| Schedule organisers and “Tasks To Do” App             | Apps with diagnostic capabilities                       |
| S Planner                                              | AliveECG                                               |
| Group communication                                    | iStethoscope                                           |
| WhatsApp                                               | Simulation apps                                        |
| ChatOn                                                 | Plastic Surgery Simulator                               |
| Google+ Hangout                                        | Touch Surgery                                          |

The list in this table is indicative. A large number of apps are available in each of the categories across various OSs.

Figure 1: (a-c) Figure demonstrating the use of mobile software application to show the markings of cleft lip repair and postoperative result. (Device: Samsung Galaxy Note 2 (Samsung Electronics, South Korea), apps used: Camera, Photo Editor) (d-f) Figure demonstrating the use of mobile software application to provide intraoperative planning in reconstructive surgery and postoperative result (Device: Samsung Galaxy Note 2 (Samsung Electronics, South Korea) with Stylus, apps used: Camera, Photo Editor, WhatsApp)
storage applications (e.g., Dropbox) has further facilitated information storage and retrieval. Internet-based resources like online repository of video clips (e.g., YouTube) provide a platform for information storage and instructional resources. These can complement traditional teaching and also act as sources of reliable online medical information for patients.

2. Retrieval of information: Other means of retrieval and access of information is in the form of online textbooks, apps-based text [Figure 2a] and reference books, medical podcasts, medical calculators, and online lectures. In addition, these can be used to access online journals and get medical news online. Software archives are packed with multimedia-rich educational applications, covering virtually every biomedical subject. Certified health care providers can have access to online continuing medical education (CME) to revalidate their credentials through these mobile devices. Mobile devices, including smartphones, can serve highly customized educational and scientific content through Rich Site Summary (RSS) feeds and social media.

Studies have showed that smartphones facilitate student learning by providing immediate access to key facts, allowing learning in the context (e.g., learning clinical diagnosis and treatment protocols in the wards by using applications like Medscape) and by repetition, supplementing other ways of learning, and making optimal use of the available time. The advantages of mobile devices-based medical education were identified as portability, flexibility, access to multimedia, and the ability to look up information quickly.

b. Communication: True to their primary purpose, these devices help in communication between peers, teachers, and other members of the medical education team about patient care using telephone, text messages, e-mail, multimedia messages, and teleconferencing. SMS-based schedule reminders have been found to be useful in increasing student participation in educational activities. Text-to-speech, speech-to-text, and speech-to-speech translations have become a reality. How these could be optimally used for improving cognitive learning among medical students remains to be seen.

c. Time management: These can be based on the use of calendar-based apps and can help students and teachers by providing access to schedules of the medical curriculum.

A few disadvantages have been identified with the use of mobile-based devices in medical education. Studies have shown that initially the m-learning applications can cause inhibition and anxiety due to the phone keypad and the screen. These anxieties seem to be addressed by newer generations of smartphones, which have larger screens and improvised input devices like the stylus that can enable data entry by free hand too [Figure 2b]:

a. Superficial learning: Some researchers have demonstrated apprehension that these devices might enable learners to access information very rapidly. This may inhibit the “internalization of knowledge,” which is a traditional part of medical education, leading to a potential for “superficial learning.”

b. Trusting information sources: Concerns have been shown about how learners should navigate the swarm of information available from the devices, how they should find “good applications,” and how they would know if the information provided was of high quality and validated.

c. Distraction: Mobile computing devices have been accounted for causing distraction from the normal activities of learners in classrooms and clinical settings. This could be in the form of receiving a call or text message, e-mail, or access to social networking sites on the Internet.

d. Concerns about information privacy: Concerns have been expressed about the possible implications for privacy and confidentiality when material related to patients is stored in one’s personal device.

e. Expenses: The cost of mobile devices, paid apps, Internet usage charges, mobile data, and talktime charges all add up to the overall expenses of the learner. In addition, the creation of apps and Internet-based training modules seem to be expensive at present. At the same time, every student cannot
Some researchers have suggested that synchronous sharing may not be possible as a result of unreliable, unstable, or unavailable mobile access. There are hardware-based concerns like battery life, which would limit their uses. Considering these disadvantages and perceived benefits, researchers have suggested that mobile technology be used only as a complimentary tool, in addition to the primary mode of education. The advantages of the use of mobile technology in health care and medical education include rapid decision-making, increased accessibility to data, improved clinical knowledge and efficiency, and an overall improved productivity. With the increase in popularity, number, and applications of mobile devices and apps in health care, the United States Food and Drug Administration (USFDA) has released guidelines regulating the usage of a number of these mobile medical apps. Similar guidelines need to be enforced in all countries to ensure the proper usage of apps in health care and medical education.

SCOPES OF RESEARCH FOR MOBILE APPLICATIONS IN MEDICINE

The field of mobile technology in health-care services and medical education is quite new and throws open ample opportunities for researchers to conduct further studies. These could be related to other aspects of the use of these devices, for example, the results of early or late adoption of the devices by learners, the use of specific applications in specific medical specialties like plastic and reconstructive surgeries, and the effects of the devices on patterns of communication and information-sharing among health care providers. Studies need to be carried out to assess the utility of mobile devices in other domains of education, i.e., affective and psychomotor domains. Cost-benefit analysis and comparisons with the existing health management systems or teaching-learning methodologies as well as well designed randomized controlled trials to demonstrate the efficacy of these newer technologies are needed to ensure their acceptance as a mainstream support in medical education and health care. High quality, multicentered, and controlled trials regarding the use of mobile devices in medicine, especially in developing and resource-poor nations need to be carried out.