SMARTPHONE USAGE AMONG MEDICAL RESIDENTS
A CROSS SECTIONAL SURVEY

By

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CERTIFICATE OF APPROVAL

This is to certify that the Master's Capstone Project of

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"Smartphone Use among Medical Residents:
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Has been approved

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Abstract

Background: Smartphones have great potential for medical education as they allow health care providers and students to access resources efficiently at the right time at the point-of-care to help in informed decision-making.

Objective: To evaluate the prevalence of smartphone usage among medical residents and to explore their attitudes, perceptions and challenges they experience when using Smartphones in their academic and clinical practices.

Methods: This study was performed using cross sectional survey was conducted on all 133 residents in 17 different specialties across two large academic hospitals, with a total of 800 beds, including out-patient clinics in Riyadh, Saudi Arabia. The outcomes were measured by a web-based validated questionnaire that included smartphones platforms preferences, and their uses in general and medical practice, and the perception of confidentiality and safety impact of using smartphones for communication and accessing patient data.

Results: With a response rate of (101/133, 75.9%) and a mean age of 27.8 (SD 3.0) years, we found that (100/101, 99.05%) of participants were smartphone users with mean duration of use of 5.12 (SD 2.4) years, and a range from 1 to 12 years. A negative linear correlation was found between age and duration of age (P = 0.004). The most common operating system used by the participants was the iOS platform (55/101, 54.5%), and English was the most used language to operate residents' smartphones (96/100, 96.0%). Further scrutiny determined that "phone calls (88/101, 87.1%)", following chatting apps such as WhatsApp, LINE, were the most non-medical-practice communication, whereas medication references (83/101, 82.2%), medical references (80/101, 79.2%) and medical calculation (61/101, 60.4%) were the most commonly used medical-practice-related non-communication apps/tools among the respondents. Short battery life (84/92, 52.2%) was the most common technical difficulty, and distraction (28/92, 27.7%) was the most likely side effect of using a smartphone in medical practice.

Conclusions: Smartphone use among medical residents in various medical specialties has become almost universal in healthcare settings. This should alert academic institutes about proper utilization of these devices into the medical training and point-of-care decision-making, while at the same time ensuring patient's privacy.

Keywords

cell phones**;** smartphone; telemedicine; medical education; medical residencies; educational techniques; patient care; communication methods; WhatsApp; Saudi Arabia; point of care technology.

Introduction

Over the last two decades[1], smartphones have been evolving rapidly in functionality and propagation. Smartphones combine a cell phone with other features such as personal digital assistant, Internet browsing, email client, GPS navigation, touchscreen, motion sensor, Wi-Fi/4G connectivity, desktop synchronization, voice recognition, high-quality camera, large displays, mobile payment, as well as third party applications, commonly referred to as "apps" [2]. These functions turn the smartphone into a portable computer. They have great potential for medical education as it allows health care providers and students to access resources efficiently at the right time at the point-of-care to support better decision making for patients' care [3-7]. Faster processors, improved memory and long-life batteries in concert with highly efficient operating systems capable of advanced functions have paved the way for apps that are beneficial for both personal and work environments.

Smartphones in many ways are similar to Personal Digital Assistant (PDAs), which have been studied well in health care education [4, 8-13]. PDAs allowed health care providers to carry multiple references in their pocket, log clinical encounters and tally of clinical time. Whereas smartphones are newer technologies that include the features of PDAs, but with expanded functions such as cellular technology for communication, Internet connectivity and a wider range of specialized applications. Smartphones are able to connect to Internet resources; even when wireless networks are unavailable [14]. Today, numerous companies are manufacturing smartphones and they are one of the fastest growing sectors in the technology industry. Operating systems include, Google's Android, Apple's iOS, Research in Motion's BlackBerry, and Microsoft Windows Phone platform [15]. Each has a designated app distribution store where individual users can choose and download a variety of free and paid applications [16].

Healthcare workflow is highly mobile, encompassing multiple settings of care such as outpatient clinics, inpatient wards, emergency departments, operating theaters, intensive care units (ICUs), radiology departments, laboratories, etc. [3, 17, 18]. Consequently, working in the healthcare system requires extensive mobility of healthcare providers as well as communication and collaboration among different individuals, including their colleagues and patients. The medical resident's nature of work involves both, clinical as well as continuous educational assignment.

Today, smartphones serve a vital role in the practice of medicine, which includes patient monitoring and diagnostics to more efficient health education and communication.

The amount of research in the use of smartphone in medicine is rapidly growing, but there are very few high-quality studies answering questions about its use and impact on medical care and education [15, 19]. Therefore, a need to study the prevalence of smartphone uses among medical residents and to know their

attitudes, perceptions and feedback towards Smartphone uses in medical practices is highly warranted.

Methods

Study Design and instrument

This is a cross-sectional survey based study using a self-administered structured questionnaire in English language. The questionnaire included 22 validated questions distributed into the following sections: a) General demographic information, b) smartphone preferences, c) smartphone general uses d) smartphone medical-practice uses, e) smartphone learning/training uses, f) communication tools/apps uses and g) smartphones privacy and security issues.

Validity

The questions were generated based on literature review about smartphone uses among medical professionals and students [2, 4, 19-22]. Then, questions were drafted using the focus group technique utilizing the authors' personal and professional experiences. Three experts in informatics reviewed the questionnaire for content accuracy, validity and reliability. A pilot study was conducted, where the initial draft of the questionnaire was distributed to 30 professionals at King Khalid University Hospital (KKUH) intensive care unit. The aim of the pilot study was to ensure the understanding and applicability of each question. Notes from pilot respondents were taken and questions were modified accordingly. A Cronbach's alpha >0.6 was also recorded for the questionnaire during the pilot testing.

Subjects

Invitations to participate in the survey were sent to all of the 128 active residents enrolled in 17 different residency-training programs as per record of the two teaching hospitals described below. No residents were excluded from the study.

Settings

The study was conducted at King Khalid University Hospital (KKUH), Riyadh and King Abdul-Aziz University Hospital (KAUH), Riyadh. Both are affiliated to King Saud University, Riyadh, Saudi Arabia. These University hospitals are the largest tertiary care referral teaching hospitals in Riyadh, with a major primary health care facility and various specialized departments, which make them priority target for many medical students of the country for residency training. Thus, residents of these university hospitals represent a random sample of Riyadh city and urban centers of the country in general.

Data collection

We distributed the online questionnaire, via an email tool available at SurveyMonkey.com to the official email list of residents registered in the residency office in the two university hospitals during the period between January 2014 and April 2014. This web-based survey tool was chosen because it was more reachable by all residents in different departments, in addition to residents who could be

rotating outside the two hospitals, where it could be difficult to reach them through conventional paper surveys [23]. Two reminders were emailed to none-respondents in one-month apart period. Moreover, printed posters encouraging participation with a direct QR link to the survey website was also provided. Posters were distributed among the hospital departments to motivate the residents to participate in the survey. In addition, we emailed all of the 17 chief residents of different residency-training programs of the university hospitals along with the advertisement poster attached, which are mentioned above, to motivate all the residents to participate in the survey. A text messaging communication service, known as "Tawasol", which is a web based communication service used to communicate with KSU staff members via short text messages (SMS), was used to send SMS with the official link of the survey mentioned to the list of residents advising them to participate in the survey. Also, cold calling the residents individually, asking whether they have participated in the survey or not, and to motivate them to go to the survey was conducted.

Data analyses

The data were exported from SurveyMonkey website into the Statistical Package for Social Sciences computer (SPSS), using standardized entry codes. For all tests, statistical significance was set at $P<0.05$. Descriptive statistics were used to present means, standard deviations and percentage. In addition, student's t-test, z-proportional test and chi-squared tests were employed to compare group variables between gender and demographic variables. Furthermore, the relationships of resident's attitudes towards using smartphone's in medical practice were assessed using regression analysis based on gender, specialties and uses. The model was generated where all the selected variables were converted into binary data (disagree & agree). For multivariable analyses (regression), we constructed a dataset that had complete values for all relevant variables across observations, thereby, discarding the observations that had missing values for any of the variables involved in the regression analysis. The strategy was adopted to maintain comparability between models so that they could be developed from the same denominator. All analyses were conducted using SPSS version 21, 2013 (IBM SPSS, Inc., Chicago, IL).

Ethical statement

All participants were informed about the purpose of the study and their electronic consent for participation was taken in the first webpage of the electronic survey. All participants' data are maintained in a secure fashion by separating participants' identification and associated data. All of the data were analyzed as a total population in a manner that individual privacy is maintained. Institutional Review Board (IRB) approval for this study was taken from the College of Medicine, King Saud University, Riyadh, Saudi Arabia (13/3914/IRB), and the Oregon Health and Science University (OHSU) Research Integrity Office (IRB00010913).

Results

Response rate

Out of the 128 approached residents, 107 responded to the study (83.6%), six of them were excluded due to not answering all or most of the questions. However, surveys with missing answers that were not related to the main outcome variables were included in the analysis. Therefore, a total of (101/133, 78.9%) were analyzed.

Demographic Information

The mean age of participants was 27.8 years (SD 3.0), ranging from 23 to 38 years old. Most of the participants (59/101, 58.4%) were in the age group of less than 28 year old. On further comparison, there was no statistically significant difference found between males and females age groups (Chi-square test; *P*=0.186). Males were higher in number and consisted (63/101, 58.9%) of respondents. Majority of respondents were in their first year (PGY-1) of residency training (55/101, 54.5%); see (Table 1).

Table 1: Demographic features of the respondents

	Features	No	%
Age			
	Mean age (±SD)	27.8 (±3)	
	Below 28 year old	59	58.4%
	28 – 32	33	32.7%
	Above 32	9	8.9%
Gender			
	Male	63	62.4%
	Female	38	37.6%
Residency Level			
	PGY-1	55	54.5%
	PGY-2	13	12.9%
	PGY-3	13	12.9%
	PGY-4	7	6.9%
	PGY-5	8	7.9%
	Board eligible	5	5.0%
Specialty (Highest seven only)			
	Pediatrics	14	13.9%
	Internal medicine	12	11.9%
	General Surgery	11	10.9%
	Otorhinolaryngology	11	10.9%
	Ophthalmology	7	6.9%
	Family Medicine	6	5.9%
	Obstetrics & Gynecology	6	5.9%

Smartphone use

Almost all participants reported that they own and use smartphones (100/101, 99.0%), with mean duration of usage of 5.12 (SD 2.4) years, ranging from 1 to 12 years. The relationship between duration of usage and age was found to follow a linear relationship (duration = 11.6 – 0.234 x age). Although this relationship was statistically significant (ANOVA; $P = 0.004$), it was not found to be a strong one ($r = 0.282$).

The most prevalent language for operating residents' smartphones was English (96/100, 96.0%), although Arabic was the native language of most participants (97/101, 96.0%). The operating systems mostly used were iOS from Apple (55/101, 54.5%) followed by Android (54/101, 53.5%), Blackberry (5/101, 5.0%) and Windows Mobile (3/101, 3.0%) in total (Table 2). Further analysis showed that (16/101, 15.8%) of participants were using two different mobile platforms, and only one participant was using three different plat mobile platforms concurrently. Out of iOS users, (10/45, 22.2%) were also Android users. All of the three Windows Mobile users reported using other devices in the same time. Two of the users were Android users and the other was an iOS user.

Table 2: Smartphone preferences

		N	%
Do you have a smartphone?			
	Yes	95	99%
	No	1	1%
For how many years have you been using smartphone?			
	Mean (±SD)	5.18(±2)	
	Range	1 – 12 years	
Operating System			
	iOS	55	54.5%
	Android	54	53.5%
	BlackBerry	5	5.0%
	Windows	3	3.0%
Language you use on your smartphone			
	Arabic	4	4.0%
	English	96	96.0%

Participants voted for phone calls (88/101, 87.1%) and chatting apps (88/101, 87.1%) such as WhatsApp, LINE as the most non-medical-practice communication tools. Both of these tools, chatting apps (66/101, 65.3%) and phone calls (65/101,

64.4%), also ranked the highest prevalent in use as a medical practice-related communication tool as shown in Figure 1. In general, drug references (83/101, 82.2%); medical references (80/101, 79.2%) and medical calculation (61/101, 60.4%) were the most common used medical-practice-related non-communication apps/tools (Figure 2).

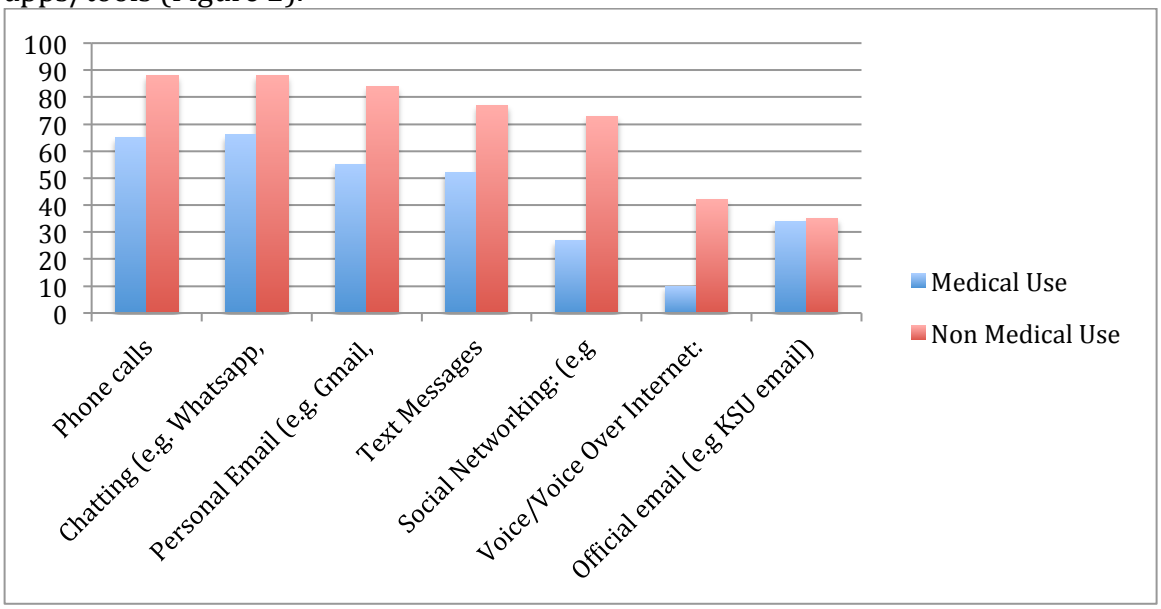

Figure 1: Medical and non-medical related usage of communication tools/apps

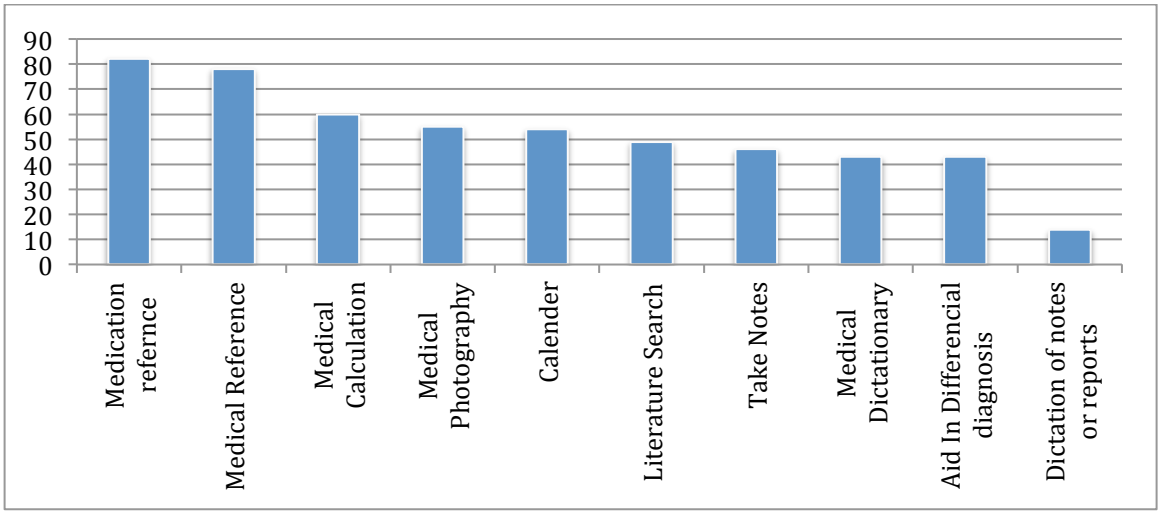

Figure 2: medical-practice-related non-communication apps/tools

Four out of five residents (73/92, 79.3%) declined awareness of smartphone medical apps provided by their institutes. There were no significant differences between males and females (Chi-square; *P*=0.347) or age groups (Chi-square; *P*=0.326). Most of the participants requested that their institutes should provide access to their patients' data via mobile version of electronic health records

(82/101, 81.2%), mobile drug references (67/101, 66.3%) and medical references (59/101, 58.4%). Almost all of the participants (91/92, 98.9%) agreed with the idea of integrating medical staff smartphones with hospital information system. Four out of five residents (73/92, 79.3%) supported replacing their current hospital pagers with hospital-provided smartphones.

Learning to use smartphone in medical practice

When investigating methods of learning how to use smartphones in medical practice, (84/101, 83.2%) of residents described themselves as self-learners, while (50/101, 49.5%) learned from their friends and colleagues, while others (27/101, 26.7%) learned from online resources such as YouTube and blogs. Only (7/101, 6.9%) were exposed to formal training such as workshops, lectures and seminars about medical uses of smartphones.

Advantages of using smartphones in medical practice

On further inspection of the usage of smartphones among medical residents for different medical practice uses, most of participants (82/92, 89.1%) reported that smartphones are useful for communication, where the remaining participants (10/92, 9.9%) provided a neutral answer. In addition, the participants reported that smartphones were useful in consultation (64/92, 69.6%), reviewing patient's lab/ radiology result (79/92, 85.9%) and critical alerts about patients (71/92, 77.2%). The highest observed reported harmful use of smartphones was communicating with patients and the patient's family (35/92, 38.0%).

Technical Difficulties

To find out about the technical difficulties users face on their smartphones, residents were asked to rate the situation/case they face with the technical use of smartphones. Results showed that over half of the participants, (84/92, 52.2%), noted that "Short Battery Life" was a challenge faced on a daily basis (Figure 3). On further inquiry about the side effects caused by using smartphones in medical practice, (28/92, 27.7%) reported that smartphones were distracting them from their work on daily basis (Figure 4).

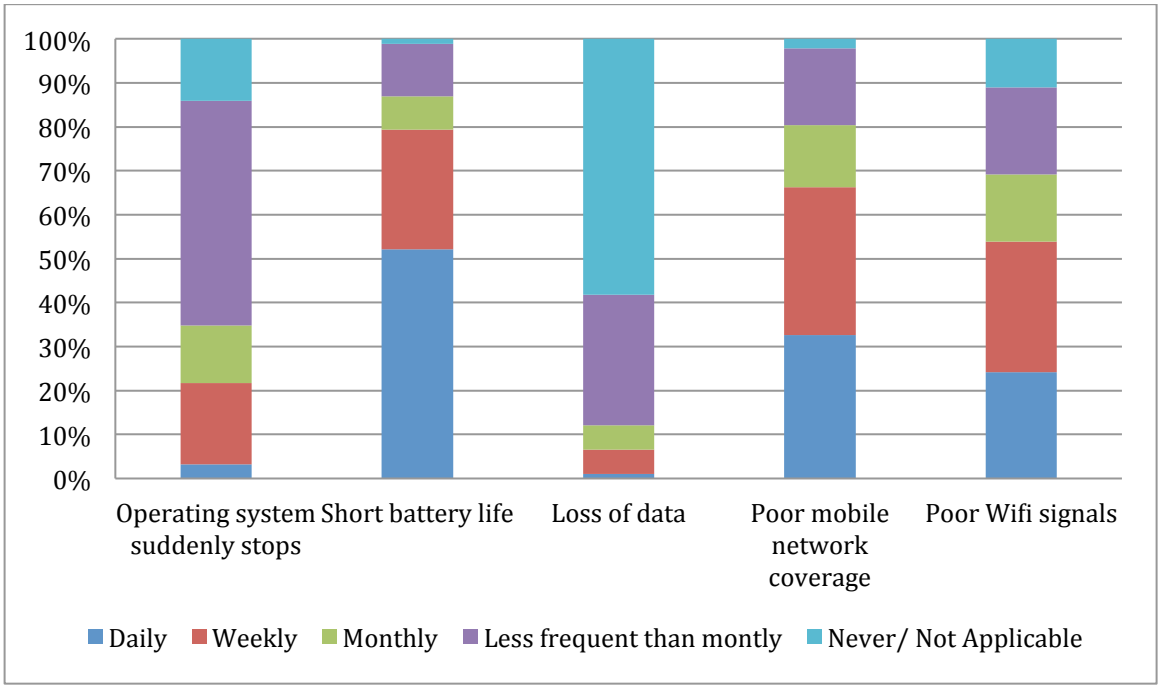

Figure 3: How frequently did you experience these technical problems on your smartphone?

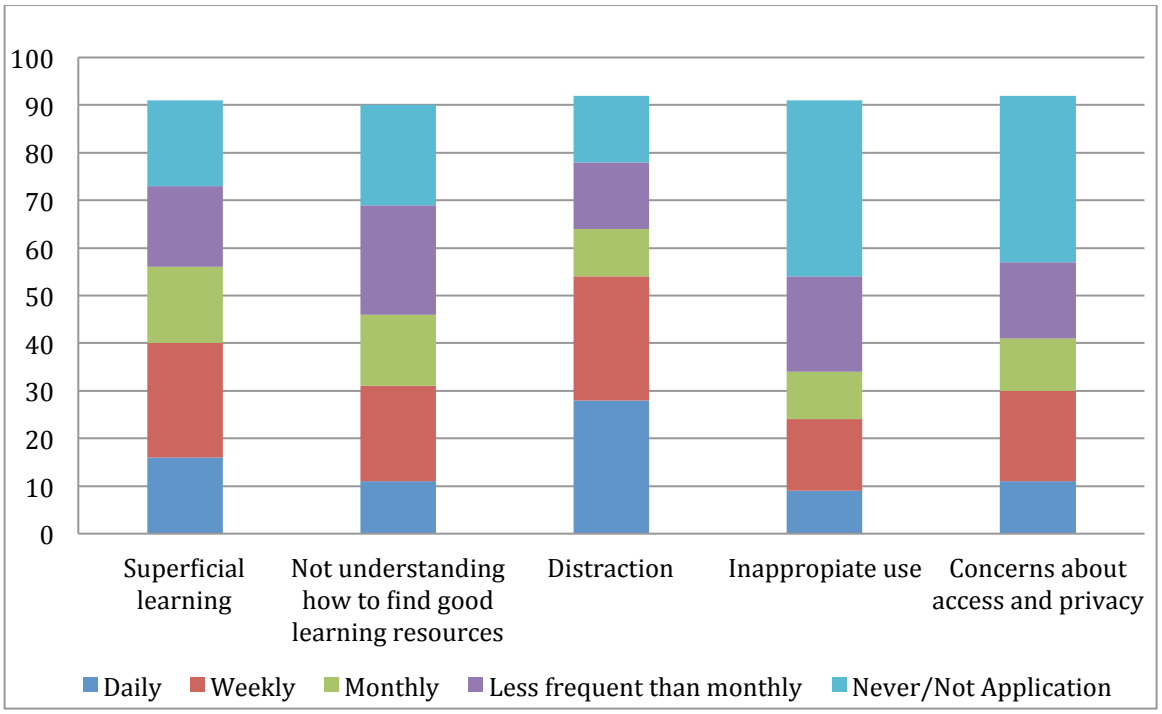

Figure 4: How frequently did you experience these challenges on your smartphone

Safety of using smartphones in medical practice

On investigating participants' opinion on how much secure are mobile communication apps/tools were, most of the participants thought that using official email (67/91, 73.6%) and personal email such as Gmail, Hotmail and Yahoo (51/92, 56.7%) was safe and secure in discussing patients' details. On the other hand, most participants reported social networks, such as Facebook and Twitter (77/92, 84.6%) were not safe to discuss patients' data (Figure 5). Females were more conservative in perceiving the safety of mobile chatting apps (χ^2_2=8.797, *P*=0.012, phi= 0.311) and Voice calls apps such as Skype (χ^2_2=9.743, *P*=0.008, phi= 0.327).

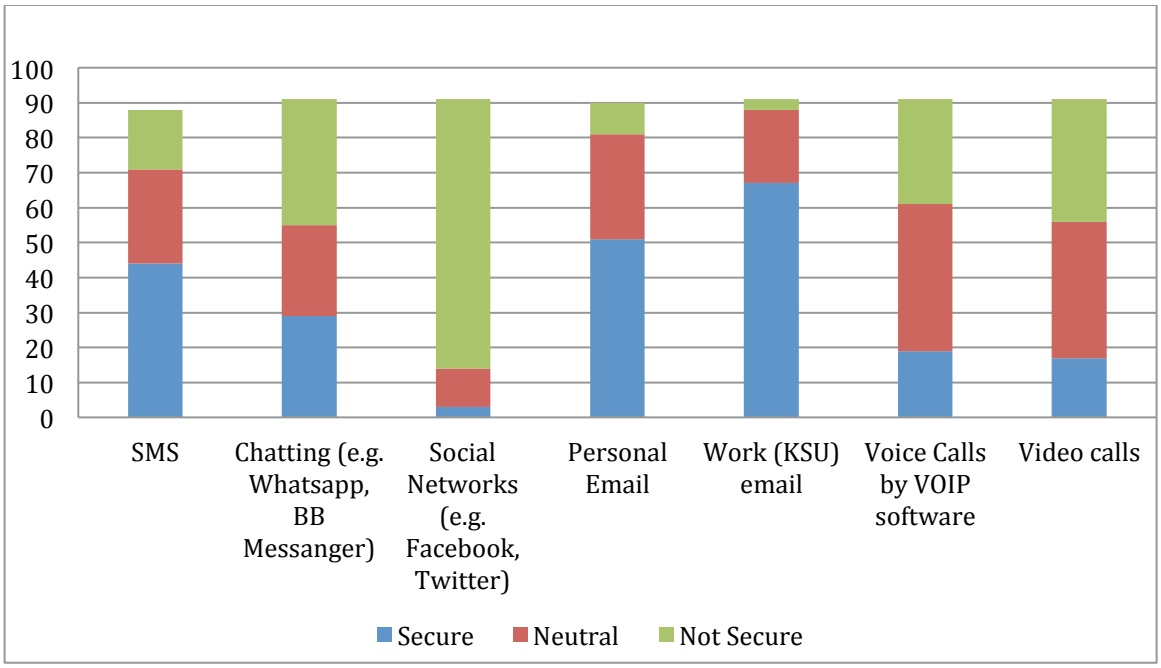

Figure 5: Are these communication apps/tools secure in discussing your patient's details?

Discussion

Due to the increased global adoption rate of mobile technology in medical practice [3], it could not be fair to compare the adoption rate of smartphone in this cross-sectional survey with previous studies. The adoption rate found (99%) in our survey is higher than pervious studies. A comparable study conducted in Riyadh a year prior to this study but in much smaller sample size showed an adoption rate of 45.5% among medical residents, with duration of usage between 5 to 9 years [13]. In the United States, the adoption rate plateaued since 2011 at a low- to mid-80 number in terms of physicians using it for professional purposes [24-26].

Although Android is the most common mobile platform in general population[27], Apple's iPhone iOS was more predominant in medical population, as was found in this study (54.5%) which is close to other international surveys (56%) [25].

Most commonly used apps

Emails are still the primary method of correspondence in health care [28] but are not that common in communication with patients [29, 30]. Similarly, communication apps, such as WhatsApp and line, usage is gradually wide spreading as found in this survey, and other literature [31-34]. Our survey showed an increasing prevalence of using mobile commercial emails and chatting apps for medical-practice related usage, which could be an alarming issue, especially, as 56.7% of our respondents perceived that it was safe to use their personal commercial emails to discuss their patients' data.

As proved in this study and other previous studies, drug information apps were the most commonly used applications used in clinical setting with a range of 72-100% of residents and physicians [13, 20, 26, 35]. Although our survey did not ask about the use of smartphone to take clinical photos, other recent studies have reported that the increasing number of physicians, especially dermatologists, capture and store patients' photos in their smartphones [34, 35].

Learning methods

In contrast to most of the other technologies applied in medical practice, vast-majority of smartphone users, as stated in this study and other studies[36], required only short time to self-learn how to use their smartphones for accessing point-of-care medical information at the bedside and engaging in self-directed learning.

Implications for practice

A very high percentage of participants (88.9% of male and 90.0% of female participants) strongly agreed that PDAs had improved their performance [13].

The use of handheld computers has improved patient documentation through more complete recording, fewer documentation errors and increased efficiency. Handheld computers provided easy access to clinical decision support systems and patient management systems, which improved decision making for patient care. Handheld computers saved time and gave earlier access to new information. There were also reports that handheld computers enhanced work patterns and efficiency[37].

Frequent challenges of smartphone adoption in medical practice found in our survey were limited-battery-life and low-network-coverage. Other studies have raised the awareness of other obstacles such as small screen size, potentially mistaken data input, viruses, magnetic interference with medical devices, hampering of patient-physician interactions, loss or theft, and breaches of data privacy and security [3].

Another distractions as an issue reported in a study is the interruption of a hospital clinician's primary task by the internally or externally initiated use of his/her smartphone [38].

Conclusion

Despite the distractions owing to the use of smartphones and the challenge of short-battery-life in their daily basis as technical issue, smartphone use among residents in different medical specialties has become ubiquitous in health care settings and plays a weighty role in their day-to-day medical practice. Residents do not use them for communication only, but mostly as a medical calculator and reference. Apple iOS operating system and English language are ranked the most used in residents' smartphones. Residents in the current study advocated to integrate their smartphones with hospital information system. They added to replace the pagers by hospital provided smartphone to access patient's data using hospital Electronic Health Record Systems.

This inclination of smartphone adoption in medical practice has potential risks to the security of patient data access and may lead to increased distractions in the medical practice. This should alert the academic institutes about proper utilization of these devices into the medical training and point-of-care decision-making, while at the same time ensuring patient's privacy.

Acknowledgements

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Conflicts of Interest

None declared.

Abbreviations

PDAs: Personal Digital Assistant
ICUs: Intensive care units
BB Messenger: Blackberry Messenger
VoIP: Voice over IP
KSU: King Saud University
KKUH: King Khalid University Hospital
KAUH: King Abdul-Aziz University Hospital
OHSU: Oregon Health and Science University
HIS: Hospital Information System
GPS: Global Positioning System
IRB: Institutional Review Board
CIs: Confidence Intervals

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