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Use of Smartphones for Clinical and Medical Education

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ABSTRACT

Introduction: Smartphones for clinical and medical education have been on the rise and show contribution to healthcare and healthcare providers. Smartphones in healthcare facilities has been examined for utilization and efficacy, however, although the advantages are abundant some healthcare facilities and providers are reluctant to change due to threat of mixing personal apps with clinical care applications, distraction to the provider using the smartphone which has led to medication errors followed by errors linked to procedures, treatments, or tests. The purpose of this research was to examine the effects of smartphones in a clinical setting and for medical education to determine the impact of smartphones.

Methodology: The methodology for this qualitative study was a literature review. Five electronic databases were pinpointed. The search was limited to articles published between 2010 and 2014 in the English language to keep the research study current, 41 sources were referenced for this literature review.

Results: This literature review examined several studies and states' the implementation and barriers of the use of smartphones for clinical and medical educational environment. Smartphones was demonstrated to have more positive effects than negative on the ability to enhance patient care and medical education. An abundance of resources were able to support the results to the findings.

Discussion/Conclusion: Utilization of smartphones is discussed as the newest and most effective and efficient method of patient care and medical education in the healthcare industry. Benefits of increased access and quality of care are further discussed.

Key Words: Clinical or educational were combined with the terms 'smartphone' and 'applications' or 'privacy' or 'mobility' or 'communication' or 'confidentiality' or 'quality' or 'care' as inclusion criteria.

INTRODUCTION

Smartphones have been on the rise and have contributed to communication across many ages (Jayanthi, 2014). The smartphone not only allows individuals to communicate through voice and text but it also allows internet access and geo-positioning which enhances its technological abilities. In addition, smartphones memory capacity, operating systems, and large screens; permit and creates multiple ways that are feasible, efficient, and effective to increase the use of smartphones in the healthcare industry and medical education (Boulos, Wheeler, Tavares, & Jones, 2011). Benefits of smartphones include: allowing patients and providers to be able to access information as they need it, educates patients, smartphones can also provide instruction on when and how often a patient can take medication. According to the authors, many applications remind patients of when doses need refilled, when a patient needs to take his or her prescription, these applications can all be accessed whenever patient needs to access this type of information (Dayer, 2013). Another advantage of the use of smartphones and smartphone apps in a clinical base setting has been smartphones are light, portable, and small with the ability to do everything a computer can do. In addition, applications of the smartphone are available for the providers to use and also can be an advantage in use of telemedicine (Bedno & Vicsik, 2014).

In a 2013 survey around 46% of medical physicians used smartphones, Ipad's, or tablets out of 1,400 surveyed. Top applications that were used included: Epocrates (free), Medscape (free), MedCalc ($1.99), Skyscape (free), Doximity (free), and Up to Date (free). Most of these

applications were free and allowed efficient and effective use of technology at the click of a finger (Glenn, 2013). Many applications are available for all targeted users that allow an efficient use of resources provided and these resources can contribute to the overall quality of care a patient receives (Mosa, Yoo, & Sheets, 2012). According to the authors, 45% of physicians claim that using smartphone, smartphone applications, and tablets have increased efficiency. It was also reported that 60% of physicians said that using smartphones, tablets, and other smartphone applications that it was much quicker to access patients Electronic Health Records (EHR) (Axium Blog, 2014).

Individuals are becoming very familiar with smartphones and smartphone applications. To embrace this technology, the ability of knowing how to use a smartphone is a major advantage in the clinical and medical education environment (Kolley, 2013). There are multiple applications for smartphones and other devices; some are free applications and others are necessary to purchase, and the quality of each application also varies. In addition, smartphones can be used in different areas of the medical field including: rehabilitation, patient monitoring, physicians, registration and many more (Ozdalga, & Ozdalga, 2012). According to a study in 2014, physicians that are using smartphone technology have the ability to capture focus assessments with a sonography and get pictures sent from a smartphone, allowing a much more efficient, effective, and faster delivery system in a clinical-based setting (Foltynski, Ladyzynski, & Wojcick, 2014). A literature review in 2014 of a study at various universities in Canada in which the data was used by medical trainees, graduate students, and other school administers to see the effects of using smartphones and other personal digital assistants in a clinical based setting and medical educational setting. Roughly, 73% of participants used the mobile device to find drug information, 58% of participants performed clinical calculations, and 52% to take

notes. In addition, residents and medical users accessed the smartphones more frequently and it was found that smartphones were being used in various ways to help answer clinical questions (Boruff & Storie, 2014).

The purpose of this research was to examine the effects of smartphones in a clinical setting and for medical education to determine the impact of smartphones.

METHODOLOGY

The hypothesis of this study was that smartphones are on a rapid increase, hospitals and medical educations that participate and adapt to this technology will be further advanced, able to detect and eliminate medical complications and decrease cost of care. The research methodology applied in examining the study was done through a qualitative literature review study.

The literature review was separated into three stages: (1) Literature Recognition and Compilation; (2) Literature Analysis and Evaluation; and (3) Literature Categorization. For this study a conceptual framework was used for literature categorization and analysis, see appendix for reference. After the adoption of smartphones in clinical and educational setting, the benefits and barriers are assessed which permits the process to restart to address barriers and evaluate benefits (see Figure 1).

Insert Figure 1

Stage 1: Literature Recognition and Compilation

      The search of literature was conducted using the search engines and academic databases accessible through Marshall University Libraries. Databases that were used to explore literature included PubMed, EBSCOhost, LexisNexis, SpringerLink and Google Scholar. In the search, the keywords 'clinical' or 'educational' were combined with the terms 'smartphone' and 'applications' or 'privacy' or 'mobility' or 'communication' or 'confidentiality' or 'quality' or 'care' as inclusion criteria. The search was limited to articles published between 2010 and 2014 in the English language, to keep the research study current. Given the shortage of scientifically peer-reviewed publications concerning the subject matter of the current study, articles from grey (literature from accredited magazines, newspapers, etc.) literature within the U.S. were referenced to supplement the academic literature.

Stage 2: Literature Analysis and Evaluation

      Literature was chosen for review on the basis of comparison between benefits and barriers of the use of smartphones in clinical and educational settings. Only primary and secondary data from literature written in the U.S. were included in this review. The primary step in establishing the relevancy of literature to the current study was to review the abstract of each respective article. If the material offered accurate information concerning the benefits and barriers of the use of smartphones in clinical and educational settings, the articles were determined to have satisfied the inclusion criteria. A combined total of 41 references were selected for this research study. The literature search was performed by TG, JV, and validated by AC, who acted as the second reader to review if articles met the inclusion criteria.

Stage 3: Literature Categorization

Relevant articles were selected after a review of the abstracts was performed. The findings of the literature review are shown in the following sections of the results using the information of each article.

RESULTS

Benefits of Smartphone Use

Convenience of Mobility

Smartphones have become pervasive in educational settings, particularly because they have been seen as "learn anywhere" resource for retrieving information and verifying if information is correct (Wallace, Clark, & White, 2012). A 2014 study conducted by Ventola, showed that medical students have been increasingly relying on smartphones as a "pocket brain" for fast and easy access to information that was needed (Ventola, 2014). Smartphones have evolved to devices that have obtained beneficial features and have become popular throughout the clinical and education fields of medicine see Table 1 for more details of Convenience of Mobility.

Enhanced Communication

Smartphones have been heavily adopted because of their use as an instant information source and have been seen to improve communication and efficiency in educational settings (Tran, et al, 2014). Patient self-reports rely on memory and are prone to bias and inaccurate information (Dayer, Heldenbrand, Anderson, Gubbins, & Martin, 2014). In a 2014 study that used WhatsApp, a messaging service, revealed the populations of an emergency surgical teams responded to 193 communication episodes in a median time of 7 minutes, the resident to 174

communication episodes (median 2 minutes), and interns to 177 communication episodes

(median 3 minutes) making communication fast and efficient (Johnston, et al, 2014). Smartphone

applications and mobility features such as, e-mail and voice calling and texting capabilities have

exponentially enhanced communication. See Table 1 for more details on how the use of

smartphones enhances communication.

Enhanced Quality of Care

Smartphones have been used in clinical settings to aid in diagnosis, prognosis, and

treatment of medical conditions, which have enhanced providers' overall quality of care.

Applications have been used to assist physicians in diagnosis by provided references to staged

systems, and have provided rapid access to published procedures in decision making (Whalen,

2013). In a 2014 study, Bierbrier, Lo, and Wu, evaluated 14 apps, which 13 functions for each

app were reviewed. The authors conducted 10 tests for accuracy on each function for a total of

1,240 tests. The majority of the functions tested on the selected apps, such as medical

calculators, were accurate in their results with an overall accuracy of 98.6% (17 errors in 1,240

tests), and 6 of 14 (43%) of the apps had 100% accuracy. Although 11 of 13 (85%) functions of

the apps had perfect accuracy, there were issues with two functions: the Child-Pugh scores and

Model for End-Stage Liver Disease (MELD) scores on 8 apps. Approximately half of the errors

were clinically significant resulting in a significant change in forecasting the course of MELD

(8/17, 47%) (Bierbrier, Lo, & Wu, 2014). The medical condition of hospitalized patients so often

changes without warning that smartphones have had the benefit of quick and easy access to

clinical data that has increased the quality of patients care. This was measured by the clinical

response rate that was defined as the frequency of clinical responses divided by the number of

critical rate value alerts during a given time period (Park, et al, 2008). For more details on how smartphones Enhanced Quality of Care see Table 1.

Insert Table 1

Barriers of Smartphone Use

Distractions and Interruptions

Many hospitals have permitted clinicians to use their own mobile devices at work, which has generated a threat of mixing personal apps with clinical care applications (Halmaka, 2011). In December 2011, concerns about distraction from smartphones in the hospital gained national attention when the Agency for Healthcare Research & Quality (AHRQ) highlighted a clinical case of a resident harming a patient because he/she became distracted while on a smartphone. The resident had been asked to use her smartphone to access the hospital's computer system and discontinue the patient's medication, but an incoming text about an upcoming party distracted her. The original task was not completed and the patient suffered negative side effects from medication that lead to a lengthy hospital stay (Katz, 2013). A 2011 study of the evaluation of smartphone to communicate between physicians found that on average there are 4.6 interruptions per hour for residents when considering calls, e-mails, and face-to-face communications (Wu, et al, 2011). For more details on the Distractions Caused by Smartphones in the clinical and educational field see Table 2.

Confidentiality and Privacy

Smartphones have become common in clinical work but it is important that focus is brought on educating medical professionals on how to appropriately use the devices. Although there has been a convenience of email and text messaging smartphones offer, these methods of communication have been often the least protected (CMPA, 2013). According to the Department of Health and Human Services, the HIPAA Security Rule outlines national standards designed to protect individuals' electronic protected health information ("ePHI") that is "created, received, used, or maintained by a covered entity (HIPAA, 1996). In a 2014 study at Peninsula Health in Washington, 134 responses to an online survey were received stating that 65% took medical images on their smartphones, 24% admitted that they did not ask for consent, and if there was consent only 23% was documented. Of the respondents who took medical images, 64% stored them personally and 82% shared them with someone else, mostly for input from another clinician, 43% of the respondents were aware that an institutional policy existed, but only 28% had admitted that they read the policy (Kirk, Hunter-Smith, Hunter-Smith, 2014). The HIPAA Security Rule allows healthcare providers to communicate electronically with patients, such as through email, but the law requires covered entities to "apply reasonable safeguards when doing so (Barrett, 2011). Confidentiality and privacy issues of smartphone use also are contributed from providers, who do not have security features on their phones and also theft, see Table 2 for more details.

Insert Table 2

DISCUSSION

The purpose of this study was to examine and analyze the use of smartphones for clinical and medical education by exploring and determining the benefits of and assessing the barriers to its implementation. The results of the literature review have suggested that smartphones has had an immediate impact and positive effects on the U.S. health systems. The possibilities of advanced use of smartphones and tablets in a clinical and medical education setting are consistently growing. In addition to growth, enhancing quality of care with factors such as: different applications, increased mobility, the ability to see pertinent patient information a click away, and the interoperability between systems. Therefore, this makes it much easier to transmit imperative information through state and federal systems with a smartphone or tablet if a provider needed to. With increased mobility, the physician, staff, or individuals receiving medical education can carry around a lightweight mobile device that allows them to do multiple things on multiple applications.

The literature review supports the information researched of smartphones for clinical and medical education. In addition, being able to access patient files immediately has a positive and direct correlation of quality of care. Smartphones and other applications assure progress and will continue to grow, develop, and enhance. It is imperative that providers are able to access patient information while being able to transmit necessary information into the hands that need it. In fact, with the capabilities and progressiveness that smartphones, tablets and other electronics has shown; smartphones allows patients the ability gain access from their own smartphone or tablet to see their own personal information.

From the literature review conducted, the steps that have been taken to development the implementation of smartphones for clinical and medical education would continue to increase the quality of care by providers (Wilson, 2013). The increase use of smartphones and other electronically device outside of the medical field has increased dramatically over the years. With increased use of smartphones and other electronics opens the door for providers and health care professionals to use smartphones. Furthermore, hospitals could save money on training and development on new employees if that individual is already using a smartphone or similar applications already (Miliard, 2010). Smartphones also have the ability to aid E-prescribing which has the ability to electronically send prescriptions rather than physicians having to hand write them. Physicians and providers would no longer have to go find a computer to prescribe medication; they would be able to prescribe medication right at their fingertips. Prescribing could be more efficient and effective and reduce length of stay allowing a faster turnover especially in an Emergency or an Immediate Care department at a hospital (Today's Hospitalist, 2014).

Medical errors could significantly reduce with the continued and increased use of smartphones in the clinical and medical education setting. With the legibility of hand written prescriptions by physicians have been proven obstacles in the clinical field and often result in prescription error to patients. This burden has been eliminated when prescriptions are electronically submitted and transferred from a smartphone or tablet that has these types of applications. Patients would benefit gratefully with smartphone technology in a healthcare facility by a decrease in missed prognosis and medical errors that could be detrimental to their overall health. Increased communication used by smartphones by healthcare facilities can allow physicians and hospital staff to communicate even if the physician or staff is not at work (Voalte Smartphones Reduce Noise, Improve Communication at Nemours Children's Hospital, 2014).

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For medical education, smartphones gives educators the ability/advantage to introduce applications that are commonly used in the healthcare facility. This allows the "up and coming" physicians and healthcare administrators know what applications to use and to get familiarized with to use in different scenarios. Smartphones and tablets in medical education have allowed professors an easier gateway to communicate and educate anywhere and everywhere for example Blackboard Collaborative. Smartphones that have cameras that have access to "FaceTime" or that are accessible to the internet to use "Skype" can help physicians reach patients outside of the hospital call Telehealth. This would be extremely beneficial to chronic patients that need to see their physician regular or more frequently. Adoption of smartphones and tablet applications for all healthcare and medical education facilities to adopt fully integrated smartphone use will be the biggest challenge itself. Many senior physicians may not be up to date on new technology or applications that would make their lives and their patients' lives much easier. Getting the senior physicians or senior medical education staffs to contribute and fully use their smartphone to its full potential can possibly be the biggest barrier that the smartphone/tablet and applications will encounter. A comparison of the effectiveness and efficiency of smartphone and smartphone applications use in clinical and medical setting could greatly enhance the efforts of better quality of care and education. In addition, federal government regulations would progress the implementation and utilization of smartphone technology by providing a standard for all to follow.

This research study could be limited by the search strategy undertaken, the quantity of databases searched, and publication bias, which may have constrained the articles that were used in this study. Researcher bias may also have been an issue given that articles were searched for and evaluated by the researchers to establish their relevancy to this study. Published research on

smartphone implementation in the healthcare industry is limited given that it is still in the developmental and trial stages across the U.S.

CONCLUSION

The findings of this study have suggested that the utilization use of smartphones for clinical and medical education has the capability to generate opportunities for increased quality of patient care, increase efficiency for all providers, increased convenience of mobility, and increase in patient-provider communication. Nevertheless, barriers to smartphone implementation and utilization still remain throughout the healthcare industry, with one of the main concerns being confidentiality and privacy.

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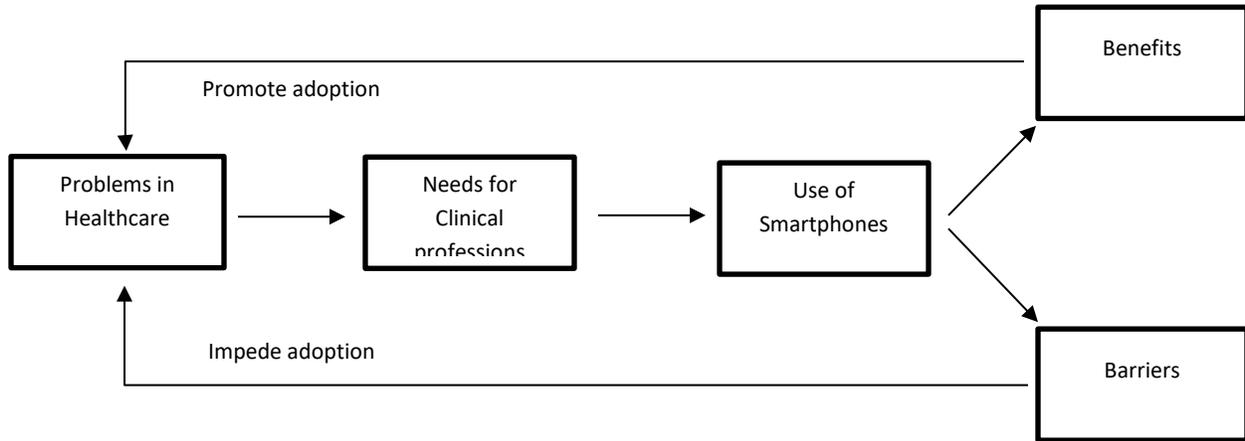International Conference. pp. 128-134.

APPENDIX

Figure 1: Conceptual Framework Used in Literature Categorization and Analysis

Adopted from Yao et al 2010.

Table 1: Benefits of Smartphone Use

Benefits	Details (citation)
Convenience of Mobility	• Smartphones are equipped with voice and text services, web searching GPS high-quality cameras, sound recorders, large memories, and high resolutions. These features have essentially made smartphones become handheld computers (Kamel Boulous, Wheeler, Tavares, & Jones, 2011). • 91% of providers owned a smart phone and 87% used smartphones during clinical practice (Koehler, Vujovic, & McMenamin, 2013). • Smartphones are lightweight devices, with sufficient memory that store large amounts of data and reference material, as with compatibilities to download larger numbers of applications including those designed

	specific medical fields (Ibrahim, Sailsu, Popoola, & Ibrahim, 2014).
	• Smartphones have been able to move 95% of medical faculty, 75% of medical residents, and 55% of medical students, respectively agreed that using a mobile device for rapid access to educational resources while "on the go", had a positive educational effect (Wallace, et al 2012).
	• Electronic documentation and computerized order entry are brought closer to the point of care by removing the need to leave a patient's room to find a distant computer terminal, which has improved recall of clinical details, has allowed better involvement of the patient in the care plan, and has improved efficiency in the clinical setting (Horng & Nathanson, 2011).
Enhanced Communication	• Smartphone medical applications that apprehend patient information before the patient-clinician contact have been used to communicate valued medical information to clinicians that their patients may have forgotten (Jayewardene, 2013).
	• In a 2011 study, over a 24-hour period, nurses sent on average 22.3 emails to physicians. Physicians received on average 21.9 emails and 6.4 telephone calls, while sending out 6.9 emails and initiating 8.3 telephone calls all via smartphone (Wu, et al, 2011).
	• In a 2011 study, residents found the use of smartphones helped to increase their mobility and multitasking abilities (Wu, et al, 2011).
Enhanced Quality of Care	• Medical apps keep track of patients' medical history for physicians to reference. An example of this is the EPI-Vista, an app that acts as a diary

	for epilepsy patients, used to record epilepsy relevant medical history (Sherwin-Smith & Pritchard-Jones, 2011).
	• Medical apps have the ability to give physicians accurate and relevant illustrations of patients medical histories and help patients recollect particular events (Beirbrier, et al, 2014).
	• Smartphones have been used as monitors for patients to record health measures and send them electronically to specialists (West, 2012).

GPS; Global Positioning Systems

Table 2: Barriers of Smartphone Use

Barriers	**Details (citation)**
Distractions and Interruptions	• Evaluation of reports submitted to the Pennsylvania Patient Safety Authority in 2010 and 2011 contained relevant terms, namely "distract," "interrupt," or "forgot, " identified 1,015 reports that have been attributed to distraction. 59.6% of the occurrences were classified as medication errors, 27.8% occurrences were linked to procedures, treatments, or test, and 13 cases cause harm such as prolonged pain, misdiagnosis, and even death of patients (Feil, 2013).
	• In a 2010 study authors found that interruptions have been even more frequent. An analysis of a 40-minute team meeting with the attending physician, seven

	interruptions were observed, the authors later associated the interruption to workflow, which have jeopardized patients' health (Westbrook, Woods, & Rob, 2010).
Confidentiality and Privacy	• According to a 2014 study, 68% of medical student reviewed, believed that the use of smartphones for patient related communication with colleagues posed a risk to the privacy and confidentiality of patient health information, 22% of the surveyed participants used their smartphone to text or e-mail identifiable patient data to colleagues, and a total of 26 % of the participants stated they did not have any type of security feature on their Smartphone (Tran, et, al 2014) • Theft of mobile devices is the most common form of security breach; in 2011 a study that conducted a survey of 600 U.S. hospital executives, physician organizations, health insurers, and pharmaceutical/life science companies found that theft accounted for 66% of reported data breaches over the past two year (Manatt, 2011).