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Smartphone (Mobile) Devices as a Mechanism to Increase Patient Safety in Healthcare within Saudi Arabia: A Systematic Review (2018)

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Abstract
Background:
The research has aimed to examine the use of smartphone (mobile) devices as a procedure to enhance patient safety in healthcare within Saudi Arabia, as these devices have been playing a decisive role in developing the lives of healthcare professionals andpatients.
Methods:
A systematic review was conducted for this research in order to draw valid inferences by following of a suitable inclusion and exclusion criteria. An aggregate of 13 literature studies were selected, out of which, 2 were primary and 11 were secondary research papers, respectively.
Findings:
According to the findings, smartphone (mobile) devices and relevant medical apps can be effectively used for raising patient safety in the healthcare sector within Saudi Arabia. The implementation of these the devices by healthcare professionals enhances patient safety. Based on the obtained findings, it is apparent that the applications, including The Stent Tracker, AFPA, and MedAdvisor among others, have the ability to enhance patient safety by facilitating the individuals to track their individual health and possess greater understanding about medication dosages and interactions. Based on the findings, there were three themes, which were significantly focused: the use of smartphone devices for monitoring; the effectiveness of implementing smartphone (mobile) devices and applications for obtaining information provision for enhancing patient safety; the use of smartphone (Mobile) devices along with applications to identify the overall needs ofpatients.
Conclusions:
It can be stated that the use of the smartphones in healthcare can help in raising patient safety in healthcare settings. The implementation of these devices can help to enhance prevention measures related to patient safety.
Keywords: *Patient safety, smartphones, Saudi Arabia*

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I. Background and Rationale

1.1 Contextual Background

Patient safety is recognised as a healthcare subset, which is described as "the avoidance, prevention, and amelioration of adverse outcomes or injuries stemming from the processes of health care" (Alotaibi & Federico, 2017, p.1173). Creation and maintenance of patient safety is strongly associated with organisations' improved business performance operating in healthcare (Alswat et al., 2017). According to Mitchell (2008), patient safety is defined as prevention of harm to patients. Various challenges related to patient safety include the lack of identification related to exact diagnosis procedures, failure to address patients' healthcare needs, shortage in communication among healthcare professionals, and medical or nursing omissions and errors (Rekleiti, Kyloudis, Toska, & Saridi, 2012; Weingart & Page, 2004). The challenges concerning the lack of identification of the exact diagnosis procedure and failure to address patients' healthcare needs arises due to shortages in skills amid medical professionals towards diagnosing and treating sufferers (Weingart & Page, 2004). Comparatively, deficiency in communication among healthcare professionals and medical or nursing omissions, alongside errors develop as challenges to patient safety, due to the lack of coordination among healthcare professionals and the absence of a correct channel to undertake treatment procedures in a more effective manner (Rekleiti et al., 2012).

There are different tools, such as the Hospital Survey on Patient Safety Culture (HSOPSC), which are widely used to measure the culture of patient safety within various healthcare organisations operating around the world. The correct application of these specific tools delivers greater assistance to different healthcare institutions in understanding the factors that can increase patient safety by engaging both public and private healthcare agents, and making them adhere to certain specific guidelines (Alswat et al., 2017). These guidelines are related to ensure safe injections, blood transfusion along with immunisations, maintaining water safety, executing secured clinical or surgical procedures, and disposing medical wastes within time in a cost-effective manner (Rekleiti et al., 2012).

Within this context, the emergence of mobile technology is evident, which is becoming important in the modern age, due to its cost-effective nature. A major proportion of the people belonging to this technology driven era use mobile technology for communication. Based on the data obtained for the period of January 2018, the worldwide mobile technology population stood at 3.7 billion; this is expected to increase in the upcoming years. As per February' 2017, mobile devices, such as smartphones, stood for 49.7% of web page views on a global basis (Statista, 2018). Mobile technology in healthcare is also increasingly becoming evident, due to its ability to diagnose, treat, and prevent diseases by identifying the patients' requirements and providing them with quality care (Chung, Mayes & White,2014).

1.1.1 The Rise of Digital Media

Digital media is defined as one of the main communication tools, which incorporates the use of computers, hardware, along with software, networks, and the internet (Kallinikos et al., 2013). It is also described as a digitised content, which is transmitted through computer networks and the internet to generate results (Pischetola, 2011). The distinct forms of digital media comprise social media and mobile devices, among others (Burke-Garcia & Scally, 2014).

In particular, smartphone (mobile) devices have emerged as a digital media tool, due to the availability of numerous applications, such as e-mails, and video streaming social media channels including Twitter, which can be accessed through smartphones ("Digital Media: Rise of On-demand Content", 2015). Smartphones' usage is characterised by certain major dimensions that entail application execution, user interactions, energy drain and network traffic. The penetration of smartphones in the healthcare domain can be determined by the growing utilisation of the internet and social media (Falaki et al.,2010).

1.2 Smartphone (Mobile) Devices inHealthcare

During the earlier years, technology usage, specifically in the healthcare industry, resulted into revolutionising the way healthcare has been offered to individuals, globally. This factor creates accountability in healthcare delivery procedures by supporting service providers in developing care quality with decreased turn around times of work flows, and overall operational costs (Falaki et al., 2010). Smartphones have entered into the purview of digital health through the application of a specific operating system (OS), which facilitates easy downloads and access of different applications. A few of the key OSs include: Windows Mobile, iPhone OS, Symbian, and WebOS (Sarasohn-Khan, 2010).

The definition of the concept of a smartphone is "a mobile phone with advanced features and functionality beyond traditional functionalities like making phone calls and sending text messages; a smartphone is equipped with the capabilities to display photos, play games, play videos, navigation, built-in camera, audio/video playback and recording, send/receive e-mail, built in apps for social web sites and surf the Web, wireless Internet and much more" (Sarwar & Soomro, 2013, p.216). The various features or functions, which are installed within smartphones, are: powerful processers, high-resolution screens, strong operating systems, and huge memories. With the help of these functions, patients' safety is ensured by forming, developing, and preserving communication with them, along with storing and accessing health records at any moment required (Ventola, 2014). For instance, by using smartphones with huge memories, healthcare professionals can store large records of the patients and thereby contribute in addressing their requirements from a base level. Moreover, patients can book their respective appointments from respective consulting physicians through the use of smartphone devices, as well as relevant applications (apps).

Involvement of smartphone devices, alongside the apps in the healthcare sector of any nation is related to the use of mobile technology. Conceptually, mobile technology represents "portable electronic technology, which serves as a medium for communication through transmission and reception of information. It includes different versions of mobile phones and handheld tablets, such as personal digital assistants and the new generation tablets such as the iPad" (Lyzwinski, 2014, p.318). The involvement of smartphone devices in healthcare is viewed as an interaction of two fast-evolving elements, which comprises smart technology and health. Additionally, evidence suggests that using smartphones in healthcare signifies the notion of mobile health (mHealth). In general, mHealth is defined as "the concept of using mobile devices, such as mobile phones, tablets, and smartphones, in medicine and public health; mHealth can be considered a subcategory of

"eHealth," which is a broader term for the use of all electronic technologies, such as computers in medicine and public health" (Dicianno et al., 2015, p.398).

Consequently, smartphone (mobile) devices are becoming integral to mHealth, as they impose positive impacts on clinical decision-making methods of the physicians, disease management mechanisms and monitoring the patients' suffering from acute or chronic diseases (Dicianno et al., 2015).

The application of smartphone devices in healthcare is perceived as an approach in modifying self-care behaviours of patients associated with weight management, diet control, exercise, and healthier lifestyle choices, such as no smoking (Ventola, 2014). Furthermore, medical professionals, at present, use smartphone devices to perform different healthcare activities, as they combine communication, along with computing characteristics in a solitary instrument. This eventually results in easy access and better usage for delivering quality care to patients (Dicianno et al., 2015). Healthcare institutions focus on using smartphone devices in areas such as: managing chronic diseases, providing training to health care workers, and examining critical health indicators. These devices and relevant applications support healthcare professionals to easily access certain tools, including: prescription reminders, physicians or hospital locators, calorie counters, and appointment notices among others (Camacho et al., 2014). Greater access to these tools helps to empower both patients and healthcare service providers to mitigate adverse medical conditions through real-time monitoring and treatment (West, 2013).

The value of engaging smartphone devices in the healthcare sector can be determined by improved information systems, effective utilisation of time, better maintenance, and access of vital health information, along with increased communications (Sarasohn-Khan, 2010). In addition, it also involves consultation with distinct medical professionals. Furthermore, successful clinical decision-making, enhanced mechanisms of patient monitoring deliverance of quality medical education, and training help the healthcare professionals to determine the effectiveness of involving smartphone devices in healthcare (Talwar, Karthikeyan, Bindra & Medhi, 2016).

Saudi Arabia is perceived to be a developing country, which possesses distinct cultural and communal contexts. Smartphone technologies are widely adopted and used in Saudi Arabia, which comprises mobile internet, e-services, and information technology (IT) applications (Aldhaban, Daim & Harmon, 2016). The use of smartphones in Saudi Arabia has grown immensely, as it help people to communicate with one another and facilitates them to access various services, such as map navigation. It is estimated that nearly 72.8% of people in Saudi Arabia used smartphone (mobile) devices in the year 2017, compared to 23 million users globally. This usage of the devices is expected to grow by approximately 6.1 million users by the year 2020 in Saudi Arabia (Arab News, 2017). The application of smartphone (mobile) instruments and smart device apps is not a new phenomenon within the Saudi Arabian healthcare sector, due to increased focus on reducing medical care costs, decreasing hospital congestion, and enhancing productivity along with the efficacy of physicians to deliver quality care to patients (Al-Ghamdi, 2018). In this context, as per the research findings presented by Al-Ghamdi (2018), medical practitioners, such as physicians in Saudi Arabia, are involved in using smartphone (mobile) devices and apps to deliver quality care and better treatment to the patients.

Some commonly used medical apps include Skyscape, Epocrates, iPharmacy, UpToDate, Medscape, Oxford clinical handbooks, Gray's Anatomy, Pubmed mobile, ECG guide, Eponyms, and the Oxford medical dictionary. These particular apps are generally used for distinct purposes, such as determining the medication dosages, understanding certain critical or unknown medical terms and maintaining patients' data among others (Al-Ghamdi, 2018). Additionally, smartphone (mobile) devices and the mentioned apps are utilised by the healthcare institutions to boost the productivity, accuracy and the efficiency levels of the physicians. Indeed, these can further enhance patients' access to medical care and safety at large (Al-Ghamdi, 2018). These apps or software can be easily downloaded into smartphones and tablets among others, which can be accessed anywhere and anytime depending on the availability of the internet connectivity, technology platforms, information gateways, and networks ("Digital Media: Rise of On-demand Content",2015).

According to the findings by Al-Ghamdi (2018), healthcare professionals associated with Saudi Arabian healthcare have used smartphone medical apps to track patients' medical records. Furthermore, it has been used to develop clinical skills. Meanwhile, the other reasons for which physicians implemented the aforementioned smartphone medical apps in the Saudi Arabian healthcare sector include updating medical news, viewing journals related to healthcare, preparing for exams, and gaining knowledge regarding medication and drugs(Al-Ghamdi, 2018). In relation to the findings by Al-Ghamdi (2018), the perceived impacts of smart device medical apps on clinical healthcare practices in Saudi Arabia has helped to save a considerable amount of time to deliver quality care to patients. This further assists in performing valuable medical related computations in an efficient manner. Furthermore, the other perceived influences include quick access to trustworthy sources of clinical skills and medical knowledge. It is also helpful in computing accurate medical doses and easy access towards performing evidence-based medical practices (Al-Ghamdi, 2018). The mHealth application is used in the Saudi Arabian healthcare sector with the objective of enhancing patients' medical conditions, thereby

ensuring improved quality of life (Al-Ghamdi, 2018; Adibi, 2014).

The strategy for using smartphone devices in the healthcare industry within Saudi Arabia emphasises certain significant areas, which deliver better understanding of the prevailing clinical settings, along with workflow. Therefore, it helps to provide quality healthcare to patients and ensures safety in solving critical medical issues by working collaboratively (Koninklijke, 2018). In the year 2016, a plan was initiated, referred to as "Saudi Vision 2030" (Vision 2030) for the purpose of developing the overall financial structure of Saudi Arabia. Moreover, as technology plays a major role in this plan, it is expected that the use of smartphones in healthcare will significantly increase (Bassi, 2017). Accordingly, it is believed that the use of smartphones will improve care and patient safety within Saudi Arabia by facilitating the medical professionals to access the latest health care related information, drug reviews, and other useful data (Al-Ghamdi, 2018). Furthermore, the correct utilisation of smartphone (mobile) devices and various apps is expected to enhance patients' care and safety in Saudi Arabia by enabling physicians to enhance their own clinical decision-making procedures to the maximum possible extent (Abadel & Saifuddeen, 2017).

1.3 Smartphone Effectiveness inHealthcare

The impacts of smartphone effectiveness in healthcare stem from processing data from broad assortments of sources comprising wireless databases, and networks. This further includes applications related to mHealth, extension along with adaptation instruments, and patient monitoring mechanisms (Dicianno et al., 2015). Within present globalisation and its technological era, numerous technological advancements for smartphone devices and apps are easily accessible. These technological advancements under the mHealth domain are identified as: 'blood pressure cuff'; 'blood glucose meter'; 'otoscope adapter'; 'ophthalmoscope device', and 'hand-held microscope smartphone adapter'. Besides, the other technological advancements include: 'wireless laboratory hand-held sensors'; 'electro-encephalography adapters'; and a 'smartphone ultrasound imaging system' (Camacho et al., 2014). In this context, the utility of the 'blood pressure cuff', along with the 'blood glucose meter', can be measured in terms of remote measuring, recording, and transmitting blood pressure, and blood glucose level respectively. These could make a difference to healthcare outcomes of patients suffering from hypertension and diabetes, among others (Camacho et al., 2014).

Comparatively, 'otoscope adapters' and 'ophthalmoscope devices' enable successful visualisation of external tympanic membrane, along with internal eye arrangements, correspondingly. This will ensure patient safety, in terms of retrieving quality primary care and improving health conditions from infectious or cardiovascular diseases (Camacho et al., 2014). In contrast, the device or the app extension of 'hand-held microscope smartphone adapter' helps to conduct remote microscopic inspections of specimens from patients, which makes differences to patient outcomes with regard to hematologic or dermatologic diseases (Camacho et al,2014).

The challenges of using smartphones in healthcare can be better comprehended from the perspective of both healthcare customers and providers. Healthcare customers (i.e. patients) can reap several significant benefits, such as increased safety from the involvement of smartphone devices and app extensions. This safety can be duly measured in the form of scheduling correct appointments, tracking individual health activities, and by easy access to their own medical records or laboratory test results (Zhang et al., 2014). In healthcare, the efficacy of other smartphone devices or application extensions, such as 'wireless laboratory hand-held sensors' and 'electro-encephalography adapters', are identified as facilitating portable devices to determine laboratory values. This is observed within the patients' samples, along with specimens and monitoring data transmissions of electro-encephalography, respectively. Correspondingly, the effectiveness of the other device or the app extension of the 'smartphone's ultrasound imaging system' relieson allowing the portable execution of ultrasound imaging for patients (Camacho et al., 2014). Additionally, factors comprising 'digital clinics', 'digital devices' and 'digital patients' increased the effectiveness of involving smartphone devices, as well as app extensions in the healthcare sector (Camcho et al., 2014). Contextually, with respect to 'digital clinics', the effectiveness of using smartphones is featured by maintaining smooth clinical workflows, developing interoperability, and incorporating digital devices in operations (Camacho et al., 2014). Furthermore, the aforementioned factors are likely to make differences in patient outcomes by obtaining treatment in a cost-effective manner.

From the perspective of 'digital devices', the usability and the accessibility of smartphones in healthcare are characterised by design simplicity along with sensors, smartphone- connected instruments, handheld imaging, lab-on-a-chip technologies, and wireless equipment. With respect to 'digital patients', the efficacy to involve smartphones in healthcare functions through: digital retention, telemedicine, digital engagement, patient self-measurements, behaviour modification and patient generated information. Medical or healthcare professionals in the present day context use various smartphone health apps to a considerable level. This is mostly to determine healthcare outcomes for diseases ranging from hypertension to coronary heart disease (Al-Ghamdi, 2018). Moreover, it is believed that health care professionals are able to perform successful

medication profiling of patients through the use of smartphone devices, along with application extensions, resulting in improved quality of care (Camacho et al.,2014).

1.4 Challenges of Using Smartphones in Healthcare

Various challenges have been reported regarding the usage of smartphones, particularly in the healthcare sector. These challenges are related to privacy, along with security concerns (data security, information protection, and encryption), lack of verification of different health applications, together with download and the execution of the applications without proper guidance (Istepanian & Woodward, 2016). Regarding security and/or privacy, currently, there is no standard procedure to ensure encrypted data storage along with transmission obtained through the usage of smartphone devices and application extensions, such asm Health (Zhang & Shen, 2015). While there is usually the possibility of information threats whilst providing treatment to patients when using smartphones in the healthcare domain,

Misuse of valuable medical information could also be viewed as a critical challenge while using smartphones in healthcare delivery procedures (Istepanian & Woodward, 2016). Hence, beneficial security should be established, developed, and maintained for the servers. Furthermore, regulations followed by different telephone and application companies in the collection, assessment, and transmission of sensitive data through individual networks and programmes also raise security concerns (Camacho et al., 2014). In addition to information security, the accuracy of using smartphone devices, along with application extensions, such as e-mails and channels of social media, should also be maintained to derive positive healthcare outcomes without facing any issue. This can be made possible by placing restrictions towards accessing valuable medical data through the use of passwords on the smartphone(mobile) devices that are used by the respective healthcare professionals (Istepanian & Woodward, 2016). Nevertheless, in this technological world, the sensitivity and the specificity in maintaining precision within these devices and extensions are not clear, as per the expectation level (Camacho et al., 2014). This is primarily due to the lack of relevant governing regulations. Therefore, regarding formal testing and standardisation is highly required for the maintenance of accuracy in using smartphone devices, especially within the healthcare domain (Camacho et al., 2014).

Digital divide and digital illiteracy are the other challenges that are associated with the use of smartphones in healthcare. The challenge of digital divide emerges during the situation when there is a gap amid individuals or social groups belonging to the same nation in accessing any sort of digital contents (Suwana & Lily, 2017). Meanwhile, digital illiteracy also develops as a crucial challenge in using smartphones in healthcare, due to restrictions to access valuable digital contents (Suwana & Lily, 2017). Additionally, it has also been observed that usability constraints exist, due to smaller screens, slow internet speed, and problems in typing, alongside reading words (Zhang, Zhang & Halstead-Nussloch,2014).

The shortage in accessing internet and mobile devices may create challenges for healthcare customers in ensuring increased safety. Contrastingly, healthcare providers are more interested in deploying smartphones in their practices for the purpose of managing time, enhancing communication levels with patients, and managing maximum safety levels (Zhang & Shen, 2015). The lack of maintaining accuracy in using smartphone devices and applications associated with health care may lead to the creation of challenges for healthcare providers when fulfilling their roles of managing patients' safety in the most effective way (Zhang et al., 2014).

1.5 Review Aims and Objectives

Aim: The aim of this research is to discuss and analyse the effectiveness and the challenges of using smartphone devices in the healthcare sector within Saudi Arabia, in order to increase patient safety.

Objectives: The following objectives have been framed based on the above study aim:

- To use the principles of systemic review to critically appraise the existing literature in the field;
- To examine the application of smartphones used to increase patients safety in Saudi Arabia;
- To analyse the effectiveness of using smartphones in health care within Saudi Arabia to raise patientsafety;
- To discuss the challenges witnessed in using smartphones to increase patient safety in SaudiArabia.

1.6 Review Question

Considering the aforementioned aim and objectives, the developed review question for this research is shown below.

"How smartphones can be used as a mechanism to increase patient safety in the healthcare domain within Saudi Arabia?"

1.7 The Importance of theReview

The importance of this review exists in identifying and analysing the ways through which smartphone (mobile) devices can be used as a mechanism to ensure patient safety in Saudi Arabian healthcare. Various significant aspects, such as the effectiveness of utilising smartphones in the Saudi Arabian healthcare industry and the challenges associated with this have been discussed critically in this research. The review is expected to provide a better understanding about the various mobile applications, which not only ensures patient safety, but also helps to develop and maintain effective communication amid both medical professionals and patients in Saudi Arabia's healthcare domain. These applications can be easily downloaded through the utilisation of smartphone (mobile) devices that have the ability to track patients' healthcare records and provide them with quality care. Various features of smartphone (mobile) devices, such as text messaging provide a basis for establishing communication amid healthcare professionals and patients in any clinicalsetting.

1.8 Summary

This chapter has highlighted the research aim, objectives, and the review question, along with a contextual background of the study. Various significant aspects, such as the involvement of smartphone devices in healthcare within Saudi Arabia have been discussed based on the aim, objectives, a review question, and study background. Moreover, the overall effectiveness of these devices and challenges of using smartphone (mobile) devices have been addressed during this chapter.

II. Methodology

2.1 Introduction

This chapter will emphasise the methods to be considered for performing the systematic review (SR) for this study. A systematic search was undertaken to review the evidence of the review question, as presented in the Chapter One. The review has aimed to identify and investigate previously published studies in developing the above framed research question, based on the given issue – i.e. the use of smartphone devices as a mechanism to raise patient safety in Saudi Arabia. Different important factors, including search design, database selection, search strategy, search inclusion, along with exclusion criteria and quality assessment, will be discussed in this chapter. With the help of implementing the systematic methodology, the review is able to identify, select, and appraise relevant research in a more critical way. This chapter further focuses on gathering and analysing required information from the included studies. Therefore, adopting a methodology, alongside stating the objectives and providing transparent measures when using the systematic methodology, will help to maintain the review's reliability and viability.

2.2 Search Design

2.2.1 Systematic Review

A SR is an approach to recognise, select, synthesise, and evaluate studies, which complies with the pre-determined inclusion criteria to answer a specific research question (Knoll et al., 2018). This helps to provide a summary of literature studies to answer a research question by using explicit mechanisms, along with objective techniques. Based on these notions of a SR, its characteristics can be identified as explicit, methodical, reproducible, transparent, and unbiased (Cohn & Brower, 2012). In this context, the explicit and the methodical facets of a SR can be determined from its statement of purpose. Additionally, it can also be determined with the support of using materials and classification of the selected literature studies based on specific research issues (Knoll et al., 2018). Comparatively, the reproducible and transparent nature of a systematic review can be verified from its methodology, as well as to draw conclusions and criteria, in addition to the corresponding decisions. Finally, the unbiased characteristics of a SR can be examined, which form its balanced research findings, which help to address an identified study issue (Cohn & Brower, 2012).

There are various reasons that a SR has been used in this particular research, as compared to other literature review methods (Knoll et al., 2018). One of these reasons is that it supported in investigating how programmes generate observed or intended results (Coryn, Noakes, Westine & Schroter, 2011). In relation to the given research, smartphone (mobile) devices are duly considered as the programmes attaining intended patient safety results. The major principles of SRs, such as examining all accessible evidence relating to the issue and using numerous questions about the literature review, are related to Theory-Driven Evaluation model that have been used in this research with the objectives of addressing the identified study issue and drawing valid outcomes (Coryn et al., 2011). In comparison with the other mechanisms of the literature review, it is evident that a SR takes into consideration the precise question for underpinning a specific piece of research and presents data in a concise format by using various methods, such as PRISMA (Robinson & Lowe,2015).

2.2.2 Key Stages for Producing a Systematic Review

The key stages for creating a SR can be better comprehended from Table 1 below.

Table 1: Key Stages for Creating a Systematic Review

Steps	Functions
Formulating an explicit and a well-defined research question.	Conducting a literature search and performing abstract along with full-text screening.
Extracting relevant data from the included studies and analysing the obtained information.	Assessing data quality, as well as generating valid findings.

It can be critically mentioned that the PICO framework was used to develop the review question and draw valid inferences in the alignment with the set research aim and objectives (Peek et al., 2012). The main reason behind the application of the PICO framework for this SR was to answer the developed review question for the research. With the help of this particular framework, greater understanding has been made through which the use of smart phone devices ensure patient safety in Saudi Arabian healthcare.

2.2.3 Advantages and Disadvantages of a Systematic Review

A SR possesses certain advantages and disadvantages that often produce mixed results, such as responding well to clinical questions and disrupting the process of data analysis by increasing the scope of bias (Robinson & Lowe, 2015). The advantages of a SR can be identified as greater control over learning objectives, increased maintenance of the generalisability of the overall findings obtained for research, and better understanding of any specific practice setting (Hoffman, Bennett & Mar, 2013). These advantages eventually help to guide the decision- making procedure in the most effective manner; thus, developing a clear understanding of a specific situation or phenomenon, and supporting the identification of research gaps, along with defining future study agendas, which are essential (Boland, Cherry & Dickson, 2017). Despite these advantages, subjecting bias is viewed as one of the most critical disadvantages of a SR. Hence, this might lead towards generating impartial research outcomes. Besides, the misrepresentation of facts can also be regarded as another weakness of a SR. This can prove significantly detrimental to the overall findings' generalisability (Hoffman, Bennett & Mar, 2013).

2.3 Search Strategy

As mentioned previously, the PICO structure was utilised to develop the study's initial framed review question. This is related to the execution of smartphone devices as a method in increasing patient safety in healthcare within Saudi Arabia. Based on the PICO framework, healthcare professionals, including nurses and doctors, along with the patients, have been considered as the Population (P) and smartphone devices as the Intervention (I) for the current study. Meanwhile, Comparison (C) was made among home care and hospital care with respect to patient education. Finally, as per the PICO structure, patient safety was duly considered as the Outcome (O) for the current research (see Table 2).

2.4 Database Selection

Table 2: Database Selection

Databases	Description/Why
Medline	National Library of Medicine (NLM), as it offers indexing excess of 25 million journals relating to medical or allied health fields.
Academic Search Premier	Provides free archives for full-text journal articles linked with medical or allied health dimensions.
CIHAL	Cumulative Index to Nursing & Allied Health Literature, as it delivers indexing to greater than 3,000 English-language journals associated with the field of nursing.
Ovid	Provides in excess of 400 journals of allied health along with nursing fields.

The application of related words and searches within the full text of the articles were considered to identify and select the most appropriate literature studies from the aforementioned databases. The initial literature search and database selection was completed by focusing primarily on the theme of smartphone devices' involvement in healthcare and the effectiveness of smartphones in enhancing patient safety in Saudi Arabian healthcare. Moreover, a manual review was required to maintain balance between the selected articles' specificity and sensitivity.

2.5 Inclusion and Exclusion Criteria

The database selection and the literature review search procedures were streamlined by using the below described inclusion and exclusion criteria in the form of a table.

Table 3: Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
• Literature studies that encompass the keywords: smartphone devices, mobile, apps, mobile tablet, iPad, patientsafety, healthcare safety, hospital safety, Saudi Arabia, andKSA. • Materials comprising data aboutusing (smartphones) for patientsafety. • The publication of relevantliterature studies between 2004 and 2018 to acquire the latest and the updated materials to address the review question. • Articles that have been published in English. • Primary and secondary papersrelated to the research topic.	• Literature studies that do not include any of the keywords mentioned. • Materials published in other languages apart from English. • Literature studies published prior to the year 2004 because smartphones generated after thisdate. • Materials depicting information for other nations rather than Saudi Arabia. • Literature studies that do not emphasise the application of smartphones for patient safety.

Based on the search results, there is no evidence of existing articles in Saudi Arabia; from the search only 18 papers were ascertain, but not related to the search question. Accordingly, the search became general worldwide, which produced findings to apply to the search question regarding Saudi Arabia.
SEARCH DATE 17/07/2018

Table 4: Databases and Keywor d Search

Search	Keywords	Medline	Academic Search Premier	CINHAL	Ovid	Total
1	Mobile OR smartphone OR mobile tablet OR iPad OR apps.	14223	11949	211540	74143	
2	Patient safety OR health care safety OR hospital safety.	11632	43358	39076	32077	
3	Saudi Arabia or KSA	1552	2068	71566	42710	
4. AND	[Mobile OR smartphone OR mobile tablet OR iPad OR apps] AND [Patient safety OR health care safety OR hospital safety] AND [Saudi Arabia or KSA.]	15	0	3	0	18
5. AND	[Mobile OR smartphone OR mobile tablet OR iPad OR apps] AND [Patient safety OR health care safety OR hospital safety].	660	191	329	221	1401

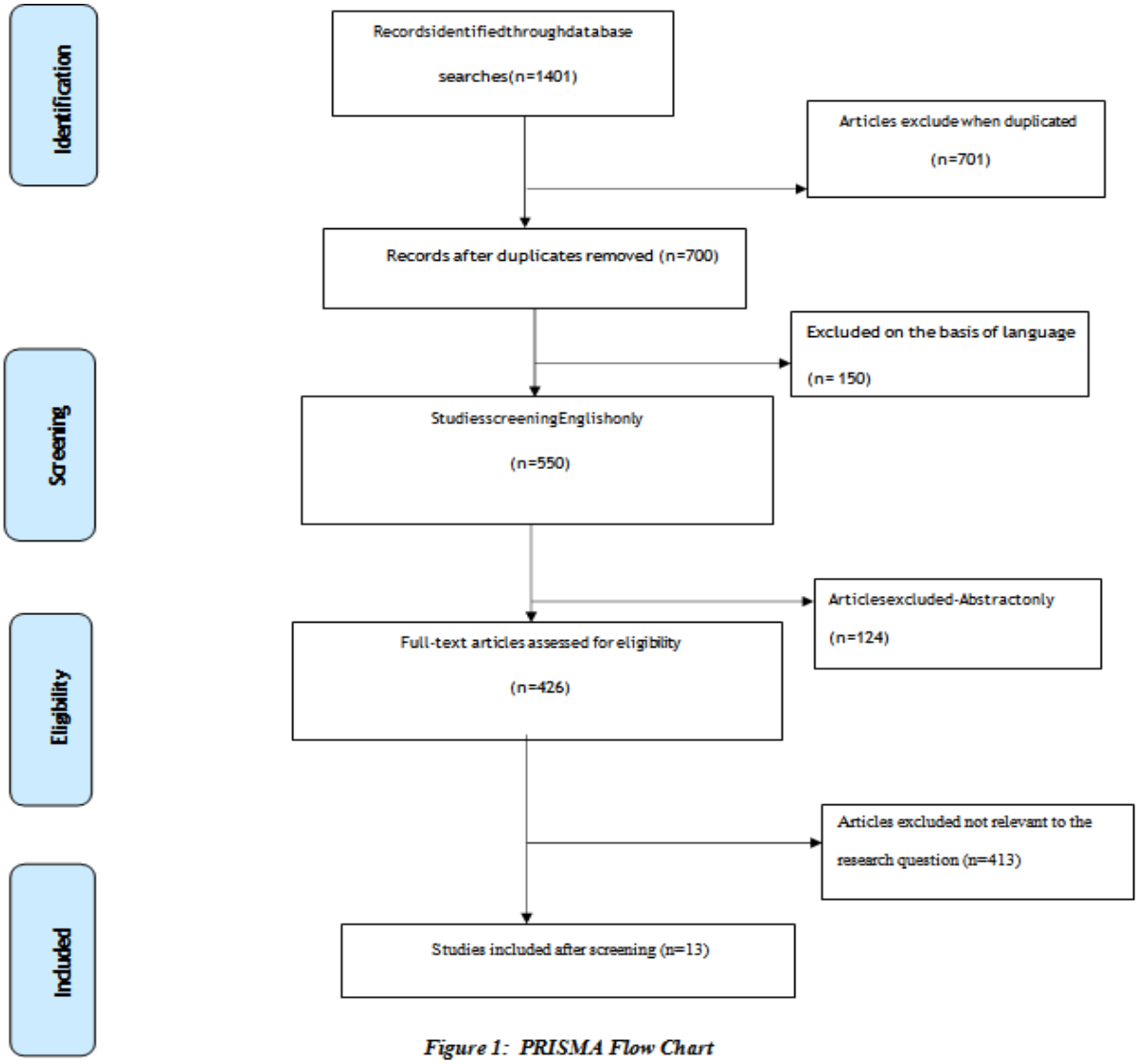

Figure 1: PRISMA Flow Chart

Relevant literatures were searched, which were conducted by using the methods mentioned in the previous chapter that highlighted the application of smartphone (mobile) devices as a mechanism for increasing patient safety in the healthcare sector within Saudi Arabia. A total of 4 databases such as Medline, Academic Search Premier, CINAHL,and Medline Ovid or University of Salford were taken into consideration when searching the research studies. These sources were related to the previously stated framed research aim, as well as the objectives and review question developed for the current research. Additionally, certain keywords, including mobile, smartphone or mobile tablet, patient safety, healthcare safety or hospital safety, and Saudi Arabia or KSA (Kingdom of Saudi Arabia) were used to search relevant literaturesources.

A search of Medline on July 17, 2018 yielded a total of 28,088 articles, along with 57,573 from Academic Search Premier. Meanwhile, a search of CINAHL on this particular date produced a total of 3 from 22,522 articles and 1 from 49,156 from Medline Ovid and the University of Salford, respectively. Based on the provided PRISMA flowchart, a total of 1,401 records were identified through database searching (700) and other sources (701). Amongst these, 700 records were considered following the elimination of duplicates. Out of these 700 records, 550 were screened, and 150 were excluded for language. After the exclusion of irrelevant sources, a total of 426 full-text articles were examined for eligibility and 124 articles were excluded when viewed as not full text while 413 articles excluded as a result of not relevant to the research question. Thus, 11 studies were included through qualitative synthesis and 2 studies were incorporated within quantitative synthesis (meta-analysis). Accordingly, all these literature studies were related to the topic of using smartphone (mobile) devices as a mechanism to enhance patient safety in Saudi Arabianhealthcare.

From the discussed PRISMA analysis, 2 primary articles, along with 11 secondary articles, were selected for the systematic review. The CASP checklist was applied to each of these selected articles in the SR, which was mainly to develop the above framed review question (see Table 5). The CASP checklists for the

selected articles covered the belowaspects.

- "Was there a clear statement of the aims of theresearch?"
- "Is a qualitative or a quantitative methodologyappropriate?"
- "Was the research design appropriate to address the aims of theresearch?"
- "Was the recruitment strategy suitable for the aims of theresearch?"
- "Was the data collected in a way that addressed the researchissue?"
- "Has the relationship between the researcher and participants been adequately considered?"
- "Have ethical issues been taken intoconsideration?"
- "Was the data analysis sufficientlyrigorous?"
- "Is there a clear statement of thefindings?"
- "How valuable is theresearch?"

2.6 QualityAssessment

The quality assessment for this SR was fundamentally based on two major elements, which included entailed Preferred Reporting Items for SRs and Meta-Analyses (PRISMA) and Critical Appraisal Skills Programme (CASP) Checklists. In this regard, PRISMA was executed during the stage of searching for relevant literature studies and CASP was performed when analysing and discussing the final literature studies selected for the study after determining the exclusion, as well as the inclusion criteria.

Table 5: CASP Tool for Quality Assessment

	The summary is structured	**Eligibility criteria have been**	**Outcome measures have been defined**	**Sample size/ power calculations have**	**Random allocation process has been**	**Baseline data have been reported**	**Paper includes a demographics**	**All outcomes have been reported**	**The effect size has been reported**	**Follow up data have been reported**
1. (Primary) (Molina et al., 2017)	√√	√√	√√	√√	√√		√√	√√		√√
2. (Primary) (Rasche et al., 2017)	√√	√√	√√	√√	√√		√√	√√		√√
3. (Secondary) (Luxton,	√√		√√				√√	√√		√√
McCann, Bush, Mishkind & Reger, 2011)										
4. (Secondary) (Killikelly, 2017)	√√		√√				√√	√√		√√
5. (Secondary) (Relias Media, 2015)	√√		√√				√√	√√		√√
6. (Secondary) (Daly, 2017)	√√		√√				√√	√√		√√
7. (Secondary) (Shore et al., 2014)	√√		√√				√√	√√		√√
8. (Secondary) (Huckvale, Morrison, Ouyang, Ghaghda & Car, 2015)	√√		√√				√√	√√		√√
9. (Secondary) (Burtson & Vento, 2015)	√√		√√				√√	√√		√√
10. (Secondary) (Moore, Anderson & Cox, 2012)	√√		√√				√√	√√		√√
11. (Secondary) (Holt, Flint, & Bowers, 2011)	√√		√√				√√	√√		√√
12. (Secondary) (Baca, Rico & Stoner, 2015)	√√		√√				√√	√√		√√

13. (Secondary) (Agboola, Bates & Kvedar, 2016)	√√		√√				√√	√√		√√

It must be asserted that most of studies used for this research (i.e. Killikelly (2017), Agboola et al., 2016; Burtson & Vento, 2015) are secondary in nature with the inclusion of qualitative study. A few of these studies considered certain ethical practices and maintained validity along with generalisability of the overall obtained results by considering those literature sources, which relate to the identified research issue; i.e. the application of smartphone (mobile) devices in healthcare to ensure patient safety. The two quantitative studies selected for this research (Molina et al., 2017; Rasche et al., 2017) reflect primary data that considered ethical practices and maintained validity, along with generalisability by selecting a suitable sample size and measures.

These factors were, thus, considered to be efficient tools for critical appraisal, which supported the SR to ensure that the literature sources selected for the given research paper were suitable in nature. Consequently, based on the PRISMA analysis, the following results were obtained (see Figure 1).

III. Findings

3.1 Overview

In this specific section of the dissertation, the overall findings have been summarised that relate to the identified study issue, i.e. the determination of whether smartphone (mobile) devices can be used as a mechanism. This can help in ensuring patient safety in Saudi Arabian healthcare. In this context, it has been apparent that a total of 13 literature sources have been considered to draw valid inferences by the inclusion of the principles of aSR.

3.2 Summary ofFindings

Based on the findings, it is stated that a clear statement of the research aim was not presented in the selected literature studies of Molina et al. (2017), Relias Media (2015), Daly (2017), Shore et al. (2014), Burtson and Vento (2015), Moore et al. (2012), Holt et al. (20110, Baca et al. (2015); and Agboola et al. (2016). However, the other selected literature studies of Rasche et al. (2017), Killikelly (2017), Daly (2017), and Huckvale (2015) presented a clear statement of research aims that have a linkage with the research issue identified. Apart from qualitative and quantitative research methodologies, the studies considered for this research adopted experimental, descriptive, exploratory, and systematic review designs, in order to draw valid conclusions (see Appendix I). According to the obtained findings, recruitment strategy was only suitable for two primary studies selected for this research (Molina et al., 2017; Rasche et al., 2017), as these focused on collecting primary data from respective participants (i.e. patients). Thus, these studies portrayed a relationship among the researchers and the participants during the time of data collection, clearly enhancing the generalisability of the overall obtained findings. Nonetheless, no evidence could be ascertained in the secondary literature sources considered for the research, such as Daly (2017), Agboola et al. (2016), Killikelly (2017), and Baca et al. (2015) regarding recruitment strategy and the association amid researchers and individual participants.

For full summarises regarding the Recruitment Strategies, Data Collection, and the Relationships between the Researchers and Participants, see Appendix II

With regard to the primary articles selected for the research, the recruitment strategy undertaken by Molina et al. (2017) was deemed as suitable, as an initial group of 194 patients who underwent ureteral stent placement was considered and tracked by using the "Stent Tracker" application. Comparatively, in the study by Rasche et al. (2017), the recruitment strategy was appropriate, as the researchers measured the subjective fall-risk of the patients by undertaking a self-test and a balance test. In this context, the self-test comprised ten standardised yes-no questions and in contrast, the balance test did not involve any compensatory movement. In relation to the quantitative study conducted by Molina et al. (2017), the relationship amid the researchers and the participants can be duly measured in the forms of obtaining pertinent data from three applicable healthcare institutions and conducting a retrospective analysis of those patients who experienced ureteral stent placement. Correspondingly, based on the study findings presented in Rasche et al. (2017), the association amid the researchers and the participants can be measured through the interaction made with the elderly patients who remained at the risk of ground-level falls.

The qualitative research methodologies undertaken in the studies of Luxton et al. (2011) and Killikelly (2017) provided a clear understanding regarding the incorporation of smartphone technology in behavioural healthcare segment and the effectiveness of developing a mobile instrument to record inpatient data linked with mental health respectively. Meanwhile, the qualitative research methodology adopted in the study conducted by Relias Media (2015) and Daly (2017) focused on determining whether the three smartphone (mobile) applications: IScrubLite, Anaesthesiologist and Pristine EyeSight can help to enhance patient safety and appraising the theoretical viewpoints surrounding an app named MedAdvisor. With regard to the secondary

studies (Shore et al., 2014; Huckvale et al., 2015), the appropriateness of using qualitative research methodologies is ascertained in the form of performing a theoretical review about mobile mental health technology and summarising the existing clinical research based on the study issue identified. In relation to the studies by Burtson and Vento (2010) and Moore et al. (2012), the suitability of executing qualitative research methodologies can be determined from verifying whether it is possible to enhance patient safety in healthcare domain through the application of smartphone (mobile) devices and relevant applications. Finally, according to the studies performed by Holt et al. (2011), Baca et al. (2015) and Agboola et al. (2016), the relevance of executing qualitative research methodologies exists in exploring the real-world phenomenon of embracing technology towards reinforcing healthcare, and developing a human connection.

Both the primary and the secondary literature studies selected for this research considered certain ethical practices that contributed to improve the generalisability of the overall obtained results (see Appendix III). For instance, the ethical issues of reviewing the final manuscript version and approving the same from the authors and obtaining authorisation from the Ethics Committee of the RWTH Aachen Faculty of Medicine based on the statement EK236/16 were considered in the studies by Molina et al. (2017) and Rasche et al. (2017), respectively. Correspondingly, in the secondary studies by Luxton et al. (2011), Killikelly (2017), and Relias Media (2015), the ethical issues were duly considered, including describing the notions from healthcare perspectives, explaining theories with respect to the subject matter, and generating valid conclusions. In relation to the studies conducted by Daly (2017), Shore et al. (2014) and Huckvale et al. (2015), the ethical issues, including selection of relevant theories by following the guidelines of The American Psychological Association Code of Ethics and moral disclosures along with software issues under quality domain were duly considered to develop the generalisability of the obtained outcomes. With regard to the study findings presented by Burtson & Vento (2015), Moore et al. (2012), and Holt et al. (2011), suitable literatures published by the certified researchers that were based on the study subject were duly considered to draw valid inferences. Finally, as per the studies of Baca et al. (2015), and Agboola et al. (2016), threats associated with patient safety such as data safety and privacy infringements were duly taken into concern to validate the research findings. Table 6 below presents a summary of the studies' values and their themes and determination.

Table 6: Summary of the Themes and Determination of the Studies' Values

Paper (no.)/Study Type/Source	**Self-tracking**	**Identify need**	**Information provision**	**Findings**	**Value**
1. (Primary) (Molina et al., 2017)	✔			There was a clear statement of the findings, which mentioned that the patient safety application of the Stent Tracker is effective in preventing the patients from "forgotten" ureteral stents.	The research is valuable in nature, as it displays the ways through which Retained Ureteral Stents (RUS) impact the quality of a patient's life.
2. (Primary) (Rasche et al., 2017)	✔			The statement of the findings was clearly depicted by stating that the "AachenFall Prevention App" (AFPA) acts as a capable instrument to self-evaluate the older patients, who remain in a position of risk concerning ground level falls.	The research is valuable based on improvising healthcare conditions for elderly patients who experience the risk of ground level falls.
3. (Secondary) (Luxton et al.,	✔		✔	No clear statement of findings was	The value ofthe research can be witnessed inthe
2011)				presented.	integration of smartphone technology in a behavioural healthcare context.
4. (Secondary) (Killikelly, 2017)		✔		No evidence of a clear presentation of statement of the findings was shown.	The research is valuable in nature, particularly from the perspective of recording mental health inpatient data by developing a mobile device.
5. (Secondary) (Relias Media, 2015)	✔			A clear statement of findings was not provided.	The value of the research can be determined in the field of enhancing patient safety through the proper execution of smartphone (mobile) apps.
6. (Secondary) (Daly, 2017)			✔	The research lacked the provision of a clear statement of findings.	The research is valuable, as it assisted patients in taking their medications effectively, safely, and timely by using relevant apps, such as MedAdvisor.
7. (Secondary) (Shore et al., 2014)	✔			A clear statement of findings was presented,which would helpthe targeted	The study is deemed to be valuable, as there was a strong association between mobile
				individuals to develop their quality oflife.	health technology and military mental health.
8. (Secondary) (Huckvale et al., 2015)		✔		There was evidence of presenting a clear statement of findings, which relates to enhanced clinical quality and patient safety.	The value of the study can be determined in relation to the support of long- term health conditions, such as

					asthma with the use of different mobile apps.
9. (Secondary)			✔	The study	The research is
(Burtson &				provided a clear	valuable in nature,
Vento, 2015)				statement on	as it provides a
				findings by	better
				stating sitter-	understanding
				reduction based	regarding the
				on the use of	execution of sitters
				mobile video	and video
				monitoring.	monitoring. This
					can help to
					enhance patients'
					healthcare
					conditions.
10.	✔			The research	The research is of
(Secondary)				highlighted a	the utmost value in
(Moore,				clear statement	healthcare settings,
Anderson, &				of findings that	as it provides a
Cox, 2012)				are associated	critical
				with the	understanding on
				advantages and	the use of
				the limitations	smartphones in
				of implementing	developing
				mobile apps in	patients' care and
				the domain of	safety in
				clinical practice.	healthcare
					organisations.
11.			✔	The study made	The value of the
(Secondary)				a clear statement	study can be
(Holt, Flint &				on the findings	evaluated in the
Bowers, 2011)				by inferring that	form of providing
				"mobile phones	guidance to the
				with audio and	nurses to reinforce
				image capability	discharge
				can be used to	instructions. This
				promote patient	can be conducted
				comprehension	by executing
				of and	mobile phone
				adherence to	technology, as
				complicated	well as
				self-care	applications.
				instructions".	
12		✔		No evidence of	The research has a
(Secondary)				presenting a	high value in the
(Baca et al.,				clear statement	context of clinical
2015)				of findings	practice, as it
				related to the	illustrates the ways
				research issue	through which
				was identified.	embracing
					technology can
					help to strengthen
					patients' care,
					along with
					developing human
					connections to the
					maximum possible
					extent.
13		✔		The research	The study is of
(Secondary)				lacked	utmost value in the
(Agboola,				presentation of a	field of
Bates &				clear statement	innovations in
Kvedar, 2016)				of findings	healthcare
				regarding the	delivery,
				association	promoting the
				existing amid digital health and patient safety.	execution of digital health in exchanging health informationamong medical professionals and patients.

3.3 Synthesis of Evidences

3.3.1 Theme 1: Smartphone (Mobile) Devices Used in Monitoring (DataTracking)

Certain primary and secondary literature studies selected for this review, such as Molina et al. (2017) and Rasche et al. (2017), provided a greater understanding regarding the utilisation of smartphone (mobile) devices and relevant applications in the health care sector to track patient data. For example, as per the primary study conducted by Molina et al. (2017), the "Stent Tracker" is regarded as a patient safety application that prevents patients from 'forgotten' ureteral stents. The patients can easily download this particular application from an "Apple" store, thereby installing and accessing this in their respective smartphone (mobile) devices. Consequently, with the help of The "Stent Tracker" application, patient safety from 'forgotten' ureteral stents can be ensured by enabling data collection and simplifying ureteral stent tracking with the help of an efficient interface (Molina et al., 2017). Additionally, another primary study by Rasche et al. (2017) highlights the use of smartphones and pertinent applications healthcare. According to this particular study, the AFPA signifies the mHealth app, which increases patient safety in health care by enabling older patients to self-appraise and observe the perils of falls individually. Similar to the "Stent Tracker" application, the AFPA can also be easily downloaded, and accessed by patients from their mobile phones. The effectiveness of this application in ensuring patients' safety from ground level fall-risks depends on increased self- assessment that relates to risks through the application of a low-threshold healthcare service (Rasche et al., 2017).

With respect to the results obtained from the findings by Shore et al. (2014), smartphone (mobile) devices and applications are widely used in healthcare settings by medical professionals to enhance patient safety. Hence, Shore et al. (2014) revealed that the application of Personal Affective Therapist for Rehabilitation of Individuals with Cognitive Impairments (PATRICIA), mCARE, iOS AHLTA-Mobile Prime (iAMP), and mHALcan increase patient safety within general mental health situations. PATRICIA is observed as a smartphone application, which uses an avatar, along with wearable sensors to record skin temperature, heart rate, acceleration, and respiration rates of the patients during their exercises. It facilitates the healthcare providers to increase patient safety by providing them with the prospects to track and check the exercise performance of individuals.

There are various applications that are used in healthcare, not only to develop the knowledge and skills of medical professionals, but also to support patients in improvising their individual medical conditions. For instance, the eMoods Bipolar Mood Tracker application is implemented in the healthcare context to develop patients' health conditions by involving a daily tracking mechanism. This allows patients to check their subjective mood ratings and observe medication usage, along with anxiety levels (Luxton et al., 2011). The use of smartphone (mobile) applications and their functions tends to improvise the health conditions of the patients in several ways: tracking diseases; assessing improved clinical; and peer support; and acquiring helpful information related to health from the respective medical professionals (Huckvale et al., 2015; Relias Media, 2015). In this regard, MedAdvisor is viewed as one of the e-health smartphone applications, which enhance the medical conditions of the patients by developing adherence, effectiveness, and safe execution of medications (Daly, 2017).

In Saudi Arabia, smartphone (mobile) devices and applications have been largely used by different healthcare institutions with different instructions. This has been to generate favourable outcomes, which include improved healthcare conditions for patients and the maintenance of greater safety within clinical settings. Additionally, these devices and applications are used to reduce medical care expenses; improve productivity of medical professionals involved in healthcare delivery; and decrease the rate of hospital congestion (Aldhaban et al., 2016). Various medical applications, which comprise Epocrates, Medscape, Pubmed mobile, and Oxford clinical handbooks are used to increase patient safety in different healthcare institutions within Saudi Arabia (Al-Ghamdi, 2018).

In Saudi Arabia, there are numerous factors that might pose threats in respect to the health conditions of patients. These factors comprise ineffective nursing leadership, inappropriate staffing levels, and the lack of knowledge regarding medication dosages. Furthermore, the other major critical aspect that can affect the treatment procedure of the patients within Saudi Arabia's healthcare context stems from breaches in privacy and data security (Agboola, Bates & Kvedar, 2016). Therefore, the better use of smartphone (mobile) devices, and the application of different medical applications, can mitigate these threats, thereby developing clinical practices. This also includes facilitating better administration of medication dosages, along with enriching health related information (Killikelly, 2017). Technology and health are regarded as two of the most significant aspects related to the use of smartphone (mobile) devices, along with relevant applications in the health care context (Holt et al.,2011).

The notion of mHealth can be to take into consideration the application of smartphone (mobile) devices in healthcare. For instance, as discussed by Shore et al. (2014), mHealth has the ability to comply with the ongoing mental health requirements of military service members, along with their families, in civilian healthcare settings. This is mostly due to the fact that it represents the "use of medical information exchanged from one site

to another via electronic communications to improve patients' health status" (Shore et al., 2014, p.865). Hence, it is evident that the discussions of Shore et al. (2014) are associated with the above framed review question. This provides additional insights towards the determination of the effectiveness of smartphone usage as a mechanism to increase patient safety in Saudi Arabian healthcare. It has been apparent that the findings presented by Shore et al. (2014) in their study duly considered the overall nature and the quality of the available evidences by elaborating upon the capabilities of mHealth. Subsequently, this creates a significant impact upon patients' healthcare quality. These capabilities fundamentally comprise improved communication, together with compliance; enriched health related data; and increased patient engagement in any clinical decision-making process (Baca et al., 2015).

In the context of analysing the use of mobile applications in healthcare, mCARE is viewed as a smartphone (mobile)-based text messaging mechanism, which focuses on forming, developing, and preserving bidirectional communication among patients, as well as medical professionals. In contrast, iAMP is a smartphone application, which has been designed to ensure direct access to patient safety through the Armed Forces Health Longitudinal Technology Application (AHLTA) outpatient EHR by using a login system, along with connected networks. Finally, the distinct capabilities of mHAL that ensure patient safety in healthcare include software advancement and technology evaluation on a regular basis (Shore et al.,2014).

The secondary paper by Daly (2017) also reflects that the use of a smartphone application, which is named MedAdvisor, manages complex patients' healthcare by adhering to the safe intake of medications and drug interactions. This particular application helps the patients to form, develop, and preserve a full medication list, containing detailed information about the instructions of personalised medicine dosages and the amount of repeat medications remaining among others (Daly,2017).

3.3.2 Theme 2: The Effectiveness of Using Smartphone (Mobile) Devices and Applications Which Aim To Achieve Information Provision to Increase PatientSafety

The secondary research review conducted by Luxton et al. (2011) portrayed the rapid growth rate of using smartphone (mobile) instruments, as well as applications for improving the safety of the majority of patients. Few of the examples wherein smartphone (mobile) devices and applications are used in healthcare settings are: diabetes management; digital imaging; perioperative practice; immunisation management; bio-optical sensing; and infectious disease management, among others (Luxton et al., 2011). For instance, the clinicians may deliver therapeutic skills training or audio record in-session training, which are related to relaxation breathing methods for the patients. These certainly ensure patient safety in any specific healthcare setting by tracking records of the individual medical conditions of the sufferers (Luxton et al.,2011).

The eMoods Bipolar Mood Tracker application can be duly taken into concern or the purpose of evaluating the effectiveness of using smartphone (mobile) devices. Thus, it aims to attain information provision for raising patient safety. This particular smartphone (mobile) app involves a daily tracking mechanism, which allows the patients to check their subjective mood ratings and observe medication usage, as well as anxiety levels, thereby ensuring increased safety in clinical settings (Luxton et al., 2011). The secondary research findings by Baca et al. (2015) highlight certain potential ways by which patient safety in healthcare can be increased by using smartphone (mobile) devices and applications. One of these ways comprises allowing patients to access healthcare information directly through the application of drug guides or dosage calculator apps (Baca et al.,2015).

In the healthcare context, the findings retrieved from Baca et al. (2015) highlighted that patients' safety under any clinical setting can be ensured by keeping the health records of the patients confidential. In addition, it also focuses on allowing only the responsible medical professionals to access it. Thus, it is evident that some of the hospitals, nursing homes, and the other healthcare units make better use of specialised barcodes/QR codes in order to make sure that the personal health information of the patients are not accessible to everyone. This not only contributes in maintaining the overall patient safety, but also helps in improving the quality of care along with the treatment of the individuals. Under this circumstance, the specialised barcodes/QR codes can be operated with the support of smarpthone (mobile) devices along with the assistance of the applications, which can be downloaded easily from the internet (Baca et al., 2015). As per the study findings presented by Baca et al. (2015), the smartphone application of iTranslation has been introduced and supported healthcare institutions, together with medical professionals, in ensuring patients' safety by acquiring a precise and a clear care assessment, along with treatment plans with the inclusion of voice recognition and conversion modes (Baca et al.,2015).

3.3.3 Theme 3: Utilisation of Smartphone (Mobile) Devices and Applicationsto Identify Needs of Patients

The utilisation of smartphone (mobile) devices and the applications to identify dissimilar patients' needs can be better comprehended from a nursing perspective. It is believed that the evolution of these devices

and relevant apps will serve the individual needs of the patients in terms of obtaining quality care, in addition to the treatment. This is undertaken by enabling the medical professionals, such as nurses, to access references and training materials associated with better healthcare delivery (Burtson & Vento, 2015). However, apart from nursing, the exploitation of smartphone (mobile) devices and applications also exists in outweighing the risks related to the patient privacy as well as security (Baca et al., 2015). In addition to mHealth, it is argued that the perception of digital health has the linkage by identifying the needs of the patients in one or the other. In general, this perception supports the healthcare providers and caregivers to identify and prioritise the needs of the patients (Agboola et al.,2016).

Digital health can be accessed by healthcare professionals along with the patients suffering from any disease through the help of mobile devices. In this context, the requirements of the individual patients can be fulfilled through the notion of digital health by accessing smartphone applications, communication networks, and other advanced technologies (Baca et al., 2015). These requirements can be related to patients' centeredness enhancement, boosting prospects for quality development, promoting safety, and reducing the incidence of causing harm to the individuals while delivering care (Agboola et al., 2016).

The use of mobile phone technologies proves to be effective in supporting patients to regain independence and adhere to self-care instructions successfully (Baca et al., 2015). In addition, they are also observed to evade symptom exacerbation. These factors are interrelated to efficient hospital discharge planning, which has an impact upon patients' post-treatment procedures. Specifically, there are several case studies that revealed the effectiveness of using smartphone (mobile) devices to perform a composite self-care procedure prior to being discharged from a hospital. One of these case studies has been explained in the study conducted by Holt et al. (2011; wherein, it is mentioned that the patients were able to change his/her own dressing at home after being discharged from hospital, without seeking help from another person. This is mainly due to both the visual and verbal instructions received by him/her on a smartphone (mobile)device.

IV. Discussion

4.1 Introduction

This particular chapter of the research will focus on exploring the overall findings in relation to the research aim, objectives, and the review question developed for thecurrent review. It will further include the discussion on the basis of findings retrieved from the previous reviews within the study field. This is also related to the application of these findings in the healthcare context and the identification of limitations relating to theresearch.

4.2 Reflection on the Findings

4.2.1 Applicability and Implications to Practice

Based on the secondary outcomes generated for this review, it has been clear that the prime objective of the healthcare system is to identify the needs of the patients, while addressing the same by delivering quality treatment. This is also used to develop new ways of systematic self-tracking (Huckvale et al., 2015; Moore et al., 2012). It can thus be argued that technologies at present have largely been executed in the healthcare settings within various nations around the world, including Saudi Arabia. This has significantly increased the hope to ensure improvements in the progression of self-tracking and the maintenance patients' life quality (Al-Ghamdi, 2018; Agboola et al., 2016). According to the secondary research outcomes, the critical factors including emerging distinct sorts of diseases, poor healthcare access by the patients, greater level of medical expenses, and sub-standard treatment or care quality, are conducive towards the utilisation of mobile devices for self-tracking in healthcare (Baca et al., 2015; Luxton et al., 2011). Under this circumstance, mHealth and the Stent Tracker evolved as the successful communications' technologies that can be accessed through smartphone (mobile) devices, supporting healthcare institutions and medical professionals globally, and specifically in Saudi Arabiatoaddresstherequirementsofpatientsandprovidequalitycaretothem(Molinaetal., 2017; Shore et al., 2014). Numerous mHealth related applications are presently in use within Saudi Arabian healthcare institutions that include the Ministry of Health (MOH) clinics and hospitals among others, which possess the ability to form, develop and maintain systematic self- tracking.

The mobile application of Physician Appointment Reminder is used in Saudi Arabia to remind patients of their appointments with respective healthcare professionals, such as nurses and physicians. The effectiveness of this particular application not only helps to develop self- tracking in healthcare, but also reduces the figure of 'no-show' patients by sending messages to their smartphone (mobile) devices. The messages are about reminding patients about time, clinical location, and date. Moreover, the Saudi Arabian MOH has introduced an interactive service of Health Mobile, which is based on patients accessing smartphone (mobile) devices to stay updated with any new medicine and health or disease prevention data. This interactive service also offers certain specialised courses, which emphasise diabetes, pregnancy, and other critical health disorders (Burtson & Vento, 2015; Adibi, 2014). Moreover, certain mobile phone companies have witnessed the deliverance of different

mHealth services, along with applications within Saudi Arabia. For instance, the Saudi Telecom Company (STC) arranged a free participation in "Your Health" services programme and sent a monthly health magazine to the mobile devices of the participants with distinct news and topics. Apart from STC, another telecom operator within Saudi Arabia, named Mobily, partnered with French Health Company, in order to launch mHealth application, which is mostly intended for diabetic patients. With the help of this application, patients are able to share health related information and obtain reports instantly from respective medical professionals. Hence, this leads to the removal of long-term complications with better control of diseases by the support of an enhanced self-tracking reporting system (Adibi,2014).

The use of smartphone (mobile) devices and applications is common among healthcare service providers and medical students in Saudi Arabia, as these ensure systematic tracking of healthcare and improved living conditions. The popularity of executing these instruments, as well as applications have gained momentum in Saudi Arabia, due to their significant facets of high computing skills, immense reliability, and the ability to perform various clinical duties successfully on a daily basis. Based on the obtained survey results, it has been apparent that healthcare professionals and medical students in Saudi Arabia use their personal smartphone (mobile) devices to communicate with patients, which subsequently, forms the basis of systematic tracking in healthcare (Alqaryan et al, 2016). Earlier studies clearly highlighted that patients' safety and privacy have been the main concern of health care institutions in almost all regions throughout the globe, including Saudi Arabia. Thus, with the help of utilising smartphone (mobile) devices and pertinent applications, it is expected that patient safety can be ensured through the development of an efficient self-tracking system by monitoring individual health conditions, scheduling appropriate appointments, and accessing personal medical reports in a more simple manner (Daly, 2017; Zhang & Shen, 2015; Zhang et al.,2014).

Smartphone (mobile) devices are duly considered to be a chief improvement tool for medicine, specifically within heavily populated nations, which are socioeconomically diverse in nature (Al-Mahadeen, 2015). The population residing within various regions in Saudi Arabia are also socioeconomically diverse and several people do not possess sufficient money to pay for medical care (Al-Ghamdi, 2018). The obtained findings show that smartphone (mobile) devices and relevant applications tend to enhance efficiency level of consulting physicians, develop access towards medical care and treatment, and decrease healthcare expenses. Therefore, it is essential to incorporate these devices and applications into the Saudi Arabian healthcare domain. In the modern era, smartphone (mobile) devices play an imperative role in the healthcare context, as health professionals tend to develop their individual skills and knowledge, while ensuring deliverance of better and quality care to patients. These devices and suitable applications can be duly considered as the mechanism for raising patient safety in the Saudi Arabian healthcare domain due to their ability to develop and maintain close association among medical professionals and patients. This further facilitates greater access towards evidence-based guidelines of patient-care (Al-Mahadeen, 2015).

Evidence suggests that the healthcare domain, particularly in Saudi Arabia, has enhanced extensively in the contemporary world, compared to earlier years. In this context, the adoption of a primary healthcare (PHC) approach can be considered to be one of the key reasons for the advancement of medical services in Saudi Arabia. This particular approach focused on educating people belonging to diverse communities in the regions of Saudi Arabia about existing healthcare issues, making provisions to supply an adequate level of safe drinking water,and promoting food nutrition, along with immunisations for children against critical communicable diseases. Despite Saudi Arabia witnessing growing development in healthcare, it can be argued that correct coordination or communication channels do not exist, resulting in wastage of resources, deceasing patient safety, and increasing duplication of efforts made by the respective medical professionals (Almalki, Fitzgerald, & Clark, 2011). Under this circumstance, smartphone (mobile) devices and appropriate applications might have a place in the healthcare domain of Saudi Arabia, resulting in enhanced coordination, as well as communication among healthcare professionals and the patients.

It is believed that execution of smartphone (mobile) devices or mobile technology in healthcare within Saudi Arabia at all levels (i.e. tertiary, secondary, and primary) could promote patient safety to a certain level. This can be made possible by addressing a more complex nature of care, establishing more provisions related to treatment for the prevailing adverse health conditions, and maintaining patients' health records to the maximum possible extent. As per the referral of the MOH, it is evident that physicians, nurses, and allied health professionals are well distributed in various public, government, and private sectors in Saudi Arabia. This eventually creates the requirement to maintain a strong communication and coordination among these personnel (Almalki et al., 2011).

4.2.2 **Discussion of the Challenges in Using Smart phones to Increase Patient Safety**

The healthcare sector within Saudi Arabia has developed rapidly in the present day context. This may be due to its increased wealth, as well as the greater prioritisation of the respective government to deliver quality care to the Saudi population. Thus, it can be stated that Saudi Arabia's healthcare at present is undergoing

reform, targeting towards progressing patients' wellbeing and quality of life. However, the growing burden of chronic diseases, increasing the shift towards the ageing populaces, and rising momentum of using advanced technologies in treatment procedures of smartphone devices and medical applications, are expected to increase healthcare costs considerably in Saudi Arabia (Al-Hanawi, 2017). Previous studies, which were conducted, regarding the use of smartphone (mobile) devices, along with suitable applications in healthcare, determined that certain issues are faced while applying health care in Saudi Arabia. These issues relate to patients' privacy and security, along with their health related data, which needs to be addressed to adhere to the needs of individuals and provide them with better care. According to the studies, there is the possibility of information threats when patients are provided treatment by using smartphones and applications. Consequently, this critical issue might impose adverse effects upon Saudi Arabia's healthcare mechanisms to increase patient safety, due to the absence of a standard procedure. Nonetheless, this helps to ensure encrypted data storage and transmission (Istepanian & Woodward, 2016; Zhang & Shen, 2015).

Based on the findings obtained through the current study, it is clear that the use of smartphone (mobile) devices and applications play a vital part in the development of the entire healthcare system in Saudi Arabia. Comparatively, the use of these instruments and apps, provide several benefits that entail diminished medical expenses of healthcare institutions. Additionally, this also delivers quality care to patients. Contextually, serious unintended issues from their application have emerged. For instance, although the mobility aspect made is quite simple to access the facilities of mHealth and other healthcare apps, the network issue still persists, and thus, reduces their overall effectiveness. Evidence suggests that smartphone (mobile) networks and internet connections are unreliable and expensive in nature. Consequently, this eventually creates a barrier in the smooth execution of technological tools in healthcare (Relias Media,2015).

In relation to Saudi Arabia, even though Saudi customers have the ability to incur expenses over the use of smartphone (mobile) devices and the access to internet connections, a lack of network connectivity may deter healthcare institutions. Hence, this would affect the nation to develop its healthcare system, manage patients' health, and deliver quality care to them. Therefore, certain technological tools, including mHealth, might prove to be beneficial for the name, which has unique and diverse cultural norms. However, at certain times, this cultural diversity factor may create a barrier for individuals to reap significant benefits from the execution of the mHealth apps. Considering that the people of Saudi Arabia possess distinct sorts of cultural values, along with beliefs, their health behaviours might become affected, due to the decreased ability in managing their individual healthcare (Albabtain et al.,2014).

From the above discussion, it is evident that privacy, along with security, cannot be considered as the sole issue. Cultural diversity along with the absence of strong network connectivity is recognised as the other issues that people face while obtaining care from the healthcare institutions and medical professionals by using smartphones and relevant apps (Baca et al., 2015). Under these circumstances, certain initiatives need to be considered for the purposes of removing the barriers that are associated with the exploitation of smartphone (mobile) devices and pertinent applications (Agboola et al., 2016); one of these initiatives can be determined as development in technical architecture. This further involves data exchange standards, which results in increased health care access by strengthening network connectivity, and maintaining the quality of mobile services. Hence, the factor concerning mobile service quality is affected by numerous aspects that embrace the mobile instrument, network, cost, information mechanism, security, and cultural elements (Holt et al., 2011). Another way to address the issues related to the utilisation of smartphone (mobile) devices and applications in Saudi Arabia's healthcare sector relates to the partnership with several external agencies, non- governmental organisations (NGOs), and potential shareholders. It is thus expected that working collaboratively with these regulatory bodies will help to enhance the healthcare system and patients' quality of life (Albabtain et al.,2014).

According to the findings, it has become apparent that the use of smartphone (mobile) devices, along with the applications, has grown substantially in the healthcare domain in this present day context, as compared to earlier years. However, there is also a growing concern regarding the challenges associated with the use of smartphone (mobile) devices and relevant applications in this technology-driven era. For instance, in relation to one of the studies performed in Saudi Arabia, it is observed that the execution of smartphone (mobile) devices has been associated with several health hazards, such as a headache, tension, sleep trouble, dizziness, and fatigue (Alosaimi, Alyahya, Alshahwan, Mahyijari & Shaik, 2016). This eventually poses threats to patient safety at an extensive level under any specific clinical setting. While discussing the challenges in using smartphones to raise patient safety, the fact cannot be ignored that these devices and associated applications have certain limitations due to their extreme dependency over the internet medium and the operational networks. As per the findings obtained through various secondary sources, it is noted that one of the smartphone applications (i.e. mHealth) is used in the Saudi Arabian healthcare domain, which tends to enhance the issue of patient safety through various ways. These typically encompass maintaining patients' health records in a uniformmanner, along with monitoring their individual diseases electronicall. This also includes creating precise medical documentation and managing workflow as per expectation level (Al-Ghamdi, 2018; Adibi,2014).

Even though mHealth application delivers effective solutions to numerous healthcare related problems and patient safety in Saudi Arabia and other regions throughout the globe, it possesses certain crucial challenges in its application. These challenges can be duly measured in the form of ethics, application management, usability, and mobile networks. In relation to the ethics factor, the challenges in applying smartphones to patient safety in Saudi Arabia can be related to privacy, trust, equity, and responsibility for errors during the deliverance of care, along with the treatment to individual patients. Comparatively, with regard to application management, issues in using smartphones to patient safety in Saudi Arabia can be duly measured in the forms of data protection and authorisation. There is also the authentication of the users towards accessing patients' healthcare records under any clinical setting. In contrast, as per the identified usability feature, the challenges in exploiting smartphones to patient safety in Saudi Arabia include: small mobile screens, inappropriate data entry into the systems, poor battery life, and unsuitable contents. Finally, in case of the factor concerning mobile networks, the issues related to the application of smartphones in ensuring patient safety in the Saudi Arabian healthcare domain are identified as: bandwidth, information integration, and network coverage (Bhutkar, Karande & Dhore, 2009). These identified challenges decipher the fact that smartphone (mobile) devices and applications can be used in healthcare for the purpose of ensuring patient safety, but should be handled with care for patients' health conditions to improve to the maximum possible extent.

4.2.3 **Applicability and Learning for Saudi Arabia**

The introduction and application of smartphone (mobile) technology has changed healthcare standards, along with that of medical professionals. This has been undertaken by supporting the decision-making procedures of clinicians and facilitating them to access patient information (Thomairy et al., 2015). It can be argued that smartphones and suitable applications can be used to increase patient safety in healthcare within Saudi Arabia by recording and safeguarding valuable information within a mobile setting (Molina et al., 2017; Rasche et al., 2017). It is the clinicians, by using handheld mobile devices and clinical reference related apps, who verify drug recommendations and safety data (Athenahealth, Inc, 2014). Furthermore, the exceptional facets of smartphones comprise universality and versatility, which eventually become part of the healthcare sector within Saudi Arabia and raise patient safety levels (Shih & Liang, 2014). Patient safety in this context of healthcare can be ensured by addressing the medication errors, such as prescribing wrong drugs and delayed or missed diagnoses. Moreover, the use of smartphone (mobile) devices and relevant medical applications can enhance patient safety in Saudi Arabia by fixing appointments with the respective medical professionals, in addition to increasing physicians' drug knowledge (Ho & Quick, 2018; Luxton et al.,2011).

While discussing the exploitation of smartphone applications in the healthcare field, the MOH is viewed as the chief health care service provider in Saudi Arabia. Its health care services are segregated into three categories: 'primary', 'tertiary' and 'secondary'. Considering that a hybrid approach is duly followed in the Saudi Arabian healthcare sector, it can be argued that the institutions involved in the provision of quality care to patients may record valuable medical data both electronically and in a paper-mode basis. Therefore, in the context of recording healthcare data electronically, pertinent smartphone (mobile) applications, including Medscape, Epocrates, Gray's Anatomy, and Pubmed Mobile are currently being used. Accordingly, this has gained momentum among different healthcare institutions and medical professionals in Saudi Arabia (Alkadi, 2016).

The utilisation of smartphone (mobile) devices and applications has relevance in the Saudi Arabian healthcare sector, especially during patients' treatment procedures. This engages three particular stages: 'admission', 'treatment', and 'discharge'; which necessitate recording medical data electronically (Alkadi, 2016). During these phases, the healthcare institutions within Saudi Arabia may use smartphones and apps, such as CloudPital Electronic Medical Record (EMR) software to develop the existing patients' data management system. In addition, this has also increased patients' safety in respective clinical settings. Indeed, the several quality characteristics of CloudPital EMR software include e-prescription, online appointments, scheduling, multi-clinic, charting, sharing data, billing, and acquiring patients' demographic details. Additionally, the other major facets of CloudPital EMR software are identified as integrated medical insurance and financial accounting. This further includes roster management, laboratory testing ,as well as medications ordering ,records of clinical procedures, and offering customised and built-in reports. With respect to the Saudi Arabian healthcare sector, the use of CloudPital EMR software through smartphone (mobile) devices is likely to ensure patients' safety by performing a better analysis and management of health records or medical data. This also helps to respond to care and improve decision-making, in addition to operational productivity enhancement of healthcare professionals (CloudPital, 2017).

According to the survey results presented in the study conducted by Alqaryan et al. (2016), healthcare professionals, comprising of physicians and nursing students in Saudi Arabia, possess personal smartphones that have security features. These features comprise data encryption and password protection, which help to better ensure patient safety on a macro-scale (Holt et al., 2011). Earlier studies highlighted the fact that smartphone

technologies that comprised of e-services, mobile internet, and IT applications are largely used in healthcare settings witching Saudi Arabia. This helps to reduce hospital congestion rates; develop medical professionals' productivity; and decrease incurred expenses in medical care (Al-Ghamdi, 2018; Aldhaban, Daim & Harmon, 2016). Nevertheless, apart from smartphone (mobile) devices, certain healthcare apps, including Eponyms, Gray's Anatomy, the Oxford medical dictionary, and the ECG guide are widely executed in Saudi Arabia's health caresettings.

These applications are used by different health care professionals, such as physicians, nurses, and students, which also functions through the intention to update their knowledge. This further involves, preparing for different medical examinations and to obtain knowledge regarding drugs or medications (Al-Ghamdi, 2018). Similar results have been presented by Sayedalamin et al. (2016), wherein, the survey outcomes revealed that the medical students in Saudi Arabia use the applications of Medscape, Uptodate, Epocrates, iPharmacy, ECG Guide, Micromedex, and Skyscape. Besides, the students also utilised the applications of Gray's Anatomy, Pubmed Mobile, Prognosis, iStethoscope, Instant ECG, and MedCalc. Specifically, amongst these medical apps, Medscape, Pubmed Mobile, Medical Updates, and Gray's Anatomy are quite popular among medical students within Saudi Arabia (Sayedalamin et al., 2016). An earlier study conducted in relation to digital health defined this notion as "the cultural transformation of how disruptive technologies that provide digital and objective data accessible to both caregivers and patients leads to an equal level doctor-patient relationship with shared decision-making and the democratization of care" (Mesko, Drobni, Benyei, Gergely, & Gyorffy, 2017, p. 1).

Evidence suggests that greater access to relevant medical applications provide active support to healthcare workers within Saudi Arabia (Almeshal et al., 2016). Consequently, due to the advancement in smartphone technology, Saudi Arabia's healthcare segment gradually transformed from a traditional paper approach to the execution of an electronic patent record mechanism. According to the National Health Service (NHS), the notion of Electronic Patient Record (EPR) is described as "an electronic record of periodic health care of a single individual, provided mainly by one institution" (Alkadi, 2016). The maintenance of EPR with the help of smartphone (mobile) devices and relevant applications helped to enhance healthcare performance quality Saudi Arabia, whilst also diminishing medical expenses to the maximum possible extent. EPR methods are utilised in distinct Saudi hospitals for the purposes of accessing suitable patients' health care information. This helps in saving operational costs; improvising data management procedure; and ensuring the safety of the individuals.

Consumers within Saudi Arabia generally take digital technology into consideration, as it is a vital aspect in the successful management of health and living conditions. In this context, the application of smartphone (mobile) devices, such as mHealth can be related to digital technology, which supports patients in Saudi Arabia to access quality care. This also facilitates treatment with greater safety, as well as the control of their individual diseases. On the basis of obtained survey results, a major portion of the people of Saudi Arabia is shown to consider technology as the crucial determinant of the management and control of their health. Based on these results, it becomes apparent that Saudi Arabian customers consider technology to manage their health care use regarding online websites of the healthcare institutions, pertinent medical applications, remote monitoring systems, and social media. Indeed, patients in Saudi Arabia have agreed to the fact that they obtain better and advanced care when health care professionals access and implement their own Electronic Health Record (EHR) through smartphone (mobile) devices and applications. Several essential aspects, which comprise generating laboratory results, providing billing information, acquiring patients' history of prescription medication, and determining immunisation, contribute to the management of Saudi customers' health (Accenture, 2016).

Smartphones can be used to increase patient safety in healthcare within Saudi Arabia by carefully accessing EHRs of patients following hospital admission until their discharge. This can also be increased by promoting healthcare quality and developing care in alignment with individual patients' needs (Papadakos & Bertman, 2017). Patient safety issues in any clinical setting mainly arise from the data provided by the individuals during the admission and the laboratory results that are generated following admission. Therefore, from the perspective of the customers or patients, the use of smartphones can ensure their safety by collecting, storing, and processing valuable health care data in a uniformed manner (Killikelly, 2017; Househ, 2014). In particular, information, which is displayed through the smartphones, such as guidelines for prescribing antibiotics, helps to ensure patients' safety. This also helps to support medical professionals to update their clinical knowledge, as per expectation levels (Relias Media, 2015; Moore & Jayewardene, 2014). The use of smartphones can improve patient safety in health care settings within Saudi Arabia by supporting nurses to access present clinical resources in the most effective manner (George et al., 2017). It is believed that the greater chance of communication among patients and physicians or clinicians is achieved by sending texts or visual messages through the smartphones, which may also contribute to improved safety aspects for Saudi Arabian patients (Honeywell International Inc, 2014).

4.3 Limitations of the Reviews

It has been mentioned previously that a total of 13 literature studies were considered for the current research following the exclusion and inclusion criteria. Out of these studies, two were primary papers and the remaining eleven were secondary sources. With respect to the primary papers (Killikelly, 2017; Molina et al., 2017; Rasche et al., 2017; Burtson % Vento, 2015; Relias Media, 2015), the limitations of the reviews can be measured based on the evaluation, as well as the validation of the applications selected in the individual researches. This also involves a lack of consideration from adequate statistical tools to analyse the collected primary data. Apart from the primary papers, limitations are also shown in the case of the secondary papers as well. For instance, the studies conducted by Daly (2017); Agboola, Bates and Kvedar (2016); Baca et al. (2015); Huckvale et al (2015); Shore et al. (2014); Moore et al. (2012), Holt et al. (2011) and Luxton et al. (2011) relied more on collecting, analysing, and interpreting secondary data, instead of performing primary research. Moreover, deficiency in the application of recruitment strategy and relationship amid the researcher(s) and the participant(s) can also be duly considered to be limitations of the selected secondary papers'reviews.

V. Conclusion and Recommendations

5.1 Introduction

In this chapter, the main research arguments to the research have been restated and the most significant evidence is reiterated, which support these arguments. Moreover, the key points derived for the study have been presented in a summarised form in this chapter.

5.2 Conclusion

There were numerous studies, which highlight the involvement of smartphone (mobile) devices in the healthcare sector. For instance, the research findings obtained from the studies conducted by Dicianno et al. (2015) and Ventola (2014) clearly stated that the application of smartphone (mobile) instruments helps in modifying self-care behaviours of patients. This is specifically related to diet control, along with weight management. It is healthcare professionals, such as the physicians, who tend to use smartphones to update their medical knowledge and to provide quality care to patients. There are various features relating to the smartphones that are used by clinicians with respect to the care delivery process. These facets fundamentally comprise high-resolution screens, huge memories, strong processors, and screens of high-resolution. With these characteristics, smartphone (mobile) devices in healthcare are used with the support of satellite transmissions, wireless communication networks, and radio waves among others (Ventola, 2014).

Based on the findings retrieved from various literature studies considered for the research, it can be argued that different healthcare institutions, including hospitals and nursing homes use smartphones. These are used mostly with the intention of treating patients with care, along with developing the overall productivity levels of staff members; this is achieved by offering quality training to them (Camacho et al., 2e014). It has been observed, especially in the healthcare sector, the importance of using smartphone (mobile) devices can be determined in terms of forming and developing, as well as preserving effective communication among the patients and the respective medical professionals. This largely enhances the information system and makes better use of time, along with available resources (Talwar et al., 2016). In this context, it can be stated that hospitals can use smartphone devices for monitoring, as well as tracking data. In this context, it has been evident that "Stent Tracker" is perceived as one of the most effective application, which is being used for the purpose of preventing patients from having 'forgotten' ureteralstents.

Initial literature search review results demonstrated compelling evidence regarding the impact of smartphone effectiveness in the healthcare context. It can be critically stated that the evolution of various technological advancements including 'blood glucose meters', 'hand-held microscope smartphone adapters', and 'wireless laboratory hand-held sensors' enhance the healthcare conditions of patients suffering from any sort of disease. For instance, the impact of 'blood glucose meters' and 'hand-held microscope smartphone adapters' can be recognised as remote measuring, recording, and transmitting forms, as well as maintaining blood glucose levels. These also help in performing successful microscopic examination relating to the specimens of the patients respectively. Correspondingly, the 'wireless laboratory hand-held sensor' influences the healthcare conditions of the patients by ensuring smooth workflows while generating the laboratory test results (Camacho et al., 2014). With differential reviews regarding the execution of smartphone (mobile) devices in the healthcare domain, it can be argued that the influences of smartphone effectiveness is characterised by various significant aspects, this encompasses handheld imaging, sensors, wireless apparatus, lab-on-a-chip technologies, and design simplicity (Al-Ghamdi, 2018). According to the literature search review findings obtained for this research, it is apparent that the main impact of smartphone effectiveness in healthcare exists in developing quality of care with respect to patients. This is undertaken by identifying and addressing their individual needs, along with performing effective medical profiling (Camacho et al., 2014).

In order to analyse the execution of smartphone (mobile) devices as a mechanism to increase patient

safety in healthcare, certain challenges have been identified, which lead to generating unfavourable outcomes. The challenges relate to privacy, security, and deficiency in verifying along with downloading medical applications without an appropriate guidance (Istepanian & Woodward, 2016). Additionally, as per the obtained literature search review results, the other challenges of executing smartphones in healthcare include the misuse of important medical information and loss of medical data due to the failure of operating systems in smartphones. It can be critically inferred that the healthcare patients and the healthcare providers are prone to face the challenges that are associated with the use of smartphone (mobile) devices. With respect to the case of the healthcare patients, the challenges may be associated with a lack of communication with the respective medical professionals. Additionally, it is also difficult to track their health statuses and access their own medical records easily. Comparatively, healthcare providers, including physicians and nurses, may face challenge with respect to managing patients' safety due to shortage in maintaining precision while using smartphones (Zhang et al., 2014).

The application of smartphones is witnessed in Saudi Arabia's healthcare segment, which has been growing at a rapid rate through this technology driven era. Based on the overall findings obtained from the literature studies, it can be inferred that mobile internet, IT applications, and e-services are some of the smartphone technologies, which are being used widely in the Saudi Arabian healthcare sector (Aldhaban et al., 2016). Apart from the smartphone devices, certain medical apps are also used by physicians, nurses, and the institutions for the purpose of reducing healthcare expenses. Additionally, it also helps in improving care delivery procedures and decreases the rate of hospital congestion. These medical apps typically include: iPharmacy, Medscape, UpToDate, Eponyms, Oxford clinical handbooks, and Pubmed Mobile, among others (Al-Ghamdi, 2018). The effectiveness of these medical apps in healthcare in Saudi Arabia helps to ensure quick access to the reliable sources of clinical capabilities, computing precise medial dosages, and facilitating healthcare professionals to perform evidence- based practices. These factors largely contribute in enhancing patient safety by an extensive level. Therefore, it leads towards developing patient's quality of life (Al-Ghamdi, 2018; Adibi, 2014). In addition, with the application of smartphone devices, the effectiveness with respect to the used of smartphone (mobile) devices and applications have been helpful in attaining information provisions for the purpose of improving patient safety. These devices have been significantly used to provide training through audio-visual sessions with. Subsequently, this has significantly increased patients'safety.

In relation to the above framed review question, the results gained from the literature search review displayed that smartphones can be used to improve patient safety in the healthcare sector of Saudi Arabia in various ways. For instance, the utilisation of the Stent Tracker and the AFPA are effective in ensuring patient safety with respect to "forgotten" ureteral stents, as well as ground level falls, respectively. This can be conducted by tracking healthcare issues with the support of effective network interfaces. The patients can easily download these applications from their smartphones and track their records to the maximum possible extent (Molina et al., 2017; Rasche et al., 2017). Moreover, other medical applications, which entail mCARE, iAMP, PATRICIA, and mHAL, have the ability to ensure patient safety. Hence, these can be applied in Saudi Arabia's healthcare industry by providing an opportunity to the healthcare professionals to evaluate individual health records of the patients (Shore et al., 2014). As per the literature's search review results acquired from the secondary sources considered for the study, patient safety can be ensured by using the smartphone application of MedAdvisor. This particular application helps patients consume the right amount of prescribed medication by the respective physicians, which in turn, increases their safety during the process of medication interactions (Daly, 2017). In addition, these devices have also been effective in understanding the overall needs of the patients. Thus, it will further help healthcare professionals, along with nurses to provide the necessary levels of care, thereby enhancing patientsafety.

The overall findings obtained for this research are deemed as reliable in nature, as a systematic review was conducted. Additionally, its key stages were followed by using an appropriate keywords search strategy, together with inclusion and exclusion criteria. For instance, the literature studies comprising keywords, such as smartphone devices, patient safety, mobile, and the materials embracing information about the utilisation of medical apps, were included. What is more, literature studies published prior to the year 2004 were excluded in this research. Following these criteria helped to ascertain valid inferences for the research by validating and enhancing the generalisability of the overall findings.

5.3 Recommendations

The application of smartphone (mobile) devices in healthcare in Saudi Arabia is expected to grow in the future. Therefore, the medical professionals belonging to different healthcare institutions should ensure that the smartphone (mobile) devices and the relevant apps are used in such a way that patient safety is enhanced as per expectation levels. In this context, it is also recommended that healthcare institutions should incorporate with mHealth in their respective healthcare systems; this is to mainly ensure patient safety (Lee, 2016; Krohn & Metcalf, 2012). Thus, this will maintain equilibrium in the benefits and the risks associated with the use of

smartphones in healthcare and patient safety. Subsequently, healthcare institutions must develop better electronic mechanisms in a more efficient way (Agrawal, 2016; Ludwin & Greysen, 2015).

It is, therefore, believed that greater access towards mobile data, along with messages in the healthcare segment, is necessary to ensure patient safety (Khalil, 2006). As a result, the healthcare institutions, together with the involved medical professionals, must check the portability, usability, and the accessibility of the smartphones to be used in the healthcare domain (West, 2014; Vincent, 2011). In addition, it was mentioned previously that privacy and security are viewed as crucial challenges, which are associated with the execution of smartphones; this often deters patient safety at large. Due to this, it is recommended to healthcare professionals to make better use of data encryption. Furthermore, they should also focus on protecting their devices with passwords, in order to mitigate the challenges as per desired levels (Benefield, 2014; Flynn,2012).

5.4 Future Research

Based on the limitations identified for this review, future research should be conducted in a more organised manner. This can be made possible by considering more primary research papers related to the developed review question for this particular research. Only 2 primary papers were selected for the research after following an appropriate inclusion and exclusion criteria. Therefore, in future research, an attempt will be made to include more primary research- based papers, in order to address the research aim, objectives, and the review question in a more descriptive way. Including more number primary research papers would increase the generalisability of the findings to be retrieved for future research to an extensive level. As per the secondary research-based papers selected for the research, a lack of developed relationships was identified to prevail among the researchers and the participants, which might have limited the scope of the present research. Therefore, endeavours will be made in the future to identify and analyse this relationship in order to generate better results. This can be made possible by using primary papers that are related to the identified research issue: the use of smartphones as a mechanism to raise patient safety in Saudi Arabia's healthcare domain.

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References

[1]. Abadel, H. M. & Saifuddeen, A. A. (2017). Study of knowledge, attitude and preferences of primary health care physicians in Saudi Arabia regarding the use of medical software applications on their smartphones.Annals of International Medical and Dental Research, 3(2), 6-9.
[2]. Accenture. (2016). Patients want a heavy dose of digital. Accenture Consulting. Retrieved from https://www.accenture.com/ t20171208T093842Z__w/sa-en/_acnmedia/PDF- 23/Accenture-Patient-Engagement-Infographic-Saudi-Arabia.pdfAdibi, S. (2014). mHealth multidisciplinary verticals. US: CRC Press.
[3]. Adibi, S. (2014). mHealth multidisciplinary verticals. US: CRC Press.
[4]. AGC Networks Limited. (2016). Healthy tomorrow with healthcare technology solutions. About AGC. Retrieved from http://www.agcnetworks.com/in/industry/healthcare/
[5]. Agboola, S. O., Bates, D. W., & Kvedar, J. C. (2016). Digital health and patient safety. Jama, 315(16), 1697-1698.
[6]. Albabtain, A. F., AlMulhim, D. A., Yunus, F., & Househ, M. S. (2014). The role of mobile health in the developing world: A review of current knowledge and future trends. Journal of Selected Areas in Health Informatics, 4(2),10-14.
[7]. Aldhaban, F., Daim, T. U., & Harmon, R. (2016). Exploring the adoption and use of the smartphone technology in emerging regions: Case of Saudi Arabia. 2016 Proceedings of PICMET '16: Technology Management for Social Innovation. Retrieved from http://www.picmet.org/db/member/proceedings/2016/data/polopoly_fs/1.3250802.1472156 617!/fileserver/file/680632/filename/16R0085.pdf
[8]. Alqaryan, S., Alkhalifa, M., Alharbi, M., Alabaishi, S., & Aldrees, T. (2016). Smartphones and professionalism: A cross-sectional study on interns and final-year medical students. International Journal of Medical Research & Health Sciences, 5(9), 198-202.
[9]. Al-Hanawi, M. K. (2017). The healthcare system in Saudi Arabia: How can we best move forward with funding to protect equitable and accessible care for all? International Journal of Healthcare, 3(2), 78-91.
[10]. Almeshal, F., Asiri, F., Alyamani, A., Aljehani, S., Almuhana, A., & Alothman, A. (2016).Bacterial contamination of healthcare workers' mobile phones in a tertiary care center in Saudi Arabia.International Journal of Advanced Research, 5(1), 1179-1183.
[11]. Al-Mahadeen, B. M. (2015). Factors affecting the readiness of medical doctors and patients with chronic conditions toward the usage of smartphones in the Saudi Arabian healthcare sector. iJIM, 9(1), 47-51.
[12]. Al-Ghamdi, S. (2018). Popularity and impact of using smart devices in medicine: Experiences in Saudi Arabia. BMC Public Health, 18(531), 1-7.
[13]. Alosaimi, F. D., Alyahya, H., Alshahwan, H., Mahyijari, N., & Shaik, S. A. (2016). Smartphone addiction among university students in Riyadh, Saudi Arabia. Saudi Med J, 37(6), 676-682. Alkadi, S. H. (2016). The healthcare system in Saudi Arabia and its challenges: The case of diabetes care pathway. Journal of Health Informatics in Developing Countries, 10(1), 1-10.
[14]. Almalki, M., Fitzgerald, G., & Clark, M. (2011). Health care system in Saudi Arabia: An overview. EMHJ, 17(10), 785-792.
[15]. Alotaibi, Y. K. (2017). The impact of health information technology on patient safety.Saudi Med J, 38(12), 1173-1178.
[16]. Alsulame, K., Khalifa, M., & Househ, M. (2016). E-Health status in Saudi Arabia: A review of current literature. Health Policy and Technology, 5, 204-210.
[17]. Alswat, K., Abdalla, R. A. M., Titi, M . A., Bakash, M., Mehmood, F., Zubairi.B.,...El-Jardali, F. (2017). Improving patient safety

culture in Saudi Arabia (2012–2015): Trending, improvement and benchmarking. BMC Health Services Research, 17(516), 2-14.
[18]. Arab News. (2017). Saudi Arabia ranks 3rd globally for smartphone use. http://www.arabnews.com/node/1075126/corporate-news
[19]. Athenahealth, Inc. (2014). Going mobile: Integrating mobile to enhance patient care and practice efficiency.White Papers. Retrieved from http://landing.athenahealth.com/Global/FileLib/Whitepapers/Mobile_Devices_Whitepape r.pdf
[20]. Australian Commission on Safety and Quality in Health Care. (2018). Background.Impact of Digital Health on the Safety and Quality of Health Care, 3.
[21]. Bassi, J. (2017). Vision 2030. Vision 2030 and the Opportunities it Represents in Healthcare in Saudi Arabia, 1-2.
[22]. Bhutkar, G., Karande, J. B., & Dhore, M. (2009). Major challenges with mobile healthcare applications. BJIMHC, 1-14.
[23]. Boland, A., Cherry, G. & Dickson, R. (2017).Doing a systematic review: A student's guide.
[24]. Thousand Oaks: SAGE.
[25]. Bowman, S.,& Fahima, R. (2013). Impact of electronic health record systems on information integrity: Quality and safety implications. Perspectives in Health Information Management,1-12.
[26]. Burtson, P. L., & Vento, L. (2015). Sitter reduction through mobile video monitoring.The Journal of Nursing Administration, 45(7/8),363-369.
[27]. Camacho, E., LoPresti, M., Appelboom, G., Dumont, E. L., Taylor, B., & Connolly, E. S. (2014). The ubiquitous role of smartphones in mobile health.Biometrics& Biostatistics International Journal, 1(1),1-6.
[28]. CASP UK. (2018). CASP-qualitative-checklist. Retrieved from https://casp-uk.net/wp- content/uploads/2018/01/CASP-Qualitative-Checklist.pdf
[29]. Centre for Digital Media. (2018). What is digital media? News. Retrieved from https://thecdm.ca/news/what-is-digital-media
[30]. Chung, H., Mayes, J., & White, A. (2014). How smartphone technology is changing healthcare in developing countries. Retrieved from https://www.ghjournal.org/how-smartphone- technology-is-changing-healthcare-in-developing-countries/
[31]. Cohn, S. M., & Brower, S. T. (2012). Surgery: evidence-based practice. California: PMPH- USA.
[32]. CorynC. L. S., Noakes, L. A., & Westine, C. D., & Schröter, D. C. (2011). A systematic review of theory-driven evaluation practice from 1990 to 2009. American Journal of Evaluation 32(2) 199-226.
[33]. CloudPital. (2017). Electronic medical record (EMR) software in Saudi Arabia.Solutions. Retrieved from https://www.alrasmyat.com.sa/n/cloudpital/electronic-medical-record-emr- software-in-saudi-arabia/
[34]. Daly, A. (2017). MedAdvisor: an app for taking medications safely, effectively and on time.
[35]. Elsevier B.V., 63(4), 268-268.
[36]. Deloitte. (2013). Digital media: rise of on-demand content. Content. Retrieved from https://www2.deloitte.com/content/dam/Deloitte/in/Documents/technology-media- telecommunications/in-tmt-rise-of-on-demand-content.pdf
[37]. Dicianno, B. E., Parmanto, B., Fairman, A. D., Crytzer, T. M., Yu, D. X., Pramana, G., Coughenour, D.,...Petrazzi, A. A. (2015). Perspectives on the evolution of mobile (mHealth) technologies and application to rehabilitation.Innovative Technologies Special Series, 95(3), 398-402.
[38]. Falaki, H., Mahajan, R., Kandula, S., Lymberopoulos, D., Govindan, R. & Estrin, D. (2017).
[39]. Diversity in smartphone usage. ACM, 1-3.
[40]. Frost, K. H., & Sullivan, S. K. (2015). Mobile devices in a medical setting: which ones are providing real value? Sprint. Retrieved from https://businesssolutions.sprint.com/rs/sprint/images/FS_WP_Devices%20HC_010615_pri nt%20FINAL.pdf
[41]. GP Bullhound LLP. (2015). Digital healthcare.Independent Technology Research Report, 7-9.
[42]. George, T. P., DeCristofaro, C., Murphy, P. F., & Sims, A. (2017). Student perceptions and acceptance of mobile technology in an undergraduate nursing program. Healthcare, 5(35), 1-8.
[43]. Hoffman, T., Bennett, S. & Mar, C. D. (2013).Evidence-based practice across the health professions - E-book.US: Elsevier Health Sciences.
[44]. Honeywell International Inc. (2014). Introduction. Mobile Device Convergence in Healthcare. Retrieved from https://aidc.honeywell.com/Catalog Documents/mobile-device- convergence-white-paper.pdf
[45]. Hostetter, M., Klein, S., & McCarthy, D. (2014). Introduction. Taking Digital Health to the Next Level, 8-9.
[46]. Ho, A., & Quick, O. (2018). Leaving patients to their own devices? Smart technology, safety and therapeutic relationships.BMC Medical Ethics, 19(18), 1-6.
[47]. Househ, M. (2014). Social media and mobile technologies for healthcare. Hershey: IGI Global.
[48]. Holt, J. E., Flint, E. P., & Bowers, M. T. (2011). Got the picture? Using mobile phone technology to reinforce discharge instructions. AJN, 111(8),47-50.
[49]. Huckvale, K., Morrison, C., Ouyang, J., Ghaghda, A., & Car, J. (2015). The evolution of mobile apps for asthma: an updated systematic assessment of content and tools. BMC Medicine, 13(1), 1-15.
[50]. Istepanian, R. S. H., & Woodward, B. (2016). m-Health: Fundamentals and applications.Hoboken: John Wiley & Sons.
[51]. Kallinikos, J., Aaltonen, A., & Marton, A. (2013). The ambivalent ontology of digital artifacts. MIS Quarterly, 37(2), 357-370.
[52]. Klein, S., Hostetter, M., & McCarthy, D. (2014). Introduction. A Vision for Using Digital Health Technologies to Empower Consumers and Transform the U.S. Health Care System, 8-9.
[53]. Knoll, T., Omar, M. I., Maclennan, S., Hernandez, V., Canfield, S., Yuan, Y.,..., Sylvester, R. (2018). Key steps in conducting systematic reviews for underpinning clinical practice guidelines: Methodology of the European Association of Urology. European Urology, 73, 290-300.
[54]. Koninklijke. (2018). Provide access virtually anywhere. Information management Mobility. Retrieved from https://www.philips.co.in/healthcare/articles/mobile-medical-apps-provide-access-virtually-anywhere
[55]. Killykelly, C. (2017). Developing a mobile device to record mental health inpatient data. Nursing Times, 113(8), 52-55.
[56]. Luxton, D. D., McCann, R. A., Bush, N. E., Mishkind, M. C, & Reger, G. M. (2011). mHealth for mental health: integrating smartphone technology in behavioural healthcare. Professional Psychology Research & Practice, 42(6),505-512.
[57]. Lyzwinski, L. N. (2014). A systematic review and meta-analysis of mobile devices and weight loss with an intervention content analysis.Journal of Personalized Medicine, 4, 311-385.
[58]. Mesko, B., Drobni, Z., Benyei, E., Gergely, B., & Gyorffy, Z. (2017). Digital health is a cultural transformation of traditional healthcare. mHealth, 3(38), 1-8.
[59]. Moore, S. & Jayewardene, D. (2014). The use of smartphones in clinical practice.Nursing Management, 21(4), 18-22.
[60]. Moore, S., Anderson, J., & Cox, S. (2012).Pros and cons of using apps in clinical practice.Nursing Management, 19(6), 14-17.
[61]. Molina, W. R., Pessoa, R., da Silva, R. D., Kenny, M. C., Gustafson, D., Nogueira, L.,...Kim, F.
[62]. J. (2017). A new patient safety smartphone application for prevention of "forgotten" ureteral stents: results from a clinical pilot study in 194 patients. Patient Safety in Surgery, 11(10), 1-4.

[63]. Mitchell, P. H. (2008). Quality care. Chapter 1. Defining Patient Safety and Quality Care, 1-1-1- 3.
[64]. Papadakos, P. J.,& Bertman, S. (2017). Distracted doctoring: Returning to patient-centeredcare in the digital age. Berlin: Springer.
[65]. Peek, G., & Melnyk, B. M. (2010). Coping interventions for parents of children newly diagnosed with cancer: an evidence review with implications for clinical practice and future research. Pediatric nursing,36(6).
[66]. Pischetola, M. (2011). Digital media and learning evolution: A research on sustainable local empowerment. Global Media Journal, 11(18), 1-6.
[67]. Rasche, P., Mertens, A., Brohl, C., Theis, S., Seinsch, T., & Wille, M.,...Knobe, M. (2017). The "Aachen fall prevention App" – a smartphone application app for the selfassessment of elderly patients at risk for ground level falls. Patient Safety in Surgery, 11(14), 1-4.
[68]. Rekleiti, M., Kyloudis, P., Toska, A., & Saridi, M. (2012). Patient Safety and healthcare quality.
[69]. International Journal of Caring Sciences, 5(2), 74-79.
[70]. Relias Media. (2015). 3 apps that could help improve patient safety. Same-Day Surgery, 39(7), 79.
[71]. Robinson, P., & Lowe, J. (2015). Literature reviews vs systematic reviews. Australian and New Zealand Journal of Public Health, 39(2), 103.
[72]. Sarasohn-Kahn, J. (2010). How smartphones are changing healthcare for consumers and providers. California Healthcare Foundation. Retrieved from https://www.chcf.org/wp- content/uploads/2017/12/PDF-HowSmartphonesChangingHealthCare.pdf
[73]. Sarwar, M., & Soomro, T. R. (2013).Impact of smartphone's on society.European Journal of Scientific Research, 98(2), 216-226.
[74]. Sayedalamina, Z., Alshuaibi, A., Almutairi O., Baghaffar, M., Jameel, T., & Baig, M. (2016). Utilization of smart phones related medical applications among medical students at King Abdulaziz University. Journal of Infection and Public Health, 9, 691-697.
[75]. Shih, Y., & Liang, S. M. (2014). Bridging research and good practices towards patients welfare.
[76]. Boca Raton: CRC Press.
[77]. Shore, J. H., Aldag, M., McVeigh, F. L., Hoover, R. L., Ciulla, R., & Fisher, A. (2014). Review of mobile health technology for military mental health. Military medicine, 179(8), 865-878.
[78]. Statista. (n.d.). Mobile internet - statistics & facts. Retrieved from https://www.statista.com/topics/779/mobile-internet/
[79]. Suwana, F., & Lily. (2017). Empowering Indonesian women through building digital media literacy.Kasetsart Journal of Social Sciences, 38(3), 212-217.
[80]. Talwar, Y. K., Karthikeyan, S., & Medhi, M. (2016). Smartphone' - a user-friendly device to deliver affordable healthcare - a practical paradigm.Journal of Health & Medical Informatics, 7(3), 1-7.
[81]. Thomairy, N. A., Mummaneni, M., Alsalamah., S., Moussa, N., & Coustasse, A. (2015). Use of smartphones in hospitals.The Health Care Manager, 34(4), 297-307.
[82]. Tirado-Morueta, R., Aguaded-Gómez, J. I., & Gómez, A. H. (2018). The socio-demographic divide in Internet usage moderated by digital literacy support. Technology in Society.
[83]. Ventola, C. L. (2014). Mobile devices and apps for health care professionals: Uses and benefits. P&T, 39(5), 356-363.
[84]. West, D. M. (2013).Improving health care through mobile medical devices and sensors. Retrieved from https://www.brookings.edu/wp-content/uploads/2016/06/West_Mobile-Medical-Devices_v06.pdf
[85]. Weingart, S. N. & Page, D. (2004). Implications for practice: Challenges for healthcare leaders in fostering patient safety. QualSaf Health Care, 13,52-55.
[86]. Wolters Kluwer Health, Inc. (2015). Embracing technology to strengthen care and enhance human connection.Dimensions of Critical Care Nursing, 34(3), 179-180.
[87]. Zhang, C., Zhang, X., & Halstead-Nussloch, R. (2014).Assessment metrics, challenges and strategies for mobile health apps.Issues in Information Systems, 15(II), 59-66.
[88]. Zhang, K., & Shen, X. (2015). Security and privacy for mobile healthcare networks. Berlin: Springer.

Appendices

Summary of Findings

Following the completion of the review, numerous findings were observed based on the CASP checklist. This has been presented in the following tables:

Appendix I: Summarises the Aim(s), Methodology and the Research Design

Paper (no.)/Study Type/Source	Aim(s)	Methodology	Research Design
1. (Primary) (Molina et al.,2017)	Provided an unclear statement of the research aim(s).	Use of quantitative methodology was appropriate, as the research conducted a clinical pilot study with 194 patients.	An experimental research design was suitable to addressthe study aims, as it focused on preventing "forgotten" ureteral stents by testing the new application of a "StentTracker".
2. (Primary) (Rasche et al.,2017)	Clear presentation of the research aim statement; i.e. "The overall aim of the field study is to determine whethera mobile health app that offers self-assessment of fall- risks would gain interest and would be used if merely presented in the major app stores of Google andApple".	Appropriateness of using quantitative research can be determined from the conduct of the field study with 197 individuals, who remained in the risky position of ground level falls and downloaded the "Aachen fall prevention App".	Experimental research design was considered in the study and its appropriateness can be measured in terms of determining whether the "Aachen fall prevention App" is effective to facilitate the elderly patients in self- assessment and monitoring of their individual fall-risk positions.
3. (Secondary) (Luxton, McCann, Bush, Mishkind &	Unclear statement of the research aims was provided.	The utilisation of qualitative methodology was	A descriptive research design was appropriate toaddress
Reger, 2011)		appropriate, as the research focused on	the identified study issue, although

		analysing the integration of smartphone technology in behavioural healthcare with strong emphasis on mHealth for mental wellbeing.	it does not answer the question regarding how/why/when smartphone technology isutilised, which has been integrated in a behavioural healthcarecontext.
4. (Secondary) (Killikelly, 2017)	There was a clear statement of the research aims, which relates to the development of a mobile device to record inpatient data of mental health.	Qualitative methodology was appropriate, due to the conduct of an audit, as well as focus groups interviews, especially with the nursing staff for assessing the effectiveness of developing a mobile instrument to record inpatient data linked to mental health.	The appropriateness of executing an exploratory research design in the study can be examined by addressing the study aims after acquiringa comprehensive understanding regarding the nature of the identified issue.
5. (Secondary) (Relias Media, 2015)	No evidence of presenting the research aims clearly.	Qualitative methodology was suitable for the study, as it focused on answering the question of whether the three apps (i.e. IScrubLite, Anaesthesiologist, and Pristine EyeSight) could help toenhancepatient safety.	The descriptive research design was appropriate to address the identified study issue, due to the consideration of various theoretical viewpoints surrounding the three specific apps.
6. (Secondary) (Daly, 2017)	The statement of the research aims was provided in an unclear manner.	Exploitation of qualitative methodology was appropriate, due to greater focus on the	A descriptive research design appeared to be appropriate, as no hypotheses were
		theoretical viewpoints surrounding an app named MedAdvisor.	developed to conclude valid study inferences.
7. (Secondary) (Shore et al., 2014)	No clear statement of the aims of the research exists.	Qualitative methodology was appropriate for the research, as it performed atheoretical review of mobile health technology, especially for military mentalhealth.	An exploratory research design was suitable for this study, as it intended to comprehend the roles played by mobile health technology, particularly within a military mentalhealth setting.
8. (Secondary) (Huckvale, Morrison, Ouyang Ghaghda & Car, 2015)	A clear statement of the research aims was provided in the study, which stated "We aimed to explore changes in the content, function, and clinical quality of apps since 2011. We used a systematic approach, based on a systematic literature review, to identify, classify, and review apps for asthma. By updating our earlier review, we sought to differentiate persistent quality issues from those that are new or have proven transient".	Qualitative methodology was suitable, as the study focused on summarising the existing clinical research on a specific topic - i.e. the use of mobile apps in ensuring the safety of patients who suffer from asthma.	The suitability of using a systematic review in this research was to address the research aims, which can be determined by understanding the effectiveness of healthcare interventions in maintaining patient safety.
9. (Secondary)	The study did not	The suitability of	The use of a
(Burtson & Vento, 2015)	contain any clear statement of the research aims.	qualitative methodology can be determined from the use of secondary sources to conclude valid inferences, instead of focusing on the primary research.	descriptive research design was appropriate, as theoretical examinations were made on sitter-reduction through the support of monitoring mobile videos.
10. (Secondary) (Moore, Anderson & Cox, 2012)	There was no evidence of a clear statement of the research aim.	Qualitative methodology was appropriate, in order to respond to the question regarding whether smartphones increase the potential to improve patient care.	An exploratory design was deemedto be suitable to meet the research aims, as current practices of using smartphones in healthcare were considered for discussion.
11. (Secondary) (Holt, Flint & Bowers, 2011)	A clear statement of the research aims was not provided.	The appropriateness of qualitative methodology can be determined from the lack of primary research use.	A descriptive design was suitable, as secondary sources were taken into consideration to gather relevant data for the purpose of drawing valid research outcomes.
12. (Secondary) (Baca, Rico & Stoner, 2015)	There was no clear evidence of the statement of the research aims.	Qualitative methodology was appropriate, as the utmost focus was given to explore the real- world phenomenon of embracing technology towards strengthening care, along with developing human connection.	The suitability of a descriptive design was deemed to be suitable, due to the use of secondary research to generate valid results.
13. (Secondary) (Agboola, Bates &	No clear aims were portrayed in the	The suitability of using qualitative methodology pertains	A descriptivedesign was suitable, dueto the utmostattention
Kvedar, 2016)	research.	to the shortages in conducting primary research.	levied on theoretical standpoints associated with healthcare delivery innovation with the association of

			digital health.

Appendix II: Summarises the Recruitment Strategy, Data Collection, and the Relationship between the Researcher and Participants

Paper (no.)/Study Type/Source	Recruitment Strategy	Data Collection	Relationship between the Researcher and Participants
1. (Primary) (Molina et al.,2017)	Recruitment strategy was suitable, due to the consideration ofan initial group of 194 patients. These patients underwent ureteral stent placement, and were tracked by executing the application of a "StentTracker".	Primary data were collected from an initial total of 194 patients.	The relationship had been properly considered by acquiring relevant information from three applicable healthcare institutions and performing retrospective analysis of the selected patients.
2. (Primary) (Rasche et al.,2017)	Appropriateness of the recruitment strategy can be determined by measuring the subjective fall-risk of the patients. This can be undertaken by conducting a self-test that encompasses ten standardised yes–no questions and a balance test of 10 seconds without the involvement of any compensatory movement.	Primary data were collected between the periods of December 2015 to December 2016.	The relationship was sufficiently considered by interacting with the participants - i.e. the elderly patients, who were at risk of ground level falls during the data collection procedure.
3. (Secondary) (Luxton et al., 2011)	No evidence of recruitment strategy was present, as emphasis was given to collect secondary information, rather	Secondary sources, such as scholarly journal articles, were used to collect the required data.	No relationship was observed among the researchers and the participants, which could be witnessed due to the lack of performing primary
	than primary data.		research.
4. (Secondary) (Killikelly, 2017)	A recruitment strategy was not appropriate, as the study was secondary in nature.	Data collection was performed by using theoretical perspectives, which were accessed through distinct secondary sources, including books and scholarly journals.	No evidence was witnessed that related to the association amid the researchers and the participants, due to the secondary and qualitative nature of the research.
5. (Secondary) (Relias Media, 2015)	No evidence of a recruitment strategy, as theoretical perspectives was considered to analyse the identified study issue.	Data collection was performed with the use of various secondary sources.	No relationship could be observed, due to the lack of primary research.
6. (Secondary) (Daly, 2017)	A recruitment strategy was not suitable, due to a strong focus on secondary research.	Secondary data collection was suitable, as information were collected from already available sources.	The relationship between the researcher and the participants was not appropriate, as focus was levied on the qualitative and secondary data collection technique.
7. (Secondary) (Shore et al., 2014)	A recruitment strategy was not appropriate, due to the shortage of conducting primary research.	A secondary data collection procedure was followed by focusing on the theoretical ideas or concepts of communication and patient engagement.	There was no evidence of a relationship among the researchers and the participants.
8. (Secondary) (Huckvale et al., 2015)	The inappropriateness of recruitment strategy can be determined, due to the adoption of a systematic review method to conclude	Secondary data was collected in order to address the research issue identified by considering inclusion, as well as	A relationship between the researchers and the participants was not adequately considered, as it
	valid inferences.	exclusion criteria.	focused on secondary data sources.
9. (Secondary) (Burtson & Vento, 2015)	A recruitment strategy was not suitable to consider a qualitative methodology.	A secondary data collection mechanism was followed, which helped to address the research issue.	No evidence of a relationship between the researchers and participants could be seen.
10. (Secondary) (Moore, Anderson & Cox, 2012)	The recruitment strategy was not suitable with respect to the research aims, as it conducted secondary research, instead of primary study.	Data was collected in a systematic manner, which addressed the research issue.	No adequate consideration of the relationship between the researchers and the participants was noted.
11. (Secondary) (Holt, Flint & Bowers, 2011)	The unsuitability inthe recruitment strategy can be determined from the use of secondarydata.	Accessing second- hand data helped to address the research issue by considering recent practices of using mobile phone technology to increase patient safety.	The relationship between the researchers and the participants was not sufficiently taken into consideration, due to the focus on secondary research.
12. (Secondary) (Baca et al., 2015)	The recruitment strategy was not appropriate, as no sample population and size were provided to gather relevant data.	The data were collected in a theoretical manner, which addressed the research issue.	No evidence of a relationship between the researchers and the participants was shown, as there was no involvement of any sample population in the data collection procedure.

13. (Secondary) (Agboola, Bates & Kvedar, 2016)	The recruitment strategy was not suitable, as it involved the use of secondary research, instead of a	Secondary data were gathered by focusing on theoretical viewpoints that addressed the	Relationship between the researchers and the participants was not sufficiently considered, as the
	primary study.	research issue.	research focused on the use of secondary research.

Appendix III: Summarises the Ethical Issues Considered and the Rigorousness of Data Analysis

Paper (no.)/Study Type/Source	Ethical Issues Considered	Rigorousness of Data Analysis
1. (Primary) (Molina et al., 2017)	The final manuscript version was reviewed and approved by the authors, along with the consent to permit DG, as well as LN, in order to acceptpatient safety in the field ofsurgery.	Data analysis was rigorous, as the data regarding patient demographics and use of a ureteral stent has been considered to generate valid findings.
2. (Primary) (Rasche et al., 2017)	The study was authorised by The Ethics Committee of the RWTH Aachen Faculty of Medicine by following legal, as well as ethical implications, based on the statement EK236/16.	Sufficient rigorousness of the data analysis can be determined from the successful execution of one-way analyses of variancesregarding objective fall-risk.
3. (Secondary) (Luxton et al., 2011)	Ethical issues, included defining the concepts from healthcare perspectives, along with clarifying the methodological approach, were considered.	Evidence of sufficient rigorousness of data analysis existed by displaying the examples and discussing them in accordance with the identified research issue.
4. (Secondary) (Killikelly, 2017)	Clarifying, as well as explaining the meanings of the concepts associated with the identified study issue, was one of the ethical issues considered to conclude valid inferences.	Data analysis was rigorous in nature, in order to elaborate various theories that are correlated to the identified research issue.
5. (Secondary) (Relias Media, 2015)	One of the ethical issues, i.e. explaining theories with respect to the subject matter of the study, was duly taken into consideration	Rigorousness of data analysis can be determined by considering relevant secondary sources that are reinforced by relevant literature.
6. (Secondary) (Daly, 2017)	There was no clear evidence of considering ethical issues due to the non-involvement of primary research, sample	Rigorousness of data analysis was adequately maintained, as the assessment of the obtained data is made under the CC BY-
	population or size.	NC-ND licence.
7. (Secondary) (Shore et al., 2014)	The selection of theories, along with relevant data, was made by following the provisions of The American Psychological Association Code of Ethics.	The data analysis was adequately precise in nature, as it considered evidence-based practices to generate valid outcomes.
8. (Secondary) (Huckvale et al., 2015)	Ethical disclosures, along with software issues under quality domain, were duly considered to obtain valid results.	Adequate rigorousness of data analysis can be examined by conducting a systematic content assessment for all the apps discussed.
9. (Secondary) (Burtson & Vento, 2015)	Relevant literature studies, which have been published by the authorised researchers, were taken into consideration to generate suitable findings.	The data analysis was satisfactorily accurate in nature, as case studies were used to address the identified research issue.
10. (Secondary) (Moore, Anderson & Cox, 2012)	Ethical issues, such as looking for the literatures based on the study subject and providing appropriate suggestions were highly considered.	The data analysis was maintained by explaining relevant examples. The study also highlighted the issues related to the subject matter of the research.
11. (Secondary) (Holt, Flint & Bowers, 2011)	There was no clear evidence of maintaining ethical issues, as secondary research was conducted, instead of undertaking a primary study.	Data analysis was precise, due to the consideration of the case studies.
12. (Secondary) (Baca et al., 2015)	There was no evidence of considering any ethical issue.	Sufficient accurateness of data analysis can be determined by making theoretical discussions on the basis of the researchtopic.
13. (Secondary) (Agboola, Bates & Kvedar, 2016)	There were threats relating to patient safety that comprised privacy breaches and data safety, which were clearly mentioned	Data analysis was accurate, which helped to provide opinions regarding healthcare delivery innovations through the support of digital health.

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