Evaluation of the Importance of the Smart Mobile Health and Telehealth Application- A Systematic Literature Review

Abdallah H. Alalawin[a], Main N. Alolayyan[b], Heba H. Hijazi[c], Yasser Bentahar[d], [a]Hashemite University, Industrial Engineering Department, [b,c] Jordan University of Science and Technology, Faculty of Medicine, Health Management and Policy Department, [d] Higher Colleges of Technology

Email: [a]abdallahh_ab@hu.edu.jo, [b]mnalolayyan@just.edu.jo, [c]hhhijazi0@just.edu.jo, [d]bentaharyasser@gmail.com

The industrialised world witnessed steady growth in the prevalence of chronic diseases in developing countries. This growth comes with a simultaneous increase in the financial burden of communicable diseases. A modern concept of "Mobile Health" is a technical term that is used to refer to the use of mobile technologies to significantly support public health and enhance clinical care. This paper has tried to analyse the pros and cons of mobile health and telehealth application i.e. risk associated, and benefits gains from the usage of these m-health applications. The researchers used a systematic literature review technique to achieve paper objectives. There is a need for conducting well-organized research to study the positive impact of m-health and telemedicine technologies on practitioners and patient health. These studies need to focus more on those individuals who use these applications in their routine life. Evidence about the positive implications has been found; however, no significant work has been done regarding clinical and economic performance. Further systematic and scientific reviews may be needed for completely covering this multi-aspect topic like Telehealth consultation and maternal and infant health care.

Key words: *Health information technology, Healthcare services, Telehealth, Mobile phone, and Privacy.*

Introduction

In the present era, making access to enhanced quality and economical health care services and providing proper health care services is the most significant challenge. According to Hawkes et al. (2004) and Boutayeb (2006) in the US around half of the population are facing some chronic diseases, which account for almost 75% financial health burden. Similarly, James (2001) founded that in the European Union (EU) about 70 to 80 % of health care budgeted is allocated to the treatment of chronic diseases. Consequently, there is a significant need to devising policies to lower down these financial burdens. This will ensure greater participation of patients and preventing the use of unnecessary and inappropriate services. Telehealth in that regard is considered an economical alternative to traditional face-to-face health care methods.

"Mobile health" or "M-health" is a modern technical term, refers to the use of mobile technologies to support public health and enhance clinical care. According to Sutherland (2010) the present-day innovation in mobile technology is supposed to largely help and improve the existing delivery and monitoring of the health care system. He further added that these innovations improve communication in the healthcare system.

In the US, more than 70 % of deaths are caused by chronic diseases, and about 75 % of the health care expenditures are incurred on it (Hawkes et al. 2004; Popkin 2001). Similarly, in the case of the EU, chronic diseases cause about 87% of all deaths (James 2001). According to literature, primary factors that determine the future of Telehealth include but not limited to 1. remarkable personalisation of health care service; 2. providing each single patient with significant level of appropriate technologies; 3. using health care-related data optimally; 4. proper awareness and modern education paradigms simultaneously for patients and providers; 5. establishment and formation of some new communities of knowledge and practice; 6. development of sustainable health care and business models in the field of Telehealth; 7. in the practice of applied side research; and 8. remarkable innovation in research methodologies within the field of Telehealth. Each of these issues will be discussed subsequently.

This paper is intended to present a proposed conceptual model, which is based on the potential contributions of M-health along with Telehealth. Furthermore, the paper intends to discuss the contemporary and future challenges faced by developing countries. We have properly examined the nexus between income level and health care services and have gathered an ample body of literature on the financial incidence and burden of chronic diseases in developing countries.

Background

It is evident from the global statistics that developing countries have been facing an increase in the incidence of non-communicable chronic diseases, still when the communicable diseases are a persistent threat. Furthermore, those diseases- which were only limited to developed countries, namely obesity, heart-related diseases, and diabetes- are increased. "Dual burden" is a term used to refer to the combined effect of communicable and non-communicable diseases in developing countries. There is a need for successful efforts for policy implementation to eradicate the dual burden.

Among others, tobacco consumption, poor diet, and less physical exertion are the leading causes of chronic diseases globally. According to World Health Organization statistics(WHO) (2005) and research by Boutayeb (2006), these non-communicable diseases largely contribute to heart diseases, diabetes, lung diseases, and cancer, which accumulatively cause half of the deaths in these countries. These researchers suggest that diseases are increasing persistently. There is a general perception that because non-communicable, diseases can be treated through complex practices, which are financially expensive to deliver especially in developing countries (Popkin 2001; Hawkes et al. 2004; James 2001; Taylor et al. 2000). However, there is a chance to improve this situation by using mobile technology (Adair and Popkin 2005). The advocates of mobile technology users in health care management give the following reasons to support their opinion: (1) To prevent chronic diseases for reaching its final non-treatable stage, there is often a need for timely and broad-based community health interventions. (2) To reduce the incidence of chronic diseases, there is a need to discourage a luxurious lifestyle and some behaviour's associated with higher income like tobacco use, high-fat diets, and low physical activities. (3) Multi-stage interventions based on continuous interactions with different components of the health system are often required to treat accordingly chronic diseases. (4) Long term treatment is required for curing chronic diseases along with the best quality medication.

Limited infrastructure and substandard hospital resources in urban areas constrain health system delivery in most of the developing countries which in turn increases the disease burden in developing countries (Adeyi, O. Smith, and Robles (2007)). As pointed out by Lopez and Mathers (2006) and Mathers and Loncar (2006), there is a significant deficiency of health care workers globally, in the case of Africa this deficiency is around 800,000.

A major determinant is a weakness in management and supervisory services (Arah, Ogbu, and Okeke 2008; Mullan 2005). A significant improvement in different areas can be brought through the utilisation of M-health, these areas include but not limited: removing of physical hurdles in care and service delivery, enhancement of weak health management systems, and communication problems.

Telehealth

Since the beginning of 19th-century different types of innovative telecommunication technologies have been utilised in the medical field to improve health care practices. History revealed that in 1878 Lancet explicitly reported the use of telephone technology to reduce the unnecessary and extra visits by the physician; similarly, Sutherland (2010) has documented the use of the tele-stethoscope in 1910. However, Boutayeb (2006) reported that the last decade has witnessed remarkable improvements in the field of m-health and telehealth.

Uniformity in the use of technology across the system is required for obtaining better results. As in the case of US where Kaiser Permanente and Veterans Health Administration (VHA), two prominent health care organisations, use a single and uniform health care system, which is composed of the hospital, district nursing, health care centre, they are all integrated into a single organisation. This unified system is known as the Electronic Health Record (HER). The system has got much encouragement from the patients on the bases of a high degree of adaptation of Telehealth practices.

Since a long time, both in the US and EU, practitioners have been testing Telehealth technologies in different innovative manners to optimise the newly developed health care models, which includes restructuring procedures for managing chronic diseases and also an enhancement in cross-sector health care management. Some of the worth mentioning examples include home hospitalisation of patients with cardiac diseases (Adeyi, O. Smith, and Robles 2007) telerehabilitation of patients, and regular home monitoring of patients with COPD procedure.

Some of the successful and large-scale Telehealth projects practised in the EU are renewing Health, United Health, and Master Mind. In each of these projects, many countries from the EU participated as in the case of the Renewing Health project. Patients with diabetes, heart problems, COPD was the target population of the project, the study has enrolled 7000 patients with the mentioned diseases. The outcomes of projects suggest that improvements have been observed in communication between patients and professionals (Lopez and Mathers 2006). It has been revealed by the practitioners that patients have been responding positively and with care about their health, since they now see and read the data about their health parameters. Similarly, professionally reported data indicates that patients were less careful about their health in situations they were having no access to their data. This research study is going to identify the role of telemedicine in various clinics and analysing how they are using it to reduce the burden of cost on health, in addition, to identify the policies needed to develop mobile health applications.

Research Methodology

Robinson and Dickersin (2002) have documented that literature review is only important if a suitable and appropriate framework is developed to collect the relevant literature. Research carried out with these guidelines results in publicly beneficial work. The following subsections have been dedicated to explain the steps involved in choosing an effective methodology properly.

Identifying Search Terms and Synonyms

A reputed and practical exploration approach is vital to recognise and collect highly pertinent info associated with the investigative query. For starting a literature pursuit, exploration terminologies should be identified. Search terminologies such as telehealth, policies, and medicine will be used.

Search Strategy

According to Humphreys and Weisner (2000), there are four dissimilar methodologies for reaching and gathering relevant information and statistics for the problem under consideration. One needs to start the search for online database initially. Binary operators were utilised for significantly increasing accuracy and authenticity. Snowballing: a collection of the data through this method results in collecting data from the most appropriate population. Hand searching: At this stage, the researcher has manually investigated the relevant and authentic published materials.

Criteria for Selection of the Studies

Adaptation of appropriate and clear criteria for inclusion and exclusion of the studies in the literature helps the author investigate and study only the most relevant materials to the current area of interest.

Inclusion Criteria

- All those published studies which are relevant to the topic.
- All those studies that evaluate and investigate the significant role of Telehealth and M-health.
- Authentic articles published in periodicals.
- And all the published work in the English language.

Exclusion Criteria

- Those works for which only abstract was available.
- Those studies which were written in a language other than English were excluded.

Quality Assessment of Selected Studies

Assessing the methodological feasibility of the studies has been gaining much importance in almost all fields of knowledge. This trend has been developed due to the inheritance quality of producing just results in terms of position, assortment, and coding and collecting data. Consequently, all researchers selected for the methodological assessment were significantly examined in terms of value assessment based on the Cochrane database instrument.

It is evident from the literature that for any scientific inquiry, validity and dependability are considered as two compulsory attributes. Joppe (2000). Alternately, we could ask the question if the investigation device permits people to hit "the bull's eye" of the investigative purpose. Scholars usually ascertain legitimacy by looking for a number of queries and would frequently seek the solutions in previously undertaken investigations. Similarly, as for as, the dependability of research is a concern it assures that all of the outcomes are driven through the scientific procedure, and all of the results are having some logical base Joppe (2000). The quantitative nature of the current study ensures both its dependability and reliability.

In a modern highly civilised society, research ethics are given much considerations and importance. Robinson and Dickersin (2002) exposed that in almost every organisation and institutions the ethical codes are defined and developed by senior-level management.

As the current research was intended to assess a methodological procedure, and there was no involvement of ethical aspects at all, hence there was no need of taking proper permission from any broad or committee. However, during the selection of studies for the literature, only those studies were incorporated that have followed the ethical codes of their respective organisations.

Data Extraction

The laborious and technical task of data collection involves specifying relevant materials. For the current research, after thorough investigation and extended search of the database's total of 169 abstracts were selected.

Figure 1. The entire method is symbolised in an illustrative manner in the chart shown underneath.
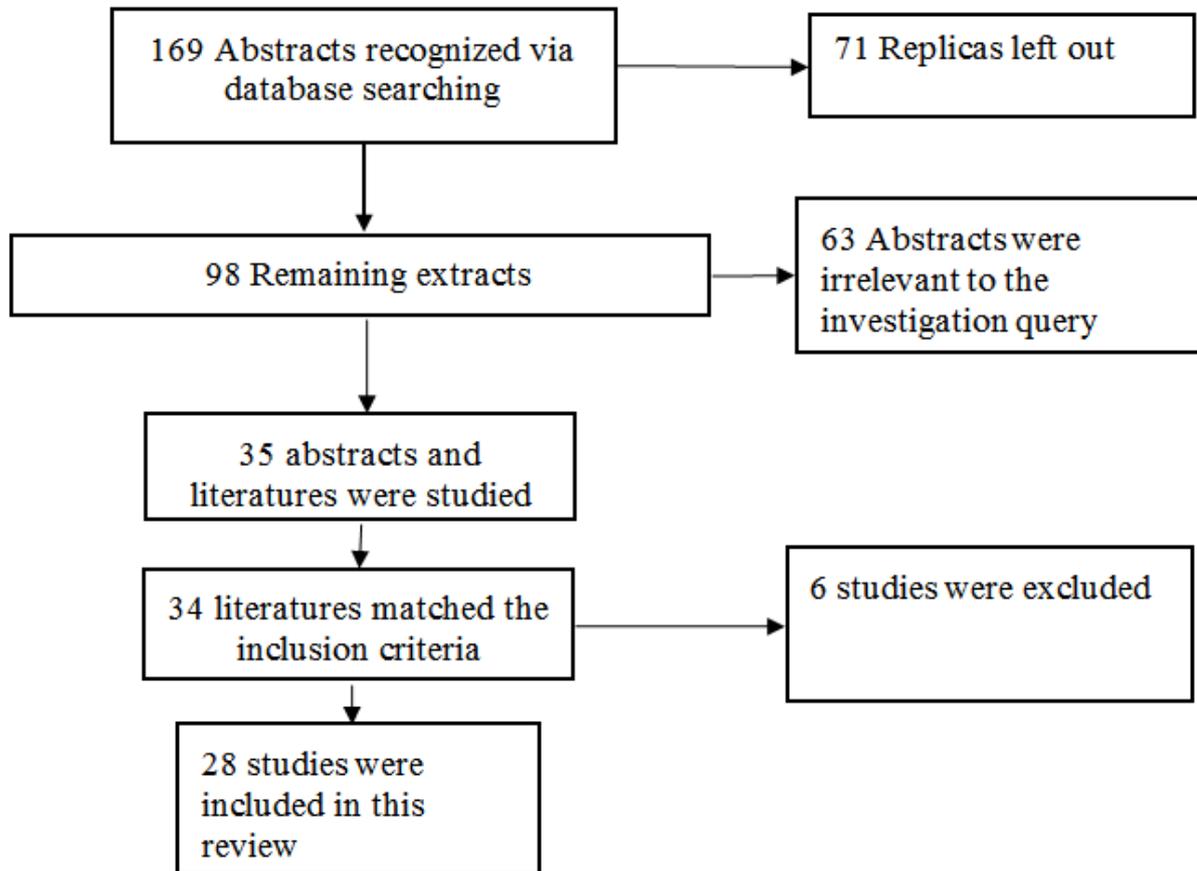
Discussion
M-Health Technology: An Overview

It is generally considered that M-health technologies have great positive potential; however, they are some risk that needs to monitor and Reduce. Numerous significant points need to be adequately emphasised in this regard. At the first place, there is a need for in-depth evaluation. However, no significant work has been done to the present in the area of M-health, with considerably insignificant work done in the context of developing countries. Hence, the current work is supposed to provide a scientific guide for M-health application and growth.

According to Adair and Popkin (2005), a number of research experiments done have explicitly shown positive results for patients suffering from chronic diseases. However, Adeyi, O. Smith, and Robles (2007) documented that no significant results have been obtained from some other similar studies. Adair and Popkin (2005) explained that most of the models of health, based on the regular Remote Patient Monitoring (RPM) procedure,

have simultaneously helped patients in achieving their health care goals and even in some cases it has minimised the impact of preventable hospitalisation for those patients with chronic diseases.

According to the outcome of the small scale studies carried out in the US and EU, Telehealth technologies have been found significantly useful for patients with long-lasting diseases. However, these technologies have not been adopted on the economy scale (Mathers and Loncar 2006; Mullan 2005). Literature suggests multi-aspect hinders that prevent Telehealth technology adaptation on large scale: societal acceptance of the technology, economic sustainability of the system, repayment risk, interoperability between EPRS, most importantly due to their heave technological nature they cannot be adopted at small size hospitals, potential for accommodating such large and heavy Telehealth programs (Chang et al. 2008).

Lastly, there is a need for an economic assessment of M-health technologies. Comparison of M-health technology with other types of technologies is possible only in case its cost is presented as disability-adjusted life-year (DALY) prevented, this is an increasingly emerging and accepted parameter in the field of health interventions (Grady 2002). Developing such a framework will expose the costs. Further, during the assessment process of m-health technology awareness regarding the practical issue of sustainability should be realised. Also, rooms should be given for tackling real-world issues, as they mostly affect the survival and growth of the projects. As pointed out by Iluyemi et al. (2009) and Krishna, Boren, and Balas (2009) real-world issues including but not limited to the financial and technical capabilities of the firms under consideration. In that regard, World Health and other leading organizations are expected to develop and provide proper guidelines for the best practising of m-health technology.

Large scale expansion and adaptation of m-health technology are also supposed to bear some non-health benefits for societies as well as stimulating economic growth beyond health care.

According to Lester, Gelmon, and Plummer (2006) and Consulting (2009), mostly technological advancements in machinery are observed in developed countries of the world, on the other hand, improvements in software technology are most widespread around the world. It is supposed that mostly m-health innovation and implementation will be limited to those developed countries. Consequently, in developing countries, there is a need for collaboration with government agencies, other stakeholders of the health systems, businesses, and communities to design and adopt M-health software applications.

For the proper implementation of M-health technologies, there is a need for up-gradation of local technical potential and also providing proper training. In this way, M-health can result

in the development of local small and medium enterprises and will create new job opportunities, and ultimately all these can add to improved health facilities.

Healthcare and E-Health Systems: The Road So Far

In the contemporary modern world, the use of wireless technology is becoming a researchable topic, especially in the field of medical informatics' and health care. Presently, most of the hospitals and healthcare centres are significantly relying on information and communication technology (ICT) for improving the practices of health care services. Although there is a critical need for producing standard from hospital information.

According to research carried out by Subramoniam and Sadi (2010), the International Health Level Seven organisation was established in 1987; The organisation has entirely implemented the seventh layer of ISO Open System Interconnection (OSI). Currently, it has become a benchmark for international standardisation. In the previous decade, more considerable attention has been given to the adaptation and development of E-health services, in addition to that rapid evolution has been observed in the field of ICT along with easy access to patient data. The emerging concept of Web 2.0 and 3.0 has further improved the practices of health care professionals and has been provided with the condition which was not available to the previously.

It is an old practice of all the stakeholders of healthcare providers to keep the multi-aspect record of patients treated. However, a new trend has emerged, as now patients even need access to these records. These records in the database also help the practitioners to assess patients' condition easily. Technically EHRs are a specific type of repositories and databases that keep and maintain health records (Eichelberg et al. 2005). It has been observed that the development of such type of EHR system can result in numerous advantages, which includes but not limited to low management costs, efficient management of large scale health-related data, and most importantly centralised patient records (Martınez-Pérez et al. 2013).

Structural and systematic type of data recording through the utilisation of HER technology is required (US Department of Health & Human Service 2015). Further HER protocols and regulations need to be wholly considered by these HER technologies (ONC Health IT Certification Program 2015). Due to significant technological advancements, different types of e-health systems have been successfully introduced, which are delivering remarkable services to the communities. Examples of presently commercialised e-health technologies include but not limited to Fetal heart rate monitoring, portable hemoglobin meter, self-powered pulse oximeter, and treatment response application (ClickMedix 2019).

Fetal heart rate monitor using a mobile phone is developed to have a significantly analyses the fetal heartbeat using a beat-to-beat accuracy algorithm. The calculation stage is then followed by sending the data to the server for storage, which is then available to a midwife for examination via a web browser(C. S. Lee et al. 2009). Mobile health record system for pediatric HIV allows physicians to integrate clinical information to manage pediatric HIV at the point of care. (Paul et al. 2009). Mobile phone image transmission for diagnosis is performed through a mobile phone that has a camera facility. This modern and significantly useful system allows a primary linking to a more developed health care service in a remote area; Multimedia Message Service is used in this process (Bellina and Missoni 2011). A mobile phone pulse oximeter is that technology combines a mobile phone with pulse oximeter sensor analyses. The sensor is placed on the figure and then the information is displayed on the pulse oximeter (Dunsmuir et al. 2012). Portable telemedicine unit: GSM, CDMA, Internet, or satellite technologies are used for connecting a mobile telemedicine with a computer server. This facility is used for multiple purposes for addressing different health care problems in remote areas. (Sutjiredjeki et al. 2008).

M. A. Hossain and Ahmed (2012) documented the ongoing innovation and advancements in multimedia technology, specifically in the field of e-health. In his work, he explicitly mentioned about health monitoring, real-time access to modern health facilities, globally available software's for healthcare, serious games for health, a medically assisted program for old age citizens, and wireless body sensor network (WBSN).

W.-Y. Chan et al. (2012) in their attempt, wrote about a serious game approach, which is used for learning the process of placement of the ultrasound-guided needle. Similarly, Maamar, Boukerche, and Petriu (2012) developed a proposal for another serious game for health, which is based on the illustration of the child obesity epidemic. Yang et al. (2012) present a hybrid solution of a bio patch for e-Health using a low-power system-on-chip (SoC) sensor and paper-based inkjet printing technology. In the field of patient monitoring and localisation, significant work has been done by Shirehjini, Yassine, and Shirmohammadi (2012), they presented an RIFD-based system. The application developed by this group of researchers detected and showed the proper geographical position of mobile hospital equipment with minimum location error. Another option was also considered in which digital TV has been utilised for cognitive prompt therapy. Martınez-Pérez et al. (2013) have presented the initial sketch, a procedure for practical implementation, and validation of the cognitive stimulation system. It is expected that patients suffering from cognitive disorders will get significant benefits from this system. For adequately protecting the privacy of health-related data, Zhang et al. (2012) have presented a solution for WBSNs. Furthermore, Masud, M. S. Hossain, and Alamri (2012) have presented the idea for efficiently managing medical date gathers from different sources. In addition to all of the above, knowledge editing services KES will significantly help practitioners in inserting further information in data

collected from heterogeneous sources in faraway health monitoring system through the utilisation of ICT facility (Colantonio et al. 2012). In a recent attempt by Wang et al. (2012) based on the CDU platform, they presented a computer-generated reality-based clinical emulator for the mandibular angle reduction. Advocates of modern technology say that these improvements in e-health services will significantly improve patients care practices. However, there is some opponent as well, who believes that using ICS health care solutions can lead to new probable health hazards (Chandra and Skinner 2012). Statistics show that hospitals now are spending higher budgets in ICT.

M-Health: The Healthcare Revolution

According to R. S. Istepanian, Costantinos S Pattichis, and Laxminarayan (2006) mobile health refers to unwired e-med. Similarly, R. S. Istepanian and Lacal (2003) has defined M-health an emerging trend of frequently using mobile technology in health care management. R. Istepanian, Laxminarayan, and Constantinos S Pattichis (2006) In their paper, they have significantly focused on the benefits gained from converging to 4G network from the previous 3G.

Mobile Health Awareness

On January 9th, 2007, CEO of Apple Inc presented to the world the iPhone 2G and its operating system (OS). That event was marked as the evolution of smart-phones and applications. The development of mobile applications opened ways for new M-health markets. Statistics revealed that in 2010, applications related to M-health were downloaded two hundred million times. Further, about 70% of the overall world population has shown interest in reaching at least one M-health application. With every day passing, new innovations have been observed in mobile phones and web browsers, and it is easy now to find free downloadable applications (Mobihealthnews 2010). In 2017 approximately 1.7 billion individuals accessed and downloaded applications related to m-Health, worth about 26 billion US dollars (Jahns and Houck 2017).

Literature suggests that all these applications are primarily downloaded for controlling different diseases, self-monitoring, health education, and drug control. These emerging trends have raised some serious questions about the security, reliability, efficiency, and quality of services provided.

There are concerns associated with this matter because to guard users, the U.S. Food and Drug Administration (FDA), from the Department of Health and Human Services, enforce guidelines on medical method endorsement and permission. An important question that must be approved is the definition of a medical device. Can a device plus a health-related

application results in a medical device? If yes, it seems that smartphones can be considered as medical devices. On February 2015, the FDA released new guidance for mobile medical apps. This apprises caused in quickly surge of the growth of health and medical apps. The FDA regulations on devices are apparent. Analogously, the European Commission (EC) Medical Devices Directive (MDD) covers the regulatory necessities of the EU for Medical Devices (Bisio et al. 2015; 93/42/EEC Directive 1993).

Discussion and Open Issues

The present-day modernisation and advancements in mobile technology have been reshaping the way of access to health information, the delivery process, and their management. Around the world, all the players in the health care industry have been getting benefits in terms of fast delivery of health care services due to modern cloud computing technology. The introduction of the modern 4G network is responsible for most of these advancements. According to Fayn and Rubel (2009), the introduction of 4G technology combined with other networks, has been empowering innovative services and consumer-friendly models, which are explicitly reflected in the contemporary M-health applications. The fruitful collaboration between M-health applications is an emerging challenge and needs an advanced level comprehensive research to understand the challenge and to recommend a possible way out. There is also the need for cooperation between practitioners and patients to cope with the problem of health-related data privacy. Finally, there is a need for researching a large sample to document the probable impact of m-health technologies on practitioners and patient health.

Telehealth

An ample body of work has been conducted on the Telehealth; however, few studies met the review criteria of the current research. Those studies which did not provide any evidence of significance, those studies whose outcomes were only given in terms of participants/patients satisfaction and those studies where health outcomes were explicitly not comparable were excluded (H. H. Chan et al. 2000). In this research, the quality assessment was carried out using Chiou's criteria (Kunkler et al. 2007). After making a comparison on scientific grounds, Chiou's criteria were developed validated through a study conducted by health economists. Most of the previous studies were conducted on a cost-effectiveness basis, hence no large-scale or meta-analysis was conducted.

About 75% of the studies reviewed were based on the concept of cost-effectiveness in Telehealth. In all those studies, when the patient's point of view was considered, Telehealth was rated as a cost-saving procedure. However, when the practitioner's point of view was considered, the response comparatively reduced to half. The majority of the studies exposed

similar results. The literature argues that technologies that provide health care services through video conferencing in real-time lead to a significant reduction in cost (Bishai, Ferris, and Litaker 2003; Noble, Coast, and Benqer 2005). Market analysis shows that all the commercially videoconferencing units available for health care services are too expensive to be installed at homes; however, studies suggest that other cost-effective alternatives are available.

Further, taking the services of on-call health care specialists to hospital wards through Telehealth has been observed to reduce the cost of services significantly, and alternatively enhanced patient's satisfaction. These models were not perfect substitutes for one another in terms of delivery of services, only two studies in the group were based on intensive care, hence there is a significant need for conducting further research in this arena.

In the case of health care, delivery was made to remote rural areas; results were found heterogeneous for indoor patients and outdoor patients. Other factors like the local policy of access to quality services, local political setups also add to the cost of the health care service in rural areas. It is worth mentioning that among all those services provided, four services were intended at child cardiology problems.

Technology

The installation and adoption cost of modern technology was the center part of the analysis for most of the studies. Although significant improvements in technology and economies of scale production have remarkably decreased the cost of communication equipment's.

The majority of the studies related to healthcare have used PSTN, i.e. they utilized their personal telephone connections, which is much cost-effective as they have already paid the installation costs. When PSTN was used for video conferencing it resulted in reduced quality images, because of low bandwidth, however still this method is still providing cost-effective health care services to the patients.

All of the studies included in this review have not considered the advanced technology of Digital Line Services (DSL), this may be in part because of the reliability issue with DSL (Poon et al. 2007). To improve the quality of its services DSL needs to provide good quality and real-time video sharing. Present day innovative wireless broadband and mobile data service have great potential for providing high-quality video conferencing facilities with a more flexible option for physical installation.

Facility Space

As the concept of video conferencing is based on connecting individuals' settings in two different locations, the relative costs in these distinct geographical locations need to be considered. Theoretically, it is assumed that usually in rural areas, patients can obtain health services without incurring extra or additional cost through Telehealth, however, it implicitly assumes that the service center has some additional spare rooms' facility, free reception facilities, and booking, which in practice may not be the case.

Health Workforce

The fact the general practitioner stays with the patient at a local basic health care center at the time when a specialist consults the patient form the hospital, leads to the high cost of Telehealth because more workforce time is dedicated to every single visit (Doolittle, A. R. Williams, and Cook 2003). However, the advocate of Telehealth proposed that this method will save significant traveling costs (Grady 2002). Another benefit of the above-stated model is the sharing of knowledge and expertise when a single patient is simultaneously examined by two medical specialists (T. L. Williams, May, and Esmail 2001; A. C. Smith, Scuffham, and Wootton 2007). According to Dowie et al. (2007), this mode has led to 5% fewer appointments in orthopedic patients.

Waiting Time

Another significant benefit of Telehealth service is a reduction in the waiting time for receiving specialist care. As stated by O'Reilly et al. (2007), Telehealth has reduced the consultation time from four months to six weeks for taking the services of ENT consultant. This early and timely consultation with the specialist could significantly increase the value of treatment (Oakley et al. 2000). Contrast to that, waiting for an extended period could result in extra interim costs, or even loss of productivity (Ehlers et al. 2008). However, it is worth mentioning that this issue was not addressed in the papers included in the review.

Conclusion

The above in-depth analysis suggests that adaptation of M-health technology could lead to a significant reduction in healthcare costs, as the services could be delivered any time and at any geographical location. The present study has analysed the modern types of technology available in the field of m-Health. Also, growth in the usage and adaptation of m-health technology, issues regarding its legislation and regulation are also discussed in the paper. The review of the literature revealed that both m-health services and applications used for its delivery have already occupied a prominent place and have largely replaced the old practices of health care provision. The analysis further shows that contemporary m-health

services have been proved significantly useful for disabled and chronically ill patients. Based on its proved usefulness, lots of efforts have now been dedicated to investigating the use of different types of m-health care delivery models. This emerging trend in the investigation has now been supported by governments and business, in order to meet the increasing demand for gaining population. It is observed that modern Telehealthcare models are more useful in cases where intervention is combined simultaneously with education and telemonitoring. The evidence for cost-savings-the proposition most often used to justify the implementation of telehealthcare has rarely been generated through robust economic evaluations. Further systematic and scientific reviews may be needed for completely covering this multi-aspect topic like Telehealth consultation and maternal and infant health care, where some basic level of studies are already available, but they need to be properly synthesized.

REFERENCES

Council, E. (1993). Council Directive 93/42/EEC concerning medical devices. *Official Journal of The European Communities, Luxembourg*.

Adair, L. S., & Popkin, B. M. (2005). Are child eating patterns being transformed globally?. *Obesity research*, *13*(7), 1281-1299.

Adeyi, O., Smith, O., & Robles, S. (2007). *Public policy & the challenge of chronic noncommunicable diseases*. The World Bank.

Arah, O. A., Ogbu, U. C., & Okeke, C. E. (2008). Too poor to leave, too rich to stay: developmental and global health correlates of physician migration to the United States, Canada, Australia, and the United Kingdom. *American journal of public health*, *98*(1), 148-154.

Bellina, L., & Missoni, E. (2011). M-learning: mobile phones' appropriateness and potential for the training of laboratory technicians in limited-resource settings. *Health and Technology*, *1*(2-4), 93-97.

Bishai, D. M., Ferris, D. G., & Litaker, M. S. (2003). What is the least costly strategy to evaluate cervical abnormalities in rural women? Comparing telemedicine, local practitioners, and expert physicians. *Medical decision making*, *23*(6), 463-470.

Bisio, I., Lavagetto, F., Marchese, M., & Sciarrone, A. (2015). A smartphone-centric platform for remote health monitoring of heart failure. *International Journal of Communication Systems*, *28*(11), 1753-1771.

Boutayeb, A. (2006). The double burden of communicable and non-communicable diseases in developing countries. *Transactions of the Royal society of Tropical Medicine and Hygiene*, *100*(3), 191-199.

Chan, H. H., Woo, J., Chan, W. M., & Hjelm, M. (2000). Teledermatology in Hong Kong: a cost-effective method to provide service to the elderly patients living in institutions. *International journal of dermatology*, *39*(10), 774-778.

Chan, W. Y., Qin, J., Chui, Y. P., & Heng, P. A. (2012). A serious game for learning ultrasound-guided needle placement skills. *IEEE Transactions on Information Technology in Biomedicine*, *16*(6), 1032-1042.

Chandra, A., & Skinner, J. (2012). Technology growth and expenditure growth in health care. *Journal of Economic Literature*, *50*(3), 645-80.

Chang, L. W., Kagaayi, J., Nakigozi, G., Packer, A. H., Serwadda, D., Quinn, T. C., ... & Reynolds, S. J. (2008). Letter to the Editor: Responding to the Human Resource Crisis: Peer Health Workers, Mobile Phones, and HIV Care in Rakai, Uganda. *AIDS patient care and STDs*, *22*(3), 173-174.

Colantonio, S., Esposito, M., Martinelli, M., De Pietro, G., & Salvetti, O. (2012). A knowledge editing service for multisource data management in remote health monitoring. *IEEE Transactions on Information Technology in biomedicine*, *16*(6), 1096-1104.

Doolittle, G. C., Williams, A. R., & Cook, D. J. (2003). An estimation of costs of a pediatric telemedicine practice in public schools. *Medical care*, 100-109.

Dowie, R., Mistry, H., Young, T. A., Weatherburn, G. C., Gardiner, H. M., Rigby, M., ... & Franklin, R. C. (2007). Telemedicine in pediatric and perinatal cardiology: economic evaluation of a service in English hospitals. *International journal of technology assessment in health care*, *23*(1), 116-125.

Dunsmuir, D., Petersen, C., Karlen, W., Lim, J., Dumont, G. A., & Ansermino, J. M. (2012). The Phone Oximeter for mobile spot-check. *Anest Analg*, 18-21.

Ehlers, L., Müskens, W. M., Jensen, L. G., Kjølby, M., & Andersen, G. (2008). National use of thrombolysis with alteplase for acute ischaemic stroke via telemedicine in Denmark. *CNS drugs*, *22*(1), 73-81.

Eichelberg, M., Aden, T., Riesmeier, J., Dogac, A., & Laleci, G. B. (2005). A survey and analysis of electronic healthcare record standards. *Acm Computing Surveys (Csur)*, *37*(4), 277-315.

Fayn, J., & Rubel, P. (2009). Toward a personal health society in cardiology. *IEEE Transactions on Information technology in Biomedicine*, *14*(2), 401-409.

Grady, B. J. (2002). A comparative cost analysis of an integrated military telemental health-care service. *Telemedicine Journal and E-health*, *8*(3), 293-300.

Hawkes, C., & World Health Organization. (2004). Nutrition labels and health claims: the global regulatory environment.

Hossain, M. A., & Ahmed, D. T. (2012). Virtual caregiver: an ambient-aware elderly monitoring system. *IEEE Transactions on Information Technology in Biomedicine*, *16*(6), 1024-1031.

Humphreys, K., & Weisner, C. (2000). Use of exclusion criteria in selecting research subjects and its effect on the generalizability of alcohol treatment outcome studies. *American Journal of Psychiatry*, *157*(4), 588-594.

Iluyemi, A. (2009). 5 Community-based health workers in developing countries and the role of m-health. *Telehealth in the developing world*, 43.

Istepanian, R. S., & Lacal, J. C. (2003, September). Emerging mobile communication technologies for health: some imperative notes on m-health. In *Proceedings of the 25th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (IEEE Cat. No. 03CH37439)* (Vol. 2, pp. 1414-1416). IEEE.

Istepanian, R. S., Pattichis, C. S., & Laxminarayan, S. (2006). Ubiquitous m-health systems and the convergence towards 4G mobile technologies. In *M-Health* (pp. 3-14). Springer, Boston, MA.

Istepanian, R., Laxminarayan, S., & Pattichis, C. S. (2006). *M-health*. New York, NY: Springer Science+ Business Media, Incorporated.

Jahns, R. G., & Houck, P. (2013). Mobile Health Market Report 2013-2017. *Berlin: Research2Guidance*.

James, W. P. T. (2001). The nutritional crisis to come. *Critical issues in global health. San Francisco, Calif, USA: Jossey-Bass*, 238-50.

Joppe, M. (2000). The research process.[Online] Available: http://www. htm. uoguelph. ca/pagefiles/MJResearch. *ResearchProcess/home. html*.

Krishna, S., Boren, S. A., & Balas, E. A. (2009). Healthcare via cell phones: a systematic review. *Telemedicine and e-Health*, *15*(3), 231-240.

Kunkler, I. H., Prescott, R. J., Lee, R. J., Brebner, J. A., Cairns, J. A., Fielding, R. G., ... & Dixon, J. M. (2007). TELEMAM: a cluster randomised trial to assess the use of telemedicine in multi-disciplinary breast cancer decision making. *European journal of cancer*, *43*(17), 2506-2514.

Lee, C. S., Masek, M., Lam, C. P., & Tan, K. T. (2009, September). Advances in fetal heart rate monitoring using smart phones. In *2009 9th International Symposium on Communications and Information Technology* (pp. 735-740). IEEE.

Lester, R. T., Gelmon, L., & Plummer, F. A. (2006). Cell phones: tightening the communication gap in resource-limited antiretroviral programmes?. *Aids*, *20*(17), 2242-2244.

Lopez, Alan D and Colin D Mathers (2006). "Measuring the global burden of disease and epidemiological transitions: 2002–2030". In: Annals of Tropical Medicine & Parasitology 100.5-6, pp. 481–499.

Maamar, H. R., Boukerche, A., & Petriu, E. M. (2012). 3-D streaming supplying partner protocols for mobile collaborative exergaming for health. *IEEE Transactions on Information Technology in Biomedicine*, *16*(6), 1079-1095.

Martínez-Pérez, B., De La Torre-Díez, I., López-Coronado, M., & Herreros-González, J. (2013). Mobile apps in cardiology. *JMIR mHealth and uHealth*, *1*(2), e15.

Masud, M., Hossain, M. S., & Alamri, A. (2012). Data interoperability and multimedia content management in e-health systems. *IEEE Transactions on Information Technology in Biomedicine*, *16*(6), 1015-1023.

Mathers, C. D., & Loncar, D. (2006). Projections of global mortality and burden of disease from 2002 to 2030. *PLoS medicine*, *3*(11), e442.

Mobihealthnews (2010). The fastest growing and most successful health & medical apps. Tech. rep. Mobihealthnews 2010 Report. URL: https : / / www . mobihealthnews . com / research / the - fastest-growing-and-most-successful-health-medical-apps.

Mullan, F. (2005). The metrics of the physician brain drain. *New England journal of medicine*, *353*(17), 1810-1818.

Noble, S. M., Coast, J., & Benqer, J. R. (2005). A cost-consequences analysis of minor injuries telemedicine. *Journal of telemedicine and telecare*, *11*(1), 15-19.

Oakley, A. M. M., Kerr, P., Duffill, M., Rademaker, M., Fleischl, P., & Bradford, N. (2000). Patient cost-benefits of realtime teledermatology-a comparison of data from Northern Ireland and New Zealand. *Journal of Telemedicine and Telecare*, *6*(2), 97-101.

ONC Health IT Certification Program, HealthIT.gov (2015). Certification of Health IT. URL: Retrieved% 20from % 20https : / / http : / / www . healthit . gov / policy - %20researchers - implementers/certified-health-it-product-list-chpl (visited on 06/03/2019).

O'Reilly, R., Bishop, J., Maddox, K., Hutchinson, L., Fisman, M., & Takhar, J. (2007). Is telepsychiatry equivalent to face-to-face psychiatry? Results from a randomized controlled equivalence trial. *Psychiatric Services*, *58*(6), 836-843.

Paul, S., Bhattacharya, S. D., Sudar, A., Patra, D., Majumdar, A. K., Mukhopadhyay, J., & Majumdar, B. (2009, December). A web-based electronic health care system for the treatment of pediatric HIV. In *2009 11th International Conference on e-Health Networking, Applications and Services (Healthcom)* (pp. 175-180). IEEE.

Poon, W. S., Wong, H. T., Goh, K. Y., Kwok, S. P., & Jacobs, P. (2007). The comparative impact of videoconsultation on emergency neurosurgical referrals. *Hong Kong Medical Journal*, *13*(5), 13-14.

Popkin, B. M. (2001). The nutrition transition and obesity in the developing world. *The Journal of nutrition*, *131*(3), 871S-873S.

Robinson, K. A., & Dickersin, K. (2002). Development of a highly sensitive search strategy for the retrieval of reports of controlled trials using PubMed. *International journal of epidemiology*, *31*(1), 150-153.

Shirehjini, A. A. N., Yassine, A., & Shirmohammadi, S. (2012). Equipment location in hospitals using RFID-based positioning system. *IEEE Transactions on information technology in biomedicine*, *16*(6), 1058-1069.

Smith, A. C., Scuffham, P., & Wootton, R. (2007). The costs and potential savings of a novel telepaediatric service in Queensland. *BMC health services research*, *7*(1), 35.

Subramoniam, S., & Sadi, S. (2010). Healthcare 2.0. *IT professional*, *12*(6), 46-51.

Sutherland, E. (2010). Counting mobile phones, sim cards and customers.[Online] Available at: www. link. wits. ac. za/papers/link-Mobile_numbers. pdf.

Sutjiredjeki, E., Soegijoko, S., Mengko, T. L. R., & Tjondronegoro, S. (2008, February). Development of mobile telemedicine system with multi communication links to reduce maternal mortality rate. In *Proceedings of the Sixth IASTED International Conference on Biomedical Engineering, BioMED* (Vol. 8, pp. 402-407).

Taylor, A., Chaloupka, F. J., Guindon, E., & Corbett, M. (2000). The impact of trade liberalization on tobacco consumption. *Tobacco control in developing countries*, 343-64.

US Department of health & Human Service, Centers for Medicare & Medicaid Services (2015). 2015-02-18- Chronic-Care-Management.

URL:Retrieved%20from%20https://www.cms.gov/Outreach-   and- Education/ Outreach/ NPC/ National- Provider- Calls- and- Events- Items/ 2015-02-18-Chronic-Care-Management-new.html (visited on 06/03/2019).

Wave, V. (2009). mHealth for development: the opportunity of mobile technology for healthcare in the developing. *United Nations Foundation and Vodafone Foundation*.

Wang, Q., Chen, H., Wu, W., Jin, H. Y., & Heng, P. A. (2012). Real-time mandibular angle reduction surgical simulation with haptic rendering. *IEEE transactions on information technology in biomedicine*, *16*(6), 1105-1114.

World Health Organization. (2005). Chronic diseases and their common risk factors. *Geneva: WHO*.

Williams, T. L., May, C. R., & Esmail, A. (2001). Limitations of patient satisfaction studies in telehealthcare: a systematic review of the literature. *Telemedicine Journal and e-Health*, *7*(4), 293-316.

Yang, G., Xie, L., Mäntysalo, M., Chen, J., Tenhunen, H., & Zheng, L. R. (2012). Bio-patch design and implementation based on a low-power system-on-chip and paper-based inkjet printing technology. *IEEE transactions on information technology in biomedicine*, *16*(6), 1043-1050.

Zhang, Z., Wang, H., Vasilakos, A. V., & Fang, H. (2012). ECG-cryptography and authentication in body area networks. *IEEE Transactions on Information Technology in Biomedicine*, *16*(6), 1070-1078.