A Review of Telemedicine in Developing Countries: Introduction and Implementation Issues

Nurazean Maarop, Khin Than Win
School of Information Systems and Technology, University of Wollongong, Australia
Correspondence: nm317@uow.edu.au

Abstract

In late 1990s telemedicine was introduced in a number of developing countries (DC). It is a field comprising a broad collection of applications applied in various disease management and treatment. Telemedicine uses extensive Information and Communication Technology (ICT) and involves various partakers. This paper encompasses telemedicine activities in DC, collaboration and support received by these regions, challenges in introducing and implementing telemedicine in DC. Conclusively some critical aspects are addressed as recommendations in order to improve the quality of telemedicine implementation which can be considered in other applicable contexts.

1. Introduction

In late 1990s telemedicine was introduced in a number of developing countries (DC). Telemedicine is a field comprising a broad collection of applications applied in various disease management and treatment. It provides health care facilities, clinical information and education over a distance [1]. Telemedicine uses extensive Information and Communication Technology (ICT) and involves various partakers (i.e. administrative staff, physician, specialist, policy maker, telemedicine vendor, and ICT maintenance team). The potential utilization of telemedicine in developing nations are often seen equally important in both aspects of clinical and educational as those in industrialized countries [2]. In general, there are a number of factors influencing the utilization of telemedicine discussed in qualitative and quantitative studies in prior literatures. However, only few studies exclusively deliberated on telemedicine implementation aspects in these nations. Still, most of these literatures have only encompassed the execution within their individual country's context.

The scope of this paper is to discover the activities of telemedicine in DC, analyze and recommend the appropriate telemedicine technology implementation aspects for these nations. The main purpose of this study is to answer the question "what are the primary challenges faced by DC in introducing and implementing telemedicine?". To answer that, this study encompasses the review of telemedicine activities, explores types of telemedicine collaborations conducted in several DC and analyzes them insightfully to gain fundamental overview of telemedicine in DC.

2. Materials and methods

The peer reviewed articles published in English from 1990 to 2008 were searched using several relevant databases: Medline, Cinahl, Pubmed, IEEE Explore, Science Direct, Proquest, and Web of Science. A combination of terms "telemedicine" and "developing countries" was used as the keywords combination. In addition to that, the "telemedicine and individual country" was searched through Google Scholar by entering the name of each country in order to locate the journal title that published those particular articles. Only full-text articles, scholarly peer-reviewed and referential cited articles bearing potential relevancy for the review have been assessed and included in the review.

3. Results

Based on the database search, 23 articles of telemedicine in developing countries were found and have reported about telemedicine in terms of:

1. The existing implementation, planning and future of telemedicine in the respective country and the experience of telemedicine project implementation during application feasibility testing, pilot and post-pilot project.
2. Collaboration initiatives.
3. Challenges faced during telemedicine introduction and its implementation in DC.

These 23 articles which are also representing relevant information of each individual country's telemedicine are treated as cases in this study. Adding to this, there are several supporting literatures of telemedicine in DC in the form of review and opinions which are also taken into consideration and cited as references.

3.1 Telemedicine Activities

In most cases the prime telemedicine activities in developing countries uncovered from the cases are related to teleconsultation for medical support and second opinion mainly via common email and through minor use of advanced videoconferencing tools. One of the emerging applications in a decade ahead is still seen to be specialist consultations and second opinions [3]. Findings of the current study also clearly show that majority of the DC regards teleconsultation as a main purpose of telemedicine for providing proxy to specialists' and second opinions' access. It can be presumed that the need of telemedicine in DC has shown strong association with the need of teleconsultation and second opinion. Store-and-forward (using common email or via special telemedicine network) telemedicine in these regions is in fact more acknowledged even though the proliferation of telemedicine systems through real-time videoconference with broad-bandwidth sounds more up-to-date and advanced. As mentioned by Paul et al., [4] an overly sophisticated telemedicine system often required significant training and demanded some time to get familiar with the system. However physicians often did not have the time to attend such sessions and this may result in underutilization. This affirms that requirements for telemedicine system must be more realistic and should only deliver necessary features to physicians especially in the developing regions that are extremely lack of medical professionals which may also plausibly suffering in heavier workload than others in the industrialized nations. Therefore sophisticated technology is simply not the determinant of the success of telemedicine in developing countries.

The introduction of telemedicine in these regions has also contributed hugely towards educational development amongst physicians. Wooton [5] declared that major application of telemedicine in developing world was education. As of to date, this fact remains justifiable, given that almost every developing country cited in this study has recognized telemedicine as a remarkable constructive service in medical education. In general telemedicine in DC have been classified into three main types of activity as the following:

1. Medical consultation:
   a. Asynchronous consultation (e.g. email).
   b. Synchronous consultation (real-time e.g. videoconference).
2. Tele-education for medical student and continuing education for physician.
3. Administrative-based activities.

Fundamentally, teleconsultation operates in one of these two-mode approaches, either to be conducted via store-and-forward (which is also known as asynchronous) or interactive (which is also known as synchronous) in which it normally incorporates video conferencing in order to enable face-to-face virtual consultation (which is also interchangeable with real-time consultation). Of late, a hybrid of the two modes is also common in practice in these DC. Amongst the specialties served via telemedicine are found to be teleradiology, teledermatology, telecardiology, telepsychiatry, telepaediatric, telepathology, and teleneurosurgery in the cited DC. However, teleradiology is found to be the predominant telemedicine application in these nations.

Email is found to be the most highly embraced and has been treated as basic, important and low-cost media for communication amongst medical and administrative staff within hospitals, telemedicine collaborators, and medical professionals from overseas. Generally it has been accepted as flexible platform to perform asynchronous medical teleconsultation and seeking for second opinion between physician and specialist. It is also found feasible and cost effective [6-9]. Instead of plain email the physician may attach files that are related to patient's medical care such as picture, audio and ECG recording thus this is such a flexible option because both parties do not have to be available at the same time. Additional equipment used to facilitate this activity are digital camera, scanner, stethoscope, otoscope, digital video-recorder, video-microscope adapter and medical acquisition software.

Real-time consultation employs videoconferencing tool and is not heavily utilized in DC compared to asynchronous mode due to slow and low bandwidth of telecommunication infrastructure in these regions. Nevertheless, this mode is becoming relevant and possible in DC. This is evident in Jordon whereby video conferencing involving 72 brain tumor cases and also real-time teleconsultation for retinoblastoma cases were found practical [10]. Thus, it was mentioned that with the advent of video conferencing some technical barriers in conducting telemedicine in Federated State of Micronesia have been widely resolved, resulted in improvement in diagnosis, referral and continuing medical education [8]. However, some networks are not appropriate to support real-time consultation such as Very High Frequency (VHF) radio, High Frequency (HF), and low-bandwidth satellite. At least the best form to deliver consultation over real-time mode is via Integrated Services Digital Network (ISDN) with proper band-width [11].

Remarkable involvement of tele-education as educational and electronic learning tool has been realized in a number of DC found through this study. Besides that, several pilot and survey studies have also indicated tremendous interest in specific telemedicine application like tele-education, tele-mentoring and distance learning via real-time mode. These are evident through several examples. As of 2005, telemedicine for continuing training and education was used successfully in Uzbekistan [12]. Around 2001, tele-education for continuing education is more receptive in China in

comparison with other telemedicine activities [13]. As of 2001 medical consultation and distance learning has demonstrated worth usability in Thailand [14]. In Brazil tele-education has shown tremendous outcome for undergraduate medical students [15]. In brief, other adjacent terms like distance learning, electronic learning tools, continuing medical education, tele-conference, tele-mentoring and tele-teaching were mostly mentioned in those articles used for this study hence indicating that tele-education is a must-have-application of telemedicine in developing countries.

E-Referral activities were found feasible as administrative-based telemedicine. For example in Malaysia, from March 2001 to September 2002, 1034 referrals were transmitted with teleradiology, teledermatology, telecardiology, teleneurosurgery and general medicine (via special telehealth network) even though it was just recently launched around 2000 [16]. The key benefit transmitting referral through proper telemedicine network is that it provides the facility to record the referral log history which can be referred in future and at the same time secures the confidentiality of data. Other than that medical coordination, exchange of medical information and report are parts of administrative activities emerged in these regions.

3.2 Collaboration Supports

Most telemedicine projects are initiated by relevant government ministry such as Ministry of Health through national agenda or policy in the respective DC. Attempts to reach success in telemedicine implementations are not limited to individual implementation but should be gained through the interaction with other affiliations. For example in India, some telemedicine services are provided by hospitals group, non-profit organizations and research institutes [11]. Apparently, several DC somehow have established collaborative initiatives with other countries in order to improve telemedicine in the existing telemedicine structure (also as introduction in the pilot projects). Collaboration ranges from a simple initiative like teleconsultation for medical advice and second opinion to telemedicine with robotic telesurgery. Most international collaboration, financial and technological supports appear from major universities, medical institutional and research institute within the country or inter-country. These joint-effort examples are provided in Table 1. Collaborations are found to be in the following forms:

- Teleconsultation for medical advice and second opinion (store-and-forward and videoconference) mostly in the areas of radiology, cardiology, pediatrics, dermatology and psychiatry.
- Tele-education, distance learning and tele-mentoring.

Table 1. Examples of collaboration initiatives

Country	Notes on collaboration
Romania [17]	Various collaborations were performed in order to utilize and improve telemedicine. (1) collaboration with NASA (United States) in the areas of telemedicine development, distance learning and robotic telesurgery; and (2) collaboration with hospital in Italy to provide second opinion consultations for patients in pediatrics surgery, dermatology, and psychiatry.
Africa [19]	By 2006 nine African countries were connected to Internet-based telemedicine in Africa. Various collaborations have been established that connects Europe-Africa and within African countries.
Bangladesh [20]	Most telemedicine efforts are from universities and hospitals and some even obtained financial collaboration from European Union.
Indonesia [21]	As of 2004, there was collaboration project between hospitals, colleges and telecommunication company with Japan using up-to-date technology.
Jordon [10]	Between 2004-2006 twinning programs were held with Canada to discuss 72 cases of brain tumors using video-conferencing. Between 2003-2006 twinning programs were held with research hospital in Tennessee (United States) through teleconsultation for retinoblastoma.
Tunisia [22]	As of 2008, 21 public telemedicine stations in this country are more engaged with foreign collaboration network (mostly European, Arab and Africa). There is also telemedicine project via satellite connecting the trans-European network aimed to be developed.
Brazil [15]	Telementoring between Brazil-US on surgical procedures was found feasible, safe and effective.
Kosovo [23]	Since 2002 there were international collaborations with 20 universities and institutions, publishing companies and others that enrich activities and knowledge of telemedicine. International cooperation is significantly growing in the form of tele-education and teleconsultation.
China [13,18]	Initially telemedicine program was perceived as expensive investment for medical purpose; fortunately there were some donations from medical universities in China and through international collaboration to purchase more telemedicine equipment.

All of these collaboration efforts are found feasible. Other than these, there are five active operators (located in developed regions) providing general purpose second opinion in DC (mostly started their operation in 1998 and above). According to Wooton [2] the operators are: (1) Partner Healthcare (USA), (2) Tripler Army Medical Center (USA), (3) iPath Association (Switzerland), (4) Swinfen Charitable Trust (UK) and (5) Geneva University Hospital (Switzerland). The Swinfen Charitable Trust established in 1998 is amongst the most accommodating operator as it serves in 34 DC and its low-cost telemedicine service had been useful and cost-effective [2,6]. As such, tremendous implementation effort should not only derive from the policy makers or national health authority but also from other representatives of external organizations thus this is such a great coalition.

Nevertheless in spite of all these, most studies of telemedicine are based on developed countries hence the findings are not applicable to DC [24]. Rigby [25] point out that experts from overseas or other places may not know appropriate treatment that are within the affordable range or available and can be accepted locally. Implementation of telemedicine services in DC requires supports from local people and if attention is not given to the chronological background behind each developing country's current health system due to the excitement to bring in western technology, telemedicine will have unconstructive impact on the country's health care [26]. According to Wright [27] sustainability of telemedicine in DC will depend on several factors like local management ability, commitment on various partners, technology and services being used. This is also supported by Latifi [28] who argued that each and every bit of the entire process in telemedicine project should be built by locals and must be based on the ability to be operated and inter-operated in between systems thus model of sustainability must also be constructed. Adding to all these arguments, Wooton [2] stated that even though most of the international telemedicine networks that provide second opinion consultation collaboration for the developing nations have been five years in operation, only 0.1% of potential demand from these regions is being met thus recommended the employment of inter-country telemedicine network which is considered more cost-effective and offers higher sustainability rate. Telemedicine in DC depends largely on within-country resources and for that reason those countries that gain support from other countries should become independent as soon as possible [2]. Furthermore continuous dependence on foreign non-government agencies may not guarantee stability to the country's condition and indeed local people are the main player to support the success of implementation [26]. For that reason, standards of telemedicine should be tailored according to the exclusive context of individual country and should not be too dependable on other countries.

3.3 Challenges of Implementing Telemedicine

Prior studies demonstrated common obstacles in introducing telemedicine and its adoption in both developed countries and developing nations which apparently seem still not fully resolved. Although substantial effort has been invested in trials and experiments of telemedicine services yet surprisingly only few applications have continued beyond the initiatives, research and development phase [29-31]. There are numbers of example around the globe where telemedicine has been introduced and rapidly abandoned, often because it has simply failed to be integrated into the circle of health and business environment [32]. The slow rate of diffusion and pick-up of the telemedicine intervention in the health systems were constrained by various barriers and factors. Unfortunately there was little information regarding utilization and optimization of telemedicine in developing countries found from these cases. As a result the barriers and challenges for this study are only based on the introduction and implementation aspects which are identified as: (1) Funding and cost, (2) Technical, technology and quality (3) Infrastructure and geographical (4) Resources and knowledge (5) Political, organization and culture. Of these, funding is evident to be the most unbearable barrier being faced by DC in reaching telemedicine success.

3.3.1 Funding and cost. Most cases claimed funding and cost are the main obstacles in telemedicine introduction and implementation in DC which have also resulted in limited investment in telemedicine equipment [21,33]. For instance, initially in China telemedicine program was perceived as expensive investment even it was found feasible for medical purpose [18]. Additionally, lack of financial viability could also lead to discontinuation of telemedicine project [20]. Some countries with poor geographical infrastructure such in Tanna Island, even a simple dial-up access has been regarded as expensive [34]. In fact the ISDN that can support more reliable interactive telemedicine in DC [11] was found very costly to implement [15].

3.3.2 Technical, technology and quality. Technical aspect is critically being pointed out next after funding. Amongst barriers related to technical, technology and quality are as in the following summary notes:

- Due to slow access and low usage of Internet in rural areas has subsequently resulted in low response time from the consulted physicians [12].
- Low quality of compressed digital images and video quality [35], lack of system friendliness [11] and lack of health data standards and interfaces for health care data acquisition which have prevented different sites to efficiently and accurately exchange

data for telemedicine practice [23,35] are mentioned in several cases. In fact in some countries, data standards are available but they are all written in English language and cannot be used directly in non English speaking country e.g. China [18].

- There are problems with equipment and configuration as some range of personal computer (PC) based medical equipment need to be imported and virtually there is no support for the equipment [11]. Equipment upgrading operation has led to some equipment failures and more frequent maintenance calls had to be made which subsequently had caused higher expenditure [15,36]. In addition to this due to weak integration, even though telemedicine program have been established and installed with appropriate equipment in a number of locations which are found satisfactory and reliable but difficulties in health are not much improving [12].

It is evident that technical barriers could complicate telemedicine implementation. Therefore efforts should be concentrating on tackling the constraints because somehow these obstacles would lead to lessening the motivation to use telemedicine service. This happened in Bangladesh where some patients chose not to use telemedicine service due to high occurrence of technical problems [20].

3.3.3 Infrastructure and geographical. Amongst infrastructure and geographical barriers faced in implementing telemedicine in these DC are found to be poor and outdated infrastructure [17], no telephone line in rural areas [34] or inadequacy of telecommunication infrastructure in rural areas [14], poor transportation infrastructure and lack of stability of electric supply [19]. As the matter of fact electrical discharge would consequently cause damage to telemedicine equipment [9].

3.3.4 Resources and knowledge. Generally there are always serious lack of physicians, specialists and also managerial staff for telemedicine program in DC and uneven distribution of health personnel between poorer rural areas and urban areas. For instance most physicians and specialists in Thailand, Malaysia and Cambodia prefer to live in big cities [9,16] for them to have better career enhancement and continuing education [14]. Technology and resources are found not only limited within big cities but also in major universities [17]. Resources to train medical personnel are also found inadequate [9,11,37]. Lack of education and training on operating telemedicine equipment is among the factors that could limit the knowledge about telemedicine capabilities. In Argentina [37], telemedicine workstations were installed in every hospital without proper training which then led to under utilization. Practical experience and training is very important not only for medical staff but those personnel who are in charge of maintenance and troubleshooting [36].

3.3.5 Political, organization and culture. There is less political and legislation control concerning the practice of telemedicine in some DC [15,17,33]. In addition, inconsistency of budgetary agenda for telemedicine project [37] and lack of fundamental medical standards, policies and practice management guidelines [23] have also contributed to telemedicine failure or project discontinuation. Poor market promotion of telemedicine service and lack of government sector enforcement could cause technology remain unused or out of reach [20]. Lack of preliminary concept in an attempt to promote telemedicine to the majority of health professionals at time the telemedicine workstations were installed has resulted in a failure of telemedicine action plan [37]. Non-supportive cultural environment could hamper technology utilization where in the end the physicians might opt to give consultation through conventional way [21]. In addition, lack of cross-communication among different disciplines has caused delays and inappropriate referrals [37]. In terms of consultation culture, patients prefer face-to-face consultations especially for those who can reach specialist within a day. For instance in Bangladesh, patients who can travel within 2 hours to main hospital prefer to physically meet the doctor rather than to use the technology at the nearest health care center [20]. Furthermore once telemedicine was introduced, the organizations have had to face some difficulties during the process of adapting structural change in health care delivery [21].

4. Discussion and recommendation

As a whole, telemedicine has become an essential delivering tool in health care since it was introduced in late 90s in these regions. Some of these countries have gained technical and financial support through international collaboration and charitable trust but majority of the DC are independent and self-governing. As evident from the results, the introduction and implementation of telemedicine have faced several barriers and the issues are almost similar in all cases cited in this study. As a result, this study recommends some suggestions that are potentially liable to enhance the benefits of telemedicine in DC as well as to resolve some issues related to the research question prompted in the earlier section. The potential recommendations are proposed as the following:

i. In the initial attempt of telemedicine execution in DC, the implementation should be relatively basic which does not rely on sophisticated tool or expensive backbone network and infrastructure.

This is because the primary activity in most DC is still concentrating on basic teleconsultation and seeking second opinion using store and forward mode in critical medical specialties like radiology and cardiology. Subsequently, telemedicine application feasibility analysis is critically required not only to assess the benefits of the new application but also to measure the real demand for this technology in order to determine further expansion. As mentioned by Rigby [25] pull of needs would determine the adoption of telemedicine in DC and not the push of supply.

ii. Several DC have gained technical and financial support through inter-country affiliation, international collaboration and even from charitable trust; nevertheless many are independent and self-governing. Given that most of the collaborations found from this study are feasible, this kind of collaboration should be encouraged particularly in those DC that are critically lack of physicians (especially in critical medical disciplines) and in those DC that are technically facing limited capacity in operating telemedicine technology. On the other hand few authors claimed that this form of dependency should not be in a long term basis to guarantee sustainability of telemedicine delivery when collaboration discontinued [2,25,26,27]. Lack of sufficient evidence for these arguments warrants additional studies. Therefore this study recommends that there should be further empirical analysis regarding international collaboration supports in DC to provide appropriate strategy and guidance concerning telemedicine collaboration in these regions.

iii. Barriers and challenges found from this study are only based on the introduction and implementation aspects which are identified as: (1) Funding and cost, (2) Technical, technology and quality (3) Infrastructure and geographical (4) Resources and knowledge (5) Political, organization and culture. Of these, funding is evident to be the most unbearable barrier being faced in reaching telemedicine success in DC thus this suggests that there should be an appropriate financial plan to assure sustainability and stability of implementation. Additionally there should be a proper action and technical plan of telemedicine to rectify related technological problems beforehand in the respective country. Adequate education and training on operating telemedicine equipment should not be overlooked as this is important not only to expose telemedicine capabilities to potential regular users but also to encourage telemedicine utilization into routine use. Frequent promotional program of telemedicine service should be conducted to create awareness of telemedicine and induce positive perception of organizational change management to the majority of health professionals. This study also suggests an incentive or reward in any means be granted to the users as to stimulate motivation amongst users in particular at the initial phase in the effort to put the service into routine practice. Finally, a utilization model towards routine-use of telemedicine should be established as part of the sustainability program once the telemedicine is introduced in any DC.

5. Conclusion

The result is based on the literature about experience of telemedicine in number of cases (country based) of DC and other form of relevant studies mentioning telemedicine in DC. This review study helped to identify the main activities, collaboration practice and barriers of the introduction and implementation of telemedicine in DC. Based on cases being employed in this study, some critical aspects were addressed as recommendation in order to improve the quality of telemedicine implementation which can be considered in other applicable setting and contexts.

6. References

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