Applicability of Telemedicine in Bangladesh: Current Status and Future Prospects

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Abstract: *Telemedicine refers to the use of information and communication technology to provide and support health care mainly for the purpose of providing consultation. It is also a way to provide medical procedures and examinations to remote locations. It has the potential to improve the accessing to quality health care services and delivery while lowering costs even in the places with scarcity of resources. Understanding the potentiality of telemedicine, many developing countries are implementing it to provide health care facility to remote areas where health care facilities are poor. Bangladesh is not an exception to this either. In this paper we mention the reasons why Bangladesh has to move for telemedicine. We also present the past and on-going telemedicine activities and projects in Bangladesh. Analyzing these projects we have found out some factors which should be assessed carefully for successful implementation of telemedicine application. Considering Bangladesh telecommunication infrastructure, finally we propose a prototype telemedicine network that can improve health facilities through telemedicine by making a connection between rural health facility providers and special hospitals.*

Keywords: *Telemedicine, information and communication technology, telemedicine implementation.*

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1. Introduction

Recent advances of Information and Communication Technologies (ICT) have helped the society to quickly access services for economic and social developments. Telehealth/Telemedicine/E-health is the blessing of ICT and is possibly the most prominent e-business service that can have a major visible effect on the development of healthcare sector of the society. Telemedicine is the use of medical information exchanged from one site to another via electronic communications to improve patients' health status [1]. The concept of telemedicine is not new. It has been used since 1959, when a two way video conferencing link was established using microwaves between university of nebraska medical school and state mental hospital [3]. The National Aeronautics and Space Administration (NASA) also played an important part in the early development of telemedicine. NASA's effort in telemedicine began in the early 1960s when human began flying in space.

Since 1970s, NASA has been in the forefront of research and demonstration in the field of telemedicine [17]. In the 1970s and 1980s, telemedicine experiments focused on the transmission of medical images using television. In the 1990's the rapid growth of computer and information technology gave a rebirth to telemedicine. Innovation of new technologies enabled telemedicine to grow up into more complex and feature-rich technology [19]. In general sense medical care relies on the face to face communication between patients and doctors, and in telemedicine concept physicians treat a patient who is some distance away. The primary purpose of telemedicine is to reach health care service to patient who is isolated from specialized care. Telemedicine can provide services for 24 hours a day and seven days a week basis. The patient may be living in remote place like rural area or in a ship in deep ocean and even in space craft. In countries where access to medical services is restricted by distance and poor transportation and where health care services are inadequate, telemedicine offers a great opportunity and possibilities to distribute medical services by utilizing ICTs.

Many developing countries can not provide minimal health service to their people due to insufficient number of doctors, health care professionals and medical services. Sometimes it is seen that there are clinics and hospitals but they are often ill-equipped. This is particularly true for the health care systems outside urban area, which are normally beyond the reach of general mode of communications. The inadequate infrastructure makes it more difficult to provide health care in rural and remote areas at the right time. If travelling cost of a patient to visit a medical specialist is higher than the cost of providing a telemedicine consultation, then telemedicine might be an economically viable solution.

Bangladesh is one of the most densely populated developing countries where most people are living in villages [13]. There is a huge disparity in health care distributions between rural and urban areas. People are also suffering due to lack of medical expertise and

health care facilities. In this scenario utilizing the limited resources, telemedicine may be an easier and cheaper way to disseminate healthcare facilities to the rural areas. Telemedicine activities emerged in Bangladesh in mid of 1999. Providing medical care is the constitutional obligation of the government. The second goal of national health policy stated "To develop a system to ensure easy and sustained availability of health services for the people, especially communities and urban areas" [11]. In order to meet the requirements of the overall objectives of the health sector, various programs were undertaken during the past decade. Strong telecommunications connection between remote health centres and special hospitals can help government to reach its goal easily.

In the last few years information and communication infrastructure of Bangladesh have been experiencing huge booming in development. Bangladesh government has given immense importance to ICT for development in economic growth and poverty reduction. In April 2007 Bangladesh got connected to the submarine cable network as a member of the South East Asia-Middle East-West Europe (SEA-ME-WE-4) consortium [14]. Internet facility is now available in every district of Bangladesh. If Government and private organization take proper initiatives, it would be not so far when a patient in remote place can consult the doctors over internet.

In this paper we have presented the overall telemedicine application and its status of Bangladesh. The organization of this paper is outlined as follows. In Section 2, we present current health care facilities of Bangladesh and recommend that telemedicine may be an effective way to distribute health care among urban and rural people even by using the limited resources. In Section 3, we present telemedicine activities in Bangladesh till now. Section 4 has been used for discussion and analysis of the past and ongoing telemedicine projects in Bangladesh. We present some factors found from our analysis which are very much interesting and can be considered for development of telemedicine in Bangladesh. In section 5, we propose a prototype telemedicine network in Bangladesh perspective followed by conclusion in section 6.

2. Telemedicine in Bangladesh: Why?

Bangladesh is one of the most densely populated countries in the world (ranked 11 in world) [13]. More than 140 million people are living within 144,000 square km of land area (1045 person/km^2). There are only 663 Government hospitals in district head-quarters and Thana (a kind of sub-town) areas. Total number of beds available in both public and private hospitals and clinics is 51,648. The ratio of hospital bed in Bangladesh is around 1:2571 [5].

Table 1 gives an overview of existing health care facilities in Bangladesh. From this table we can see the inadequate healthcare infrastructure of this highly populated country. Around 80% of the total population of this country live in rural areas [6]. And rural health centres are often ill-equipped. Moreover most of the doctors are city based. After being selected as a cadre of Bangladesh Civil Services (BCS) usually the doctors get employment in remote health centre of Bangladesh. Due to poor infrastructure of rural health centre and poor infrastructure of villages most of them leave the rural areas within 1-2 years and shift to city area. They feel that they become professionally isolated and outdated if stationed in remote areas. As a result health staffs in rural areas are usually young, have little work experience and show high job rotation. In many cases rural health centres are headed by infirmary technicians who are barely trained. In this situation rural people rarely get any specialist doctor's advice when they go to health centres in Thana or Upazila level. To get better consultancy, rural people spend most of their money on travel to visit a doctor in urban areas. Sometimes, it is not possible to transfer a patient to the suburb or to the city on time due to his/her critical health condition and poor communication facilities in those areas.

Table 1. Health-care facilities in Bangladesh [5].

Facilities	Quantity	Year
Number of hospital beds	51,648	2005
Population per hospital bed	2571	2005
Hospital beds per 10,000 population	3.43	2005
Number of health centers	1385	2004
Number of physicians	42,881	2005
Population per physician	3169	2005
Physicians per 10,000 population	3	2005
Population per nurse	6442	2005

Under these circumstances providing health care in rural areas, two options are open. One is building hospitals in rural areas and improving the infrastructure so that doctors and others staffs feel convenient to stay in these places. The other is to take initiatives so that it is easier to access quality of health care services by people in rural areas. To implement the first one huge investment and time are needed. Hence, the second one seems most feasible option. To implement second option, telemedicine is the best way as it can provide better health care by using maximum utilization of limited resources.

3. History of Telemedicine in Bangladesh

Telemedicine in Bangladesh emerged in mid to late 90s. Many physicians and surgeons in Bangladesh were practicing informal teleconsultation with their colleagues in different countries. The early initiatives were sporadic and unorganized and most of them were based in store and forward technologies such as

telegrams and e-mails. A more formal approach was taken only after 1999.

3.1. Time Line of Telemedicine in Bangladesh

1999 First telemedicine link was established by a charitable trust named Swinfen Charitable in Bangladesh [20]. It established a link between the Centre for the Rehabilitation of the Paralysed (CRP) in Dhaka (the capital city of Bangladesh) and Royal Navy Hospital, Haslar, UK. It was e-mail based connection. It used a digital camera to capture still images which was then transmitted via e-mail. It was a very successful project. An evaluation of the 27 referrals made during the first year of operation showed that teleconsultancy had been useful and cost-effective. Based on the success of the Bangladesh project, the Swinfen Charitable Trust supplied digital cameras and tripods to more hospitals in other developing countries [20].

- July 1999: Telemedicine Reference Centre Ltd. (TRCL) Dhaka, Bangladesh, a private company launched its journey with an ambitious project to set up telemedicine project to help doctors identify diseases at early stage. Dr Sikder M. Zakir, President & CEO of TRCL said "If we get the diseases in early stage then it is possible to save 20 times more money that are being spend". In the beginning TRCL linked 200 specialist who offered their expert opinion to rural doctors. Although it is a privately funded project, Ministry of Health and Family Welfare of the Bangladesh Government was playing a significant role in the implementation. TRCL started feasibility study and infrastructure development to establish national and international telemedicine services.
- Mid - 2000: Grameen communications took rural tele-health initiatives using wireless technology.
- 2001: TRCL demonstrated telemedicine system in the US trade show 2001 in Dhaka using icare software and normal Internet connection & started test-run of the system between US and Bangladeshi physicians [18].
- April 2001: the Bangladesh Telemedicine Association (BTA) was formed. But the lack of government participation the technology remains out of reach to majority of poor people of the country.
- 2003: Sustainable Development Network Program (SDNP), Bangladesh began in January 2003. The e-health project built two network segments (8Km; and 6Km) using point-to-point radio with bi-directional bandwidth of 2 Mbps. Currently, SDNP has four regional nodes in different parts of Bangladesh (Cox's Bazar, Dinajpur and Satkhira), including Mymensingh. These nodes are connected to satellite through VSAT 22 (SCPC/MCPC) technology. Under this project every Friday they arranged consultancy and diagnostic support to the physician at remote end, though medical experts at the SDNP head office [16].
- 2003: Bangladesh University of Engineering & Technology (BUET) and comfort nursing home had started a telemedicine project with the financial collaboration from European Union (EU) via e-mail. Recently the project is not functional.
- May 2004: Bangladesh DNS diagnoses centre, Gulshan-1 and comfort diagnoses and nursing home started a telemedicine centre. This project was discontinued because of lack of financial viability, patient disinterest and poor market promotion.
- 2005: In August 16, 2005 Grameen Telecom (GTC) in collaboration with the Diabetic Association of Bangladesh (DAB) launched telemedicine services, giving patients at General Hospital in Faridpur district of Bangladesh access to specialist doctors of their choice in Dhaka. DAB's BIRDEM Hospital, Dhaka, was connected via a video conferencing link to DAB Faridpur General Hospital. Consultations now take place over video conference where patient and doctor see each other on television screen. The cost per consultation for a new patient was 600 BD Taka (10 US$), with repeat patients getting some discount [8].
- 2006 November: TRCL and Grameen Phone started a unique telemedicine service "health line dial 789" a GSM infrastructure based call centre for Grameen Phone's 10 million subscribers, providing different types of medical information facilities, emergency services (SMS based LAB report, ambulance) and real time medical consultation over mobile phone [18].
- 2007 September: The project 'ICT in rural Bangladesh' is working for the development of health care facilities in rural Bangladesh through ICT. The project is funded by SPIDER (the swedish program for ICT in developing regions) for the period of September 2007–December 2009 and is in collaboration with Grameen communications, Bangladesh; Grameen phone, Bangladesh; Bangladesh sheikh mujib medical university, Bangladesh; and International Institute of Information Technology (IIIT), India. The overall goal of the project is to improve the performance of rural health workers and increase the access to healthcare services for rural poor in the district of Magura in Bangladesh [15].

3.2. Existing Telecommunication Infrastructure of Bangladesh

The success of Telemedicine depends on the improvement of information and telecommunication infrastructure structure. Telecommunication sector in Bangladesh has got a huge boom in the last few years. Several private and public telecommunication

operators have established their networks all over the country. As they are expanding their operation to the most rural areas, they are also dwelling to improve the network performance and inclined to introduce latest technologies to the people. We have summarized the telecommunication infrastructure status of Bangladesh in Table 2.

Table 2. Telecommunication status in Bangladesh.

Number of Telephones (land-lines)	134 million
Number of mobile phone subscriber	44.8 million
Digitised districts	100%
VSAT Provider	31
VSAT user	64
Number of ISPs	185
Internet user	450,000 (2006)
PSTN Phone Subscribers has reached	1,186.919
Interne penetration	0.3% 0.5
Telephone density	1 per 100 persons

Bangladesh is the first optical fibre network user in Asia. It established a 1800 km long optical fibre network for Bangladesh Railway in 1986, along with the installation of digital switching [7]. Bangladesh Telegraph and Telephone Board (BTTB) have also established optical fibre links in most cities. SEA-ME-WE-4 is a submarine cable consortium connecting a total of 14 countries at 16 landing stations. To connect the whole country with this submarine cable, different activities have been undertaken.

4. Discussion

4.1. Lessons Learned From Previous Telemedicine Projects

The first project of telemedicine between CRP in Dhaka and Royal Navy Hospital was successful and it encouraged other developing countries to take these type of initiatives. At the beginning the outcome of DAB Pilot Project was satisfactory. In the first three months, there were 52 new patients and 6 returning patients. But the number of patient rate was not satisfactory later. The patient rate was around 1.3 to 1.5 per day until 2006. Later some technical problems occurred that decreased the patient rate. The performance of the camera was not satisfactory and pictures were damaged in rough weather due to the last end radio link connection. We think another reason of failure of this project is the implementation in a place (Fardipur) which is very near to Dhaka. It takes only 1.5-2 hours to go Dhaka from Faridpur by bus. So the patient may have found it more convenient to come to Dhaka and physically meet doctor of their choice. The SDNP telehealth project is running now. They only provide teleconsultation with remote doctor on every Friday, which is not enough to support emergency situations.

Telepsychiatry is another application of Telemedicine. It is the most successful and low cost telemedicine application, because of the fact that it needs only a good videoconferencing between two end points. According to national mental health survey in 2003-05 about 16.05% of the adult population of Bangladesh are suffering from mental disorders [22]. There is a high prevalence of psychiatric disorders in rural Bangladesh. Money spent for mental services is less than 0.5% of the total national health expenditure. There are 50 outpatient mental health facilities, 31 community-based psychiatric inpatient units, 111 community residential facilities and one 500 bed mental hospital in the country. In past telemedicine projects it did not get much attention. Telepsychiatry can be considered as a way for providing mental health care services.

Although telemedicine is not a panacea for all problems related to health care, it can help to minimize the problems that are related with time in distant. Telemedicine activities are still in primary level in Bangladesh. There is no support to meet the emergency medical need such as heart stroke, and sever injury for people in remote areas. Many developing countries have implemented telemedicine networks which have made a connection between remote hospitals and special hospitals. We can take India [21], China as for example [23]. China has three major telemedicine networks. The IMNC network is primarily based on telephone line and Internet. To provide data transmission over low bandwidth they are using powerful image compression algorithm that can reduce the file size dramatically [23]. Bangladesh government always patronized past telemedicine projects. This is in accordance with our views that the government have lots of responsibility in this aspect. It should encourage private organizations to invest in telemedicine implementation.

4.2. Overcoming Challenges

In spite of the tremendous benefits of telemedicine and its global expansion, some major barriers prevent its world wide use. There are a number of unresolved problems which need consideration before telemedicine can be fully practiced in Bangladesh.

- Telemedicine laws and reimbursement policies since telemedicine practicing is increasing day-by-day in Bangladesh, so it is very much needed to provide structured laws and regulations about physicians, patient issues, issuing license to physician and telemedicine providers. There should be clear rules about reimbursement issues. Since in telemedicine system a local doctor or paramedic

treats a patient and they consult with specialist who is far away, question arise as who will be responsible in patient issues?

- User acceptance: the success of any system depends on acceptance of users. Though there is no difference between conventional consultation and teleconsultation, patients and doctors who are accustomed to personal visit may be reluctant to alter the traditional methods of health care. Maybe non-IT savvy medical staffs and physicians will face difficulty in using new technology. To overcome this problem, sufficient training programs should be offered to enable physicians to adapt this new technology. Bangladesh TeleVision (BTV) and others satellite channels can play a significant role to make telemedicine popular. They should broadcast the successful cases considering the efficacy and cost effectiveness of telemedicine.
- Cost much of the equipment used in telemedicine is still expensive and network cost is also significant. Bangladesh Government also should create policy in favour of rural peoples so that they can enjoy low cost telemedicine services.
- Hardware and software compatibility telemedicine systems and services require that users have compatible hardware at both ends of the communications link, which reduces interoperability and benefits of access to different sources of telemedicine expertise. If equipment is difficult to access or operate clinicians are less inclined to involve. Wireless telemedicine equipments are more preferable than wire devices.
- Privacy and confidentiality telemedicine involves the electronic transfer of patient medical records and information from one location to another via the Internet, or other computerized mediums. Medical data are frequently sensitive, confidential, and private. Thus, telemedicine presents significant challenges for safeguarding the privacy and confidentiality of patient health information. There should be specific privacy regulations on the practice of telemedicine so that patients can feel secure in knowing that discloser of their personal information will have to suffer certain penalties.

The following factors should be assessed before setting telemedicine implementation in a specific health care.

- Medical need: first we have to consider what kind of medical facilities can be provided by this specific health centre. Establishing a high-end telemedicine cell in Thana level would not be significant because of the structure of health care.
- Organization and structure of healthcare: according to structure of health care, telemedicine support can be different.
- Location of the health centre: if the location of the health centre is in same city of the super or large hospital then people may prefer face to face consultancy rather than teleconsultancy. We have seen this problem in DAB project where the health centre is Faridpur and special hospital is in Dhaka, the capital of Bangladesh and the distance between these two locations is one and half an hour by bus [8].

5. Proposed Model

Telemedicine can be divided into two basic modes of operation: real time and store and forward [22]. In real time telemedicine treatment, the patient is accompanied by an attending physician who consults with specialist who is far way from them. In store and forward mode, all relevant information are transmitted electronically to the specialist. For this mode, the response does not have to be immediate. An ideal telemedicine is a combination of these two modes. Wide bandwidth is very essential for real time telemedicine.

In Bangladesh maximum large hospital and special hospitals are in Dhaka. By establishing a telemedicine network among already established health centres with advanced medical establishments, the healthcare professionals in specialised fields, such as cardiology, urology, oncology, psychiatry, surgery and many others, can access or exchange information for diagnosis, treatment and prevention of disease. With current Bangladesh telecommunication infrastructure real time telemedicine is possible up to district level between special health care providers and district hospitals. There is optical fibre link in most of the districts. Internet facility is also available in maximum sub-town (Thana). But bandwidth is not wide enough. Store and forward basis telemedicine support can be expanded up to Thana level by using telephone lines.

5.1. Considerations for Proposed Model

Considering the communication background of Bangladesh we are proposing a telemedicine network model. The objective of our proposed model is to build up a connection between remote health centres and large or special hospitals. It will minimize unnecessary patient transfer, from a remote site. Before implementing the proposed telemedicine network the following attempts should be installed.

- Need to provide structured laws about physician patient issues; issuing license to physician and telemedicine providers and escorting the privacy and confidentiality of patient health information.
- Need standardization of telemedicine services of different telemedicine centres for enhancing interoperability among various telemedicine systems. The standard will assist the government and health care providers in planning and implementation telemedicine network.

- Need to prepare appropriate education and training programme for health professionals on the use of telemedicine equipment in order to comply with the international standards and protocols.

Our proposed model is shown in Figure 1. In this model, we have categorized all kinds of health care providers including hospitals, special hospitals and health complexes into three categories as follows:
Cat 1: large hospitals and special hospitals.
Cat 2: district hospitals.
Cat 3: Thana health complexes.

5.2. Network Architecture and Connectivity

In our proposed model wide bandwidth connection is needed between Cat 1 and Cat 2 for real time telecommunication. To transfer electronic medical record we can use existence optical fibre connection or Very Small Aperture Terminal (VSAT).

For connection between Cat 3 and Cat 2 we can use digital data network where the duty physician will collect patient record and other reports. After compressing data they send the record to Cat2 hospitals if they need any help. With a 28.8 Kbps dial-up connection, transmission of a standard X-ray takes 30 minutes.

5.3. Equipment and Peripheral

Telemedicine infrastructure: Cat 1 and Cat 2 include the following infrastructure.

- Telemedicine network: VSAT connectivity with a synchronous data-transfer rate of 384 kbps and optical fibre link.
- Video conferencing system using multi-point-SONY PCS 1P [resolution: common intermediate format 352 pixels× 288 lines; frame rate: maximum 30 fps; colour system: PAL system [21] and 29" flat television.
- Digital microscope (leica DM LS2) and A3 size X-ray film scanner (U-max) with transparency adapter.
- Connection between web-based database servers for storing patient information
- PC at all departments of Cat 1.
- Telemedicine equipments such as BP monitor speedometer, ultrasound, tele-ECG, digital camera, document camera, glucometer.
- Beside these, in Cat1, there is a available team of specialists to provide guidelines, opinion and diagnosis to Cat2 level doctors. Cat1 is connected with other Cat1s and medical universities.

Cat3 is equipped with medium level of telemedicine equipment so that they can collect patient records and send to special hospitals for consultations. They refer the difficult cases to Cat2 where the patient gets treatment. Cat2 discuss with Cat1 if any help is needed and also make an appointment with specialist for patient if necessary. Each Cat3 centre includes the following infrastructure:

- At least dial up connection for transferring patient information to Cat 2.
- Video-conferencing system using single point-SONY PCS 1600P (resolution: CIF- 352 pixels X 288 lines; frame rate: maximum 30 fps; colour system: PAL system) and 29″ flat television.
- Laser scanner for scanning X-ray data.
- Event recorder to record ECG data and transmit over internet line.

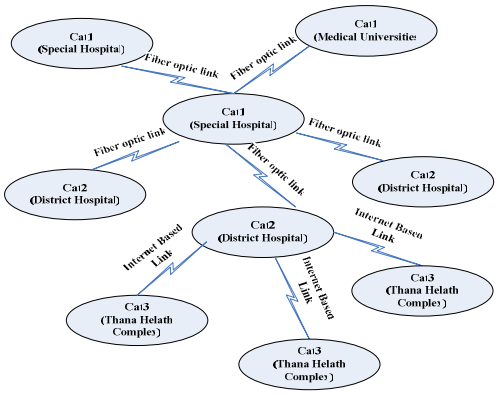

Figure 1. Proposed telemedicine network.

6. Conclusion

Telemedicine promises great potential in providing significant improvement and cost effective access to quality of health care to the under-served communities. In this paper we focus on the necessity of implementing telemedicine application in Bangladesh. We also present the past and ongoing telemedicine projects and future prospects of telemedicine with respect to Bangladesh. Some of the major programs initiated by the Government of Bangladesh were the development of physical infrastructure like Thana Health Complexes (THC), district hospitals, medical college hospitals through out the country. Adding telemedicine in existing health centres can make it easier and cheaper to provide health care to the people in remote areas. The number of emergency visits to the hospital can be reduced. Unnecessary admissions can be avoided. In this paper we have also recommended some suggestions regarding implementation of telemedicine in Bangladesh. We strongly feel that the government should patronize private organizations to invest in telemedicine sector. Telemedicine can serve not only by providing health care services to remote people but also generate new source of employment.

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