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# Telemedicine for Rural and Underserved Communities of Nepal

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**Abstract—** Health workers in rural health care serve most of the population in Nepal, but are isolated from specialist support and access to current medical information. Fortunately, the advent of Information and Communication Technologies (ICT) has unleashed new opportunities for the delivery of health services. In Nepal, there are very remote and less developed communities with limited access to roads and poor infrastructure to access direct health services; here, telemedicine can be taken as the best alternative form to physically travelling and treating people. The strengths of telemedicine (TM) for remote populations include making specialty care more accessible, eliminating lengthy travel and costly transportation, and reducing the cost of some medical services in rural settings. This paper will focus on implications, barriers, proposed solutions, and future extensions of telemedicine in rural and remote places as well as a review on the kinds of services which are most appropriate in the context of Nepal. The main purpose of this paper is to explore practicability of telemedicine in Nepal and its scope of implementation and use.

**Keywords—** Telemedicine, Nepal, Remote and Underserved Populations, ICT, Health care.

## I. INTRODUCTION

Nepal is a hilly country consisting of around 4000 village development committees (VDCs), around 60 municipalities, and 75 districts. It is a poor country having low GNPs, low per capita income, and low literacy rates but higher population density. There is also an acute shortage of doctors with the person to doctor ratio at approximately 4800:1 [1]. These factors have contributed to the prevalence of communicable, respiratory, and nutrition deficiency diseases, which are among the most common disorders seen in hospital outpatient departments. Telemedicine is therefore an attractive potential means of improving health services in Nepal.

Telemedicine as a service is the process of providing medical expertise and health services to remote, rural, and underserved communities in primary care, secondary care, and in emergency conditions with the help of telecommunications. It is particularly helpful to deliver health care to remote and rural areas, and is therefore very useful in Nepal where there is an acute shortage of medical specialists separated from most of the population in remote places [2]. Since people in all parts of the country need proper health care, telemedicine can be used as an alternative form of treating people in the absence of

medical facilities in the area [3]. At the district level, many diseases can be diagnosed and treated via specialists' advice through telemedicine. Using telemedicine for surgeries and complex examinations may prove to be more difficult, but common diseases and ailments can be diagnosed and treated in a timely manner; furthermore, follow-up treatment and routine health checks are made easier by this technology [3].

Telemedicine as a system allows the integration of technology and sharing of information, enhances accessibility of health service to people and health providers, increases efficiency of treatment, lower health related costs, and improves patient care [4]. TM is beginning to have an important impact on many aspects of health care in developing countries. When implemented well, telemedicine may allow developing countries to leapfrog over their developed neighbors in successful health care delivery [5]. Places such as Nepal, Bangladesh, and Pakistan may find that local practitioners can provide the best advice to their patients without having to send them from small communities to large urban centres.

One of the major problems that rural and remote communities of Nepal have been facing is information poverty. Since the IT revolution is limited to a smaller percentage of population, there is huge digital divide within the country. More than 80 percent of the computers and Internet connections are located in Kathmandu city only. This kind of disparity should be amended for the overall development of the country. For this, TM could also be a very good potential mode. Since telemedicine is possible only when ICT infrastructure is well developed, it will make ICT accessible to remote places and reduce the digital divide. Telemedicine may in fact have a more profound impact in developing countries than in developed countries [6].

The development of ICT infrastructure and access capabilities is vital for the overall development of the country. Nepal has availed the opportunity to develop various sectors such as health, education, agriculture, tourism, and trade, among others, using information technology [7]. It should be developed and expanded as a foundation for the enhancement of public awareness, development of knowledge based societies, temporal and monetary savings, proper dissemination of information, as well as for merging into the mainstream of globalization. The establishment of vibrant information technology will mitigate some of the disadvantages Nepal faces on account of its geographical condition [7].

Currently, some TM projects are running at different places in Nepal. One of them is from Kathmandu Model Hospital (KMH) to Dolakha Hospital, and this project seems to be the most suitable project to extend further due to its location and current status of telemedicine. There is a uniformity of health problems and diseases among most of the rural communities where similar kinds of methodologies can be used to deliver health services. In the first phase, it is better to cover most of the mountainous districts and some hilly districts. Once TM is utilized and people start seeing and accepting the benefits, the service can be expanded gradually to more districts. In fact, it is possible to extend TM services to all the 75 districts to provide health services to people across the country. This paper will discuss some implications, barriers, proposed solutions, and future extensions of TM services throughout the country as well as a review on the kinds of services which are most appropriate in the context of Nepal.

## II. BARRIERS

Today, a lack of electric power is the biggest problem in Nepal. This problem has slowed down the overall development of the country. Specifically, the lack of energy supplies in rural and remote places is remaining as a chronic problem. Other major hindrances are due to technological development, remote and inaccessible geographic terrain of the country, non-uniformity in the construction of infrastructure over all the regions, lack of skilled human resources to adopt newer technology, lack of timely supply of required man powers to particularly underserved areas, lack of motivation to the available human resources (lack of incentives, trainings etc.), and disturbances in developmental works due to the political conflicts.

In Nepal, most of the diseases in underserved societies are related to communicable and infectious diseases. About 70% of all health problems and deaths in Nepal are attributed to infectious diseases [8]. People still die from simple diseases like diarrhoea, malaria, encephalitis, dengue fever, hepatitis A, etc. due to lack of knowledge or inaccessibility to medicinal services. Many children die from easily preventable and treatable diseases such as malnutrition, dysentery, acute respiratory infections, etc. [9]. Skin problems are also common in rural and remote areas of the country as is diabetes, asthma, high blood pressure, and some chronic diseases are increasing both in rural as well as urban areas of Nepal. These types of diseases can be diagnosed, treated, and managed with the help of TM services like teleradiology, telepathology, and teledermatology. If facilities could deliver these services successfully to the remote and underserved people, the government will be able to solve most of the health problems and prevent many deaths in Nepal.

Additionally, many doctors and medical specialists are neither fully convinced nor familiar with telemedicine; the very thought of diagnosing and treating a patient when physically absent, solely on basis of data provided through the TM system, is not one that sits well with medical professionals. Furthermore, studies suggest that patients from remote places feel uncertain about using technology-based remote health services and are reluctant to use telemedicine, decreasing the opportunity for providers to utilize the technology [10]. In particular, people who believe in a hands-on approach to healing are more comfortable with traditional medicine which comes from the laying of hands. These kinds of hesitancy on the side of both patient and physician toward the use of technology are remaining as a barrier to successfully adopt TM services.

## III. APPROPRIATE SOLUTIONS

In any country, economic health has a direct impact on the implementation and sustainability of new technology, which, in turn, are affected by the geographical conditions, transportation and communication systems, socio-cultural factors, and the political situation of the nation. In addition, the technological development depends upon pre-existing or old infrastructures (installed bases) into which new infrastructures are designed and developed.

Nepal is a hilly and mountainous country, so the establishment of a good telecommunication network is the biggest physical challenge to deliver TM services. For the connectivity of remote villages, there are several requirements like low installation and maintenance costs, low power, robustness, scalability, and ease of use. It is not feasible to connect mountains and hilly areas by the use of wired communication because the installation cost is too high and maintenance and reliability are also not cost-effective.

Now-a-days, optical fiber networks have reached most of the cities and some of the district headquarters (towns). Figure 1 illustrates the national optical fiber backbone of the country. This study substantiates that it is economically viable to extend this optical fiber network using microwave links to connect remote and rural villages. The city or town connected to the optical fiber network should have a good line-of-sight (LOS) and minimal distance from remote villages. If there is a clear LOS, a microwave link is a more appropriate and cost-effective technology than satellite communications would be. From this figure, it can be observed that it is better to connect mountainous and hilly districts from Kathmandu and other cities using microwave links. The optimal way of connecting several villages is to use point to point (P2P) connectivity from optical fiber (city) to distribution point and point to multi-point (P2MP) from distribution point to multiple villages. In this network, optical fiber has reached Pokhara

city and is used to connect distribution point of some villages using P2P connectivity. This technology is suitable for speedy and movable setup, last-mile communications, and mobility. It further has the advantages of relatively high bandwidth, low cost (for both provider and user), ease of setup, use, and maintenance.

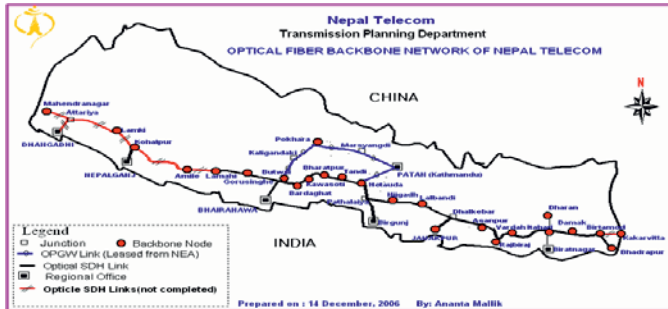


Figure 1: National optical fiber backbone [11]

For the transfer of information, the Internet may be the best option. It allows all kinds of data communication (e.g. audio, video, text, image, etc.) and is inexpensive and easy to use for health workers. Wireless extensions using microwave links from national optical fibre backbone is an appropriate technology to connect remote VDCs of Nepal. Moreover, there are some installed bases of wireless connectivity from Kathmandu and other cities to many districts for the purpose of communication, banking, insurance, and more. The most viable economic solution to establishing a network is to use pre-installed bases as much as possible.

Telemedicine is possible only when there is required amount of electric power is accessible. Fortunately, alternative energy resources like micro hydro, solar panels have the potential of greatly improving the living conditions of rural and underserved communities. They are perhaps the most appropriate, modern, small-scale, decentralised energy supply technologies.

The most cost-effective way of capturing images suitable for diagnosis and management of cases is to use high pixel digital cameras and inexpensive equipment already available on the market. Digital cameras have reasonable prices, very high resolution, and vibration-reduction ability, all of which are suitable to use in, at least, telepathology, teleradiology, and teledermatology. Today, an advantage to implementing TM services is the affordable price of electronic devices (e.g. camera, scanner, etc.) which is decreasing even though their specifications and functionalities are increasing.

It has been mentioned that the beginning of suitable TM services in Nepal is based upon the store and forward method, which is cheaper, easy to sustain, and suits most of the health problems of remote and underserved societies. The modality of telemedicine services proposed in this paper is very simple. If we have reliable connectivity we can send all the patients' data online which will then be studied by the specialists at the

centre and provide advice according to which health care workers at the remote places take action.

An appropriate implementation of telemedicine in the context of Nepal is the balanced approach, a combination of horizontal and vertical. It is better to establish a limited number of reasonably capable sites in the beginning for the effective management of training and technical support. This type of implementation maximizes likelihood of success in initial sites and allows participants to have a hands-on understanding of the vision and scope of what TM can achieve with further deployment.

In order for patients to feel comfortable using telemedicine, health care practitioners must first learn how to communicate effectively using the technology. If health care workers and medical specialists make effective use of technology, the resulting better communication will encourage people to adopt the technology as well. In order to address uncertainty and build confidence, it is critical that both medical specialists and patients have access to quality training in how to use technologies to deliver health services. If doctors and patients are aware of what TM is and how it is used to deliver health services, this will reduce uncertainty in many ways. Moreover, it will help understand how the use of TM services impacts relationships with doctors, which in turn, can influence a patient's health. In addition, it is exceedingly important to provide effective training and better incentives to the health workers utilizing TM services. As they have to work in rural and remote places, they need more incentives to work happily, and developing training and retaining incentives is not costly for the majority of organizations, especially when benefits often outweigh costs. It is important that local health care workers are trained and encouraged to take a lead in developing and operating telemedicine projects as far as possible. This will assist in further economic stability as more health professionals feel adequately trained in their field of work by reducing typically high turnover rates in the health care sector. What's more is that the sites will save time and money by interviewing, hiring, and training new employees less frequently and with a more structured organizational process.

#### IV. FUNDING AND SUSTAINABILITY

One of the major problems of any development project in Nepal is its sustainability. Usually, after execution of donor support, the program is eventually terminated due to the lack of financial resources. Nepal is a poor country and, in many instances, cannot afford to pay for implementing newer technologies, even if installation costs can be managed. It appears to be better to take financial help from donor agencies to setup and run TM projects as they are willing to support rural health programs; but for sustainability, programs should

not depend fully on donor agencies for financial support throughout the lifetime of the system. Additionally, large supporters of TM initiatives, like local or national governments will be more likely to invest in and continue to support telemedicine programs that have a set plan for long-term sustainability and can produce results affirming the cost-benefit trade-off. Since there will be a larger number of patients hoped to use TM services, a service fee will also be a good income to support the long-term sustainability of the project.

In the context of Nepal, one way to achieve sustainability is to focus on TM services having less running and maintenance costs, such as services that are based on asynchronous and/or remote monitoring techniques. These kinds of services have low running costs in comparison to that of real-time, or synchronous, services where there must be the presence of both parties at the same time while using high bandwidth connectivity. Although store-and-forward is an older form of TM, it is suitable to utilize in the first phase of implementation. After utilizing and understanding asynchronous transfer modes, which is often the most common transfer of information in TM systems, clinical practitioners will have an easier time adjusting to TM methods and it will be easier to exploit synchronous transfer modes (real-time).

## V. CONCLUSION

Telemedicine is the process of providing medical expertise to remote places with the help of telecommunication which indicates that it has a great potential to deliver health services for the people of underserved communities. Telemedicine is a concept which allows very remote and less developed places that have limited access to roads and poor infrastructure to receive direct health services. Access to specialist services, especially for remote areas, is of great importance, especially where there are few or no health workers available to provide quality health care. Fortunately, Nepal has availed from the opportunity to deliver health services to the remote places using Information and Communication Technologies.

This paper covers the background study of telemedicine in Nepal, the review of currently running TM projects, and the analysis of their implications for future works. We have discussed the highest reported diseases in rural and underserved communities that contribute most of the health problems and deaths in Nepal and how they can be diagnosed, treated, and managed with the help of TM. Similarly, the methodologies to connect rural and remote places, the kinds of telemedicine services, as well as the implementation approach appropriate in the context of Nepal are well covered. Moreover, the analysis of funding and sustainability of TM

projects as well as the proposed extension of TM services and the technology is performed.

This paper specifies delivering TM services for rural and underserved communities of Nepal and their importance. The implementation barriers are analyzed in depth and the solutions are proposed for all of them. The proposed solutions are cost effective, sustainable in the long-term, and practicable from every aspect of implementation. However, it will be successful only if governmental bodies will be responsible for making legal framework, strategic plans, reforms, visions, and effective monitoring and evaluation systems; additionally, private sectors should also actively participate in TM development. The Government could further propel the process through the formulation of effective policies to attract foreign organizations for investments and technology transfer.

This paper specifies the array of activities for the successful revolution of telemedicine in Nepal. The purposed model of telemedicine introduced in this paper is found to be the most appropriate model to deliver health services and to make familiar with the importance and potential of telemedicine technology. When well implemented, the vast population living in rural and remote places will benefit from quality health services and ICT will be accessible to the general public, which will greatly reduce information poverty and the digital divide, at least within national borders. It is concluded that this will be a strong foundation for the growth and future extension of telemedicine in Nepal.

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