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REVIEW

Telemedicine in Resource-Limited Setting: Narrative Synthesis of Evidence in Nepalese Context

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Abstract: The traditional model of health services imposes limitations, especially in resource-limited countries like Nepal. Introduction to information technology can mitigate various challenges like geographic complexity, urban-rural disparity, poor accessibility, shortage of healthcare professionals, inadequate health facilities, higher cost, and time. Nepal is a resource-limited country with diverse geographic features making it hard to have proper access to healthcare facilities. Telemedicine service has the potential to improve service quality and accessibility of the disadvantaged and underserved population by overcoming the existing challenges. The objective of this review was to explore the roles of telemedicine in vanquishing existing challenges. Seven data sources (namely CINAHL, PubMed, POPLINE, Web of Science, Scopus, DOAJ and Summon) were consulted using five keywords (telemedicine, telehealth, eHealth, mHealth and Nepal to find the literature using the Boolean operator AND) to obtain the relevant materials. The narrative synthesis method was used to review papers and to analyze the findings. This review selected 27 papers for further analysis by scrutinizing 1161 initial search results. The most common features of telemedicine services so far, implemented or piloted in Nepal, were addressing geographic remoteness (21%), a shortage of in healthcare service providers (11%), saving time (11%), addressing challenges of extreme conditions (10%), cost saving (9%), service quality (9%) and real-time services (8%). Some other features of telemedicine were communication, transportation, referral, collaboration, addressing challenges in proper diagnosis and the shortage of health professionals. In a nutshell, the review findings suggested improved service quality, increased collaboration and accessibility and decreased the disparity in comparison with traditional health service models. Although it cannot be said that telemedicine in Nepal has been mainstreamed, yet the appeal is increasing due to its positive impact, especially in rural and hard-to-reach areas where with a lack of healthcare set-up and professionals.

Keywords: barriers, health facilities, health professionals, opportunities, quality

Introduction

Enhancing accessibility for the population as a whole and utilization of health services is paramount to achieving faster and sustained improvement in health status.[1] People's accessibility in healthcare varies from and within cultures and countries. In general, people of Low and Middle Income (LMICs) countries have comparatively less access to health services. LMICs account for 90% of the world's diseases but compose only 12% of the world's health expenditures.[2] In LMICs, proper accessibility is still to be ensured, there is a lack of adequate number of health service providers, required skills and adequate resources including healthcare settings.[2] The perception about accessibility also varies greatly, from one perspective it can refer to

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geographic availability.[3] Penchansky and Thomas (1981) present a far broader definition of accessibility highlighting four dimensions: availability, accessibility, affordability, and acceptability.[4]

The need for a more comprehensive and people-friendly method of providing quality healthcare services, coupled with relevant development in information and communications technology (ICT) has caused increased use of ICT applications over the past decade.[5] The application of ICTs in healthcare services has helped to expand healthcare provision in several ways. For example, telemedicine and other forms of technology-based distant services have contributed significantly to provide quality services in terms of diagnosis, patient care, capacity building of healthcare professionals, coverage, referrals, etc.

Telemedicine is comparatively a new method to provide healthcare services for patients in a resource-efficient way. Patients do not need to travel distant places to get expert consultation; rather treatment-related decisions are made at the local level, close to the patient's location using information and communication technologies (ICTs). Telemedicine did not arise as a separate and well-defined discipline with separate technologies but combines existing technologies in the healthcare sector to overcome geographical barriers, shortage of service providers, inadequate infrastructures and increase overall accessibility.[6] This innovation is especially beneficial for rural, marginal, underserved communities in developing countries and in emergency or extreme conditions.[5]

Distance between patients and health professionals can limit healthcare provision significantly, especially in rural areas. Telemedicine in this regard can make healthcare services available for a greater population. According to the WHO Global Observatory for eHealth series – Volume 2, telemedicine has increased the accessibility which effectively helped to meet the previously unfulfilled needs and has a positive impact on health services.[5] The same report mentioned four elements as germane to telemedicine-

- To provide clinical support.
- To overcome geographical barriers.
- Use of various forms of ICT.
- Improved health outcomes.

According to the government of Nepal and the UN, Nepal is one of the underdeveloped countries with a low human development index.[7] The country is geographically diverse containing hill, mountains and plain lands; and around 83% of its total population still live in the rural areas. Over the last couple of decades, Nepal has worked hard to expand its healthcare network throughout the country and to reduce inequality.[8] Despite this progress, the country is still confined by some dominant health challenges. Many citizens face financial, socio-cultural, geographical, and institutional barriers in terms of accessibility to healthcare. Disparities exist depending on the social status, geographic positionality, remoteness, communication system, availability of skilled healthcare service providers and an adequate number of healthcare facilities.[8]

The traditional model of health service delivery requires physical visits of patients to the healthcare facilities. Physical visit of the patients and their caregivers can be described from the perspectives of transportation, communication, skilled workforce and adequate equipment. While poor communication, distance and travel time impose a challenge to access quality healthcare services, telemedicine has the potential to overcome geographic barriers and connects patients with specialized service providers efficiently.[9] Thus, telemedicine can be particularly beneficial for people living in underserved and hard-to-reach areas where lack of both health facilities and healthcare professionals exist.[10–12]

This paper has been prepared based on a narrative review of available literature in order to understand the role of telemedicine to reduce existing inequality and to increase overall accessibility to healthcare services. The review was conducted following some specific questions:

- Role of telemedicine services in Nepal helping to minimize the barriers of geographic difficulties and emergency situations.
- The role of telemedicine services in Nepal helping to increase people's accessibility regardless of economic capacity, gender difference, age difference, ethnic difference, religious difference, etc.
- Whether telemedicine has helped to overcome the limitations of not having adequate number of healthcare facilities and skilled health service providers.

Materials and Methods

This review work used a narrative synthesis method in order to meet the objectives. A comprehensive literature search was included in the review work using a stepwise system to identify all relevant literature. Then, relevant information was extracted through narrative synthesis using a qualitative approach.

Search Strategy

In this review, we used seven data sources, namely CINAHL, PubMed, POPLINE, Web of Science, Scopus, DOAJ (Directory of Open Access Journals Search) and Summon in order to find out the relevant materials. We considered telemedicine as a communication term and used other words and concepts which followed the broad description of telemedicine. We identified the MESH terms of telemedicine using the PubMed search engine. This review included three other terms, such as telehealth, eHealth and mHealth; which are synonymous in this review and will be used interchangeably.

Finally, we used keywords including telemedicine, telehealth, eHealth, mHealth and Nepal to find the literature using the Boolean operator AND.

Inclusion Criteria

This review has taken the definition of telemedicine from WHO, which states – a system of "healing at a distance" signifying the use of ICT to improve patient outcomes by increasing access to care and medical information.[13] In order to present a broad definition, we also considered the definition adopted by WHO containing the following description:

> The delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities.[14]

Initially, we wanted to put no further barriers as the number of scholarly documents were limited in the Nepalese context. Later, we only included materials produced based on activities related to telemedicine.

Detailed inclusion criteria aimed to include materials focused on-

- If it addresses the accessibility issue of underserved, marginalized, rural and disadvantaged population in general.
- If it addresses communication gaps and the problem regarding the distance of healthcare facilities.
- If it aims to save time and to overcome geographical differences.

- If it aims to minimize the challenges due to inadequate infrastructure and a shortage of healthcare service providers.

Selection of Material

This search yielded 1161 materials, including project reports, review articles, clinical trials, original research articles, opinion pieces, communication materials, technical notes, workshop/conference preceding, observational notes, study/project protocols, editorials, strategy papers, etc. Reviewers then scrutinized the titles, context, objectives and abstract (where available). Sometimes reviewers had to face problems selecting the right materials by going through titles, context (country), objectives and abstract. In that case, they had to go through and review the full text. Following this review procedure, reviewers identified a total of 27 materials.

Analysis Methods

Data extraction and analysis for the scholarly materials selected through the screening process were undertaken by all the authors and the data was then recorded in a previously developed matrix. We did not summarize any outcome measures; therefore, assessment of bias was not done. Given the high levels of heterogeneity among the included materials, data analysis took the form of a narrative synthesis of the evidence.[15] The narrative synthesis approach is especially helpful for synthesizing the information of documents crossing disciplinary boundaries and when scientific research fails to present to adequate evidence.[16,17]

Data extracted for each selected material included, where available:

- Subject area of intervention
- Types of the intervention/study
- Target population
- Brief overview of the intervention/study
- Target group/population
- Geographic area
- Background/context details
- Outcomes/findings
- Technology used

Limitations of the Review

It is likely that many of the evidence on Telemedicine in Nepal were excluded from this review because of fixed inclusion criteria. This review considered pieces' evidence in only the Nepalese context. But there are many other

countries with similar types of challenges, where authorities are also implementing telemedicine. If those evidence could have included, this review would have provided a more comprehensive scenario. In that case, the findings of this review cannot be generalized to other contexts with similar characteristics and challenges.

The research questions were not relevant to issues like theoretical framework, methodology, sampling, ethical issues, etc.; which leaves room for reporting bias. As a result, this review did not assess these issues. In addition to these, this review only included seven electronic search databases, grey literature, thesis and, dissertations were excluded. These limitations may increase the selection bias.

Definition of Key Terms

Telemedicine: The delivery of healthcare services, where distance is a critical factor, by all healthcare professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of healthcare providers, all in the interests of advancing the health of individuals and their communities.[14]

Telehealth: Telehealth involves the use of telecommunications and virtual technology to deliver health care outside of traditional health-care facilities. Telehealth examples include virtual home health care, where patients such as the chronically ill or the elderly may receive guidance in certain procedures while remaining at home. Telehealth has also made it easier for healthcare workers in remote field settings to obtain guidance from professionals elsewhere in diagnosis, care and referral of patients.[18]

mHealth: mHealth is a component of eHealth. The Global Observatory for eHealth (GOe) defined mHealth or mobile health as medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices. mHealth involves the use and capitalization on a mobile phone's core utility of voice and short messaging service (SMS) as well as more complex functionalities and applications including general packet radio service (GPRS), third and fourth generation mobile telecommunications (3G and 4G systems), global positioning system (GPS), and Bluetooth technology.[19]

eHealth: eHealth is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology.[20]

Accessibility: World Health Organization (WHO) defines accessibility in three layers. In this study, we have considered all these types of accessibility. Key issues of accessibility are[21] -

- Availability of good health services within reasonable reach of those who need them and of the opening hours, appointment systems and other aspects of service organization and delivery that allow people to obtain the services when required.
- People's ability to pay for services without financial hardship. It takes into account not only the price of the health services but also indirect and opportunity costs (e.g. the costs of transportation to and from facilities and of taking time away from work).
- Rights to seek, receive and impart information and ideas concerning health issues.

Results

A total of 1161 results were yielded during the initial search. After completing the preliminary screening, 128 results were further assessed and finally 27 papers were included in the review. The detail search strategy and selection process has been shown in Figure 1. Table 1 illustrates the overall summary of the selected papers and observation from the review team. For every paper in the selected sample, we made observation and analysis for challenges addressed in the papers, outcomes and used technology. First two columns are for identification of the selected papers. Third column presents the objectives and broad challenges addressed in the papers. Fourth column lists the outcomes, results and suggestions derived from the papers. The last column lists the tools and technologies discussed in the papers. Studies are listed in order of publication year with the most recent at the top. The reference numbers correspond to those in the references section.

Narrative synthesis was done to all the evidence relevant for inclusion criteria and the research questions. In total, this synthesis identified 16 factors or characteristics of telemedicine services in Nepal. Factor wise distribution of papers has been outlined in Affinity Matrix (Table 2).
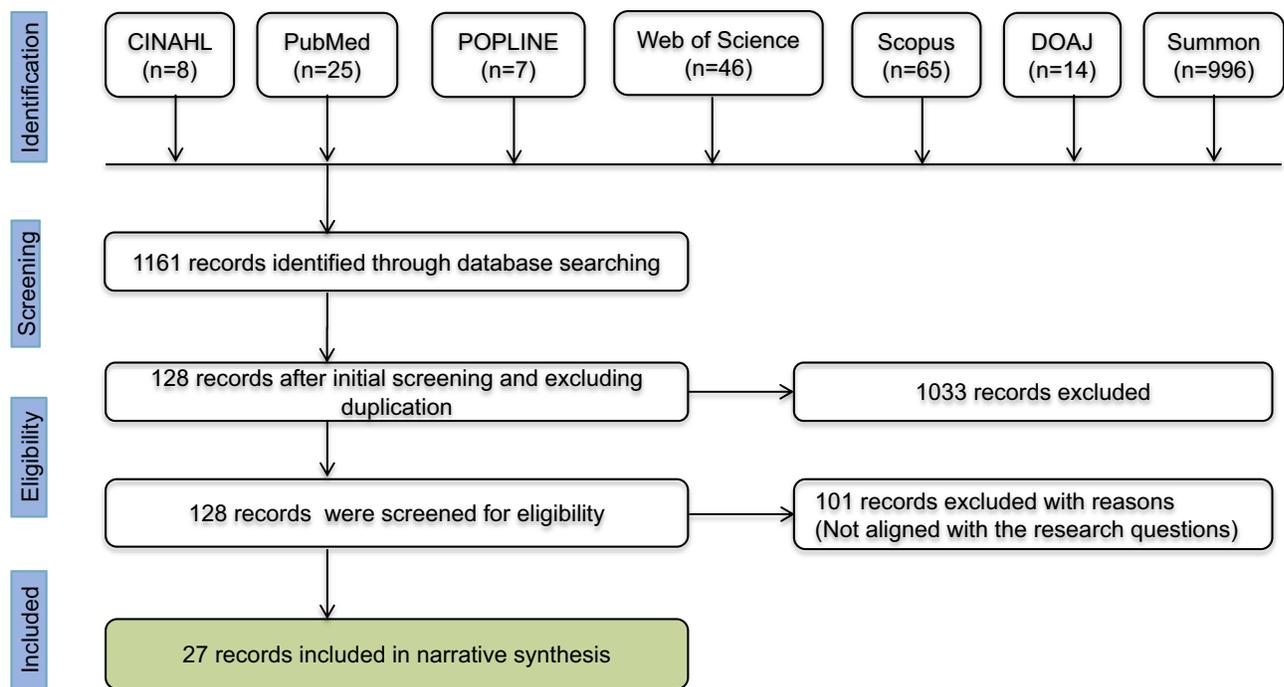
Figure 1 Stepwise flow diagram on selection of materials for the review.
Abbreviations: CINAHL, cumulative index to nursing and allied health literature; POPLINE, population information online; DOAJ, directory of open access journals.

This affinity matrix compiles commonalities among different selected papers. It will help the reader to understand the trend and frequency at a glance. The frequency presented in the above table does not necessarily define importance, but many review literatures have used it just to show probability and occurrences in diverse disciplinary areas.[22–26]

Synthesis of Results

Theme 1: Geographic Difficulties and Emergency Context

A common finding emerging in this review was that telemedicine contributed significantly to overcome geographic hurdles and remoteness. People living in remote areas had less access to healthcare services. Review identified many reasons behind the lack of accessibility, such as poor communication system, land slide or flash flood during rainy season, etc. In total 20 papers reported the telemedicine features of addressing challenges of geographic remoteness[27–46] and 11 papers reported time saving[29–33,40,41,47–50] character. 4 papers reported communication and transportation[30,32,46,49] related issues. Review found significant delays between the injury and medical evaluation due to distance, poor communication and lack of proper information.

Another dominant factor in the healthcare sector of Nepal is that, because of the vast Himalayan peninsula; it

is very difficult to provide quality services to people in extreme weather conditions. This includes people coming from all over the world to visit the Himalayan summit. A total of 10 evidences has been reported, addressing the challenges of extreme condition[27,28,31–38] 8 papers reported providing real-time service.[27,28,33–38] People living in extreme environments, especially mountaineers often experience complications in breathing and in their respiratory system. In these circumstances, rapid decision-making is a prerequisite to avoid any unexpected situation. Review reported the feature of telemedicine regarding decision-making during emergency situation[36,38,42] in 3 papers.

Theme 2: Accessibility Issue in Terms of Rural–Urban Disparity, Economic Capacity, Age-Gender Difference, Ethnic and Religious Difference

Increasing accessibility in general is one of the key steps in achieving Universal Health Coverage.[51] In low and middle-income countries, this accessibility needs to be ensured without causing financial damage.[52] Telemedicine services in Nepal also encountered such issues. Review found 9 papers discussing about cost-effectiveness[30,33,40,45,48–50,53,54] and 3 papers about increased access.[30,44,48] Rural-urban disparity and lack of services in rural areas block the way to increased accessibility. 2 papers reported the issue of addressing challenges of disparity in terms of rural-urban difference in

Table I Summary of Selected Papers

Author and Year of Publication	Broad Challenges Addressed/Aim of the Study	Outcomes	Technology Used
Rajbhandari et al 2019[47]	Most people with epilepsy live LMI countries like Nepal; especially in rural areas where there are relatively few doctors coupled with lack of quality services, treatment gaps, etc. Smartphone application using tab was launched in order to reach this population group.	Non-physician health workers were involved to provide timely and effective care using smartphone for epilepsy patients. Results suggested reduced gap in epilepsy treatment from 43% to 9%.	Teleconsultation and video conferencing
Mandavia et al 2018[54]	To assess the validity of smartphone-based services in diagnosing ear disease and to refer the patients of rural Nepal in outpatient clinics.	Compared to standard assessment, the smartphone-based device demonstrated its potential to diagnose ear disease and onward referral. Findings showed cost-effective role of smartphone-based remote tool to screen for ear disease in remote settings by trained non-medical workers.	Smartphone-based device
Sein et al 2018[46]	Most of the people in Nepal live in rural areas where there is severe shortage of skilled health professionals and adequate facilities. Telemedicine as a part of ICT development aims to bridge between gaps and the needs of marginalized and rural people.	Findings showed a collaborative diagnosis by rural health workers and remote experts using forward audio/video images of patients. While patients were also present, and while the remote doctors could see and visually examined them, all consultation occurred between the rural health workers and specialized doctors.	Teleconsultation, image sharing and video conferencing
Parajuli et al 2017[48]	A telemedicine project was launched to reduce gender-based disparity in accessing required healthcare services in rural areas.	Findings showed that use of telemedicine reduced travel restrictions, travel time and treatment expenses. Most of all, telemedicine helped the sexual and reproductive health services more accessible for rural women and girls.	Smartphone-based service and teleconsultation
Thapa et al 2018[29]	Providing adequate healthcare to the remote mountainous villages remains a huge challenge, which is shaped by the scarcity of doctors and poor communication. Nepal telemedicine project was initiated to meet these challenges.	The project aimed to "bringing in" virtual medical expertise to these remote mountain villages. It did so through daily video conferences between health workers in village medical clinics and doctors from urban hospitals. The project also started tele-education for village health workers on general medicine.	Videoconferencing and teleconsultation
Bhatta et al 2015[40]	To improve the accessibility of specialist health services and overcome the challenge of inadequate physician–patient ratio.	Rural-telemedicine service allowed patients from a remote area to get specialist service easily through videoconferencing which helped to save travel time and cost.	Videoconferencing and teleconsultation
Patterson et al 2015[56]	In rural areas telemedicine programs started through non-medical health workers to reach out people who cannot access quality epilepsy care due to the shortage of skilled physicians	Community health workers visited door-to-door in order to fill up the app-based questionnaire to identify people with Epilepsy. These data were later used to design comprehensive services. People did not have to visit to any physical healthcare settings.	Smartphone-based service
Patterson et al 2014[43]	Epilepsy patients in rural areas in Nepal are mostly deprived of any treatment, because of inadequate doctors and health facilities. Telemedicine program was initiated to overcome these shortcomings.	A mobilephone-based app was developed for non-medical health workers and inexperienced doctors, and they used it in parts of the validation study in order to successfully diagnosis epilepsy cases. This app helped to reduce the barrier of shortage in adequate number of physicians.	Teleconsultation and smartphone-based service

Study	Description	Technology
Byrne et al 2014[34]	Geographic barrier, poorer quality services, persistent cultural and traditional practices pose serious challenges to delivery of health services. Telemedicine service started with the hope to improve the maternal, newborn and child health outcomes in mountainous regions in Nepal.	Teleconsultation using computers and wireless internet connected health workers and patients in the mountain villages with central hospitals to increase access to and utilization of specialist doctors. Patients reported increased satisfaction and confidence in care.	Videoconferencing and teleconsultation
Peeler et al 2014[49]	Due to significant distances between home and health facilities, people from different parts especially who are farmers cannot get timely treatment for corneal disease. In order to ensure emergency treatment a telemedicine set up was established supported by dozens of satellite clinics and camps.	The agreement about the diagnostic category and follow-up interval between the examiner and all readers was statistically significant (P<0.0001). Identification of anterior segment pathology for blindness was successfully done by transmitting sit-lamp photographs of patients from satellite clinics and screening camps in rural areas to specialized hospital for review and triage. Therefore, this method prevented blindness.	Diagnosis data storage, data and image sharing, and teleconsultation
Kao et al 2013[36]	The effectiveness of transmitting physiological data from the remote and harsh environment of Mount Everest base camp to remote center using telemedicine method and getting emergency consultations were examined.	The study first of all demonstrated feasibility of transmitting real-time ECG and GPS coordinated transmission via satellite phone. Continuous health updates of the mountaineers were transmitted to remote health center using as wireless and light-weight surveillance method. Experts then determined climber's capacity to continue an ascent and summit attempt by evaluating their physiological condition.	Satellite phone and patient data transmission; and teleconsultation
Morrison et al 2013[55]	To overcome the barriers of shortage of skilled health workers in rural areas and to increase connectivity between the district and peripheral health facilities using mobile phone.	Teleconsultation helped the service providers and resource-poor peripheral health settings to make decisions in serious cases through continuous support from physicians at district hospital. This approach helped to make successful referral, timely treatment and to reduce the rural-urban disparity.	Mobile-based service
Chib et al 2012[32]	Geographical and communication and urban–rural-related disparity have deep impact over accessibility in healthcare sector in Nepal. Mobilephone-based service was tested to bridge these gaps by delivering information, improving knowledge levels and providing critical communication links.	Mobilephone-based intervention could ensure the availability of information in time especially for remote, distant and emergency cases. Remote hospital organized regular session by bringing the entire healthcare networks in a single place. Patients were benefited through regular access to the doctors available to the community healthcare.	Mobile-based service
Aggarwal et al 2012[50]	Many people with depression feel stigmatized through the lexicalization of their illness and prefer community interventions to healthcare settings. Visiting a health facility to get the service may be delayed because of multiple factors associated with people's health-seeking behavior and decision. Mobilephone-based service was initiated to reduce all these barriers.	Mobile phones Increased access by altering the traditional mode of healthcare services. With the help of mobile phone services, patients did not have to go the facilities. Rather, healthcare services came to their doorstep. Patients' data were collected through text messaging. Eventually, this method helped to reduce transportation costs, hospital waiting time and increased accessibility. Findings suggested that health programs might face partial success or even total demise if social and cultural differences between providers and recipients were not bridged. Mobile phone did that effectively.	Mobile-based service

(Continued)

Table 1 (Continued).

Author and Year of Publication	Broad Challenges Addressed/Aim of the Study	Outcomes	Technology Used
Lama et al 2011[39]	Management of emergency situation, where patient requires immediate treatment, which is difficult in traditional healthcare settings with limited resources.	Teleconsultation with remote experts was proven effective for emergency cases in terms of cost savings and getting timely services. This case illustrated the potential for telephone-delivered rural care and management in emergency situations, and to reduce cost significantly related to transportation.	Teleconsultation
Jha et al 2011[41]	To bridge the gap created due to geographically distant rural communities and scarcity of skilled manpower.	Telemedicine program using videoconferencing and Teleconsultation was launched to provide real-time services to the patients with skin diseases in rural areas where people had no nearby access to healthcare facilities and essential medicine. The same infrastructure was also used to provide education to rural communities.	Videoconferencing and teleconsultation
Subedi et al 2011[30]	People living in remote and distant places with poor communication facilities are often deprived of proper information and quality health services. Telemedicine program was launched as the best alternative form to physically travelling and treating people.	Telemedicine made specialist care more accessible for the people living in remote areas. It also eliminated prolonged waiting time, travel time and transportation cost. Results suggested increased use of telemedicine to provide specialist services to the underserved population.	Teleconsultation, image sharing, and video conferencing
Otto et al 2009[28]	To provide emergency health services to the mountaineers through remote guidance using satellite phone and teleconsultation.	This paper demonstrated the successful use of satellite-coordinated telemedicine services to guide thoracic ultrasound examinations of the climbers at Mount Everest Base Camp.	Satellite phone, patient data sharing, portable computer and teleconsultation
Nelson et al 2009[33]	It is difficult to provide diagnostic and other required healthcare services to the seriously injured patients living in remote and emergency environment. Emergency physicians use portable ultrasound-associated telemedicine technologies in order to quality service in such conditions.	In mountain areas, portable ultrasound devices were used to collect and transmit images, video clips and other health-related data to the remote telemedicine center via satellite. This allowed for remote viewing by specialists. Such real-time guidance decreased the initial training time and at the same time capacitated nonphysicians to provide required quality services.	Satellite phone, patient data sharing, portable computer and teleconsultation
Graham et al 2003[45]	Telemedicine services were initiated to meet the unmet needs of people living in mountainous areas without access to basic medical treatment due to shortage of experts and communication problem.	This pilot study showed that telemedicine method was in one hand cost-effective, and on the other hand had the potential to benefit for diagnosis and management of medical conditions in rural Nepal where there was a severe shortage of experts. It also reduced treatment costs and increased accessibility.	Teleconsultation, videoconferencing and diagnostic image sharing

Reference	Aim	Description	Technology
Graham et al 2002[53]	Access to quality service is problematic in the countryside of Nepal due to lack of skilled service providers in neurological issues and people's unaffordability of required money. Telemedicine can help to address these types of challenges.	Considering the lack of expertise to deal with HIV-associated disease, suggestion and treatment decision was taken from an expert living in Ireland through Teleconsultation; which suggested an affordable and effective way of treating the patient. Findings suggested increased accessibility of people and enhanced skills and understanding of local physicians.	Teleconsultation and image sharing
Graham et al 2001[44]	People living in rural areas of Nepal cannot access to quality services, life-saving investigations and treatments. Telemedicine program was launched to address these types of challenges.	In this case, initially local experts opinionated for an expensive treatment. Since the cost was too high for the patient, expert opinion was asked from an expert living in Ireland. Patient history, medication and diagnostic reports were shared and then a teleconsultation was organized. Through this way, a cost-effective way emerged which was both feasible for patient and hospital.	Teleconsultation and image sharing
Harnett et al 2001[31]	A telemedicine program was launched in the remote and grueling environment of Mount Everest following some deadly incidents to monitor the vital signs and other health issues of the climbers.	A vital sign monitoring system was developed to collect, aggregate and transmit the vital signs and location of the climbers. All the data were then transferred to the telemedicine center at Yale University. This enabled timely intervention, which ultimately helped to save lives.	Satellite phone, patient data sharing, portable computer and teleconsultation
Angood et al 2000[38]	To provide medical service to the mountaineers of Mount Everest and people living in such condition through telemedicine service method.	The equipment used offered the physicians an objective basis for their clinical assessments and treatment plans; and the investigators demonstrated that real-time physiologic data transfer from remote locations is plausible which helped the climbers in emergency situation.	Satellite phone, patient data sharing, portable computer and teleconsultation
Satava et al 2000[27]	To provide advanced medical support at Mount Everest Base Camp (EBC) from a telemedicine clinic	The GPS location functioned well for most of the climbers. The telemedicine clinic provided their suggestions and initial treatment through acquisition and analysis of data.	Satellite phone, patient data sharing, portable computer and teleconsultation
Grasso et al 1999[37]	A telemedicine service and monitoring mechanism using satellite was introduced to ensure the safety of Mount Everest climbers, as death is common phenomena for climbers attempting the summit.	From the base camp clinic, video and data were transmitted via the INMARSAT Indian Ocean satellite to Santa Paula, California. Yale medical personnel consulted with doctors from different facilities worldwide. Continuous health monitoring of the climbers enabled the medical personnel to provide timely solution for health-related complexity.	Satellite phone, patient data sharing, portable computer and teleconsultation
White et al 1999[35]	To provide advanced medical support to the climbing expeditions at the Mount Everest Base Camp from a telemedicine clinic and to evaluate the effectiveness and functionality of Yale Telemedicine Initiatives	At high altitude and in remote mountain range, telemedicine with the help of remote experts pushed to new limits of diagnosis and treatment to the emergency patients by providing real-time consultation. Through telemedicine technology, a powerful link between Yale and the Mount Everest Base Camp enabled the implementation of clinical care, research and education.	Satellite phone, patient data sharing, portable computer and teleconsultation

Table 2 Affinity Matrix

Factor	Article Reference Number	Frequency
Addressing Challenges of Geographic Remoteness	[1,3–8,12–18,21–27]	20
Addressing Challenges of Disparity in Terms of Rural–Urban Differences, Gender, Age, Ethnicity etc.	[2,4]	2
Shortage in Healthcare Service Providers	[4,7,8,10–15,20,23]	11
Time Saving	[2,5,6,9,15–21]	11
Addressing Challenges of Extreme Condition	[1,3,17,18,21–27]	10
Service Quality	[5,10,13,14,17–24]	9
Cost Saving	[2,5,9,11,12,16,19,21,23]	9
Real Time Service	[1,3,21–27]	8
Communication and Transportation	[9,14,16,18]	4
Increased Access	[2,13,16]	3
Inadequate Health Facilities	[6,15,23]	3
Proper Diagnosis	[9,10]	2
Referral	[14]	1
Enhanced Capacity	[6]	1
Decision Making in Emergency Situation	[7]	1
Increased Collaboration	[7]	1

healthcare provision. In addition, 2 papers reported the role of telemedicine in overcoming challenges in terms of gender, age, ethnicity, etc.[39,48]

Theme 3: Address Shortage of Healthcare Facilities and Skilled Health Service Providers

Quality healthcare service depends largely on the presence of adequate number of healthcare facilities and healthcare service providers respective to the total amount of population. Availability of equipment and logistic facilities are also some of the most important contributing factors. In Nepal, access to quality service is limited due to lack of healthcare facilities in rural areas which is coupled with inadequate health service providers. The current review

identified 11 papers reporting the issue of shortage of healthcare service providers.[29,39,42–47,53–56] 3 papers have highlighted the issue of inadequate health facilities.[29,41,54] These three papers discussed one common thing, which was the lack of skilled and specialized healthcare service providers outside of the mega cities of Nepal. They argued that this is one of the key issues behind poor accessibility to quality services.

A vast majority of people living in rural areas cannot visit specialized service centers and therefore cannot access quality health services. Challenges of ensuring quality services in rural areas create an extra burden when Nepal is working hard to reach the coverage of health service and proper diagnosis to all its population with limited resources. This review found 9 papers discussing about service quality[31,32,35,40,44,46,47,50,56] and 2 paper discussing about proper diagnosis[49,56] as key benefits of using telemedicine.

Few other issues were also highlighted through the review although in a small scale. Referral,[46] enhanced capacity,[41] and increased collaboration[42] had been reported in 1 paper, respectively.

Discussion

Traditional healthcare services require the patient to physically visit healthcare facilities. This process demands a lot of time and high expenses. When it comes to the question of Low and Middle Income Countries (LMICs) like Nepal, the situation is worsened with resource-poor status and inadequate facilities. On the contrary, most of the people, especially poor, marginalized and rural population are primarily dependent on government health facilities. Unfortunately, the government of Nepal is struggling to meet all the existing demand with limited resources and budget. One study found the allocated budget was very limited considering the needs.[57]

Considering the limitations of health systems in (LMICs) to provide quality, affordable and timely services; policy-makers, donors and other interested parties were searching for an effective and feasible option. This concern and endeavor have resulted in the potential of telemedicine and other ICT-based healthcare services. This innovation is coupled with unprecedented increase of low-cost cell phones and internet.[19] Application of telemedicine helps to extend geographic access to health care, which is particularly promising given the poor distribution of healthcare service providers and inadequate equipment in many (LMICs).[58]

The features of using telemedicine identified through this narrative synthesis are consistent with the findings and arguments of research conducted in (LMICs) contexts. Glinkowski and Ciszek (2007), Kifle et al (2010), Combi et al (2016), Kruse et al (2017) and Kvedar et al (2006) have stressed the value and importance of telemedicine in resource-limited country settings to overcome geographic and resource barriers.[22,59–62] Alghamdi et al (2015) and Bali & Singh (2007) argued that mobile-based health services have the potential to improve the overall quality of healthcare delivery in developing countries because of certain features like building awareness among patients, disease self-management, decrease in healthcare costs, remote monitoring of patients, etc.[63,64]

This review has also identified the comprehensive use of telemedicine in Himalayan extreme condition among mountaineers and other local mountain dwellers. Telemedicine has also shown its effectiveness on healthcare delivery in extreme conditions.[65] Otto (1999) discussed two telemedicine projects initiated in places with extreme weather in order to highlight the feasibility of telemedicine in similar environments.[66] Latifi et al in their study showed the use of telemedicine among swimmers in the Atlantic Ocean.[67]

Health sector of developing countries is confined with numerous problems like acute shortage of healthcare professionals (e.g. physicians, nurses, pharmacists, public health workers) and inadequate healthcare facilities. Researchers around the world have identified the effective contribution of telemedicine to overcome these challenges. Edworthy (2001) showed the potential of telemedicine to link health professionals irrespective of where they were.[68] Other scholars have also demonstrated the role of telemedicine to overcome the challenges related to shortage of healthcare professionals and healthcare centers.[69] Thus, it enhances the scope of collaboration and enables specialists supporting the remote and isolated communities. A study by Kim et al (2014) found positive impacts in delivery patterns in non-NICU hospitals using telemedicine services.[70] Ganesan et al presented a classic example of collaboration using ICTs in health sector to increase physical activity resulting in increased outcome. Academic researchers teamed up with the private sector professionals to implement and monitor the 100-day Stepathlon programme among 70,000 participants where most of the participants were from developing countries.[71] Telemedicine also strengthens primary healthcare by developing the capacity of healthcare professionals living and working in rural and hard to reach areas. Application of mobile phone improves the capacity of the patients by enhancing the scope of self-management.[72] At the same time, it increases the capacity of rural health professionals to be more responsive and to provide instant, timely services.[72]

Wang et al described telemedicine from the perspective of reduced cost and timely diagnosis.[73] They argued in Chinese context that telemedicine connects specialists with healthcare facilities. Their study showed the net saving of some USD 2.3 million for patients USD 3.7 million for specialists, because patients received proper diagnosis services without moving to specialist's health facilities and also specialists did not have to physically visit rural areas for providing services to them. A comprehensive review on telemedicine protects in emerging and developing country context by Combi et al found remote diagnosis, remote intervention, remote monitoring and remote education as some of the primary objectives of designing and implementing telemedicine services.[61] The review included China, India, Sub-Saharan Africa, Amazonia, Egypt and Pacific Island.

Low cost of ICTs and its use in health sector have the potential to improve health outcomes. Hamine et al studied usability, feasibility, and acceptability of mobile-based intervention in healthcare. They found significant improvements in disease-specific clinical outcomes.[74] Several other studies have also found positive outcomes of using telemedicine in the health sector. Angus et al (200) and Vespa (2005) in critical care; Lai (2009) and Silva et al (2013) in stroke treatment; and Boniface et al (2011) in diagnosis tests have found significant improvement of the robotic telepresence.[75–79]

Treatment, diagnosis and timely services have been coupled by remote monitoring, rapid decision-making, etc.; which has improved patient outcomes. Application of telemedicine in ICU is widely recognized in improving treatment outcomes.[80–82]

Conclusion

The reviewed papers demonstrated that telemedicine was designed and implemented in order to overcome the major challenges of health sector in resource-limited countries like Nepal had been suffering from. In most of the cases, geographical location, shortage of equipment and health facilities, poor communication system, income level and inadequate skilled workforce work as primary determinants of people's access to quality health care in Nepal. Therefore, telemedicine certainly highlights its potential for large-scale use in order to triumph over these challenges. Overall, telemedicine has made great advancement from both research and institutional point

of view. In order to gain more benefits from telemedicine services, we need to find the loopholes and to utilize the technologies according to it. Therefore, proper trial on telemedicine is suggested to measure the real impact and to scaling up. According to a different and broader point of view, telemedicine is still not an integral part of the health systems in low- and middle-income countries. The overall health systems will start getting gross benefits when telemedicine will become an integral part of health service delivery, not as a standalone approach. To reach that goal, more research is required to understand the sustainability status of already implemented programs, its cost-effectiveness, regulatory mechanism and so on. No well-established business model of telemedicine is visible in developing countries, which leads to unsustainability. In order to properly design and estimate the overall mechanism including human resource, equipment and costs, it is essential to undertake a comprehensive research from the perspectives of economy, policies and contextual needs.

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Disclosure

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