

A Systematic Review of Studies Analyzing the Trends, Opportunities and Challenges of Telemedicine Sector

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ABSTRACT: The use of telemedicine is increasing, and in a developing country such as India, where there is huge inequality in health-care distribution, Telemedicine has the potential to bridge this inequality and to facilitate access to healthcare in the remote and underprivileged population if absorbed into existing healthcare delivery system. But its efficacy for getting significant or improved clinical outcomes has not been confirmed in many medical specialties. The aim of this systematic review is to evaluate the efficacy of interventions of telemedicine for health outcomes. This review gives an overview of telemedicine in different healthcare areas including radiology, obstetrics, psychiatry, telemedicine in surgery, telepathology etc.

KEYWORDS: Telemedicine, underprivileged, healthcare delivery, radiology, telepathology.

I. INTRODUCTION

Term Telemedicine is acquired from greek word 'tele' which means distance and latin word 'mederi' meaning to heal. Hence, telemedicine literally means distance healing. It's a field that arises from the effective fusion of Information and Communication Technologies (ICT) with medical sciences. It has enormous potential to meet the challenges of healthcare delivery to remote areas.

Telemedicine is - "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 continuing education of healthcare providers, all in the interests of advancing the health of individuals and their communities", as defined by World Health Organization.

Telemedicine involves two types of technology: (1) Real Time: It could be a telephone call or a telemedical video conference or a telerobotic surgery. It requires a telecommunication link between both parties that allows a real-time interaction to take place, with the help of broadband telecommunication media provided by satellite and terrestrial network. (2) Store-and-forward: It involves acquiring medical data and then transmitting this data to a medical specialist later at a convenient time for offline assessment. It can be tele-pathology, tele-radiology, or tele-dermatology.

Telemedicine has been in use for over 40 years and NASA played an important part in its early development when physiological parameters were transmitted from the spacecraft and space suits during missions

A National Task Force has been set up by Ministry of Health & Family Welfare for promotion of telemedicine and launched - National Rural Telemedicine Network (2007) of medical colleges and district hospitals under the Integrated Disease Surveillance Project. It will be a tiered hierarchical structure that would include:

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LEVEL I: Primary Health Center (PHC) / Community Health Center (CHC) connected to a District Hospital

LEVEL II: District Hospital connected to a State Hospital / National Super Specialty Hospital

LEVEL III: State Hospital / National Super Specialty Hospital connected to each other

LEVEL IV: Mobile Telemedicine Unit covering few villages connected to nearest PHC / CHC or directly to District Hospital

To build an ubiquitous country wide health network for telemedicine, Fiber optic network has been laid down across the country by both government and private telecommunication service providers paving the way for availability of high bandwidth terrestrial connectivity. As per Rural Health Statistics 2012, despite considerable improvement in health personnel, there is a huge shortfall - 76 per cent for doctors, 88 per cent for specialists, 52 per cent for ANM/nurses, and 58 per cent for pharmacists. The shortfalls remain, 20 per cent for Sub-Centres, 24 per cent for PHCs and 37 per cent for CHCs.

In a developing country such as India, there is huge inequality in health-care distribution. Although nearly 70 per cent of Indians live in rural villages, more than 75 per cent of Indian doctors are based in cities and 90 per cent of secondary & tertiary care facilities are in the cities and towns far away from the rural India. People living in rural and remote areas struggle to access timely, good-quality specialty medical care. The poor infrastructure of rural health centres makes it impossible to retain doctors in villages, who feel that they become professionally isolated and outdated if stationed in remote areas. Incentives to entice specialists to practise even in suburban areas have failed. A recent study conducted by the Indian Institute of Public Opinion found that 89% of rural Indian patients have to travel about 8 km to access basic medical treatment, and the rest have to travel even farther.

Telemedicine has the potential to bridge this distance and to facilitate access to healthcare in these remote and underprivileged population if absorbed into existing healthcare delivery system. With the due advantages there are certain limitations in the field of Telemedicine. As an emerging area, telemedicine has many unresolved questions. There is a need for specific evidence of efficacy/therapeutic and diagnostic impact/cost analysis in many areas of telemedicine. The Issues of diagnostic/therapeutic efficacy, privacy and security of information transmission, clinical standards and guidelines for practice, technical interoperability of systems and technology, and human resource planning are examples of the questions, which must be addressed by telemedicine applications/projects.

II. REVIEW OF LITERATURE

Frederiek de Vette, et all in 2015 realized that though telemedicine can alleviate the increasing demand for elderly care, but user adherence to technology in telemedicine interventions is low. Their research emphasized on the need of a strategy called gamification that has recently emerged to increase technology adherence, specifically of the elderly user. With an objective to provide a foundation for creating a new framework for applying gamification in telemedicine applications to effectively engage the elderly user by increasing and maintaining adherence, they studied the existing theoretical frameworks for the application of gamification and the methods that specifically target the elderly user and explored user classification theories, which are needed to gain insight into the user and serve as a tool to effectively tailor content. They found out that the current frameworks for gamification rarely target the elderly user and there is a significant gap in knowledge on the effectiveness of a gamified application in practice. It was suggested that a framework should be developed for gamification based on solid scientific foundations and includes a user classification that specifically assesses the elderly user. KimberP Richter and 11 others assessed the comparative effectiveness and cost effectiveness of two models for delivering expert tobacco treatment to cigarette smoking cessation in 2015: (1) telemedicine counselling which was integrated into smokers' primary care clinics (Integrated Telemedicine—ITM) versus (2) telephone counselling that was delivered to smokers in their homes in South America. 566 Smokers were recruited from 20 primary care and safety net clinics. They were randomly assigned to receive 4 sessions of ITM (286) or 4 sessions of Phone counseling (280). Patients in ITM received real-time video counseling, in clinic exam rooms by trained counselors. The counseling duration and content was the same in both groups. Both groups also received identical materials and assistance in selecting and obtaining cessation medications. A control group design was employed with individual randomization. It was found out that there were no significant baseline

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differences between groups. ITM increased utilization of cessation pharmacotherapy and produced higher participant satisfaction, but Phone counseling was significantly less expensive. From the provider perspective, counseling costs were similar between ITM and Phone; however, total provider costs varied widely depending on how the clinic space for delivering ITM was valued. Therefore, Findings did not support of ITM's superiority over telephone counseling for helping rural patients quit smoking.

K. G. Mohamed et al studied the Gezira Family Medicine Project (GFMP) in 2015 in Sudan that provides a 2-year master's degree in family medicine, with fully integrated ICT. This cross-sectional study described ICT implementation and utilization at the GFMP for the years 2011-2012. A questionnaire-based data was used to assess candidates' perceptions and satisfaction. In the period 3808 telemedicine online consultations were recorded by 125 candidates enrolled in the program. The study revealed that almost all respondents confirmed the importance of telemedicine and rated high the online lectures. Physicians highlighted some patients' concerns about the use of telemedicine and EMRs during consultations. Results from this study confirmed the suitability of ICT use in postgraduate training in family medicine and in service provision. M. Abo-Zahhad, Sabah M. Ahmed, and O. Elna has studied the adoption of a system in 2014 that continuously collects and evaluates four different physiological signs - ECG, SpO₂, temperature, and blood pressure, and further relayed them to an intelligent data analysis technique to diagnose abnormal pulses for exploring potential chronic diseases. Once abnormal event happened, all physiological signs were immediately transmitted to remote medical server through both internet and cellular networks. Also data can be transmitted to a family member's mobile phone or doctor's phone via GPRS. A prototype of such system has been developed successfully and implemented, offering high standard of healthcare with a major reduction in cost for society.

Alharthi in 2012 investigated and compared the telehealth practices in 8 countries – New Zealand, Australia, the USA, Canada, UK, Malaysia, China and India, with a view to discover the similarities and differences at a strategic level in telehealth practices. He employed PEST, SWOT and CSF analysis in the research that revealed that all 8 countries have a high demand on telehealth, due to high costs of current healthcare system, big population against low healthcare coverage, uneven population distribution and low satisfaction on current healthcare services. All the countries were found to share some common concerns regarded as general CSFs: Standardization of technical specifications, legislation and regulation, business modelling and program evaluation (operational feasibility, financial profitability), financial constraints, and need of more trained professionals into telehealth. He suggested that future development of telehealth may have 3 priorities: further and continuous improvements in technical perspective, re-examination of current healthcare system thus adjust it to suit telehealth development, and WHO needs to establish regulations & strategies to develop telehealth programs in international level.

Hussein, Khalifa provided a comprehensive Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis of the current telemedicine applications in Egypt to provide an overall roadmap for telemedicine in Egypt in 2012. The authors conducted three workshops with healthcare stakeholders to develop SWOT analysis of telemedicine in Egypt by identifying influence factors for eight influence sectors – Economy, health, education & research, legalization, ICT, cultural & social aspects, human resources and governmental policies. Based on that, four future trends for telemedicine in Egypt were identified, each was driven by one of the main Egyptian sectors i.e. the government, private sector, ICT sector, or medical sector. Future trends were analyzed using Impact/Uncertainty Grid, wherein the influence of the key factors is ranked in 2-dimension matrix. Consequently, these future trends were aligned to the global trends in telemedicine; and it was concluded that the most efficient future trend will be Trend #1 i.e. the telemedicine should be part of a National eHealth Initiative to guarantee success and sustainability. This is because; the governmental support will facilitate the (1) establishment of the required technical and legal framework of telemedicine in Egypt (2) establishment of a well-defined business model based on Public Private Partnership (PPP) models; and (3) Participation in eHealth international projects and initiatives. Maurice Mars, Richard Scott in 2012 identified and assessed a new metric—consultations per site per week (C/S/W) to describe the use of telemedicine services. To determine the existing usage, they reviewed 2510 papers, abstracts & reports. Out of which 77 provided sufficient data to calculate C/S/W. It was found out that Average use was low, 1.8 ± 3.5 C/S/W, with 61% of services reporting less than 1 C/S/W and 71% reporting 2 or fewer C/S/W. Studies reporting on data from 2006 to 2009 showed

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less use (average 1.5 ± 2.3 ; C/S/W) than earlier reports from 1996 to 2005 (1.7 ± 2.5 ; C/S/W). They proposed C/S/W as a standard measure of telemedicine service use.

Paolo Zanaboni, Emanuele Lettieri, realized in 2011 that during last decade many telemedicine applications that were adopted with great expectations quickly became failures and were subsequently abandoned. Healthcare regulators are still debating why institutionalizing telemedicine applications on a large scale has been so difficult and why health care professionals are often averse or indifferent to telemedicine applications. They emphasized that the lack of consolidated procedures for supporting decision making by healthcare regulators is a major weakness, and aimed to find out on how to legitimize decision making about the institutionalization of telemedicine applications on a large scale. For Legitimization by the key stakeholders, they discussed 3 main requirements - rationality, fairness, and efficiency; that should underpin decision making. They identified 3 assessment dimensions for telemedicine applications that should be reviewed by decision makers: (1) clinical outcomes (2) cost containment, and (3) access. They proposed and illustrated a 2 staged reference process for legitimate decision making to implement telemedicine applications on a large scale, in which a preliminary proposal and then a full proposal were reviewed. Preliminary proposals structure information in 2 main sections: a description of the context into which the telemedicine application should be introduced and a description of the proposed telemedicine application and its benefits. At this stage, all the preliminary proposals should be prioritized by an institutional committee to submit the full proposal.

The World Health Organization (WHO) has established the Global Observatory for eHealth (GOe) to review the benefits that ICTs can bring to healthcare and patients' wellbeing and providing WHO's Member States with guidance and reliable information on best practices, policies, and standards in eHealth. The Findings from the survey in 2009 show that teleradiology currently has the highest rate of established service provision globally (33%). The field of telemedicine is in its infancy and its promise is great. ICTs can be costly, as can be the programmes using ICTs to improve health outcomes. Infact, the most frequently cited barrier to the implementation of telemedicine solutions globally is the perception that the cost of telemedicine is too high. The three most requested areas of information by Member States: Almost 70% of countries on the cost and cost-effectiveness of telemedicine solutions, over 50% on the infrastructure necessary to implement telemedicine solutions and 60% on the clinical uses of telemedicine. It also revealed that while developing countries are more likely to consider resource issues such as high costs, lack of expertise and underdeveloped infrastructure, to be barriers to telemedicine, developed countries are more likely to consider legal issues surrounding patient privacy and confidentiality, a perceived lack of demand and competing health system priorities to be barriers to telemedicine implementation. Following the analysis of the survey results, WHO recommended steps that Member States can take to capitalize on the potential of ICTs like creation of national agencies to coordinate telemedicine initiatives.

Zayabalaradjane, Zayapragassarazanand, Santosh Kumar assessed the awareness, attitude, knowledge and skills of telemedicine among the health professionals working in the teaching hospitals of Puducherry in 2016. A cross-sectional survey was carried out, in which a total of 120 teaching faculties and practitioners participated. A pre-validated self-administered questionnaire was used for the survey, which mailed to the respondents. The analysis revealed that 63% of respondents had high level of awareness and 24% don't have adequate knowledge of telemedicine. With respect to the attitude level, 39% possessed high attitude level towards telemedicine and 56% are unskilled in handling telemedicine and its related equipments. It was also found that neither any of the respondents had undergone any formal training nor had attended any conference or seminar related to telemedicine. However, 91% of respondents expressed their interest in undergoing training programmes to acquire hands-on experience on telemedicine. The findings of the study suggested that the need of the hour is to educate and train the health professionals about telemedicine and issues related to its use.

Sujitha and 3 others in 2013, analysed the existing system of telemedicine record keeping in Microsoft excel sheets. When a Doctor needs information of another doctor or a patient, they need to search for the specified file in the system and reports are generated manually. Therefore, she proposed an online browser system, which provides a centralized database. It stores the entire information of the particular patient's prescription or treatment data. It can also create

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Excel reports and PDF documents based on the information in its database. This application software was computed successfully and implemented in five modules, namely administrator, medical Staff, doctor, patient and reporting. It was also tested successfully by taking “test cases”. The application showed 5 advantages over existing system: (1) Increased performance (2) Increased Security (3) Timely report generation (4) Swiftness in updating the details (5) Displays a menu for users to choose kind of service or advice (6) Displays user-friendly screens to submit or download the files (7) 24 hours availability of system services (8) Easy maintenance

Indra Pratap Singh, Saroj Kanta Mishra, Repu Damandeveloped a low cost mHealth Tool Kit at SGPGIMS Lucknow in 2013, which consisted of a Laptop, portable wireless broadband internet, video-conferencing system, Non Invasive Blood Pressure (NIBP), Spirometer, ECG, SPO2 integrated with Curesoft Telemedicine software (specifically designed and developed for this kit). A month long pilot study was conducted in Gujarat in 2010. The in -service paramedical, lab technicians & nursing staff were identified and were trained in handling the tool kit. The kits were installed in the 4 PHCs and 1 CHC. All five nodes were connected over broad band internet with expert hospital in the city. The electronic medical records were created using medical devices like ECG, SpO2, NIBP etc., which were integrated with the laptop through USB 2.0 and web based videoconference session was initiated for tele-consultation after the successful transmission of the data to specialist. The outcome of the study was satisfactory as the overall performance of the kit was acceptable to the users.

Sharma Kalpa in 2012studied the current status and role of health IT in improving the delivery of health care services; and assessed the challenges faced in its implementation. The major constrains revealed were: (1) lack of accessibility, since internet connectivity is not available in all geographical areas especially in rural areas (2) Non availability of comprehensive policy on HIT which results in absence of standards, guidelines and quality control mechanism (3) Cost incurred in purchasing & installation of technology and improving the infrastructure to support IT (4) Lack of basic computer knowledge amongst staff. To expand the utilization of HIT she suggested: (1) Formulation of policy, standards or guidelines to maintain and control the quality (2) Improvement in Government funding to have availability and improvement in current infrastructure (3) Recruiting competent staff or train existing health staff to enhance their computer skills.

SushmaAgrawal and 5 others in 2011observed the poor Radiation oncologists: cancer patient ratio in UP state i.e1 : 2000 as compared to the recommended 1 : 250; and also the poor infrastructure of radiation oncology departments suboptimal for teaching, training of resident doctors, and treatment. Hence, to bridge the gap, they established a telemedicine facility in their department linked with another medical institute located 25 kms away, and designed the academic sessions for trainee residents in their department and at the remote end. Regular videoconferencing sessions comprising of lectures on clinical oncology, medical physics, and radiobiology were held. After 2 years of implementation, feedback from the users revealed satisfaction with the content of the academic sessions for the purpose of MD training. It was concluded that distance education in radiation oncology is an important tool for training of the trainee residents.

Meenu Singh and RashmiRanjanDasstudied the utility of telemedicine for children in 2010. The data of 306 pediatric patients which were managed between 2005-2009 in the telemedicine centre of PGIMER, Chandigarh was analyzed. The data included clinical details, investigations and radiological images. The consultations were given on management of respiratory problems (64), gastrointestinal problems (57), neurological diseases (49), infectious diseases (41), haematological disorders (32), cardiac diseases (26), renal problems (10), oncological diseases (9), Dermatological diseases (8), rheumatologicaldiseases(5) and neonatal problems (5). It was found that 10% of children were critically ill and hence, could not have been in a position to be transported safely and 12% of the consultations resulted in videoconferencing. Only 12% patients had follow up visits. Therefore, it was concluded that increasing use of videoconferencing, remote monitoring devices and mobile units can solve the health problems of children located in remote areas in India. Krishnan Ganapathy, and AditiRavindra discussed the challenges faced and the methods implemented by the Apollo Hospitals Group in introducing telemedicine in the India in 2009. Today, with 115 centers (including 9 overseas), the Apollo Telemedicine Networking Foundation (ATNF) is the oldest and largest

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multispecialty telemedicine network. More than 57,000 teleconsultations in various disciplines, have been provided. Patients have been evaluated from distances ranging from 120 to 4,500 miles. It has also made pioneering efforts the Pan African e-network project and started the first formal educational course in telehealth.

Surya Bali and Amar Jeet Singh conducted a study to ascertain the acceptability and feasibility of consultation by mobile phone in rural Haryana in 2007. The mobile number of community physician was advertised to public and people were invited to call at any time for a medical consultation. During a seven-month study, 660 calls were received. The mean call duration was 2.7 min. 63% calls were for seeking advice, 22% were for outpatient follow-up, 4% were for seeking appointments. The most common problems were skin, respiratory, mental health and sexual problems. Of the 387 callers who were interviewed, 78% stated that they had followed the advice provided. Of these, 91% found the advice very helpful in managing their health problems. About 96% of users wished to continue to use the service in future. As the majority of calls made were of a primary care nature which could easily be dealt with by phone, it was concluded that the concept of using mobile phones for medical consultations seemed to be acceptable to the people in rural Haryana.

B. Bowonder, Mohit Bansal, and A. Sharnitha Giridhar in 2010 analysed the implementation of ICT in the field of medicine with specific reference to Apollo's Telemedicine project in Aaragonda, a remote village in Andhra Pradesh. One live case was studied as an illustration which inferred that there are only two ways to make telemedicine economically viable: (1) By obtaining government support for the infrastructure (2) by providing a bundle of shared services using the same infrastructure. The administrative personnel & doctors were also interviewed for getting the first-hand experience of managing this project which indicated three critical success factors for sustaining telemedicine network: (1) Low cost - economic sustainability (2) Connectivity - technological efficiency and (3) Trust - behavioral acceptability.

III. CONCLUSION

It is evident from the literature review that telehealth interventions have generated positive results when they were used in case of critical medical conditions. In some researches, mental health problems were also taken care of by providing counselling and behavioural modification techniques through videoconferencing. It is analyzed that there is comprehensive evidence which supports subsets of telemedicine uses, like remote monitoring of patients for different medical conditions. Literature shows that rapid growth is seen in the use of telemedicine services recently. These services are also used for training and education in healthcare sector as concluded by some of the researches. But there are very few studies depicting the effectiveness of telemedicine services. Two approaches are required to address this existing gap in the evidence with future research. One approach is to continue to develop additional research in a variety of clinical areas using telehealth services. In some areas there is no sufficient synthesized evidence in literature which shows the use of telehealth services for consultation, in ICU, surgery and maternal and child health. Second approach is to go for more primary research so that additional information can be extracted about hidden arenas including the effectiveness of telemedicine services.

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