

Telemedicine in India – an investment of technology for a digitized healthcare industry: a systematic review

Varun VERMA¹, Vijaya KRISHNAN², Chhaya VERMA³

¹ Father Conceicao Rodrigues Institute of Technology, Navi Mumbai, India

² Mahatma Gandhi Mission's College of Physiotherapy, Navi Mumbai, India

³ Physiotherapy School and Centre,
Topiwala National Medical College & B.Y.L Nair Charitable Hospital, Mumbai, India

vverma22600@gmail.com, victoryv2@yahoo.co.in, cvverma100@gmail.com

Abstract: Connecting rural India to modernised healthcare facilities through telemedicine has been a long-time vision of the Government of India. Telemedicine provides continuity of care to patients keeping the doctor-patient interaction alive. This study aims to explore telemedicine and its ever-growing trend. The journey of its evolution from a doubtful start to its current position is examined in this study. A systematic electronic search for articles available between 2014 to 2020 using MEDLINE, EMBASE, Cochrane Database and Google Scholar was performed using PRISMA guidelines. Studies published in English, with free full-text availability and “telemedicine” and “India” used as keywords were included. 126 studies were identified and, after a further analysis, 21 of 44 articles were chosen for assessment. The healthcare industry is largely benefitting from telemedicine. Different fields of medicine have provided successful evaluations and remedies by utilising telemedicine. We found that systematic availability and functioning of ICT, technical infrastructure, data storage systems, standardization of health protocols are few of the challenges faced. COVID 19 has forced the resilience of patients and professional Indians to overcome the barriers and explore telemedicine to achieve quality patient-centric and value-based healthcare. Digitization displays tremendous potential to facilitate a booming practise in telemedicine with suitable training and stringent guidelines.

Keywords: Telemedicine, India, Digitization, Health Care.

1. Introduction

Information and communication technology (ICT) advancements in the last decade have delivered a great boon to the industry of healthcare namely “telemedicine”. Telemedicine is a tool which delivers healthcare services to the remote corners of the world and to communities, by connecting the patients to the doctors through electronic media. Through telemedicine, the health services are delivered by different means of communication (audio, video, conferences etc.) which connect the divergent extremes of India. (Bhatia & Singh 2014; Chandwani & Kumar, 2018) NASA & Indian Space Research Organisation - ISRO played a major role in conceiving and developing this novel field. In 2005, the National Telemedicine Taskforce, an initiative of the Ministry of Health from India, implemented various projects such as ICMR-AROGYASREE, NeHa, ONCONET, village resource centres etc., anticipating the improved healthcare available in the country (ISRO, 2005; Mishra, Kapoor & Singh, 2009; Bali et al., 2015).

Telemedicine makes life easier and simpler for the population of India from rural areas through the access to modern healthcare facilities. Telemedicine is a unique portal demonstrating capabilities to surmount the shortage of healthcare professionals from rural India, by ensuring quality care for all the patients, including non-ambulatory and home bound patients, and by reducing the cost and the expenses. The doctor-patient interaction continues with much easier follow-ups, health monitoring and continuous health services during natural calamities and epidemics (Wilson & Maeder, 2015; Chellaiyan, Nirupama & Taneja, 2019).

Besides “Digital India”, a vision of the Administration meant to transform the country into a territory with a digitally vested society and economy, telemedicine was not welcomed by many parts of the country. Multiple barriers were listed by the patients and health care personnel. Lack of adequate infrastructure, computer literacy, resistance to change, perception & acceptance of technology, cultural barriers, technical issues, legal challenges, government policies, security of patient data, care quality are few roadblocks among others (Bakshi, Tandon & Mittal, 2019; Chowdhury, Hafeez-Baig, Gururajan & Chakraborty, 2019).

Although telemedicine has been sporadically used in the Indian healthcare system so far, the COVID-19 pandemic has helped us to exploit the potential of telemedicine to its fullest, during these unprecedented times. Telemedicine extensively helps to minimize transmission of the disease by avoiding any physical contact and serves as a vital tool for providing continuity of care to patients. It also helps in keeping alive the patient-doctor interaction. Telemedicine was considered futuristic and experimental a few years ago, but the rapid advancements from technology paved the way to make it real.

Thus, this study was conducted to examine the recent trends and advancements in telemedicine in India. The objectives were to explore the technological intrusions in the health industry, to understand its assets and boundaries and to review its potential in a post COVID world.

2. Methodology

This review was conducted in accordance to Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) guidelines (Liberati et al., 2009).

2.1. Study Selection Criteria

The studies were evaluated based on the articles from the period 2014 to 2020 written in English and with free full text availability. Any editorial, blogs, commentary along with those studies whose methods or concepts lack the telemedicine practise were excluded. Studies for which open access was denied were also excluded.

2.2. Search Methods

A wide-ranging electronic search based on articles accepted in MEDLINE, EMBASE, Cochrane Database and Google Scholar was performed with “telemedicine” and “India” used as keywords. Boolean operator “AND” helped in the selection of relevant articles. The titles and abstracts of the articles were scanned for resultant studies and only the obtained pertinent articles were considered eligible for review. The details such as lead author, year of publication, research design, target population, medical field and outcomes were listed. The process of data collection is illustrated in the Figure 1.

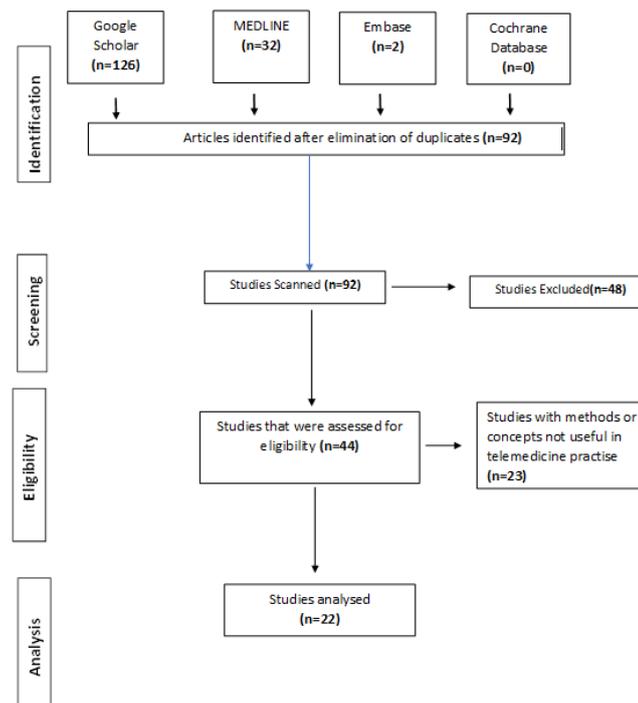


Figure 1. Flow diagram of study inclusion

3. Results

The studies included 126 documents which were identified from the above-mentioned databases. After the elimination of duplicates yielded 92 articles to be considered. Out of this, 48 articles were excluded for not meeting the eligibility criteria while the other 44 studies were considered for the review. Only 21 studies out of these 44 appeared eligible for the review. The others were left aside due to lack of relevant information.

Table 1 contains the features of the 21 analysed studies. It summarizes the analysed articles with respect to the study designs, domain of medical practise, themes elaborated, catalysts and challenges faced to the use of telemedicine in COVID 19 pandemic. The earliest publication considered was in 2015. There were 7 review studies, 4 cross-sectional surveys, 4 viewpoints, 1 case study, 4 commentaries and 1 book chapter included in the present study.

These studies covered areas from the description of telemedicine, its history of development in India as well as globally, the various branches developed, scope and strategies for its use in healthcare domains and last but not least, elaborated the pitfalls and hurdles limiting its utility amongst health care professionals and the general masses.

Table 1: Articles reviewed

Sr. No	Lead author Year Study Design Reference	Area of medicine explored / Target population	Themes elaborated in the study	Outcomes / Catalysts for telemedicine during COVID 19 pandemic	Challenges in telemedicine
1.	Agarwal et al. (2020) Narrative Review 2	Health care providers, policy makers, stakeholders	Description of telemedicine from global and Indian perspectives with changes following Pandemic. Practice guidelines were established.	Delivery of healthcare services to patients irrespective of their location, care for chronic conditions, systematic medical data maintenance. For patients - Reduced financial burden, minimized travel and exposure, easy medical services availability were observed.	Inadequate patient information privacy and confidentiality, lack of specific capabilities, familiarity and skills, limited infrastructure and equipment, lack of training, limited access to IT professionals
2.	Gosh et al. (2020) Narrative Review 20	Physicians, diabetologists.	Telemedicine - definition, modes and scope elaborated. General strategies regarding the role of telemedicine in treating patients with diabetes were discussed along with its utility limitations.	Practical methods for the use of telemedicine were summarized. Guidance regarding general rules, recording the patient history, assessment and treatment was described.	Face to face consult recommended for the first visit, conditions such as gestational diabetes, infections etc. Physical evaluation cannot be replaced by telemedicine. Digital literacy can affect the use of telemedicine. Lack of physician knowledge about data protection and privacy laws
3.	Iyengar et al. (2020) Narrative Review 22	Health care providers, policy makers, stakeholders	The interactions between telemedicine and remote consultations are described.	Standard operating procedure for the use of telemedicine is discussed. The guidelines for good practises are described. The regular patient feedback and audit are recommended.	Medico-legal issues can be a concern for telemedicine implementation. Patients' capacity for decision-making is to be judged to avoid misinterpretation of the consult. Clinical procedures and medications are prescribed on the basis of provisional diagnosis.
4.	Ganapathy (2020) Review	Telemedicine in neurological practise	Tele neurology – training and implementation	By reducing the face-to-face consultation, remote evaluation has become the main-	Rapid unstructured use of telemedicine. Development of many misleading

	Article 18			stream. Telehealth guidance is to be supplied to healthcare providers for better outcomes. Digital CME and resident training for remote consultation were discussed. Recommendation to establish a tool for “Digital triage”	concepts and myths about telemedicine. Technical and operational challenges such as regulations, credibility etc affects the delivery of tele neurology. Adaptation to the teleconsultation can be a barrier to both the patients and the physicians.
5.	Mahajan et al. (2020) Special article Commentary 25	General health care workers, paediatrics.	Aims of telemedicine, introduction and functioning of - “teleconferencing , tele proctoring, teleradiology, telepathology”	Time saving, social distancing, boon for vulnerable population etc. The app for teleconsultation and payment developed by The Indian Academy of Paediatrics is meant to simplify the critical situations during Pandemic. The training for Accredited Social Health Activists (ASHAs) can facilitate and aid in faster diagnosis and care, telemedicine being recommended as an adjunct to traditional treatment	Lack of physical examination affects diagnosis especially in the case of younger children (< 2 years of age). Examination is hampered by the quality or lack of video facilities. Chances of misdiagnosis or underestimation regarding the child’s condition. Technological issues and patient literacy can be a barrier for treatment.
6.	Bindra (2020) Short commentary 9	Obstetrics and gynaecology .	Care of vulnerable population, namely “pregnant women”	Telemedicine represents a boon in helping care takers to identify the warning signs during pregnancy, leading to early detection and prevention of various conditions. Development of apps “Apollo 247, Ask Apollo” to aid women in need via tele consults. Obstetrics and gynaecology consultation triage has been designed owing to pandemic situation.	Healthcare workers need to be trained to observe and identify minor details. Medicolegal issues and taking clinical decision represents a challenge for teleconsultation. Telemedicine is not a substitute for physical assessment. Patients need to be taught and made aware to look for warning signs such as daily foetal movement, signs of going into labour etc. which may not be reliable.
7.	Manglani et al. (2020) cross-sectional Survey 26	Paediatrics, community medicine.	Care of vulnerable population during pandemic via teleconsultation. Monitoring and mentoring health care providers at anti-retroviral therapy centres.	Initiation and development of paediatric HIV telemedicine “e-decentralized model” for providing virtual hand-holding, expert opinion, CMEs etc. The quality of care for children living with HIV was found to be improved.	Many ART centres were not linked to the main stream facility due to various technical issues and lack of expertise. Patient and provider acceptance, training etc were reported as barriers to implementation of the facility.
8.	Mishra (2020) Short commentary 29	Healthcare workers, clinicians.	Technological advancements and implementation of telemedicine were discussed	Pandemic has opened opportunities and reduced resistance to use of telemedicine primarily owing to safety and reduced financial burden associated with continued health care. Respondents expressed willingness to accept telemedicine even in post Covid circumstances.	Factors such as compatibility, complexity etc. were identified as influencing the adoption of telemedicine practices.
9.	Biswas and Batra (2020) commentary 10	Ophthalmology, policy makers, medical fraternity	Telecommunication has a vast potential which remains to be explored further	Development of “forward triage” in disaster management. Importance of pictorial representation (2-D and 3-D images). Improved acces-	Legal barrier was identified as a major factor. The other barriers stated were technological barrier, due to internet

			especially in radiology, pathology etc.	sibility of care for all the patients irrespective of their geographical location.	and technological illiteracy, financial barrier as telemedicine is not a part of health insurance policies, ethical concerns due to unregulated and uncontrolled world of the internet and lastly but not the least, the scientific barriers which doubt the authenticity of the examination and diagnosis conducted on this platform.
10.	Garg et al. (2020) Commentar y 19	Public health care delivery, general Medicine, policy makers	Utility of telemedicine in screening patients suffering from COVID 19 and helping patients with mental health issues.	E-health concept and its global adoption are discussed in detail. Virtual care was found to be a valuable tool for the pandemic. India's rise to the use of technology and various schemes developed were elaborated.	Investment, legal consideration and licensing in telemedicine are major challenges apart from other ethical and security issues.
11.	Mittal & Pareek, (2020) Viewpoint 30	Paediatrics, health care practitioners	Telehealth platforms – WhatsApp networks, Emitra kiosks were discussed.	The study summarized that, for a major impact, the infrastructure needs to be scaled up. Telehealth needs to be included in "routine health practises".	Development of long term sustainable models is challenging. Telemedicine is to be incorporated in the curriculum. Apart from working with technology, human behavioural change is discussed as a potential barrier.
12.	Kumar et al. (2019) Case Study 23	Psychiatry	Primary care tool for psychiatry developed using digital technology	Patient consultation and follow up conducted via tele-OCT, CVC module.	Further evaluation of these models and their effect on larger population and different circumstances are yet to be assessed. The mentoring of primary care doctors is critical.
13.	Chellaiyan, Nirupama & Taneja, (2019) Review article 16	Community medicine, family medicine, public healthcare workers	Telemedicine, history of innovation in India and its services were discussed.	The potential for remote diagnosis was explored. The telemedicine apps used for education, healthcare delivery, healthcare management, disease screening, disaster management etc were elaborated.	The lack of awareness and acceptance of new technology from both the patients and professionals are holding it back. Awareness and best practises and guidelines are to be established in order to ensure a widespread utilization.
14.	Pradeepa et al. (2019) Overview 3 2	Diabetology, ophthalmology, public health	Mobile health care, self-monitoring, large scale awareness etc were discussed.	There is ample scope for telemedicine to improve diabetes care outcomes. Telemedicine driven complication screening could help to reduce the risk of microvascular and macrovascular complications.	The limited access to real time screening, the lack of training and of expensive equipment for digital imaging are still to be overcome. The change in the doctor-patient relation dynamics, the lack of expert support and organisational infrastructure pose serious barriers to practise.
15.	Chandwani & Dwivedi, (2015) Viewpoint 13	Policy makers, end users, doctors and paramedical	Exploring the scope, current practises and challenges regarding the	The study revealed the various roles for diverse stakeholders in the human infrastructure that were engaged in the program	Technological and human resources face problems at different levels. Tech support is required for the appropriate infrastructure

		personnel and technical staf	implementation of telemedicine in India		while appropriate training is required for the staff. Sociocultural barriers are also limiting the use of telemedicine. Pilot projects for healthcare delivery are still elusive.
16.	Bali (2018) Chapter in text book 5	Policy makers, researchers, administrators, health personnel	Identifying barriers and ways to overcome them	The current status of telemedicine in developing countries is not very satisfactory and passes through a crisis, but the minimization of certain barriers will help telemedicine strive in the near future.	The major barriers identified were geographical access, acceptability, availability, appropriate developments, policy, legal and tech barriers inclusive of rapid upgradation, organisational issues and the lack of trained personnel, among many others.
17.	Ateriya et al. (2018) Review 3	Health practitioners	Telemedicine and virtual consultation were discussed	Benefits of telemedicine were explained with respect to connectivity and improved follow up outcomes. The authors have provided suggestions to overcome the challenges regarding the use of telemedicine in the future.	Lack of infrastructure and training, knowledge about tele-practise laws, standardization, medicolegal problems, negligence issues among many others.
18.	Mathur et al. (2017) Review 27	Healthcare delivery workers	Importance of telemedicine in the current era and its distribution in India	Though not a substitute for the traditional health care system, telemedicine can be used to overcome the disparities in underserved areas.	Major challenge reported is the acceptance as a method of health care delivery via telemedicine. Also, there is the issue of integrating telemedicine centres across India.
19.	Zayapragas sarazan & Kumar (2016) Cross-sectional study 36	Healthcare professional Academicians.	Awareness, knowledge, attitude and skills and understanding among Teaching Hospitals	Teaching faculty have a positive attitude towards the adoption of telemedicine. Respondents suggested that compulsory implementation of telemedicine with adequate tech support and incentives will improve the response further.	Lack of skills, financial and infrastructural support and ethical issues were reported.
20.	Acharya & Rai (2016) Cross-sectional study 1	Rural healthcare services, medical specialists, private sector setups	Perception and cost effectiveness of telemedicine practice were explored.	Telemedicine in healthcare could prove to be useful for patients from remote regions and for doctors from rural areas of India	Technical issues, lack of patient satisfaction and the time needed to adapt to services were listed as problems faced by telemedicine.
21.	Chandwani & Kumar (2018) Viewpoint 14	Policy makers, tech support teams, healthcare professional, stake holders	Factors boosting telemedicine were highlighted.	Increased connectivity, critical program designs and creative treatment were found to be key elements for the practise of telemedicine.	Unreliable network, low expertise, varied socio-cultural and economic backgrounds, resistance to the use technology and poor awareness are few of the challenges.

4. Discussion

India, a land with a rough potential, is a country with 29 states and 6 union territories. The biggest challenge faced by the health industry is to supplement basic and quality health services in the remotest rural areas of the country. There is a huge mismatch in the doctor-patient relation especially in the rural areas. The biggest challenge in telemedicine is represented by an equitable distribution of the healthcare personnel in order to serve this large population. There is a huge concentration of healthcare amenities in the urban areas whereas the rural regions where 68.84% of

the population resides are still miles away from the nearest, well-equipped hospitals and clinics. (Census of India, 2012). Owing to the COVID 19 pandemic, the already challenged health care system has been further compromised. Telemedicine is currently in an excellent position to narrow this disparity by providing an excellent solution to join the primary and secondary health care set ups in order to enhance the care for the underserved population. (Kaeley et al., 2021). The provided services include rural and remote consultations, continued medical education, disaster management support along with regular monitoring and mentoring for emergency care set ups.

This paper is an attempt to highlight the voluminous advancement of technology rendering support to achieve a digitized health care future. With the help of the research done and a constant upgradation of technology, the authors of this study would like to bring your attention to the journey of telemedicine and the future of healthcare system with technology advancement.

4.1. Benefits of telemedicine

Telemedicine is the product of an effective amalgamation of knowledge and communication technology. Most of the studied articles mention that the core use of telemedicine is the provision of healthcare services in remote areas, thus increasing the patient access to health care facilities. It improves health care services, helps to the exchange of knowledge between professionals and increases rural health care practises. With the proposed new guidelines, the transformation of the healthcare sector can be initiated and facilitated to provide equitable access to health services.

4.2. Strengths of telemedicine

Telemedicine has come a long way in India, from being a mere dream in the past decades to being an independently functioning alternative to traditional medical practise extremely valuable in these trying times. Although, it was not used earlier on a large scale, the strong foundations were established for many projects in the healthcare domain. After reviewing various studies and viewpoints considered for our study, we noted some of the key strengths of telemedicine. The most prevalent is the capacity to reach rural and underserved areas and provide them specialized health care services. Reducing the distance and the travel time have also helped to not only to gain time but also to save money. Today, technology redefines the healthcare by making it accessible and available and by reducing the financial burden. Virtual world has reduced travelling for health care needs beyond imagination. Telemedicine has proved to be an asset through the COVID-19 pandemic as it helped immensely to reduce the transmission of diseases, lower the burden of morbidity and help to minimize the number of visits to speciality hospitals. (Bhatnagar, N. et al., 2020) The management of chronic conditions have become easier and more efficient, ensuring regular follow up too.

4.3. Weakness of telemedicine

Though telemedicine has played a vital role in supporting patients clinical care during COVID-19 pandemic it has also helped us demystify challenges that come with it. The potential of telemedicine and its adoption rate is yet to be determined. It becomes imperative to understand the requirements and capacities of the multiple stake holders involved in different backgrounds, the expectations, the digital literacy and technical knowledge in the field. There's also the presence of doubts regarding the efficiency and efficacy of Information and Communication Technology (ICT) and its role in health care domain. The sudden surge in the use of technology comes with many disadvantages. Numerous critical issues have surfaced which need to be adequately addressed before we proceed to witness the ever-happening exponential growth of technology.

Telemedicine can act as an effective mode only when technology enables accurate capture, recording and transfer of information. It needs to serve as a medical information conduit. The lack of appropriate training makes it difficult to perform triage, establish a correct diagnosis and to communicate with the patients. Data come along with technology and that requires infrastructure and proper storage space. Therefore, a proper technical infrastructure and data storage systems are required for a proper functioning of telemedicine.

The studies reviewed above have also identified cultural barriers along with other barriers (social, technological, etc.) as one of the perceived risks in adopting telemedicine in India. Willingness to adapt and a positive attitude towards change amongst all the stake holders is, therefore, one of the main pre-requisites needed for a smooth functioning and development of technology. User's perception with respect to interactivity, data security, usefulness, trust, ensuring privacy also influences the adjustment of telemedicine for regular utilization in health care practise. The major limitations identified commonly through this attempt are the lack of generalization, policy barriers and medico-legal issues. Connectivity, infrastructure and tech support are still the foremost identified challenges. There is also an absolute lack of professional rules for protecting patient privacy and confidentiality which needs to be addressed.

4.4. The way forward

Proper functioning of ICTs and maintaining them regularly is the main priority. To overcome the primary challenge of integrating telemedicine in the main stream health care delivery system, standardized guidelines for health care procedure as well as infrastructure need to be formulated. It is essential for telemedicine to be covered under health insurance facilities. The roles and expectations, duties, rights etc., of the principle stakeholders need to be clear to them. Various new projects developed need to be monitored and stimulated for smooth development and functioning of this technology.

The use of stringent guidelines and a suitable training are key things to be considered before practicing telemedicine, because, without these, a proper functioning of technology is next to impossible. Embracing the technology needs to be promoted among masses and health professionals.

The wider use of technology enables the promotion of many projects in telemedicine that will improve the future of healthcare industry. Some of these initiatives (as a defined framework for information technology infrastructure for health, promoted e-health industries, ONCONET project, HEALTHSAT project, chronic web-based telemedicine system etc.) can revolutionise the healthcare sector. (Chaudhari & Kumar, 2014) The most recent addition to this initiative is "eSanjeevani" developed especially by the 'Digital India' initiative during COVID 19 pandemic. (Porecha & Singh, 2021; Press Information Bureau, 2020; Wilson & Maeder, 2015) India in future is gearing itself to provide a robust environment for the exponential growth of telemedicine in the health care delivery system. Technology has the prospective to bring a paradigm shift in the health care practises which should be encouraged and promoted.

5. Conclusion

Telemedicine aims to achieve superlative patient-centric and value-based health care. The COVID-19 outbreak has forced both patients and health care professionals to overcome the barriers and explore telemedicine and its utility. India will witness major changes in the health services delivered in a post-covid world. Digitization displays tremendous potential to facilitate a booming practice in telemedicine in the future. Suitable training and stringent guidelines will play a major role in fostering its growth. These will help doctors to follow protocols needed to ensure safe and efficient medical care through telemedicine. Therefore, the wider acceptance and implementation of telemedicine in the future will surely help us to prepare better for any possible pandemic.

REFERENCES

1. Acharya, R. & Rai, J. (2016). *Evaluation of patient and doctor perception toward the use of telemedicine in Apollo Tele Health Services, India*. Journal of Family Medicine and Primary Care, 5(4), 798-803.
2. Agarwal, N., Jain, P., Pathak, R. & Gupta, R. (2020). *Telemedicine in India: A tool for transforming health care in the era of COVID-19 pandemic*. Journal of Education and Health Promotion, 9(1), 190-195.
3. Ateriya, N., Saraf, A., Meshram, V. V. P. & Setia, P. (2018). *Telemedicine and virtual consultation: The Indian perspective*. The National Medical Journal of India, 31(4), 215-218.
4. Bakshi, S., Tandon, U. & Mittal, A. (2019). *Drivers and barriers of telemedicine in India: Seeking a new paradigm*. Journal of Computational and Theoretical Nanoscience, 16, 4367-4373.
5. Bali, S. (2018). *Barriers to Development of Telemedicine in Developing Countries*. Telehealth, 1-18. Intech Open.
6. Bali, S., Gupta, A., Khan, A. & Pakhare, A. (2015). *Evaluation of telemedicine centres in Madhya Pradesh, Central India*. Journal of Telemedicine and Telecare, 22(3), 183-188.
7. Bhatia, J. S. & Singh, C. (2014). *Impact of usage of discrete networks on Telemedicine capabilities especially in India*. In International Conference on Medical Imaging, m-health and Emerging Communication Systems (MedCom), (pp. 311-318).
8. Bhatnagar, N., Garg, S., Gangadharan, N., Singh, M., Raina, S. & Galwankar, S. (2020). *Telemedicine: Embracing virtual care during COVID-19 pandemic*, Journal of Family Medicine and Primary Care, 9(9), 4516.
9. Bindra, V. (2020). *Telemedicine for Women's Health During COVID-19 Pandemic in India: A Short Commentary and Important Practice Points for Obstetricians and Gynaecologists*. The Journal of Obstetrics and Gynaecology of India, 70(4), 279-282.
10. Biswas, P. & Batra, S. (2020). *Commentary: Telemedicine: The unsung corona warrior*. Indian Journal of Ophthalmology, 68(6), 1012.
11. Census of India (2012). *Rural urban distribution of population* [Online] Available at: <http://censusindia.gov.in/2011-prov-results/paper2/data_files/india/Rural_Urban_2011.pdf> Last accessed: 8 December 2020.
12. Chandwani, R., De, R. & Dwivedi, Y. K.K. (2018). *Telemedicine for low resource settings: Exploring the generative mechanisms*. Technological Forecasting & Social Change, 127(C), Elsevier, 177-187.
13. Chandwani, R. & Dwivedi, Y. (2015). *Telemedicine in India: current state, challenges and opportunities*. Transforming Government: People, Process and Policy, 9(4), 393-400.
14. Chandwani, R. & Kumar, N. (2018). *Stitching Infrastructures to Facilitate Telemedicine for Low-Resource Environments*. In Conference on Human Factors in Computing Systems, paper no. 384, pp. 1-12.
15. Chaudhari, K. & Karule, P. T. (2014). *WiMax network-based e-health service and telemedicine applications for rural and remote populations in India*. In International Conference on Medical Imaging, m-health and Emerging Communication Systems (MedCom), pp. 398-406.
16. Chellaiyan, V. G., Nirupama, A. Y. & Taneja, N. (2019). *Telemedicine in India: Where do we stand?* Journal of Family Medicine and Primary Care, 8(6), 1872-1876.
17. Chowdhury, A., Hafeez-Baig, A., Gururajan, R. & Chakraborty, S. (2019). *Conceptual framework for telehealth adoption in Indian healthcare*. In 24th Asia Pacific DSI Conference Program (APDSI 2019), (pp. 230-239).

18. Ganapathy, K. (2020). *Telemedicine and Neurological Practice in the COVID-19 Era*. *Neurology India*, 68(3), 555.
19. Garg, S., Gangadharan, N., Bhatnagar, N., Singh, M., Raina, S. & Galwankar, S. (2020). *Telemedicine: Embracing virtual care during COVID-19 pandemic*. *Journal of Family Medicine and Primary Care*, 9(9), 4516.
20. Ghosh, A., Gupta, R. & Misra, A. (2020). *Telemedicine for diabetes care in India during COVID19 pandemic and national lockdown period: Guidelines for physicians*. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, 14(4), 273-276.
21. ISRO (2005). *Telemedicine Initiative* [Online]. Available at: <<http://www.televital.com/downloads/ISRO-Telemedicine-Initiative.pdf>> last accessed 21 December 2020.
22. Iyengar, K. Jain, V. & Vaishya, R. (2020). *Pitfalls in telemedicine consultations in the era of COVID 19 and how to avoid them*. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, 14(5), 797-799.
23. Kaeley, N. Choudhary, S. Mahala, P. Nagasubramanyam, V. (2021). *Current scenario, future possibilities and applicability of telemedicine in hilly and remote areas in India*. *Journal of Family Medicine and Primary Care*. 10(1), 77-83.
24. Kumar, S., Pant, M., Uzzafar, F., Manjunatha, N., Kumar, C. & Math, S. (2019). *Telemedicine-Based Tobacco Treatment Model in Primary Care from a Low-Resource Setting*. *Journal of Neurosciences in Rural Practice*, 10(04), 690-692.
25. Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gotzsche, P. C., Ioannidis, J. P. A. et al. (2009). *The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration*. *BMJ*, 339, b2700.
26. Mahajan, V., Singh, T. & Azad, C. (2020). *Using Telemedicine During the COVID-19 Pandemic*. *Indian Pediatrics*, 57(7), 658-661.
27. Manglani, M., Gabhale, Y., Lala, M., Balakrishnan, S., Bhuyan, K., Rewari, B. et al. (2020). *Reaching the Unreached: Providing Quality Care to HIV-Infected Children through Telemedicine - An Innovative Pilot Initiative from Maharashtra, India*. *International Journal of Pediatrics*, 1-11.
28. Mathur, P., Srivastava, S., Lalchandani, A. & Mehta, J. (2017). *Evolving Role of Telemedicine in Health Care Delivery in India*. *Primary Health Care Open Access*, 07(01), 1-6.
29. Mishra, S., Kapoor, L. & Singh, I. (2009). *Telemedicine in India: Current scenario and the future*. *Telemedicine Journal and e-Health*, 15, 568-575.
30. Mishra, V. (2020). *Factors affecting the adoption of telemedicine during COVID-19*. *Indian Journal of Public Health*, 64(6), 234.
31. Mittal, A. & Pareek, P. (2020). *Telephonic Triage and Telemedicine During the Peak of COVID-19 Pandemic — Restricting Exposure to Healthcare Professionals*. *Indian Pediatrics*, 57(10), 973-974.
32. Porecha, M. & Singh, P.V. (2021) *eSanjeevani -The government-owned dark horse in India's telemedicine race*. Available at: <https://the-ken.com/story/esanjeevani-the-government-owned-dark-horse-inindias-telemedicine-race/?utm_source=daily_story&utm_medium=email&utm_campaign=daily_newsletter>, last accessed 18 March 2021.
33. Pradeepa, R., Rajalakshmi, R. & Mohan, V. (2019). *Use of Telemedicine Technologies in Diabetes Prevention and Control in Resource-Constrained Settings: Lessons Learned from Emerging Economies*. *Diabetes Technology & Therapeutics*, 21(S2), S2-9-S2-16.

34. Press Information Bureau, New Delhi (2020). *A big win for Digital India: Health Ministry's 'eSanjeevani' telemedicine service records 2 lakh tele-consultations*. Available at: <<https://pib.gov.in/PressReleasePage.aspx?PRID=1646913>>, last accessed: 06 December 2020
35. Wilson L. S & Maeder, A. J (2015). *Recent directions in telemedicine: Review of trends in research and practice*. Healthcare Informatics Research, 21, 213–22.
36. Zayapragassarazan, Z. & Kumar, S. (2016). *Awareness, Knowledge, Attitude and Skills of Telemedicine among Health Professional Faculty Working in Teaching Hospitals*. Journal of Clinical and Diagnostic Research, 10(3): JC01-4.



Varun VERMA is currently a 4th year student at Computer Engineering, Father Conceicao Rodrigues Institute of Technology, Navi Mumbai, India. He completed his research internship at Topiwala National Medical College & B.Y.L Nair Charitable Hospital, Mumbai under the guidance of Dr. Chhaya Verma PT, Ph.D. During his tenure as a research intern, he published a research paper related to COVID-19 published in an indexed journal. He also participated in the Harvard US-India Initiative which is a student-run organization that aims to create dialogue between Indian and American youth to address some of India's most pressing social, economic, and environmental issues today.



Vijaya KRISHNAN (PT) is currently an Assistant Professor at the Musculoskeletal Department, MGM College of Physiotherapy. She has 5 years of experience in teaching. She is the co-author of numerous publications in international and national journals and also of book chapters. She has presented papers at many conferences and won an award at the World Ayush Expo, 2019. She aspires to be an asset to the field of physiotherapy.



Chhaya VERMA (PT) is currently holding the post of Professor and Head at Physiotherapy School and Centre, Topiwala National Medical College & B.Y.L Nair Charitable Hospital, Mumbai. She has 36 years of experience in the field of physiotherapy. She completed her PhD at Dr. D.Y. Patil Medical College, Navi Mumbai in February 2020. She has also done her PGDHHM (Post Graduate Diploma - Hospital Health Care Management) at the University of Pune in 2002. She is currently pursuing her GSMC-FAIMER Fellowship (Batch 2020) at Seth Gordhandas Sunderdas Medical College (GSMC) and the King Edward Memorial (KEM) Hospital. She has published over 60 articles in international and national journals and is the author of chapters in 3 textbooks. One of them is a recent contribution as co-author with her colleague Dr. Jaimala Shetye (PT) of a chapter titled "Physiotherapy & Rehabilitation in COVID-19 patients" published in "Principles of Medical Management of COVID-19: The MCGM Experience" textbook.