COVID-19 pandemic and quick evolution of telemedicine: A gap analysis

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Abstract

Telemedicine though not a newer concept to healthcare community, it is relatively a new acquaintance to both healthcare providers and the general public. Since 11th of March 2020, the day when WHO declared COVID-19 infection as pandemic, the telemedicine services had achieved quick popularity. In fact this pandemic boosted a solid foundation for telemedicine and now it is one among the scope of services offered by any reputed healthcare organization globally. This article aims to emphasize how a symbiosis between telemedicine, POCT and mobile health units can help to deliver a high quality healthcare eliminating the risk of infection spread to both patients and health care providers. The methodology adopted includes collective viewpoints of authors which are based upon working experience gained during the current pandemic and literature review of recent and relevant articles related to process and pitfalls of telemedicine. Literature search was conducted by searching using key words and phrases like 'Telemedicine', 'COVID-19 and Telemedicine' and 'Non-Communicable Diseases management during pandemic'. The scope and gaps observed by literature survey and personal experience included infrastructure, awareness and training of both health care providers and patient population, utilization of POCT devices, internet connectivity, need for an nationwide unified Health Information Management System (HIMS) to aid easy access to patient health information and easy referrals to higher centers. In summary telemedicine is an absolute necessity during this on-going pandemic and its enhancement by integration with artificial intelligence and machine learning algorithms is a real need of hour.

Introduction

The unprecedented COVID-19 pandemic situation and its coexistent risk of contracting infection during hospital visits actually had given a kick start to telemedicine services which was otherwise not so popular among the general public. Even before this COVID-19 pandemic, actually health systems worldwide were very actively managing the silent pandemic of non-communicable diseases. Health policies and programs of both developed and developing nations gave greater emphasis to control Non-Communicable Diseases (NCDs) namely diabetes, cardiovascular diseases like coronary artery disease, stroke and cancers.[1] Now the biggest question is that "Are these non-communicable diseases left unmonitored focusing only on COVID-19 pandemic?" and a very simple answer to this question would be "No", because this is where telemedicine evolved quickly forming a major pillar of support. Most nations adopt the concept of 'health for all' and are striving to deliver equally higher quality healthcare to all levels of community. Now with the existing pandemic situation it is a challenging task for nations to maintain continuity of patient care especially to their rural population. Also now we know that the COVID-19 virus is constantly mutating and mutated variants are capable of causing fresh waves of infections. So it becomes an absolute necessity that countries should improve their telemedicine infrastructure in order to provide uninterrupted healthcare services. This article aims to reflect and reveal why we are in need of expansion of scope of telemedicine services; what do we currently have in terms of technology to deliver this service to general public; what initiatives can improve the delivery of telemedicine services at all levels of health system starting from tertiary centers to primary care centers and finally having addressed the existing gaps, how potential is telemedicine to emerge as a definitive allied medicine science in nearest future.

Materials and Methods

The material and method is achieved by the exploring the working experience and literature review of recent and relevant articles related to process and pitfall of telemedicine. The article constitutes the collective opinion of the authors based on individual experience gained while working

during the current pandemic situation. However published literature search were also conducted by searching using key words and phrases like 'Telemedicine', 'COVID-19 and Telemedicine', NCD management during Pandemic. Articles focusing current telemedicine scenario in India and other similar developing countries were referred preferentially the literature review is mentioned in Table 1.

What we have and what we need

In developing countries like India telemedicine services at present have achieved a considerable popularity and awareness in urban areas and among its residents.[2] A vast majority of healthcare organizations both government and private are currently offering telemedicine consultation.[3–5] Most of video consultations are through free video call platforms like Facebook, WhatsApp, Skype and Zoom. Though few of these applications offer end to end encryptions these are per user's selection of privacy settings during installation in their Personal Computer (PC) or smartphones which may be inappropriate. Few private hospitals have their own dedicated telemedicine software applications that are sophisticated and handcrafted to

ensure the privacy and patient data safety but come with a huge initial investment which may translate into hefty consultation charges.[6,7] In contrast to urban cities and towns in most rural areas and villages the sole provider of healthcare services is government run chain of Primary Health Centers (PHCs) and infrastructure to implement telemedicine practices really a distant dream. Major challenge for effective implementation of telemedicine practices at rural areas starts from its awareness and education about refraining visiting PHCs for simple ailments that can be treated by home remedial measures. Discussion about devising strategies to implement telemedicine in rural areas would be beyond scope of this article. Currently healthcare providers through telemedicine services manage to cater variety of consultations services like physician follow-up for NCDs, diet advice from nutritionist, demonstration of home based physiotherapy exercises, all forms of expert counseling etc.[2,5,7–10] It is evident that effective disease management through telemedicine services is impossible without conducting relevant medical investigations. These investigations may be necessary for initial assessment of the patient or as follow-up to previous consultations. Blood investigations required may be anything starting from simple glucose monitoring for diabetes to complex therapeutic drug monitoring for chemotherapy. Similarly non-invasive investigations may include blood pressure, electrocardiography (EKG), echocardiography, ultrasonography etc.[11,12] Currently to overcome this challenge there are plenty of FDA approved and CE marked In Vitro Diagnostics (IVD) Point Of Care Testing (POCT) available in markets for tests like glucose, including Continuous Glucose Monitors (CGMs), ketones, cholesterol, haemoglobin, creatinine, urine routine strips etc. that are easy to use and maintain domestically at home.[2,11–13] Most of POCT manufacturers have come out with step by step demonstration videos that are indexed and freely available in social network platforms like YouTube.[14–19] Though such equipment adds additional expenses at the beginning, however in a long run this would workout cheaper as it saves time and resources spent for hospital visits. Likewise there are many FDA approved ECG monitors that are capable transmitting the results to treating physician's PC and smartphones.[20] In situation where continuous monitoring of EKG is required online sellers like Amazon have started renting medical devices like Holters monitors, which appears to be a promising initiative. Similarly scope of such renting services shall be broadened to include certain

portable POCT devices like i-STAT Alinity that are capable testing wide spectrum of blood analyses. In case of complex investigations telemedicine services must handshake with mobile health units, which again have evolved swiftly during this pandemic. Developed nations provide province wise a fleet of mobile health units starting from ground ambulances to air ambulances that are fully equipped with a comprehensive set of POCT devices. Scientific societies like American Association for Clinical Chemistry (AACC) and Canadian Society of Clinical Chemists (CSCC) have issued guidance for POCT testing in such mobile health units[21–24]. Similar guidance and policies must be issued or adopted and compliance of the same needs to be monitored in developing nations.

Technology based strategies

Telemedicine services in order to be considered as a sustainable solution, it requires a strong support of technology. As the name implies firstly telemedicine requires an internet connected communication devices. Governments of developing nations should start investing to improve their communication infrastructure. Countries like India, which claims rural areas and villages as its backbone, should achieve 100% internet connectivity to all its PHCs irrespective of its location. This should be the first initiative to be prepared for any upcoming waves of existing

COVID-19 or any such pandemic in future.[25] Every nation should develop their own unified HIMS and sufficiently large databases for archiving health records of its entire population. The records of each individual can be linked to their social security number like Aadhar number in India or to medical insurance numbers. Clear policies and protocols should be established to access such archived health records by a governing medical council registered treating physicians working for either public or private healthcare organization. Data security and patient confidentiality shall be ensured through safe authentication procedures as demonstrated in Figure 1.

Next step would be investing in large-scale production of short range and long-range drones and establishing adequate number of control rooms to monitor drone traffic. These drones shall be deployed for swift delivery of prescription medications[26] (even portable oxygen cylinders) to patients and for pickup of samples like dried capillary blood, urine samples, variety of swab samples packed in appropriate storage containers. Patient identification before drone based deliveries and pickups shall be ensured with help of biometric data or face recognition or QR code based software developed incorporating artificial intelligence and machine learning.

Virtual software technology have tremendously improved and scaled up to meet the increasing demand of telemedicine
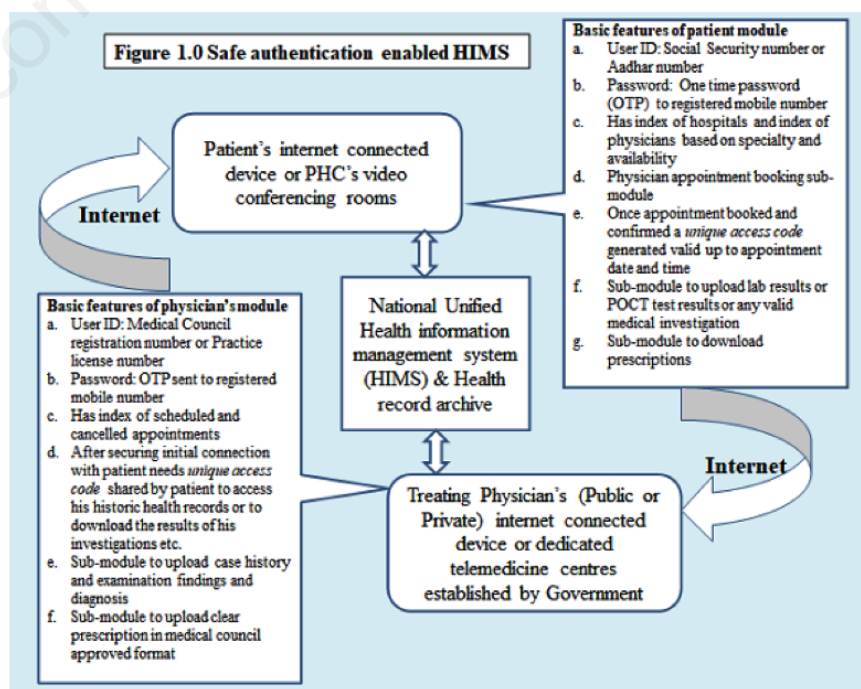

Figure 1. Safe Authentication enabled Health information management system (HIMS).

Table 1. Literature review of the prior studies related to telemedicine adaptation.

	Article	Authors and year	Conclusions and remarks
1.	Telemedicine during the COVID-19 pandemic: experiences from Western China. Journal of medical Internet research	Hong, Z, et al. (2020)[27]	The authors explains the success of telemedicine in western china using the network synergizes with 5G service, a smartphone app, and an existing telemedicine system
2	Exploring the adoption of telemedicine and virtual software for care of outpatients during and after COVID-19 pandemic	Bokolo, A. J. (2021)[28]	The author have explored the factors impacting the adoption of telemedicine and virtual software platforms and highlighted funds, training, workforce integration, Data privacy, Wi-Fi quality , Licensure requirements and Health insurance and reimbursement policies
3	Use of telemedicine and virtual care for remote treatment in response to COVID-19 pandemic	Jnr, B. A. (2020)29	The authors have provided practical guide to use virtual care during the COVID-19 pandemic an also highlighted the gaps such as necessary infr structure, inadequate funds, lack of experience among health professionals in optimal use of telemedicine
4	Telemedicine in neurosurgery: lessons learned and transformation of care during the COVID-19 pandemic	Mouchtouris, Nikolaos, *et al.* (2020)[30]	The study is focused on use of telemedicine in surgery field and describes various adaptation of effective utilization
5	Telemedicine in India: Current Scenario and the Future	Mishra SK, *et al.* (2009)[31]	They have described Indian Space Research Organization mediated SATCOM-based telemedicine network and also mentioned the inclusion curriculum in telemedicine training programs at various levels
6	Telemedicine: History and Success Story of Remote Surgical Education in India	Yadav SK, *et al.* (2021)[32]	They emphasized on tele-education in surgical field in Indian scenario and propose integration of telemedicine within the framework of routine medical education.
7	A survey of awareness, knowledge, attitude, and skills of telemedicine among healthcare professionals in India	RakeshDatta, *et al.* (2021)[33]	They have analyzed the "Telemedicine Practice Guidelines were promulgated in India in 2020" for AKAS and concluded the requirement of training and education about the skills and provisions for effective use to avoid medico-legal issues
8	Current scenario, future possibilities and applicability of telemedicine in hilly and remote areas in India: A review protocol	NidhiKaeley, *et al.* (2021)[34]	They have highlighted the need of telemedicine in hilly and remote area and to implement telehealth by effective collaboration of primary and secondary health care setups and to reach population staying in underserved areas
9	Telemedicine as techno-innovation to tackle COVID-19: A bibliometric analysis	Carlo Drago, *et al.* (2021)35	They describe a "semantic cores" in the literature which represents the relevant results on telemedicine themes which will aid in evidence based literature analysis, necessary for policy making and implementation
10	Are state telemedicine parity laws associated with greater use of telemedicine in the emergency department?	Kori S. Zachrison, *et al.* (2021)[36]	The authors examined the use of telemedicine in emergency and the payment policy from issuers, effect the use of telemedicine and also described factors for implementation, such as regulatory environment, ease of interstate credentialing, and even the extent of payment parity
11	Africa turns to telemedicine to close mental health gap	Paul Adepoju (2020)[37]	The article draws attention to increase use of telemedicine during pandemic in most African country as seen by increase in traffic in help-lines and effectiveness of telemedicine for mental health is on par with one-on –one counseling
12	Telemedicine for Mental Health in the United States: Making Progress, Still a Long Way to Go	Michael L. Barnett, *et al.* (2019)[38]	The authors have explore facility adoption of telemedicine using national survey conducing in united state and suggested telemedicine as most effective option to utilize the workforce and provide service to patients needing to reach the health centers by hours away in vehicle

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13	Telemedicine Adoption during the COVID-19 Pandemic: Gaps and Inequalities	Jake Luo, *et al.* (2021)[39]	They study was done in Milwaukee area of Wisconsin, United States and identified several reasons for disparities in telemedicine adoption such as income, education level, race, and insurance type.
14	Telemedicine Across the Globe-Position Paper From the COVID-19 Pandemic Health System Resilience PROGRAM (REPROGRAM) International Consortium (Part 1)	SonuBhaskar, *et al.* (2020)[40]	The Consortium has looked into telemedicine related issues during the pandemics across various region including India, they team has pointed out the lack of infrastructure and lack of regulation is the major drawback in India. However they have concluded the positive role for telehealth or telemedicine in improving health systems
15	Revisiting health information technology ethical, legal, and social issues and evaluation: telehealth/telemedicine and COVID-19	Bonnie Kaplan (2020)[41]	The author describes extensively the ethical and legal issues and how to develop the framework for effective utilization of telemedicine in USA and also highlighted the need for cyber security and informatics infrastructure
16	The COVID-19 Catalyst: Analysis of a Tertiary Academic Institution's Rapid Assimilation of Telemedicine	Clayton Davis, et al (2020)[42]	The authors analyzed the patients' utilization of telemedicine in Virginia. USA. The observed 82% of patients surveyed were the view to use telemedicine over a face-to-face encounter for a routine visit during future flu seasons.

in order to deliver quality medical opinions on outpatient basis even to the remotest areas during Covid-19 pandemic. Brief review of the literature describing utility and limitation of various aspect of telemedicine done in many countries such as Norway, Africa, Australia, USA, India and China is presented in (Table 1).[27-42]

Conclusions

We authors believe that for sustainable successful telemedicine practice a perfect blend of technology and medical science is mandatory. In addition an improved awareness and education to public about benefits of telemedicine also plays a vital role. Imparting computer education into curriculum of all medical and allied medical science should be considered on highest priority as a way forward. During this pandemic developing countries are redistributing their healthcare workers serving in rural villages to urban areas in order to handle high patient loads in thickly populated cities. Such redistributions to a greater extent cripple delivery of primary health care services in villages. Such crisis can be to some extent managed with help of having well connected video conferring rooms in PHCs for outpatient consultations. With advent of newer technologies in the field of biomedical science it is evident that telemedicine has huge scope to transform into an unavoidable field of medical science. Now

it's right time to well integrate all advancements in information technologies, artificial intelligence and machine learning technologies and medical sciences to fill existing gaps in current telemedicine practices.

References

1. Srivastava RK, Bachani D. Burden of NCDs, policies and programme for prevention and control of NCDs in India. Indian J Community Med 2011;36:S7–12.
2. Dinakaran D, Manjunatha N, Kumar CN, Math SB. Telemedicine practice guidelines of India, 2020: Implications and challenges. Indian J Psychiat 2021;63:97.
3. Agarwal N, Jain P, Pathak R, Gupta R. Telemedicine in India: A tool for transforming health care in the era of COVID-19 pandemic. J Educ Health Prom 2020;9:190.
4. Ministry of Health and Family Welfare, GOI. e-Health & Telemedicine. Accessed 2021 Jun 13. Available from: https://main.mohfw.gov.in/Organisation/departments-health-and-family-welfare/e-Health-Telemedicine
5. Chellaiyan VG, Nirupama AY, Taneja N. Telemedicine in India: Where do we stand? J Family Med Prim Care 2019;8:1872–6.
6. Zhang K, Liu W-L, Locatis C, Ackerman M. Mobile videoconferencing apps for telemedicine. Telemed J E Health 2016;22:56–62.
7. Sood SP, Bhatia JS. Development of telemedicine technology in India: "Sanjeevani"'-An integrated telemedicine application. J Postgrad Med 2005;51:308.
8. Reimagining The Indian Government's Telemedicine Platform [Internet]. Microsave 2021. Accessed 2021 Jun 13. Available from: https://www.microsave.net/2021/02/10/reimagining-the-indian-governments-telemedicine-platform/
9. Dasgupta A, Deb S. Telemedicine: A New Horizon in Public Health in India. Indian J Community Med 2008;33:3–8.
10. Govt. of India's telemedicine service completes 3 million consultations. Accessed 2021 Jun 13. Available from: pib.gov.in/Pressreleaseshare.aspx?PRID=1705358
11. Sherling D, Sherling M. The promises and pitfalls of telemedicine. AJMC. Accessed 2021 Jun 13. Available from: https://www.ajmc.com/view/the-promises-and-pitfalls-of-telemedicine
12. Iyengar K, Jain VK, Vaishya R. Pitfalls in telemedicine consultations in the era of COVID 19 and how to avoid them. Diabetes MetabSyndr 2020;14:797–9
13. Mehta SJ. Telemedicine's potential ethical pitfalls. AMA J Ethics 2014;16:1014–7.

14. Francis AJ, Martin CL. A practical example of PoCT working in the community. ClinBiochem Rev 2010;31:93–7.

15. Shaw JLV. Practical challenges related to point of care testing. Practical Lab Medi 2016;4:22–9.

16. Malcolm S, Cadet J, Crompton L, DeGennaro V Jr. A model for point of care testing for non-communicable disease diagnosis in resource-limited countries. Glob Health Epidemiol Genom 2019;4:e7.

17. St John A, Price CP. Existing and emerging technologies for point-of-care testing. ClinBiochem Rev 2014;35:155–67.

18. Hayward G, Dixon S, Garland S, et al. Point-of-care blood tests during home visits by out-of-hours primary care clinicians; a mixed methods evaluation of a service improvement. BMJ Open 2020;10:e033428.

19. Clifford LJ. The pros and cons of point-of-care testing vs laboratory testing. Medical Laboratory Observer, 2018. Accessed 2021 Jun 13. Available from: https://www.mlo-online.com/continuing-education/article/13017084/the-pros-and-cons-of-pointofcare-testing-vs-laboratory-testing

20. Bansal A, Joshi R. Portable out-of-hospital electrocardiography: A review of current technologies. J Arrhythm 2018;34:129–38.

21. Füzéry AK, Kost GJ. Point-of-care testing by ambulance teams: an opportunity for a new standard. AACC.org. Accessed 2021 Jun 13. Available from: https://www.aacc.org/cln/articles/2021/may/point-of-care-testing-by-ambulance-teams-an-opportunity-for-a-new-standard

22. AACC. Guidance document on management of point-of-care testing. AACC.org. Accessed 2021 Jun 13. Available from: https://www.aacc.org/science-and-research/aacc-academy-guidance/management-of-point-of-care-testing

23. Nichols JH, Alter D, Chen Y, et al. AACC Guidance document on management of point-of-care testing. J Appl Lab Med 2020;5:762–87.

24. Yip PM, Venner AA, Shea J, et al. Point-of-care testing: A position statement from the Canadian Society of Clinical Chemists. Clin Biochem 2018;53:156–9.

25. Jayamani J, Thangaraju P, Thangaraju E, Venkatesan S. Decentralisation of healthcare system due to COVID-19 and its impact on hospital based laboratories - Pandemic panic patients' reflection? J Responsible Technol 2020;1:100003.

26. Hii MSY, Courtney P, Royall PG. An evaluation of the delivery of medicines using drones. Drones 2019;3:52.

27. Hong Z, Li N, Li D, et al. Telemedicine during the COVID-19 pandemic: experiences from Western China. J Med Internet Res 2020;22:e19577.

28. Bokolo AJ. Exploring the adoption of telemedicine and virtual software for care of outpatients during and after COVID-19 pandemic. Irish J Medical Sci 2021;190:1-10.

29. Bokolo AJ. Use of telemedicine and virtual care for remote treatment in response to COVID-19 pandemic. J Med Syst 2020;44:132.

30. Mouchtouris N, Lavergne P, Montenegro TS, et al. Telemedicine in neurosurgery: lessons learned and transformation of care during the COVID-19 pandemic. World Neurosurg 2020;140:e387–94.

31. Mishra SK, Kapoor L, Singh IP. Telemedicine in India: Current scenario and the future. Telemedicine and e-Health 2009;15:568–75.

32. Yadav SK, Mishra A, Mishra SK. Telemedicine: History and success story of remote surgical education in India. Indian J Surg 2021; Available from: https://doi.org/10.1007/s12262-021-03020-9

33. Datta R, Singh A, Mishra P. A survey of awareness, knowledge, attitude, and skills of telemedicine among healthcare professionals in India. Med J Armed Forces India 2021; Available from: https://www.sciencedirect.com/science/article/pii/S0377123721002550

34. Kaeley N, Choudhary S, Mahala P, Nagasubramanyam V. Current scenario, future possibilities and applicability of telemedicine in hilly and remote areas in India: A review protocol. J Family Med Prim Care 2021;10:77–83.

35. Drago C, Gatto A, Ruggeri M. Telemedicine as technoinnovation to tackle COVID-19: A bibliometric analysis. Technovation 2021;102417.

36. Zachrison KS, Boggs KM, Cash RE, et al. Are state telemedicine parity laws associated with greater use of telemedicine in the emergency department? J Am Coll Emerg Physicians Open 2021;2:e212359.

37. Adepoju P. Africa turns to telemedicine to close mental health gap. Lancet Digital Health 2020;2:e571–2.

38. Barnett ML, Huskamp HA. Telemedicine for mental health in the United States: Making progress, still a long way to go. Psychiatr Serv 2020;71:197–8.

39. Luo J, Tong L, Crotty BH, et al. Telemedicine adoption during the COVID-19 pandemic: gaps and inequalities. Appl Clin Inform 2021;12:836–44.

40. Bhaskar S, Bradley S, Chattu VK, et al. Telemedicine across the globe-position paper from the COVID-19 pandemic health system resilience PROGRAM (REPROGRAM) international consortium (Part 1). Front Public Health 2020;8:556720.

41. Kaplan B. Revisiting health information technology ethical, legal, and social issues and evaluation: telehealth/telemedicine and COVID-19. Int J Medical Inform 2020;143:104239.

42. Davis C, Novak M, Patel A, et al. The COVID-19 catalyst: analysis of a tertiary academic institution's rapid assimilation of telemedicine. Urol Pract 2020;10.1097/UPJ.0000000000000155