

TELEDENTISTRY: PROPOSAL OF AN IMPLEMENTATION MODEL IN INDIA

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Abstract

While oral health is recognised as a key element of overall health, well-being and quality of life, a significant disparity exists within India when it comes to access to qualified dental care. It is noteworthy that while there is one dentist for every 10,000 urban dwellers in India, in rural India, this ratio falls to one dentist for every 150,000 people. Teledentistry is the use of telecommunications and information technologies to support long-distance clinical oral health care, patient and professional health-related education, public health, and health administration. This could include appointing a general dental surgeon and/ or dental hygienists at the remote centres, who aim to extend proximal and cost effective care to their catchment population, while supported remotely by specialists. In addition to patient care, Teledentistry can be utilised to provide remote clinical training to dental professionals as well as enhanced patient education using web based self-instruction and/ or video-conferencing tools. High reliability and low latency internet bandwidth is a key infrastructure backbone required for effective teledentistry. Some training and capacity building of the professionals involved in the care value-chain, as well as an effective technical support group is required at the hubs. Also, an institutional framework and a clear set of policies are required, which respond to issues such as liability/ accountability of the professionals involved, malpractice protection for patients, data privacy/ confidentiality of patient information and ensuring prior informed consent of patients. This paper is an attempt to discuss the concept of teledentistry, its applications, scope and limitations in the Indian context.

Key words – Dentistry, Teledentistry, Teleconsultation, Remote Healthcare.

Introduction

Even with around 290 dental colleges and over 25,000 graduates each year, the most vulnerable sections of our society, both the urban poor and our rural masses, do not have access to basic oral health care. It is noteworthy that while there is one dentist for every 10,000 urban dwellers in India, in rural areas this ratio falls to one dentist for every 150,000 people.¹ It is also a fact that dental care services are available in very few states at the primary health care level and this remains a fundamental gap in the Indian social security scenario. A number of root-causes underlie this situation; migratory tendency for educated and qualified professionals away from rural areas, geographic remoteness, lack of effective public transport networks, lack of awareness and poverty, among others.

Teledentistry, a subset of the concept of telemedicine, involves the use of telecommunications and information technologies to support long-distance clinical oral health care, patient and professional health-related education, public health, and health administration. Through this approach, the Internet and similar telecommunication medium are combined with digital imaging and electronic recordkeeping tools and then employed to link dental health care providers in rural or remote communities with specialists in centres of excellence. This is emerging as an effective way of extending oral healthcare services to remote areas or underserved populations by leveraging recent technological advancements and enhanced penetration of wireless and wired telecommunications throughout India.

The initial teledentistry pilot studies have given very encouraging results and have demonstrated that this

approach can have a transformational impact on oral health of a remote or underserved population. However, for teledentistry to emerge as a mainstream element of oral health strategy in India, a number of infrastructures, policy and institutional framework aspects need to be reviewed and addressed as a matter of priority.

History of Teledentistry

The Telemedicine Information Exchange (1997) defines telemedicine as the "use of electronic signals to transfer medical data (photographs, x-ray images, audio, patient records, videoconferences, etc.) from one site to another via the Internet, Intranets, PCs, satellites, or videoconferencing telephone equipment in order to improve access to health care." Telemedicine may also be defined as "the use of advanced telecommunications technologies to exchange health information and provide health care services across geographic, time, social, and cultural barriers".² The history of Telemedicine goes back to 1924, when a physician consulted his patient over the radio. However, the concept of teledentistry is relatively new. The initial concept of teledentistry developed as part of the blueprint for dental informatics, which was drafted at a 1989 conference funded by the Westinghouse Electronics Systems Group in Baltimore. Focus was on a discussion of how to apply dental informatics in dental practice to directly affect the delivery of oral healthcare.³ The term "Teledentistry" was first used in 1997, when Cook defined it as "... the practice of using video-conferencing technologies to diagnose and provide advice about treatment over a distance".⁴

Types of Teledentistry

There are broadly two approaches used in teledentistry; two-way interactive or real time consultation; and “store and forward” teledentistry.

Two-way interactive or real time consultation: As the name suggests, this type of tele-consultation occurs live, where the dentist can directly communicate with the patient or another care-giver located at a remote location. This type of teledentistry is possible by the use of high speed internet and video-conferencing, which allows two or more locations to communicate simultaneously by live video and audio transmission.³

Store and forward teledentistry: While real-time consultation requires elaborate set up of advanced technologies at both ends, another alternate type of teledentistry is the store and forward type, where information can be gathered and stored then forwarded or transferred to consulting clinicians or beneficiary locations. This gathered and stored data generally consists of patient’s history, photographs of the relevant areas and X-ray radiographs, tomography scans, magnetic resonance imaging etc.^{5,6} For any teledentistry consultation, it is imperative that special video conferencing equipment and/or an internet connection are available at both the consulting and the remote site. Usually a questionnaire is either filled by the local dentist/ caregiver or the patient before the actual teleconsultation. This questionnaire, history, photographs or radiographs and other relevant information are either stored and transferred digitally or discussed during the in-person teleconsultation through video-conferencing. If two-way video link is available, a live examination of the patient, aided by a local care-giver where available, also takes place in course of the consultation event.

Applications of Teledentistry

Teledentistry has the potential ability to provide better access to oral health care, improve its delivery system and lower its costs for the underserved population.⁷ In addition to extending general dental care to an underserved population or location; teledentistry can also have a number of specialized applications. Studies have documented successful use of teledentistry to extend highly specialized consultations as well.⁸ Some of the traditional as well as emerging applications include:

Application in general oral diagnosis and radiology: Oral diagnosis is a key department of dentistry concerned with identifying, investigating and diagnosing an oral disease. Given the general lack of qualified and experienced specialists in non-urban/ remote locations of India, accurate diagnosis of complex and serious oral conditions is severely constrained and therefore an appropriate line of treatment is often not employed. A study done to assess the feasibility of distant teledentistry revealed that distant diagnosis can be an effective alternative in the diagnosis of oral lesions and the use of two or more distant consultants significantly improved diagnostic accuracy. This study involved

documenting 25 cases of oral lesions over a period of 1 year in a primary care public health clinic in Parana in Southern Brazil. Detailed charts and images of the patient and the lesions were sent by email to two oral medicine specialists with different field experience and they were asked to give maximum 2 clinical hypotheses for each condition.⁹ Teledentistry, therefore, provides an opportunity for timely diagnosis, analysis and treatment planning of oral diseases for patients located in such remote or underserved areas. Direct consultation through video conferencing or transfer of the collected data like history, radiographs etc. to the specialist consultant through e-mails can significantly enhance diagnostic accuracy and further treatment of the patients.

Application in oral surgery: In India, the prevalence of oral cancers has significantly increased over the last few decades, especially in remote areas and amongst the poorer, uneducated and vulnerable sections of the society. A high prevalence of tobacco chewing and smoking, compounded by a lack of awareness of risks associated with these habits is amongst the leading causes of this prevalence of oral cancer.¹⁰ Studies have been done to prove the use and efficacy of teledentistry in treatment planning and pre-surgical assessments of oral surgical interventions.¹¹ By extending such approaches to early intervention in oral cancer cases, teledentistry may prove to be an important tool in delivering improvements in treatment prognosis and survival rate amongst oral cancer patients.

Application in orthodontics: Orthodontics is a highly specialized branch of dentistry and general dentists typically have limited understanding of orthodontic problems and associated lines of treatment. Uses of teledentistry tools, for remote specialist supervision of orthodontic treatments and interventions undertaken by local dentists have proved to be very beneficial.¹²

Application in restorative dentistry and endodontics: Teledentistry tools, especially review of radiographs and images by remotely located specialists, have proved to be advantageous in the field of endodontics by ensuring a better understanding of dental morphology including the location of root canal orifices as well as aiding more robust diagnosis of the condition of the dental pulp and/ or periapical tissue.¹³ It may be noted that the life of an endodontically treated tooth materially depends on the accuracy of the diagnosis and planning of the root canal treatment, which can be significantly enhanced using teledentistry approaches.¹⁴

Application in Prosthodontics: Full mouth rehabilitation, overdenture and immediate denture prosthesis is highly specialized works and usually pose a number of technical difficulties to general dentists. Immediate dentures and overdentures play a significant role in smooth psychological and physiological transition from dentulous state to edentulous state.¹⁵ With the use of teledentistry, suitable technical guidance can be provided to the general dentists by remotely located specialists at critical stages including diagnosis, treatment planning, laboratory works,

port-intervention follow-ups and contingent interventions. Studies have demonstrated such remote interventions and consultations to be feasible and effective.¹⁶

Application in pediatric and preventive dentistry: Dental diseases, especially dental caries and early gingivitis can start at an early age due to improper oral hygiene. It is therefore important that children learn about oral hygiene at an early age. Several such awareness programs and camps are frequently conducted in schools and localities within the larger cities of India. However, children residing within rural and remote areas remain significantly underserved in this regard. Therefore, in addition to aiding diagnosis, treatment planning and specialist follow-up/ intervention related consultations, teledentistry can play a very important role in educating schools children about dental diseases and in spreading awareness about basic oral hygiene.¹⁷

Scope and Relevance of Teledentistry in India

With a population of approximately 1.21 billion, India is a large and diverse country, both geographically and demographically.¹⁸ A large percentage of this population dwells in rural areas, with limited resources in terms of education, infrastructure and most importantly, basic health care facilities.

The Government has implemented many programs to improve the rural health care services. One such program is The National Rural Health Mission (NRHM) started in 2005 with a purpose to improve rural health care system. Through this program many PHCs (primary health centres) and CHCs (Community Health Centres) have been established in rural and remote areas. Government has also appointed many primary level health workers to work in coordination with these PHCs and CHCs in providing basic health care and education. In addition, District Hospitals also play a significant role in providing basic health care in remote locations across the country. What these centres and facilities often lack is specialist expertise and experience in differential diagnosis, modern treatment planning and expert follow-up/ contingent interventions that may be required for responding to the more complex cases.

While oral health is recognized as a key element of overall health, well-being and quality of life, a significant disparity exists within the country when it comes to access to qualified dental care. Even with around 290 dental colleges and over 25,000 graduates each year, the most vulnerable sections of our society, both the urban poor and our rural masses, do not have access to basic oral health care. However, in the field of telecommunication and internet usage, in India has grown exponentially over the last decade. India is the 2nd largest country in the world in terms of mobile phone users, with around 27 million people using smart phones. In terms of internet usage India is the third largest country after China and USA, with over 330-370 million internet users. This advancement in the technology can be leveraged in the field of remote health care services

and education for the people living in remote and rural areas.

Since dental treatment is highly specialized and technique sensitive, addition of teledentistry to our national health care system can not only enable enhanced availability of oral health care at the PHCs/ CHCs but can also have a significant preventive impact by spreading awareness about oral diseases and importance of proper oral hygiene(including, by using web based self-instruction and/ or video-conferencing tools).In addition, teledentistry can also be utilised to remotely provide specialized clinical training to dental professionals located at the beneficiary locations.

Also encouraging is the fact that focused/ specialized telemedicine programs undertaken in certain remote parts of the country have already been a success; as an example, the successful implementation of a tele-ophthalmology project in Tripura has inspired the Planning Commission of India to incorporate the tele-ophthalmology program in the 12th Five Year Plan of the country.¹⁹

Limitations

High reliability and low latency internet bandwidth is a key infrastructure backbone required for effective teledentistry. Although India is ranked 3rd in the world in terms of number of internet users, the average bandwidth available is considered amongst the lowest in the Asia-Pacific countries, with an average speed of 1.7 mbps.²⁰ Effective video-conferencing at a resolution suitable for clinical consultations requires stable data speed of about 3-4 mbps.

The linguistic and cultural diversity of the country also poses a challenge for effective tele-or video-conferencing based clinical consultations. Another major limitation for teledentistry is the patient consent, legal and ethical issue regarding privacy, storage and transfer of patient data. While data protection law in India states that mishandling of any digital data a crime, the application of such principles to remotely transmitted or stored patient data is yet to be settled in India.²¹



Figure 1: Spatial distribution of dental colleges in India
 Source: <http://www.mapsofindia.com/education/dental-colleges/>

A Possible Implementation Model

As stated earlier in the document, there are around 290 dental colleges in India. An indicative map representing the spatial distribution of these colleges is presented under *Figure 1*.

A brief perusal of the above map highlights the geographical spread and potential reach of these dental colleges across the country. Each of these colleges can be a potential centre of specialized expertise, located within the appropriate linguistic and cultural setting relevant for a particular population catchment, using a de-centralized “hub-and spoke” model (*Figure 2*).

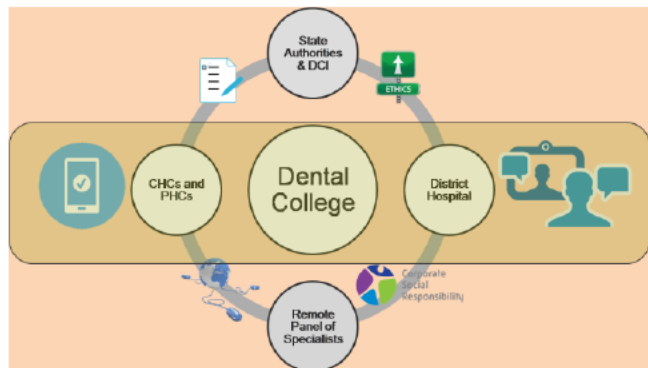


Figure 2: - A De-centralized “Hub and Spoke” Model

Therefore, these dental colleges can act as a “hub” for providing teledentistry consultations to a group of remotely located PHCs or CHCs (which, as the “spokes”, would be digitally connected to a designated college). Relevant Data can be collected by local dentists or healthcare workers appointed at PHCs and CHCs and transferred to the hubs through email or smart phones and scheduled consultations can be performed via direct video-conferencing. Each college/ hub may also maintain tele-contact with a remote panel of super-specialists, who may be called upon for additional consultation/ advice on an as-needed basis.

Internet Service Providers (ISPs) are in the process of rolling out pan-India high speed networks. One such ISP (Reliance JioInfocomm) will provide 4G high speed data coverage to about 5,000 towns/ cities as well as over 215,000 villages in India within 2015, with a target to expand coverage to over 600,000 villages²² (Press Trust of India, November 04, 2014). For the success of the teledentistry initiative, it is therefore important to partner with an ISP, who could support this initiative by providing free or low-cost bandwidth, possibly as a part of its Corporate Social Responsibility (CSR) program. Such programs are now mandatory for large corporate by way of a recent amendment in the Companies Act and interestingly, healthcare is one of the primary focus areas identified under the relevant Schedule of the Companies Act, 2013²³ (Press Trust of India, Apr 6, 2014).

Also, from an infrastructure standpoint, it may be noted that most, if not all, accredited dental colleges in the country would have appropriate Information Technology (IT)

systems at their end to support such an initiative. The user end (i.e. the PHCs/ CHCs) can leverage mobile/ handheld devices and wireless connectivity provided by the partnering ISP (or other implementation partners) to transmit digital data, images and to conduct video-conferencing.

Record-keeping could be a shared responsibility between the college (the hub) and the PHCs/ CHCs (the spokes), with paper/ hard-copy data and records being maintained at the PHCs/ CHCs and electronic data stored within a secure, dedicated data server maintained at the Hub location.

The author recognizes that effective implementation of any such program is a complex endeavor, involving multiple stakeholders and a number of institutions. Therefore, as a starting point, a Pilot Program may be considered at an appropriate location (possibly in close proximity of a high-risk, remotely located population) to test the feasibility of such an initiative. This may be undertaken by way of a Public-Private-Partnership (PPP) model and/ or by leveraging the emergent drivers around community healthcare as a CSR initiative for large corporates.

The Pilot Program may be reviewed on an ongoing basis by regulatory bodies such as the Dental Council of India and the relevant State Government/ District Administration and based on the learning’s there from, a formation of a National Teledentistry Mission maybe considered by the relevant statutory stakeholders, articulating amongst others, an appropriate institutional framework, norms and guidelines as well as an implementation plan to take this de-centralized Hub-and-Spoke model (or a variant thereof) nationwide.

References

- Gambhir RS, Brar P, Singh G, Sofat A, Kakar H. Utilization of dental care: An Indian outlook. *J Nat Sci Biol Med* 2013;4(2):292–297.
- Reid J. A Telemedicine Primer: Understanding the issue. Innovative Medical Communications, Billings, Mont, USA, 1996.
- Chen JW, Hobdell MH, Dunn K, Johnson KA, Zhang J. Teledentistry and Its Use in Dental Education. *J Am Dent Assoc.* 2003;134(3):342–6.
- Fricton J, Chen H. Using teledentistry to improve access to dental care for the underserved. *Dent Clin North Am.* 2009;53(3):537–48.
- Clark GT. Teledentistry: What is it now, and what will it be tomorrow? *J Calif Dent Assoc* 2000;28(2):121-7.
- Folke LE. Teledentistry- An overview. *Tex Dent J* 2001;118(1):10-8.
- Golder DT, Brennan KA. Practicing Dentistry in the Age of Telemedicine. *J Am Dent Assoc* 2000;131(6):734-44.
- Bradley M, Black P, Noble S, Thompson R, Lamey PJ. Application of teledentistry in oral medicine in a community dental service, N. Ireland. *Br Dent J.* 2010;209(8):399–404.

9. Torres-Pereira C, Possebon RS, Simoes A, Bortoluzzi MC, Leao JC, Giovanini AF *et al*. Email for distance diagnosis of oral diseases- A preliminary study of Tetedentistry. *J Telemed Telecare*. 2008;14(8):435–8.
10. Ramchandra NB. The hierarchy of oral cancer in India. *Int J Head and Neck Surg* 2012;3(3):143-146.
11. Duka M, Mihailovic B, Miladinovic M, Jankovic A, Vujcic B. Evaluation of telemedicine systems for impacted third molars diagnosis. *Vojnosanit Pregl*. 2009;66(12):985–91.
12. Berndt J, Leone P, King G. Using teledentistry to provide interceptive orthodontic services to disadvantaged children. *Am J Orthod Dentofacial Orthop* 2008;134(5):700-6.
13. Brullmann D, Schmidtmann I, Warzecha K, d’Hoedt B. Recognition of root canal orifices at a distance – A preliminary study of Teledentistry. *J Telemed Telecare*. 2011;17(3):154–7.
14. Estrela C, Holland R, Estrela CR, Alencar AH, Cousa-Neto MD, Pecora JD. Characterization of successful root canal treatment. *Braz Dent J* 2014;25(1):3-11.
15. Mallick R, Tamrakar AK, Sachdeva S, Perwez E. Immediate overdenture: taking advantage of two specialized procedures. *Annals of Dental Specialty* 2014;2;(4):148-51.
16. Ignatius E, Perala S, Makela K. Use of videoconferencing for consultation in dental prosthetics and oral rehabilitation. *J Telemed Telecare* 2010;16(8):467-70.
17. Chhabra N, Chhabra A, Jain RL, Kaur H, Bansal S. Role of teledentistry in dental education: Need of the era. *J Clin Diagn Res* 2011;5(7):1486-1488.
18. The Registrar General & Census Commissioner; Government of India, March 2011. Provisional Population Totals. Government of India: New Delhi.
19. Governance Knowledge Centre, Ministry of Personnel, Public Grievances and Pensions, Government of India, August 2011. Case Study, Tele-ophthalmology in Tripura. New Delhi: Government of India.
20. Akamai Technologies, Inc 2014. Akamai’s state of the internet. Cambridge: Massachusetts.
21. Dalal P. 2006. Data Protection law in India: The TRIPS prospective 11:126-131.
22. Press Trust of India, November 04, 2014. Reliance JioInfocomm Applies for Network Test Ahead of 4G Launch. Press Trust of India: New Delhi. Available at <http://gadgets.ndtv.com/telecom/news/reliance-jio-infocomm-applies-for-network-test-ahead-of-4g-launch-616167>
23. Press Trust of India, Apr 6, 2014. Promoting healthcare comes under CSR ambit: Government. Press Trust of India: New Delhi. Available at http://articles.economictimes.indiatimes.com/2014-04-06/news/48908562_1_csr-norms-csr-activities-csr-work.

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