ORIGINAL RESEARCH

Teledentistry-based Program to Improve Oral Hygiene Indicators in Rural Pakistan—A Protocol

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Abstract

Aim: The primary aim of this research protocol is to secure funding to initiate a teledentistry pilot project in order to improve the oral hygiene conditions of the most vulnerable population of rural Sindh in Pakistan, through hands-on training of 1,000 lady health workers by dentists and community dentistry specialists of other colleges led by Jinnah Medical and Dental College.

Materials and methods: Training courses on digital health consultation would be given to participating healthcare workers. The trainees would be trained on all aspects of dental hygiene including precautions, tooth brushing techniques, and oral care. During the 2-day-long course, lady health workers will be taught various tooth brushing techniques, as well as basic instructions about oral hygiene and how to address queries of people regarding oral health. They will also get guidance about the various multimedia softwares in the phone and how to use them. The study would also include teledentistry consultation as a real-time patient learning tool for patients, healthcare workers, and trainees.

Results: Results will be made available when the trial has been completed in 2021. The program will be evaluated by assessing its usability, acceptability, knowledge, and satisfaction of users.

Conclusion: The protocol is designed to illustrate the underlying concept that a more reliable and robust model can be built through creating interactive communities of practice for consumers of telehealth in dental education. The Telehealth Skills Coaching and Delivery Initiative would incorporate and test a technically oriented paradigm of Internet-based medical education for vertically incorporated, community-based learning environments.

Clinical significance: Teledentistry has the ability to expand access to oral health care, increase the provision of oral health care, and decrease costs. In view of the immense advances made in this field, teledentistry can continue to promote specialized health care in the remotest corners of the world. Many countries have already embraced virtual health care (telemedicine) in the face of an increase in cases of COVID-19; however, teledentistry has yet to play its role in this pandemic by enhancing the accuracy and efficiency of dental treatment. In the case of LMICs such as Pakistan, which lack advanced technologies such as teledentistry within their national healthcare network, the COVID-19 pandemic is a challenge to introduce the requisite legislative changes to promote the widespread use of teledentistry.

Keywords: Dental caries, Oral hygiene, Teledentistry.

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Background

The Islamic Republic of Pakistan is a country in South Asia. It is the sixth most populous country in the world with a population exceeding 199 million people.[1] It is the 36th largest country in the world in terms of size with an area covering 796,095 km^2 (Table 1). Pakistan is bordered by Afghanistan, India, Iran, and China. Pakistan has a coastline stretching up to 1040 km.[2]

Pakistan Socioeconomic Profile

Pakistan is ranked at 145 out of 187 countries in human development according to the human development index report of 2011. The report ranks all criteria like gender, inequality, poverty, health, education, and security, all these factors are considered as keystones of human development. Pakistan's healthcare system is inadequately structured to deal with such a massive population. That is why basic treatment needs of the population remain unmet.[7] Only 2% of the total allocated budget is spent on health care.[8] Pakistan has a 70,000 strong lady health workers labor force who works at the community level, mostly in rural areas, and provides basic health services like child immunization, family planning advice, and community health services.

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Table 1: Key highlights about Pakistan (CIA. The World Factbook)

Population	*207,774,520 (2017 EST.)*[3]
Area	796,095 sq. km
Ethnic group	Punjabi, Sindhi, Hazara Seraki, Mohajir, Baloch, Pathan
Literacy rates	62.3%[4] Males 68.6%, females 40.3% (2018)
Workforce	Agriculture 21.6%, industry 24.9%, services 53.4%
GDP growth	1.9% (2019)[5]
Urban population	36% of the total population (2010)
Religion	98% Muslims 1% Hindus, Sikhs, and Christians
Per capita income	1357 (2019)[6]

Dental Situation

Periodontal disease is the most common dental disease in Pakistan and only 28% of 12-year-old children surveyed have healthy gingiva, almost 95% of the elderly population suffer from gingival bleeding or some form of periodontal disease.[9] Oral cancer rates are also very high in Pakistan due to the cultural use of betel nut, which is a key risk factor in the etiology of cancer. Tobacco use also remains very high, particularly in youth. One study found that 74% of all school-going children consume betel nut.[10] Lack of knowledge of oral hygiene and poor oral hygiene are major public health issues in Pakistan. Eight percentage of the population never cleans their teeth while only 36% of the population cleans their teeth every day. Pakistan lacks an official oral health policy, there is a public health policy that does not address oral health in any way.[11]

Considering the situation described above, we have decided to initiate a dental hygiene program for Pakistan focused on reducing the prevalence of dental diseases using mobile technology. As an initial setting, we have chosen the province of Sindh in Pakistan, with this budget, it is impossible to initiate a countrywide pilot. Sindh is the third largest province by size and second-largest province by population. According to the recent poverty index, Sindh is considered as the poorest and deprived province in terms of resources and poverty index.[12]

Overview of Teledentistry

Teledentistry is an innovative type of dentistry. Teledentistry is a branch of telemedicine that uses digital technologies and electronic communication networks to deliver healthcare services across large geographical locations.[13] Teledentistry has the potential to boost access to dental services and reduce treatment costs.[14] Teledentistry synchronizes mobile technology digital imaging, mobile technology, and the internet to create an interface where dental patients and professionals could communicate to communicate.Telemedicine-centric dental technologies (teledentistry) have been fully deployed as models for improving dental education and adherence to health care.[15] Teledentistry has proven especially successful in solving dental health problems in distant, far-flung, and rural locations where logistics and approaches to dentists and oral health specialists are constrained.[16] The global digital communication network and the internet have been the cornerstone of all teledentistry and telemedicine-based applications, offering knowledge exchange from one region of the world to another in near real-time. Most of the basic uses in teledentistry are dependent on the internet along with almost all remote consultations.[17] Different studies have demonstrated that video conferencing in dental professional education is suitable for long-distance dental learning.[18] Telemedicine cannot be defined as one distinct technology, but rather a constituent of a larger network of the global communication system. Telemedicine is considered to strengthen this chain and increases the reliability and safety of health services.[19] In the provision of Continuing Dental Education (CDE), teledentistry has also proved to be highly cost-effective and useful.[17] Teledentistry has proven its relevance to the increasing understanding of health care and technological skills. Dental professionals and undergrad dental students can save time and resources to travel through online teledentistry courses on the internet. Digital CDE offers multiple advantages over conventional on-site CDEs.[18] While examining the literature, it appeared that while a great deal of research has been undertaken on the scientific dimensions of teledentistry, the aspects dealing with patient privacy, confidentiality, copyright, and other legal issues have not been investigated and identified thoroughly. To date, there are no formal protocols and clearly established guidelines for the nascent technology known as teledentistry, while future work will provide the foundation for a well-defined standard procedure for teledentistry-based consultations.[14] One teledentistry study carried out over a span of 1 year in 2002 found that the cost-effectiveness of teledentistry would improve with increase in experience and technical know-how of the equipment.[20] The last two decades have witnessed a revolution in telecommunication technology and giant technological leaps in the industry. Intraoral cameras are available in most dental hospitals, and high-speed internet is almost always available at affordable rates in all developed countries. Video conferencing is very much part of everyday life as of 2020. Therefore, improvements in technology will enable broader use of teledentistry in general dental practice. To aid conceptualization of the use of teledentistry for the project's implementation and evaluation, this pilot study will enhance the oral hygiene standards of the most disadvantaged population of Sindh by educating 1,000 health staff.

Methodology

The protocol proposed a 3-month pilot study. The project has decided to train 1,000 lady health workers who are already working in rural Sindh for various health projects. At the outset, a 2-day training program will be organized in which the lady health workers will be given an overview of dental hygiene and how to impart the knowledge they have learned to the wider community. All lady health workers are generally well versed in mobile technology as they are educated so using a mobile phone will not be a problem. The area has no persistent issues of electricity breakdown either. During the 2-day-long course, lady health workers will be taught various tooth brushing techniques as well as basic instructions about oral hygiene and how to address queries of people regarding oral health. They will also get guidance about the various multimedia softwares in the phone and how to use them. The trainees will be given hands-on instruction on how to use the mobile device in half-day training session, if required. The session would include hands-on instruction on how to use key features of the mobile including multimedia, texting, camera, preinstalled medical softwares, and other essential features. They will also get instructions on how to receive and make calls/SMS messages. The trainees would be trained on all aspects of dental hygiene including precautions, tooth brushing techniques and oral care. Before

distributing the cell phone to the trainees, multimedia material containing videos and PowerPoint presentation documents would be added to the phone with didactic material related to dental hygiene, its treatment and prevention. The training program will consist of a set of "hygiene modules," simulating interactive cases that were adapted to the mobile device. The case series involved several topic areas, the most common being tooth brushing techniques, flossing, and dental hygiene. The team would be provided with basic dental examination instruments along with gloves and masks. The authors have officially written to the Government of Sindh requesting authorization to begin the pilot study in October 2020. The research team is awaiting a response from the Government of Sindh. Officials in the Sindh Government have told the authors that the response and authorization will take time due to the Covid-19 Pandemic and immediate priorities of the Government of Sindh.

Key Software

The dental research team has decided to preinstall two key softwares in all the mobile units which we will be distributing to the health care workers. These softwares will serve as another powerful tool that the lady health workers can access without even connecting to the internet. After careful considerations and research, the two softwares that we decided to preinstall on the smartphones are **Medscape mobile**, which is a free and most comprehensive guide for healthcare professionals. The application is available on all platforms and serves as a complete database of almost every medical condition and treatment option. The other application we have decided to install is the **dental suite general practice** (DDS-GP), this is another powerful free tool and the most powerful chairside application for patient education.[21] The application provides thorough information regarding hundreds of dental conditions and their treatments. It is hoped that both these applications coupled with direct support from a dental specialist (whenever required), 2-day training of various oral hygiene scenarios and didactic material will be useful for the lady health workers to build their own capacity and impart the knowledge they have gained for the wellbeing of the wider community.

Training on Screening of Critical Oral Health Diseases

Lady dental healthcare workers will be trained in detecting dental caries and filling the world health organization dental hygiene form. This data collection will be extremely useful not only for future research but also for early detection of dental caries and childhood rampant caries. The officers will also be instructed to give nutrition advice to the community which would include decreasing consumption of sugars and fermentable carbohydrates which are the leading causes of dental caries.[22,23] The healthcare workers will be able to send real-time pictures of the oral cavity to the dental hospital if they have many doubts and will receive feedback to answer their queries. The clinical pictures will also serve as a database for future research along with the clinical findings recorded in the World Health Organization (WHO) oral assessment form. If any doubts exist, they will have access to caries diagnostic tools on their phones and also access to the internet in certain situations.

Other clinical scenarios would also be presented in front of the trainees through various methods including multimedia files and PowerPoint presentations. The trainees would be tested at the end of the training session through SMS-based multiple choice answers on the material they studied that week. A survey questionnaire would be given to each trainee at the midpoint to assess satisfaction and learning outcomes. The feedback would be important in creating a strategy to improve the program. The project will use frontline SMS, which would make it easy to transmit SMS to multiple trainees at once and would also help in data gathering and analysis at the end. Frontline SMS would be connected to the internet at the main hospital making it easier to collect and gather the patient data being submitted by the trainees from various stations. The project will interact with local telephone service companies and disease details should be stored on the central portal in all studies. The details submitted to the server would be stored automatically in a database and tested for anomalies. From the server, data will be transmitted to district health offices as well as research stakeholders, e.g., research institutes and/or served as a data information tool for decision making at the governmental level.

Didactic Content Tailored for Mobile Devices

The research team would create content tailored for mobile phones to disseminate information regarding oral hygiene practices and the prevention of dental diseases.

- Assessment of teaching didactic teaching material available—e.g. creative commons, open license, open content, Wikipedia, etc. and evaluate possibilities of integration into our teaching material.
- Creation of relevant digitalized dental teaching material and uploading microcontent on the phone in various formats (EPUB, PDF).
- Cloud dropbox service would be created for microcontent creation and sharing of ideas between various experts and also the trainees. The dropbox service will be a place to share ideas, content, questions, and recommendations. The cloud will also contain guidelines on how to use various mobile softwares like EPUB, E-Reader, PDF, frontline and will serve as a central database for integration and collaboration.
- The teaching material will be translated into the local Urdu language to make the content more relevant, web-based translators will be used for the purpose.

Device and Technical Overview of the Project

The mobile device we have selected is the Lenovo K3 note due to its affordable price of 145 USD per phone as well the phone specification, durability, and battery time. We have selected the android platform as it is considered more open platform and repair is more universal and cheap.

We would be using the android platform for the cell phone and the mobile phone Lenova which operates on the android is a midrange model costing $ 145 a unit and the team will purchase 1,000 such units which will be distributed to the trainees. The model has all the configurations required for this process including SMS, multimedia, word processing, Bluetooth, and Wi-Fi. According to android authority, the K3 is a powerful device with high-level functionality and battery life is better than average devices.[24] The device is equipped with all the functionalities needed for this project; the Wi-Fi and 3G technologies mean that the healthcare workers will be able to benefit from various sources of information. Lenovo K3 note has 5.5 inches screen which is useful for the purpose of displaying material to families during door to door visits. Bluetooth technology is also important as Bluetooth can be used to transfer data from remote health monitoring devices like pulse oximeters, glucose monitors, heart rate monitors, asthma

Table 2: Budget allocation

Item	*Cost*
1,000 Lenova mobile phones	$ 145,000
1,000 data packages for 3 months	$ 15,000
Lunch coupons for 3 months	$ 60,000
Printing	$ 2,000
Total cost	222,000

inhalers, etc., which can be used both at home and at the hospital.[25] GPS options available on the phone will help the unit track the position of the trainers and any possible emergencies. Geotagged photographs will also help identify areas that require special attention. 1,000 units of Lenovo could cost USD 145000, well within the budget of the project (Table 2).

Mobile Phone Service

The mobile phone will come with a preloaded sim card with 1000 minutes talk time, unlimited SMS, and 1 GB 3G connection. Such a connection costs USD 5 per month per connection in Pakistan, so for 1,000 connections, the total cost would be USD 5000 per month and 15000 for the 3-month project.[26] The service would be used for communication as well as transferring new material.

Implementation

The main aim of the project is to empower people in the community to protect their communities regarding their oral health. The results of the project will be evaluated by outpatient records from various dental stations. Incidence of caries from gum diseases can be a good indicator to assess how effective our program has been in imparting training. Oral cancer rates can be examined if the study becomes a long-term project. We will encourage the trainees to pass on the dental hygiene skills they have gained to other people in the community. Our lady health trainers would be able to play audio–visual teaching material. The device will be preinstalled with a **VLC** player which is a cross-platform popular player and can play subtitles as well.[27] Android-based presentation software called **PowerPoint keynote remote** would be installed in the device which can connect to PCs and TV sets via Bluetooth, in case when there is a large presentation to be given by the healthcare workers in schools or dental camps.[28] This will be useful for giving presentations connecting the phone via Bluetooth with a TV set or a computer.[29] Going door to door, the lady health workers will not only be able to demonstrate tooth brushing techniques but also make it interactive by playing videos with subtitles, this would be very stimulating particularly to kids. A survey questionnaire will be first given to the people we have trained to assess satisfaction and feedback on the tutorial quality and skills gained. As we wouldn't have the resources or the time to monitor each person taught by our trainers individually, it is best to focus on the training we impart to our trainers and make sure that they understand the instructions completely so that they are able to transfer their knowledge to other people. The results of the questionnaire will also be key to understand how effective our intervention has been. The health workers will also be provided with custom-made oral hygiene charts with colorful graphics displaying the importance of oral hygiene and brushing techniques in a playful way particularly for the kids. We will be providing lunch coupons to all health workers in the field. The average price of a good meal in rural areas is less than one dollar. We have calculated that for a period of 3 months that would cost us USD 60,000, but this is an important incentive for the health workers not only to build capacity but also to get a free meal, which would increase their savings.

Caries Screening

Dental caries are the most common childhood disease in the world, it is five times more prevalent than childhood asthma.[30] Oral diseases can be easily detected by regular screening and early detection is the key to halting the disease or preventing it completely. Caries and other oral diseases are much less expensive to screen and prevent than to treat.[22] That is why our team of lady health workers will screen children and adults for dental disease and note down the findings in the WHO screening form which we would supply them with. The results can be used for research and future dental hygiene campaigns in the region with various stakeholders.

Screening of Oral Cancer

Oral cancer is the sixth most common cancer in the developed world and causes over 9,000 deaths in the USA alone. Oral cancer is a preventable disease, and alcohol and tobacco are primary risk factors. In South Asia, the practice of betel nut chewing is the most common risk factor leading to oral cancer. The use of Oral cancer goes back centuries in South Asia.[23] Studies from Pakistan, India and China consistently showed that chewing of areca nut was the major etiological factor for Oral Leukoplakia and Oral submucous fibrosis.[31] In a large cohort study in India, it was observed that the incidence of leucoplakia fell significantly after concentrated health education projects on the hazards of smoking and chewing areca.[32] Oral cancer detection is visual and tactile and the need for early detection cannot be stressed more. If detected, early chances of survival increase. Oral cancer has a mortality rate of 50%. Prevention is another key, trainers will be instructed and trained in motivating people to quit smoking and betel nut chewing. Betel net chewing, smoking, and alcohol consumption have a synergistic effect on the development of oral cancer.[33] The health professionals would have the opportunity to send the images of the oral cavity where the suspect oral cancer directly to a maxillofacial surgeon for confirmation of the diagnosis.

Drug Prescription and Referral

In case that our lady health workers find that any person examined requires immediate dental and medical attention, they would send clinical pictures of the patient to the dental specialist at the main hospitals. Immediate attention would be warranted in case of extreme pain, pus formation, and suspicion of oral cancer. If the specialist is convinced that the patient requires immediate hospitalization or treatment, the patient would be referred to the nearest dental facility. When the patient requires pain relief, the lady health workers in consultation with the dental specialist would be able to prescribe pain killers and antibiotic treatment.

SMS-based Oral Hygiene Reminders

While recording patient data, the oral hygiene workers will record the contact details of each family. Most people in Pakistan now own a cell phone, as we have an unlimited SMS plan, we would use it to send daily reminders of simple oral hygiene instructions like brushing teeth to each family. Each health worker will be asked to send custom-based Urdu language oral hygiene reminders to the community. Frontline SMS would be an ideal tool for sending these messages and the data will be recorded. The SMS messages

could serve as a powerful tool of reinforcing positive behavior some previous studies have shown.[34]

Collaboration with Other Partners

The research team will make active efforts to engage local dental associations, village elders, town level administrations, NGOs, and civil society in order to make the oral health project a success as the long-term success of these mobile health programs depends on collaboration and support of local programs. There are a few examples mainly from the United States where a local dental community program with the help of community members has not only been successful but also brought the caries rate in children down.[35] Field healthcare workers, village elders, religious clerics (moderate), teachers, and alternative medicine practitioners will all be approached and encouraged to be part of the dental program.

Evaluation of the Project

The program will be evaluated based on multiple outcomes. The first and foremost is the feedback from the lady health workers we trained. As mentioned previously throughout the process, we would receive feedback from the health workers on their satisfaction levels and skill learned. At the end of the pilot study, a final questionnaire on the outcomes and skills will be administered which would be helpful in ascertaining satisfaction and capacity building of our project. Capacity building is crucial as the area lacks trained dentists and these workers can fill in some of the jobs that traditional dentists do meanwhile also increasing their skill repertoire and earning potential. The advantage of selecting people from the community is the fact that they understand the community and demography better than anyone else.

The second demographic factor that will determine the outcome of the project is the people of the community. The incidence of dental caries and oral cancer over the period of the next year collected from the outpatients can be used to evaluate the success of the project.[36] Previous studies have shown that these interventions are successful. Involvement of the community is crucial and no program can be successful without the participation of the community. Some of the goals of the project is to strengthen cooperation between government and nongovernmental organizations operating in the disadvantaged areas of the country. In rural areas where services and dental personnel are limited, teledentistry-based initiatives will alleviate the issue and offer dental treatment to isolated communities at an affordable cost.[37] Teledentistry can be a very powerful tool for providing ongoing dental education to dental workers. Given the expense of conventional continuing education services like (travel, accommodation, and food) telehealth-based continuing education services have many benefits over standard continuing education programs.[38] The role of digital technologies in continuing dental education is important, electronic video conferencing, and web-based online training courses are transforming the landscape of distant learning.[39]

Cost Effectiveness

Reduced costs and better resource utilizations are regarded as the keystones of any successful teledentistry project.Dental treatment is highly expensive, that is why poorer segments continue to ignore oral diseases, particularly in poor countries. One of the key aims of the pilot study and the subsequent project is to prevent dental diseases in the community as it is much cheaper to prevent dental diseases than to treat them.

Results

If the project yields positive results, it would be possible to collaborate with government and nongovernmental agencies and create a nationwide dental hygiene program that will cover the whole country and would provide wider coverage. The continuation of the project depends on the success of the pilot project. Smartphones connected to the Internet are excellent for downloading and uploading data and can change the face of health care if employed properly.[40,41]

Conclusion

Integration of technology-based interventions into the healthcare system of countries like Pakistan remains a challenge. The biggest challenge remains awareness and lack of support from policymakers and key stakeholders. A pilot study like the one we envision could be a very useful beginning to the process of integrating telemedicine/dentistry into the local healthcare ecosystem. The current protocol has identified the technology, organizational structure, and sociocultural profile of Pakistan in order towards the pilot stage of the study.

Lady health professionals trained in teledentistry-based procedures have the potential to make a huge contribution towards healthcare delivery in rural areas as they evolve from the training stage to future health advocates. Challenges affecting the distribution of patient services and healthcare services can be solved by telehealth-based programs such as this teledentistry-based proposed project. It is imperative that lady healthcare workers are equipped with knowledge of teledentistry and hands-on skills so that they can be an innovative force for advancement in teledentistry initiatives.

Authors Contributions

All the authors are involved in the conceptualization and write-up of the protocol.

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