A conceptual framework for oral rehabilitation – Decision Support System

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Abstract

Dental care and periodontal diseases are considered to be one of the global burdens of diseases. Over the past three decades in India, oral diseases/conditions have reportedly affected almost 600 million people. Despite the scale of these problems, only 12.4% of adults have ever got their oral cavity examined by a dentist according to the draft National Oral Health Policy 2018 notes. Due to the pandemic attack of the corona virus 2019 disease, it has been observed that patients seeking dental treatment were not able to get the services on time by the dental practitioner, which has now caused a huge burden on the Indian health system. Therefore, to evaluate the use of an interactive two-way mobile-based personalised human-centred application for facilitating the delivery of personalised oral care for patients, we designed a conceptual framework for providing oral rehabilitation services for patients. This system is equally important for such cases where it is considered to provide a wide range of treatments to patients, dental aesthetic, awareness, support, health monitoring and online consultations. Such a system will play a vital role in changing a person's appearance and improving their self-esteem. However, the acceptance of this system will be evaluated using a questionnaire-based Likert-type scale assessing the System Usability Scale testing. With the introduction to the proposed system into practice, the Personalised Human Centred Oral Rehabilitation – Decision Support System can bridge the operational gaps by training healthcare professionals such as dental practitioners, dental technicians, nutritionist, patients, frontline workers (Accredited Social Health Activist and Anganwadi workers) and choosing the right technology platform to avail the dental services post-treatment as a prophylaxis rehabilitation tool. This can also result in improved community health with diversity in Indian settings for remote diagnosis and early management of dental diseases/conditions through electronic communication.

Keywords: Decision support system, oral rehabilitation, periodontitis, SUS, teledentistry.

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1. Introduction

Dental care and periodontal diseases are considered to be one of the global burdens of diseases. The severity and distribution of oral diseases range across different geographies which include dental caries, periodontal diseases, malocclusion, or facial anomalies, dental fluorosis, loss of teeth, temporomandibular joint disorders, dental trauma and, the most prevalent in developing countries, oral cancers that have affected more than half of the population globally, including India (Dental public health—Why is it important in India?, n. d.). Dental caries, on the other hand, occurs in 60%–90% of school children and a vast majority of adults as reported by the World Health Organisation (WHO) (WHO, n. d.). Social behavioural and environmental factors have also been reported to be evident in many epidemiological surveys (Hernandez, Blazer & Institute of Medicine (US) Committee on Assessing Interactions among Social, Behavioural and Genetic Factors in Health, 2006).

Over the past three decades in India, oral diseases/conditions have reportedly affected almost 600 million (49.2% in comparison to 400 million; 50.2%) people in 2017. Different oral conditions, such as untreated caries of permanent and deciduous teeth and severe periodontitis, have a significant burden affecting 403 million (32%), 101 million (8.3%) and 108 million (13.3%) people in India. Despite the scale of these problems, only 12.4% of the adults have ever got their oral cavity examined by a dentist according to the draft National Oral Health Policy 2018 notes(Dental public health—Why is it important in India?, n. d.).

Looking to a global pandemic attack of the corona virus disease 2019 (COVID-19), it has been observed that patients seeking dental treatment were not able to get the services on time by the dental practitioner, which has now caused a huge burden on the Indian health system. Oral rehabilitation is equally important for such cases, where it is considered to provide a wide range of treatments to patients. Therefore, dental aesthetic and ethical practices play a vital role in changing a person's appearance and improving their self-esteem.

Over the last decades, there is a shift in the use of technology in the field of dentistry where most of the manual tasks have been converted into computer-assisted concepts and digital technologies. The digital technologies as a form of population health informatics have emerged within the field of oral rehabilitation that has been described in more or less comprehensive review articles (Beuer, Schweiger & Edelhoff, 2008; Bidra, Taylor& Agar, 2013; Maruyama, Nakamura, Hayashi& Kato, 2006; Neumeier & Neumeier, 2016; Rekow, 1987; Steinmassl et al., 2017; Van Noort, 2012).Dentists have continuously implemented innovations with the aspiration to provide safer, timely and cost-effective care with less inconvenience and more predictable diagnoses and treatment outcomes.

Digital dentistry has been applied to simplify oral rehabilitation procedures. However, it could help to keep a track of dental health monitoring in underserved settings, especially in rural parts in India. Since the greatest burden of all diseases is on the disadvantaged and socially marginalised counterparts, therefore, a major benefit of the common risk factor approach is the focus on improving health conditions for the whole population as well as for high-risk groups, thereby reducing inequities. Even the WHO's Global Strategy for the prevention and control of non-communicable diseases is a new approach to managing the prevention and control of oral diseases (WHO, n. d.). With this view, to bridge the gaps between the healthcare seeker and healthcare providers, we developed a draft conceptual framework with the help of dental informatics that will help to manage the dental problems remotely. This framework aims to help patients adhere to a virtual oral rehabilitation programme to improve their oral health and reduce the chances of clinical re-visits due to recurrent oral and dental problems during the COVID-19 pandemic.

2. Objectives

2.1. Primary objective

To evaluate the use of an interactive two-way mobile-based personalised human-centred application for facilitating the delivery of personalised oral care for patients.

2.2. Secondary objectives

1. To examine and compare the factors that influence regaining strength among oral patients in rural settings of India.

2. To identify the necessary components of the Personalised Human-Centred Oral Rehabilitation Decision Support System (PHCOR-DSS) that can gather, analyse and provide individualised practices feedback by preventing the condition from getting worse.

3. To improve oral health and recover from dental conditions, other forms of dental diseases or surgery to treat oral and dental disease, there by reducing the risk of future dental problems and improving quality of life.

4. To compare the effectiveness of the PHCOR-DSS to other paper-based methods of oral rehabilitation for documenting intervention among dental patient.

3. A conceptual framework for OR-DSS

This conceptual framework is based on the Precede-Proceed model used to design a causal relationship between various factors and oral health, thereby leading to the overall quality of life (Application of the Precede-Proceed planning model in designing an oral health strategy, n. d.; Binkley & Johnson, 2013; Dimitropoulos et al., 2018). The precede component gives an idea of workingretrospectively from the ultimate goal of the health outcome (quality of life) to create a blueprint to guide the formation of the new innovative interventions through informatics (Figure1).
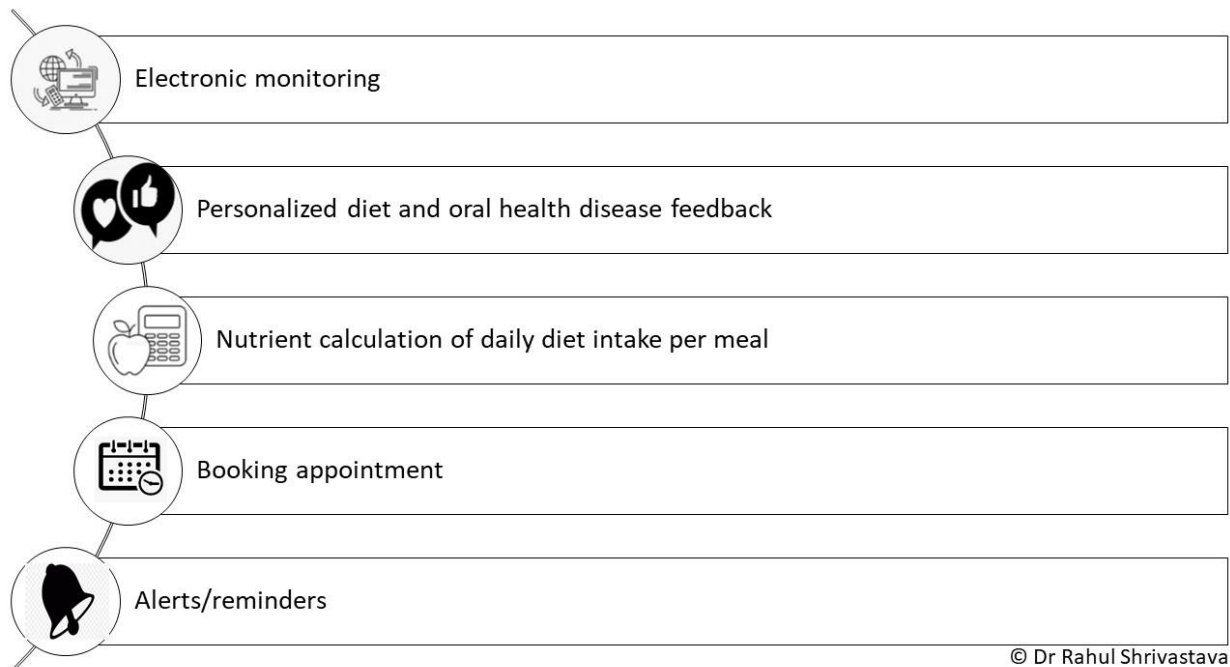
To understand this concept better, we designed a system, integrating information technology into dental health, to track various changes in the oral condition post-treatment to certain diseases with co morbidities like diabetes and hypertension. This will record their daily dietary intake, preventive measure for maintaining their dental health, health promotion activities and oral hygiene practices by using a telephone linked to PHCOR-DSS, and will also receive personalised feedback/support and reminders via SMS. This mobile web-based platform will help in designing a tailored dietary and health education and counselling to dental patients. The respondents will then be able to access their oral health records either through their computers or mobile-linked services, depending on the technology accessible platform available to them. Such a system will also generate automatic alerts that will serve as reminders to the patients who have not reported their oral hygiene practices based on a daily planner.
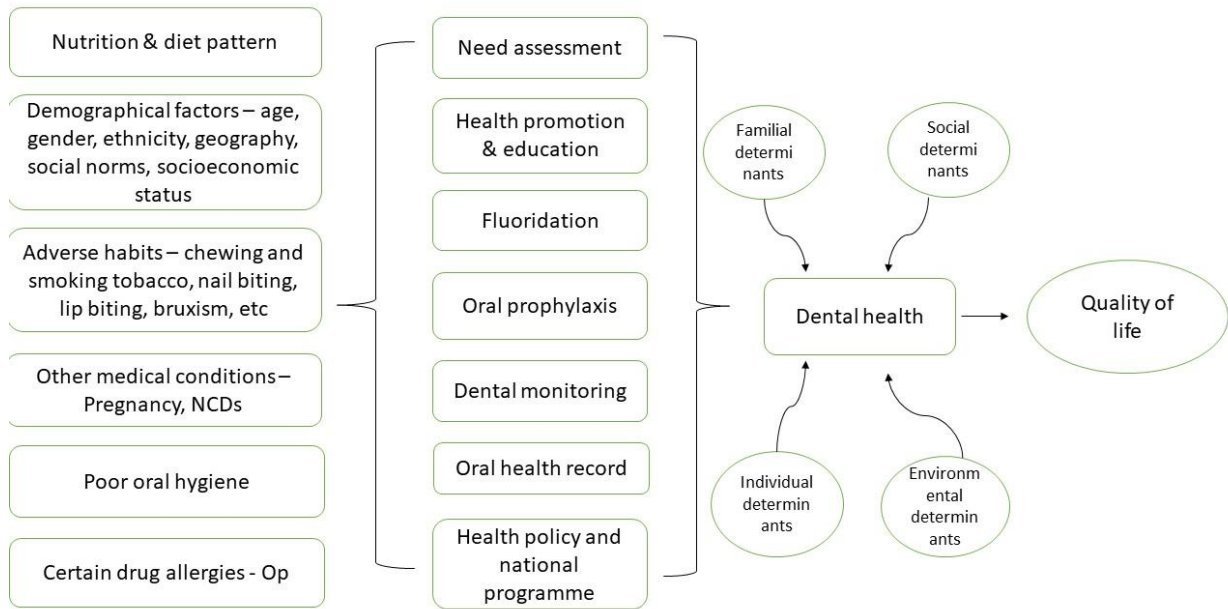
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Figure 1*.* Procede-*Proceed* model for oral rehabilitation

Based on the principle of a human-centred approach, this system can help to build and promise a quality and timely approach to real-time tracking of oral records of patients. This comprises the components shown in Figure2.

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Figure 2*.* Components of *the* PHCOR-DSS

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Such a system can easily be installed on mobile phones, personal digital assistants and computers depending on the technology platform available to users across various Indian settings. Oral health information from prospective users can be gathered daily through informed consent and education about other, more conservative, therapies. A multilingual message library, in English, Hindi and Marathi –the local dialect – should be prepared so that individuals can be sent weekly messages on how best to manage their oral health. The system will also receive auto-generated reminders/alerts if their oral health information is not received as scheduled. However, qualified specialists or experienced general dental practitioners are capable of treating all levels of oral rehabilitation and completion of courses as specific commercial institutes will not be required.

4. Component of the system/app

- Socio-demographics –Baseline data were gathered on study participants' age, income levels, employment status, education level, smoking status, alcohol consumption and nutritional assessment. Information was collected on computer usage, frequency of usage, internet usage and sources of health information.

- Health literacy –Health literacy is defined as the ability to carry out basic reading and numerical tasks required to function in the healthcare environment. Health literacy can be assessed using a three-item health literacy screening questionnaire having inadequate, marginal or adequate health literacy (Bertakis, n. d.; Frost, Thompson& Thiemann, n. d.; Schuitevoerder, Fortino & Vetto, 2017). The questions included:

  1. How often do you have someone (like a family member, friend, hospital/clinic worker or caregiver) help you read healthcare materials?

  2. How often do you have problems learning about your medical and dental condition because of difficulty understanding written information? (Reading problems)

  3. How confident are you filling out forms by yourself? (Confidence with forms)

Responses were rated on a Likert scale ranging from 0 to 4 and include the options: all of the time, most of the time, some of the time, a little of the time or none of the time (Schuitevoerder et al., 2017).

- Anthropometry – Height, weight and waist circumference were measured using a standard technique (Sanchez-Garciaet al., 2007). Body mass index was then computed from the height and weight measurements.

- Medical and dental evaluation –Initial evaluation can be carried out for physical abilities, medical limitations and other conditions, like mental health, that dental patient may experience. Ongoing evaluations will help the dental experts to keep a track on progress over time. This will assess the risk factors for any complications like dental caries, gingivitis, periodontitis, cancerous lesions, missing/fracture teeth, etc. Based on individual need, a tailor-made oral rehabilitation programme can be designed to meet the patient's need making it safe and more effective.

- Preventive activity –Oral rehabilitation will definitely improve their dental fitness through the introduction of preventive measures in their daily planner. All participants will need to complete preventive tasks assigned to each user by the dentist for maintaining their dental health as a prophylaxis measures in order to calculate the total time they spent doing various forms of activities, like brushing, flossing, mouth wash, orofacial exercises, etc.

- Lifestyle education – Healthcare professionals can make sure individual participants receive support and education on making healthy lifestyle changes, such as eating a healthy diet, maintaining oral hygiene regularly, maintaining a healthy weight and quitting smoking and other tobacco substances. This will also include managing the conditions of hypertension, diabetes and high cholesterol.

- Booking appointment –To ease a long waiting period and travel time, this system can facilitate to book an early appointment before visiting the dental clinic.

- Support –A counselling session can facilitate to learn healthy ways to cope with depression and other feelings while adjusting to a serious dental problem which often takes time. This will include vocational and occupational therapies to teach new skills to help the patient return to their work.

5. Systemusability testing

To develop and implement such a system on a larger scale, system usability has to be tested based on the System Usability Scale (SUS) scores (Brooke, 1996).The SUS is an inexpensive, yet effective tool for assessing the usability of a product, including websites, cell phones, interactive voice response systems, TV applications and more. It provides an easy-to-understand score from 0 (negative) to 100 (positive) (Determining What Individual SUS Scores Mean: Adding an Adjective Rating ScaleJUS, n.d.). As an enduser, one can report the feature with the feasibility of the system with the following questionnaire (Figure3) to assess its usability using the Likert scale, including rating their likelihood to use such system from 0 (low) to 5 (high). These scores help to comply with the standards of matching the acceptability of the system into their practice.

1. I think that I would like to use this system frequently.
2. I found the system unnecessarily complex.
3. I thought the system was easy to use.
4. I think that I would need the support of a technical person to be able to use this system.
5. I found the various functions in this system were well integrated.
6. I thought there was too much inconsistency in this system.
7. I would imagine that most people would learn to use this system very quickly.
8. I found the system very cumbersome to use.
9. I felt very confident using the system.
10. I needed to learn a lot of things before I could get going with this system.

Source: Usability..gov

Figure 3. SUS questionnaire for system usability testing

The SUS scores from 0 to 100, with ratings of greater than 68, were generally considered to demonstrate the acceptable usability. This usability can be assessed on additional information such as feedback, physical activities, nutritional diet, educational material, preventive measures, support system, learnability, any technical skill required to operate the system, teledentistry services, etc.

5.1. Data management and quality assurance

Oral health data of users can be exchanged based on HL7 and HIPAA standards using the harmonisation process to protect the privacy of participant's health information and to provide the security for a health IT process. Collected health information data should have features like interoperability in order to use the patient's data on different formats for analysis and future scope.

5.2. Health outcomes

The following health outcomes can be expected from such a system:

- Oral health knowledge scale: It assesses the relationship between diet and dental disease with nutrient content (e.g., fat, fibre, calcium, calorie and sodium), physical activity and preventive measures to maintain good oral health.

- Oral health attitude scale: It assesses the care about nutrition, diet, preventive care, physical activity based on a 5-point Likert scale: 'strongly disagree', 'disagree', 'neutral', 'agree' and 'strongly agree'.

- Oral health behaviour scale: It assesses the oral hygiene practices and care about nutrition and types of the physical workout (orofacial) based on a 5-point Likert scale: 'never', 'seldom', 'sometimes', 'often' and 'always',

- Satisfaction with dental care: This can be measured using the Client Satisfaction Questionnaire using a 4-point Likert scale.

- Blood pressure and diabetes testing: We can also assess the user's blood pressure and diabetes levels to assess the pattern of the systolic and diastolic blood pressure along with diabetes control.

6. Conclusion

Th nationwide lockdown due to the COVID-19 pandemic brought telemedicine to the forefront as governments urge the general public to use approved telemedicine facilities to seek treatment for mild symptoms instead of going to a hospital and risking the exposure. The biggest challenge of adoption of telemedicine is the lack of awareness of the power of health information system. However, awareness among people is now increasing as the Indian government and healthcare providers are disseminating this information and encouraging them to utilise the telemedicine services as a forefront. With the introduction to the proposed system into practice, the PHCOR-DSS can bridge the operational gaps, including training healthcare professionals, such as dental practitioners, dental technicians, nutritionist, patients, frontline workers (Accredited Social Health Activist and Anganwadi workers) and choosing the right technology platform to avail the dental services post-treatment as a prophylaxis rehabilitation tool. This can result also in improved community health with diversity in Indian settings for remote diagnosis and early management of dental diseases/conditions through electronic communication.

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Author' Contribution

The corresponding author designed the concept of the paper with a conceptual framework. The co-authors contributed to designing the system with usability testing to assess the feasibility with a larger group.

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