

The use of teledentistry and Artificial Intelligence (AI) in dental and oral health services for the elderly in the era of the covid-19 pandemic: A systematic review



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Abstract

Objective: This paper aims to determine the use of teledentistry and AI in the elderly to maintain the health of their oral cavity and teeth during the COVID-19 pandemic.

Methods: Technology in dentistry today is developing very rapidly, improving the quality of dental and oral health services. During the pandemic, the elderly has concerns about Covid-19 contamination when they have to see a dentist. Their situation has led to discussions and efforts to use teledentistry and Artificial intelligence to facilitate services and care for the elderly during the pandemic.

Results: Teledentistry is used as a medium for consultation, diagnosis,

referral system, treatment, and follow-up. While Artificial Intelligence (AI) has been used in diagnostic, patient data management, restoration, and CAD/CAM-based denture manufacture, detecting periodontal disease, and dental radiology.

Conclusion: Teledentistry and AI can be a promising alternative in dental and oral health services to reduce anxiety and fear of contamination with Covid-19. The technologies make it easier for health workers, especially dentists, to maintain and improve the quality of life of the elderly during the pandemic.

Keywords: Artificial Intelligence (AI), Covid-19, Dental Practice, Ora Health, Teledentistry
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Introduction

Advances in science and technology play an essential role in improving health services, especially dental and oral health. Common dental and oral health problems in the elderly are dental caries or cavities, periodontal disease, and tooth loss. Generally, aging is associated with several physical changes, making individuals more susceptible to chronic diseases. These changes can also be observed in the oral cavity and manifest as tooth structure damage (caries), the onset of periodontal disease. Such a pathological state requires professional treatment from a dentist.^{1,2}

In recent years, there has been a COVID-19 pandemic. According to a report from the World Health Organization (World Health Organization), elderly patients have an increased risk of severe illness and death if infected with Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). The elderly with multiple comorbidities has been identified as the highest risk group for the fatal clinical outcome of Coronavirus Disease 2019 (COVID-19). Therefore, prevention of transmission from the individual, family, and community levels is crucial.³

Due to the widespread of SARS-CoV-2, healthcare

providers are at increased risk of transmitting infection and becoming potential carriers of the disease. According to the Occupational Safety and Health Administration, dental health workers (Dental Health Care) is placed in a category with a very high risk of exposure, considering that the dentist's work area is located in the patient's oral cavity. This route of transmission of the virus has significant involvement in dental practice. Aerosols and droplets produced in many dental procedures can facilitate the spread of infection.

The use of technology is one of the keys to simplifying, shortening, and streamlining dentists' working time. The choice of using technology wisely today is the right choice, especially for the elderly. Teledentistry and Artificial Intelligence (AI) are two descriptions of the use of digital technology related to network-based computerization, digital information sharing, remote consultation, examination, and health analysis. The convenience of using this technology can be applied better, especially in the era of the COVID-19 pandemic. In this literature study, we want to discuss how AI and teledentistry are used in the dental field, especially in the elderly, to prevent the spread of COVID-19.⁴

Methods

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Dental Problems in Elderly Associated with the COVID-19 pandemic

The elderly is a very vulnerable population and at high risk of being exposed to the COVID-19 virus, limiting, and making it difficult for the elderly to access dental and oral health services. The risk of death is very clear from infection with SARS-CoV-2. The majority of the elderly have chronic and comorbid diseases at much greater risk than the general population, with more than 80% of COVID-19-related deaths occurring in those aged 65 years and over. In addition, the comorbidities such as diabetes, cardiovascular disease (CVD), and chronic kidney disease, some of the critical risk factors in SARS-CoV-2 infection. The drugs commonly prescribed for hypertension and CVD: angiotensin-converting enzyme-2 inhibitors and angiotensin receptor blockers, can upregulate ACE-2 receptors located widely in the body, including the heart, lungs, and lungs. And digestive system. The SARS-CoV-2 virus uses the ACE-2 receptor to attach to cell surfaces and enter the lower respiratory tract. Patients using these drugs are at a higher risk for COVID-19 infection and possibly exacerbating their illness.⁵

Dental and oral health problems that commonly occur in the elderly are dental caries or cavities, periodontal disease, and tooth loss. Generally, aging is associated with several physical changes, making the elderly more susceptible to chronic diseases. These changes can also be observed in the oral cavity. They can manifest as tooth structure damage such as caries, tooth loss, dry mouth/xerostomia, and periodontal disease onset. Such a pathological condition requires professional treatment from a dentist. Lack of maintaining dental hygiene ease bacteria to get access to the oral cavity. It results in common health problems such as heart disease and other diseases. Infections in the oral cavity in the elderly can harm the health and quality of life of the elderly.^{2,3}

Based on one of the previous studies during the Covid-19 pandemic in Brazil, the highest dental care for the elderly included restorative and prosthetic treatment followed by periodontal, oral surgery, and endodontic treatment. This study was conducted on the elderly aged 60 years or more who have internet access which involved approximately 705 elderlies. Based on the literature study during the pandemic, it was found that the adult population showed an increasing prevalence of periapical lesions and oral infections while prioritizing the management of emergency cases such as tooth pain, fractured fillings, or dental trauma.

In developing countries, dental and oral health conditions in the elderly are classified as poor, characterized by dental caries, periodontal disease, tooth loss, high need for dental prostheses, need for replacement of restorations, easy tooth fracture, or the need for other dental procedures. To avoid deteriorating clinical conditions or triggering inflammatory or infectious processes, the elderly decide to carry out dental procedures during the pandemic.⁶

During a visit to the dentist, it is ideal for the elderly to have a unique companion, immediately served by the dentist, even, if necessary, without waiting in the waiting room. One study explained that during the COVID-19 pandemic, the elderlies were even advised to limit the number of visits to the dental clinic. Likewise, dental service providers limit the number of people in the waiting room, maintain a distance between patients, wait outside or in vehicles, limit introductions, and even make special arrangements according to restrictions.

The thing that is taken into consideration in elderly visits to the dentist is that they need assistance. Sometimes, it is based on the level of need and the presence of patient comorbidities. These considerations confirm that paramedics can adjust the schedule based on the safety protocol for elderly patients. This, of course, poses a challenge for dentists to anticipate the treatment that will be carried out related to the elderly during the Covid-19 pandemic.

The fear of the elderly to visit the dentist during the covid-19 pandemic.

Most of the elderly population are not afraid of being contaminated with Covid-19 at the dentist's practice. Still, the majority agree that visiting will experience a moderate level of high risk of contamination. The pattern of prevention has also been applied in such a way by dentists by adopting health protocols to prevent virus contamination, which is very important given the high risk of complications of SARS-CoV-2 in the elderly. The elderly may feel safe with the precautions taken by the dentist, and because of the need for treatment, many will put aside their fear of getting dental problems resolved, even assuming the risk of infection during this period.^{7,8}

The elderly population who has concerns about Covid-19 contamination at the dentist tends to be higher. This is due to the increasing number of elderly cases contaminated with Covid-19 and the low level of education affecting the fear of being infected at the dentist. As people get older and

have a low level of education, they can have adverse psychological effects such as anxiety, stress, fear, and panic during a pandemic. changes from time to time, especially in densely populated areas, the elderly are affected by feeling anxious and feeling that they are a population that is very vulnerable to disease transmission.^{9,10}

Along with the mutation of the Covid-19 virus and its widespread transmission, it has sparked discussions and updates on various platforms, both among the government and scientists trying to find solutions to improve the quality of dental health services for all age groups, especially those susceptible to contamination such as the elderly. Cutting-edge technology such as teledentistry and AI in handling non-emergency cases in dentistry is considered very helpful for the elderly during this pandemic period.

The use of teledentistry and AI technology in dentistry as an alternative treatment during the COVID-19 pandemic

The term teledentistry was first used in 1997. It can be defined as the remote provision of dental care, advice, or treatment through the medium of information technology rather than through direct personal contact with any of the patients involved. Teledentistry can also be defined as the provision of dental care, advice, or treatment remotely through the medium of information technology, not through direct personal contact with the patient involved. In dental practice, it is widely used in disciplines such as preventive dentistry, orthodontics, endodontics, oral surgery for dental, periodontal conditions, and early detection of dental caries patient education, oral medicine, and diagnosis¹⁹.

The term AI was coined in the 1950s and refers to the idea of building machines that can perform tasks usually performed by humans. Machine Learning (ML) is a subfield of AI, in which algorithms are applied to learn patterns and structures intrinsic in data, which enable the prediction of invisible data.¹¹

The use of Teledentistry in dentistry

Teledentistry has been used in oral surgery, oral medicine, periodontal conditions, early detection of caries, and most importantly, disseminating preventive advice to the masses. Telediagnosis, teleconsultation, electronic patient records, and patient referrals are fundamental modes used in modern dental practice. Teledentistry is proven to provide access to underserved populations, improve

the quality of care, and reduce the incidence of oral disease.

The American Dental Association (ADA) has issued guidelines to reduce the burden on healthcare practitioners and flatten the coronavirus disease 2019 (COVID-19) curve. These guidelines state that all non-emergency oral health care facilities should be suspended, and only emergency care should be provided for, for example, conditions such as uncontrolled bleeding, cellulitis, and trauma to the facial bones that impair the airway. The ADA advises dentists worldwide to use teledentistry to limit the spread of COVID-19, and audiovisual telecommunications technology can be used to share live video between patients and healthcare workers. Health information (e.g., patient radiographs, photos, videos, digital displays, patient history, etc.) may be shared via a secure electronic communication system with health care practitioners [Figure 1](#). A dentist can provide advice based on patient information without direct contact in real-time because the teledentistry system is not limited by space and time.^{12,13}

Teledentistry concept is divided into two systems: Web-based, Self-instruction educational system; This system was developed where patients can independently access the forms of education needed by patients. The advantage of this system is that users can control learning abilities and can repeatedly review as required. The drawback is the lack of duration of face-to-face between patients and doctors, so communication is not well.

Interactive-Conference Video; It can be done via POTS (plain old telephone service), Satellite, ISDN, Internet, or Intranet. This system is face-to-face virtual through video conferences with perfectly regular cameras where patient data can be adequately conveyed and supporting information such as patient data, radiographs, etc., have been sent previously even at the same time as video conferencing. The advantage of this type is that the patient can receive an immediate response.

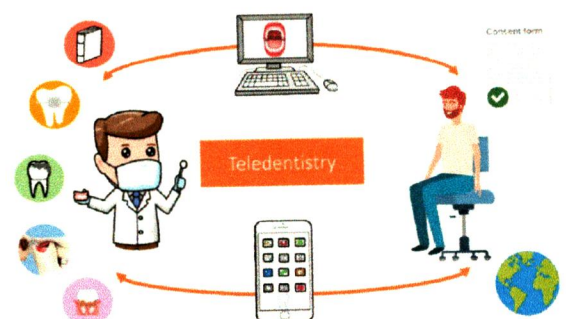


Figure 1. Overview of virtual media that can be used in teledentistry

Table 1. Teledentistry in Dentistry

Disciplines	Application
Periodontic	Consultation, Diagnosis
Preventive Dentistry	Consultation, caries detection dan diagnosis
Oral Medicine	Consultation, Diagnosis, treatment, Follow-up
Oral Surgery	Consultation, diagnosis, referral system, preoperative evaluation follow-up
Orthodontic	Consultation, Diagnosis, emergency, follow-up
Endodontic	Consultation, diagnosis, root canal identification
Prosthodontics	Consultation, CAD-CAM, Diagnosis, treatment plan, follow-up
Pediatric Dentistry	Consultation, diagnosis (caries, anomaly, fluorosis, etc.)
Gerodontology	Consultation, diagnosis, follow-up
Education	Professionals and Students (Training and updating knowledge) Patient (Dental health instruction and counseling)

Table 2. Advantages and disadvantages of using teledentistry

Advantages	Disadvantages
Access to care for underserved populations	Proper internet connection is required for teleconferencing
Cost-effective	The experience and knowledge of fellow dentists are also diverse
Saving time	Most are still not legally tested
Strengthening communication between patients and dentists or fellow dentists	Productivity can be another issue as practitioners are just getting used to using technology
Early diagnosis	
E-recipe	
Assist dentists in remote locations to make referrals	
Data storage	

Table 1 teledentistry offers a wide range of clinical applications from patient record management, diagnosis, and clinical decision-making. It has the potential to provide underserved patients with oral health services. In addition to clinical applications, teledentistry can be a valuable tool to reduce disparities and ensure equity in the provision of oral health services. The technology used in teledentistry enables rapid transfer of images, files, and documents and provides access to this information for specialists and practitioners.¹⁴

Despite the many disciplines that can benefit from teledentistry and its various applications, limitations in communication and information technology still exist. The use of digital images in diagnosis can be a helpful tool for diagnosing visible lesions, but pictures have their drawbacks. The image represents a two-dimensional view

of a three-dimensional object, which can affect the diagnosis's accuracy. Another limitation of images is the quality of the images captured, as teledentistry requires high-quality photos which cannot be produced in every center/clinic in rural areas. That brings another challenge: the costs of teledentistry technology support that can burden both governments and individuals. Evidence shows that teledentistry is a rapidly growing field with a lot of potentials but is still in its infancy, and more emphasis is needed on allocating funds and grants to conduct more clinical trials to provide more evidence and to identify how teledentistry can play a role in the provision of dental health care Table 2.

The use of AI in dentistry

Figure 2 AI is an refers to various domain methods designed to work with human-like intelligence. This requires combining vast volumes of data with sophisticated algorithms to create machines that can work independently. AI is effective in improving the quality of care by updating old systems and accelerating innovation.¹⁵

AI in Dentistry started with the advent of data computing and the availability of large amounts of patient data. For example, in radiology, certain types of algorithms are generated, which further aid in diagnosing and treating oral pathologies/diseases.^{16,17}

Results

AI in dental diagnostics

AI is used in determining diagnosis and treatment plans. Various fields of dentistry are used effectively. In the oral disease, such as recognizing the type of lesion or recurrent aphthous ulcers through specific algorithms. Specific genetic algorithms have also been shown to help predict the location and size of unerupted teeth, such as premolars and canines. AI can simplify the initial diagnosis process, such as detecting the presence of caries or assessing the precision of the use of materials and medicines.¹⁸⁻²⁰

AI inpatient management

Management of patients based on AI can be achieved with services without physical contact with patients. AI-based virtual services can manage everything from patient scheduling, patient data management, planning, storing medical records, and even facial and voice recognition of patients. The correct patient database management system will make it easier for dentists to diagnose and conduct online consultations. Not only with dentists but relationships with third parties or insurance can also be accommodated by the use of AI, for example, in recording claims and so on.²¹

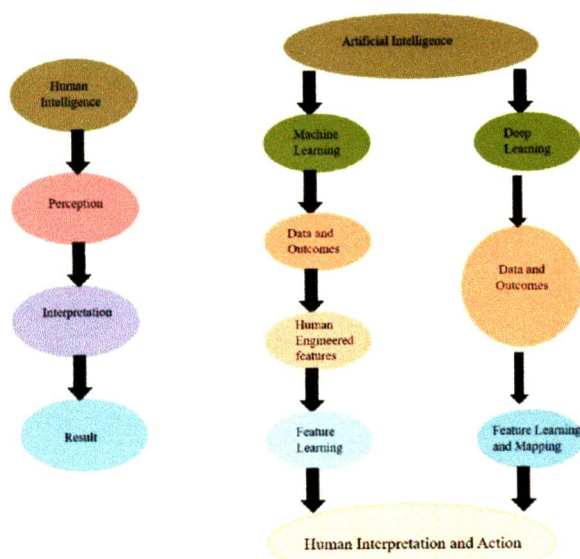


Figure 2. The workflows comparison between manual and AI

Table 3. Advantages and disadvantages of using AI

Advantages	Disadvantages
Addresses subjective variability in individual examinations, increasing effectiveness and minimizing treatment costs.	Depend on the use of software so that it requires updating according to the latest technology
Digital data is easily accessible and more structured	Requires a high cost in maintaining the tool
Able to integrate different and heterogeneous data domains. For example, medical/dental history, sociodemographic and clinical data, biomolecular data, social network data, etc.	Requires more detailed processing of the method of using AI-based tools
Strengthening communication between patients and dentists or fellow dentists.	
Streamline work and increase the face-to-face time that doctors/dentists and their patients have.	
Health services become more participatory, especially if patients actively share their data.	
Patients can perform self-monitoring and self-care.	

AI in restorative/prosthetic dentistry

To provide the perfect prosthesis to the patient, there are several factors that a dentist must consider, such as anthropological calculations, facial measurements, aesthetics, and patient preferences. The use of computer-based technology for the proper placement of prostheses is another breakthrough of AI in dentistry. In addition, CAD/CAM-based systems are used in dentistry to achieve high-precision final dental restorations. Furthermore, an AI-based system is used to design

inlays, Onlays, crowns, and bridges. This system has replaced conventional methods of making prostheses, helps determine color, saves time, and minimizes errors.²²

AI in periodontic

Digital Convolution Neural Network-based system consisting of 16 convolution layers and two fully connected layers to detect periodontitis in premolars and molars. ANN can also be used effectively in categorizing patients into aggressive periodontitis and chronic periodontitis based on their immune response profile.²³

AI in radiologist dentistry

Dental radiology is one of the standards in diagnosis. A large amount of patient data is recorded via digital Intra Oral Peri Apical X-ray (IOPA), 3D scanning, and so on. AI provides the ability to integrate with imaging methods such as MRI and cone computed tomography, enabling it to identify even minor deviations from normal that remain unnoticed by the human eye. For example, dentists use it to localize the minor apical foramen, thereby increasing the accuracy of radiographic determination of working length and in the diagnosis of proximal caries. It can also detect internal disorders of the temporomandibular joint and other diseases. The machine learning algorithm can detect abnormal or normal lymph nodes in the head and neck region used by trained radiologists who can interpret by analyzing the thousands of images labeled as normal or abnormal Table 3.²⁴

Discussion

During the Covid-19 pandemic, it is highly recommended that before carrying out any dental procedures at the dentist's practice, you should consult digitally through teledentistry. By doing teledentistry, patients can communicate their complaints in advance and send photos of their teeth so that the dentist can analyze whether the case can be handled by doing treatment at home and by carrying out oral hygiene at home or issues that require emergency action at the dentist's practice. Teledentistry helps in prioritizing patients who need emergency action, and if they need direct action, they can provide care quickly and precisely because they have got a previous picture of the case to be handled.²³

AI plays an essential role during the Covid-19 pandemic, both for patients in general and the elderly. It is used for medical research and development, diagnosing individuals, testing

potential treatments, assessing public health consequences, and much more. This makes it more efficient with scheduling, saves costs and provides a new patient experience. Data analysis with algorithms, this application is considered capable of minimizing and even eliminating human errors that could occur.

Conclusion

Based on the results of the study that has been carried out, it can be concluded that the prohibition of visiting the doctor or dentist except for emergency measures is not a problem to carry out health control to support the quality of life of the elderly. Alternative efforts available from treatment are utilizing teledentistry as a telescreen medium so that it can be a health solution, especially dental problems through long-distance communication. In addition, AI plays a vital role in developing dental technology, which makes diagnosis and dental practice more practical. Teledentistry and AI can be alternative dental and oral health services models to reduce anxiety and fear of being contaminated with Covid-19. Both make it easier for health workers, especially in dentistry, to maintain and improve the quality of life of the elderly during the pandemic.

Acknowledgment

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Conflict of Interest

The authors report no conflict of interest.

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