EGAS MONIZ SCHOOL of HEALTH & SCIENCE | INSTITUTO UNIVERSITÁRIO EGAS MONIZ

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MESTRADO INTEGRADO EM MEDICINA DENTÁRIA

IMPACTO DA TELEMEDICINA DENTÁRIA NA ERA PÓS COVID-19

Trabalho submetido por

Hechem Guesmi

para a obtenção do grau de Mestre em Medicina Dentária

Julho de 2024

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Prof. Doutor Jorge Rebola

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"Manter o corpo em boa saúde é um dever... caso contrário, não seremos capazes de manter a mente forte e clara."

*" **Buda**"*

DEDICATÓRIA

Aos meus pais, o Ali Guesmi e a Souad Krichi por tudo o que me ensinaram, pelos valores que me transmitiram e por estarem sempre presentes.

As minhas duas irmãs Heni e Hiba, por todo o apoio e força que sempre me transmitiram durante este longo caminho.

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ABSTRACT

The medical act is still a very vague notion in spite of the numerous developed attempts of definition. The treaty of medical law stays the reference but the development of information and communication technologies and in particularly the telemedicine open the debate. This remote medical practice gives a new dimension to the medical act which deserves to be discussed. The odontology often stood back in the development of the telemedicine. Nevertheless there is a real public health issue on the oral state of the frail populations in all countries.(Nicolas Giraudeau., 2014)

The current health crisis has led to the emergence of new practices, new tools, and an increased use of digital health. Unfortunately, these are too often developed in a way that defies all logic or which has nothing to do with public health. Oral health professionals have been particularly affected during this crisis, and the use of digital health, and especially teledentistry, has been considered in many countries. It is time that teledentistry be adequately considered, while ensuring the quality of the medical procedure and with the aim of reducing inequalities in terms of access to oral healthcare and public health problems.(Giraudeau, 2021)

Rather than saving money and time to healthcare facilities, teledentistry could also save energy and time from the patients and it is priceless. Teledentistry should be implemented to be officially evaluated, because it seems to be a good public health tool, on the theoretical aspect.(Olivier et al., 2019)

Teledentistry has the potential to improve health system performance in terms of efficiency and equity. Efficiency can be assessed either alongside a clinical trial or through modeling methods.
However the evidence regarding the economic evaluations of teledentistry programs is scarce. Methodological guidelines to the economic evaluation of teledentistry might help researchers to design and implement such evaluations.(Mercier & Marino, 2018)

The use of teledentistry in daily clinical practice is still limited in most countries. Few countries have instituted teledentistry programs at national level. Laws, funding schemes and training are needed to support the incorporation of teledentistry into healthcare systems to institutionalize the practice of teledentistry. Mapping teledentistry practices in other countries

and extending services to under-covered populations increases the benefit of teledentistry.(El Tantawi et al., 2023)

There is a significant need for teledentistry education and training as well as on regulations. It may be necessary in the future to ensure that all stakeholders in the field of dentistry work together to improve these two topics for dental practitioners. It is also worth noting that teledentistry and telemedicine are public health tools and that they could provide inequitable access to medical care. However, teledentistry must be implemented to decrease inequality and ensure it does not do the opposite.(Giraudeau et al., 2022)

Keywords: Dentistry, Telemedicine, Teleconsultation, Covid-19.

RESUMO

O ato médico continua a ser uma noção vaga, apesar das numerosas tentativas de definição desenvolvidas. O tratado de direito médico continua a ser a referência na definição do ato médico, mas o desenvolvimento das tecnologias de informação e da comunicação e, em particular, a telemedicina, acrescentam uma nova dimensão ao ato médico que merece ser discutida.

Apesar da medicina dentária não ser pioneira na aplicação da telemedicina, a saúde oral, particularmente em populações desfavorecidas, é um verdadeiro problema de saúde pública que encerra um potencial de aplicação desta metodologia emergente. (Nicolas Giraudeau., 2014)

A pandemia do COVID 19 levou ao aparecimento de novas práticas na área da medicina dentária, ferramentas inovadoras e a um aumento significativo na utilização da saúde digital.

É imperativo que a telemedicina dentária seja avaliada de maneira adequada, garantindo a qualidade dos procedimentos médicos com o propósito de reduzir as desigualdades no acesso aos cuidados de saúde oral. (Giraudeau, 2021)

A implementação da telemedicina, embora no plano teórico possa ser considerada um ferramenta útil em saúde pública, ainda carece de avaliação prática. (Olivier et al., 2019)

A telemedicina tem o potencial de melhorar o desempenho do sistema de saúde em termos de eficiência e equidade. A eficiência pode ser avaliada quer através de um ensaio clínico, quer através de métodos de modelação.

No entanto, as provas relativas às avaliações económicas dos programas de telemedicina são escassas. As orientações metodológicas para a avaliação económica da telemedicina podem ajudar os investigadores a conceber e implementar tais avaliações. (Mercier & Marino, 2018)

O uso da telessaúde odontológica na prática clínica diária é ainda limitado na maioria dos países. Existe uma necessidade significativa de educação e formação em telessaúde odontológica, assim como em regulamentações.

Pode ser necessário, no futuro, garantir que todas as partes interessadas no campo da odontologia trabalhem em conjunto para melhorar estes dois tópicos para os profissionais de odontologia.

É relevante salientar que a telessaúde odontológica e a telemedicina são ferramentas de saúde pública que podem proporcionar acesso desigual à assistência médica.

No entanto, a implementação da telessaúde odontológica deve ser realizada para reduzir a desigualdade e garantir que não ocorra o oposto. (El Tantawi et al., 2023; Giraudeau et al., 2022)

Palavras-Chave: Medicina Dentária, Telemedicina, Teleconsulta, Covid-19.

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I Introduction

Global healthcare systems are facing challenges due to the COVID-19 epidemic. The World Health Organization (WHO) designated it a pandemic because it has affected nearly every nation. Aerosols are created during almost all dental treatments, and these can transfer viruses from patients to dental personnel and vice versa. As a result, numerous advisory and regulatory dental organizations across the globe have requested for the provision of only emergency services during the COVID-19 pandemic and advised the highest precautions in dental treatment.

The WHO declared COVID-19 to be a "public health emergency of international concern" on January 30, 2020. Consequently, the current health crisis has presented dentists with new problems and inspired new goals, including protecting patient safety, controlling and minimizing contamination risks, and improving the effectiveness of the treatment to raise output and efficiency. Thus, there have been advancements in methods, tools, and digital health applications.

The trend of COVID-19 infections increasing suggests that this epidemic is not going to cease anytime soon. In order to maintain safe dental care with a low risk of infection, dental care services would need to be revised and innovative if the conjectures in this regard prove to be accurate and COVID-19 becomes endemic. In the present and the future, teledentistry may offer an innovative way to provide dental care in addition to the COVID-19 epidemic.

The word "teledentistry" combines the definitions of "tele" which means distance, and "dentistry" which denotes the branch of medicine that specializes in the diagnosis and treatment of dental conditions. Teledentistry is essentially the practice of dentistry from a distance. It includes diagnosing, treating, or instructing dental patients via email, radio, television, computers, and other telecommunication devices. This phrase was first described by Cook in 1997 as the use of video-conferencing technologies to provide remote diagnosis and treatment recommendations.(Cook, 1997)

The term "teledentistry" describes the application of computerized data and communication technologies to facilitate professional health-related education, long-distance oral clinical treatment, and patient-related activities. In order to improve patient handling, teledentistry can be used as a capstone to clinical dentistry research. In areas where healthcare services

are lacking, this new technology has the potential to significantly reduce the gap between the supply and demand for dental specialists. It can also ensure patient safety during the pandemic while simultaneously delivering dental care and promoting good health management.

The acceptability of an appropriate infrastructure by patients and clinicians, payment issues, and security concerns were recognized as obstacles associated with teledentistry. Using requests that complied with the Health Insurance Portability and Accountability Act and providing education to patients and clinicians were two strategies used to address these concerns. The primary advantages of teledentistry include treating patients during the epidemic and extending care to areas without access to dental care.

II Development

1 General information on telemedicine, teleconsultation and telemonitoring

1.1 Telemedicine

1.1.1 Definition

Telemedicine is the remote practice of medicine using information and communication technologies. It provides a response to demographic, epidemiological and organizational difficulties. The regional health agencies support the roll-out of telemedicine by entering into contracts with project sponsors.

Five authorized telemedicine procedures :

Teleconsultation, tele-expertise, remote monitoring, remote assistance and medical regulation.

Telemedicine uses new technologies to put patients in contact with one or more healthcare professionals, or with several healthcare professionals.

It can be used to:

- ✓ Establish a diagnosis
- ✓ Monitor a patient at risk as part of prevention or post-treatment follow-up
- ✓ Request specialist advice
- ✓ Prepare a therapeutic decision
- ✓ Prescribing products, prescribing or performing services or procedures
- ✓ Monitor patients' condition.

Responding to demographic, epidemiological and organizational challenges:

Telemedicine is a fundamental lever for setting up new organizations capable of meeting current challenges such as:

- ✓ The ageing of the population.
- ✓ The increase in chronic diseases.
- ✓ The uneven distribution of healthcare professionals.
- ✓ And budgetary constraints.(Giraudeau, 2018)

Patient experiences and preferences for telemedicine versus face-to-face care during the COVID-19 pandemic: (Yu et al., 2023)

A comparison study that was released on May 23, 2023, found that overall, patient-physician communication and patient-perceived quality of treatment were comparable for both face-to-face and telemedicine appointments. However, patients using telemedicine reported lower quality of care and patient-physician contact as compared to men, older individuals, and those who were not seeking urgent care.

Methods: at November 2021, the authors polled 2,668 persons at a sizable university health system. Patients' reasons for their most recent visit, their opinions of the level of care and communication between them and their doctors, and their views about telemedicine in comparison to in-person care were all gathered through the survey.

Findings: Of the participants, 552 (21%) underwent a telemedicine consultation. Patients who saw their doctor via telemedicine and in-person agreed on the general perceived quality of the visit as well as the ease of communication between the two. However, telemedicine was linked to a worse perception of patient-doctor contact in those 65 years of age or older, men, and those who did not require urgent treatment.

1.1.2 Accelerating factors and incentives for the development of telemedicine

It's hard to admit, but the pandemic has at least had one positive spin-off. It has enabled doctors to try out teleconsultation, even in emergency situations.

While Covid-19 has put our healthcare systems to the test, it could also be a tremendous opportunity for telemedicine to spread. In France, the decree published on 9 March 2022 lifted a regulatory hurdle by relaxing the rules governing access to this practice for the duration of the epidemic. Faced with hospitals under strain, telemedicine is presented as a tool for managing the influx of consultation requests from worried patients, while respecting lockdown measures. The health situation and the emergency use of telemedicine provide an unprecedented opportunity for large-scale observation and experimentation.

In mid-September 2020, the French health insurance agency (Assurance-maladie) made the same observation: "The crisis caused by Covid-19 has led healthcare professionals to innovate and shake up the way patients are cared for.

Teleconsultation has been used on a massive scale, becoming an essential component of the healthcare offering across the country."

The figures are staggering. Between February and April 2020, the number of teleconsultations increased more than 100-fold - a meteoric rise. Reimbursed procedures rose from 40,000 in February to 4.5 million in April. In June, there were still 1.9 million, and in August 650,000. That's over 10 times more than before the health crisis.

At the time of the lockdown, the Assurance-maladie points out, teleconsultation accounted for one in four consultations. "Today, more than one in two doctors uses it, and it concerns patients of all ages, not just young urban dwellers: one in five people using it is over 70. This autumn, it accounts for 3% of consultations". The vast majority of teleconsultations (96%) are billed by self-employed doctors, four out of five of whom are general practitioners.

In fact, the Assurance-maladie has been reimbursing teleconsultation since September 2018 - and tele-expertise since February 2019. There is one condition: that the attending physician, who is familiar with the patient's state of health and history, is consulted first. But telemedicine has been slow to take off. It took the sudden onset of the pandemic to put the brakes on. As soon as the pandemic was under control, the conditions for reimbursing teleconsultation were relaxed. And their reimbursement increased from 70% to 100%.

1.1.3 Private operators covet the market

Faced with the public platforms that largely dominate the sector, private players quickly identified an opportunity to increase their market share. A number of companies, including Doctolib (Europe's leading e-health company), CompuGroup Medical and Hellocare, have made their teleconsultation solutions available free of charge for the duration of the epidemic.

These companies are betting opportunistically on habit-forming: once they've mastered the tool, it's a safe bet that doctors will be tempted to continue using it. There is no doubt that competition between public and private platforms has been heightened by this episode.

The pandemic has led the government to rethink the French-style model for regional platforms. Overall, these platforms suffer from a lack of pooling and interoperability: it's not easy to integrate all types of medical data.

Another weakness is the lack of any way for patients to trigger the system. In fact, only 11% of platforms allow direct access by patients, and their activity is heavily dominated by tele-expertise between healthcare professionals (82%).

1.1.4 Unsuspected agility of hospital structures

Only 2% of teleconsultations were carried out by establishments over the period 2018-2019, as indicated by the Assurance-maladie. However, some healthcare establishments have managed to develop teleconsultation very quickly, whereas in the past they rarely used it. However, the more prepared the establishment was, the better the practice was deployed.

Over the last 20 years, hospitals have developed a wide range of telemedicine practices based mainly on making medical expertise available. We all remember telesurgery and its technological prowess. In 2001, the first operation on a patient in Strasbourg performed by a surgical team in New York paved the way for remote surgery, remote clinical examinations and remote expertise, for example in the interpretation of X-ray examinations or clinical cases. These tools also meet the need for university hospital expertise in under-resourced areas.

This expertise is a rare resource in certain geographical areas. Beyond our borders, the spread of Covid-19 to areas with few resources in this area, such as large parts of Africa, means that tele-expertise needs to be stepped up in order to support healthcare professionals in the care of infected populations and patients.

1.1.5 Systems for town-hospital coordination

Remote monitoring of patients is particularly effective in the case of chronic diseases (diabetes, heart failure, kidney failure and cancer). There are many structures and systems in place, such as the Cardiauvergne remote monitoring and care coordination service for heart failure patients, set up in 2011.

This health cooperation group aims to reduce the barriers between primary care and hospital care, to provide better care for the more than 1,500 patients benefiting from remote monitoring.

Similar but lighter solutions have been and are being developed during the health crisis. Given the number of people contaminated by the coronavirus but who did not require extensive treatment, the rapid deployment of remote monitoring solutions was essential. Several applications have been developed, including Covidom, designed by Assistance publique-Hôpitaux de Paris and software publisher Nouveal e-santé.

The principle is that patients regularly complete a digital survey, and the information entered can be used to generate alerts so that appropriate care can be taken.

The health crisis has shown that telemedicine is an interesting solution that can usefully complement other care systems.

1.1.6 New telemedicine equipment

The emergence of telemedicine is accompanied by the appearance of new medical equipment enabling the summary examination needed for an initial diagnosis:

- ✓ The booth
- ✓ Terminal
- ✓ Trolley
- ✓ The case

These devices come in various forms, more or less fixed or mobile, to suit all situations and uses.

Remember that all forms of teleconsultation, with or without equipment, are reimbursed by the health insurance scheme in the same way as face-to-face consultations.

- ➢ The connected teleconsultation booth :

An enclosed space that maintains confidentiality, often designed to accommodate 2 or 3 people in cases where the patient needs a companion (pharmacist, nurse, care assistant), it is also sometimes called a teleconsultation station.

The teleconsultation booth has :

- ✓ A camera and microphone
- ✓ A large screen
- ✓ A number of medical devices capable of measuring physiological constants (blood pressure, oxygen saturation, pulse, forehead temperature, etc.)
- ✓ And often a printer for printing prescriptions

- ➢ Installation sites:

A booth can be installed in a university hospital, a nursing home, an old people's home, a senior citizens' residence, a town hall, a place of education (school, college, high school, university), a company, on a motorway service area, in a railway station or airport, on a boat, etc.

- ➢ Use:

Access to a telemedicine booth is subject to various arrangements, depending on where the booth is located (pharmacy, health center) but in general this process is followed:

- ✓ The patient makes an appointment (via a website or telephone number, or at a health center) with a teleconsulting doctor in a booth
- ✓ The patient goes to the appointment, enters their health card into the machine and types in their appointment code
- ✓ The teleconsulting doctor dialogues with the patient via video transmission, showing him how to use the connected instruments: thermometer, blood pressure monitor, stethoscope, otoscope, scales, dermatoscope, oximeter, etc.
- ✓ If necessary, the doctor makes a diagnosis and writes a prescription, which is printed out in the cabin or sent electronically to the nearest pharmacy.
- ✓ Between each patient, a booth referent disinfects the premises and replaces "consumables" (protective covers, etc.).

The aim of these initiatives is to tackle the worrying problem of the spread of medical deserts.

- ➢ Suppliers of connected cabins :

- ✓ The Tessan telemedicine booth:

Tessan offers a connected telemedicine booth with 7 medical devices available.

The teleconsulting doctor receives the data taken by the patient on his or her own screen, enabling him or her to complete the medical file.

- ✓ The Médispot teleconsultation booth:

Médispot is announcing a low-cost teleconsultation booth, available in 2022, equipped with 6 medical instruments and designed and manufactured in France.

The booth will also be compatible with teleconsultation software from Doctolib, Qare, Maiia, MedecinDirect, Medaviz and Mesdocteurs.

- ✓ BewellConnect, H4D, H&S, CSI:

BewellConnect, H4D, H&S and CSI also offer cabins for medical examinations, vital sign measurements and remote consultations with a doctor.

- The telemedicine trolley :

The telemedicine trolley is a small device, often mounted on wheels, so it is mobile and can be moved around.

Equipped for videoconferencing, the trolley is also fitted with a range of medical equipment, depending on the model and requirements: blood pressure monitor, thermometer, spirometer, stethoscope, pulse oximeter, otoscope, glucometer, ECG, ophthalmoscope, ultrasound scanner, dermatoscope, connected glasses, intra-oral camera (for dental care).

The measurements are sent directly to the teleconsulting doctor.

The telemedicine trolley is particularly suited to the following situations:

- ✓ Patients confined to bed, in hospital or in a clinic
- ✓ Patients at home with ALD or serious pathologies
- ✓ Patients in nursing homes
- ✓ Disabled people

- The teleconsultation terminal :

The Tessan terminal: Tessan offers a medical teleconsultation terminal equipped with 6 devices (blood pressure monitor, thermometer, stethoscope, otoscope, dermatoscope, oximeter).

Standing 1.5 meters high, 78 cm wide and 57 cm deep, the terminal can be installed in pharmacies, doctors' surgeries and nursing homes.

The terminal is the equivalent of a trolley, but in a fixed form.

- The teleconsultation case :

The teleconsultation case is the most compact form of telemedicine device. It contains a series of medical devices as in a telemedicine booth or on a trolley.

The teleconsultation case is particularly useful for emergency medical services - fire brigades, SAMU, SMUR, mountain brigades, wartime doctors - because it enables medical examinations to be carried out on the spot, at the scene of an accident, an attack or a natural disaster, for example in cases of: stroke, respiratory distress, loss of consciousness, wound, hemorrhage, open fracture, serious burns, crisis in the absence of a doctor in an EPAHD, infectious disease.

Responders can take measurements directly on the injured person, and these measurements are transmitted live to an emergency doctor who can then diagnose and prescribe first aid.

Although expensive (between €20,000 and €100,000 by 2022), this teleconsultation suitcase will enable economies of scale to be made by avoiding certain high costs, such as medical evacuation by helicopter or ambulance.

1.2 Teleconsultation

1.2.1 Definition

Teleconsultation is a remote consultation of a patient by a doctor (general practitioner or any other medical specialty), with or without the patient being assisted by another healthcare professional (e.g. doctor, nurse, pharmacist, etc.).

Teleconsultation is a new way of facilitating public access to healthcare throughout the country, including in areas where there are few healthcare professionals. For example, teleconsultation can be offered by your general practitioner, enabling you to get an appointment and faster treatment when circumstances require it, or to get an appointment within a suitable timeframe with a specialist doctor after referral by your general practitioner. For some patients who are not very mobile, teleconsultation avoids unnecessary journeys or visits to emergency departments.

1.2.2 Who can offer teleconsultation?

Any doctor can offer you a teleconsultation, whatever his or her specialty, area of practice or place of practice, in a town or health establishment (town practice, multi-professional health center, health center, nursing home, hospital, clinic, etc

1.2.3 For which patients?

Teleconsultation can benefit all types of patient, whatever their age, pathology or place of residence. It is up to the medical professional to assess the appropriateness of using this practice in the light of the patient's clinical situation, the availability of the patient's data and the patient's ability to communicate remotely and use IT tools. The patient must give his consent and the patient must give his consent.

1.2.4 What guarantees of quality and safety are there?

Teleconsultation, like any medical activity, must be carried out under conditions that guarantee the quality and safety of care. To this end, it must comply with the same obligations as face-to-face consultations, including :

- ✓ Conditions of practice, professional ethics and standards of practice

- ✓ Patient consent must be obtained from the healthcare professional before any procedure is carried out.
- ✓ The obligation for digital tools to comply with the legal framework applicable to health data.

The Department of Research, Studies, Evaluation and Statistics (DREES) has published a new study on teleconsultations carried out in 2020 and 2021, based on health data supplemented by survey data from general practitioners. It presents trends in the number of teleconsultations in general practice from the time of their deployment in 2018 to the end of 2021, and describes the characteristics of the doctors and patients who made use of them in 2020 and 2021. (Julie Kamionka, 2022)

In particular, it sheds light on the territorial dimension of this practice: the location of doctors and patients using it, and the doctor-patient distance observed during teleconsultations.

In 2021, 9.4 million general practice teleconsultations were carried out by private practitioners and 1.1 million in health centers:

As a result of the health crisis, the use of teleconsultations has grown significantly in France, whereas it was previously marginal. Private general practitioners will be carrying out 13.5 million remote consultations in 2020 and 9.4 million in 2021, compared with 80,000 in 2019. In addition, a large number of teleconsultations were also carried out by general practitioners employed by health centers: 600,000 in 2020 and 1.1 million in 2021, most of them in centers where teleconsultation is the main activity.

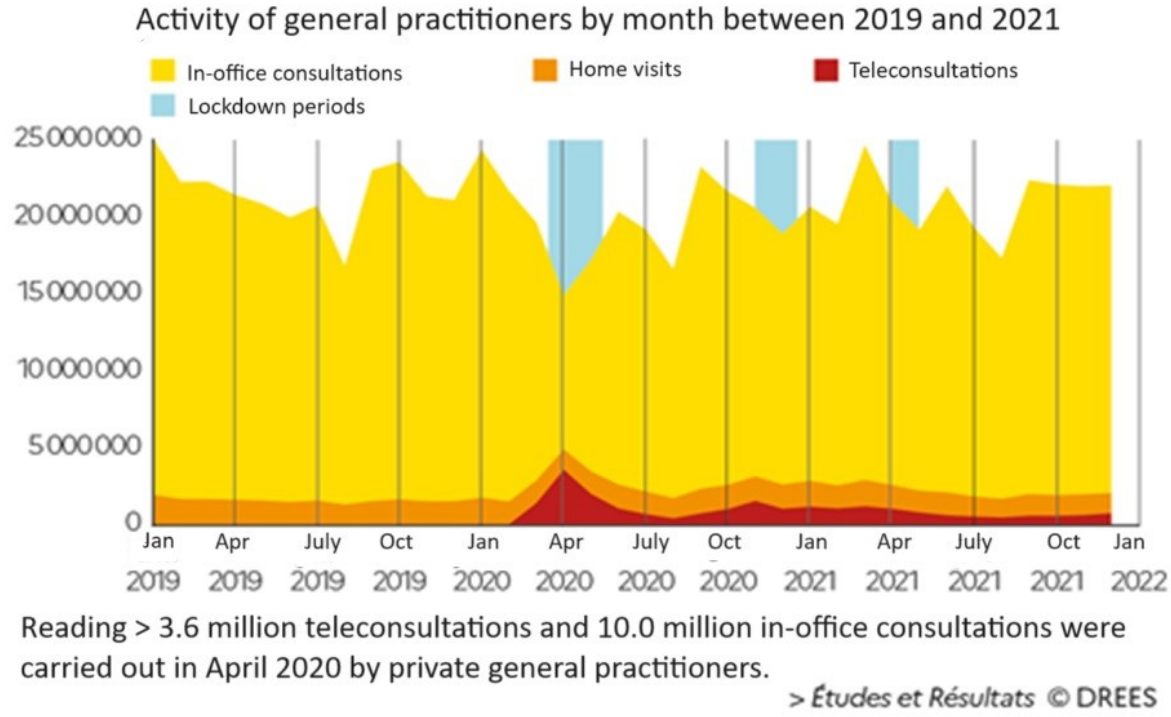

Figure 1: Activity of private general practitioners per month in 2012 and 2021 (adapted from Julie Kamionka, 2022

Beyond periods of lockdown, the use of teleconsultation is establishing itself as a permanent but relatively infrequent practice:

The use of teleconsultations was particularly high during periods of high epidemic intensity and lockdown. Beyond these periods, teleconsultations seem to have established themselves as a permanent practice for private general practionners, representing 3.7% of their activity in 2021 (5.7% in 2020). Ultimately, teleconsultations have become a significant component of medical activity, although they remain relatively rare. In particular, they have become less frequent than home visits since the end of the first containment period.

Younger doctors and patients make greater use of teleconsultation:

Remote consultations are more common among younger practitioners (4.8% of the activity of self-employed general practitioners aged under 40 in 2021, compared with 2.5% of that of their colleagues aged 65 or over). Similarly, teleconsultations are more often carried out with young patients, whatever their area of residence. In 2021, 45.2% of general practitioner teleconsultations will be carried out with patients aged between 15 and 44, compared with 28.7% of office-based consultations.

What's more, this system is not particularly used by the most disadvantaged people: teleconsultations are less often carried out with a patient who is a beneficiary of the complementary health insurance scheme (CSS) than office consultations, particularly among young people.

Seven out of ten teleconsultations are carried out with patients living in major urban centers:

The situation is similar for patients: 69.4% of teleconsultations are carried out for patients living in city centers or the suburbs of major centers, where 56.9% of the population live. In comparison, 17.9% of remote consultations are for patients living in rural areas outside the French overseas departments and territories, where 27.6% of the population live. These differences in the use of teleconsultations cannot be explained by differences in age structure between the different regions.

Teleconsultations are not particularly carried out with patients residing in areas with the lowest number of general practitioners: 23.3% of teleconsultations are carried out with the 20% of the population with the highest number of general practitioners, while 17.9% are carried out with the 20% with the lowest number.

Most teleconsultations are carried out close to the patient's place of residence:

As with office-based consultations, teleconsultations are most often carried out between a doctor and a patient who are not far away. In 58.6% of remote consultations, the doctor practices in the patient's home town or less than 5 kilometers away (compared with 62.7% of office-based consultations). Furthermore, the majority of remote consultations take place with the patient's general practitioner. This is the case for 69.1% of teleconsultations carried out in 2021 by private general practitioners (compared with 67.2% of office-based consultations).

Despite a relatively harsh view of teleconsultation (only 16% said they were very or completely satisfied, with 38% being moderately satisfied), half of doctors intend to continue teleconsulting after the Covid-19 epidemic. One in three doctors believes that teleconsultation could be a solution for treating patients living in areas with low medical density. (Julie Kamionka, 2022)

1.3 Remote monitoring

1.3.1 Definition

Telemonitoring facilitates access to healthcare and enables remote medical monitoring of patients.

The Covid health crisis accelerated the roll-out of digital healthcare and demonstrated the value of remote monitoring solutions for managing patients remotely. Telemonitoring is now emerging as a relevant solution for alleviating medical deserts, reducing unnecessary travel, making patients more autonomous and improving compliance with treatment.

Remote monitoring can be carried out via a variety of digital channels (SMS, web pages, messaging applications, mobile applications, connected objects, etc.) to adapt to patients' needs and different pathologies. So as not to widen the digital divide and reach the elderly, who suffer more from chronic illnesses than the rest of the population, SMS is the most effective medium.

With the advent of these tools, patients have more control over their care, they are no longer dependent on overloaded switchboards, and healthcare professionals have more time to devote to patients who really need it. This avoids the need to travel, especially for people with reduced mobility, and reduces the risk of cross-contamination. As a result, patients have quicker and easier access to care, and for chronically ill patients, this represents a real improvement in their quality of life.

1.3.2 Connected remote monitoring medical devices

Examples of medical devices include:

- ✓ Blood pressure monitor, to measure blood pressure
- ✓ Electrocardiogram, to measure heart rate
- ✓ Scale, to monitor weight
- ✓ Urinometer, to measure urine output
- ✓ Oximeter, to measure the level of oxygen exhaled by patients suffering from respiratory diseases.

These connected medical devices send their measurements remotely and, if they deviate from the expected values, trigger alerts.

1.3.3 Who should manage the alerts?

We asked ourselves what is the best level of skill to manage these alerts?

A study of a diabetologist's telemonitoring patients showed that he simply didn't have the time to manage all the alerts received by email. It would therefore seem that qualified nurses are best placed to manage remote monitoring on a routine basis.

"Another application of telemedicine in cardiology is the remote monitoring of patients who receive an implanted automatic defibrillator (IAD) to treat serious cardiac rhythm disorders

such as fibrillation or ventricular tachycardia. Initial studies have shown improved safety in the use of IADs and a reduction in the number of face-to-face consultations. The medical service provided to patients with IADs is significantly fewer inappropriate shocks when remote monitoring is organized than when it is not. This reduction in inappropriate shocks has a favorable impact on patients' myocardium". (Chidiac et al., 2017)

1.3.4 Remote monitoring pathologies

Telemonitoring makes it possible to monitor patients suffering from the following pathologies in particular:

- ✓ Diabetes
- ✓ Heart failure
- ✓ Respiratory failure
- ✓ Renal failure
- ✓ Or who have received a cardiac prosthesis (implant).

1.3.5 Encouraging patient compliance

In patients with chronic diseases, poor compliance leads to health complications.

France has 20 million patients suffering from chronic diseases, so encouraging compliance is a public health issue. With the Covid crisis, these patients, who were at greater risk of contamination, were at risk of breaking off relations with their caregivers, and thus of non-compliance.

New remote monitoring technologies now make it possible to encourage patients to comply with their treatment at a distance. A number of tools can be used, for example to send text message reminders to patients to take their medication, to chat with patients and alert healthcare professionals to any abnormal responses, or to share information with healthcare professionals.

The use of these new technologies means that patients can live better and be safer from a distance, while healthcare professionals can save time and ensure better coordination.

The technological resources are in place to roll out remote monitoring tools to as many people as possible. This also presupposes that all the players involved coordinate their efforts around the patient, to ensure remote medical monitoring, supply the technical solution and provide therapeutic support.

With the development of these technologies, the question arises as to who will be held liable in the event of error. The doctor who followed the algorithm or the algorithm's publisher?

Concerns about data protection are also surfacing. However, the legislative framework in France is highly protective in this area. Health data is a special type of personal data, considered sensitive and protected by a number of laws. Hosts of digital health data must be certified, but as with all stored data, there is a risk of piracy.

1.3.6 Conclusion

The importance of telemonitoring was highlighted during the Covid crisis, but its value is part of a more global trend towards more personalized medicine and a more autonomous patient. Telemedicine is set to expand, and hopes are high that it will improve compliance, save time for healthcare professionals, and promote coordination between healthcare professionals and patients.

1.4 The benefits of teledentistry

The utilization of teledentistry offers numerous advantages, particularly in regions where there is a shortage of healthcare professionals. Patients are able to connect with doctors located far away, both nationally and internationally. This allows for seeking second opinions and accessing specialized care with ease. Additionally, teledentistry helps in saving resources, money, and energy that would have been spent on travel and consultations. It eliminates the inconvenience of long queues at tertiary care centers (Batra, 2017), saves time, reduces absenteeism from work or school, and contributes to the economic growth of the nation.

Particularly during emergencies, odd hours, or pandemics like COVID-19, these services prove to be extremely beneficial. Furthermore, teledentistry has the potential to transform the healthcare ecosystem from focusing on curative treatments to preventive measures, thanks to technological advancements. (Batra, Panchali, Anika Dawar, 2020; Tagra H, 2021)

It also enhances the efficiency of follow-up care for high-risk or differently abled groups, as well as improves access to underserved populations.

1.4.1 Benefits for patients

- **Cheaper medicine**

For patients, remote medicine - reimbursed just as much as conventional medicine - could have the advantage of reducing or even eliminating all ancillary costs:

- ✓ No petrol or parking costs (for example: by teleconsulting your dietician 4 times a month on her therapist's website, you save 4 return journeys a month)
- ✓ No childcare costs, especially when both parents work or when only one parent has custody and an absence is complicated to manage
- ✓ Fewer hospital costs - thanks to teleconsultations for pre-operative care or post-operative follow-up, unnecessary hospitalization can be avoided.

- **Better access to healthcare for particularly isolated populations**

Certain groups find themselves isolated, either geographically or socially, or for legal reasons:

- ✓ Elderly people, particularly those losing their independence or unable to drive or use public transport.
- ✓ Rural or mountain populations.
- ✓ Infectious patients who have to remain confined in quarantine (because of covid, but not only because there are dozens of infectious diseases).
- ✓ Prisoners, who are often deprived of healthcare because of the cumbersome prison system.
- ✓ Migrants and undocumented migrants.
- ✓ Some disabled people benefit from being able to teleconsult without having to travel: among others, the hundreds of thousands of blind or severely visually impaired people, as well as people who are paralyzed or in wheelchairs, avoid the painful effort of travelling.
- ✓ All these people clearly benefit from teleconsultation.

- **Faster medicine**

With a wider range of services available remotely, patients are less likely to have to deal with a doctor who is unavailable. They can teleconsult for a simple opinion or to renew a course of treatment.

They also save time by not having to lose a day's work to travel to the doctor's. This is not necessarily good for employees, who would rather take a day off, but it is good for the professions, which will lose less turnover.

In the event of a life-threatening emergency, equipping emergency services (fire brigades, SAMU, SMUR) with a teleconsultation kit means that vital signs can be measured quickly and transmitted live to a teleconsulting emergency doctor.

- **Reducing the risk of infection**

For all infectious diseases, doctors are likely to carry germs from patient to patient.

Similarly, waiting rooms in doctors' surgeries, hospitals and clinics present risks of contamination.

Telemedicine has the advantage of reducing the risk of contracting influenza, gastro-enteritis, bronchiolitis, coronavirus, tuberculosis, measles, malaria, chikungunya, Lyme disease, etc.

1.4.2 Benefits for doctors

- **Saving time and increasing income**

For doctors and other healthcare professionals who have turned to e-health, practicing medicine online means they don't have to waste time travelling between patients, so they can treat more patients.

Visits are therefore reserved for cases requiring a thorough medical examination, and teleconsultation is used to determine whether a home or office visit is necessary.

- **Saving space**

Practicing remotely reduces the need for space in a doctor's surgery: instead of 10 patients in a waiting room, you have 5, and you can see the others by videoconference.

In towns where property is expensive, you can even do without an office, or share an office with other doctors.

- **More reliable diagnoses, more appropriate treatments**

General practitioners recognize the benefits of tele-expertise: even if they practice face-to-face, from a patient's home they can easily obtain immediate medical advice from a specialist doctor for cases that they find difficult or uncertain.

For example, they can

- ✓ Send photos of a skin lesion to a dermatologist to find out whether it looks pathological or to predict how it might develop
- ✓ If the results of an examination are inconsistent or difficult to interpret, the doctor may ask for the opinion of laboratory or medical imaging experts, blood specialists, radiologists, etc.

- **Remote practice by retired doctors**

Faced with a national shortage of doctors, which is particularly acute in some rural areas, some retired doctors could provide teleconsultations for cases that do not require an in-depth examination, or that require an initial medical opinion before referral to a specialist.

These part-time doctors could work just a few hours a week from home, without having to pay the various costs and bills of a medical practice (rent, insurance, electricity, etc.).

1.5 The disadvantages of telemedicine

When it comes to delivering dental care during the pandemic, teledentistry has shown to be an invaluable resource. It's crucial to recognize that there are drawbacks to this strategy as well, especially when it comes to the interaction between patients and medical staff.

The potential of teledentistry has not been fully realized because of these obstacles. Teledentistry's efficacy is restricted by factors like under-digital-literate populations, poor internet and infrastructure access, unequal service availability, privacy and security concerns, and a lack of comprehensive regulations for digital healthcare. These drawbacks highlight the necessity of additional research and advancement in the field of teledentistry.(Batra et al., 2022)

1.5.1 Disadvantages for patients

- **Dehumanization**

For certain social groups, the doctor's visit plays a psychological role of comfort and human warmth. For example, isolated elderly people like to know that there is at least one person who cares about them.

However, there is nothing to stop teleconsultation being used to improve care for these isolated people.

In addition, e-health should alternate with physical visits, and should only be carried out in close geographical proximity.

- **Lack of health insurance**

Not all mutual health insurance companies cover telemedicine, at least not in all countries. Even so, in France and other European and Western countries, telemedicine seems to be well on the way to standardization.

- **Patients' technical incompetence**

Some users of new technologies have poor skills or equipment.

Dependent elderly people, people with disabilities, or people with hearing, visual, motor or intellectual impairments, may have insurmountable difficulties using new technologies.

- **Poor Internet connection**

What's more, some people live in areas with poor Internet access (rural areas suffer from a combination of medical desertification and poor broadband Internet coverage; but local pharmacies can solve this problem by offering telepharmacy services, including teleconsultation booths equipped with equipment to carry out basic tests, and a broadband Internet connection), or in areas where the connection is expensive (for example, in Benin in Africa, the monthly connection is the equivalent of €500 in France!)

This disadvantage of telemedicine can also be partly overcome by telephone teleconsultations.

- **Risk of leakage of personal health data**

Like any form of telecommunication, telemedicine presents a risk of personal data being pirated, and therefore of medical confidentiality being breached.

Nevertheless, a number of platforms are already offering secure telecommunications.

However, these services have already suffered setbacks, such as when data stored by third-party services used by Doctolib was maliciously hacked:

"in July 2020, 6,128 appointments with the patient's surname, first name, gender, telephone number and email address, as well as the appointment date, name and specialty of the healthcare professional involved in the appointment "were accessed by malicious hackers"

1.5.2 Disadvantages for doctors

- **Dehumanization**

Doctors also fear a dehumanization of medicine and believe that human contact between patient and doctor plays an important role and is an integral part of the therapeutic process.

To counter this disadvantage, it should be remembered that e-health consultations and telecare are not intended to replace physical examinations and treatment: telemedicine should only be used in specific cases.

- **The cost of teleconsultation booths**

The cost of equipping pharmacies with teleconsultation booths is considerable. However, it seems that this cost is more or less quickly offset by the increase in activity.

2 Communication during the health journey

2.1 Situation before the COVID health crisis

Even before the COVID-19 crisis, communication within the healthcare pathway was an important issue.

2.1.1 Doctor-patient communication

Prior to the pandemic, doctor-patient communication was considered an essential element in healthcare delivery. Good communication was essential for establishing a relationship of trust, fostering mutual understanding, encouraging treatment compliance and improving health outcomes.

Here are some key aspects:

- ✓ **Doctor-patient relationship**: The doctor-patient relationship was based on trust, respect and empathy. Doctors sought to establish a strong bond with their patients in order to understand their needs and concerns.

- ✓ **Verbal communication:** Doctors primarily used verbal communication to explain diagnoses, treatment options, medical procedures and test results to patients. They used appropriate language to make medical information understandable to patients.

- ✓ **Non-verbal communication:** In addition to verbal communication, doctors also used non-verbal cues such as eye contact, gestures and facial expressions to reinforce communication with patients and express empathy.
- ✓ **Patient education:** Doctors played an active role in patient education, providing information about the disease, treatments, lifestyle changes and so on. They answered patients' questions and made sure they understood the information provided.

- ✓ **Shared decision-making**: Doctors often encouraged patients to participate in decision-making about their own health. They discussed treatment options with patients, explained the pros and cons of each choice, and respected patients' preferences wherever possible.

- ✓ **Confidentiality:** Confidentiality was a fundamental aspect of the doctor-patient relationship. Patients felt confident in sharing personal information with their doctors, knowing that this information would be treated confidentially.

“In 2016, London digestive surgeon Prof. Shafi Ahmed, already a KOL, dons Snapchat Connected Spectacles while in the operating room and broadcasts his surgery live, with the patient's permission. The video will rack up two million views on YouTube, and 56 million people will talk about it on Twitter”, says Denise Silber in her white paper “The Connected Practitioner". (Denise Silber, 2023)

The author also mentioned the exemplary case of Geneva University Hospitals, which had had a remarkable presence on YouTube, Facebook, Twitter and Instagram for some ten years. Healthcare professionals took it in turns to manage these accounts, with 90,000 subscribers on

YouTube and over 1,000 videos online before the Covid-19 crisis. Some of these videos had reached two million views, which is unheard of in the healthcare sector.

2.1.2 Communication between healthcare professionals

Healthcare professionals, such as dentists, doctors and specialists, generally communicated through shared medical records, written reports and meetings. However, there were challenges associated with coordinating care between different professionals and transmitting medical information effectively.

- ✓ Verbal communication: Dentists often met face-to-face to discuss cases, share information and make collaborative decisions. Team meetings, clinical conferences and informal discussions were common means of communication.
- ✓ Paper medical records: Patient information was generally stored in paper medical records, making it difficult to share information quickly and securely between healthcare professionals. Information was often transmitted by fax or post.
- ✓ Telephone calls: Dentists frequently used the telephone to communicate with each other, whether to discuss cases, seek advice or transfer patients. However, it could sometimes be difficult to reach the right people at the right time.
- ✓ E-mail: E-mail was used to send non-urgent information, reports and test results between healthcare professionals. However, this could lead to delays in transmission and response.
- ✓ Hospital information systems: Hospitals and healthcare facilities often used information systems to record and share patient information. However, interoperability between different systems could be a challenge, limiting communication between different facilities.
- ✓ Interprofessional meetings: In some cases, healthcare professionals came together to discuss complex cases, notably at multidisciplinary meetings. This enabled a more holistic and collaborative approach to decision-making.

Given the constant evolution of healthcare knowledge and medical practices, healthcare professionals are obliged to keep up to date and multiply their communication channels.

From social networks to online communities, mobile applications and, last but not least, telemedicine, healthcare professionals can't escape the digital age, and e-health has well and truly taken its place in the way they communicate with each other.

Up to now, digital technology has offered a wealth of possibilities, but these have been characterized by difficulties of application and a reluctance to use them on the part of practitioners, who seem to be waiting for a helping hand to break through the barriers of traditional tools, get out of their comfort zone and make the most of new technologies.

2.1.3 Institutional communication

Healthcare institutions and government organizations used a variety of communication channels to disseminate information about public health, prevention programs, awareness campaigns and new medical research. These included brochures, posters, websites, conferences and traditional media.

Awareness and education programs were also set up in schools, workplaces and communities.

2.2 Situation during the COVID health crisis

The pandemic is said to have made healthcare professionals aware of the benefits and advantages of digital technology in an unprecedented way. Pressed for time and affected by contact limitations, dentists are looking for solutions adapted to this exceptional situation, and expect convenience, rapid responses and meetings tailored to their conditions. Increasingly, healthcare professionals are learning, asking questions and sharing information via digital tools, primarily their Smartphones.

The study “Digital Doctor 2020” (Reena Sangar, 2020), conducted by Ipsos, analyzed the digital uses of healthcare professionals in 21 countries around the world, and showed that the majority of practitioners claimed to have a good knowledge of today's digital solutions, notably telemedicine with 69% (Compared with only 34% before the health crisis) and remote patient monitoring tools with 51%. Doctors had a very positive attitude towards e-health, with high expectations of pharmaceutical companies: 69% thought that these companies should play a proactive role in developing connected solutions for patients. Nearly 81% believed that connected health devices will be integrated into patient treatment and follow-up even after the COVID-19 crisis.

The national barometer “Health crisis accelerating Caregiver 3.0?” (360 Medics, 2021), carried out by 360Medics in collaboration with Egora, Techtomed and SimforHealth and published in February 2021, highlighted the accelerating digitization of healthcare professional’s practice in response to the pandemic. Carried out among 2,400 healthcare professionals in France, the national barometer shows that digital is now embedded in medical practice, with almost 87% of doctors and 81% of caregivers using at least one digital tool as part of their profession since

the start of the health crisis. The increase in usage was observed for all digital tools without exception. However, it should be noted that the tools with the lowest pre-crisis penetration showed the strongest progression, notably teleconsultation (+21%), followed by peer-to-peer platforms (+13%). For the 3 tools most widely used before the crisis, we also observe a rather remarkable progression: websites of learned societies and healthcare institutions (+8.4%), online medical journals and scientific publications (+5.1%) and mobile medical applications (+5%). In terms of confidence in these digital tools, around 80% of caregivers said they trusted them, an increase of 26% on pre-crisis results.

As a matter of fact, almost 64% of healthcare professionals used digital tools for training, information or prescription assistance “during the consultation, in full view of the patient” (360 Medics, 2021), and around 88% of doctors thought that digital tools would have a positive long-term impact (>10 years). In addition to trust, the national barometer reported a high level of digital dependency: 80% of doctors said they couldn't do without digital tools in their practice. The barometer also pointed out that: " Concerning the areas in which caregivers most need digital today, access to scientific information comes in 1st position (78.1%). In 2nd place, access to clinical and practical tools (70%) and in third place, exchanges between colleagues (49%)" (360 Medics, 2021).

In her white paper “ The connected practitioner" (Denise Silber, 2023), Denise Silber described the relationship between healthcare professionals and social networks. She showed that the network most cited by practitioners was LinkedIn. This professional network makes it possible to identify and connect with healthcare professionals from all over the world, thanks to a multi-criteria internal search engine, numerous specialized groups, and hashtags or keywords inserted in publications.

As for Twitter, Silber points out that it is mainly used by individual practitioners, but also by learned societies, medical congresses and events, as well as institutions, to inform and generate discussion via hashtags. "On Twitter, nearly 14,000 hashtags concerning medical congresses are listed worldwide in June 2020" (Denise Silber, 2023). It's worth noting that the hashtag #doctoctoc is widely used between doctors to call on the community and seek advice from colleagues.

Since 2014, the “Patients in Network” association has been developing social networks for patients with severe pathologies and those around them, with the aim of helping them live better with their illnesses.

With this in mind, the association conducted a survey (Patients en réseau, 2020), in September 2020, on the use of these social networks by cancer patients during the health crisis.

The results showed that these networks played an important role for patients in their fight against cancer. In fact, half the patients connected to them at least once a week, including 25% every day. Nearly 92% of those surveyed trusted the information offered by these networks, and 89% would recommend them to other patients.

The average rating given to these social networks developed by the association was 8.4/10.

Thanks to the Internet (Web and social networks), almost 55% of patients discovered the social network “My Cancer Network” and signed up mainly to look for information about cancer (73%), exchange with other patients (62%) and receive advice about their disease (49%).

Patients said that using this social network enabled them to prepare for treatment (42%), exchange with other patients suffering from the same disease (40%), find out about supportive care (39%) and support structures (34%), and cope with the undesirable effects of their treatments (32%).

Finally, the survey highlighted the importance of digital technology and social networks, in particular “ My Cancer Network “, in breaking patients' isolation during the pandemic and giving them the opportunity to express themselves and find out more about their disease.

Public authorities have encouraged the use of telemedicine services by easing restrictions:

Prior to the COVID-19 pandemic, telemedicine services were becoming more common, but they still made up a relatively tiny fraction of all healthcare services provided in the OECD countries2. In Australia, Canada, and Portugal, for example, telemedicine services accounted for between 0.1% and 0.2% of all in-person consultations (Oliveira, 2020). Although using telemedicine services was feasible in the majority of countries, the unique regulations that it frequently had to adhere to tended to hinder its adoption.

All OECD nations were given until the end of April 2022 to submit their answers to the Telemedicine and COVID-19 Survey questionnaire, which was distributed to them in December 2021. A total of 31 countries responded. The use of information and communication technology to deliver medical care remotely is known as telemedicine (Oliveira, 2020). It has three categories—teleconsultations, storage and transmission, and remote monitoring—which can be combined as needed. discloses that, before to March 2020, nine nations—Estonia,

Hungary, Iceland, Ireland, Korea, Luxembourg, Mexico, Turkey, and the United States—only permitted in-person medical consultations. (Figure 2).

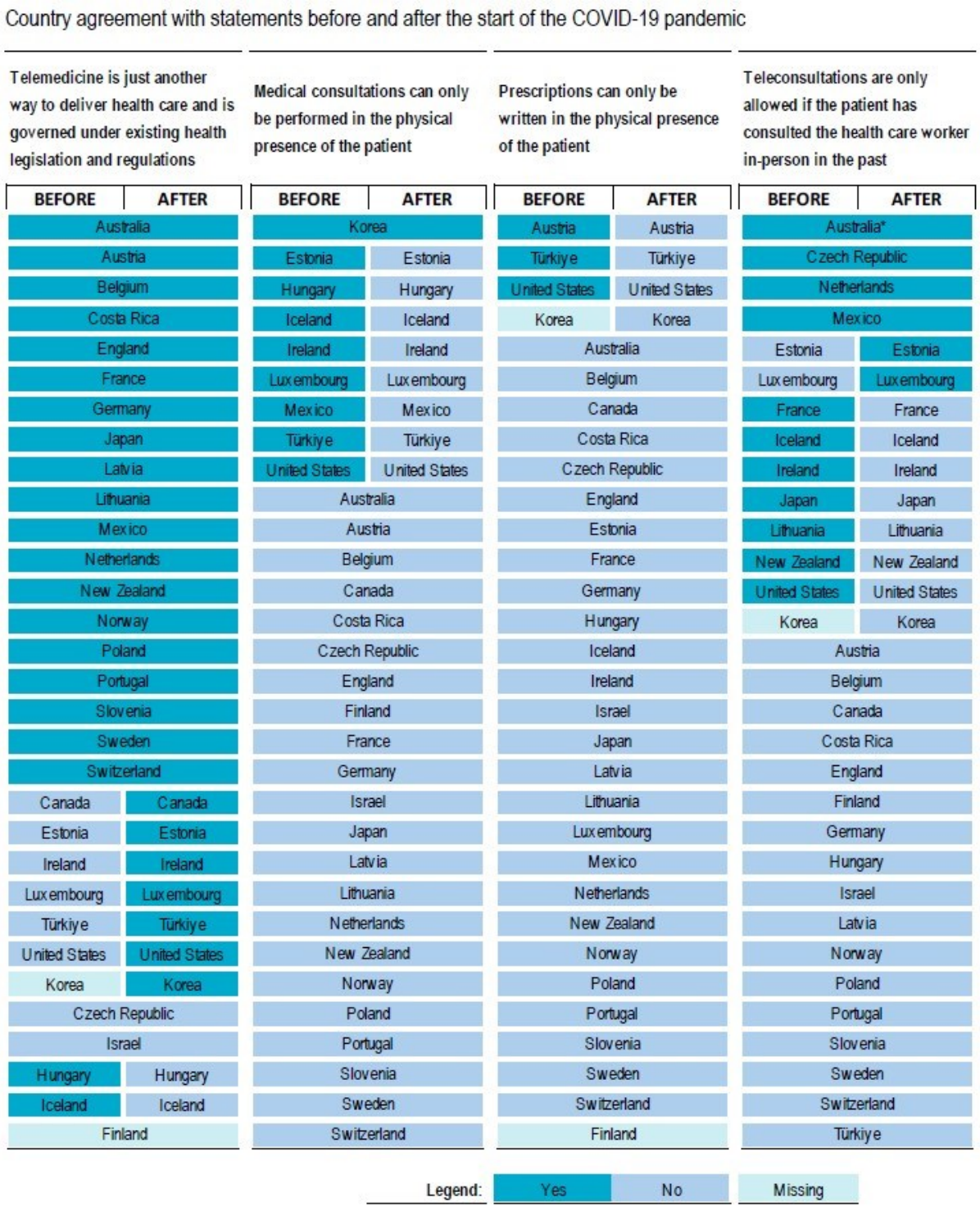

Figure 2 : Pre-pandemic restrictions on the use of telemedicine eased in early 2020 (adapted from OECD, 2023)

Public authorities and healthcare providers swiftly resorted to remote care services in early 2020 as a response to the COVID-19 pandemic (OECD, 2023). All of these nations, with the exception of one, did away with this criterion after March 2020. Prescriptions no longer need to be written in the presence of patients in Austria, the US, or Turkey. Additionally, seven states have loosened the restriction that only permits teleconsultations for patients who have previously seen their doctor in person. Since the pandemic's breakout, Estonia and Turkey have updated their laws and implemented new ones to permit or control the use of telemedicine. The Medicare program's restrictions, which limited telehealth to practitioners located in rural areas, have been eliminated in the United States. Korea authorized the temporary use of telemedicine services once the maximum alert threshold for COVID-19 had been reached.

Significant changes were implemented after the epidemic began to enable health providers other than physicians—nurses, for instance—to provide remote consultations. The policies of six nations—Germany, Estonia, the United States, Iceland, Luxembourg, and Portugal—about medical personnel authorized to provide teleconsultations have been modified. Currently, teleconsultations by healthcare providers other than physicians are permitted in 23 countries. Whether or not to accept patients under these circumstances is a decision that is left to the healthcare professionals alone in 20 OECD nations.

The patient has to provide prior written or verbal consent in 23 different nations. Following a teleconsultation, in-person sessions are not necessary in 28 countries, and teleconsultations between providers are permitted in an additional 23 countries.

[2] : Australia, Austria, Belgium, Canada, Chile, Colombia, Costa Rica, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

The use of telemedicine surged during the COVID-19 pandemic, partly offsetting the disruption to face-to-face care services:

In the initial months of the pandemic, teleconsultations skyrocketed, to the extent that they somewhat compensated the drop in in-person medical services.

In Australia, teleconsultations accounted for 15.5 million, or 13.3%, of all services covered by the Medicare system between July and September 2020.

In Belgium, 44.4% of all appointments in April were conducted remotely; in January and February, there were no teleconsultations; thus, benefits totaling around EUR 238 million were disbursed.

In contrast to 1.8% of all ambulatory visits in the fourth quarter of 2019, 73.7% of all general practitioner consultations and 63.9% of specialist consultations in Canada were performed remotely in the second quarter of 2020.

2020 saw 33% of discussions in Costa Rica take place virtually (OECD, 2021).

The number of teleconsultations that were billed to the Health Insurance in France climbed by 40,000 acts per month in the first half of 2020, reaching 4.5 million in April. Out of four consultations, one was place via teleconsultation during the lockdown.

In comparison to the same period in 2018,-19, primary care centers in Iceland offered 69% more telephone consultations in March and April. At that time, over 80% of medical appointments were made through remote services.

By 2020, there were about 52.7 million Medicare fee-for-service teleconsultations conducted in the US, a 63-fold increase.

In 2020, teleconsultations accounted for over half of all medical consultations in Denmark and Spain.

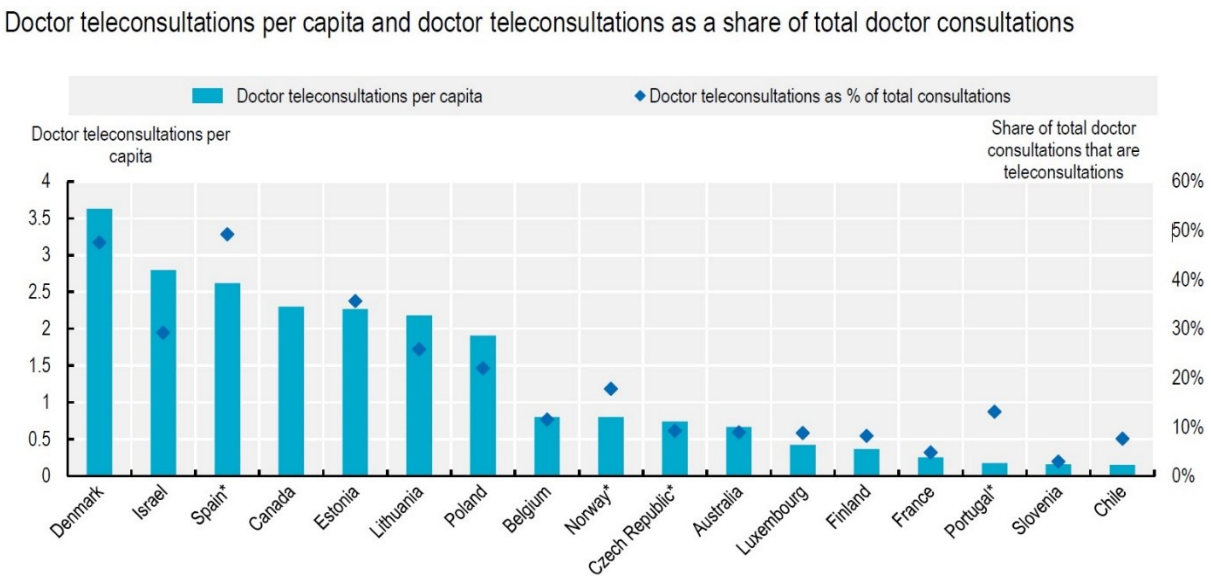

Figure 3 : Medical teleconsultations in OECD countries, 2020 (adapted from OECD, 2023)

Telemedicine measures adopted in response to the pandemic are often temporary:

Changes to financial arrangements were or are transitory and may be subject to review in 12 other OECD nations examined, while regulations were made temporarily in 16 of the countries and are subject to ongoing or periodic reassessment.

Since the commencement of the pandemic, Austria has seen multiple renewals of the temporary measures.

In Korea, teleconsultations are only used in extreme circumstances, such pandemics, and services linked to them are temporarily established in order to stop the spread of contagious diseases within hospitals.

Eight nations—the United States, Mexico, Costa Rica, Hungary, Iceland, Lithuania, and Belgium—are presently assessing and creating frameworks to control and govern the use of telemedicine services through legislation.

2.3 Situation after the COVID health crisis

Switzerland has only made a few of the modifications to the funding and/or payment systems for providers permanent; Australia, England, Estonia, Lithuania, Luxembourg, Poland, and Turkey have all made these changes permanent.

Since January 1, 2022, the majority of the telehealth services in Australia that were established to combat COVID-19 have been made permanent as part of a national telehealth program that includes, among other things, coverage for all video services provided during the pandemic and ensures that patients affected by natural disasters have unrestricted access to medical consultations with doctors.

Since the provinces and territories in Canada bear primary responsibility for the administration and financing of healthcare services, the kind of modifications made and whether they are permanent or temporary differ depending on the area in issue.

Six nations (Estonia, France, Israel, Luxembourg, Portugal, and Turkey) have legislation that, at the very least, partially established after March 2020 and are now permanent. (OECD, 2023).

3 Relationship between teledentistry and treatment planning

3.1 From diagnosis to treatment planning

A branch of telemedicine called teledentistry has revolutionized dentistry. By utilizing digital communication technology, it increases accessibility, eliminates geographical barriers, and gives patients and practitioners more authority.

- **Virtual consultations for diagnoses:**

Teledentistry removes the necessity for in-person consultations by enabling patients to consult with a specialist remotely. Dentists can analyze oral health issues, evaluate symptoms, and make preliminary diagnosis via video chats or secure messaging systems.

- **Digital imaging and X-rays:**

High-resolution images are obtained by the use of intraoral cameras and digital radiography in teledentistry. Dental experts can securely receive and examine these pictures.

For instance, a nearby clinic can perform a panoramic X-ray on a patient who is experiencing jaw pain. After that, the picture is sent to an expert for evaluation, which aids in the diagnosis of temporomandibular joint (TMJ) conditions.

- **Collaboration and second opinions :**

Dental experts can collaborate more easily thanks to teledentistry. More precise diagnoses are made possible for dentists by their ability to obtain second opinions from peers or specialists.

Example: To discuss a complicated case with impacted wisdom teeth, a general dentist uses a virtual platform to communicate with an oral surgeon. The surgeon gives advice on the most effective course of treatment.

- **Treatment planning and case discussion:**

Beyond diagnosis, teledentistry also includes treatment planning. Patients and dentists can communicate virtually about treatment alternatives, risks, and advantages.

An illustration would be a patient who is considering an implant-supported prosthesis. During virtual consultations, the dentist shows various treatment options while accounting for costs, aesthetics, and bone density.

- **Preventive education and oral hygiene advice:**

Patient education is the main objective of teledentistry. Dentists can provide nutritional suggestions, preventive measures, and individualized advise on oral hygiene.

Example: The pediatric dentist makes a video call to the parent of the child, showing them how to brush properly and going over cavity prevention tactics.

- **Progress monitoring and follow-up :**

Following the start of treatment, teledentistry allows for remote follow-up. Dentists are qualified to evaluate healing, track advancement, and address any issues.

For instance, a patient recovering from periodontal surgery emails pictures of his gums each week as they grow back. The dentist keeps an eye on things and modifies the treatment plan as needed.

To put it briefly, teledentistry allows patients to actively engage in their dental health journey by overcoming physical barriers. From the first diagnosis to the total planning of care, it promotes a cooperative, patient-focused methodology. Teledentistry holds the potential to transform the dental care industry by enhancing accessibility, efficiency, and patient-friendliness, in line with the ongoing advancements in technology.

However, the technological prowess of teledentistry is not the only factor contributing to its success; the dental practitioners who use this game-changing instrument also need to possess empathy and knowledge.

3.2 Use of Teledentistry for Diagnosis and Patient Monitoring in Orthodontics

There have been several descriptions in the literature regarding the potential uses of technology for remote diagnosis and monitoring of orthodontic patients. (Favero L, Pavan L, 2009; Zotti F, Dalessandri D, Salgarello S, Piancino M, Bonetti S, Visconti L, 2016)

One of the main challenges faced by clinicians is finding reliable methods for assessing soft tissue (Fourie Z, Damstra J, Gerrits PO, 2010). While three-dimensional examination methods have brought significant innovation (Metzger TE, Kula KS, Eckert GJ, 2013), static records have inherent limitations when it comes to evaluating the lip posture of orthodontic patients.

In order to overcome this drawback, Zamzam and Luther (Zamzam N, 2001) examined two dynamic lip position evaluation techniques in kids with and without cerebral palsy. The authors evaluated the viability of a video surveillance system in their research as a substitute method for obtaining trustworthy data on kids' resting mouth posture (open or closed). The assessment technique comprised filming patients going about their regular lives with a video camera so that observers could watch them in private.

Direct clinical examination was contrasted with this assessment method. Patients' lip positions were categorized (Jackson D, 1962), and the two approaches' agreement rates were computed. While the agreement between the direct examination and the remote surveillance system was deemed good, the intra-examiner agreement rates were only modest for each approach separately.

This finding implies that videotaping patients may be a useful method for determining lip posture. Given that mouth breathers' open mouth posture has been demonstrated to negatively impact craniofacial growth and occlusion development, this approach may be especially helpful in assessing children who may be suspected of having oral respiration (Feres MF, Muniz TS, de Andrade SH, Lemos Mde M, 2015; Lione R, Buongiorno M, Franchi L, 2014).

Furthermore, as patient collaboration is essential to the effectiveness of orthodontic treatment, video recording may also be a useful tool for tracking patients' treatment compliance. Video recordings may offer insightful information about how patients are progressing.

Orthodontic cases that are considered "difficult" by orthodontists themselves are often associated with issues related to oral hygiene, compliance, and patient requests for additional appointments (Cassinelli AG, Firestone AR, Beck FM, 2003).

However, using mobile videophones for remote patient monitoring has showed potential in treating minor orthodontic problems. Ten young orthodontic patients were given mobile videophones and told to call their orthodontist for guidance in the event of a small emergency in a study by Favero et al. (Favero L, Pavan L, 2009). The majority of the situations could be handled at home with ease, and the patients expressed great satisfaction, therefore this strategy worked. Supporting the use of this resource in private practices as well as public health services should be easy given how simple it is to provide remote support and how beneficial it has been shown to be. This would minimize disruptions for professionals, patients, and healthcare systems in addition to lowering expenses.

In a different study, Zotti et al. (Zotti F, Dalessandri D, Salgarello S, Piancino M, Bonetti S, Visconti L, 2016) investigated the use of a smartphone app to help teenagers receiving full-fixed orthodontic treatment maintain their dental hygiene. Two groups of patients were created, one for the study and one for enrollment in a WhatsApp group. Patients in this group were invited to upload "selfies" showing their level of oral hygiene and to compete. Additionally, they were told to snap photos both before and after using tablets that revealed plaque, and a weekly ranking of their cleanliness level was established. Users of the WhatsApp group could communicate with one another and exchange movies, images, and information about orthodontics and dental hygiene. Compared to the control group, the study group showed improved rates of gingival and plaque indices after six months of therapy. This demonstrates how app-based strategies may enhance the results of oral hygiene practices during orthodontic treatment. Following the completion of the ninth month of therapy, the study group saw a significant decrease in the incidence of caries and white spot lesions.

Voice over Internet Protocol (VoIP) technologies, like Skype, should be widely adopted in private practice offices as an alternative to traditional telephone service, according to Mupparapu (Mupparapu M, 2008). The author claims that VoIP may be simply installed in any office with broadband connectivity and offers significant cost advantages.

In conclusion, it is strongly advised to routinely integrate such instruments into orthodontic clinical practice. The majority of the time, practitioners and patients can benefit greatly from the use of low-cost technologies to remotely monitor, diagnose, connect with, and inspire patients. Nonetheless, it is vital to tailor every resource to the unique needs of the patient, the clinical setting, and the purpose itself, giving top priority to objectives like enhancing patient oral health, cutting expenses, and raising output. Prior to deploying any system, privacy-related

concerns, along with ethical and legal considerations, must be carefully addressed, as patient confidentiality is a fundamental concern (Jampani ND, 2011; Sfikas PM, 1997).

3.3 Teledentistry and Implantology

The e-health area has experienced a revolution thanks to the digitization of health data and computer-assisted implant surgical techniques, which have enabled an unparalleled interchange of knowledge among specialists. The quality of prosthetic rehabilitation on implants has significantly improved as a result of these developments.

In order to assess the final prosthetic project from a multidisciplinary standpoint, specialists from different fields may now work together through a shared software interface thanks to the availability of digitized, trustworthy, and useable data for prosthetic rehabilitation. Surgeons, dentists, prosthetists, and patients can address surgical, occlusal, cosmetic, and design restrictions with the program by merging bone pictures, mucosal contours, dental impressions, occlusion, and face scans of the patient. Accurate virtual 3D modeling of the patient is made possible by the use of guided surgical procedures and planning templates.

Telemedicine and teleexpertise further contribute to improving the quality, security, availability, and accessibility of implantology. Continuous digital workflow protocols ensure seamless collaboration among all stakeholders involved in implant planning, optimizing the prosthetic, occlusal, and aesthetic outcomes while considering surgical and anatomical constraints. Patients are informed about potential complications before surgery, eliminating any uncertainties that may arise postoperatively.

As a result, the patient is really satisfied when the temporary prosthesis is placed right away. Consequently, both the patient and the physician experience less stress during the implant surgery. When combined with a numerical streaming element, 3D planning is a useful teaching and communication tool for the patient, dentist, prosthetist, and surgeon. In order to improve accuracy and speed in implant rehabilitation, telemedicine and teleexpertise are becoming the go-to technological solutions thanks to this cooperative approach and the validation of computer-assisted numerical streaming surgery.

The effectiveness and practicality of a prosthetic attached to an implant are influenced by a variety of factors including bone structure, occlusal alignment, prosthetic design, and surgical limitations. The health information necessary for prosthetic restoration on an implant is now easily accessible, accurate, and readily available in digital format. The integration of health data into digital platforms, along with computer-assisted protocols for implant surgery,

facilitates a groundbreaking exchange of knowledge among professionals in the field. Utilizing telemedicine and teleexpertise, e-health enhances the range, quality, safety, and accessibility of interdisciplinary implantology. By utilizing digital streaming, experts and contributors can collaborate to determine and confirm the optimal placement of implants in the prosthetic treatment plan.(Giraudeau, 2018)

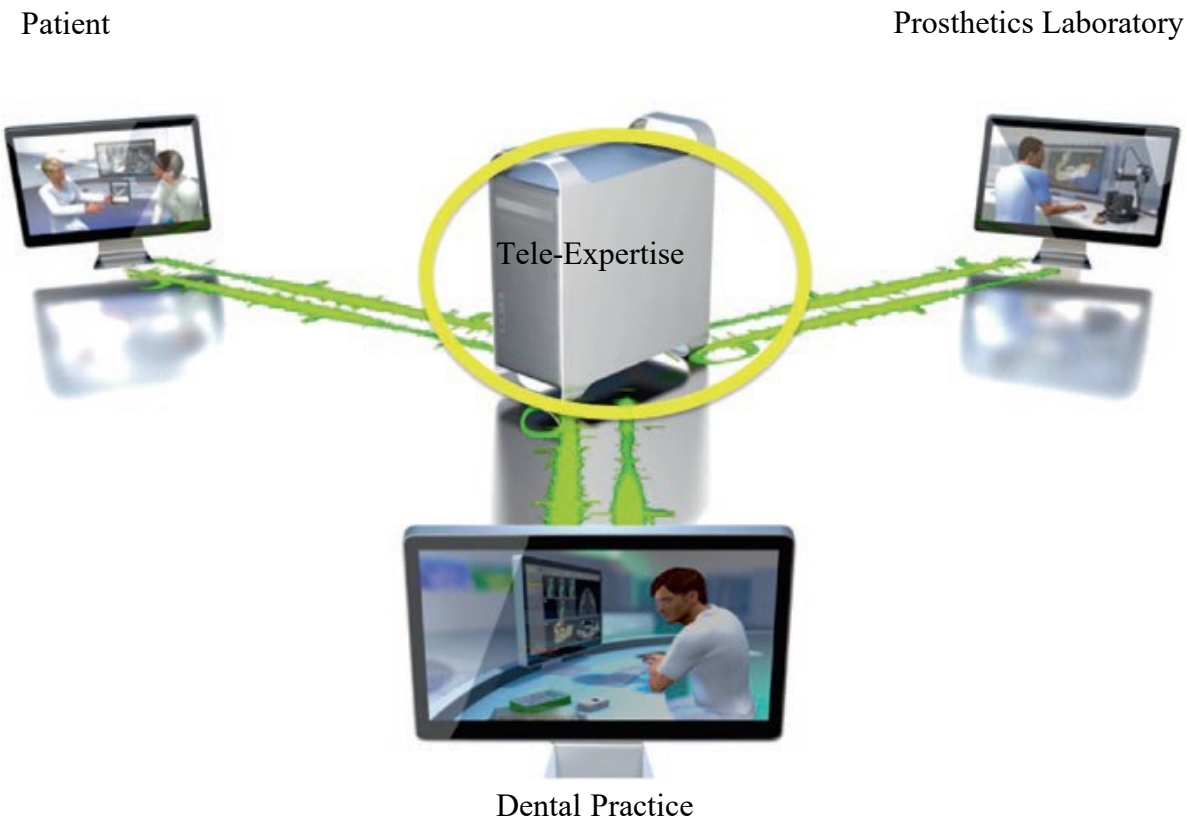

Figure 4 : Dataflow between tele-experts (adapted from Giraudeau, 2018)

E-health makes it possible for knowledgeable medical professionals from different specialties to share ground-breaking healthcare information. For patients, dental implant recovery is a complex, taxing, and expensive process. Prosthetists, dentists, and surgeons need to have access to specialist knowledge in this sector and complete extensive training programs. Patients who live in rural places can get professional advice from a distance thanks to telemedicine, which gives them access to important communication and information tools.

When it comes to providing implant alternatives to their patients or having to keep an eye on the results of surgery, many dentists could experience a sense of isolation. Using digital imprints, X-rays, and a clinical examination, a general dentist can assess an implant's feasibility. A specialist can then promptly and thoroughly offer a remote expert opinion if

needed. By using this method, the number of needless appointments is decreased and time management between consultations and implant placement is optimized. Patients gain from more implant options and simpler post-operative follow-ups as a result. Effective and interdisciplinary care is made possible by teleexpertise, which improves the implant project's quality and safety.

Digital streaming plays a crucial role in enhancing implant positioning by replicating the ideal implant position, which is initially validated by expert contributors in the prosthetic project (Davarpanah K, Demurashvili G, Daas M, Rajzbaum P, Capelle-Ouadah N & S, 2012; Hämmerle CH, Stone P, Jung RE, Kapos T, 2009).

Modern protocols involve a seamless digital workflow, including dental scanning (Dicom), digital impressions (STL), superimposition of dental scans and impressions, facial scanning, planning, 3D printing of surgical guides and dental arches, as well as milling of temporary and permanent prostheses. However, it is important to note that certain computer-assisted surgical aid software lack a digital streaming component, requiring the fabrication of a stone model, which may compromise accuracy.

Thanks to the software, surgeons, dentists, and prosthetists are granted complete autonomy in creating prostheses and guides or positioning implants by utilizing a modifiable "open STL" file. This eliminates the need for a guide maker to make decisions ranging from the guide to implant positioning, which previously led to issues during the fabrication of the permanent prosthesis. Consequently, practitioners now have full authority over the final product.

Surgical guidance and computer assistance facilitate the development and verification of a preoperative product. Gum flap separation from the mucosal incision is modest to nonexistent (Moraschini V, Velloso G, Luz D, 2015). The risk connected with the drill is eliminated by the stabilization of the drill bushing handle within the drill tip.

Improved primary stability of the implant is ensured by the lack of drill impact point displacement caused by sliding when drilling on an uneven or projecting bone crest. Drilling that is both quick and safe keeps the drilling circular and reduces the chance of heating the bone. Placing the implant apex precisely in contact with the downhole is made easier by the implant burying mark on the implant holder. When rotating the implant abutted in the downhole, there is no chance of harming the peri-implant soft bone. Operating X-rays and implant axis control are not required. As a result, there is less intrusive surgery, shorter recovery times, and easier postoperative care. Additionally, collateral damage and prosthetic failures

including intra-sinus implant, nerve and neighboring root damage, and unsuitable implant axis are avoided.

The prosthetic project is maximally optimized in terms of occlusion and aesthetics, while taking into account bone and surgical limits (Davarpanah K, Demurashvili G, Daas M, Rajzbaum P, Capelle-Ouadah N & S, 2012; Hämmerle CH, Stone P, Jung RE, Kapos T, 2009).

Prompt patient satisfaction is ensured by the interim prosthesis being implemented immediately (Stapleton BM, Lin WS, Ntounis A, Harris BT, 2014). The procedure is less "stressful" for the patient and the surgeon when implant surgery is simplified (Nickenig HJ, Wichmann M, Hamel J, Schlegel KA, 2010; Sarment DP, Surkovic P, 2003).

The surgeon, prosthetist, dentist, and patient can all communicate and learn from each other using 3D planning. It makes the sharing of knowledge and comprehension about the prosthetic project easier. Visualizing the future crown before surgery allows the project to be validated or adjusted in a multidisciplinary manner to fulfill the patient's needs and respect the surgeon, prosthetist, and dentist's limitations. The practitioner can accurately estimate the future cost of the prosthesis for the patient by knowing the location of the implant in the future and the kind of pillar that will be utilized.

In order to reduce surgical risks and human error, it is imperative to anticipate all risk variables prior to surgery in order to limit the probability of failure in the prosthetic implant project. Every stakeholder contributes to verifying the planning process and making sure that patients are informed of any project challenges in advance to avoid complications after surgery. This technique requires expertise and a comprehensive surgical and digital vision, with meticulous planning to avoid errors during surgery. Successful management of unexpected challenges necessitates a high level of surgical implant experience.

Telemedicine and teleexpertise offer opportunities for collaborative validation and computer-assisted surgery, enhancing the accuracy and efficiency of implant rehabilitation. However, mastering these technologies requires a learning curve and close collaboration among the surgeon, dentist, prosthetist, and patient.(Giraudeau, 2018)

3.4 The role of virtual reality (VR) in diagnosis and treatment planning

In dentistry, virtual reality (VR) has emerged as a potent instrument that is transforming the way practitioners approach diagnosis and treatment planning. Virtual reality (VR) offers dental practitioners an interactive and dynamic platform to investigate complicated anatomical

structures, simulate treatment situations, and improve their decision-making process by submerging users in a simulated three-dimensional world. The following are some important details:

- Precise visualization of dental anatomy

The fine details of dental anatomy are typically missed by traditional radiography and two-dimensional imaging. Clinicians can see soft tissues, teeth, roots, and bone structures in a realistic three-dimensional environment by using virtual reality.

For instance, in endodontics, a practitioner can digitally rotate and dissect a patient's impacted third molar to determine the exact position of the tooth in respect to surrounding tissues. This allows for more precise treatment planning.

- Interactive treatment simulation

Clinicians can practice different treatment scenarios using virtual reality before doing actual surgeries. This participatory method improves comprehension and self-assurance.

For instance, in oral surgery can simulate orthognathic surgery on a patient with severe malocclusion by using virtual reality. Through the use of virtual jaw adjustment, they evaluate the effects on airway patency, occlusion, and face aesthetics. The surgical plan is based on this informed simulation.

- Collaborative decision-making:

Virtual reality has made it possible for dental teams to collaborate easily. Together, prosthodontists, dentists, and oral surgeons may evaluate cases, go over available treatments, and come to well-informed conclusions.

A multidisciplinary team might debate a challenging implant case, for instance. They investigate bone density, angulation, and closeness to important structures using virtual reality. In order to ensure ideal function and aesthetics, the prosthodontist visualizes the finished restoration.

- Patient education and informed consent:

People's understanding of patient education is being revolutionized by virtual reality, which allows users to virtually visit their own mouth. Patients obtain enhanced comprehension of their ailment and suggested interventions.

Patients with nerve damage, for instance, are given a virtual tour of their impending root canal treatment. They witness the diseased pulp chamber, the tools being used, and the methodical procedure. Anxiety is lessened and confidence is increased by this immersive experience.

- Limitations and challenges

Virtual reality has promise, but there are drawbacks, including expense, technology needs, and the demand for specific training. Furthermore, not every dental operation is a good fit for virtual reality simulation.

In conclusion, virtual reality has the potential to revolutionize dental diagnosis and treatment planning. Dental practitioners can enhance accuracy, teamwork, and patient engagement by incorporating virtual reality into their clinical operations. We expect to see even more creative applications in this ever-evolving field as technology advances

4 Artificial intelligence (AI) and Teledentistry

Recent years have seen tremendous progress in artificial intelligence (AI), and when combined with teledentistry, AI has the potential to completely change remote dental care. Predictive models for risk assessment and diagnostic services in oral health have been developed through the application of machine learning, specifically deep learning algorithms.

By facilitating remote screening, diagnosis, record-keeping, triaging, and condition monitoring of dental issues, this development can improve teledentistry. (Batra, P.; Tagra, H.; Katyal, 2022; Mariño, R.J.; Uribe, S.E.; Chen, R.; Schwendicke, F.; Giraudeau, N.; Scheerman, 2024)

Patients have the potential to take control of their own health by self-diagnosing and implementing preventive measures or managing initial stages of dental conditions. Both the patient and the dental professional may benefit from the use of AI in teledentistry. By handling basic cases that only require routine treatments, dentists can focus on more intricate cases. Moreover, this technology can allow dentists to reach a broader underserved population in remote areas. AI in teledentistry has the ability to change dentistry from being a field focused just on treatment to one that takes a personalized preventive approach.

Future advancements in teledentistry are anticipated as artificial intelligence (AI) is incorporated. In dentistry, artificial intelligence (AI) refers to the creation of intelligent devices and systems that, via the use of preset algorithms, can simulate human intellect. These artificial intelligence (AI) tools can assist researchers, educators, and dentists in their specialized fields. (Batra, 2017)

AI's machine learning component allows systems to learn from experience instead of just preprogrammed data. Deep learning, which uses systems that use numerous layers of data processing akin to the neural networks in the human brain, is another development brought about by the advancement of AI. Through the analysis of these data layers, the system can provide interpretations. (Batra, Panchali, Anika Dawar, 2020; Tagra H, 2021)

For instance, AI-powered systems can analyze radiographs and suggest diagnoses based on differences in radiopacities, such as identifying carious teeth. AI-based tools can aid clinicians in screening, diagnosing, and making informed decisions. AI has been applied in the medical field for a number of purposes, such as data management, surveying, monitoring, medical education, health promotion, consultation, triaging, imaging, treatment, self-management, drug development, surgery, forecasting hospital death rates, evaluating treatment effectiveness,

assessing global health risks, forecasting pandemics, and assuring cybersecurity of telemedicine platforms. (Zhanar Bukeyeva, Timur Saliev, Senbekov, Maksut, 2020)

AI has proven to be useful in the diagnosis and treatment of a variety of acute and chronic illnesses, including diabetes, dermatological problems, cardiac problems, stroke treatment, ophthalmological abnormalities, and more.(Ellahham S, 2020; Li JO, Liu H, Ting DSJ, Jeon S, Chan RVP, 2020; Rabinovich EP, Capek S, Kumar JS, 2020; Young AT, Xiong M, Pfau J, Keiser MJ, 2020)

4.1 Platforms for Teledentistry

Teledentistry can be practiced using a variety of dedicated healthcare platforms that adhere to the guidelines set forth by the Health Insurance Portability and Accountability Act (HIPAA). These platforms prioritize the security and privacy of patient information by implementing end-to-end encryption. However, it is important to note that common platforms like Skype, Zoom, and Google Meet can also be used for teledentistry, provided that the necessary settings are configured to ensure HIPAA compliance. Alternatively, there are dedicated versions of these platforms, such as "Zoom for Healthcare" and "G Suite" by Google Meet, specifically designed for healthcare professionals.

In addition to these options, there are several teledentistry platforms available that utilize artificial intelligence, such as Dentulu, Toothpic, Rhinogram, Review tools, Smile snap, Teledentix, TeleDent, Carestack, and Dental Monitoring. (Morris RS, Hoye LN, Elnagar MH, 2019)

These platforms offer various functionalities, including diagnosis, sharing virtual records, providing alerts for potential complications, virtual monitoring of case progress, facilitating payments, and promoting dental health awareness. However, caution should be exercised when using platforms like WhatsApp, Apple FaceTime, and Facebook Messenger, as they do not comply with HIPAA regulations.(Park JH, Rogowski L, Kim JH, Al Shami S, 2021)

4.2 Applications of artificial intelligence in Teledentistry

Health care systems, physicians, researchers, and patients can all benefit from artificial intelligence (Figure 6). The following is a summary of the primary applications.

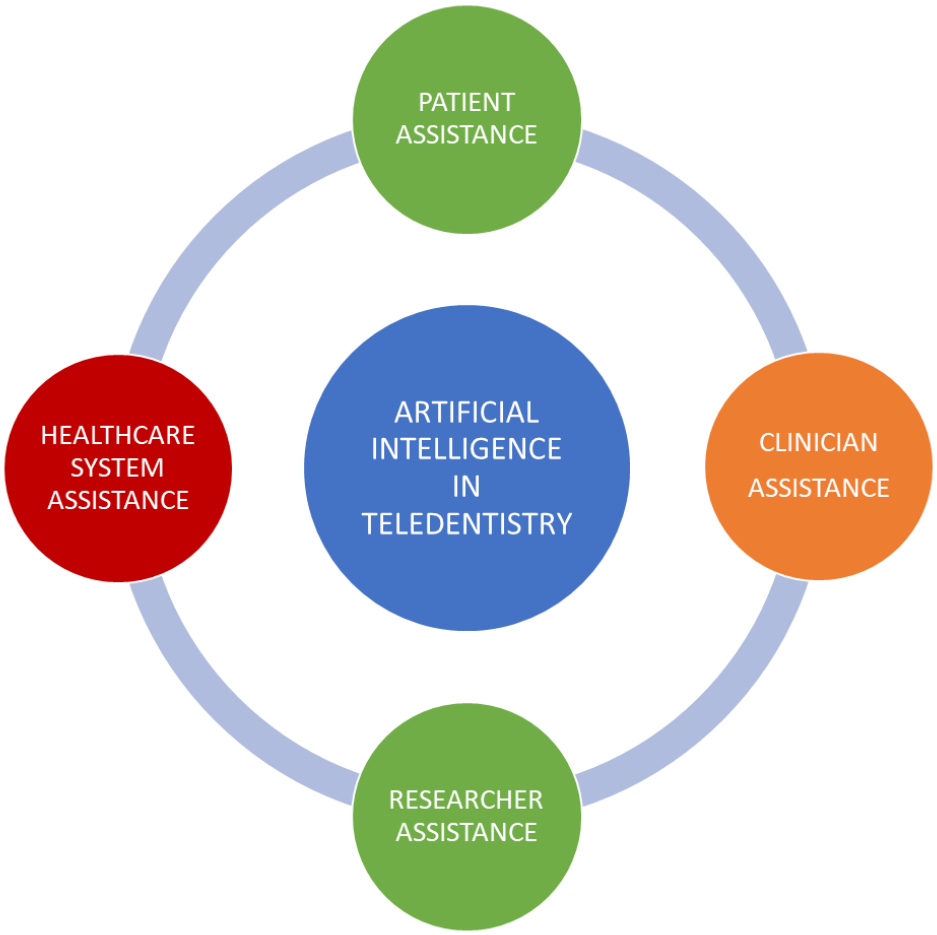

Figure 5 : Application of Artificial Intelligence in Teledentistry (adapted from Batra et al., 2022)

4.2.1 Screening, Diagnostic Workup and Triaging:

There are several benefits to using remote oral screening when the emphasis is on preventive rather than curative care. There could be a significant drop in problems linked to oral health by routinely screening the population. Early detection of demineralization can help avoid common dental disorders such as caries.

Furthermore, early detection of premalignant and malignant lesions can reduce mortality and morbidity. Remote oral surveillance can be helpful in screening for more serious disorders including oral malignancies. Oral cancers can be prevented in part by identifying high-risk groups and carrying out routine remote oral screenings. Patients with a high risk of oral cancer have been identified using artificial intelligence (AI) based on a variety of criteria, such as risk factors, habits, sociodemographic data, and genomic information. (Speight PM, Elliott AE, Jullien JA, Downer MC, 1995)

For the remote screening of illnesses such as lichen planus lesions, leukoplakia, and oral squamous cell cancer, straightforward techniques such as intraoral images have shown promise. (Fu Q, Li Z, Y Chen, 2020)

Additionally, an AI-powered smartphone-based auto-fluorescence oral cancer probe has been created to test for oral malignancies and rank them according to each patient's needs. (Song B, Sunny S, Uthoff RD, 2018)

By installing these probes in primary care facilities serving high-risk populations, remote consultations are made possible even in the event that medical personnel are not present. This strategy ultimately lessens the burden of oral diseases by facilitating predicted population risk classification. Additionally, AI has significantly improved remote forensic dentistry.

Based on radiographs or medical photos, software may reliably estimate a patient's age, and machine learning models can help with full-face reconstruction utilizing lateral cephalograms (De Tobel J, Radesh P, Vandermeulen D, 2017). (Niño-Sandoval TC, González FA, Jaque RA, Guevara Pérez SV, 2017)

Radiographs are a dentist's most important diagnostic tool since they are easily disseminated over the internet for teleconsultations. With the advent of digital radiography, precise measurements of object length, angle, location, and density are now achievable. A digital radiograph is made up of several pixels, each of which emits a distinct brightness level. (Yoon DC, Benn DK, Mol A, 2018)

By identifying differences in radiopacities, intelligent software and apps can analyze and interpret radiographs. These apps can help with cephalometric analysis during orthodontic diagnostic workup, offer recommendations about the existence of dental caries (Lee JH, Kim DH, Jeong SN, 2018), and alter bone level in relation to periodontal disorders. A physician then confirms these recommendations from a distance.

AI-based programs may also determine the extent of a lesion and suggest possible courses of action for the restoration of carious teeth. Similar to this, 3D CBCTs (Cone Beam Computed Tomography) have algorithms built in that can recognize and interpret cephalograms from CBCT images, as well as identify bones like the maxilla and mandible. This lessens the work that a clinician must do in addition to saving time.

Artificial intelligence is currently being used to diagnose a variety of dental diseases, including filled teeth, gingivitis, periodontitis, crowned teeth, and dental implants, thanks to the availability of digital images.(Hammerle CHF, Wiedemeier D, Steinmeier S, 2020)

AI can assist with tissue diagnosis in addition to clinical diagnosis by taking high-resolution pictures of biopsy slides, which a pathologist can subsequently examine remotely. (Skandarajah A, Sunny SP, Gurpur P, 2017)

4.2.2 Clinical Decision Support and Follow-Up

AI has significantly enhanced remote decision-making after the initial diagnosis. Various software applications have been created to aid healthcare professionals in making decisions using advanced deep learning algorithms. Simple decision-making software for cavities, marking margins on teeth in preparation for prosthesis fabrication, designing smiles, offering orthodontic treatment options, evaluating treatment results, modeling orthodontic or surgical procedures, tracking treatment progress, identifying bone loss through X-rays, and identifying the type of periodontitis by analyzing subgingival plaque are just a few examples of these tools.

Apart from the above described communication channels, there are specific AI-enabled observation and follow-up applications accessible. Dental Monitoring is one such piece of software that enables remote observation of tooth movement, fractures, wire engagement, and other pertinent variables. Furthermore, there are software applications designed to remind patients about medication schedules, upcoming appointments, and payment deadlines.(Kravitz ND, Burris B, Butler D, 2016)

4.2.3 Feedback Mechanism

In order to increase overall quality improvement, encourage reflective practice, and support professional development, patient feedback is essential. Traditionally, feedback is obtained through questionnaire-based assessments, which are now being incorporated into both medical education and medical revalidation processes. During a typical consultation, feedback is gathered through two main channels: face-to-face interactions and formal questionnaires. However, as remote interactions are not naturally comfortable for either party, the rise of teledentistry has brought a new dimension to the doctor-patient relationship.

Regretfully, the subtleties of distant contacts are not sufficiently covered in medical education. Therefore, in order to support continued progress in doctor-patient interactions within teledentistry, a constant and effective feedback mechanism is needed.

It will not be adequate to rely only on typical feedback questionnaires that are given out at predetermined times. In order to solve this, we suggest putting in place an AI-based framework that can gather input and help improve telemedicine doctor interactions. (Batra et al., 2022)

This framework categorizes feedback into 4 types:

- Form-based feedback
- Facial expression-based feedback
- Patient adhesion-based feedback
- Social media-based feedback

4.2.3.1 Form-based feedback

A mobile application utilizing Case-Based Reasoning to implement an AI system can be designed to inquire intelligently about the patient's satisfaction level during teleconsultation.

By considering the patient's profile, visit history, responses to previous questionnaires, and other relevant factors, this application can assess the quality of the interaction and provide a rating accordingly.

4.2.3.2 Facial expression-based feedback

During remote interactions, the detection of patient emotions holds significant importance. Emotion detection can be achieved through both verbal and non-verbal communication methods. However, non-verbal communication techniques are typically more effective at identifying emotions in contexts like distant learning and healthcare. Patients' facial expressions can reveal information about the kind of involvement they are receiving. These expressions can be ones of fear, joy, sorrow, rage, or perplexity. (Joshi M, Narahari KN, Chatterjee A, 2019)

Deep learning networks (DLN) that incorporate convolutional neural networks (CNN) are widely used to evaluate and detect facial expressions. (Khalil-Hani M, Liew SS, Syafeeza AR, 2014)

Remote instruction has previously made use of these models. (Tonguç G, 2020)

Both patients and physicians can have their facial expressions evaluated to see how engaged and expressive the physician is during a conversation. It can, for example, detect whether the doctor came out as irritable or friendly during the exchange, or whether any cell phone calls interrupted them, all of which could have an effect on their rating.

4.2.3.3 Patient adhesion-based feedback

AI-powered software has the capability to analyze the instances where patients fail to attend their scheduled appointments, which can also indicate a decline in patient retention. Additionally, AI can be utilized to evaluate the optimal timing for the next appointment for each individual patient. This assessment takes into account various factors including the patient's oral health, oral habits, likelihood of potential dental issues based on the current condition of their teeth, and their overall health status (including any other existing medical conditions).

If a patient fails to attend their appointment based on the aforementioned parameters, they would be classified as a lost patient. By conducting statistical analysis on a group of patients, the effectiveness of teledentistry can be evaluated.

4.2.3.4 Social media-based feedback

The emergence of different social platforms has led to patients openly sharing their experiences regarding the quality of their interactions with healthcare facilities and professionals, as well as providing ratings. Among these platforms, Twitter stands out as the most widely utilized form of social media for healthcare communication.(Pershad Y, Hangge PT, Albadawi H, 2018)

Automated web crawlers are employed to gather information from these platforms and provide valuable feedback. Web scraping involves the extraction of data from the internet through various methods. (Pereira RC, 2015)

Additionally, these forums play a crucial role in boosting a patient's confidence, especially when undergoing complex medical treatments.

4.3 Conclusion

The rise of various social media platforms has enabled patients to openly discuss their experiences concerning the quality of their interactions with healthcare providers and facilities, along with giving ratings. The most popular social media channel for communicating about healthcare is Twitter in particular. Automated web crawlers are utilized to collect data from these platforms, offering valuable insights. Web scraping encompasses the process of extracting data from the internet using diverse techniques. Furthermore, these online forums are instrumental in enhancing a patient's assurance, particularly during intricate medical procedures.

In the future, AI and teledentistry are expected to work together to improve the effectiveness and caliber of care while also helping healthcare organizations provide services at a reasonable

cost. To achieve this goal, further research in the field of AI is essential to facilitate the implementation of cost-effective interventions.

5 Economic implications of teledentistry

Teledentistry holds promise in enhancing the effectiveness and fairness of the health system. The effectiveness of teledentistry can be evaluated in conjunction with a clinical study or by utilizing modeling techniques. Nevertheless, there is a lack of evidence when it comes to the economic assessments of teledentistry initiatives.

5.1 Efficiency Is a Key Dimension of Health System Performance

In order to deliver dental care, consultations, and education, teledentistry makes use of information technology and telecommunications. It might improve how well the healthcare system functions. A health system's performance evaluation requires a clear definition of its parameters as well as an understanding of the main goals that it seeks to achieve.

A health system, according to the World Health Organization, is made up of all the entities, resources, and people that are involved in the financing, governing, and provision of services that are mainly meant to promote or preserve health. Different institutions and organizations, however, have proposed different definitions; some, like the OECD, have adopted broader viewpoints that encompass all determinants of health, including individual behavioral factors, while others have focused on more constrained bounds centered on medical care.

Different stakeholders are involved in each definition of the health-care system, and their information needs, communication styles, and goals may not always coincide. Service users, healthcare providers, buyer organizations, regulators, national or local government agencies, researchers, and the general public are some of these stakeholders.

Additionally, every definition outlines a unique collection of outcome metrics that must be taken into account during the assessment procedure. Population health, health status (clinical quality and appropriateness), responsiveness (including satisfaction and expectations), fairness (in terms of access and financial issues), and efficiency are generally the five core dimensions of health-care system performance (Smith, 2009). Performance of the health system is by nature multifaceted, irrespective of the boundaries that are acknowledged.

Teledentistry holds promise for improving oral health outcomes, reducing avoidable hospital stays, decreasing healthcare costs (i.e., efficiency), and improving access to dental services (i.e. equity). The efficiency of teledentistry's performance is emphasized from an economic standpoint. This makes it something that everyone concerned must take into account.

The public and commercial payers are interested in the efficiency for price purposes, patients expect better dental care, governments are willing to support treatments that improve results, and the sector is looking for creative business strategies.(Daniel SJ, 2016)

5.2 Economic Evaluations and Costs

Despite the fact that most reviews have emphasized the beneficial effects of teledentistry on oral health outcomes, it is important to proceed cautiously when interpreting these findings because the studies' overall quality is low. Although teledentistry's advantages and pilot programs have been thoroughly investigated, little research has been done on the usage of teledentistry's immediate effects and clinical efficacy.

These reviews (Flores, A.; Lazaro, S.; Molina-Bastos, C.; Guattini, V.; Umpierre, R.; Goncalves, M.; Carrard, 2020; Irving, M.; Stewart, R.; Spallek, H.; Blinkhorn, 2018; Joshi, V.; Bhardwaj, P.; Joshi, N.; Singh, K.; Bajaj, K.; Suthar, 2021; Uhrin, E.; Domokos, Z.; Czumbel, L.; Kói, T.; Hegyi, P.; Hermann, P.; Borbély, J.; Cavalcante, B.G.N.; Németh, 2023) summarized cost-related data rather than offering actual economic evaluations. The primary focus of these assessments was the cost savings linked to teledentistry, including fewer travel and waiting hours, as well as other cost-related features of telehealth, such as increased productivity, fewer needless travel, lower lodging costs, and shorter service wait times.

While some reviews did contain studies on cost savings, they did not connect these results to health outcomes, indicating that teledentistry may be a more affordable choice than in-person consultations.

However, some reviews (Irving, M.; Stewart, R.; Spallek, H.; Blinkhorn, 2018; Joshi, V.; Bhardwaj, P.; Joshi, N.; Singh, K.; Bajaj, K.; Suthar, 2021) merely assumed the cost-effectiveness of teledentistry without concrete evidence to support these claims.

Conversely, a study (Daniel, S.; Wu, L.; Kumar, 2013) emphasized the need for additional economic analyses in teledentistry to support any claims made about cost-effectiveness.

Although assumptions rather than hard data are usually the basis for these beliefs, teledentistry is frequently seen as a cost-saving and cost-effective option. Numerous reviews that have examined the health economic effects of teledentistry have depended on observational studies of low quality with imprecise methodology, limited sample sizes, participant self-reports, or subjective assessments.

These study designs don't offer a strong enough basis on which to draw judgments about the efficacy of teledentistry that are supported by data. Clinical trials are often regarded as the most suitable means for evaluating the effectiveness and cost-effectiveness of interventions, allowing for strong evidence-based conclusions. This is especially true of randomized controlled trials (RCTs) and other quasi-experimental designs. RCTs and other conventional methodologies may not be suitable for evaluating digital health interventions due to their complexity. (Hrynyschyn, R.; Helmer, 2022; Prediger, C.; Stock, C.)

RCTs may not adequately capture the long-term effects and economic consequences, even while they provide insightful information on the clinical efficacy and safety of therapies. Effectiveness trials may provide more useful information on how interventions function in the actual world when evaluating cost-effectiveness.

In order to find potential substitutes for RCTs in the evaluation of digital health interventions, Hrynyschyn et al. (2022) carried out a scoping review. (Hrynyschyn, R.; Helmer, 2022; Prediger, C.; Stock, C.)

The authors discovered that factorial designs, stepped-wedge designs, sequential multiple assignment randomized trials (SMARTs), and micro-randomized trials (MRTs) were the most often utilized designs for evaluating digital health interventions. (Hrynyschyn, R.; Helmer, 2022; Prediger, C.; Stock, C.)

These techniques enable the modification of interventions (like SMART or MRT) and the assessment of certain intervention elements (like factorial designs). (Hrynyschyn, R.; Prediger, C.; Stock, C.; Helmer, 2022)

In order to give lawmakers and dentists useful information about the viability, benefits, and challenges of teledentistry integration into healthcare systems, economic evaluations are essential. Researchers and healthcare professionals are beginning to recognize how important it is to assess the teledentistry's cost-effectiveness, return on investment, and overall economic sustainability. The growing popularity of teledentistry emphasizes the need for economic analyses to fully understand the benefits and financial ramifications of integrating it into oral healthcare systems. (Daniel, S., Mariño, R.; Ghanim, 2013; Wu, L.; Kumar, 2013)

In spite of this, Mariño et al. (2013) (Mariño, R.; Ghanim, 2013) brought attention to the persistent problem of the lack of research that sufficiently address the economic assessment of teledentistry.

In their thorough analysis of telemedicine, Eze et al. (Eze, N.D.; Mateus, C.; Cravo Oliveira Hashiguchi, 2020) found that a sizable percentage of the included systematic reviews were of poor to critically low quality. They pointed out that telemedicine has the potential to improve clinical outcomes, including glycemic control in diabetes patients and the quality and nutrition of their diets, at a reasonable cost. But they also noted that poor quality and reporting standards restricted how far these results could be applied.

6 Ethics and Teledentistry

When considering the concept of "telemedicine", which involves the absence of a physical health worker, it becomes evident that the fundamental aspect of medicine, the patient/practitioner relationship, undergoes a significant transformation.

Reflecting on the ethical implications of this practice ultimately involves questioning the impact it has on the unique interpersonal relationship that exists between healthcare providers and patients during a consultation. It requires finding a balance between the practice of telemedicine and ensuring the protection and well-being of individuals seeking dental tele-consultations.

6.1 The ethical issues in dentistry with regard to Telemedicine

6.1.1 Telemedicine’s Place Within Health Care

The increasing pervasiveness of technology in our daily lives may necessitate the acquisition of new competencies by dental practitioners. In addition to dental surgeons, this group also consists of nurses, nursing assistants, dental assistants, and other professionals who might become "e-health-care providers," thereby forming a new vocation. These healthcare professionals would become increasingly common in an industry that has experienced rapid expansion in recent years. Furthermore, a variety of experts from other disciplines, including radiologists, biologists, dentists, orthodontics, implantologists, periodontists, and general practitioners, are already working together to offer patients comprehensive care.(Denost H, Blaizot A, Trentesaux T, 2016)

Given the challenges in accessing healthcare services due to a shortage of professionals, e-health-care providers could play a vital role in meeting patients' needs. For instance, a trained nurse's aid could work alongside a dental surgeon remotely to provide essential dental care for an elderly person in a nursing home. In such cases, the nurse's aid may need to establish a close relationship with the patient independently due to the dental surgeon's physical absence. Apart from technical skills, it is essential for the nurse's aid to be aware of the unique aspects of healthcare relationships, especially concerning oral health.

Understanding the symbolic significance of the mouth and teeth in terms of pleasure, satiety, and desire can help the nurse's aid appreciate the importance of even seemingly routine actions like using an intra-oral camera. Despite being accustomed to intimate physical contact with patients, recognizing the deeper meaning behind dental procedures can enhance the quality of care provided by the nurse's aid.

Utilizing medical psychology or psycho-dentistry could offer a dual advantage in acquiring this skill: it would enable the nurse's aid to carry out the task calmly (given the common hesitations faced by nurse's aids in dental care settings) and provide the patient with a proficient and attentive healthcare intermediary.

In a broader context, with the increasing technical expertise and growing number of healthcare providers, there is potential for dental professionals to play a more active role. The envisioned scenario is one where dental surgeons are recognized as central figures in healthcare, with the ability to collaborate with other healthcare providers through personalized medical and/or dental records to focus on the patient's well-being.

6.1.2 Prevention: A Major Ethical Issue

The prevailing emphasis on the culture of care often overshadows the culture of prevention in the medical field. This raises the important question of whether prevention truly constitutes a significant ethical concern for all healthcare professionals.

The advancement of telemedicine in dentistry presents a unique opportunity for collaboration among various healthcare stakeholders. The changing landscape of the dental profession, the increasing importance of patient education (Trentesaux T, Delfosse C, Ternois M, Rousset M-M, Hervé C, 2009), and the potential establishment of a new role in oral health known as "hygienists" are all topics that challenge our ethical principles. Hygienists, as allied healthcare professionals primarily dedicated to preventive care, could effectively utilize telemedicine to implement proactive measures. The target population for such initiatives is diverse, encompassing individuals of all age groups who are at risk of dental caries and periodontal disease.

6.1.3 The Patient’s Freedom of Choice

In health-care settings, unless the patient objects, it is assumed that they consent to the exchange and sharing of their data by the "care team". Whether the patient is in their own home, a residential care facility, or any other surrogate residence, health-care professionals have the ability to share information about the individual they are responsible for with each other.

However, the patient's express consent is required before any health-care provider can access or distribute the data. Multi-professional care homes and other collaborative care environments are subject to this criterion as well.

Concerns around the sharing of personal information or the possible dehumanization of the caregiver-care recipient relationship might occasionally arise with the adoption of digital

technologies in the healthcare industry. However, it's critical to acknowledge that communication and information technology can help to transmit pertinent data for care continuity.

Additionally, measures such as cyber security and access controls are in place to safeguard the personal data of individuals.(Lucas J, 2013)

Here, we will review the typical situation that was previously discussed: a patient in an elderly care home needs to have a consultation via "e-health" mode. An intra-oral camera will be used by a nurse to conduct the tele-consultation. A dental surgeon, or perhaps I should say "a" dental surgeon, will then submit their findings and suggest a course of action a few days later.

Then, who is the main player in this well-known "unusual consultation" that links the patient and the doctor? This seems to be the nurse's job, but the nurse might not be able to answer any questions the patient could have about their dental or gingival discomfort. Is the "remote" dentist not just turning into a service provider, and how much can the patient or their family choose the person—who is now called the "oral cavity technician"—who can evaluate their condition and provide guidance, making the caregiver/care recipient dynamic legitimate and in accordance with modern perspectives on information and consent?

This is precisely where the term "consent" holds significance as "the patient consents!".

It is crucial to emphasize the importance of trust in the relationship between a patient and a healthcare provider, even in situations where the practitioner is not physically present. Despite the advancements in technology, it is essential to remember that there is a human element involved, requiring skill and understanding.

In the context of tele-diagnosis, the question arises whether tacit consent, influenced by organizational considerations within the healthcare team, can be deemed acceptable. This raises concerns about the level of choice available to patients in such scenarios.

Currently, dental tele-consultations in France are limited in scope and primarily offered through public institutions. If this service were to transition into a private enterprise, it could potentially impact the dynamics of trust between patients and healthcare providers. The shift towards a market-driven approach in tele-dentistry may raise questions about patient autonomy and decision-making.

To ensure that information and communication technologies are utilized for the benefit of patients, it is essential for each healthcare provider to uphold individual responsibility. This is crucial in maintaining the integrity of patient care in an increasingly digital healthcare landscape.(Conseil Européen des Ordres des Médecins, 2014)

6.1.4 Protecting the Person

Confidentiality of consultations is an important consideration, irrespective of the technology being used. It seems that machines make matters more complicated when it comes to remote treatment.

There are two scenarios that should be distinguished here, depending on whether telemedicine is utilized in an emergency situation or not. It appears to be simpler to uphold confidentiality in the case of remote dental consultations, especially when the consultation is not conducted in an emergency setting. In a more direct and pressing conversation, there is a far greater risk of disclosing any aspect of one's personal life—even simply one's face. It must be noted, though, that this appears to be restricted to a very limited number of extremely specific teleconsultation cases, such as for people at sea or, even less frequently, for those in space.

In a more typical situation, many telemedicine programs eventually use video conferences as their standard platform. Thus, it would seem that upholding ethical standards, which include data security and medical confidentiality, is a rather simple matter. However, despite appearances, this intricacy is not as new as it seems, since questions concerning the security of medical data and information storage have been raised since information technology was first used in dental offices several decades ago. Thus, it will be noted that this may not be the most important path of investigation.

Regardless, the patient, as the object of interest or the beneficiary of telemedicine, needs to be protected by the scientist, the legislator, and the legal practitioner, who are all aligned in an ethical manner.

6.1.5 Assessment and Research in Telemedicine

Telemedicine and tele-dentistry are relatively new fields, which means that our understanding of their impact, efficiency, and potential is still limited. It is essential for any medical discipline to conduct valid scientific research to assess the effectiveness of telemedicine, including the evaluation of new technical devices and their advantages. Additionally, research into the ethical considerations surrounding telemedicine is crucial to address any existing issues.

Given the close relationship between ethics and finances, it is important to consider the ethical aspects of these new expenditures from both an individual and collective perspective. This involves examining the potential benefits and drawbacks for both patients and healthcare providers.

Furthermore, when evaluating telemedicine, it is necessary to assess the professionalism and skills of the users. Recognizing the qualifications and expertise gained through the use of telemedicine applications should be accompanied by fair compensation for healthcare providers, as treatments and services provided through telemedicine should be appropriately codified and remunerated.

In summary, a comprehensive assessment of telemedicine should encompass economic, social, legal, ethical, and professional considerations to ensure its successful implementation and fair compensation for healthcare providers.

6.1.6 A Public Health Social Challenge

The legitimacy of tele-dentistry is contingent upon the broader public health landscape and the actions of healthcare professionals. Tele-dentistry may offer dentists the opportunity to be recognized as public health clinicians and to assume full accountability. Assuming responsibility involves reflecting on the concepts of equitable care, the role of institutions in regulating practices, and the importance of prevention.

While it is premature to definitively assess the impact of tele-dentistry on healthcare access, the ability of tele-consultations to address various vulnerabilities suggests that dental tele-consultations present a significant ethical challenge by enhancing care provision.

6.2 Beyond Efficiency: Ensuring Privacy and Humanity in a Telemedicine Age

Consultations, whether direct or indirect, play a crucial role in the provision of medical care(Hervé C, 2016). They serve as a mirror reflecting the patient's overall well-being, revealing their level of vulnerability. The dynamic relationship established between the healthcare provider and the patient during consultations necessitates qualities such as attentive listening, caution, and respect. Christian Hervé highlights various ruptures that underscore this vulnerability, such as a loss of self-esteem leading to a lack of agency in managing one's own health. Additionally, disruptions in the perception of time can result in the patient's life becoming centered around illness and discussions about physical or cognitive limitations. Over time, patients must adapt to a new reality regarding their body's capabilities and intellectual capacities.

Paul Ricoeur (Ricoeur P, 1990) defined the loss of self-worth in relation to these ruptures as the inability to actively participate in one's own life, resulting in a state of inactivity and a lack of freedom and autonomy. The caregiver bears the duty of maintaining a connection that is characterized by honesty and responsibility. Consequently, the caregiver/care receiver relationship facilitates access to freedom and increased autonomy, akin to fairness achieved through receiving care that is ensured by a healthcare commitment. Three fundamental tenets form the basis of this commitment: getting informed permission, protecting medical secrecy, and the right to the truth.

What role does telemedicine play in achieving this goal? What strategies can be employed to safeguard the essence of this form of consultation, which is rooted in interpersonal and comprehensive communication?

Research in narrative medicine (Charon R, 2004) has revealed that in healthcare, patients are typically given only 18 seconds to express themselves. Can teleconsultations extend this time frame? This remains uncertain.

It is necessary to reconsider existence from the perspective of the patient. Engaging and reshaping the perspectives of the general public, patients' support network, medical professionals, family caregivers, and the patients themselves should be the main objectives of consultations.

Undeniably, there is a growing reliance on technological tools such as telemedicine to bridge the gap between hospital-based healthcare providers and those in community settings, ensuring effective follow-up care in terms of quality and efficiency. French legislation, in particular, (Légifrance, 2002) emphasizes the importance of a multi-professional approach to care coordination, which proves beneficial in enhancing the efficiency of delivering optimal care to individuals with chronic illnesses, particularly the elderly who may be experiencing a decline in autonomy, dependency, or disability, rendering them consistently vulnerable. In terms of the exchange of information, it is important to encourage discernment, whether it be through words, gestures, or behavior. The purpose of this exchange is not to share secrets, but rather to provide colleagues with essential information that is necessary at a particular moment. This ensures that decisions made will result in optimal benefits for the patient, minimizing any potential harm, and benefiting the collective in terms of well-managed resources.

Instead of solely safeguarding data, the focus should be on privacy and the consequences of the illness.

Telemedicine is more than just an extra tool for dentist or medical practices. With the goal of putting the patient at the center of the healthcare system, it represents a unique organizational strategy. This is not the same as corporate, institutional, or governmental methods.

It seems that all the conditions have been satisfied in France today for the cohesive national rollout of telemedicine and tele-health systems. (Pavageau E, 2013). Patients and users clearly express their needs, as these platforms serve as tools to address the challenges posed by the aging population, medical migration from rural areas, and routine medical care. Healthcare practitioners receive assistance and training to help them adjust to utilizing Health Information and Communication Technology tools, which might not be intuitive at first. Furthermore, from an ethical and responsible perspective, emphasis is placed on guaranteeing confidentiality and interoperability in compliance with rules.

The deployment of telemedicine and tele-health services also opens up new employment opportunities at a regional level. This contemplation becomes increasingly crucial in light of technological advancements.

Ethical considerations regarding the legitimacy of information sharing and its potential repercussions fall under accountability ethics, which aim to safeguard patients against untimely disclosures. Ultimately, while data sharing is significant, safeguarding an individual's privacy remains the primary goal.

7 Obstacles to the development of telemedicine

The effectiveness of telehealth programs, which serve as a feasible option for delivering services or facilitating collaboration, highlights the significance of addressing technological and managerial aspects. (Hu PJ-H, Chau PYK, 2002)

Numerous barriers to the implementation of telemedicine technology in healthcare facilities have been examined (Paul DL, Pearlson KE, 1999; Tanriverdi H, 1999), as they play a crucial role in the successful implementation of such technology.

Broens (Broens THF, in't Veld RMHAH, Vollenbroek-Hutten MMR, Hermens HJ & LJM., 2007) found a number of variables that affect telemedicine adoption, including technology, acceptance, financing, organization, and policy and legislation.

7.1 Technology Issues

When creating a teledentistry system, it is necessary to consider several technical and informational elements. The necessity of addressing common technological issues in telemedicine software, such as usability, security and confidentiality, efficiency, interoperability, integrability, portability, configurability, and maintainability, is emphasized by Fitch et al. (Fitch CJ, Briggs JS, 2000).

Reliability and availability pertain to the degree to which a system provides its users with the anticipated service. Ensuring reliability is crucial because unreliability might result in unforeseen problems and implications that the user might not notice right away. (Fitch CJ, Briggs JS, 2000)

In electronic health records, Boonstra et al. (Boonstra A, Versluis A, 2014) stress the importance of hardware availability and system dependability, highlighting the necessity for speed and a lack of failures. Since telemedicine is essentially an electronic health record that is shared between organizations, these issues also apply to it.

The ease of use and error-free operation of a system are the main aspects of usability. This topic has been well examined in the literature on information systems (Davis FD, Bagozzi RP, 1989; Venkatesh V, Morris MG, Davis GB, 2003), and it is especially important in telemedicine (Chau PYK, 2002) and teledentistry. (Petcu R, Ologeanu-Taddei R, Bourdon I, Kimble C, 2016; Whitten PS, 2002)

Security and confidentiality are essential considerations in teledentistry. Security encompasses the quality of information, including its availability, confidentiality, and integrity (Fitch CJ,

Briggs JS, 2000). In teledentistry, this issue becomes even more significant, especially when considering the adequacy of information obtained through teleconsultations, particularly in orthodontics, and the confidentiality of patient records.(Patel RN, 2013)

Efficiency relates to how effectively a system utilizes resources to perform its tasks. (Fitch CJ, Briggs JS, 2000)

The practice of teledentistry entails the use of networking technologies into healthcare procedures, frequently necessitating the execution of applications across several computing environments.(Fitch CJ, Briggs JS, 2000)

Interoperability and integrability are significant concerns in the exchange of information within the healthcare industry (Zwaanswijk M, Verheij RA, Wiesman FJ, 2011)and telemedicine. (Ganguly P, 2000; Romanow D, Cho S, 2012)

Interoperability refers to the ability of different systems to operate together seamlessly (Fitch CJ, Briggs JS, 2000). Some authors consider interoperability as a unique characteristic of the healthcare environment (Romanow D, Cho S, 2012). In teledentistry, sharing medical data with healthcare providers is valuable but can be challenging due to the sensitive nature of patient records (Romanow D, Cho S, 2012). Telemedicine systems are particularly susceptible to this issue compared to other health IT systems. While real-time telemedicine systems send a significant amount of data, teledentistry frequently entails collaboration across many sectors and disciplines (Fitch CJ, Briggs JS, 2000). The integrity of audio and video signals must be preserved in order for them to reach their destination unaltered.

Maintainability refers to the ease with which changes can be made to a system (Fitch CJ, Briggs JS, 2000). Romanow et al. point out that the ongoing use of proprietary systems and databases causes the healthcare sector to lag behind other businesses in terms of health IT interoperability. Because of this, medical data frequently stay separate within information silos that are under the authority of providers who are not connected to the hospital (Romanow D, Cho S, 2012). Paul et al. investigate the impact of technological constraints on telemedicine adoption rates and discover a discrepancy between the level of technology sophistication and end-user expectations for therapeutic activities (Paul DL, Pearlson KE, 1999).

Furthermore, there can be major obstacles to the usage of telemedicine if end-user and technical training are not supported (Paul DL, Pearlson KE, 1999). Telemedicine adoption may also be influenced by prior computer and health technology exposure or experience. (Or CK, 2009).

Technical aspects, including the complexity of existing technology (software and hardware), introduce challenges in systems integration, processing speed, and security (Barki H, Rivard S, 1993).

In addition to the technical dimension, the significance of the information delivered through teledentistry is crucial. Boonstra et al. (Boonstra A, Versluis A, 2014) emphasized that insufficient documentation of patient information and the overwhelming amount of information pose significant challenges in electronic information sharing. These challenges can also be extrapolated to telemedicine initiatives and, consequently, to teledentistry.

7.2 Acceptance Issues

The opinions of patients and professionals on teledentistry technology have been shown by authors to have an impact on the implementation of teledentistry successfully. The perceived utility and usability of the technology are critical factors in determining its acceptance (Davis FD, Bagozzi RP, 1989).

The adoption of technology in telemedicine innovation is significantly influenced by the attitudes of medical professionals (Hu PJ-H, Chau PYK, 2002).

Particularly important to the success of teledentistry are nurses, whose acceptability is correlated with their prestige and professional tasks (Petcu R, Ologeanu-Taddei R, Bourdon I, Kimble C, 2016).

Oral teleconsultation presents a new set of challenges for nurses, who must accept the service's offering in addition to embracing technology. Nurses' work processes are significantly altered by the introduction of teledentistry projects, which also affects their relationships with other healthcare professionals and practices as well as the material conditions of their employment (Nicolini D., 2006).

Nurses' acceptance of teledentistry is critical because strong acceptability can assist overcome obstacles with the technology itself as well as inadequate resources (Wade VA, Eliott JA, 2014).

Another crucial component of teledentistry application is patient acceptance (Petcu R, Ologeanu-Taddei R, Bourdon I, Kimble C, 2016).

Giraudeau et al. (Giraudeau N, Valcarcel J, Tassery H, Levallois B, Cuisinier F, Tramini P, 2015) have brought attention to the problem of patients' lack of confidence in France, while Patel and Antonarakis (Patel RN, 2013) have expressed concerns regarding the difficult acceptance issue of direct patient contact being absent in the UK.

7.3 Financing Issues

The importance of financial concerns in the broad application of teledentistry is emphasized by Broens et al. (Broens THF, in't Veld RMHAH, Vollenbroek-Hutten MMR, Hermens HJ & LJM., 2007)

A workable business plan for telemedicine has also been emphasized by other scholars (Chen S, Cheng A, 2013).

When compared to traditional dental care methods, the advent of teledentistry has a significant financial influence on the many stakeholders engaged in the healthcare process. This has led to a redistribution of costs and revenues. The development of a viable teledentistry business model in France is hampered by a number of ethical and legal issues, not the least of which is health insurance companies' unwillingness to pay for telemedicine services (Giraudeau N, Valcarcel J, Tassery H, Levallois B, Cuisinier F, Tramini P, 2015; Ologeanu-Taddei R, Bourdon I, Kimble C, 2016).

Consequently, it becomes imperative to bring about changes and reforms to the existing legal framework governing telemedicine in order to address these challenges in the long run.

7.4 Organizational Issues

Telemedicine implementation also raises concerns related to organizational issues. The resistance to health IT (HIT), particularly among physicians, is influenced by the specific characteristics of the healthcare environment. (Bhattacherjee A, 2007; Lapointe L, 2005, 2006; Romanow D, Cho S, 2012)

This resistance can be attributed to the way physicians work and exert control over their tasks, which is often based on collegial control and professional autonomy. Professional autonomy is closely linked to the high level of expertise required to manage complex healthcare tasks.(H, 1990)

Berg suggests that the success of an information system depends on its integration into the workplace (Berg M., 2001) , highlighting the importance of addressing professional autonomy in the context of teledentistry to mitigate resistance.

Moreover, the adoption and application of teledentistry technology as a novel strategy affect healthcare organizations' limits and call for fresh partnerships with outside healthcare organizations.

IT implementations are recognized for their ability to bring about significant changes in employees' job roles (Bala H, 2013). Researchers have also explored the impact of technology-driven changes on skills and tasks within healthcare organizations, affecting physicians, nurses, and support staff (Davidson EJ, 2007) .

Establishing a new partnership between clinical telehealth providers and IT providers to enable the deployment of dental consultation and diagnosis tools is a major problem. (Petcu R, Ologeanu-Taddei R, Bourdon I, Kimble C, 2016; Wade VA, Eliott JA, 2014) .

Successful implementation of teledentistry initiatives requires robust managerial support and champions who can navigate the interests of various stakeholders (Wade V, 2012; Wade VA, 2013) .

Previous studies (Vuononvirta T, Timonen M, Keinänen-Kiukaanniemi S, Timonen O, Ylitalo K, Kanste O, 2009) have identified ten distinct categories of adopters in telehealth projects, ranging from enthusiastic users to positive nonparticipants, underscoring the importance of addressing acceptance issues and healthcare professionals' resistance.

Furthermore, recent research on electronic health records has brought to light a number of issues such as inadequate training, lack of support for change, limited user involvement, lack of recognition from top management for key stakeholders, heavy workload during implementation, lack of coordination among stakeholders, insufficient time allocated for user training, lack of strategic alignment between administration and medical leaders, ineffective internal communication strategies, and failure to anticipate technological risks (such as business interruption or failure) (Cresswell K, 2013).

Addressing these issues requires a project management approach, which is crucial for successful implementation. Risk factors for all IT projects have been identified and prioritized by Nelson (RR, 2007). These variables include the absence of a project champion, project ambiguity, insufficient knowledge or skills, changes in the composition of the project team, and inadequate resources, which are key risk factors in clinical information systems implementation projects, and can also be applied to telemedicine and teledentistry projects.

Additionally, telemedicine must navigate the involvement of various stakeholders such as governments, healthcare providers, general practitioners, and patients in a multidisciplinary and collaborative setting, each with different objectives (Masella C, 2008).

7.5 Policy and Legislation Issues

A variety of questions are raised by teledentistry, such as those pertaining to the sharing of medical records, the definition of teledentistry practices, and the legal limitations on payment and cost-sharing amongst different medical specialties. As important contextual variables in health information technology (HIT) (Romanow D, Cho S, 2012), concerns about the confidentiality of digital patient records and medical data are often addressed in HIT literature (Anderson CL, 2011; Angst CM, 2009; Romanow D, Cho S, 2012).

Several researchers (Boonstra A, Versluis A, 2014; Paul DL, Pearlson KE, 1999; Zwaanswijk M, Verheij RA, Wiesman FJ, 2011) have demonstrated that patient privacy and confidentiality concerns have an impact on HIT and telemedicine.

Looking ahead, social policies and legislative matters will play a critical role in determining the financial sustainability of teledentistry.

7.6 Conclusion

Understanding the role of technology, acceptance, organization, policy, and regulation is crucial for teledentistry to successfully go from a pilot program to a large-scale adoption. Although these issues have been assessed in information systems projects, the health sector, and especially telemedicine programs, place even more importance on them. This is a result of healthcare workers' autonomy as well as the possible influence of technological malfunctions and information flow problems on medical errors and patient outcomes. In order to obtain the expected benefits, it is imperative that top managers, decision-makers, and sponsors see the necessity of such analysis and change management engaging all stakeholders as investments rather than costs.

III Conclusion

Teledentistry is expected to progress further, with its benefits being particularly advantageous in remote and rural areas or among underserved populations. It can also be utilized to link areas with limited infrastructure to specialists in order to enhance healthcare services.

The expansion of teledentistry would necessitate the development of suitable health policies and strategies, along with political backing, to support such endeavors. However, numerous countries are lagging behind in terms of e-health advancements. Likewise, the majority of countries lack well-defined regulations concerning telemedicine parity. Through overcoming obstacles, improving procedures, and prioritizing patient-focused strategies, teledentistry has the capability to improve the availability of high-quality dental care and play a role in the advancement of contemporary dental healthcare.

The training of today's healthcare professions should incorporate more notions of dentistry, and in particular the ability to act as a professional in oral and dental telemedicine.

Nurses who already have skills in odontology could benefit from special recognition when caring for the oral health of patients in their care.

In the same vein, oral telemedicine certification could be envisaged for all professionals involved in this type of activity. Applicant healthcare professionals would have to be able to produce high-quality videos, and have a certain knowledge of oral medicine.

As for the medical professionals required, they must be able to analyze the images and videos transmitted and make a diagnosis. To enhance the value of these special skills, it would seem appropriate to introduce a certification scheme for oral telemedicine. Similarly, if the devices enabling oral telemedicine evolve so that they can be used directly by patients, it would be worthwhile for the latter to receive training and certification attesting that they have sufficient mastery of the device to carry out an oral teleconsultation.

Secondly, from a purely legal standpoint, certain elements need to be incorporated into the Public Health Code. Firstly, the Public Health Code gives dental surgeons exclusive rights to practice preventive oral health care. Indeed, it seems incomprehensible that only dental practitioners should be able to provide preventive care. This exclusivity must end with the introduction of dental hygienists. At the same time, the potential development of oral telemedicine could open up oral prevention to other healthcare professionals.

Similarly, the code of ethics for dental surgeons should be amended, as it has been for doctors, to incorporate telemedicine in the articles that require it.

Finally, in economic terms, it is vital that oral teleconsultations are recognized by health insurance companies. Indeed, as the saying goes, "all work deserves reward", so it is essential to find the economic model that will enable oral teleconsultation to develop. This proposal is of interest to all those involved in oral telemedicine.

Health authorities will have to allocate additional nursing time to medical and social establishments. It must also allocate the appropriate budget to acquire the equipment needed for oral teleconsultations.

From a public health point of view, it could be justified for the Health authorities to require public health establishments to carry out an oral and dental consultation by a specialist on admission to the establishment. This consultation can be carried out in a conventional way, or via telemedicine.

Telemedicine should not be seen solely as a tool for dental surgeons to manage the patients under their care. This new activity is not intended to replace existing services, but to facilitate care for populations lacking access to dentists. Its development would enable us to take a further step towards the health democracy we are so keen to see.

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