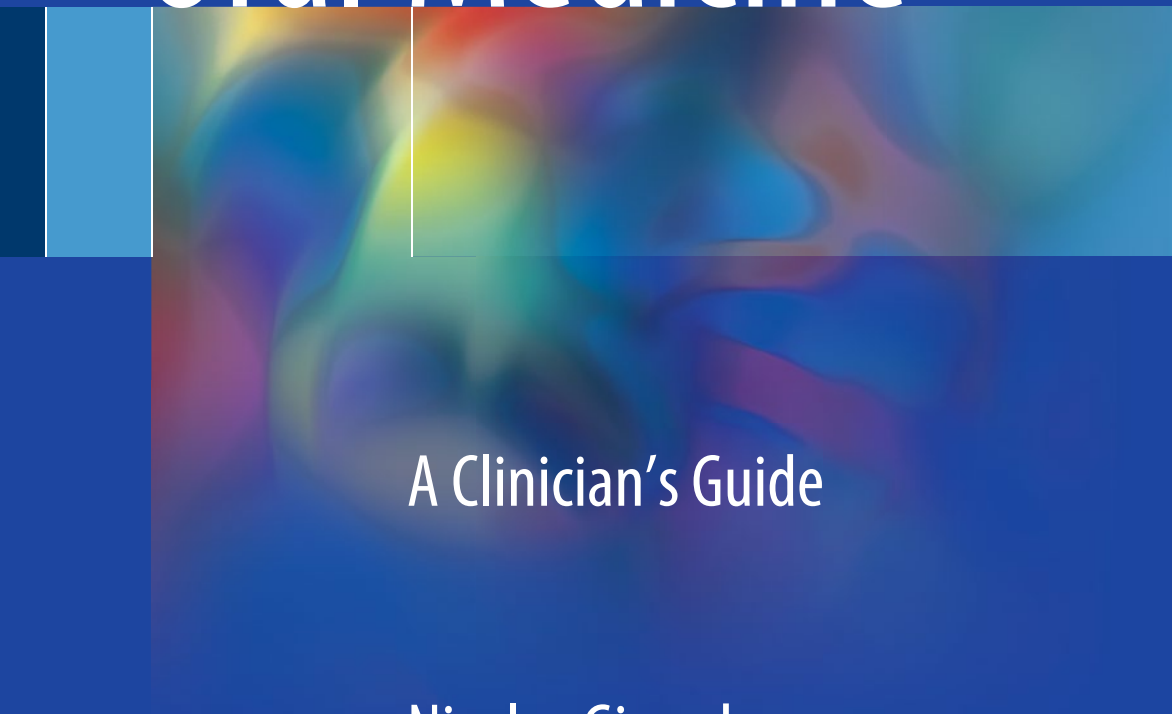
e-Health Care in Dentistry and Oral Medicine



A Clinician's Guide

Nicolas Giraudeau
Editor

Springer

e-Health Care in Dentistry and Oral Medicine

Nicolas Giraudeau
Editor

e-Health Care in Dentistry and Oral Medicine

A Clinician's Guide

Springer

Editor
Nicolas Giraudeau
Public health, LBN EA 4203, Odontology,
University of Montpellier
Montpellier, France

ISBN 978-3-319-69449-8 ISBN 978-3-319-69450-4 (eBook)
https://doi.org/10.1007/978-3-319-69450-4

Library of Congress Control Number: 2017964626

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Contents

Part III A Global View on Teledentistry

Part I

General Aspects of e-Oral Health

Definition of Teledentistry

1

Rodrigo Mariño and Aghareed Ghanim

Abstract

The concept of teledentistry proposes the application of a variety of information and communications technologies (ICT) to facilitate oral health care for geographically distant patients and/or practitioners. This chapter presents an overview of the uses of information and communication technologies in oral health. The first part defines teledentistry, addresses general concepts and provides an overview of teledentistry and its common uses in oral health. The final section describes some of the general health implications of teledentistry, explaining the role played by health professionals in promoting the uses of ICT in oral health and stimulating the need for further interdisciplinary research and education in teledentistry. The chapter aims to describe the foundation for teledentistry and underline its merits for the delivery of oral health care. The chapter also discusses the opportunities and benefits associated with the adoption of teledentistry solutions as well as its utilisation and impact on the oral health system and the population.

Keywords

ICT • Telehealth • Tele(oral)health • Teledentistry • e-health • e-(oral)health

1.1 Introduction

The use of communication technology to improve access to and quality of health care and to decrease inequalities in health has a long history. There has always been a connection between medicine/health and communication tools. For example, the use of a torch system to relay messages by the ancient Greeks [1], the use of sounds

R. Mariño (✉) • A. Ghanim
Melbourne Dental School, The University of Melbourne, Melbourne, 3010 Victoria, Australia
e-mail: r.marino@unimelb.edu.au

N. Giraudeau (ed.), *e-Health Care in Dentistry and Oral Medicine*,
https://doi.org/10.1007/978-3-319-69450-4_1

(drums, bells), the use of quipus (or talking knots, a complicated systems of recording and administration based on the use of strings) by the Incas, and smoke signals were all early attempts to exchange or communicate health information, news about major catastrophes or significant health events like the bubonic plague in Europe [2, 3]. Despite this, these are not considered examples of telemedicine [4].

According to Vladzymyrskyy and coresearchers, there is a strong connection between telemedicine and electrical and electronic communication tools [4]. Telemedicine started as soon as these technologies (telegraph, telephone and radio) were invented. Thus, it was not until the 1850s that technological advances for the transmission of information by telegraph, telephone and radio allowed for the expansion of telecommunication and informatics. From this perspective, the history of telemedicine, and probably the term itself, can be traced to the mid-nineteenth century. The telegraph was used during the American Civil War and in Central Australia in 1874, in which records show how the telegraph played an important telemedicine role in enabling care for wounded people [5]. Later, in the early twentieth century (1905), there was a transmission of an electrocardiogram (ECG) [6].

The prefix "tele" is derived from a Greek term which means "at a distance"; hence, more simply, telemedicine means "healing at a distance". The term was first used in 1927 in a newspaper article [4]. A few years earlier, in 1924, Hugo Gernsback described "teledactyl" [7], an early vision of telemedicine, where a doctor could use radio signals to generate a video image of the patient and remotely operate a robotic hand to examine the patient. In his vision, the doctor of the future could "feel at a distance". Back then it sounded like science fiction, but 90 years later it is a reality. Radiology images started being sent in the 1940s via telephone lines [7]. Nonetheless, it was not until the 1960s and 1970s when modern telecommunication technologies started expanding and being ubiquitous in our world that the term telemedicine started being used as largely military and space applications and the health care began demonstrating how information and communications technology (ICT) could provide new solutions in areas of shortage of specialists or lack of proper health care. Terms such as teleconsultation and telediagnosis start appearing in the 1970s. More recently, with the exponential growth of sensors and social applications, cloud, big data, etc. and the increasing familiarity of patients to these technologies, a demand has been created for anytime anywhere access to information and health care [8].

This chapter presents an overview of the uses of information and communication technologies in oral health. It is organised into three main sections; the first section will look at a definition of telemedicine and explore differences between e-health, telehealth and telemedicine and will present major areas of telehealth applications. The second section will expand on the definitions of telemedicine and teledentistry and will present the most common uses of teledentistry in oral health. The final section will describe some general health implications of teledentistry, explaining the role played by health professionals in promoting the uses of ICT in oral health and stimulating the need for further interdisciplinary research and education in teledentistry.

1.2 Telehealth and Telemedicine Defined

Just as the uses of ICT have developed over the years, the terms to describe healthcare services at a distance, such as "telehealth", "e-health" and "telemedicine", have also evolved. Within this evolution, Standards Australia defines e-health, which is generally accepted as composed of two elements: (1) *health informatics*, which relates to the collection, analysis and movement of health information and data to support health care, and (2) *telehealth*, which relates to direct (e.g. videoconferencing) or indirect (e.g. website) delivery of health information or health care to a recipient [9].

E-health has also been defined by the World Health Organization (WHO) as the "cost-effective and secure use of information and communication technologies in support of health and health-related fields, including health-care services, health surveillance, health literature and health education, knowledge and research" [10]. However, WHO uses "telehealth" and "e-health" as umbrella terms "to encompass the rapidly evolving discipline of using computing, networking and communications - methodology and technology - to support the health related fields, such as medicine, nursing, pharmacy and dentistry" [11].

For the European community, e-health includes "products, systems and services that go beyond simply Internet-based applications. They include tools for both health authorities and professionals as well as personalised health systems for patients and citizens" [12]. Examples include electronic health records, telemedicine services, personal wearable and portable communicable systems, health portals and many other information and communication technology-based tools assisting prevention, diagnosis, treatment, health monitoring and lifestyle management [12].

Other components of e-health include the use of mobile devices, such as mobile phones, patient monitoring devices and other wireless devices, for medical and public health practices, and the use of rules, regulations, guidelines or definitions with technical specification to make the integrated management of health systems viable at all levels (standardisation and interoperability) [10].

Although some definitions suggest using telemedicine and telehealth as interchangeable terms, telemedicine is different from telehealth. Telehealth is broader in definition than telemedicine as it includes computer-assisted telecommunications to support management, surveillance, literature and access to medical and health knowledge [11]. Telemedicine is the use of telecommunications for any health-related activities carried out over distance by means of information communication technologies.

A definition of telemedicine is provided by the World Health Organization [11] as:

> The delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities.

This definition identifies four connected elements [11]:

- Its purpose is to provide clinical support.
- It is intended to overcome geographical barriers, connecting users who are not in the same physical location.
- It involves the use of various types of ICT.
- Its goal is to improve health outcomes.

Moreover, it establishes first and foremost that it is the delivery of health care through the use of ICT. It includes the potential to benefit health care by enhancing early diagnosis, facilitating timely treatment of oral diseases, reducing isolation of practitioners through communication with peers and specialists and improving access to care. It also includes the support of long-distance and remote patient and professional health-related education, public health and health administration. Additionally, other definitions specify that telemedicine [10]:

- Reduces inequalities
- Reduces costs and brings economic benefits
- Improves the quality of care
- Achieves socio-sanitary objectives (reduction of waiting lists, teleconsultation)

1.2.1 Telemedicine: Applications and Mechanism of Delivery

Given the breadth of this definition, telemedicine has a wide number of beneficial applications across medical fields and is firmly embedded within the broader area of telehealth. Table 1.1 outlines the variety of telehealth technology applications available.

Table 1.1 Major areas of telehealth technology applications

Teleconsultation Telediagnosis Tele-treatment	The patient, with the local health professions, consults the specialist and obtains the line of treatment
Tele-education Tele-training	For continuing professional development (CPD) and training for oral health professionals Methods for sharing scientific knowledge, such as e-publication, open access, digital literacy and the use of social networks
Tele-monitoring	Regular monitoring of physical and/or biochemical parameters in chronically ill patients (dialysis and cardiorespiratory patients, etc.) for intensive care and/or emergency care
Tele-support	Support to remote health facilities located in isolated areas, remote places or in areas affected by natural disasters, armed conflict, etc.
Tele-administration	Electronic medical records or electronic health record and the use of communications technology for purely administrative work (e.g. scheduling and managing appointments)
Consumer medical and health information	Websites used for both clinical and educational purposes combine different applications ranging from merely informative (static) pages to completely interactive applications

Sources: Modified from [13–15]

There are primarily three basic techniques that are used for telemedicine, according to the time when information is transmitted: real-time consultation, store and forward and near real time. Each has its own value for particular subspecialties in specific situations [16].

Real-time consultation, also known as synchronous, collects information which is transmitted and displayed with no delay between parties at the sites. Videoconferencing is a common method of real-time communication. The system could utilize audio-visual tools so that the users at either site can see and interact with each other. Individuals can share work space on their computer desktops. It might also be "application sharing", where a piece of software can be run and controlled by both parties [13].

The store and forward technique, also known as "asynchronous" or "pre-recorded" consultation, utilizes less complicated equipment and can operate via the Internet. The health professional collects all the necessary information and stores it in a file. The file is forwarded via e-mail, or other means. The consultant retrieves the file and examines its contents. Recommendations are then provided to the dental professional in the same manner in return [17].

Both real-time and store and forward techniques require the same basic types of hardware, software, peripheral devices and telecommunication links with appropriate bandwidth. They involve a dental care professional digitising and electronically transmitting videos, drawings, diagrams, photographs and X-rays to the distant site [18]. The true real-time consultation allows for a detailed discussion by personal contact and clarification of points as they arise. The availability of a camera allows for capturing snapshots even when images for 3D objects such as models are required [13]. Because of its special functional characteristics, when compared to the store-forward technique, real-time operations required faster connections, the deployed equipment are usually more sophisticated and expensive and an extremely high speed network connection is required which is not usually available outside of major municipal areas unless a satellite is utilized [16]. In contrast, the store and forward technique is much less expensive yet provides vast benefits for a wide range of applications and is just as effective at presenting cases in a real-time setting. It can be achieved using ordinary telephone lines. For many clinicians, store and forward form is acceptable, since it can also be difficult to arrange convenient times for real-time contact [13].

The near-real-time solution is a variant of the real-time mode where data sent ranges from low-resolution, low-frame-rate images to something that looks like jittery television [16]. This mode is applicable where network connections are poorer, when communication costs are high or when real-time communication is important, but data quality is not a critical issue. For example, this was the solution used by Mariño and his collaborators for sites that could not accommodate 3 Mbits/s stream [19]. In those cases, a store and forward version was developed that enabled the Mpeg4 file to be stored on a central server for asynchronous download a few minutes after the actual exam.

1.3 Teledentistry Defined

Commonly, teledentistry has incorporated the prefix "tele" to common dental clinical applications. Terms have evolved to describe the application of telehealth to those particular dental specialties, such as "teleprosthodontics", "teleperiodontology" "teleorthodontics", "tele-oral surgery" and "telepaedodontics". As a consequence, several definitions and descriptions of teledentistry are found in the literature, each highlighting some aspect of teledentistry [20–28]. Nonetheless, the use of a telemedicine definition helps to identify the realm of teledentistry as a branch of telehealth. More specifically, as the use of ICTs to support oral healthcare delivery, and for the organisation, management and distribution of health information in support of patient and professional health-related education, practice, public health, research, health-care administration, information gathering and synthesis and knowledge sharing [14, 15, 29].

As such, it represents an intersection of traditional methods with ICT to meet oral health's clinical, administrative, research and educational needs. It allows better accessibility to oral health-care information and services to high-risk populations living in underserved areas. It also empowers and upskills local community oral health-care providers in rural areas who are able to access advice from specialists in major metro teaching hospitals and practices [30].

As mentioned, the use of electronically based information technologies in oral health is not new. As early as 1950, dental educators pioneered the use of closed circuit television and its facility for image amplification through electronics [31]. Dental continuing education courses were first distributed by video telecommunications via satellite transmissions in the 1960s, and in return of the growth of reimbursement for health-care services by third-party payers, the American Dental Association in 1969 invented and developed a standardised dental disease coding system which introduced automation and computer processing of claims for reimbursement for dental treatment [31]. This system today enjoys universal use by practitioners, demographers, insurance companies and government agencies. Still, compared to medicine, teledentistry is a relatively new area of health using ICT. Teledentistry remains under-used as a means of diagnosis, consultation and referral in everyday dental practice ICT applications.

Probably the largest teledentistry undertaking in the world is currently being performed by the US military [27]. The teledentistry-military project began in 1994 to serve the troops and their dependents around the world by improving their oral health and offering continuing dental education [32]. This project primarily deployed a conventional telephone system, with two different communication modalities: real time and store and forward. The project concluded that teledentistry decreased overall cost, was expandable to remote and rural areas, offered better care for patients than a traditional referral process and provided more complete information for data analysis [31].

1.3.1 Reasons for Teledentistry

Teledentistry has the potential to benefit oral health care by enhancing early diagnosis, facilitating timely treatment of oral diseases, reducing isolation of practitioners through communication with peers and specialists and improving access to care. People living in rural or underserved areas are among the most in need of oral health care in their communities [33, 34]. In addition to the lack of oral health-care providers in these areas, barriers to the accessibility of quality dental care appear to be geographical distance and limited local resources [27, 33–35]. Many rural communities lack the clinical settings and finances that are required to attract specialised dental providers. Patients living in rural areas who are referred to dental care providers in more urban settings must travel to these areas which is usually expensive and time-consuming. Teledentistry can close this distance gap by allowing oral health-care providers in the rural areas to seek advice from specialists in the urban settings [33, 34]. This can be performed without the patient having to physically enter the specialty practice.

At the current level of development, most teledentistry programmes have focused on distance management and administration of remote facilities, learning and continuing education and consultation and referral services rather than direct patient care. A review of the literature showed that teledentistry applications are highly diverse in both study context and methods applied [30]. Areas of intervention in teledentistry indicated that the most common types of intervention evaluated were oral and maxillofacial surgery, oral medicine and pathology, orthodontics, preventive dental care (i.e. oral health-care maintenance and interventions) and dental education in different disciplines but mainly orthodontic [30]. More recently, other dental specialties have also incorporated teledentistry uses. Still, fewer studies were conducted on paedodontics, periodontics and prosthodontics, oral and maxillofacial trauma, endodontics and other dental fields [30].

Furthermore, if dentistry parallels medicine, the areas of oral medicine (mucosal lesions) and chronic facial pain will be areas in which teleconsultations will be incorporated. Specialists who can treat orofacial disorders such as oral mucosal diseases, temporomandibular joint dysfunction, orofacial pain and oral medicine are not affordable in rural areas. These disorders are usually chronic conditions that need recurring visits and intense patient care [36].

Patients of all ages, children/parents to geriatrics, have reported high levels of satisfaction with teledentistry [19, 37]. In addition, several studies have demonstrated acceptable levels of equivalence between teleconsultation and face-to-face consultation [19, 38]. However, oral medicine consultation studies have found that a face-to-face patient assessment is more precise in establishing an appropriate diagnosis for oral mucosal disease than transmitted descriptive patient data alone as it was preferred to have seen more oral mucosal pathologies information [39, 40]. Nonetheless, at the current state of development of teledentistry, there is no replacement for face-to-face oral health care. Oral health professionals cannot treat the

majority of oral health problems with a simple prescription, except where there is obvious infection. Instead, the patient must be referred for care. As such the type of clinical application typically undertaken in teledentistry focuses on tele-education, tele-diagnostic, teleconsultation and tele-treatment as the only applications [30]. Some studies have also incorporated tele-support and tele-monitoring. They represent some of the broad range of teledentistry clinical and non-clinical applications. Other applications included the combination of tele-diagnostic and tele-treatment, teleconsultation and tele-diagnostic, teleconsultation and tele-treatment and tele-education and teleconsultation [30].

Teledentistry has yet to be employed as a routine delivery system. Wider implementation would also require appropriate health policies and strategies, as well as political support for these initiatives. In many countries, teledentistry initiatives are behind e-health progress. Also, there is a need to expand the evidence on which decisions to implement teledentistry programmes are based. For example, in Australia, there are Medicare benefits available for teleconsultation between medical specialists and patients who are located in telehealth eligible areas. They are also available in eligible aged care facilities and Aboriginal medical services throughout Australia [41]. Medicare benefits are also available for clinical support provided by a health professional who is with the patient during the video consultation [41]. However, so far, dentistry is not included in this scheme.

1.4 Towards e-Oral Health as a Scientific Field of Inquiry

However, while Mariño and Ghanim concluded that teledentistry is a mature field, more information about the implementation of clinical uses is still needed [30]. Teledentistry solutions require rigorous evaluation to inform policies and strategies on ICT and telehealth applications in oral health. This will create new opportunities to support, promote and facilitate research and projects that use ICT tools and technologies for the improvement of oral health. There is also a need for more studies and information on the economic benefits of telemedicine, in particular, teledentistry solutions. Legal and ethical considerations also need to be addressed, as well as policies on data transferring and confidentiality.

Furthermore, a report from Ernst and Young identified six megatrends, each of them standing on its own but with a clear interactivity. These include a digital future, rising entrepreneurship, a global market place, an increasingly urbanised world, a resourceful planet and reimagined health [8]. These trends are driving a fundamentally different approach to the delivery of health care. These developments will lead to a chain of interconnected pieces of information from a “single molecule to the entire human population” [42]. For this to happen, a new generation of oral health scientists who can combine knowledge and skills from clinical and public health research and informatics is required [43].

Kuhn and his collaborators [42] group this research challenges into four areas: bioinformatics and systems biology, biomedical engineering and informatics, health informatics and individual health care and public health informatics. A recently

created network within the International Association for Dental Research in e-oral health creates a forum and opportunities to support, promote and facilitate research, best clinical and public health practices and educational and learning programmes that use ICT tools and technologies for the improvement of oral health. The network, through its various activities and members, will assist in the promotion and dissemination of e-health research and evidence of teledentistry and telehealth outcomes, as well as generate cooperation and research between experts in the areas of informatics, engineering, economics, statistics and social sciences.

While the field of teledentistry is growing and developing in a consistent fashion, teledentistry cannot provide the complete answer to everything; however, it will never realise its full potential if it does not receive the attention it deserves. Given current technological trends, and the number and magnitude of changes brought by ICT, its potential applications will only increase in the future and will be implemented in an increasing number of countries around the world. Thus, it can be expected that teledentistry will follow the patterns in research output that characterise the trends in the field of telemedicine. Future cooperation with the public sector and research will make available the benefits of new technologies in ICT. This will drive a reduction in health inequalities and improve access to health as a human right, improving quality of life and social participation. Nonetheless, while the use of ICT by the public is wide, its access is still not universal. Access to telemedicine is so far unequal within and between countries [44].

On the other hand, it is essential that practitioners and the public grasp these technologies to reach their full potential. Oral health professionals must be trained in the use of teledentistry. It is assumed that today's oral health professionals and students are computer literate. However, this needs to be further explored, as it may still be the case that a digital divide exists among the future oral health workforce [45]. Thus, more needs to be done at dental schools or in continued professional development courses to prepare oral health professional for the use of this technology.

Conclusions

In many countries considerable inequalities exist in access to health-care services; income level, geographical location and cultural distance are among these barriers. Teledentistry seeks to provide and/or support oral health care in areas underserved by dental practitioners, transcending these barriers. Teledentistry has the potential to reduce costs, improve patient outcomes and deliver greater access to quality dental care. Teledentistry can benefit oral health care by enhancing early diagnosis, facilitating timely treatment of oral diseases, reducing isolation of practitioners through communication with peers and consultation with specialists and improving access to care.

Information and communications technology (ICT) has been used in medicine for over 40 years for diagnosis, consultation and treatment. Telemedicine already has considerable impact on the health-care industry to deliver health records, graphics, audio and digital imaging between participants who are physically at a distance from one another for the purpose of communication