Review

Impact of Telemedicine and Telediagnostics on Risk Management in Healthcare

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Abstract: Telemedicine has been increasingly considered an effective strategy to support patients with several diagnosis and therapies, avoiding the on-site visit and drastically reducing the risks to share infections. In the recent years, a number of different technologies have been developed and applied to clinical studies, with the aim to investigate new ways for increase the early diagnoses and monitor the clinical evolution of the most predictable diseases directly from the patients' home. Telemedicine refers to all those technological interfaces used to remotely perform clinical procedures. Telemedicine applications could be useful in several medical fields, such as preventive medicine, home patient care, education for healthcare professionals and patients, research, public health, and health management. On the other hand, the synergy of these different technologies has a significant impact on the clinical risks analysis, particularly useful in frail patients. Although Telemedicine shows to have important advantages, undoubtedly important issues still remain. The present work aims to shed light on the main advantages and disadvantages related to of each application's features, which may serve as a useful tool for researchers.

Keywords: telemedicine; risk management; healthcare; translational medicine; personalized medicine

1. Introduction

The social and sanitary interest towards the so called "telehealth" has rapidly grown over the past two decades in the public and private sectors. The terms "Telehealth" and "Telemedicine" are often used interchangeably. More specifically, Telemedicine is considered under the field of Telehealth and refers to clinical services [1]. Both practices cover similar services, including health education, remote patient monitoring, patient consultation via video conferencing, wireless health applications and also transmission of images and medical reports [1].

In recent years, especially following the COVID-19 pandemic, Telemedicine has emerged worldwide as an indispensable resource for: (a) improving patient surveillance, (b) curbing the spread of disease, (c) facilitating the timely identification and management of patients and, most importantly, (e) ensuring the continuity of care of frail patients with multiple chronic diseases. In a constantly evolving healthcare context where the main objective is to offer increasingly high-quality care under conditions of maximum safety, the assessment and control of actual patient safety within healthcare organizations is of great importance. With the development of information technology, Telemedicine service becomes more and more popular in the healthcare system [2,3].

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Worldwide, governments have invested considerably in advancing information communication and technology (ICTs) infrastructures to offer public services. The use of technologies in medicine has great potential to reduce the costs of health care services by making appropriate decisions that provide timely patient care. Over time, with the aim of providing healthcare services, several technological modalities have been developed to enable the connection between healthcare workers and patients. Particularly, the modalities include synchronous, asynchronous, and remote patient monitoring [4].

During the last decade, understanding the factors affecting the use of healthcare technologies has been a crucial topic that has been extensively studied, using different technology acceptance models and theories [5]. Over the years, the acceptance of different information technologies and applications has been explored in the healthcare field. These technologies include internet-based health websites [6], picture archiving and communication systems (PACs) [7], mobile applications, telemedicine technologies [8], and electronic health records [9].

The ambitious EU4Health 2021–2027 investment programme promoted activities to enhance Telemedicine and supported optimal use of this [10]. In this landscape, the goal of the work was to investigate the possible impact of Telemedicine and Telediagnostics on healthcare service systems and on risk management in healthcare.

2. Telemedicine risk-related

Clinical Risk Management is a crucial and topical issue. It comprises the clinical and administrative systems, processes, and reports employed to detect, monitor, assess, mitigate, and prevent risks. In particular, it represents the set of actions implemented to improve the quality of healthcare services and ensure patient safety, by identifying and preventing circumstances that could expose a patient to the risk of an adverse event. Healthcare organizations are high-risk and highly complex and risk management is very important, because even a low-risk event could have serious consequences affecting patients, personnel, costs and the hospital's reputation [11].

Risk assessment in telemedicine requires consideration of the professional and non-professional figures involved in the care process, as well as the particular context in which the health care itself takes place.

3. Issues and Considerations on Telemedicine in Healthcare

The evolution of Telemedicine poses a series of clinical and medicolegal considerations.

According to the *American Telemedicine Association (ATA) "Telemedicine is the natural evaluation of healthcare in the digital world"*. It is considered an heterogeneous area, with several branches at different stages of development and implementation in day-to-day life [12], that includes portable wellness e-health, telemedicine and progress science such as genomics, artificial intelligence (AI) and big information [13]. In particular, Telemedicine can be divided in three macro-categories, including: (i) specialist Telemedicine, which includes services of a specific medical discipline provided remotely); (ii) Telehealth, that includes all activities that allow doctors/healthcare assistants to diagnose, monitor and manage patients; and (iii) Teleassistance, specifically taking care of non-self sufficient people (especially disabled and elderly people) [1,5,13]. Based on its composition, a classic Telemedicine system can be divided into two specific sections: 1) user or patient accessible components (such as telemedicine system terminal) and 2) components available only to the telehealth service provider (telehealth system and medical team involved) [14]. The patient is the final beneficiary of the medical services, regardless of whether the service is delivered directly or indirectly via medical staff [14]. Today, technological advances also facilitate the management and control of chronic diseases [15]. For this reason, many countries have begun to use Telemedicine and technology in the healthcare sector. Although many research groups have turned their attention to Telemedicine [16], publications that currently attempt to demonstrate the effectiveness of this intervention show inconsistent results. In this scenario, demand for virtual healthcare system optimization has insightfully increased worldwide for consultation, diagnosis and follow-up in different healthcare specialties [17]. Recently, several groups of researchers have developed applications requiring the

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use of the Internet in healthcare. Such applications have the main goal of improving the diagnosis, managing and treatment of several diseases [18].

4. Telemedicine and Telediagnostics: advantages, limitations, and possible use

Telemedicine presents a myriad of advantages, including: a) Increased Access to Healthcare; b) Enhances Quality of Health Service Delivery and Patient Care; c) Helps Curb Rising Healthcare Costs; d) Boosts Patient Satisfaction and Engagement; e) Enhances Physician Satisfaction. Specifically, the main benefit of using Telemedicine is that it improves the accessibility and quality of healthcare between patients and healthcare professionals [19], saving costs, space barriers and time [20,21]. It overcomes spatio-temporal limitations, in order to carry out medical care at a distance, promoting the influx of high-quality medical resources at the basic level and thus optimizing the allocation of medical resources [22,23]. Additionally, it offers the healthcare provider the advantage of recording, storing and accessing electronic patient records quickly and conveniently [24].

Patient safety is crucial and must be implemented into Telemedicine protocols.

In detail, the patient safety consists of patient identification, confirming a phone number in case of disconnection, obtaining the patient's physical location in case of an emergency, and confirming emergency contact information. Telemedicine, one main area of application of e-health, offers highly relevant potential especially for categories of people, who require continuous care. These patients may need constant monitoring of certain vital parameters to reduce the risk of complications. It makes it possible to provide the patient with a better service, through a faster availability of information on the state of his or her health, thus enabling the quality and timeliness of decisions by healthcare professionals, particularly useful in emergency-urgency conditions [19,21-23]

While Telemedicine has the potential to improve healthcare in many ways, it should be considered alongside and in support of traditional medicine. Its benefits reverberate both on healthcare facilities and on doctors, as well as on patients and citizens in general. In addition, it could carry significant risks, certainly not to be underestimated. Nevertheless, the most significant and obvious limitations that Telemedicine faces include the lack of assessment of vital signs and the limitation of physical examinations [25]. Considering doctors and specialists, it makes it possible to follow a greater number of patients, even outside their geographical area, also extending the hours of availability beyond the times set by the health facilities. In this sense, technology and telecommunications play a crucial role as they help improve the efficiency and safety of care, as well as the confidentiality and protection of patients' personal data [26].

One of the most developed components of Telemedicine is the Telediagnostics. Specifically, it is a modern healthcare practice that means "remote diagnosis" and involves the activities necessary to carry out a remote diagnosis. Telediagnostics make use of technology to exchange images and data for making a diagnosis of disease [27], and often do not require direct clinical examinations. In the past, medical professionals relied on clinical examinations to make diagnoses; but now, they may diagnose and treat patients remotely. In this context, Artificial Intelligent (AI), has emerged to greatly assist medical personnel in evaluating evidence.

Recently, there has been a rapid increase in the use of AI in Telehealth settings [28]; it can assist Telehealth in several ways, such as improving diagnostic accuracy (by simulating the face-to-face interaction between medical professionals and their patient), enhancing patient outcomes and increasing the efficiency of healthcare delivery and monitoring [29,30]. The adoption of treatment and care models based on Telemedicine brings benefits from a social and sustainability point of view for the people and the medical professional involved, especially when considering travel time and costs. Not only patients benefit from Telemedicine services, but also doctors and healthcare professionals can reach patients and colleagues in distant areas in a short time. Telemedicine reduces the cost and inconvenience of traveling. In view of all the benefits of Telemedicine for both patients and healthcare professionals, the demand for Telemedicine is increasing [31].

Specifically, the field of Telemedicine, defined as "an ecosystem made up of simple and flexible technologies", helps to provide effectiveness in the capacity to deliver and monitor care. However, there are many obstacles to consider and overcome, which can range from technical to ethical

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obstacles, and confidentiality [24]. Nowadays, doctors can use Telemedicine for many other purposes, including: a) general healthcare (such as wellness visits and blood pressure control), b) mental health counseling, c) nutrition counseling, d) prescription for medications, e) tele-intensive care.

Currently, there is a growing evidence base suggesting that Telemedicine services can be used to design more appropriate patient pathways. Although Telemedicine has the potential to enhance the accessibility, quality and performance of healthcare, the risk of cyber-attacks and data violations is high and should certainly not be underestimated. Cyber-attacks on Telemedicine systems not only put patient's privacy and safety at risk, but also result in economic damage to healthcare in general [32]. Compared with face-to-face encounters, Telemedicine encounters are more vulnerable to privacy and security risks. Considering this risk, Telemedicine services must continually pay attention to ensure the privacy and security of patient data. To meet these objectives, the cybersecurity issues, associated with the Telemedicine service, require the implementation of specific security guidelines for maintaining and managing appropriate cybersecurity measures, including end-to-end encryption services and multifactor authentication [33,34]. Currently, despite telehealth platforms are highly encrypted, no platform is 100% safe from hackers or data breaches [33].

Additionally, a very important aspect is how to identify data controllers and/or data processors and, at the same time, ensure the protections provided by the regulations for the parties involved in the network. General Data Protection Regulation (GDPR) represents a regulatory law on data protection and privacy in the European Union (EU). However, there are many other privacy-related issues to consider for users employing this type of technology [34,35].

Examples of Telemedicine include group therapy, nursing interactions, education and training, and medical image transmission [35]. Telemedicine is used successfully in a wide range of medical specialties, including cardiology [36], dermatology, psychiatry, radiology, neurology, oncology, wound care, and also dentistry.

Telehealth rules and regulations vary greatly by State and are constantly emerging and evolving. This creates unclear understandings regarding standards and guidelines among healthcare organizations. Over time, Telehealth services have raised many questions regarding malpractice liability, including informed consent, practice, and use of Telemedicine. Particularly, in Italy, Telemedicine services have been scattered in different applications, with poor interconnectivity and inconsistent local and regional reimbursement practices, and not covered by the national health system. Specifically, in 2012, the National Institute of Health first published general guidelines aimed to offer guidance for the implementation of Telemedicine solutions [37]. However, these guidelines have never been applied in practice. Although some results have been achieved, there are some risks associated with Telemedicine that must be managed.

5. Discussion

Based on high quality evidence, Telemedicine interventions improve survival rates and reduce the risk of heart failure related hospitalizations, when compared to usual face-to-face care.

Specifically, structured telephone support and Telemonitoring reduces the odds of mortality and hospitalizations related to heart failure compared to usual post-discharge care. Telemonitoring is also associated with a reduction in planned hospital visits, and does not compromise survival [38,39]. Remote monitoring, in particular, is an additional tool for implementing reliability in Telemedicine. Thus, evidence supported the benefits of remote monitoring in reducing hospitalization/rehospitalization, improving patient drug compliance and improving health outcomes [39].

Globally, multiple studies and meta-analyses have been performed, which provided evidence on the efficacy of Telemedicine for the management of hypertension [40-42], a principal risk factor for the occurrence of cardiovascular disorders, stroke, and kidney diseases. Further, several studies have addressed the efficacy of Telemedicine in controlling cardiovascular risk factors [43], such as smoking, diabetes mellitus [44], and sleep apnea [45]. Previous studies have shown that the use of

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technology (such as Telemedicine, Telemonitoring, and Teleconsultation), not only has economic benefits, but it is also effective in the management of chronic diseases, such as diabetes [44].

Since the World Health Organization (WHO) highlighted the alarming situation of diabetes, especially in developing countries [44], the use of technology has attracted the attention of several research groups [46]. However, before this technology can be applied, more attention needs to be paid to multiple factors, such as the provision of the necessary infrastructure and equipment, as well as the training of healthcare personnel and patients themselves [47].

On the other hand, Telemedicine has shown cost-effective benefits for chronic pain management in many areas worldwide [23]. Also, it was considered an effective way to improve mental health, especially through cognitive behavioral therapy. In particular, it is at least as effective as face-to-face interventions in tackling depression and/or anxiety, symptoms of obsessive-compulsive disorder (OCD), insomnia, dementia [48,49], excessive alcohol consumption, and common neurodegenerative disorders (Alzheimer Disease and Parkinson Disease) [50]. Although numerous studies document methods and strategies for achieving accurate neurological assessment through telecare; however, limitations persist and continue to support apprehension about its use [51,52]. Still, current evidence seems insufficient, and more data are required for the wide implementation of Telemedicine in managing neurological risk factors.

In the field of healthcare, oral health plays a crucial role in the quality of life [53]. Thus, preserving oral health is essential [54], therefore, improving access to dental care is crucial [55,56]. Furthermore, numerous studies have highlighted how oral diseases can promote the connection of inflammatory and infectious processes at a systemic level, with progressive worsening of the clinical picture of the subjects [56]. Teledentistry has emerged as a new tool with promising potential for several dental fields [57], including endodontics, orthodontics [58], pediatric dentistry and oral surgery [59-61]. More in detail, it offers the opportunity to continue practicing dental care by avoiding face-to-face visits, which put both patients and health workers at risk of infection [27, 56]. For example, in underserved communities, with limited access to specialized dental care, oral lesions, such as ulcerative and potentially malignant lesions, can be difficult to diagnose in dentistry [57]. Additionally, considering that oral hard and soft tissue changes can cause aesthetic and biological problems, planning a protocol that improves the maintenance of the affected tissues is essential [62].

Teledentistry may be able to fill this gap while also improving the quality of treatment. Among older adults, since poor oral status is considered an important indicator of fragility and improvement of oral conditions, Teledentistry could be used for dental screening and prevention pathologies in the elderly [62].

The development of new and intelligent approaches in healthcare has opened new roads for innovative procedures that have been demonstrated to work good and safe [63]. In the past, healthcare decisions were made almost exclusively by humans; the development of intelligent services and/or machines to make or assist them has raised many questions over time, especially to issues of accountability, transparency, and privacy [64]. Additionally, the acquisition, conservation and sharing of clinical data would facilitate the development of precision medicine, and thus, consequently, the personalization of prevention, diagnosis and treatment for each single patient.

For example, in the field of oncology, the possibility of carrying out a differential diagnosis between benign and malignant lesions affecting specific areas of the human body should always be taken into consideration. A rapid diagnostic evaluation through technological support, together with adequate histopathological verification, are essential to improve the management and prognosis of the specific disease.

Since current medical evidence is predominantly based on in-person medical counseling, there is a need to develop a sort of guidelines for the implementation of Telemedicine to control and improve the quality. It would be possible that the application of Telemedicine increases the benefit of home-based training by improving adherence and safety. Several studies report a moderate to high level of diagnostic and management concordance between Telemedicine and conventional in-person treatment [65,9]. In order to better understand, analyze and identify the main strengths and weaknesses of the developed Telemedicine services, opportunities and threats offered, SWOT

analyses were conducted to highlight the opportunities and limitations of their adoption. Specifically, SWOT analysis is mainly applied when the improvements to be applied are various and in different parts of the healthcare process [63]. On the other hand, it is commonly used to describe case studies by comparing them with related scientific literature, with the aim of acting as a sort of guide to achieve a "better approach". Several pieces of evidence suggest that data sharing and data mining, machine learning, artificial intelligence, blockchain and big data are revolutionizing our society, especially impacting current strategies for healthcare management [65,67].

In conclusion, patients equipped with smartphones, tablets, laptops can easily use telehealth applications to connect with healthcare assistants, who can s. who can potentially diagnose, monitor and treat a multitude of acute and chronic conditions. In this scenario, approval and acceptance are increasing because Telehealth and Telemedicine are efficient and effective tools for improving healthcare access and outcomes. However, several barriers to Telehealth practice remain to be overcome.

6. Conclusions

Telemedicine, certainly, represents an innovative development that improves the level of medical and health services in general throughout the world. Telemedicine is a constantly growing tool that sees an increased need for health literacy. Its application in various fields of medicine has been extensively investigated.

However, given the growing interest in a better state of psycho-physical well-being in our society, Telemedicine could represent a promising strategy to employ, especially in the preventive field. Additionally, cost-effectiveness is perhaps the most important outcome of Telecare interventions. If properly executed, it combines quality (clinical success) and investment (both on the part of clinicians and healthcare institutions). In this regard, health professionals need to be trained and updated on the different modalities and forms of Telehealth, which are now constantly evolving. Telehealth and Telemedicine are considered efficient and effective tools for improving healthcare access and outcomes.

Despite the important progress, achieved with the advent of technologies in various sectors, it is important to underline that Telemedicine cannot be understood as a replacement method for traditional medical services, rather as an integration to improve their effectiveness.

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