
THE TELEMEDICINE AND ICT AS TOOL TO IMPROVE THE LOCAL HEALTHCARE

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Abstract

The recent worldwide experience related to the health emergency of the Covid-19 pandemic has highlighted a renewed interest in telemedicine. This health care system assisted by technological innovation including, for example, ICT (Information Communication Technology) and support by smartphones and tablets allows treating patients directly at home, avoiding contacts with health professionals. Moreover, telemedicine offers the possibility of reorganizing healthcare, moving the focus of care activities from the hospital to the territory and a series of economic, social and environmental advantages. The introduction of ICT and telemedicine can be a valuable tool in support of the management of endocrine diseases such as diabetes which represents one of the main chronic diseases common spread in Italy. Diabetes treatment is certainly one of the fields in which telemedicine and eHealth have been principally tested. In this context, the present work intends to give an overview of the new opportunities offered by telemedicine and various medical devices used to the care and assistance of patients among those suffering from diabetes. In particular, some information is presented on the spread of this pathology in the province of Foggia and on the estimates of the costs incurred by the local health system. Possible applications of telemedicine could be implemented to improve the treatment and control of this pathology in this territory.

Keywords

Telemedicine, diabetes, ICT, Covid-19, healthcare

JEL Classification

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Introduction

The recent worldwide experience related to the health emergency due to the Covid-19 pandemic, has shown a great technological and social interest for new trends in sustainable business including medical devices and information and communication technologies or ICT (Information Communication Technology) the so-called telemedicine (Moazzami et al., 2020). These tools are generally used in the remote healthcare sector but with the appearance

of the Covid-19 have been used also to fight this new infectious agent. It can be said that Italy was one of the first countries in the world to experiment the telemedicine, with the transmission of electrocardiograms from a distance since 1970. Almost forty years later the Emilia-Romagna region established, with the participation of others Regions (Tuscany, Liguria, Marche, Campania, Veneto, Sicily and Lombardy) the National e-Care Observatory. This monitoring structure was accomplished also following a special agreement stipulated with the Ministry of Health. The aim of the e-Care Observatory was to evaluate and monitor telemedicine applications, to allow the exchange of good practices and related technologies, as well as to improve the accessibility and effectiveness of the services provided online to citizens. A few years later, the European Commission issued document COM (2008) 689 on "Telemedicine for the benefit of patients, health systems and society", aimed at supporting Member States to implement the Telemedicine services through the European territories by specific initiatives such as: a) building trust in Telemedicine services; b) to encourage its acceptance; c) clarify the legal aspects in the member states; d) to solve technical problems; e) facilitating the development of the market (Commissione della Comunità Europea, 2008). Following this communication, on 10 July 2012, national guidelines on Telemedicine were approved by the General Assembly of the Superior Health Council (Ministero della Salute, 2012a) in Italy. Later, in 2017 the National Center for Telemedicine and New Care Technologies was established by the Istituto Superiore di Sanità (ISS), whose aim is to conduct, promote and coordinate research and system governance for social applications and healthcare in the field of new information technologies and telemedicine (<https://telemedicine.iss.it>) (ISS, 2018). Telemedicine assisted by ICT allows to treat patients directly in their homes, avoiding contact with doctors and nurses. More generally, the introduction of this form of care entails advantages in terms of economic, social and environmental sustainability, as well as promoting programs for the prevention of certain diseases such as diabetes. It is often difficult to treat sick people in inaccessible territories or in rural areas where the utilities are very far from the health assistance centres, especially when the population is elderly and there are problems for transport to the hospital. In addition, moving from home to hospital involves fuel consumption and car use contributing to both greenhouse gas emissions (especially CO₂) and roads congestion (Cravo et al., 2013). Furthermore, there is no doubt that treating patients at home results in savings for the national health system (NHS) and a reduction in overcrowding in receptive health facilities. However, studies on economic analyses are limited while no cost-effectiveness assessment has yet been performed (Tsou et al. 2020). Currently, through telemedicine it is possible to cure different pathologies such as diabetes and endocrine pathologies, neuromuscular diseases, cardiovascular emergencies, rehabilitation activities, etc. (Ministero della salute, 2012a; Ghosh et al., 2020). Therefore, technological innovation and the tools used by telemedicine (devises and ITC) can contribute to a reorganization of health care, in particular by moving the focus of health care from the hospital to the local territory (Amicizia et al., 2013). Regarding the ICT solutions currently available on the market can have overlapping combine use with the technologies widely diffused on the market such as mobile telephony, tablet and smartphone medical devices, broadband networks, etc. Moreover, the reduced size and costs and the easy use in domestic environments of these devises, it allows to effectively manage all collaboration activities among health care stakeholders, including the patient and his family (Ministero della Salute, 2013). The present paper aims to provide an overview of the new opportunities offered by telemedicine and the different devices for the care and assistance of sick people and in particular those with diseases characterized by polyuria, polydipsia and polyphagia such as diabetes. In addition, some information is presented on the spread of this disease in the province of Foggia and on the estimates of the costs incurred by the local health system.

Telemedicine as service to improve the healthcare delivery system

Telemedicine which literally means "distance healing" was introduced in the 70s of the last century. It can be considered as a subset of telehealth, since it refers exclusively to the provision of health services and distance education of patient, through the use of telecommunication technology. According to the World Health Organization (WHO) there are more than 100 definitions among which the most accredited one states that: *telemedicine allows 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* (WHO, 2010).

Telemedicine includes the use of electronic communications and software to provide clinical services to patients without visit to them in the hospital. The technology in Telemedicine is often used for disease diagnosis, follow-up visits, management of a patient's chronic condition, planning and control of drug delivery, specialist advice and a range of other clinical services that can be provided remotely using tablets or smartphones connected via Wi-Fi or Bluetooth. To date, this healthcare model has been based on spontaneous and fragmented initiatives, therefore, to spread it on a national scale, it is necessary to move to a planned and regulated strategic interventions that involves all the actors of the hospital management system. In this way, by slightly modifying the processes and assistance services it is possible to ensure the coverage of professional skills in disadvantaged or isolated or difficult to access territories such as rural areas. Furthermore, Telemedicine can support the hospital sheltered discharge, the reduction of hospitalizations of the chronically ill people, the less use of hospitalizations for the elderly and nursing homes, the reduction of patient mobility in search of better treatments. Moreover, it allows the creation of specific care models for individuals with chronic diseases or with more complex needs, such as the elderly, prisoners or disabled people. Therefore, this new organizational model improves the quality of health care by ensuring the quality and continuity of care for all. Telemedicine is also able to promptly support an assistance network during major events or in response to natural disasters or collective emergencies such as the recent pandemic from Covid-19 (Ministero della salute 2012). Among the other advantages offered by telemedicine there is the possibility of making the communication among the various stakeholders (i.e. health managers, doctors, patients, etc.) usable and continuous, directing the use of the available resources (i.e. economic, hospital personnel, etc.) in a more rational and appropriate way. In addition, patient waiting times as well as complication risks are reduced. Therefore, an organizational model like this can lead to the rationalization of socio-sanitary processes with a possible impact on the containment of health expenditure while reducing, at the same time, the social cost of diseases. However, the economic importance of telemedicine not only manifests itself in a potential containment of healthcare expenditure, but also in a significant contribution to the economy, in a sector in which the European industry above all ITC and medical devices, but also the national one (including numerous small and medium-sized ones companies) is in a good position and has undergone rapid expansion in the last decade. According to a study by BCC Research (2018) the global value of the telemedicine market reached \$ 31.2 billion in 2018 and is expected to reach \$ 72.5 billion by 2023. These estimates are likely to grow further in the coming years, considering the importance of telemedicine in containing infections.

Devises which contribute to improve the telemedicine

Telemedicine and electronic healthcare, and more generally that of technologies applied to medicine (medical devices), is one of the industrial sectors with the highest rate of innovation. As mentioned, the ITC can assist the development of telemedicine and can be considered as the set of methods and technologies that implement the systems of transmission, reception

and processing of information useful for the diagnosis, treatment and control of diseases. In Italy, in particular, in recent years there has been a strong push towards a technological evolution that goes in the direction of the Digital Transformation of the country, with investments that aim to implement solutions at the base of the "Third Platform" such as Cloud Computing, Mobility, Social Business, Big Data and Analytics. In this direction, the awareness of even medium-sized companies of the importance of ICT as an indispensable tool to improve their level of competitiveness on the reference market has significantly accelerated. The importance of this sector is evidenced by the growing turnover that recorded in 2019 an expenditure of Italian companies that exceeds 31 billion €. This value increased by 2.3% compared to 2018, and this expenditure will reach almost 31.5 billion € in 2020, with a growth of 0.9% compared to 2019 (Assintel, 2020). In the monitoring of diabetes, it has a not only diagnostic but very useful function to better treat this pathology and prevent very frequent complications over time. It is also essential to test and verify adherence to the therapeutic program assigned to the patient after diagnosis. Care follow-up is carried out today, almost exclusively, using outpatient checks and glucose measurements with equipment and kits with rapid response (provided free of charge by the NHS in Italy and distributed by the pharmaceutical service). Today there are similar tools equipped, however, with a direct transfer system via Wi-Fi or Bluetooth connection mode using the latest generation smartphone. These cell phones are increasingly used as a tool for health monitoring thanks to the new processors with greater computing capacity, the availability of more capacious memories, larger screens and open operating systems that favour application development (Crico et al., 2018). This allows to speed up the analysis, data transmission and above all the reduction of costs. For some years, small devices, the so-called 'glucose sensors', have been available for continuous glucose monitoring (CGM). These are devices which are little more than a coin and slightly thicker, which are fixed to the skin with an adhesive and which, through a small cannula which passes through the skin, allow to continuously detect the level of glucose in the interstitial fluid of the subcutaneous, providing hundreds of values per day. Two types of systems are currently available: real-time CGM (real-time CGM, rtCGM) and intermittently viewed CGM (iCGM), also called glucose flash glucose sensors (flash glucose monitoring, FGM). Both systems provide information about current and past glucose levels, thus providing valuable information to prevent dangerous blood sugar fluctuations. In some of these systems it is also possible to activate alarms that go off in case of hypoglycaemia or hyperglycaemia (Bruttomesso et al., 2019).

Telemedicine and diabetes

In general, ICT management and telemedicine in particular, can be a valid tool to support the management of endocrine diseases such as diabetes which represents one of the main chronic diseases. In particular, the treatment of diabetes is certainly one of the fields in which telemedicine and eHealth have been most tested. The chronic nature of the disease and the need to empower patients make diabetes mellitus an ideal context for testing ICT with the aim of supporting home care.

In general, diabetes as a chronic disease requires frequent visits to the doctor for periodic check-ups, lifestyle advice and treatment adjustments. In this situation, telemedicine can help patients to get in touch, comfortably from home, with their doctor away from hospitals, also decreasing the chances of contracting infections. However, the telemedicine service does not replace traditional health services in the personal doctor-patient relationship, but supplements it to improve efficacy, efficiency and appropriateness. Thanks to special *devices*, doctors can interact with the patient, analyse the patient's medical history, analyse blood values such as blood sugar or blood pressure and provide advice. Since the early 90s of the last century, various telemedicine projects and studies have mainly focused on type 1 and type 2 diabetes. Initially, the projects consisted of: *structured-telephone support*, that is, remote management

of the patients provided through structured telephone contact between patients and healthcare professionals - with or without home visits and reporting of symptoms or physiological data; or *telemonitoring* characterized by the use of particular sensors connected to the patient, whose signals are transferred wirelessly to a central station or "node". The anomalies observed trigger a response from healthcare professionals. Subsequently, interest in this innovative care system increased. Furthermore, compared to the previous decade, most of the new projects have used new devices or processes for better management of the diabetic patient. For example, by using a remote monitoring device, the blood glucose level, blood pressure, heart rate and weight were controlled. The patient then received a series of educational messages on the cell phone about the disease (diabetes, high blood pressure) and comorbidity factors. Other projects included self-measurement of the evening blood glucose level and transmission of information to the health care centre via a web portal. Finally, between 2015 and 2019, numerous telemedicine projects based on machine learning devices that use artificial intelligence and ITC (elements that define telemedicine 2.0) have emerged, or are still in progress, whose devices were connected via Bluetooth or Wi-Fi for monitoring type 1 and type 2 diabetes and its comorbidities. All diabetic patients involved in telemedicine projects have shown a marked improvement in the quality of life and some parameters such as glycated haemoglobin (HbA1c) and the content of low-density lipoprotein (LDL). In addition, telemedicine has made patients more aware of their state of health by promoting greater adherence to therapeutic and hygienic-dietary measures (Andrès et al., 2019). Moreover, other scientific studies on the use of telemedicine in diabetic patients have also shown benefits to patients who use telemedicine. In fact, a recent meta-analysis carried out in China showed that diabetics followed video chat, mobile phone and e-mail remotely had a reduction of HbA1c by 0.37% (p 0.001) compared to controls. The research carried out on 35 randomized studies involved over 3500 patients followed over a period of time from 3 to 60 months. Similar results have been obtained in another research which analyzed 21 randomized studies on patients with diabetes (for a total of 2768 people). These patients have been treated with interactive telemedicine (remote monitoring or video chat in real time) in addition or alternatively or partly replaced by standard therapy. On the contrary, the controls were treated by standard therapy only. The survey showed a reduction in HbA1c by 0.31% (p 0.001) in telemedicine patients compared to controls. A meta-analysis of 46 studies, which included 24000 patients with type 2 diabetes mellitus (T2DM) and 2052 patients with type 1 diabetes mellitus (T1DM), also showed an overall average reduction in HbA1c from 0.12% to 0.86% for T2DM and from 0.01% to 1.13% for T1DM (Ghosh et al. 2020). In Italy in November 2019, a national study was launched by the Associazione Medici Diabetologi (AMD) and ISS to verify the benefits of using telemedicine to treat diabetics. The aim is to evaluate on a sample of about 1000 patients with type 2 and gestational diabetes whether the use of a home telemedicine system, associated with remote educational support, improves glycemic control and the cardiovascular risk profile compared to normal methods of management by the diabetology service. The project is based on its ability of patients to self-manage the disease and on maintaining continuous contact with the health service, reducing the need for visits to the diabetes clinic (Martucci, 2019). According to Istat data in 2016, there were over 3.2 million people with diabetes in Italy, that is 5.3% of the entire population (16.5% among people over 65). Since diabetes is a pathology strongly associated with the socio-economic disadvantage, it is more widespread in the southern regions where the age standardized prevalence rate is 5.8% against 4.0% in the North. Particularly among 45-64year olds the percentage of obese people suffering from diabetes is 28.9% for men and 32.8% for women. In the same age group 47.5% of men and 64.2% of women with diabetes do not engage in any light physical activity in their spare time (ISTAT, 2017). In particular in the Apulia region, in southern Italy, in 2018 the average discharge rate of diabetes mellitus in patients over the age of 45 was 8.28%. The province of Foggia was the one with the greatest spread of this

pathology (second in incidence in Italy) with a rate higher than 16% (Fig. no. 1). Diabetes in Italy has a total cost which in 2017 was 20.3 billion € per year, of which 46% of direct costs and 54% of indirect costs. Within the former, about half (49%) are due to hospitalizations, 7% to diabetes drugs, 17% to patient visits, 23% to other drugs. Conversely, the use of devices would significantly reduce expenses considering that they would affect between 4-7% of the total costs inherent in the treatment of the disease. On average, the average cost of hospitalizing a diabetic patient exceeds 5,000 €. It has been estimated that increasing spending on devices by only 3% would result in a 34% saving in healthcare costs. This means that the NHS would save more than 4,4 billion per year considering that annually the cost to treat people with diabetes is 10 billion €, to which must be added 3 billion spent by individual patients (SID, 2017). So, it is wrong to consider that technological innovation is the first reason for the increase in healthcare costs.

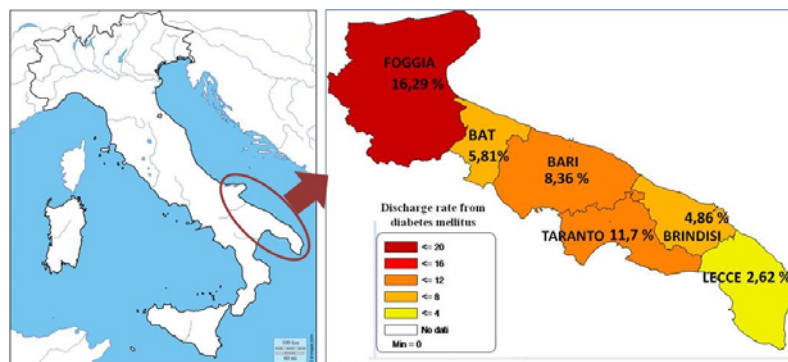


Fig. no. 1 Discharge rate from diabetes mellitus in the Puglia region

Source: our elaboration

The Apulia region, therefore, could take advantage of the introduction of telemedicine both in economic efficiency terms of the assistance service provided. The province of Foggia, in particular, would be the one that more than the others would benefit from it since it is characterized by a large territory with a high percentage of the elderly population. In Italy, each diabetic patient requires on average an annual total expenditure for direct costs of approximately 2,800 € (Marcellusi et al., 2014). Considering that in the province of Foggia in 2016 about 500 diabetics were discharged (ISTAT 2016) the health expenditure incurred for their treatment was almost 1.4 million €. This estimate, however, can increase if we also consider complications such as: a) nephropathies and macrovascular complications, which require amputations and revascularizations of the lower limbs (4,500-5,000 €/year per patient); b) cerebrovascular pathologies (3,500 €/year per patient); heart disease, retinopathy, neuropathy and acute complications (1,500 and 2,000 €/year per patient) (Lee and Lee, 2018). Therefore, since the cost incurred by the regional health system can reach considerably high values, the introduction of telemedicine could help keep healthcare costs low.

Conclusions

From what has been highlighted, it is easy to understand what the benefits of introducing telemedicine could be to our society. From the observation of epidemiological data on diabetes, it is easy to deduce that this pathology is continuously increasing, and that in Italy in the next few years it will go from 3 million € in 2014 to 5 million € in 2030. This pathology, in addition to causing a low quality of life for the patient, to involve the affective aspects concerning his family weighs economically on society. Its treatment, in fact, has significant direct healthcare costs, with a high per capita cost: for this reason, there is a need to resort to effective and inexpensive care systems and treatments that respond promptly to the

emergency. Telemedicine services therefore give the opportunity to solve problems both economically and socially. As highlighted, the introduction of this health care system has led to positive results regarding patient care. This does not imply healing the patient, but an improvement in his quality of life and his family, with a consequent positive approach to the disease, increasing tranquillity and awareness of his health. The introduction of new cheaper devices with numerous applications combined with ICT and the greater diffusion of smartphones and tablets makes the transition to telemedicine faster and more pervasive within the nation's health system. The Apulia region and in particular the province of Foggia characterized by a percentage of diabetic patients in Italy could avail of these advantages. Therefore, the development of a good telemedicine system allows not only to have a rapid exchange of information between patient and doctor, a reduction of hospitalizations of patients and a prevention of critical events, but also a knowledge and greater acceptance of new technologies in the field of national health.

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