TECHNOLOGY MEETS HEALTH CARE MANAGEMENT. HOW TELEHEALTH CAN LOWER COSTS AND INCREASE OUTCOMES IN HEALTH CARE SETTINGS IN GREECE

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Declaration

This dissertation titled “Technology meets Health Care Management. How telehealth can lower costs and increase outcomes in health care settings in Greece.” is submitted for the degree of Doctor of Philosophy in Health Care Management at Selinus University. I do hereby attest that I am the sole author of this thesis and that its contents are only the result of the readings and research I have done.

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Prayers up!

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Abbreviations Table

AIMS: Anesthesia Information System

BP: Blood Pressure

CIM: Clinical Information Management

COPD: Chronic Obstructive Pulmanary Disease

ECG: Electrocardiograph

EDIT: National Telemedice Network (translated from Greek)

EOPPY: National Organization for the Provision of Health Services (translated from Greek)

HIS: Hospital Information System

IRR: Internal Rate of Return

IT: Information Technology

LIS: Laboratory Information System

MMIS: Material Management Information System

MRI: Magnetic Renosance Imaging

NASA: National Aeronautics and Space Administration

NPV: Net Present Value

OTE: Hellenic Telecommunications Organization (translated from Greek)

PACS: Picture Archiving and Communication System

PC: Personal Computer

Abbreviations table –(Continued)

PCP: Primary Care Provider

PCMCIA: Personal Computer Memory Card Association

PHC: Primary Health Care

PIS: Pharmacy Information System

QALY: Quality-adjusted life year

RFID: Radio Frequency Identification

RIS: Radiology Information System

WHO: World Health Organization

Abstract

Telehealth is a broad term which is used by clinical staff to refer to various aspects of health care at a distance. Telehealth, or telemedicine, uses telecommunication technologies to provide medical services and information in a variety of settings from a distance where conventional approaches cannot be used (i.e. in remote areas, during the Covid-19 pandemic). Therapeutic and preventive services, diagnostics as well as patient and medical staff education can be provided via telemedicine services. The purpose of this paper is to present the various applications of telehealth as well as how it can be utilized to increase benefits and reduce overall costs in health care settings.

Keywords: telehealth, telemedicine, e-health, healthcare, smart hospitals

Introduction

One of the most important advancements in the history of Medicine is its connection to technology. According to WHO, “Medical Technology” can be defined as any technology which can diagnose, treat and/or improve a person’s overall health and well-being by using both low and high-risk medical devices. A global definition of a medical device is difficult to be established, however any telemedicine tool is considered “Medical Technology” (Simons et al., 2013).

On the other end, Telemedicine is the science of distant medicine. The history of telemedicine begins in the 1970's. However, with the advent of computer systems and the rapid development of network technology as well as the simultaneous development of many telemedicine applications (i.e. teleradiology, telepathology, teledermatology), it further progressed in the 1980's and the 1990's.

In Greece in particular, the development of telemedicine opeations are strongly connected with the Laboratory of Medical Physics of the Medical School of the University of Athens. Nowadays, important applications have been developed in the public and private sector which confirm the endless possibilities and the positive effects that telemedicine can have on the provision of high quality health services. The aim of this paper is to discuss the telemedine applications in Greece as well as present ways to overcome the obstacles that refrain the national healthcare system from a complete transition to a new digital era.

1. DIGITAL REFORMATION OF HEALTH CARE IN GREECE: A HISTORICAL REVIEW

1.1 Digital reformation

Technology is changing rapidly and has a direct impact on our lives. The health sector, which is one of the largest in the world, has a fast growth rate and thus, has become a magnet for IT companies. Technological advancements have created the right conditions for innovative collaborations between health and the IT sectors in order to improve the quality of services provided. Devices such as smartphones and portable sensors as well as developments in genetics create large volumes of data. Proper analysis and study of such can contribute to the better functioning of the health market, the creation of products and services that focus on the needs of the patients as well as individualized clinical care.

For the purpose of this essay, it is necessary to first describe Digital Health. Digital Health is a general term that encompasses all applications, technologies, and systems related to healthcare, which result from the partnership of medicine, genetics, and technologies (Simon et al., 2013). Digital Health uses interconnected technologies to include the full range of healthcare providers, consumers, and researchers to ensure comprehensive, effective, and personalized patient care and family care. The benefits of utilizing Digital Health include but are not limited to the following: improvement of the quality of care, easy access to health services and reduction of the overall cost of health services.

Under the pressure of the global economic crisis and the Greek Memorandum, public funding for health expenditure in Greece, and Southern Europe in general, has been declining over time. Therefore, some reforms were deemed necessary to contain health costs and identify additional resources (Andersson & Titov, 2014). Such efforts were imposed by Troika (the European Comission, the European Central Bank and the International Monetary Fund) and were applied to ameliorate "chronic pathogenesis of the Greek health system" (Kontodimopoulos et al., 2013) which led to the formation of a health system "without boundaries and with the simultaneous absence of a strategic, plan at a national level" (Niakas 2013).

All of the above contributed to the formation of a long series of deficit state budgets for health expenditures, the absence of funding criteria, the irrational distribution of resources, the absence of electronic information systems, the emergence of black markets and costly out-of-pocket payment, all of which created an increased demand for health care services in the private sector opposing to the original plan which was based on the need for free health care services for all citizens (Economou et al., 2017). As a result, a need of an integrated health care information system for both public and private hospitals emerged which formed the beginning of electronic filing of health care services and eventually telehealth, as means to reduce health care costs and provide affordable quality services (Weinstein et al., 2014).

1.2 Telehealth and Telemedicine

The prefix "tele" comes from the Greek word which means"far" or "from a distance" or "distant". Consequently, the word telemedicine indicates a health service which is offered remotely, the use of telecommunications to provide medical information and services (Smith et al., 2020). It is the transfer of medical information via telecommunication technologies for the purpose of consulting or for remote medical procedures or examinations. In essence, the notions e-health, telecare, telemedicine and telehealth are used interchangeably. However, according to Harst et al. (2019), "telemedicine can be clearly distinguished from the terms "telehealth" and "teleworking". Telemedicine uses information and communication technology to convey medical information for diagnosis, treatment, and educational purposes. Telehealth includes information and telecommunication technologies for the transfer of healthcare information for the provision of clinical, administrative, and educational services. At times, the term teleworking is also used to describe the application of telemedicine to the provision of medical services to patients themselves in their homes or at supervised institutions. For the purpose of this paper, telemedicine and telehealth will be used interchangeably.

Telemedicine involves the use of modern information technology, in particular two-way interactive audio/video communications, computers, and telemetry, to provide health services to remote patients and to facilitate the exchange of information between primary care physicians and specialists which are at some distance from each other. (Harst et al, 2019).

The basic legal framework that governs the operation of telemedicine in Greece is Law 3984/2011, article 66, par. 16: “Telemedicine services are provided if possible and under the responsibility of the treating physician who deals with each case. The treating physician, for reasons of personal data protection, is responsible for requesting from the patient or if this is not possible from a first-degree relative, the signed approval for the use of telemedicine services. If this is not possible, then the treating physician uses telemedicine services at his discretion. The instructions of the Hospitals and Health Units that provide Telemedicine services are advisory and in no case mandatory. "

The most comprehensive effort that has been made to date in terms of its use both in the community of health professionals and the beneficiary population, is the “EDIT” (National Telemedicine Network, Department 2 of Piraeus and Aegean RDA). EDIT is a network of telemedicine stations implemented by the 2nd RAE with funding from the OP "DIGITAL CONVERGENCE" 2007-2013. EDIT started its productive operation at the beginning of 2016 and operates within the area of responsibility of the 2nd RIA of Piraeus and the Aegean. It includes:

- 30 Telemedicine Doctors - Patient Stations (STIA) located in remote locations: from Kythira to Kastelorizo and from Lemnos and Oinousses (Health Centers and Multipurpose Regional Clinics).
- 12 Telemedicine Consultant Stations in large Hospitals of the 2nd RAE
- 5 Regional Hospitals: Rhodes, Samos, Syros, Mytilene, Chios
- 7 Hospitals located in Attica: Asklipieio, Tzanio, Thriasio, Metaxa, Nikaia, Attikon, PSNA)
- 1 Telemedicine Station of a Medical Consultant at EKEPY. Data Center hosted in the Information Society (IS SA)
- HELP DESK which is located on the premises of the 2nd DYPE.

1.3 History of Telehealth

The beginning of telehealth can be traced back in the 1970s. Essentially, it began to grow in the 1980s with the advent of computer systems and even more so in the 1990s with the rapid development of network technology as well as the parallel development of many telemedicine applications. The following is a brief history with the most important dates that were the main pillars for the use of telemedicine services (mHealthIntelligence, 2015).

1906: The inventor of the Einthoven electrocardiogram makes the first remote medical diagnosis by telephone, transmitting a phonocardiogram and breathing sounds.

1920 - Medical advice is given to ships in Sweden with Mor's marks.

1924: The first radio telemedicine report is published on the cover of "Radio News" in April 1924, featuring a physician who was able to communicate with the patient in real-time via radio waves.

1957: On November 3, 1957, with the launch of the Sputnik2 rocket, Soviet scientists develop advanced telemedicine systems for the time to observe the state of health of Laika, the first living organism in space.

1960: The first transmission of astronaut biomarkers takes place via one-way microwave link and audio and video communication via two-way microwave link. This two-way communication essentially creates a closed circuit between long distances.

1964: Two-way closed-circuit television is used at the Nebraska Psychiatric Institute, which is connected to Norfolk State Hospital, 112 miles away. This link was used for both educational and advisory purposes.

1967: The first telemedicine application is implemented with doctor-patient interaction and the installation of a telemedicine station for the provision of medical services 24 hours a day to airport employees- but also for travelers' emergencies- achieving radiological examination via video monitor and telephone consultation between Logan Airport and Massachusetts General Hospital.

1970: Telehealth services to isolated hospitals in secluded cities were made possible by the use of ATS-6 satellites.

1972-1975: Medical assistance is provided to astronauts through telemedicine under the responsibility of NASA.

1976: The Canadian Memorial University of Newfoundland participates in the Canadian space program for connecting and transmitting patient biomarkers via the American-Canadian satellite Hermes (Whalen, 2021).

1988 - A telemedicine network between Yerevan and four medical centers in the United States is set up and installed by experts from the USSR Working Group on Space Biology following a major earthquake in Yerevan, Armenia.

In general, typical examples of countries that make extensive use of telemedicine are the USA, the United Kingdom, Canada, France, Sweden, Australia and other Scandinavian countries. Some developing countries such as Bhutan, Sri Lanka, Thailand, Micronesia, Jordan, Mexico, and Taiwan also make use of telehealth (Board on Health Care Services et al., 2012).

1.4 Telehealth in the Greek Primary Healthcare

Primary Healthcare, or PCH, refers to essential health care that is based on scientifically sound and socially acceptable methods and technology. This makes universal health care accessible to all individuals and families in the community. As far as Greece is concerned, telehealth units and information systems provide PHC services to residents of remote/inaccessible areas by using telecommunications to reduce or even remove the doctor's formal and routine contact with the patient. This innovative approach to medical care has been developed for many years and covers many medical specialties. Telehealth services have brought great financial benefits. For example, the installation of telemedicine units/systems on the islands of Patmos and Leros produce great saving costs for the health units that have been using them. The overall costs were reduced, due to the low costs of having to transport doctors to the islands, with savings that range from approximately 20,000 to 80,000 euros per year. The social benefits are also of high significance as telehealth services reduce regional inequalities in patients' right to primary health care and create a sense of security for both for patients and physicians (Kouskoukis, 2017).

Additional benefits of telehealth may include managing emergencies such as accidents and special treatments for the chronically ill. Furthermore, the modernization of the existing telecommunications network, the upgrading of health infrastructure and medical equipment, the education/training and the improvement of the working conditions of doctors and nursing staff, as well as the full staffing of hospitals, health centers and regional clinics are additional benefits. Overall, the ability to serve patients despite of the severe weather, in remote areas further emphasize the potential advantages.

In Greece, telehealth services are proving to be a promising solution, especially in areas which are not easily accessible by public transportation and they can be utilized to increase the quality of life and improve the living conditions of the residents. However, According to Roumeliotaki et al. (2009), in a survey conducted by the World Health Organization (WHO) for Greece in 2007, it was observed that only 27.1% of a total of 1000 respondents felt comfortable with a virtual medical or mental health appointment even though continuous monitoring of the patients through telehealth allows timely intervention during their treatment.

Acccording to another research by Chronakis and Associates (2007), 1000 participants aged 15-80 were asked about the benefits of e-health services and the use of virtual medical examinations but only 26% os the sample indicated that they were satisfied with telehealth because of lack of intimacy with the physician.

In regards to Greece, it is important to mention the Vodafone telehealth project which was launched in 2003. The Vodfone telehealth project is a unique program which offers a variety of virtual services to children who live in remote areas. Such services include pediatric , physical therapy, occupational therapy, speech therapy, counseling and social work services. (Gigoriadou, 2018).

1.5 Telehealth in the Greek Secondary Healthcare

Secondary Healthcare refers to medical care that is provided by a specialist or facility upon referral by a primary care physician and that requires more specialized knowledge, skill or equipment that the primary care physician can provide. Secondary care can be provided by the following institutions:

- Public Hospitals. The state finances public hospitals through the state and social security budget. As a percentage of all beds, they occupy first place with a percentage of about 65%.
- Private Hospitals and Clinics. They are autonomous private companies. These institutions own 60% of all hospitals in Greece, with about 30% of all beds.
- Legal Entities under Private Law - non-profit. They are subsidized by the state; the number of beds in this category is small.

The internal dynamics of a healthcare provider's clinical IT stems from the need for a better quality of care. Carr & Dimitrakakis (1999) describe this quality of care as a process whose focus is not on the functions of the traditional hospital but the aggregation and consolidation of a wealth of relevant care information into that health care provider (well, a hospital) that can manage them and utilize them improving the quality of the final service. Karys (1998) refers to the need to devise managed care mechanisms as custodians of its quality who, by introducing them into the health system, ended the "technological paradox" in health. Spurr et al. (1996) distinguish the importance of some "critical pathways" in the management of care which is nothing more than care instructions which, however, are based on the experience gained over time for a disease (or group of patients) and is used based on specific critical pathways to provide the best possible care.

The technological paradox lies in the contrast between the existence of medical technological equipment but its widespread use in the treatment process. The reason was the differences in the philosophy for the provision of health services between the medical staff and the administrative Health Mechanism (Karys 1998). The medical staff considered that the overriding criterion for health services is the best possible quality of care and the use of every possible means to achieve it. Thus, in the past, the medical community used technology as much as possible (but the majority of freelance physicians could not use it due to cost). On the other hand, the criterion for the health management mechanism was not only the quality of care but also the control of costs through the effort for better organization and avoidance of waste of medical resources. This opposition has led over the last decade, mainly abroad, to the adoption of Care Management Mechanisms.

Such mechanisms do not try to reconcile cost and quality in care but on the basis of scientific analysis and the adoption of clinical IT to offer through a new decision-making mechanism the best quality of care at the lowest possible cost (Karys 1998). Clinical informatics serves two main purposes in the context of the operation of a health institution: first, it serves the organic and strategic goals of the institution, and secondly, it provides all kinds of health services to the patients served by the specific institution.

To the extent that these procedures are automated, the health care provider moves to a higher level of care organization and management. This self-identification is even more necessary today when it is argued that the most appropriate method of care should be applied from the outset to a patient not on the basis of demographic or economic criteria but the basis of clinical expediency (Karys, 1998). The problem with implementing a Clinical Information System or Integrated Delivery Network (IDN) to emphasize the importance of immediacy in health care support is that there is no standard or just solution for the creation of such a system (Sood et al., 2007). This is due to several reasons, mainly economic, technical, and commercial. The financial cost of undertaking such an operation is significant and directly depends on the capabilities and experience of a healthcare provider to stop it at a technical obstacle and management, adaptation and even the creation of software is not always an easy task. in results. It all starts with the non-existence of specialized software for clinical services in the market until today because, among other things, the market is small for such applications with the data of its manufacturers, forcing those healthcare providers who can either use it or not. modify existing commercial applications for other purposes, usually older versions due to high cost.

The result is the creation of a limited number of innovative clinical software systems that can meet current needs and serve as a platform for future support and large-scale and content telemedicine applications (Evans, 2016). The creators of such software today are usually large and (private) healthcare providers abroad who run a significant volume of healthcare services whose importance is not only commercial but also research since a significant part of medical research is carried out based on this institutional organization.

With the development, installation and gradual dependence on clinical software, health care providers are beginning to face challenges in the administrative organization and management of their new systems. Matthews & Newell (1999) make the necessary distinction between clinical informatics and clinical informatics management. Their basic premise is that achieving clinical information management (CIM) is not a matter of course with the introduction of new technology. It is a graphical learning process for the whole health institution as an organization that gradually rises to a higher level of integration, complete control, and utilization of its technological potential. This is the concept of management in modern health.

The starting point of Matthews & Newell's (1999) claims is based on the assumption that clinical IT is a necessary but not sufficient set of technologies and systems that lead to the management of clinical IT. If clinical information and data collection mechanisms are not processed for the ultimate purpose of making rapid and detailed care decisions then clinical management cannot be achieved. The mechanism that undertakes the linear integration of all clinical IT systems and decision-making processes to ultimately lead to clinical management is the integration hub of the system. The motivations for the design and implementation of the system integration center that will lead to the clinical administration of a health care provider are its aspirations for the quality of care, the technological means at its disposal, and its organizational needs both at the system and individual level. level, ie the ability and expediency of using clinical techniques to achieve the desired result (Matthews & Newell 1999).

However, the main advantages of Telemedicine appear when medical care is provided jointly between a hospital and local doctors. In many cases, this is both possible and desirable. In general, these can be either chronic diseases for which treatment requires regular and continuous evaluation of the patient or cases that require detailed but short-term observations so that appropriate treatment decisions can be made (Arkwright et al., 2019). Although many diseases belong to the above categories, to date only a few of them have benefited from Telemedicine. The range of existing practical applications is limited but is likely to expand based on the techniques in place for outpatient follow-up of specific cases.

1.6 Telemedicine in the Greek Tertiary Healthcare

Tertiary care refers to highly specialized medical care usually over an extended period of time that involves advanced and complex procedures and treatments prrformed by medical specialists in state-of-the-art facilities. In Greece such facilities consist of regional general and university hospitals, which are fully equipped to cover specialized cases. The cost of providing such health services represents a significant and ever-increasing share of the EU Member States' National Product (Pirtle et al., 2019). But while these costs are socially and nationally acceptable, the problem of providing these services most cost-effectively always remains. The cost of providing health services is increasing at a very high rate as the patient is forced to move from his home to hospitals or referral units, ie the costs increase significantly from primary to tertiary care (McConnochie, 2019).

It has therefore been identified that there is an urgent need to use technologies to monitor patients at home or in the city and to improve the suitability and efficiency of the medical care system at all levels. At the same time, the increasing frequency and severity of degenerative diseases require a review of the health system strategy (Wang, 2014). Often complete recovery of health is impossible and the goals of care delivery are mainly to maximize the quality performance of the patient's functions so that he is able to live as independently as possible. Achieving these goals requires technology and support systems to continuously monitor the patient's condition and monitor his or her home, work, and leisure environment.

The widespread introduction of telemedicine in the field of health brings about significant changes in both the structure and the organization of the nursing units, as from closed subsets they evolve into open environments of integrated health care (Martin et al., 2011). What we must attach is that through the new telematics applications control of the cost of the services offered, with significant benefit for both the public administration and the taxpayer. The presence of specialized sciences in the regional telemedicine centers, supply all τthe units with the corresponding equipment and the training of doctors in the new methods, in combination with the introduction of the new information systems in the hospitals, as well as the implementation of the National Medical Database (Chen et al., 2020). Those become the main conditions of the transition from the current National Health System to the National Network of Integrated Health Care, including the rural hospitals.

The completion of the connection of healthcare providers at the European level, and their respective networks, both private and public, will contribute to the faster evaluation of the whole process of the framework of the applications that will be developed. Ensuring medical confidentiality (Lea & Tannenbaum, 2020), concerning the abundance of data that will be constantly accumulated in national databases, is a dominant concern of both doctors and the organized state.

Telemedicine can meet many medical needs that would be difficult or impossible to meet otherwise. Some of these needs are: in remote areas where it is difficult to have medical services, on ships, in homes for medical care, in emergencies, in health facilities for tourist areas, in tele-education, in the coverage of rare specialties, and so on. There are patients who due to distance can not have the best medical care (Rhoads, 2015). Using telemedicine is the best way for patients to get what they need. The use of telemedicine helps both medically and financially. From a medical point of view because a vast majority of patients will be treated quickly and from a financial point of view because these patients will not need to be transported to a hospital, even a rural one or a suburban Healthcare Center (Haynes et al., 2021). In emergencies where time is precious, many lives can be saved even by one phone call. In tourist areas, especially in summer, there is not always a doctor available. Telemedicine is the best solution since not all specialties are available in all hospitals. So if you need a diagnosis, treatment, or even an operation that requires a specialty that does not exist with the help of PCs, all three can be done.

One major role can be played by the nurses. As they participate in almost all medical actions and at times are as well as doctors trained in cases when a regular check-up is scheduled or in cases of consultancy, e-prescription in some countries is also an advantage of nurses (Maier, 2019), the electronic nursing documentation can include appropriate data and complete a patient's file. The documentation of the nursing care provided is a vital part of the nursing process, as indeed 38% of the daily nursing time is dedicated to the recording of a performed nursing project (Urquhart, 2018). Nursing documentation is done to fulfill administrative and clinical purposes.

The nursing literature mentions 7 ways of nursing documentation: 1) Narrative type notes, 2) Problem-oriented files, 3) Source-oriented files, 4) Exceptional recording, 5) Case-by-case recording, 6) The electronic files, 7) The Kardex (nursing accountability in files). Nursing documentation studies highlight the problem of incomplete and incorrect recording of nursing care (Kelley et al., 2017). With the aim of patient safety, improving the quality of health care provided, reducing the cost of health services, increasing patient and nurse satisfaction, and securing the nursing project, an effort was made to improve the nursing documentation by using advanced printed forms, however, the problem remains. The solution that emerges is the use of technology and the introduction of electronic documentation. Computers reduce healthcare-related errors, especially by supporting decision-making, easy-to-read logging, and anti-duplication. They also limit the time required by the documentation process and provide authorized users with direct access to patient data (Wang et al., 2015). The involvement of nurses in the analysis of requirements, in the design and installation of IT applications in their workplace, is imperative, in order to ensure the response of these applications to the needs of users and therefore their success.

2. APPLICATIONS OF TELEMEDICINE

2.1 Teleconsultation

Teleconsultation covers the need for exchange of views as well as the organization of specialist medical councils to deal with specific complex situations where the simultaneous study of the patient's condition is required by specialists of different specialties.

Teleconsultation is directly related to what we call telephone medicine. Telemedicine should be included in telemedicine discussions as long as this type of telematics health service is provided from the start of telephone services. The importance of paying attention to such a service lies in the following: (a) low cost, (b) low training requirements for effective telephone support, (c) its increasing implementation is linked to public emergency numbers, (d) basic implementation and acceptance precede any other social acceptance of telemedicine support, e) immediate benefits related to patient service and reduction of the waiting list (eg solving smaller problems).

2.2 Collaborative diagnosis

At times, in order to make the final diagnosis of a patient's condition, it is necessary to work with doctors of different specialties located in different locations. It goes without saying that in urgent cases the diagnosis must be made quickly and with great accuracy. Collaborative diagnosis, as an application of telemedicine, provides the solution in this case.

Collaborating physicians use telemedicine technology to exchange information, such as patient images and laboratory data, and present their views. Then they come to a common decision, not only about the disease but also about the treatment plan they have to follow. Two or more doctors of different specialties may be involved in this procedure. The means of communication do not preclude traditional simple communication or the use of e-mail, but extend to video conferencing, where multimedia transmission capabilities (images, audio, video) coexist.

2.3 Home Telephony: Applications and Evaluation of Telemedicine Applications in Home Care

Home care should be understood as telemedicine services that the patient can receive at home. They include the following devices:

- Security technologies, tele-alarms, video, burglar alarms, fire alarms, warning devices, protection devices, etc.
- Health care monitoring systems, treatment devices and analysts.
- Daily activity support devices and personal assistants for rehabilitation treatments, for personal care and protection, for household, for communication, entertainment and education.
- Environmental control devices (furniture and home adaptations, assistants for handling products and goods, assistants and equipment for improvements and control environment).

Home health care is a fast growing area of health care. Telephony covers the existence of the remote nurse and the support of the community. Compared to hospital practice, it should be noted that the patient's home environment does not have health professionals, it is less safe than in-hospital environment and care services are provided late. Home care technology is any technology used to implement home telemedicine services. It can also incorporate any device or instrument for monitoring patients, for treatment or environmental control.

Most developed countries today face serious problems in the provision of health services such as:

- Increased needs for health services due to the increasing number of the elderly as well as the chronically ill (patients with end-stage renal disease, asthma, etc.).
- Need for access to services outside of hospital units at home and in general in the patient's familiar environment.
- Need for increased efficiency, personalization and high quality health services in conditions of limited available budget.
- Difficulties for the prevention and maintenance of medical staff in general and, in particular, for the service of the elderlyIncreased need to provide services and maintain the quality of life for the elderly and the chronically ill.

These challenges and demands make telemedicine for home support one of the fastest growing health care providers in the developed world. In fact, this increase is expected to be even more dramatic as national supply models change health studies and related studies evaluating experimental applications of such services (Weinstein et al. 2014).

Telemedicine for home care is further strengthened as the model of health services changes from medical-centric to anthropocentric, in which the citizen becomes responsible for the personal management of his health and related services, which in fact, whenever feasible provided at the place where the citizen resides. The application of telemedicine and / or tele-health in the home environment is often referred to as home telematics health support (telehomecare, home telehealth home or based eHealth). It is about the use of information, communication, measurement and control technologies for assessment of the state of health and the provision of health services and support in the citizen's living space.

This communication allows the evaluation of the normal functioning of the organic systems (eg cardiac), measurement of biomarkers (tightness, pressure, etc.), while it is often accompanied by educational programs for the patient and his family, with special emphasis on personalized health management. and especially any chronic disease. Like other telemedicine sectors, the telematics home support environment is characterized by varying levels. The highest level corresponds to the services provided, such as tele-monitoring, tele-consulting, remote-control, tele-education and other value-added services. The intermediate level includes all those applications that support communication and collaboration in order to implement the above services. Such computing applications include email, video conferencing, asynchronous and synchronous communication, virtual immersive environments, interactive multimedia medical data review, and other related applications. Finally, the lower level includes the necessary technological infrastructure, such as medical devices, computer tools and telecommunication networks. Telematics services for home health support are divided into the following categories:

- *Services that address the patient / citizen's stress and anxiety.* These services aim to stimulate the sense of security of the elderly and high-risk citizens and to reduce their need for the use of standard health services. Typical examples are systems that support telephone communication in emergencies.
- *Services to provide information and advice aimed at quality of life.* These services aim to address the feeling of loneliness and quality of life of citizens,

creating a virtual community between them, their family and the staff that provides services health, supporting communication through the use of electronic media and the internet. This may include services aimed at monitoring patients' compliance with treatment protocols, diets and suggested lifestyles (eg for diabetics, etc.).

- *Services that include telemetry of specific biomarkers and parameters.* These services aim at the continuous, remote monitoring of the health condition by specialized personnel. Smart alarms support non-invasive monitoring of the patient in the private space, while recent developments include the use of sensors integrated in the monitored person, as well as other devices for greater automation of telemetry with simultaneous production of the independence and freedom of movement of the individual.
- *Services that promote personalized health care.* These services often combine all of the above. They often include some form of telemetry and allow the patient to communicate directly with medical and nursing staff, while promoting and supporting patient information and education.

In practice, most telematics applications for home health care are limited to two important services: audiovisual teleconsultation and biomarker telemetry. Telematics services for home support are usually applied to support the chronically ill and the elderly, and cover diseases such as:

- Cardiovascular diseases: reintegration support after surgery, heart attack (eg heart attack), prevention of emergencies, monitoring of chronically ill, e.g. people with "pulse feeling".
- Diabetes mellitus: teleconsultation in order to comply with the treatment and to learn the appropriate way of life (eg diet, exercise).

- Respiratory diseases: follow-up of chronically ill people (eg asthma) and tele-counseling for treatment compliance (eg after lung transplantation).
- Oncology cases: for the provision of care and support through teleconferences and tele-visits.
- Psychiatric cases: psychological support of end-stage patients (eg cancer patients) and enhancing compliance in the treatment of severe psychiatric cases (eg schizophrenia).
- Counseling: in case of chronic pain.
- Neonatal monitoring: virtual tele-visits for biomarker telemetry, weight monitoring in high-risk neonates.
- Elderly support: mainly by monitoring mobility.
- Kidney Diseases: Supporting Patients on Dialysis and Supporting Patients on Peritoneal Dialysis.

2.4 Robotics and Telesurgery

Another area of intensive research is the development of equipment that will allow treating physicians to have immediate knowledge of their patients' condition and when they are away from the hospital, or to have access to their examinations. Modern medical centers are exploring an innovative solution that allows treating physicians to personally monitor the health of their patients after surgery, without being by their side using a robot from their office or home. By using a controller, the treating physician can guide the agile robot through hospital corridors and patient rooms through the hospital's wireless network. Equipped with a camera, screen and microphone, the robot allows the doctor to talk to his patient in almost the same way he did traditionally.Through the camera the doctor can enlarge and review the surgical incision, but also to control the vital signs of the patient. The question is whether this method will prove safe and effective.

A recent study (Kulviwat et al., 2007) found that patients preferred to see their doctor after surgery rather than on-duty staff they did not know personally, even if the visit was "virtual". However, virtual reality-based medical applications are evolving rapidly. These include: telepresence surgery, 3D visual anatomy for educational purposes, virtual reality surgical simulators and virtual models surgical equipment and operating theaters. Although telepresence can be extended to many other applications such as emergencies, remote robotic microscopy, etc., one of the most impressive areas is computer-assisted surgery, especially with the use of minimally invasive surgical techniques through endoscopy. The requirements that need to exist for a tele-operation are the following:

1. Camera of sufficient resolution, color and with adequate focusing capabilities.

2. High cost installation possibilities: 3D virtual reality reconstruction model

3. Low delay and high speed reaction

4. Security issues including quality control

5. Satisfactory, easy-to-use and customized user interface (in remote robot surgery)

2.5 Telepathology

Telepathology refers to the use of telecommunication and computer means for the remote realization and evaluation of pathological examinations. As early as 1968, an experimental device had been developed which, using a black-and-white camera attached to a microscope, transmitted images via microwave coupling. Although the application was not clinical in nature, it succeeded in highlighting the possibilities of developing such telemedicine applications. In 1986, with the use of satellite channels and a high-definition camera, which was connected to an electric microscope, it became possible to transmit high-resolution biopsy images as well as remote mechanical control of the microscope (focus, magnification, etc.).

Telepathology is distinguished in static and dynamic. In the case of static telepathology, one or more static images are collected, stored temporarily, and then transmitted in non-real-time diagnosis. In dynamic telepathology, the transmission of moving images in real time is achieved, in combination with the remote mechanical control of the microscope. In both cases of telepathology, the standard equipment includes a high-definition camera connected to a microscope, a computer station for digitization, coding, image transmission, electromechanical systems for the control of the microscope and the camera as well as the computer system for receiving, displaying and storing on the part of the specialized doctor.

In the case of both static and dynamic telepathology, the resolution of the data digitization and display system is a critical parameter, while in the case of dynamic application, the telecommunication network bandwidth is equally important.

2.6 Distance education

The evolution of telecommunication and information systems in recent years has made possible and at a relatively low cost teleconferencing between two or more people. Medicine was one of the first sectors to take advantage of this opportunity to provide specialized health services. As a result, nowadays, it is quite common in cases where the experienced opinion of one or more doctors is required to be received in real time through teleconferencing services. Ideally, it is possible to remotely guide the examination using teleconferencing as the experienced physician can see the patient during the examination and at the same time guide the treating physician. In other cases, it is possible to set up medical councils via teleconference without the need to move specialized doctors who may be located in different places.

A variation of the above case is distance education through teleconferencing services where a group of doctors / students can be trained in specific medical procedures / techniques without necessarily being in the area where the medical procedure is performed. Of course, the evolution of virtual reality technologies has created multiple possibilities in distance education since now the previously "passive" education is transformed into "active" with the virtual participation of the trainees (Karys, 1998).

2.7 Teleradiology

In most medical specialties, medical imaging has become one of the most important diagnostic tools. The first experience of radiological diagnostic services in remote areas appeared about 30 years ago. However, these early developments were flawed hardware, software and communication, which led to inadequate image resolution, slow transmissions and costly data storage and retrieval procedures. Recently, with advances in communication technologies and in hardware and software, it is easy to find applications that provide adequate quality in reasonable cost-benefit ratios.

A teleradiology system must be capable of receiving X-ray images at a location and for transmission to one or more remote areas, where they are displayed on a screen or converted to paper copies. Teleradiology requires convergence variety of different technologies and different human groups. In all processes used (image acquisition, compression, storage, image transmission, download, demonstration and interpretation), adequate quality of information must be guaranteed. For each of them procedures have established international standards in an effort to standardize the sector.

Teleradiology can improve the quality of medical care and enable radiological diagnosis in areas where there is no qualified staff, by concentrating the 24-hour daily radiological emergency and making it possible to taking a second opinion on difficult situations, etc.

2.8 Telecardiology

The first telecardiology applications appeared 70 years ago, using the telephone network to "tele-listen" to heart sounds and respiratory findings using sensitive microphones connected to the telephone network. In the 1960s, fax was used to transmit cardiographic and encephalographic prints over a telephone network. Nevertheless, only in the last decade has it been possible to remotely diagnose echocardiograms.

The most common application of telecardiology is the transmission of electrocardiograms (ECGs) for diagnostic purposes. In its most common form, the application requires the use of a digital cardiograph to retrieve, in digital form, the cardiogram, a telecommunications network, usually a simple telephone network, and a computer station to store and display the ECG.

2.9 Teleophthalmology

Teleophthalmology aims to provide ophthalmic diagnostic advice, along with the possible administration of appropriate medication. As in most telemedicine applications, the components of a teleophthalmology system are the image retrieval and digitization system and the digital image transmission system.

Most teleophthalmology applications require the transmission of still digital images. This means that the retrieval of the image will be done directly- digitally of course- by using the appropriate medical equipment or a process of digitization of the analog image. In most common cases, there is the use of a CCD camera in front of an ophthalmic microscope or an X-ray angiographic device. Another possibility is the digitization of images from a laser ophthalmoscope for the examination of retinal abnormalities. In any case, the diagnostic images are digitized, stored and later transmitted to the specialized ophthalmologist for advice and further instructions.

2.10 Telepsychiatry

Telepsychiatry offers a special challenge in communication technology. Complex emotional information needs to be transmitted and received, which is often a complex process due to the sensitive condition in which the patients find themselves. Such difficulties can be addressed when the professional is able to create a "safe space" for interaction. The special requirements of telepsychiatry include:

1. Pay special attention to sound quality.

2. Sufficient bandwidth to ensure that instantaneous speech is not altered and eyes are clearly presented.

3. A satisfactory environment that allows the control of facial and body expressions.

4. Minimum training in conducting escort from a distance.

5. Adequate secrecy and isolation.

Howevern, the development of telepulmonology is not yet satisfactory (Valenta et al., 2021). This is due to the following factors:

1) Telecommunication lines, even today, do not allow easily and cheaply the rapid transmission of large volumes of data required in telepulmonology.

2) Innovative technological applications are not always easily accepted by doctors and patients.

3) Most applications are created by funded research projects, which after the end of their funding, there is no possibility or interest to continue to be used.

4) There are no important national strategies for telepulmonology because the institutional framework for the operation of such programs and applications is missing.

2.12 Telecellulology

Telecellology can be defined as the subset of telemedicine services that require image transmission and refers to video-based cytological diagnosis - images, plain images or measurements taken from samples. Telecellular systems can be divided into: statistical, dynamic and hybrid.

In telecellology, the procedures for diagnostic purposes are:

- Telediagnosis, when the cytopathologist provides immediate remote diagnosis.
- Teleconsultation, when the cytopathologist provides support / advice to another doctor or to the cytothoracologist who is responsible for the case under consideration.

Limitations that are associated with telecellology include sampling problems, image capture/ display problems and interpretation problems.

2.13 Teledermatology

The applications of teledermatology are simple. The patient with the dermatological problem is in clinic A (where he is usually staffed by a general practitioner) and the specialist dermatologist is in clinic B. Dermatological images, patient history, laboratory tests and any other relevant data are transmitted electronically from A to B, where the dermatologist evaluates the clinical data, makes a diagnosis, and determines further operations. Although there are currently no statistically substantiated studies on the rates of dermatological cases that can be diagnosed through telemedicine, it is generally accepted that this percentage is significant. Although dermatological cases are very common (7-20%), they are usually poorly treated and are not referred to specialized dermatologists.

Experience has shown that the retrieval, storage and transmission of real-time dermatological images is perfectly capable of turning dermatologists into diagnosing and managing a significant number of dermatological cases (Wenstein, 2014). For this purpose, the required teledermatology equipment consists of a high-resolution image recovery device and a digital data transmission device. The part of digital data transmission is similar to that of telecommunication applications - transmission of static digital images.

In fact, there are two ways that are widely used to retrieve digital dermatological images:

- Via an analog camcorder connected to a digital still image retrieval system
- Via digital cameras and then transferring to the telecommunication system.

In addition to receiving and transmitting in real time, interactive teledermatology is also possible, which is essentially a teleconferencing application. The dermatologist examines the skin abnormality using a camera, in real time and comes to the diagnosis of the disease. Although this technique has the advantage of direct contact with a specialist / patient, it is more costly, requires more contact time and in many straightforward cases has no substantial advantages (Weinstein, 2014).

2.13 Teleoncology

Telecology can be defined as the application of telecommunication technology that provides oncology services. Telematics capabilities can help manage cancer patients at all stages. Specifically, four strongly related categories of services can be used in telecology: prognosis, diagnosis, treatment, monitoring.

The intensive quality assurance efforts made by various European Institutes are linked to the CONQUEST project (telematics applications, 4th framework of the European Union).

3. TELEMEDICINE AND CHRONIC ILLNESS

3.1 Greece's tele-care services for the chronically ill

In cases where the patient suffers from chronic diseases, the operation of telemedicines is a saving solution for many people. The first teleclinics in Greece are already a reality and have been operating for some years at the Sismanogleio hospital. Telecare services are divided into:

- Personal alarm systems, which started to be implemented in 1980 and allow the elderly and people with disabilities to send help calls via a mobile device. The calls are directed to a center, which then communicates with family members or calls for immediate assistance. Personal alarm systems are usually provided as services of communities (municipalities) or private companies.
- 2nd generation telecontrol, which has a series of upgrades in relation to the 1st generation. The use of drop sensors, movement, smoke, temperature, etc. allows the automatic call for the provision of social care services in case of emergency. 2nd generation telecontrol is based on the infrastructure of personal alarm systems with additional teleconferencing services.
- 3rd generation telecontrol, which is based on new emerging ICTs with the ability to identify potential problems of a user before they even appear and intervene preventively. Such services use sophisticated methods of monitoring and identifying types of behavior and activity of the tenant. (http://www.edoeap.gr/2012/12 / health-telematics berlin /)

3.2 Benefits from the implementation

The specialists evaluate the data they receive and refer to pre-existing patient information stored in the electronic file system, in the archiving and image management systems and in other systems. Communication between the local doctor and specialists can be done in a video conferencing environment, especially when direct communication is required. This telemedicine system offers the following in the lives of patients suffering from a chronic illness:

- Reduces the cost of care and increases the quality of life.
- Through these services, everyone lives more and better at home, as a patient, who can self-manage their disease. Thus, his stay in the hospital will be needed only for the necessary, the minimum possible period of time.
- Home care with the help of technological means (such as telemedicine and telemedicine, via digital channels of mobile telephony, video, television, etc.) will be provided by experienced clinicians at the appropriate time, as the connected specialized centers will be at his disposal. 24 hours a day.
- Integration into the daily medical practice of remote health care can effectively help patients with heart failure, chronic respiratory pneumonia (COPD), stroke, etc.

The increase in the aging population (with or without health problems) is constantly increasingly and it burdens the health care systems of all countries (Zhou et al., 2021). Any effort that utilizes new technologies to lighten this burden, is worthy of attention or imitation. Such efforts:

- Enhance access to medical services for remote patients.
- Allow patients to stay in their own space.
- Reduce the number of canceled appointments due to bad weather.
- Reduce the time for investigation, diagnosis and treatment through faster consultation.

- Provide a second opinion in real time.
- Increase access to health education and highlights rehabilitation opportunities.
- Enable the best use of resources (doctors, nursing staff, carers and ambulances),
- Reduce and / or eliminate the emotional burden of the patient and his family, as long as the disease is monitored and treated at home.

3.3 Examples of telemedicine uses in specific chronic diseases

3.3.1 In diabetes mellitus

Diabetes mellitus is a common and dangerous disease, which affects cellular metabolism and energy production. The disease is divided into two types, I and II. Sugar tests are crucial for the control of diabetes and are effective in reducing the risk of complications and in improving the quality of life. Unfortunately, both elderly patients and those in charge of their care have difficulty monitoring their blood sugar levels. One study has developed a communication platform for diabetes surveillance (Kelley et al. 2017). This platform encourages diabetics to measure their blood sugar frequently at home and provides comprehensive information about the patient's measurements to those in charge of providing care in remote locations. The platform organizes and combines home glucose measurements, data assessment and precautions. The advanced system monitors diabetics who measure their blood sugar daily at home and then evaluates the measurement data. If an abnormality occurs, a process of informing the people who are responsible for the patient's care is implemented and then the appropriate actions are taken to help the patient. The platform is installed in the patient's home. The information from/for the people responsible for the care of the patients is done through predefined communication channels. Available channels are: email, fax and mobile text messaging services. (Montori G., 2001) As a result, this process helps to improve diabetes control and increases the individual's social activities and their quality of life.

3.3.2 In chronic obstructive pulmonary disease

Chronic obstructive pulmonary disease (COPD) is characterized by progressive and chronic airway obstruction while it is distinguished by pathological lesions in the lungs and by systemic effects such as anemia, loss of muscle mass, osteoporosis and depression. It is a major health problem worldwide and has serious economic and social consequences. The treatment of COPD patients increases and has high costs for healthcare systems when patients make multiple or repeated admissions. (Scotland A., 2007). Telemetry systems can be applied to a range of technology platforms with multiple measuring devices providing uninterrupted care and facilitating monitoring in patients with various comorbidities. (Pinnocka H., 2009)

Many people with severe COPD who are locked up at home due to the limitations of the disease can monitor their health online and work with trusted health professionals. It is important to research before launching how many patients have access to the internet, how many can use technology to convey their health status, and how well they can manage the emotional impact on them and their caregivers when telephony application is withdrawn. Understanding the emotional effects of people with COPD is important because stress and depression often coexist with the disease.

Significant studies have shown that patient involvement in self-management and monitoring programs improve clinical outcomes in asthma and COPD although further research is needed (Davis et al. 1989). Remote monitoring seems to promote COPD self-monitoring when combined with a diary kept by patients noting symptoms, spirometry and pulse oximetry and provided the ability to connect to a call center answered by clinicians, who can support the patient and prevent an exacerbation or worsening of the disease. Tele-monitoring reduces hospital admissions and hospitalization days for some patients.

3.3.3 In hypertension

The measurement of blood pressure (BP) is a basic diagnostic tool, however, it might present a number of limitations when it is planned only as part of a medical visit:

- Does not give information about pressure values outside the doctor's office.
- Usually a limited number of measurements are performed per visit, representing a small percentage of values per 24 hours.
- Technical errors in reading due to the observer can be made (lack of time, poor knowledge of the technique, audiovisual problems).

These limitations have led to the search for alternative methods of diagnosing and monitoring patients with hypertension, such as 24-hour ambulatory blood pressure monitoring and self-monitoring of hypertension. The first technique requires 24-hour recording on a mobile device both at during the day as well as during sleep. It also allows clear conclusions to be drawn about the variability of BP and the effectiveness of antihypertensive therapy within 24 hours, without placebo effects.

On the other hand, according to the World Hypertension Society, self monitoring is a technique for measuring blood pressure outside the office, usually in the patient's home and it is performed by non-health professionals. Thus, while providing repeatability in measurements for many days or even months, allowing early diagnosis, estimating the effect of medication and significantly lower costs than 24-hour ambulatory recording, has the disadvantage of any unreliable measurements due to measurement errors or inaccurate recording BA on behalf of the patient.

A good way to monitor BP at home would be to use reliable electronic sphygmomanometers with the ability to transmit the measurements over a telephone line to a data center. Thus, the doctor would have reliable measurements, without the intervention of a patient in measurement and recording, with the possibility of data processing, graphical display of results, as well as parallel monitoring of heart rate. Patient and doctor using virtual counseling via live video connection, can communicate, exchange concerns and opinions in a direct and fast way. An alarm and paging system can inform the treating physician of any major changes in the listed parameters, so that timely intervention and treatment can take place.

3.3.4 In heart diseases

Heart disease is the leading cause of premature disability and death in western countries. In addition, due to the increase in the average age of the population, the number of deaths from heart disease is steadily increasing.

However, the only available diagnostic tool that is useful for assessing the likelihood of a heart attack is the electrocardiogram (ECG). It is true, though, that most deaths are caused by heart attacks which occur outside the hospital. This is why new strategies are needed to reduce the rate of these fatal heart attacks.

The telemedicine devices needed to monitor heart disease are:

- Automatic detection of tachycardia, bradycardia, atrial fibrillation and cardiac arrest,
- Automatic recording of the incident,

- Automatic transmission of the electrocardiogram via Bluetooth wireless mobile phone connection or via simple wired landline device,
- Acceptance of ECG from the server and sending to the treating physician via fax or e-mail (email)
- Abduction loss detection,
- Clear screen and audible alert.

An example of a heart patient who uses telecare diagnostic tools is one who suffers from a heart arrhythmia. The symptoms of this disease (fatigue, fainting, dizziness), can cause a decrease in heart rate and lead to low performance resulting in severe discomfort. The patient is given one portable EKG device. EKG sensors are used to continuously monitor the condition and for long periods of time until an abnormal heartbeat is detected. When a system is discovered, the data is sent immediately for analysis and in case of emergency an device that is part of the sensor network (PDA, telephone, PC / laptop) can be used to make an emergency call.

4. E-HEALTH: MEASURING COST AND BENEFITS

4.1 Methodologies Used in Measuring Costs & Benefits of E-Health Interventions

Regarding e-health, there are not any official guidelines concerning the measuring of cost and benefits as a part of economic evaluation. However, there are referenes of multiple methods. The chosen approach will be definitive for the inclusion of specific costs and benefits. Thus, each economic evaluation of e-health interventions is different. Nonetheless, it is common to include resources such as hospitals, health centers, governments and patients. If the approach is health-professional-center, then the evaluation will only include how cost effective and how beneficial is e-health for health professionals. On the other hand, a more patient-centered approach would only take into account costs and benefits for the patients.

4.2 Costing

There are two basic categories of costs when evaluating e-health interventions: healthcare and non-healthcare costs. The first category refers to the health recources that are essential for an e-health service. The second includes costs that are not directly linked to the health sector, like lost time, accessibility costs, costs for transferring etc.

4.2.1 Healthcare costs

The calculation of healthcare costs progresses in three steps. At first, the different types of possible health resources are estimated in order to conclude which of them should be concluded. They can be health professionals, equipment, emergencies etc. Secondly, the selected types of health resources are calculated by appropriate units, such as type of health professionals, the kinds of equipment, the time needed to tranfer to a location etc. Lastly, the selected resources are valued by appropriate unit costs. Some examples are health professionals' salaries, prices of different kinds of equipment etc.

Furthermore, there is a common way to measure health care costs: the resource costing method. It requires the collection of health care use date, that can be obtained by patients charts, hospital records or clinical trials and other studies. The service of health resources is then multiplied by price weights. This can be done by "micro-costing", that is breaking down every cost item into components, for example lab tests, druf doses etc. Another way is "gross-costing", which identifies and counts healthcare encounters, types of service uses or bundles of service uses, such as general practitioner visits, bed days and consultations. The selection of bundle units depends on the available price weights of the analysis. The units sould also be able to identify possible cost differences. Some cost evaluations use both micro-costing and gross-costing

Health institutions and published studies can be used for the collection of price weights. National charges and tariffs could also play the same role. In any case, price weights sould be in accordance with the approach. Center-spesific price weights can be collected from the financial departments of the involved hospitals, while national unit costs can be calculated by health resource groups and diagnosis related groups.

The equipment costs are usually more concerning when it comes to e-health interventions. They can be seen as one-time investments, a monthly or a yearly leash. Other times, they are measured based on their expected lifespan, the cost for maintaining and the discount that is expected to bring overtime.

4.2.2 Non healthcare costs

A social approach would consider costs regardless of who they regard. Non healthcare costs usually include costs for social services, costs for the patients and their families etc. Non health care costs also include the costs to employers when their employees must be absent from work. Those costs are measured by observational studies and clinical trials. Travel costs, fees and time costs are considered private costs. Time costs are about the time that patients invest in searching and receiving care and the time spent by their families who take care of them. Time-off work is considered as a productivity loss. Gross wage rates are typically used when measuring production costs, but the friction cost method can also be implemented. The basic concept is that the amount of production loss can vary, depending on the time spent to restore the production to where it would be if the employ was at work. For e-health interventions, the most common time costs are the patients' healthy time that was lost because of death, and the time patients take off work in order to receive health services.

4.3 Benefits assessment

Benefits include the effects that e-health interventions would have on health. Those are usually measured as health changes and outcomes, such as biomarkers, time of stabilized conditions, cured condition and others. Measurable outcomes may include blood pressure, cholesterle levels, days of absent symptoms, number of saved lives etc. Essentially, these measurements reflect reliefe from disease and disease progression. These measurements describe symptom relief and disease progression. Nevertheless, the outcomes sould also include how patients view their current ssymptoms and health status. Quality-adjusted life year (QALY) is a measurement used for putting value on health outcomes. It measures disease burden, including both the quality and the quantity of life lived.

In order to estimate QALY in clinical trials, patients usually complete a health-related quality of life questionnaire with preference values. Many economic evaluations use descriptive systems such as EuroQuol-5D, Short-Form Health Survey-6D and 12-item Short-Form Survey.

There are also other instruments to estimate quality of life, such as the Short-Form Survey-36 and the Diabetes Quality-of-Life measure. In any case, quality of life measures do not rank health statuses according to patients' preferences. Thus, there is a limit to their usefulness when it comes to economic evaluations.

5. THE CURRENT ROLE OF E-HEALTH

5.1 The recognition of e-health

In 2015, the World Health Organization (WHO) defined e-health as "cost-effective and secure use of communication and information technology to support health as well as health-related areas, including healthcare services, health monitoring, health education, health knowledge and research" (World Health Organization, 2016).

E-health is a new emerging field that connects medicine with information and concerns the provision or enhancement of health and IT services through the internet or other related technologies. According to Eysenbach (2001), the term e-health should not be limited to the concept of technological development, but should develop new horizons in changing the way of thinking and attitude about health care, locally, regionally and globally.

The term e-health includes a range of services or systems that serve healthcare and information technology, such as electronic records, e-prescribing, telemedicine, virtual monitoring by health teams, m-Health (Khan et al, 2019).

According to the European Union, e-health consists of four interdependent functional subsets which are as follows:

- It concerns the systems of clinical information systems.
- It concerns telemedicine and home care and includes personalized health systems and services such as tele-counseling, tele-education and other specialized telemedicine applications / tools such as tele-radiology.

- Integrated health information networks, at national and regional level, including the electronic health record as well as services recorded in it such as electronic prescribing, electronic references.
- It concerns the application of non-clinical systems which includes specialized systems for researchers or other support systems such as billing systems etc.

5.2 E-health in the digital era

5.2.1 Electronic health file / electronic health records

Electronic health records refer to the set of information about patients' health data, which is stored in digital form and secured throughout their life. The information is stored, used and served by legitimate users. The operation of such a system to be effective requires the interconnection of different actors health services, such as Public Hospitals, private hospitals, private clinics and diagnostic centers, laboratories, as well as liaison between medical, paramedical staff, etc.

In general, the data in the electronic file provide all the information that the authorized doctor can use to help him in making decisions such as the patient's demographics, vital signs, the medication that follows, previous reactions from drugs or allergies. reports of acute events, laboratory and radiological tests performed in the past and present, previous admissions and procedures the cost of the services provided (Roehrs et al, 2017). The basic benefits include:

- Continuous monitoring of individuals and not only during treatment and recovery.

- Patients' handwritten records were replaced by the electronic health record, which ensured the most efficient and secure sharing of medical information among the health care providers involved.
- It allows the holistic management of patients' health, and the provision of medical advice remotely.
- Ensuring the health data of individuals is a prerequisite for the timely and correct diagnosis of diseases, as well as for the avoidance of multiple diagnoses and the reduction of operating costs.
- The provision of safer and more effective care through the utilization of patient data and the provision of personalized solutions that are tailored to the specifics of each individual. Using the patient's electronic health record in conjunction with integrated information systems, according to studies, can reduce medical errors by 83%.
- Saving employees time resulting in their most efficient and better workflow.
- The vast amount of data stored in the electronic health record can be used by researchers for statistical studies from which useful conclusions can be drawn that can promote public health.

Nonetheless, there are also some obstacles for implementation and use of electronic health files. These are:

- Barriers to the implementation of the electronic health record can come from its initial high cost (eg software installation, conversion of files to electronic files, user training) as well as from the high cost of maintenance.

- The resistance of the end users which will lead to a reduction of productivity is compensated over time with the appropriate training and familiarization with the use of the electronic health file.
- The growing number of health register information exchanged by patients and healthcare providers, both nationally and across borders, raises security and data protection concerns.

According to an Accenture survey in America (2020), 38% of health consumers say they use digital tools and digital health services but are concerned about the confidentiality or security of their data while 20% do not trust the effectiveness of these services. According to the research on the highest degree of confidence of health consumers for their safe use digital health information, such as the electronic health record, ranks hospitals (84%) and their doctor (83%) while technology companies and government rank the lowest.

In line with European Union Recommendation 2019/243, which refers to a European format for the exchange of electronic health registers, particular importance for the development and exchange of electronic health records Health registries has the creation of high standards that will provide security and data protection. For secure access and trust, the use of secure electronic means of electronic identification and authentication, digital signatures, electronic signatures, electronic registered delivery services has been introduced in the electronic health register systems. (EU Recommendation) 2019/243).

In Greece, the security of personal data of the individual electronic file of patients's health is criminalized, according to Law 4600/2019, (Government Gazette 43

/ A / 09.03.2019) of article 84, any illegal intervention or processing of personal data of the individual electronic file (Law 4600/2019).

7.2.2 Individual electronic health file

In Greece, on 9/3/2019 the individual health file was voted with article 84 of Law no. 4600 (Issue A '43 / 09.03.2019). Access to the individual health file concerns the entire population of Greece, declaring universal and equal access to the National Health System which, through health services, will provide quality and quantity of adequate care services. (National School of Public Administration & Local Government, 2020).

While the electronic health record refers to records containing the health records of each patient to be managed by the authorized physician for patient health decision making, the individual electronic health record also includes the management of the patient's health by him in collaboration with the authorized doctor. The individual electronic health record contains what the electronic health record also contains, ie the health history of the person receiving health services, the clinical data and assessments of the general condition, of his clinical development upon his admission to the hospital / clinic. The records of individual electronic health file are observed for life (Roehrs et al., 2017).

The family doctor and the person who is registered and who receives the health services have access and use in the individual electronic health file. In a different case access and use of individual electronic health file can be done by another authorized doctor specializing in general medicine, pathology or pediatrics (Law 4600/2019).

The benefits for patients from the individual electronic health record are many, including direct access to data and information about their health and their empowerment through self-health management in collaboration with health care providers. However, there are limited studies that prove the benefits of patients from the use of the individual electronic file (Showell & Turner, 2013).

In a literature review, Showell (2017) attempted to look at the barriers that exist regarding the continued use and adoption of the individual electronic health record by patients as well as the causes that cause these barriers. According to the study, the most important barriers associated with patients' use of the individual electronic health record were literacy (such as reading and comprehension of texts), health education as well as the use and skills in digital technology. The financial inability to cover the cost of a device or internet connection is also an obstacle to the use of individual electronic health file (Showell, 2017).

5.2.3 Electronic prescription

Electronic prescribing is a combination of application of computer systems and special software, through which the introduction, creation and transfer of electronic prescription drugs as well as referral medical examinations from the authorized doctor to the patient will take place. E-prescribing is part of the information systems that are connected to healthcare providers such as hospitals, pharmacies, private radiology and laboratories. Through the authorized doctor, the transfer of the information of the prescription of medicines or referral medical examinations to the concerned health bodies, such as pharmacies, health insurance, is done safely (Samadbeik et al., 2017).

The design and implementation of electronic prescribing systems as well as the adjustment of standards is done according to the needs of each country (Harvey et al., 2014). Its main benefits are:

- Cost reduction. With the introduction of electronic prescribing, the use of unnecessary printed documents has decreased. (Samadbeik et al., 2017). The number of prescriptions would also be reduced, as well as the prescription drugs in them.
- Reduction of electronic prescribing errors. The risk of illegible prescriptions is reduced and thus the risk of errors (Samadbeik et al., 2017).
- Error reduction is ensured by the electronic prescribing system through drug interaction control. The electronic error system checks and warns the doctor who prescribed it for a registration error.
- Online access to authorized physicians, where they can be informed of patients' health and medication history to give optimal results in their medication. (Samadbeik et al., 2017).
- **5.2.4 m-Health**

M-Health is a subgroup of e-health that has evolved in recent years. Electronic health services and applications and mobile telephony work together, as in the case of electronic records where the patient can have direct access. Their use is important for the transfer of patient health data as well as for easy access to information for citizens and health care providers. Mobile telephony is a useful tool for health professionals in accessing patients' health data, diagnosing, imaging, monitoring, counseling and educating patients as well as communicating and informing them from other health care providers. Through m-Health, access to health care becomes more affordable, which contributes to the quality and efficiency of the health services provided. Its use is particularly important in remote areas as well as in the elderly, the chronically ill and other vulnerable populations.

Mobile health telephony includes specialized applications (applications) through which systems of medical devices or sensors are connected, which are also used by telemedicine services, as well as systems of personalized guidance and medication reminders (Apostolakis, 2014).

Mobile health telephony could help save time for health professionals as well as reduce costs. Most medical interventions as well as care interventions could be done by health professionals through m-Health. Also patients, such as chronic patients, are involved in managing their health through guidance from monitoring and reporting systems (European Commission, 2014).

6. THE ROLE OF TELEMEDICINE DURING COVID-19

6.1 Telehealth in the age of social distancing

Nowadays, the growing demand for pandemic-controlling technologies has focused on slowing the spread of the disease and reducing cases. For this slowdown, the "social distancing ”and the telehealth solutions that were proposed and implemented, were the detection and prevention of transmission through the remote evaluation and provision of care. In this context, applications and monitoring systems for population subsets, either positive cases or high risk of COVID-19 infection, have already been developed. One such example is a monitoring application (a set of digital tools for detecting, reporting and monitoring COVID-19, for use on Android phones) based on its platform District Health Information Software 2 (DHIS2), one of the largest IT platforms world health management systems.

The application collects information (demographics, disease symptoms, contact data) of high-risk individuals entering a country from other countries at higher risk. The information is passed on to health care providers in their respective geographical areas for the purpose of detecting, reporting, actively monitoring and rapidly intervening in cases of COVID-19.18 infection. Based on the same platform, another application, TraceTogether, was developed to support Singapore's efforts to limit the spread of COVID-19 by locating Bluetooth contacts on mobile phones in order to determine and control the distance between users. The data is encrypted and stored only on the user's personal mobile phone while the competent ministry of health of the country can download the personal data (only after the user's consent), in order to locate his contacts and call in time for guidance and care (Kapoor et al., 2020).

In the same vein, the Chinese government released a new one mobile contact ("close contact detector") application to help citizens check if they have come to a contact with the virus. To do this, users will need to enter a phone number, a name and a number identity. According to the application company (XINHUANET), users can obtain it by scanning a code (Code Reader: QR) from platforms such as WeChat, Alipay and QQ that are already very popular mobile applications in China. The application gives end users, information based on government data, about whether they came in "close contact" with a person who has the disease, if they are close to someone who has not protection, or someone who has a confirmed or suspected case. The app also works as a means of educating citizens about what to do if they have to some "close contact" with the virus, ie either to stay at home or to receive instructions from the health authorities (Kapoor et al., 2020).

6.2 Digital mental health support applications

Telemedicine is practically feasible and suitable for support for patients, families and health care providers during the pandemic. Psychological symptoms that COVID-19 have already been observed at the population level, with manifestations of panic shopping due to anxiety, and paranoia in watching massive international events (Grand view Research, 2020). Large percentages of the population remaining in social distancing due to confinement in homes, are expected to have psychological symptoms due to stress, reduced autonomy and anxiety about income, work, security and fear of pandemic. Governments have pointed out the psychological side effects of COVID-19 and have concernes about the long-term effects of isolation, stressing that fear and panic in the community could do more harm than the COVID-19 pandemic itself (Zhou et al., 2020). Solutions have been provided in this area with prevention of mental effects due to the pandemic.

Various digital counseling and mental health assessment platforms such as "betterhelp" (https://www.betterhelp.com/), "Online Clinic" and myCompass (https://www.blackdoginstitute.org.au/) are typical examples.

In terms of prevention, "Doing What Matters in Times of Stress" created by the WHO is another example. This is an illustrated guide with optional accompanying audio instructions that aims to provide people with practical skills with practical skills. stress and help treat it. In mobile solutions, Mindfulness (https://www.onebreath.eu/) for Apple and Camh (http://www.camh.ca/) for Android and iOS phones are examples of tools that have been around for a few years but have also been developed for stress management especially during the COVID-19 pandemic.

6.3 Intangible prescription

During the period of COVID-19 coronavirus, the possibility of intangible prescribing was given, according to the provision of article 36 and 49 of P.N.P. (Government Gazette 68 / A '/ 20-03-2020). The purpose of this provision is to ensure that the spread of Covid 19 that can result from physical contact between patients and physicians is limited, as well as to facilitate patients and avoid unnecessary movement that would increase the risk of transmission of Covid-19 coronary artery disease. . (National School of Public Administration & Local Government, 2020). Intangible prescribing was instituted in accordance with article 13 of Law 4704/2020 and therefore functions as a permanent procedure (Law 4704/2020).

The transfer of the intangible prescription as well as the intangible referral is done exclusively through the Primary Health System. Citizens have the opportunity to express their desire to receive medical care online recipes via their email or mobile phone. By entering the Barcode's Electronic Prescribing System or the patient's social security number, the pharmacist can retrieve the intangible prescription (Voutsidou, 2021).

7. THE ROLE OF TELEMEDICINE IN SMART HOSPITALS

7.1 An introduction to smart hospitals

The cost of health is estimated to increase by an average of 5% in Europe each year (as well as in Greece) in the coming years (Zanaboni & Wootton, 2013). According to experts, organizations such as hospitals need to change and -with the help of technology- meet the challenges of the new era by adopting solutions that offer automation and optimization. Moving to a "Smart Hospital" has the potential to reduce costs and optimize efficiency for health care providers. The primary goal of smart hospitals is optimal patient care by making the most of advanced information and telecommunications technologies.

At the heart of the "smart hospital" is the central data monitoring unit, which ensures the ability for central and data-supported decision-making, gathering clinical and operational data from across the hospital as well as from external outlets (care). at home). Through this unit, the overall supervision of the system for the management of referrals and transfers of care is activated, as well as the proper operation of the hospital facilities themselves as well as the connection with third parties, e.g. for procurement management. Through mobile devices, the medical staff obtains at any time the image of the patient through the complete medical file of the patient, results of medical examinations but also a continuous flow of vital data of the patient that are collected with the help of wearables.

Connected medical devices and wearables technologies allow for the provision of treatment alternatives, such as virtual and remote care. Virtual care provider connects physicians, patients and health professionals in real time to provide health services, promote collaboration between professionals, support disease management and coordinate care.

Through telemedicine technologies, the "Smart Hospital" can provide care outside the physical limits of the hospital, thus improving the patient's experience (since the treatment takes place in the comfort of his home), but also the functional efficiency of the hospital unit. , since chronic conditions are treated more effectively in this way, saving resources.

The main goals of a smart hospital are the following:

- Greater safety and comfort for hospitalized patients.
- The proper service of patients and non-patients who visit the hospital, for treatment, or for diagnosis.
- Reducing costs from an economic and energy point of view.
- The increased quality of the health services offered in all departments of the hospital.

Smart hospitals may have a broad variety of systems, such as automatic fire safety systems, automatic temperature system, sensors, smart devices, voiced control appliances and many more. However, the following section focuses on the ones deemed more relevant to telemedicine: the information systems.

7.2 Information systems in smart hospitals

7.2.1 Defining information system and data base

Information systems enable a hospital to operate more efficiently. Thus, the basis of these systems is related to the evolution of information technology and telecommunications. These systems are spreading so fast over time and their use has several advantages. The information systems are adapted with the main goal of meeting the medical needs. Thus, they are given the opportunity to evolve, in order to create the "smart hospital", which will have special functions in the field of health and care.

All information systems include the use of databases, internet, wireless networks, as well as mobile devices that include computing capabilities. In this way the time for the provision of these services is reduced to a minimum and the information is disseminated through the smart devices that the users have. However, new computer systems also require special know-how. Thus, the staff of a "smart hospital" must be trained to learn how to operate applications as well as the special equipment used to connect applications to it.

By the term Database in the field of Informatics, we refer to collections of related data, which are organized and stored electronically or digitally. The software that handles these collections is called a Database Management System. Patient data, as well as patient histories, should be stored in Databases, where treating physicians have a complete picture of patients visiting the hospital. In the Databases, in addition to the patient data, the diseases are registered where there is a detailed record of their symptoms, as well as the medication to be given to any disease.

7.2.2 Application for medical appointments

In a smart hospital, it is important to store patients' appointments with the hospital's doctors in Database. This way the hospital staff will have direct access to the current day appointments.

The patient will be able to make an appointment with the doctors of the hospital through a mobile application or through a web page. This way he/she can see which doctors are available on the day of the appointment and what are their free hours. The doctor, on the other hand, will know in advance what appointments he has during the day. In addition to the appointments' check, the doctor will have the opportunity to study in advance the file of the patient who is registered in the Database.

Thus, there is great convenience on the part of patients and doctors, as well as better organization. It is worth noting that each doctor has the ability to attend only his/her own appointments and not that of other colleagues using passwords. On the other hand the patient will have to register via the booking form to store his/her personal data again using private passwords to access data.

7.2.3 Priority system

In outpatient clinics, the number of patients who visit these facilities can exceed hundreds in one day, with the main goal of undergoing medical examinations. For the better organization of the secretariat and the persons to be examined, there should be a priority system, where when the person enters the waiting room of the outpatient clinics, it is possible to provide a service number. Thus, the patient will wait in the waiting room in turn to be served. This is found in most conventional hospitals.

In a smart hospital, there could be more relief on the part of waiting patients. One way to reduce concentration of many people in the same space, is to create a priority number booking application. The patient can obtain a number from a mobile application, which is connected in real time to the priority system of the hospital. In addition to the number it receives, it has the ability to monitor which number is currently being served, as well as how much time is estimated by the system remaining to be served. This is not only time-saving, but also more cost-effective for those who end up taking a whole sick day from work.

7.2.4 Digital patient file

One of the most important issues that deserves to be analyzed, is the organization of medical data related to patient care, in electronic form. As technology evolves, it is considered necessary for the health data of each patient to be organized, stored, modified and processed if deemed necessary.

The reported data are stored in the Database and are the digital files of patients, where only hospital's medical stuff has access to them, so as to ensure validity and reliability of the data entered. The patient's digital file includes his / her history, the results of the medical examinations, the diagnoses from the doctors he / she has visited regarding his / her health condition and also if he / she is receiving medication and which one, so that the doctors examining him / her are informed. Patient data, which is securely stored in the hospital Databases, can be used for any statistical research, but due to medical confidentiality, it should be noted that the anonymity of the patients from whom this information is obtained is maintained.

With regard to medical confidentiality, the data should be stored in the Databases and only the competent users should have access to them. For this reason, access rights are given only to the doctors and nurses of the hospital. This ensures the protection of patients' personal data, as well as sensitive data, such as a chronic illness.

7.2.5 Nurses' call mechanism

For a large part of the patients who visit the hospitals, they need to be admitted for treatment in the treatment rooms. The staff, which is responsible for the care and monitoring of the admitted patients (nurses), must be well trained, to be always on standby, to serve the needs of the patients in each case.

Because nurses do not have the opportunity to stay in patients' rooms, except when needed, they are usually concentrated in special areas (offices) and visit the patients who call them. In smart hospitals, there are radio communication systems, installed in patients' beds. The patient can press a button to send a signal and call the nurses, where those available respond the requests.

7.2.6 Automated hospital systems

A smart hospital is a great environment to implement telemedicine, thanks to the following automated systems:

- Picture Archiving and Communication System (PACS): It is a system that provides the ability to collect images (from CT, MRI, digital angiographs, ultrasound devices) for storage and retrieval and includes image imaging and management devices, connected to storage devices.
- Pharmacy Information System (PIS): This system performs the pharmacy procedures of a hospital (prescription processing, maintenance of the drug database, monitoring of their use, etc.)
- Material Management Information System (MMIS): Used to manage and control all processes related to the procurement of materials (purchase, receipt, classification, inventory, etc.)
- Anesthesia Information System (AIMS): This system collects data from numerous sources regarding the monitoring of procedures in anesthesiology departments, provides the ability to analyze this data and generates various types of reports.

- Laboratory Information System (LIS): Used to collect information from a variety of devices, to store clinical data, to verify the accuracy of examinations, to calibrate instruments, and to create (and update) patient records.
- Radiology Information System (RIS): A system that collects and stores data from radiological devices.
- Hospital Information System (HIS): It is the central system of a hospital, which collects data from all systems and allows access to all individual procedures, providing the possibility for overall management of the hospital.

Networking devices of a category that do not obey a standard, usually require special interfaces (hardware and / or software) and protocol converters. The problem of networking between the devices of different suppliers is addressed by the application of communication standards, which ensure data exchange between different types of devices. Also, the need to network all the systems that make up the HIS, requires the existence of a standard for the exchange of data between these heterogeneous systems.

7.3 Medical equipment to implemt telemedicine

Smart hospitals generally have the information and other automatic systems required to implement telemedicine. However, it is also required to possess medical equipment that is compatible with the systems mentioned above, as well as others.

7.3.1 Cardiograph

ECG reception systems today are generally permanent devices, computer systems or monitors that record patients' electrical signals through the patient with a twin cable. The cardiograph is a small ECG device, which is worn on the body, offers complete mobility of patients and is capable of wireless data transmission. Measurements transmitted to a transmitter via Bluetooth wireless technology. The system is independent.

It transmits wirelessly a 12-channel ECG (via a 10 pin cable) to a receiver, located at a short distance of up to 10 m. It is powered by a simple battery and the cardiogram that is transmitted can be used by health professionals in the health areas. It has a built-in electrode detection contact and a heart rate monitor, whose results are displayed on a built-in LCD screen. It can be used in all medical applications where the long rigid trunk of conventional cables can be a problem because of their weight, or their electromagnetic sensitivity, or because they restrict the patient to freedom of movement.

Electronic stethoscopes serve many purposes: in addition to the obvious usefulness for transmitting sounds in telemedicine applications, they provide possibilities for storing sounds for comparison in the second year, integration in the patient's electronic medical file, enhancing volume, reproduction at different frequencies (eg at half frequency to clarify a blast), application of special filters, as well as their use for educational purposes. The first electronic stethoscopes were significantly behind the conventional ones, to the extent that their clinical use was questionable.

Today, however, stethoscopes are available that are highly reliable and provide the ability to store the audio file either in their built-in memory or on a computer. There are also electronic stethoscopes that transmit sound in real time.

7.3.2 Spirometers and oximeters

There are many spirometers on the market today that provide the ability to connect to a PC. In many cases the provided software enables the transmission of data to a receiving station. There are also flowmeters and spirometers that either have a built-in modem (digital transmission) or adapted to the handset of the common telephone (analogue transmission) to send the data. Spirometer and oximeter combinations in the form of PCMCIA (personal computer memory card association) have also been released, which allow their integration into laptops.

Finally, commercial oximeters with Bluetooth technology are available, the transmitter of which looks like a clock and transmits the measurements wirelessly to a receiver inside the house, which in turn can send the values to a monitoring center.

7.3.3 Electronic sphygmomanometers

The usefulness of electronic blood pressure monitors is found in the diagnosis of hypertension through measurements at home. Electronic sphygmomanometers with a built-in modem for sending the measurements are available on the market today, while a new service model is being developed, during which the patient rents, at the suggestion of his doctor, a special electronic sphygmomanometer from the most complete contracted pharmacy, and then through of the internet the device is programmed according to the requirements of the doctor. The data is stored and transmitted at regular intervals to a reception center, to which the treating physician has access, via the internet.

7.3.4 Telemedicine systems with the ability to transfer and store images

Most telemedicine systems have the ability to transfer and store radiographic images from imaging systems (MRI, CAT, etc.) of a radiology department. Through these systems it is possible for X-rays to be transmitted directly (using the DICOM protocol) or indirectly (using medical digitizers or film digitizers) from machine to machine, from computer to computer and from hospital to hospital.

7.3.5 Ultrasound devices

Most modern ultrasound devices have digital H / Y connection outputs and follow the DICOM protocol, which makes them suitable for image transmission. The transmission can be real-time, so the critical parameter is the amplitude of the telecommunication connection, or by the method of local storage and sending in a second time. Particular attention should be paid to the fact that portable ultrasounds are available today that have image transmission capabilities and are an ideal solution for mobile medical units, health centers or home care applications.

7.3.6 Image and video transmission systems

In applications where the image plays a central role in diagnosis (pathology, ophthalmology, dermatology, etc.) can be used:

- Specialized systems for the specific specialty, eg systems for pathological anatomy with the ability to control the microscope located at a remote point, by moving the field of view through a special control.
- CCD cameras that adapt to existing equipment (eg slit lamp) and allow image transmission.

7.4 How smart hospitals contribute to healthcare.

7.4.1 Enhanced diagnostic and invasive skills

The convergence of information and communication technologies (ICT) provides the opportunity for the development of new methods of treatment (for example robotic surgeries are able to perform microsurgery, which can not be performed by clinicians), while it can also improve existing existing methods. Hospitals are increasingly using data mining techniques for the purpose of diagnosis and selection of the best possible treatment.

7.4.2 Emphasis on the provision of health services

It also emphasizes the provision of high quality health services and the smooth flow of patients within hospitals as this can lead to a reduction in waiting times and length of stay of patients in it, as well as to reducing errors and enhancing patient satisfaction and employees. Modern technologies can be utilized for the detection, analysis and resolution of congestion in the system, thus contributing to the more efficient provision of health services and the normalization of the flow of patients. The availability of information at all stages that the patient goes through, from admission, treatment planning, to exit, as well as the simplification and optimization of admission, examination and discharge procedures results in improved patient flow.

7.4.3 Interconnected devices

Utilizes the interconnected devices (IoT) leading to exceeding the "natural limits" of the hospital space and thus allowing the provision of remote medical care. A variety of medical devices e.g. Implantable or "wearables" allow real-time patient monitoring by recording vital signs, and these measurements are readily available to hospital staff and systems. These remote capabilities are augmented by various medical devices that enable the patient to act (eg administer a dose) depending on his condition or through remote controls. Therefore, admission of patients to hospitals can be limited in cases where it is deemed necessary, achieving reduced care costs and improved experience for the patient, as he is now able to receive treatment from the comfort of his own home.

7.4.4 Effective management

In addition, IoT leverage upcoming digital technologies to effectively manage complex support processes. Thus, IoT participate in digital supply chains and automatically replenishs stocks of consumables, utilizes technologies to monitor the management of medical equipment, uses robotic process automation to perform backoffice operations of large volumes, and so on.

7.4.5 Security and privacy

IoT rely on managing a wealth of data for their smooth operation. Patient safety and privacy are non-negotiable concepts for "Smart Hospitals", while through the use of next generation technologies such as blockchain, relationships with third parties become reliable and secure.

7.5 Economic benefits

Telemedicine can improve access to specialist care in areas suffering from a lack of know - how or in areas where the access to health services is difficult. Remote monitoring can improve the quality of life of people suffering from chronic diseases and to reduce the duration of hospitalization.

Modern health systems worldwide have presented and still present, malfunctions and problems that have to do mainly with the cost and quality of health services provided. The main concern of all the necessary bodies is the search for the required solutions and interventions towards the best efficiency and efficiency of health systems. Telemedicine is one of the most effective solutions of these systems. The study and experience of its implementation at international level contributes to the evaluation of the individual parameters, related to its effective implementation in a modern health system.

Also, based on the Greek reality, application of telemedicine would bring economic and social benefits, as it would contribute to the decongestion of large hospitals, while at the same time would reduce unnecessary travel and transportation of patients from the periphery to the major hospitals of the center. However, it would be difficult for the Greek hospitals to make big changes fast, due to problems of the healthcare system (see 7.6.1).

7.6 An example from Greece: Papageorgiou Hospital

One of the good examples of "Smart Hospital" is the General Hospital Papageorgiou of Thessaloniki which becomes "smart" through the adoption of new digital technologies, achieving upgrading of nursing services, improving patient satisfaction, reducing operating costs and increasing productivity. Its transformation into a "smart hospital" began through the implementation of innovative solutions of Informatics and Communications of the “OTE Group” (Hellenic Telecommunications Organization) and the use of products and solutions of the Cisco company.

The two companies installed wireless voice and data transmission systems at the hospital, which allow authorized access to the hospital's information systems via tablets or smartphones. At the same time, the two companies proceeded to the installation of a new IP call center in the hospital, as well as its connection with the existing one. With this unified infrastructure, for data and Internet telephony, the staff can receive internal calls on their smartphone, while providing free Internet access to patients and their attendants. In addition, a Location Base Services service is provided for the important assets of the hospital, through Radio Frequency Identification (RFID) technology, which allows them to be monitored in real time, with an accuracy of one meter. Finally, in each bed were installed terminals with touch screens (bedside terminals), which function as units of entertainment, information and support of patients and their companions, but also as a working tool for the nursing, medical and administrative staff of the hospital.

This complete make-over of the hospital allowed a significant set of telemedicine services for the purpose of evaluation, diagnosis and monitoring of nephrological patients. The goal was to create a program for patients that would enable them to receive all the necessary information through an online platform in order to better manage their disease and to be actively involved in it. This innovation was awarded in 2019 by the Health Business Awards.

7.6.1 Estimating further implementation in Greece's healthcare system

Papageorgiou Hospital is a good example of a Greek smart hospital, however it is the exception rather than the rule. It has become common knowledge that Greece's public hospitals and healthcare centers face multiple difficulties, are usually understuffed, underequipped and struggle to function in old fascillities. The recent pandemic has also strained the healthcare system, while more and more patients need to be hospitalized.

This raises the question of further implementing telemedicine in Greece's hospitals, not only to reduce costs, but also manage as many healthcare services as possible, covering the needs of patients, reducing the transsmisions and reliefing the overworked stuff.

Indeed, the provision of care through emerging technologies, which find application within the smart hospitals could reduce any deficiencies and improve the results of patient care. Smart hospitals would inform patients, reduce their stress levels and encourage them to take an active part in their care.

Technologies such as process automation with Robotics would help make the country's hospitals more efficient, improving existing procedures, reducing costs and enhancing transparency. At the same time, staffing and scheduling in a "smart hospital" would be optimized using technologies, thus enabling staff to perform better. Staff training could be accelerated through the use of digital media and online courses.

However, we must not forget that the approach required to implement a "smart hospital" with state-of-the-art transformational capabilities consists of recources, and specific phases, which include strategic visioning, case use prioritization, capability mapping and application design. Given the current economical and managerial strain from controlling COVID's consequences, it would be unreasonable to assume that many more hospitals would follow the example of Papageorgiou Hospital.

However, even though Greece is far from transitioning to a smart-hospitals-reality, telemedicine has found ways to enter and strongly affect healthcare. The following chapter discusses some of them, which do not require to take place in a full-blown smart hospital.

8. OTHER TELEMEDICINE ACTIONS

8.1 Telemedicine in ambulances

The transmission of data, such as images, videos, and biomarkers, can be very useful for patients in the emergency care system. Wider application of these technologies, with the use of higher telecommunication bandwidth (volume of data transmitted in a specific or given time) and new computer achievements, can change the critical point at which the assessment and treatment of the incident begins. Wearable computers and high-speed networks are likely to be used in a new generation of telemedicine systems in pre-hospital care. For example, at the scene of a car accident, victims can be assisted directly by the remote specialist.

During the transport, especially if it is expected to last a long time due to the distance to the hospital, the condition of the patients can be assessed, while the possibility of more treatment options is provided thanks to the opinion of the specialist. The development of future systems is very likely to increase the efficiency of such applications. With the provision of 3G mobile telephony services, it is expected that video transmission systems will be among the basic equipment of ambulances, as is the case with radios. The remote visual contact offered by these systems will improve the efficiency of specialist physicians, offering more diagnostic options and treatment options while the patient is on the road.

An ambulance incorporates the following devices: Digital camera, TV, microphone, Vital Sign Monitor, touch screen tablet and handwriting recognition software. The ambulance computer combines the patient's biomarkers and the data entered by the ambulance crew, incorporating the video image received by the hospital. An independent video recording system in the ambulance records the image and sound, so that later comparison with the information transmitted to the hospital is possible. For data transmission, parallel mobile phone connection (with simultaneous transmission) is used for optimal performance.

However, the low bandwidth of mobile telephony limits the data that can be sent "in real time" to the hospital and many vital signals are represented by numbers, such as heart rate, oxygen and thus do not require high bandwiddth. The range required for images, videos, sounds and waveforms such as the cardiogram is much higher.

On the hospital side, data is received through common telephone connections with conventional modems and stored on a server with security specifications. The data on the server is stored in a database (Microsoft SQL), which cooperates with another server (Microsoft Internet Information Server) and in this way the data is available in the internal network of the hospital. As a result, doctors using a common web browser they are familiar with can access real-time ambulance data from their desktop computers through the hospital's local network.

8.2 Telemedicine in emergency units

Even if it is difficult for Greek hospitals to completely become “smart”, they can still plan the installation of one telemedicine emergency unit (Grigoriadou, 2018). The ability for the specialist to see the incident from a distance, images or video, enables him to share his experience. The specialist can make an assessment and make diagnostic and therapeutic decisions, based or not only on the transmission of sound but also image. As a result, the preparation of the hospital is faster and focused on the needs of the specific patient. In addition, the incident will be directed to hospitals with the appropriate infrastructure, while its onset treatment can be done while the patient is still on the road.

Wireless communications and mobile telephony play an important role in prehospital care, meeting the need for online administrative and medical communication. Although voice transmission has been the practice in recent decades, the technological developments of recent years in wireless telecommunications and expected in the coming years, have allowed the transmission of data between mobile ambulances and specialists.

Data transmission via mobile telephony and networks provides an economical solution, with wide geographical coverage and transmission security. However, there are a number of issues related to video streaming from a mobile ambulance. The most important problems are the available bandwidth and whether the transmission is possible.

In addition to the limitations posed by low bandwidth in image quality and flow, connection difficulties and quality must be taken into account in the design. As a result, video compression models such as MPEG find it difficult to utilize for the needs of the application, which requires, for example, selecting specific video segments for transmission over limited bandwidth. Telemedicine systems can be designed using the maximum possible number of tried and tested commercially available products. A system can consist of just two basic components: a portable unit for use in ambulances and a receiving station in a hospital, connected to the inside of a computer network.

8.3 Telemedicine in ships

An extremely important aspect of healthcare servies in the Navy is the PCP who provides services on ships, submarines, Navy battalions, and Navy hospitals and clinics. The naval primary forces are some of the most remote in the world and have rare access to medical information. The Navy therefore has every reason to use

Information and Communication Technologies, as well as wireless and portable technology, to promote receiving healthcare services by providing specialized information to highlight the diagnosis and early treatment of complex medical problems.

The use of telemedicine on ships, in relation to its potential benefit, has been of great concern to the large shipping companies, while the small ones seem to have ignored it. The use of this relatively new technology, however, is significantly beneficial, not only in terms of protecting the health of crews and passengers aboard ships in general, but also from a financial point of view and the reason is the non-existence of those responsible for providing medical care on ships, who are ultimately not doctors, so do not have the appropriate level of training and experience, or are doctors with rarely specialized knowledge and training to deal with all cases of different medical specialties.

It is therefore necessary to transport patients from ships, which is expensive on the one hand due to the cost of renting a helicopter and on the other hand sometimes at least impossible due to the constraints that may arise either due to bad weather or long distances from the coast.

It should be noted that the cost of diverting the ship, for disembarkation of a sick or injured person is large, taking into account the loss of profit for the shipowner. Diseases and injuries at sea, remain the main cause of insurance claims by shipowners. Up to 1/3 of insurance claims arise from injuries, illnesses and repatriations of crew members and passengers aboard ships in general.

However, with the assessors' ability, a quick assessment of the patient or injured person's condition can be made, so that a decision can be made in time to transport when required or to stay on board and to receive appropriate treatment on the advice of a specialist onshore. In some cases, the decision to transport can be particularly critical for the patient, because it can be the cause of further medical complications.

9. TOWARDS THE FUTURE: OBSTACLES TO OVERCOME

9.1 Human factors

Doctors who use telemedicine- in contrast to traditional medicine techniques- not only have to manage some level of uncertainty in regards to the patient's condition but also additional uncertainty due to the quality of the medical information in regards to the patient. For example, poor quality images can lead to misdiagnosis. Telemedicine also requires the specialist doctor and the provincial doctor to be present at the same time. Because of the cost of communication and the need for the right staff to make this possible, efficient meeting planning is important for both parties. Another concern is the motivation for doctors as they need to spend more time on telemedicine than on traditional medicine. In essence, a new technology is being introduced into the medical system that not only makes work more efficient, but also changes the way medicine is practiced, and this can therefore create many problems. For example, there are doubts as to whether the introduction of telemedicine in the countryside will reduce costs and whether telemedicine applications will reduce the incentive for doctors to work in rural areas.

9.2 Evaluation

It is essential to define what factors are important in evaluating a new medical technology, such as telemedicine. First, new technology must have been proven safe and effective. . In terms of the matter of safety and efficacy, it requires comparing the validity of telemedicine diagnoses with immediate diagnoses. Second, the platform used must have clinical utility. Third, it should have a relatively small cost.

9.3 Acceptance and training

Another factor to consider when designing and operating a telemedicine system is the trust of medical and paramedical staff both in technology and their willingness to cooperate, be trained and familiarize themselves with its equipment and operation. Often, there is reservation and suspicion towards the organizational structures in the work context required by the new telemedicine structures.

Various theoretical models have been developed to investigate the acceptance of telemedicine by health professionals. One of them is the TAM model which has been applied to explain the acceptance of technologies by its users. Specifically, the TAM model has two factors:

- The first is usefulness; i.e. whether the respondents believe that technology will contribute to productivity as well as quality of their work.
- The second factor refers to the perceived ease of use of technologies; i.e. whether the respondents believe that technology will be easy to use and will contribute to their efficiency as well as the quality of their work (Davis et al., 1989). The TAM model has been used by many researchers, but its effectiveness remain unclear. Research on the TAM model for the adoption of technologies has mainly focused on knowledge rather than what its use in health services affects (Kulviwat et al. 2017).

In addition, A prerequisite for the effective adoption of e-health by health professionals and other health users, as well as for its sustainable development is the continuous evaluation of knowledge, views and preferences of end users about its use in health services (Wernhart et al., 2019).

In a recent survey conducted at the University of Vienna on the views and practices of e-health and telemedicine known to health professionals and medical students, both groups of the population stated that they were moderately informed about e-health and telemedicine. Both sample groups agreed that telemedicine can reduce the cost of health care and expressed a positive view on the impact of telemedicine on the holistic approach of patients as well as the relationship between doctor and patient (Wernhart et al., 2019).

Furthermore, extra effort and time are required for continuing education, harmonization with legislation, ensuring medical confidentiality, familiarization of physicians and medical staff with technologies, all of which cause delays and difficulties in adapting to new conditions.

9.3.1 Digital education/eHealth literacy

Adequate health education is essential for the use of a wealth of comprehensive medical information. Essential for digital health education is the acquisition of a set of skills, including the ability to find and evaluate health information online, integrate and apply it. The term digital education is used interchangeably with the term e-health literacy although digital education also aims at interactivity via the internet (Patil et al. 2021).

Electronic health literacy is an important skill that health professionals should have in order to find valid and reliable information through which to obtain high quality information on health issues. Health professionals encourage patients to self-manage their health care as well as use e-health tools to reduce the need of transferring as well as the cost of health services. All this can be achieved by using the internet. Properly informing patients about health issues that are relevant to them is particularly important for making decisions about their health and proper management of their health. The abundance of health information can divide a person or put him or her at risk for his or her own health due to misinformation or even dangerous health information. During the training of patients and their caregivers, the nurse evaluates the use of electronic health information by patients and caregivers and corrects any misunderstandings of online information that they have as well as assists them in the skills of electronic health literacy (Park, 2019).

9.4 The patients' trust

In a research by Accenture (2018), health consumers stated that the main advantages that they consider in terms of virtual health care are that it can reduce patients' medical expenses and that appointments can be made according to their needs and desires which therefore provides timely health care.

As far as Greece is concerned, the degree of trust of the respondents in the various bodies for the security of their personal information is sufficient for the hospitals and the National Organization for the Provision of Health Services (EOPPY) but also for private doctors. On the contrary, they trust the public services less and much less the private companies, especially the technological ones. Their trust in Greece's government is the lowest of all. These views may appear incompatible with each other, as the Government is beyond and above the hospitals and the EOPPY. Plus, it actually secures the personal data with the provisions that it implements and shapes at local and European level. It is noteworthy that another research by Accenture (2020) in the United States of America presented the same results; hospitals are more trusted (84%) for data protection, while the lowest degree of trust is ranked by technology companies and government (38%). It is possible that this reflects citizens' distrust for their governments's capability and integrity in general, but this has not been confirmed by research.

It is also well documented that the fear of inadequate data protection negatively affects the positive evaluation of e-health technology among health professionals (Muigg et al., 2019). Digitized data could potentially be misused and passed on to insurance carriers and companies (Simon et al., 2013). This result is in line with other relevant publications that show that privacy and security issues are of concern to various stakeholders, such as primary care physicians and patients (Mohammadzadeh & Safdari 2014).

9.4 Gradual transition

As it has been discussed earlier, in Greece, the high cost of building and operating a smart hospital makes it particularly difficult to create the appropriate infrastructure and install platforms that would provide smart services to users in a more comprehensive way. However, modern systems are gradually being used more and more in large hospital units. "SIEMENS", "Philips", "Toshiba", "Biotech", "Merten" and "Microsoft" are just some of the well-known and largest companies that provide automation systems and smart technology for high quality healthcare and services. Other companies are "BEMS", "Legman", "S&S Constructions", "GDS", "Smart Buildings" and "Xparity".

Conclusion

Telemedicine is of particular importance for Greece, due to the geographical uniqueness of the country (mountain villages, numerous and isolated islands) and the unequal distribution of the population in the major urban centers and the region. Given the value of human life is invaluable, the need to apply telemedicine for the best provision of medical services nationally and globally is recognized. Although the length of time that telemedicine has been in operation does not allow safe conclusions to be drawn, some sound indications can be made in terms of its first positive effects on the health system.

Telemedicine promises the coming of the day where the guideline for the clinical care of the patient will be personalized and the long-term monitoring of patients with chronic illnesses will be possible. Also, better access to unserved areas, such as rural communities, is one of the most significant benefits promised by the rise of the telemedicine era.

It is true that telemedicine is an ongoing challenge to which we must respond with knowledge, modern design and planned actions. However, this modern design is the responsibility and obligation of all operating parties in the field of medicine and technology, whose experience and expertise will be the cornerstones of the changes that need to be made. In addition, the health service providers need to cooperate efficiently by contributing to the wide implementation of effective telemedicine networks in Greece as well in the rest of the world.

Despite the high initial cost of implementation, as well as the discomfort that any big changes may bring, telemedicine should be considered as a set of major opportunities for the national and global healthcare system. Hopefully, in the near future there will no longer remote areas that do not provide the possibility of receiving clinical care through telemedicine.

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