Department of Economics
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D 3.3.1: Policy Implementation Guidelines for achieving long-term objectives

WP 3: **Policy Integration**

IMPROVING HEALTHCARE ACCESS TROUGH A PERSONAL HEALTH MONITORING SYSTEM

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http://www.ehealthmonitoring.eu/

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1. Coherent historical depiction and clarification of terms

1.1 The difficulty of definition

Telemedicine is an extremely complex environment of human activity that has as its object the provision of medical service through distance using IT and communications infrastructure in combination with medical equipment. It is, perhaps, established - in public debate or in society - the assessment that telemedicine is a modern and new activity, but it has a history and presence of more than 100 years and of course it is constantly evolving rapidly over the last 20 years, precisely because of the constant and leaps developments in Medicine, Informatics, Telecommunications and Medical Equipment Technology.

The "nuclear" components of Telemedicine are obviously Medical Science, Computer Science, Communication Science and Medical Laboratory Technology. It is therefore a multidisciplinary field which aims to provide medical services, not by conventional means when doctor and patient are in the same geographical / spatial field (ie in the same area), but when they are located in remote geographical locations.

For compatibility with the rest of the literature but also for the completeness of the treatment of the issue of typology, the following are some of the most common, in terms of IT, medicine or even policy definitions for telemedicine:

- ⇨ The use of modern information and communication technologies to meet the needs of citizens, patients, health professionals, healthcare providers and health policy makers (European Union I - 2000).
- ⇨ Refers to tools and services that use information and communication technologies to improve the prevention, diagnosis, treatment, monitoring and management of health and lifestyle (European Union II - 2020).
- ⇨ Cost-effective and secure use of information and communication technologies to support the health sector, including healthcare, health surveillance, health education, knowledge and medical research. (World Health Organisation).
- ⇨ It is the emerging field at the intersection of medicine, information technology, public health and business, with reference to health services provided remotely via the internet and related technologies with the aim of creating a new way of thinking and a new world wide web for improving the health of citizens at local, regional or central level. (JMIR: Journal of Medical Internet Research 2001).

- ⇨ The ability to search, find, understand and evaluate information about a person's health from or through electronic sources and the application of knowledge gained to solve a health problem. (CameronNorman & Harvey Skinner, 2006)
- ⇨ Electronic health or telemedicine is defined as the use of information and communication technologies that support the health of individuals and health systems with distinct roles to work together harmoniously to address and improve health problems as well as medical research, management and administration. (E-healthstrategy & scientificreview 2018, initiative of 10 countries - Austria, Germany, Sweden, Switzerland, Netherlands, Scotland, Lithuania, Slovakia, Ireland, Denmark).
- ⇨ The provision of medical services even in cases where the distance between the patient and the doctor is intervened, with the use of specialized infrastructure and other knowledge (EKPA - Athens Medical School, 2008).
- ⇨ Telemedicine generally refers to the use of telecommunications and medical technologies to provide some or all of the following types of information exchange: data, audio and / or visual communication between physician and patient or between physician and other physician or nurse enable the exchange of information for medical, research, educational or teaching purposes. Such exchanges can be real or in real time (Inmarsat, Horsch & Balbach 2009).

1.2 Coherent historical record of Telemedicine - parallel stories

In order to clearly define the history of a multidisciplinary field, surely the imprinting must be done from the nuclear components that make it up. In the case of Telemedicine, one certain nuclear component is medical science. In the first component of the word "tele", however, the approach is a little different and requires more careful investigation. Considering the term "electronic health" equivalent to the term "telemedicine", then the development and historical development of telemedicine is closely related to that of electronics, which, however, is not an independent science but belongs to Physics.

Medicine is also an extremely dynamic science with very dynamic research that was originally developed from the field of biology and chemistry (biochemistry) and extended to the field of microbiology and the study of molecular behavior (molecular biology). From 1953, when Watson & Crick first officially documented the discovery of the structure of DNA, Medicine as a whole was launched scientifically, academically, educationally, and research-wise.

The convening of the two worlds of Physics and Medicine have yielded and continue to yield to human society important and high value tools for improving the quality of life and human health. This convergence has created Telemedicine and other exciting scientific fields such as:

- The personalized pharmacy (pointofcare) where the drugs will be determined per disease and per person taking into account a large list of standards and conditions achieving a faster cure with zero risk of toxicity from the drugs,
- Bioelectronics which now provides integrated circuits as implants to support the health of mainly chronic diseases with a more typical example initially the

  pacemaker, insulin injection device (for diabetics, which essentially replaces the pancreas), the pneumogastric nerve stimulator, which is an electronic implant in the brain to control certain types of epilepsy.
- Robotic invasive surgery which has up to 36,000 more surgical handling skills than the human hand. Robotic surgery, although theoretically achievable with telemedicine, is not covered by it.

Therefore, telemedicine has a spectacular field of development and perspective at the level of research and this remains to be spread in society.

1.3 Telemedicine in Greece

Telemedicine in Greece has not managed to escape the usual treatment of most (if not all) of the world's top progress issues. Initially, a large fragmentation of projects, actions, funding is identified, for a number of programs which in the end had either an overlapping result or zero value in terms of their implementation or utilization. And of course the research pluralism and the multiplicity of scientific research, of academic research is legitimate, but for the size of the country this tactic has not worked to date, as much as it really could. In a small country such as Greece, with all the measurement standards (general population, size of medical staff, educational institutions and bodies, funding and allocation of funds) instead of a concentration of research procedures with clear objectives, complementary or independent that can lead to a substantial upgrade at the level of the country , either at the educational or technological level for telemedicine, the well-known Greek model of fragmentation of human resources and resources has been followed, with the result known of course: very low penetration of Telemedicine and poor research and applied results.

1.3.1 Greece with great contrasts and untapped opportunities

Despite the fact that the Medical Schools of National and Kapodistrian University of Athens and the University of Ioannina are considered among the top in Europe and among the top in the world, despite the fact that the educational institutions of technology (NTUA, University of Patras and Polytechnic School of Crete) have registered excellent scientific research and success in areas such as robotics, informatics, especially software development and communication technology. Despite the fact that government spending on research and development is constantly being reduced, it is constantly being fragmented into less and less available funds as European funding is constantly growing. Despite the fact that the geography of Greece favors the development of telemedicine systems either due to the existence of the islands and the dispersion of the population on them or due to the mainland with restrictions and difficulties in travel. And while the country theoretically has all the prerequisites to become a leader in this field, it remains in line, documenting the emergence of great contradictions and the loss of untapped opportunities over time.

1.3.2 Telemedicine programs and projects

Apart from government actions and European programs, in the context of either technological research or corporate social responsibility, the private sector in Greece has developed or taken initiatives and pilot applications for telemedicine systems mainly from the telecommunications providers Cosmote and Vodafone. commercial policy, the development of telemedicine systems requires and is based on high-speed and high-availability wired or wireless telecommunications networks.

Vodafone Greece has formed a joint venture with the Athens Medical Center, the Vodafone Foundation, the parent company in England Vodafone UK, the Greek telematics and telemedicine company Vidavo and the National Inter-Municipal Network of Healthy Cities & Promoted by Health was established in 2007 at the initiative of KEDE. The program was launched in 2006, also incorporating new architectures and international standards, making it scalable and interoperable The system is in its 13th year of life, it has been developed in 100 points in the Mainland and Island Country, it concerns a population of 500,000 inhabitants and has performed 42,000 examinations on 8,000 sick citizens. It is perhaps the only case of a private initiative to develop telemedicine services in Greece to such an extent and with such consistency of operation.

1.3.3 Current situation

The current situation for telemedicine in Greece cannot be better and contrary to what has been mentioned above, it is a natural evolution of them.

Sismanoglio hospital is theoretically the Support Hospital of the Telemedicine Network of the National Health System since 1991 with the telemedicine unit being theoretically interconnected with 19 regional K.Y. and aims to support and strengthen Primary Health Care throughout the cycle (emergency support, monitoring of chronic cases and diseases, training of health professionals). Its substantial and any utilization has been completed since 1998 where it remains inactive.

The General Hospital of Attikon, Tzanio, Nikaia, Metaxa are the respective support hospitals of the Telemedicine Network with interconnection of 43 telemedicine stations in Island Greece since 2016, with gradual operational utilization from 2017 and it is expected to yield the first data of integrated operation in 2018 and beyond.

In the Private Sector, the network of telemedicine of Vodafone-Athens Medical Center is the only private initiative so far for telemedicine in Greece, as a closed system of telemedicine services which does not interact with the public infrastructure in the developed patient data centers (electronic health record).

1.4 Telemedicine in the EU

Some important European programs that implement the above categories are:

- CHRODIS+
- e-SMART – European Cancer Patient Coalition
- e-health standards
- Pen Medicine
- Open Medicine
- i CARE 4 EU
- ICT for Life
- Semeoticons
- Simpathy
- Meditrav (Medical Information Platform for Continuous HealthCare Services to European Travelers)

- ⇨ HUS PACS,
- ⇨ MEDCOM
- ⇨ RUBIS
- ⇨ PROMODAS
- ⇨ MOMEDA
- ⇨ ReAction
- ⇨ SJuNet
- ⇨ SmartCare
- ⇨ SESAM Vitale
- ⇨ CHRONIOUS
- ⇨ BraveHealth
- ⇨ United 4 Health
- ⇨ Valu-e-Health
- ⇨ InterSTRESS
- ⇨ ISISEMD
- ⇨ JASHEN : Join Action to Support the e-health Network–EIF
- ⇨ REMPARK PHS (Personal HealthCare System)
- ⇨ ALFRED
- ⇨ SPLENDiD
- ⇨ Help4Mood
- ⇨ Momentum
- ⇨ HeartTEN (Horizon 2020)
- ⇨ PD_Manager (Horizon 2020)
- ⇨ C3 Cloud (Collaborative Care & Cure Cloud) (Horizon 2020)

The overall funding architecture in the EU over time for telemedicine (and beyond) is shown in the following figure:

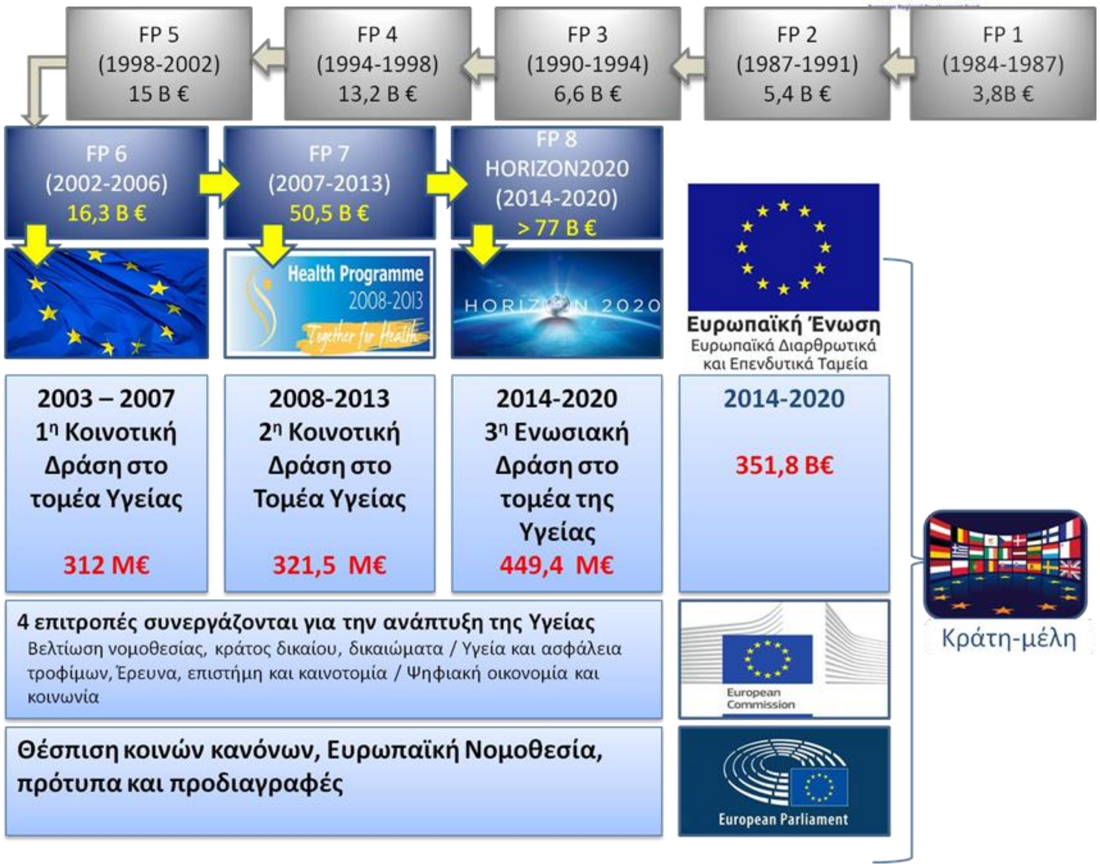


Figure 1: Telemedicine and digital health financing and implementation architecture in the EU

1.5 Telemedicine in the international environment

Telemedicine in the international environment has an extremely interesting, constantly evolving position in research and academia, in business and investment but also in society. A comprehensive study of the international environment for telemedicine provides the following conclusions.

The United States of America was one of the first countries in the world in the telemedicine program at all levels (social, military, space, research) and is the country with the greatest development and the most money for research and investment in telemedicine. The American Telemedicine Association-ATA was created in 1992, which until 1996 had 490 members and today has about 10,000 members and associates divided into 4 groups (membe rgroups).

The United Kingdom is another country that has a tradition in the development of telemedicine since 1992 where ATM networks were first developed and then developed into High Speed TCP / IP, connecting medical schools with hospitals through the SuperJanet Network program. Hospitals in Scotland in Edinburgh and Aberdeen and England in London, Manchester and Southampton have been linked to medical schools and the image is being transferred from imaging systems for further research and medical study.

In 1998, a telecardiology program was started in Berlin, Germany, and the University of Stuttgart started a telepathology anatomy program. Along with the participation of private technology companies (Siemens, Biotek, Teleflex Medical) they developed robotic surgery and non-penetrating surgery. In 1997 DeutcheTelecom in collaboration with the Federal Agency for German Pathologists developed a health network that connects all doctors in the country. In Frankfurt, two-way household radio and video services are used as a first step in homecare. In the field of health technology, Germany is undoubtedly one of the leading countries that influences or even leads the developments in telemedicine.

France started using telemedicine really early. From 1947 the Center of Maritime Health Care Consultation began offering its services through telephone and radiotelephone were the tools for medical advice. With the creation of the SAMU and SAMUR services in 1968, telemedicine in France began to evolve very rapidly. . In 1991 the country adopted the EU recommendation for a common number for all people, 112, to use it for emergency calls. Since 1993, more than 20 hospitals in the country have been using video telephone and high-speed networks for the needs of telemedicine, especially in the field of teleneurology. At the same time, the national agency AgirPourla Telemedecine has been established in the respective standards of the USA and the UK and has a strategic plan by 2020 to put France at the top of the utilization and application of telemedicine in Europe.

In Spain in 1990 the General Directorate of Telecommunications created the REVISA program, a medical care program in the Canary Islands. The island hospitals were equipped with high-definition video telephones and video cameras to record medical advice.

In the Netherlands, medical care is quite developed. There is a connection between hospitals, doctors and pharmacies in a single health network. In 1991, a memorandum of cooperation was signed between the shipping companies of the Ministry of Transport and the Ministry of Health for the provision of telemedicine in shipping. As a result, more than 300 doctors can receive medical results, X-rays, etc. from a distance from the ships.

Austria is also considered a pioneer in telemedicine mainly in terms of its operational exploitation. Telepathological anatomy began in 1989 between Vienna and Heidelberg. They used static images and used ISDN. In 1998, a government-funded pilot project was launched between two major hospitals in Austria and included telepathology, teledermatology and teleradiology services. In 2018, at the initiative of the Austrian National Telemedicine Agency (ASSTeH), a strong cooperation is created between it, Germany (DGG) and Switzerland (SAMTeH) for the exchange of know-how, experiences, best practices for interoperability between countries. Austria also has the most complete system of digital health cards for citizens.

Italy, From 1970 and then, began to transmit medical data via telephone lines and in 1987 the development of photographic data and communication systems began. The first study in the field of telemedicine began in Florence and its first use in Trieste. In 1986, through European programs, the Polytechnic University of Milan was one of the first telephoto laboratories to conduct telesurgery experiments.

Norway, through the Mastemind program with a total funding of 14 M €, since 2017 has the Norwegian Center for Integrated Care and Telemedicine (NST) which is characterized as the world's largest center for research, development and operation of telemedicine systems.

1.6 Goals and Benefits of Telemedicine

The goals of telemedicine, as shown by the Greek or European programs and the literature are:

1) The punctual and valid transfer of information and not of the patient,
2) Medical expertise, diagnosis or differential diagnosis available to all regardless of the patient's place of residence, without geographical designations.
3) Greater efficiency and productivity of health and care services and better operation of health systems.
4) Optimal emergency management with faster and safer opinions and decisions for immediate treatment, with simultaneous access to all medical information.
5) The interconnection of applied Medicine with the training for transfer of know-how, experience, clinical cases that enhance the acquisition of knowledge of Medical students and in the medium term cover the (expected) lack of experience in the profession

The expected or recorded benefits from the development of telemedicine, according to the policy texts from Greece and the EU, the scientific approaches, the Medical community and the results of pilot or European programs, can be determined as follows:

1) Increasing the level of medical service and care provided by reducing the physical and geographical isolation of populations,
2) Improving the effectiveness of emergency response
3) Minimization of the absolutely necessary movements, resulting in the reduction of the cost of the patient / citizen for the health services but also the reduction of the environmental footprint of the medical care service,

4) Modernization of the working environment of the doctor and the nursing or paramedical staff

5) Facilitate and upgrade the education and continuing training of Doctors.

6) Upgrading the provided health services mainly at local level.

7) Strengthen Medical Research, Medical Statistics and other related life sciences research, due to access to a wide range of factual data.

8) Reduction of the operational and administrative costs of health services.

9) Enhancing convergence between Health Services and Social Welfare and Care Services as a more effective framework for citizens

10) Creation of an outpatient health / medical care environment resulting in the decongestion of the infrastructure (Health Centers, Hospitals) as a whole and the improvement of the services provided in them

1.7 Classification and fields of telemedicine applications

The following block diagram provides a classification of telemedicine in terms of Medical function, Medical application and Information & Communication Technology:

Figure 2: Telemedicine and eHealth Architecture

Finally, telemedicine can have different fields of application, depending on some design criteria that can be set. So they can grow and exist:

- ⇨ Telemedicine in the military field where the US military is at the forefront of operations in the former Yugoslavia, Iraq and Kuwait under the name "Operation3"
- ⇨ Telemedicine in shipping where there are now international regulations to support the health of ship crews.
- ⇨ Telemedicine in space, where NASA has already developed and implemented telemedicine programs since 2004 for its own missions.

It is clear that the aforementioned specialized applications have correspondingly specialized equipment, software, work only with satellite communications mainly for the interconnection of the ends of the systems, while even the medical equipment has other specifications (ruggedized).

2. Telemedicine, Health Policies and the Challenges of Health Systems

2.1 The new trends and challenges of the Health systems and the role of Telemedicine

According to a number of industry surveys, the EU policy texts (indicative and not restrictive the Commission COM 2018/233) but also the actual measurements of the competent Health bodies, throughout Europe and in Greece have reflected the following trends in the health systems:

- ⇨ Increasing the life expectancy while the population is aging creates new growing needs for medical services and care for the population,
- ⇨ Increased risk of treatment-resistant infections and infectious diseases due to extensive use of antibiotics or due to the presence of new mutant pathogens (seasonal influenza) or recurrent pathogens that had been prevented in recent years (mainly due to migrant populations, limited or non-existent vaccination). This fact puts pressure on the system in terms of dealing with infectious diseases, increasing the operating costs of the health system, the need to take new protection measures or create other structures.
- ⇨ The spread of neurodegenerative and neoplastic diseases (cancer) creates great pressures on the health system that must respond quickly, adequately and multiple therapies to cure the patient or to reduce the effects until the end.
- ⇨ The presence of new complex diseases resulting from syndromes with a significant spread in the general population, is another burden for both Medical research and patient care, that has to be provided by the Health System.

At the same time, for both Greece (mainly) and Cyprus as well as for other EU Countries, the following trends have been identified:

- ⇨ Pressures and weakness of public budgets for the support of the Health Systems due to the increase of the operating costs and the capital constraints of the Insurance Systems, in the context of the budget constraints and the balanced budgets,
- ⇨ Prevention as a systematic health precautionary measure may be an area that works beneficially to the Health System but the exact size cannot be captured on a short-term basis, while long-term value can also not be assessed. There is no linear dependence that reducing smoking, for example, will reduce the number of cancer

patients in the coming years. However, prevention is not cheap, it requires increasing expenditures either from the public budget or the contribution of the private sector in other actions (communication, training, social field research, etc.).

- The cost of research for the production of new drugs is observed to increase systematically and over time, due to multiple factors, such as Biomedical and biology engineering for diseases and rare diseases, drug-resistant therapies, etc. This trend has as a consequence outside the increase in the cost of research and the increase in the cost of medicines, which clearly affects both the health system and the citizens / patients and insurance organizations (public and private).

The aforementioned trends and challenges are not the only ones but they are the dominant and the most important ones and their treatment is or should be at the center of the Health Administration, the Health Economy, for a modern and effective Health System, which by definition will have fundamental resource constraints.

It is clear, then, that a reliable and effective telemedicine system, in addition to a systematic patient monitoring environment, can evolve into a multi-purpose platform for health systems.

In terms of support in health care and medical services, a reliable and powerful Telemedicine system, utilizes exactly this inherent ability to provide services without geographical restrictions, especially in Greece, in cases of emergencies or emergencies reducing the need for activation the state agency or private insurance companies for air travel. Either where first examinations and their results from a regional clinic or local health unit can be linked to a larger health center or hospital or if cognitive support is provided to the doctor examining a patient by providing real-time second opinion or documentation medical findings, it is certain that some air travel can be avoided.

These conditions obviously do not include special cases such as pregnancy and termination of the obstetric procedure or a life-threatening emergency that requires increased hospital care in an ICU (eg serious cardiac events, severe ischemic attacks, burns, meningitis) in children etc). But in a number of other cases, where the medical service is strengthened and strengthened by a telemedicine support center to diagnose and treat these cases, thus ensuring high primary care locally. It has also been reported several times - mostly unofficially - that district physicians, and especially young physicians who lack clinical experience, to avoid responsibility or the possibility of an adverse disease, activate the air traffic protocol for simple cases or for hospitalization. in a hospital where this treatment is ultimately excessive as it could be treated locally.

2.2 Health Policies, development strategies and telemedicine as key success factors

2.2.1 Health and Telemedicine Policies in EU

Health policy is at the heart of European policy in a mixed design that includes Health (as a service), Economy (in terms of cost) and Innovation (in terms of research and technology). In a sense it could be said to be a duplication of the Canadian model of the social context in which telemedicine borrows from the United States.

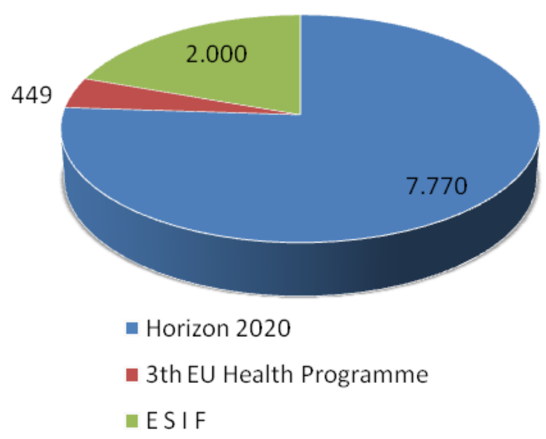
European health policy specifies the content, development and role of telemedicine in the 3rd Union Health Action as described in Regulation 2014/282 and Commission Communication 2018/233 to facilitate the transformation of the healthcare sector in digital single market, empowering citizens and developing a healthier society

Funding for this policy comes from three different sources:

1) The 3rd Union Action with a budget of 449.4 M € for 7 years,

2) From FP8 - Horizon2020 with an estimated budget of about 10% of the total, ie € 7.7 billion (with the first 981 € to be launched and distributed along the axes of the program during the two years 2018-2019).

3) From the Structural and Investment Funds to support national policies, programs and infrastructure, estimated for all MS in approximately € 2 billion.



Therefore, the EU plans to allocate a total amount of € 10.2 billion, equivalent and competitive with that of the US / Canada, seeking to achieve the goals of holistic architecture and in addition to:

- ⇨ Strengthening employment, work, economic growth,
- ⇨ Strengthening the internal market and its export activity,
- ⇨ Better health risks from immigration,
- ⇨ Improving the human rights of citizens,
- ⇨ Health insurance, also linked to food safety,
- ⇨ The efficiency of the social resources of the insurance systems.\

The system of governance is only three levels, at the base are the national bodies and the National Contact Point, followed by the two competent authorities depending on the subject matter where the role of coordinators of the programs is the European Medicines Agency and the European Safety Authority. of Food and is followed by the European Commission. This design achieves fast and flexible management of programs and financial resources for telemedicine and health programs in general.

Figure 3: National Contact Point for Greece in terms of policies is the Ministry of Health and in terms of applications is IDIKA SA

2.2.2 Health Policies in Greece for Telemedicine.

From the coherent presentation of the situation for Telemedicine in the paragraph 1.3 there is a big gap in our country for telemedicine (but not only in this field of health services). The National Health System, founded in 1983, in fact never met the prospects and expectations of the citizens to a high degree.

The causes are obvious and understandable, Greece:

- did not have and still does not have today in 2019 a comprehensive strategic health policy plan,
- has not had and has no continuity and consequence of planning and implementation

Any serious and important but fragmentary cases of quality and treatment of special medical cases, of course have their special value but cannot equalize the number of problems that exist in the field of health care in Greece.

3. Telemedicine Technologies

3.1 The Digital Health ecosystem (e-healthecosystem)

The Digital Health ecosystem is the overarching set of tools, infrastructure, systems and procedures to support the improvement of citizens' health and care. It is definitely based on high-performance information and telecommunication systems, with the ability to securely transmit, store and manage huge volumes of digital data where analysis and artificial intelligence are applied to them in order to:

- improve the provision of medical care,
- develop new, faster and better diagnoses and treatments
- manage financial resources more efficiently and effectively,
- medical education and medical research are strengthened.

The clarification of the terms with the application of typology mainly by the EU, as in the case of telemedicine, results in the expression of commonly accepted terms as follows:

Digital health (digita lhealth, d-health) or equivalently electronic health (e-health) is the superset of the following interrelated systems:

- **Clinical / Medical Information Systems** (Medical Information Systems) that include specialized software and hardware tools for health professionals and such indicative are medical imaging systems, nursing management, mobile emergency health units. These systems are operated by medical and nursing or appropriately trained staff and provide information in the context of digital health.
- **Telemedicine**: which includes personalized healthcare systems and health services as well as remote patient care and monitoring services. Telemedicine also provides information and receives information from the Clinical Information Systems. Users are certified and specialized doctors.
- **Homecare systems and mobile health applications (m-health)** which are the personalized fixed or mobile outpatient systems located in the homes or premises of patients, participating in monitoring the progression of the disease with data, up to complete cure. Users are patients and certified doctors.
- **National Health Information Systems** which include the high-speed telecommunications networks operated by the public with distributed file systems or

shared services (Electronic Health Record, electronic prescription, electronic appointments, Certified Medical Users and Certified Medical Users).

- **Management Information Systems** that include all organized information systems for the management of finances, resources, administrative procedures, pricing of services, patient insurance capacity and coverage. Users are administrators with access to the administrative and not to the medical databases of the patients (for the issuance of an invoice only the examination or its code will be mentioned and not its results).
- **Educational Information Systems** which are of two categories: the "closed systems" which are accessed by certified physicians, researchers, professors or medical students and technology and medical equipment companies for education, lifelong learning - learning by transfer of experience and know-how and "Open systems" concerning the open education of citizens, patients and can be from simple websites or specialized portals, to YouTube channels or modern and asynchronous distance learning platforms.
- **Social security information systems**

From the above, the e-health ecosystem is distinguished based on the typology and use of the information system (doctors / nurses, administrative staff, patients) and the management of their data.

The reality is that the broader term e-health includes:

- medical information systems
- telemedicine
- Homecare systems
- Mobile Health–m-health
- Patient / Citizen e-services
- Non-clinical and administrative health systems
- Medical Education Systems

3.2 Integrated Telemedicine System

An Integrated Telemedicine System includes:

- ⇨ The medical equipment where the patient is examined by medical or nursing staff and their results, in addition to printing in printed form, can be sent to be stored and processed, analyzed at a second level through software information systems in the hospital. Tests can range from simple blood tests to complex serum tests or imaging tests depending on the infrastructure of the regional health center.

- ⇨ Local information system, which operates and supports but is also supported by the services of the national infrastructure and records the whole process while sending the data according to their format to the corresponding data point (data repository) of the other systems. A local telemedicine information system includes local area network switching equipment for interconnecting computers and medical equipment; a wide area external network (Rourouter) router; as well as for secure access to national systems (eg prescription, insurance capacity, electronic patient record). At the same time the same computer is the sender and receiver of the medical examinations to the telemedicine center of the hospital. Such a system definitely has a real-time video communication subsystem (realtimevideo) for both tele-examination and counseling, training or medical advice and investigation from the hospital center.

The three critical infrastructures for Digital Health systems in total are:

1. The information infrastructure
2. Telecommunications infrastructure - data networks
3. Software applications

All three critical infrastructures are analyzed in the spirit of the present in the next paragraph.

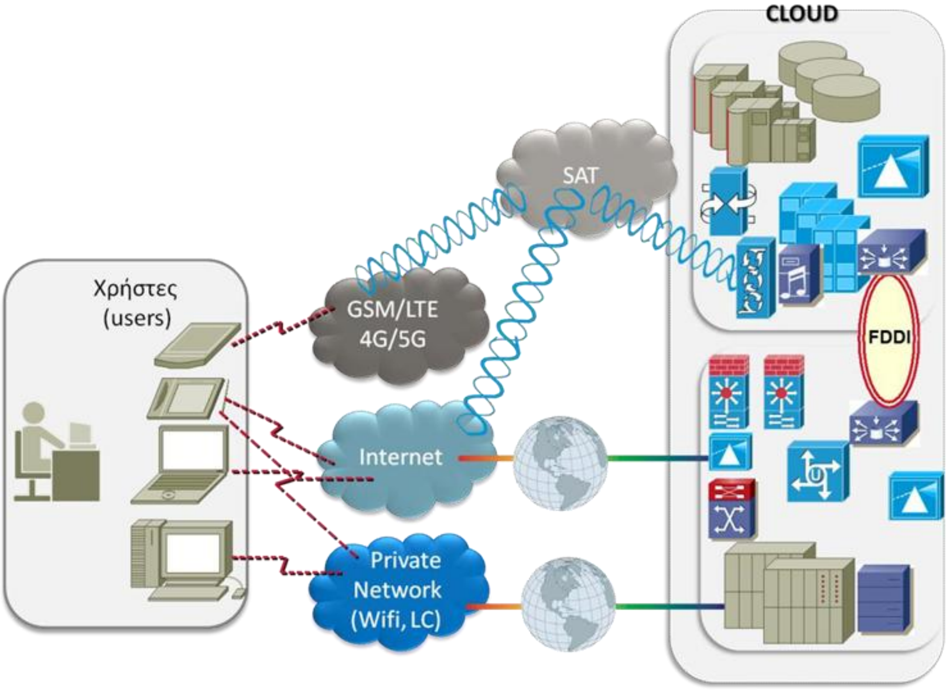
3.3 Modern Technologies and Architectures for telemedicine

There is a huge literature, studies and researches on the protocols, technologies and information and communication systems involved with telemedicine applications, which in addition to historical value ensure the technological continuity but also go beyond the present analysis. This section coherently mentions the modern technologies for the development of telemedicine systems, which are widely used for the development of other forms of e-health without focusing on the technical characteristics of the protocols but at the level of conceptual design.

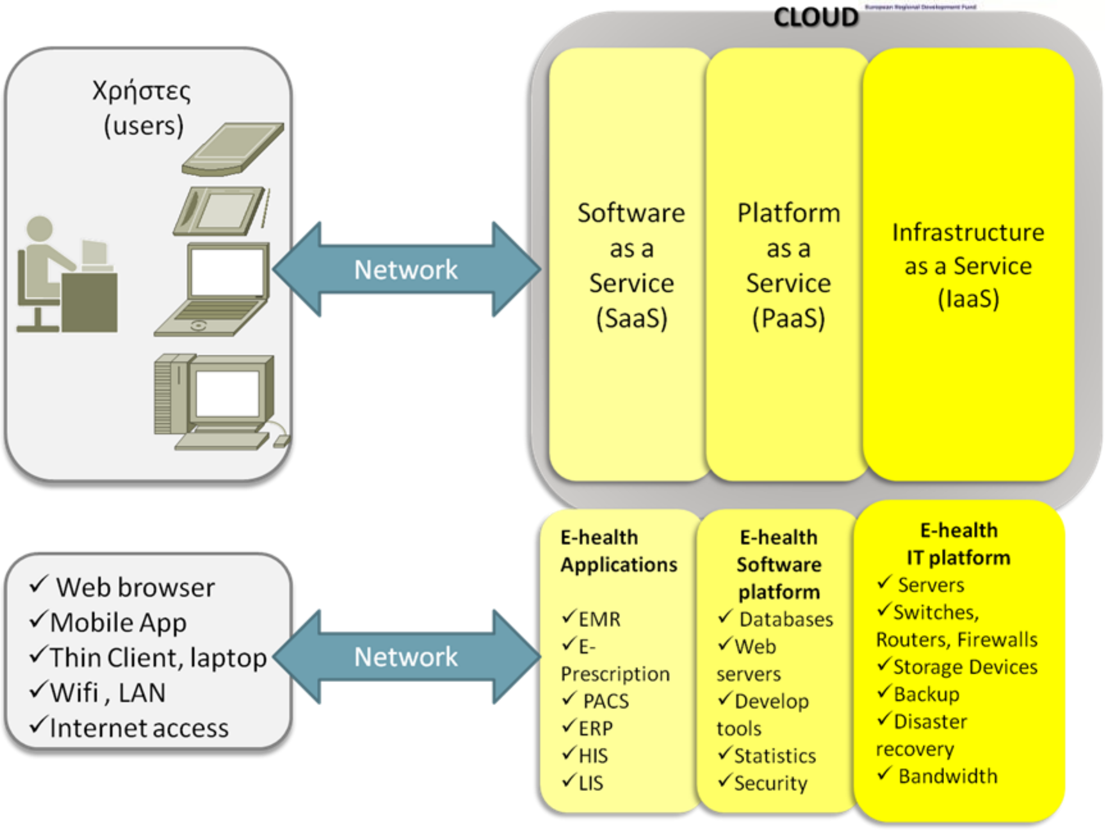
3.3.1 Cloud & Intercloud

Cloud computing is the 5th generation in the field of Information Science in terms of integrated information systems development architectures. This is a new philosophy for the development of computer rooms and computer resources where they go beyond the concept of ownership of the facility in a particular space.

A typical layout of a cloud computing is shown in the following figure:



As shown in the figure below, Cloud computing is based on the well-known three-tier service model: Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS).



Infrastructureas a Service (IaaS): Provides on-demand building resources. These resources are either logical structures, such as virtual machines (VMs), or physical, such as processors, storage, network access, network equipment, security, access, backup systems, or even disaster recovery systems. (disasterrecoverysites). The billing policy followed is for the user to pay on a usage basis. In some

Platformas a Service (PaaS): Provides platform resources such as operating systems, software development tools, relational databases, access management software and authenticated user access (SSL, PKI, DigitalSignature) that allow the user to develop their own applications (medical) based on the Cloud and at the same time how it distributes and accesses them, user rights, etc.

Software as a Service (SaaS): Provides on-demand web applications. The Cloud provider can also be the owner of the applications, and users pay a fixed subscription or depending on usage or even free if the system refers to a public telemedicine infrastructure the amount of resource used, while in others the time period.

3.3.2 Fiber Optic Broadband Networks

If information infrastructure is a critical element in the development of telemedicine, the second is telecommunications networks. The means that are transferred with speed, accuracy and completeness the medical and non-medical data for the support of the patient. Telecommunications networks are a vast scientific and technological field with vast literature and research, which continues unabated today and seems to continue in perpetuity.

In general, there are two main categories in the way of transmitting information: wired networks, which concern the way of interconnection and transmission of information through copper cables, and wireless networks, where the means of transmission is air. The evolution of telecommunications produces a new technology of information transmission via fiber optic cables. Another feature of the evolution of networks, regardless of the mode of transmission, is the convergence and common transmission of multiple types and formats of data. With the evolution of mobile networks and parallel high-speed terrestrial networks and depending on the user's desire or the design need of the system, communication networks are now able to transfer simultaneously: data, audio, video at high speeds, resolutions, clarity accurately and without errors.

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Broadband networks provide users with access to a wide variety of advanced services and applications (e-services) including all forms of "tele-activity" (teleworking, distance learning, telemedicine), network services between peer-to-peernetworkingservices, transmission of static or moving image (video) of high quality and clarity, interactive applications.

Today in Greece, telecommunications providers (Wind, Vodafone, Cosmote) are developing fiber optic networks in urban areas (subscription networks) and backbone networks, with a total investment of € 3 billion for the four years 2016-2020. Today, there are more than 60,000 km of fiber optics from the three providers in Greece, while in combination with the networks of remote rural areas (Ruralnetworks) that have been developed and the new PPP project for the development of fiber optics in the country that will launch UltraFastBroadband in 2019 with integration horizon in 2025, there appears to be adequate high-speed network infrastructure at particularly low cost to support telemedicine systems. This eliminates any malfunctions and communication problems, making telemedicine systems almost reliable and efficient at the same time.

3.3.3 Basic telemedicine software applications

It is the third critical pillar of the operation of telemedicine and the entire ecosystem of digital health. Software applications are those that complete the diagnosis by presenting, editing, recording, classifying the health issue, monitoring the progression of the disease, medication and complementary treatment while creating a large database of real clinical cases where in a second year can analyze data for research or statistical purposes.

Telemedicine software applications, in order to support a reliable and efficient telemedicine system, must have the following characteristics:

- ⇨ Security of access, data entry and management,
- ⇨ Interoperability with other application software systems of other categories
- ⇨ Portability with access from any authorized device and user
- ⇨ Single record: so that no re-entry of data is required which may create multiple duplicate records or alter the content of the information with useless tags or misleading information.
- ⇨ Multiple checks: to avoid incorrect entry

There are 4 basic software applications for the development of telemedicine which are: the electronic health record (EHR: Electronic Health Record), the Electronic Medical Register (EMR: Electronic Medical Record), the Electronic Prescription (E-prescription) and the Electronic Social Security System: Social Insurance Information System). These software systems in the telemedicine technology architecture are usually public infrastructures to which specific users with specific rights have access. Also due to the evolution of the technological specifications of telemedicine (and digital health) the first interface between the medical and social security systems appears.

Electronic Health Record (EHR)

The Electronic Health Record (EHR) is a timeless systematic collection of electronic health information for a patient / citizen generated by one or more interactions in any form of care. This digitally stored information should be shared in different healthcare facilities to monitor patients wherever they go - to the specialist, hospital, health center across the country or even in another country such as the new cross-border health model promoted by the EU.

The Electronic Health Record includes information about the patient such as:

- ☑ Personal and Demographic information
- ☑ Ιστο Medical history
- ☑ Drugs and allergies
- ☑ Medical diary (appointments, visits, examinations)
- ☑ Immunization status
- ☑ Opinions
- ☑ Consistent test results
- ☑ Vital signs
- ☑ Personal statistics such as age and weight
- ☑ Chronic diseases
- ☑ Progress notes and problem details
- ☑ Costing information for the social security system.

Electronic Medical Record (EMR)

EHR / EMR / PHR provides a comprehensive and time-consuming picture of a patient's health status, as it incorporates patient history and information from all providers who have access to the file. This allows healthcare providers to monitor EHR / EMR / PHR data over time, monitor patient visits and their progress. The quality of care is improved, as there is coordination between providers and prevention of situations in which the patient may find himself. Finally, the patient has a complete picture of his health.

The main factors that lead to the adoption of electronic files are the following:

- ⇨ Government and European initiatives to improve health systems, protect them, control and resource efficiency, cross-border health.
- ⇨ Mandatory adoption

- ⇨ Pressure to reduce health care costs or increase cost effectiveness.
- ⇨ Increasing demand for their integration into healthcare systems
- ⇨ Strong return on investment
- ⇨ Public health management initiatives
- ⇨ Reduction of medication errors
- ⇨ The incidence of chronic disorders increases

Electronic prescription (e-prescription)

It is the standalone software system that apparently works with the EHR / EMR and manages the medication to treat an illness independently.

The system usually includes:

- ⇨ The main application of prescription drugs
- ⇨ The main application for issuing referrals for medical examinations
- ⇨ Business Intelligence System (BI Business Intelligence) for the exploitation of data with statistics, for the evaluation of the system and the monitoring of costs but also for any other kind of information.
- ⇨ Autonomous Fraud Detection subsystem such as over-prescribing, guided prescribing, inappropriate and irrelevant prescribing.
- ⇨ Therapeutic protocols that link the medical opinion and the administration of the treatment with the active substances and the quantity of the medicines.
- ⇨ Drug Filters - Pharmacology and duration of treatment and quantity through SPC (summary of characteristics) drugs where the patient is protected from side effects or chronic uses of drugs for hypotoxicity or other adverse reactions.

3.4 Interoperability and Value of data, health indicators

Interoperability is a dominant technical concept in information and communication systems that really takes off both the technical and technological value of the system itself and the business exploitation and acceptance by society and users. E-Health is called upon to ensure the sustainability of healthcare systems. To this end, data interoperability is vital.

Interoperability is defined as the ability to transfer and use information in a uniform and efficient manner from different organizations and information systems, or the ability to exchange and integrate digital data formats from different and heterogeneous information environments through the adoption of common standards.

The main benefits of interoperability are

- ☑ Service and satisfaction of information needs. The information is provided regardless of time and physical space. Also, the improvement of the process of handling all types of data (digital signals, documents, multimedia data - image / audio) through information systems forms better service providers.
- ☑ Data exchange: efficient services fully automated and linked to the ultimate goal of saving money by managing and processing the information itself

Conditions for ensuring interoperability are:

- ☑ The adoption of open architectures, which define the location and role of each subsystem. The open architecture of an information system is what promotes the freedom of choice in the components and allows the synthesis of the most suitable solution from interchangeable components, without committing to proprietary technologies and solutions of a manufacturer.
- ☑ The existence of common and widely accepted standards (Standards), which describe the way of communication between subsystems and the form of information exchanged.
- ☑ The control of products by independent organizations, for their compliance with the standards.

For effective data communication between all public organizations, with the aim of uniform access of citizens to public and private data, Greece follows the Greek eGovernment Services Framework (Greek eGIF), which is based on the British e-GIF and specializes for domestic needs, ie for the definition of the Greek GovernmentCategoryList and the design of Greek XML schemes. The Greek e-GIF sets the techniques, policies and specifications for achieving the interoperability and coherence of public sector IT systems in Greece, as well as the interactions between:

- ☑ Government and citizens
- ☑ Government and business
- ☑ Government and organizations
- ☑ Government and other governments (inside and outside the European Union)

The Greek e-GIF includes rules and standards for the implementation of the general strategy and architecture of e-government regarding:

- ☑ The certification of public websites
- ☑ Interoperability between information systems
- ☑ The development of electronic trading services
- ☑ The digital authentication of citizens and businesses
- ☑ Open access to public data and documents
- ☑ Secure access to private data and documents.

Interoperability standards lead to the following benefits:

- ☑ create the necessary connectivity and data exchange between health systems,
- ☑ minimize the risks of developing new technologies,
- ☑ prevent dependence on a single supplier or service provider
- ☑ reduce costs, as they facilitate the development of competition and eliminate the need for expensive solutions,
- ☑ ensure the diffusion and adoption of new ICT solutions in health,
- ☑ effectively address specific concerns about privacy, security and identification.

3.5 Data access and GDPR

According to EU standards, all citizens have the right to access and share their health data. From 25 May 2018, when the General Data Protection Regulation (GDPR) comes into force, citizens will potentially have control over the use of personal data concerning them, including health data. The public consultation confirmed that the majority of participants in it want more access to their health data. They also want to be able to share this data for the purposes of their treatment or for research purposes, provided that appropriate guarantees are provided. Technology should ensure the existence of these guarantees by creating infrastructure that complies with data protection rules.

However, at present many citizens in Europe have limited electronic access to their health data. Often, data is undetectable and scattered throughout. This can have a detrimental effect on diagnosis, treatment and monitoring, for example, if a person is abroad and their medical data is not accessible. In addition, incompatible electronic health record system formats and standards continue to be used across the EU.

3.6 From telemedicine, to telematics and to m-health

The use of mobile and wireless information and communication technologies has the potential to transform the face of health care providers around the world. There are more than 7.5 billion mobile subscriptions in the world - in many places people are more likely to have access to a mobile phone than to clean water.

The so-called "m-Health" refers to the integration of portable and portable devices such as smartphones and Wearables and other electronic health systems for measurements, which are used for health monitoring purposes. The use of mobile devices to achieve health goals is a revolutionary service health around the world. A combination of elements is the motivation for this revolution. It is about rapid improvement of mobile technologies and applications, development of new perspectives for integration of mobile health in the prevailing e-health services and continuous evolution of mobile network coverage (WHO Global Observatory for e-Health, 2011). The great spread of mobile technologies as well as developments in their inventive application to address health concerns have evolved into the new field of e-health, referred to as m-Health. The World e-Health Observatory (GOE) defines mobile health as “a medical and public practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs) ". M-health can also be defined as "the use of mobile communications - such as PDAs, Smartphones, Wearables, Tablets - for health services and information"

It also includes applications (such as lifestyle and wellness applications) that may be connected to medical devices or sensors (eg bracelets or watches) as well as personal guidance systems, health information and medication reminders provided via SMS and telemedicine. provided wirelessly. The solutions include various software applications that interact with telemedicine systems, which among other things count important points such as:

- ☑ heart rate,
- ☑ blood glucose level,
- ☑ blood pressure,
- ☑ body temperature
- ☑ the activity of the brain

4. Efficient and sustainable telemedicine systems

4.1 Systems and data for research promotion

Personalized medicine is an emerging approach that uses data generated by telemedicine systems and digital health in general in order to better understand individual characteristics and provide the right care to the right person at the right time. New technologies make it possible to make wider use of genomic and other elements (such as molecular characterization, diagnostics, environmental and lifestyle data) and therefore, support physicians and scientists to better understand diseases and ways by which can improve prognosis, prevention, diagnosis and treatment. Support for the collection of genomic and other health data is already being provided through various national and regional initiatives, with the aim of promoting research and personalized medicine. There is a need to improve the coordination of these existing initiatives in order to ensure the necessary critical mass at EU level and to achieve results similar to those of similar initiatives undertaken in other parts of the world. . Significant leaps in progress can be made by linking Europe's fragmented resources to secure cross-border digital infrastructure and ensuring full compliance with data protection legislation and ethical principles. Ensuring interoperable standards for genomic and other data is also crucial for the efficient sharing of datasets.

4.2 Strong citizen participation and patient-centered care

According to the EU, the aging of the population combined with the increasing burden due to chronic diseases and multi-morbidity have resulted in a steady increase in demand for health services and care. This means that health and welfare systems need to develop a different approach to enable more efficient care and to address the complexity of the different services that patients are now required to use. For this reason, it is widely acknowledged that health systems need to shift from treatment to health promotion and disease prevention, to focus on prosperity and man rather than disease, and move from fragmentation of services to integration and coordination. To make further progress in health promotion, disease prevention and the provision of integrated services based on human needs, health systems must develop innovative solutions through the use of new technologies, products and organizational changes. Central to the success of this transformation are the following:

- ☑ development of new models of care,
- ☑ use the evaluation of health technologies to achieve higher quality and sustainability of health services
- ☑ participation of multi-specialty care teams with new or remodeled roles for healthcare professionals,
- ☑ integrating health promotion and prevention into primary care,
- ☑ providing human resources in the health sector with adequate skills and competencies,
- ☑ active collaboration between healthcare professionals and patients, as well as
- ☑ utilization of digital solutions, which offer in their entirety the necessary means to provide effective and cost-effective care

Patient-centered approaches to health and care organization enable citizens to take responsibility for their own health, increase their well-being and quality of care, and contribute to the development of sustainable health systems. With the use of digital solutions, such as mobile devices and "mobile" health applications, citizens can be actively involved in the protection of health and self-management of chronic diseases. This development may, help curb the growing demand for health and care services. Digital tools provide important opportunities for the dissemination of scientific knowledge in an easily accessible form and, in this way, help citizens to maintain good health and, consequently, not to become ill in the future. Through the use of scientific information on risk factors, digital solutions can be used in all areas, such as education, transport and urban policy, to promote information and awareness campaigns on healthy lifestyles. Digital tools also enable citizens to provide feedback and data about their health to their doctors. This potential can contribute to improving the quality of health services and, ultimately, to improving human health and well-being.

Therefore, the second criterion for effective and sustainable telemedicine systems is to extend to the entire application cycle of digital health and especially to the current trends of m-health and homecare because then and only then the "outpatient care system" is created massively and at the same time the load and telemedicine systems.

4.3 Evaluation of Telemedicine systems

4.3.1 Evaluation of health technology, the start

The development of Health Technology Assessment takes on transnational dimensions by evaluating interventions at the technological, political, individual and population levels, coming from international and national organizations. Political analysis, evidence-based medicine, economic evaluation and the social sciences and humanities are part of the research evaluation methodology, providing a data link between the field of research and management for decision-making on the diffusion of health technology. health systems.

The Health Technology Assessment aims to inform health policy and those who make decisions on issues related to health technology. Its strong foundation is the research on the effects on the patient's health but also on the wider effects of the use of technology in the field of health. Its dynamic contribution to providing safer and more effective health care is universally accepted. Health Technology Assessment is a process designed to ask the right questions and seek those answers that are based as much as possible on indisputable and factual information that can be obtained from disciplined analysis. At the same time, it identifies evaluation indicators for the calibration of health technology systems in order to determine the compatibility with safety and efficiency specifications. Where important information is not available, the need for additional research can be found. The Health Technology Assessment reinforces – does not replace – the decisions that need to be made by those legally designated for the health strategy.

4.3.2 Methods and criteria for evaluating health technology

Health Technology Evaluation in the early 1970s was limited to technology evaluation. However, over the years its activity has expanded to address issues at all levels of health care decision-making as it may include research into the effects, characteristics and application of health technologies. In general, the key components of a comprehensive Health Technology Assessment study are:

- ☑ Technology safety: Assessing the potential side effects of a diagnostic or therapeutic health technology
- ☑ Reactivity and effectiveness: The appreciable ability of new technology to achieve the expected results in both ideal and real conditions
- ☑ Efficiency (economic evaluation): After evaluating the efficiency, it is necessary to evaluate the efficiency, ie the optimal use of resources.
- ☑ Social consequences: The assessment of the social consequences from the application of a new technology is necessary. This estimate includes both equal access and opportunity cost of new technology
- ☑ Ethical and ethical issues: The ethical implications and implications of a decision to use a new technology should be taken into account (eg cloning)
- ☑ Acceptance, availability, accessibility and indications for use: The evaluation of functional issues such as the above is essential for the diffusion and use of a health technology.

4.3.3 Evaluation in the EU and internationally

The EU is committed to policies, develops and strengthens health technology evaluation systems and methodologies and mechanisms to disseminate evaluation results and make better decisions and best choices. Today 13 Member States have a national body for the evaluation of Health technologies, 14 Member States do not have a similar legal entity or any organized structure for it (obviously including Greece), while the health theoretical bodies with the largest theoretical basis are Norway and Switzerland.

Common issues for health technology evaluation have been clarified as follows:

- ☑ The evaluation of activities for the promotion of health and the prevention of diseases in relation to the benefits, the risks, the economic, the social and the moral consequences

- ☑ The development of systems related to the daily exchange of information between programs on emerging technologies, priorities for future evaluation, performance and timing of these mid-term evaluations
- ☑ Identifying possible joint evaluations
- ☑ The development and dissemination of best practices and the submission of evaluation reports, as well as the identification of needs for the development of methodologies
- ☑ The development and coordination of training and support of networks for individuals and organizations that undertake or use the evaluation of health interventions and the identification of needs in the specific area that will assist in the creation of new provisions.
- ☑ Identify and disseminate successful approaches that link evaluation findings to health policy and practice and that contribute to health indicators and healthcare decision-making.

4.4 Perspectives and future development of telemedicine

Innovative digital telemedicine solutions and applications can improve human health, quality of life, and provide more efficient ways of organizing and delivering health and care services. To achieve this, they must be designed to meet the needs of citizens and health systems and carefully implemented to fit the local context. Digital technologies and telemedicine applications should be considered an integral part of health and care and should be geared towards the broader goals of health systems.

The most successful and rapid development of innovative digital health and telemedicine solutions requires cooperation at EU level and exchange of experiences on development, impact measurement and innovation transfer between Member States and regions. The active involvement of all parties is essential to successfully securing a triple-benefit solution for citizens, health systems and the economy.

4.5 Sustainable telemedicine and digital health systems

4.5.1 Health systems as Best practices for sustainability and performance

It is well known in the field of Health Economics that sustainable national health systems have not yet been managed for many reasons of multiple origins. Even health systems such as the British (GNNHS), the Dutch (DHS) and the French (FHCS), which are (and are) considered to be the best in terms of organization, efficiency and control of global health systems, remain major discrepancies and very serious economic and technical problems. All three countries have a very organized health systems development process that includes the following five (5) levels:

- ⇨ Multi-year national health strategy which is implemented gradually and evaluated continuously
- ⇨ Highly competent public administration that consistently implements the national strategy, at a specific time with a specific objective
- ⇨ Education, stakeholder participation and diffusion of the system, functions and methods in society, the educational community
- ⇨ Strong e-government and interconnection with OPS (Integrated Information Systems) and BI (BusinessIntelligence) systems, with the result that no information, no data is lost. This helps in the overall evaluation, in the implementation and execution monitoring.
- ⇨ Redesign and constant reforms.

It is typically stated that France has established and every 10 years evaluates its health system, redesigns or improves it, implements 2 years of implementation and starts a new cycle of 10 years of evaluation. The last 10 years were completed in 2011 with the evaluation and redesign being completed in 2012 and the implementation of the "system 2014" version as it is called today.

Since 1991, France has interconnected social security systems with the health system for resource monitoring, implemented the 112 single health support call system, started the systematic use of telemedicine, and since 2001 has been implementing home care systems for chronically ill people. Since 2000, the WHO, based on the health systems evaluation report, has stated that the French system is close to the best general situation in the world, while in 2008 it was declared the most effective health system: “best performing system in the world in terms of availability and organization of healthcareproviders”.

The Netherlands has refurbished and redesigned its systems 3 times in the last twenty years, and now has a standard system developed in two clear pillars (Health healthcaremedicine - Social Security) with specific selection programs - coverage and costing packages of Health, with implementation treatment protocols. The Dutch system is evaluated as one of the most effective in terms of medical care and health protection, the most complete in terms of care and services, treatments, etc., but it is considered high costs for citizens and the state. From 2015 until 2018 (for 2019 the evaluation has not been completed yet) the system is graded with 916 points with an excellent 1000 with first and in the 48/60 indicators of the European system. It is characteristic that 13% of the necessary expenses of the system are covered by citizens outside the Netherlands who choose the country and its system for the provision of medical services with the aim of this percentage to rise to 22% in 2022.

Of particular interest is the Norwegian health system, which according to the European evaluation in 2015 to 2018 is consistently third, where in addition to telemedicine and digital health, its strategy focuses on improving the way of life of citizens by preventing and treating smoking habits, obesity, lack of exercise, unhealthy diet, HIV / AIDS awareness and treatment of mental illness to reduce suicide. Since 2016, the adaptation of the system to meet the UN Sustainable Development Goals (Agenda 2030) has begun.

In conclusion: the allocation of resources of a system must have intelligence, targeting, absorption control and measurement of result by evaluation. Clearly, financial resources are important and irreplaceable, but they are not the only ones that need to be activated for sustainable telemedicine and digital health systems in general.