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INNOVATION THROUGH ICT IN CARE HOMES

IN-ICT-CARE

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Abstract

This report presents literature review, methodological implementations and policy lessons that could help public authorities at all levels of the EU Member States for using new Information and Communication Technologies (ICT) in long-term care service provision for older people. These intellectual outputs have come out of the IN-ICT-CARE Erasmus Plus project carried out by the coordinator and partners as above listed name and funded by Turkish EU Agency.

These outputs could help public and private long-term care authorities to modernise via the use of ICT their social protection systems in the field of long-term care, ensuring effectiveness, adequacy and sustainability.

These outputs also describes the different policy instruments offered by the European Union, which could help public authorities to implement these policy outputs.

Legal warning

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INTELLECTUAL OUTPUT 1

MAPPING SCIENTIFIC LITERATURE REVIEW

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LITERATURE REVIEW

Information and Communication Technology (ICT) has improved efficiency and quality in many sectors of the economy and made a considerable contribution to the modernization of public administration at all levels (34). This is also true in the case of health care, where technologies are helping to transform the sector with the introduction of new medical technologies, evidence-based medicine and new financial models (21). Electronic medical and patient record systems, in particular, are "predicted to change and improve health care" (85). Some literature on the adoption and the impact of technology on service delivery by public organizations (54,99) has shown that the effective adoption of ICT has changed over the years, as technology has evolved, and its incidence among organizations has grown and become more pervasive (23).

However, health care professionals and organizations have found that they do not always have adequate systems to deliver strategic change. To remain competitive, health care professionals and organizations are looking to information technologies for help. According to Eng (2018), the adoption and implementation of ICT in the health care sector is developing much more slowly compared to other sectors, such as finance and commerce. This is due to several impediments observed by Ganesh (2019). These include the continuing lack of awarenessamong patients of the availability of online access to specialist knowledge or the legal issues implicated by the use of electronic communications in medicine. In practical terms, although some ICT systems are already in place in the healthcare sector for the execution of administrative tasks, such as billing, scheduling and inventory management, there is scant adoption of extensive integrated clinical information systems. Although some of these factors persist to a certain extent, greater computer literacy (188) in the general population, the availability of communication infrastructures and changes in government policies and increased support for clinical computing in particular, suggest that this trend is changing and will continue to do so in the coming decade. Such considerations are substantiated by previous studies focusing on the level of adoption of ICT tools by the health care systems in different EU countries, both at general practice level and at acute hospital level. Continuity of care and effectiveness of health care policies can be achieved at regional and European levels if the main actors of the care processes share information on their patients' history. Hospitals around Europe have been introducing electronic medical record systems, to keep track of their patients' records and to facilitate the administration of prescriptions. Assessing the diffusion of ICT among the latter becomes paramount for stimulating the creation of longitudinal patient summaries that might contribute to more efficient health care processes for individuals and more effective health policies. To this end, understanding the use, diffusion and degree of pervasiveness of ICT among acute care organizations sets the grounds for depicting the nature and direction of new trajectories in health care practices based on a more comprehensive and informed basis for decision making (41).

Aging populations are bringing significant challenges to societies everywhere (3). Worldwide increases in elderly populations are demanding more healthcare services, including those of hospitals and nursing homes. For elderly people unable to take care of themselves, it is critical for a nurse or family member to pay extra attention to them during their daily care. Ordinarily, the costs of elderly care in hospitals, nursing homes or by employing professional nurses are very high. These approaches may bring financial pressure for the families with aged people, even worse the elderly with chronic conditions. A prospective solution that can reduce these costs is to care in private homes with the help of wearable technologies (90). Fortunately, the advent and advance of wearable technologies have opened a door to develop feasible devices for elderly care.

Currently, smartwatch, smartphone and smart clothing are the mainstream products embedded wearable technologies with care functions. All of them have attractive advantages for delivering health information. For instance, smartphones are ubiquitously carried by people everywhere and every day; besides the big enough screen of smartphones can behave as a great avenue for Human-Computer-Interaction (HCI). However, the limited number of sensors and the locations where sensors are placed restricted smartphones' functions. Functions that need skin contact monitoring are difficult to be realized by smartphones. Smartwatches, a networked computer with an array of sensors, can realize continual connection to the skin to monitor physical signals. Moreover, smartwatches are body mounted, with a standard, fixed location. This means we do not need to fix sensor locations. Nevertheless, smartphones also suffer from the constraints such as limited sensor quantities and locations. Another gimmick product that can behave as "e-health" systems for elderly care is smart clothing, which incorporates technological capabilities into existing wear [211]. A superior advantage of smart clothing is that this platform can embed more sensors to realize diverse function than smartwatch or smartphone. At present, several smart clothing solutions have been reported already. For example, smart shirts by HeddokoTM (Montreal, Canada) collect full-body bio-mechanical data that can be viewed in real time or saved for later playback via a cellphone app [4]. Similarly, health related smart shirts that can measure heart and respiratory rates and the intensity of wearers' workouts have reportedly been developed by Hexoskin, Cityzen Sciences, Ralph Lauren Polo, and Athos [15]. All these smart shirts are designed to monitor the status of various human physiological properties while their wearers are exercising. In addition, some companies (i.e (86) and (97)) have developed novel smart clothes for babies that can track sleep status, breathing, body position, and orientation and forward the information to a monitoring application.

Quite a lot similar smart clothes have been designed that can be used for elderly care. Some of these can recognize the physical activity and monitor the physiological vital signs of the elderly; some are capable of early disease detection (e.g., heart attacks or Parkinson's disease). However, traditional smart clothes cannot track precise position. Image that when an elderly people suddenly fell down, and very serious, he or she may require a prompt response from doctors and nurses to avoid additional injuries [318], the first thing is to locate the elderly people quickly. In this review, considering the specially requirements of elderly care, we extended the current smart clothing concept and presented the wearable technologies for the design of elderly care systems include methods for precise positioning, tracking physical activity, and monitoring vital signs in real time. Positioning involves accurate localization of elderly people, including in both indoor and outdoor locations. Outdoor positioning is performed outside buildings and indoor positioning is performed inside buildings (e.g., houses, hospitals, and malls) (119). There are several well established and widely used navigation systems for outdoor positioning, such as the Global Positioning System (GPS), the Global Navigation Satellite System (GLONASS), Galileo Positioning System (GALILEO) and BeiDou Navigation Satellite System (BDS). All of these are satellite-based systems for which ground-based sensors rely on signals from at least four satellites to estimate user coordinates. These technologies are currently accurate to approximately several meters for outdoor scenarios [10]; however, they cannot be used to determine precise indoor locations because of the significant attenuation of satellite signals in buildings. The indoor positioning errors of satellite-based systems are currently unacceptably large. Hence, the existing satellite-based positioning technologies can meet the demands of elderly care only for outdoor scenarios.

For human activity recognition (HAR), several approaches have been proposed. The current up to date researches on this topic can be mainly divided into two categories: vision-based recognition and sensor-based recognition (113,14). For vision-based HAR, systems require a two-dimensional (2D) video recorder or a low-cost integrated depth sensor (such as the sensors and cameras in a Kinect™) [15]. Human movements are recognized from Red, Green, and Blue (RGB) data in conjunction with depth data. Considering the likelihood that many elderly people not only reside indoors but also spend time outside, vision-based HAR is unsuitable for elderly care because it is both difficult and too expensive to install cameras in all the places where elderly people are active. Moreover, the recognition accuracy of such systems decreases in outdoor environments because of variable lighting and other disturbances [145,16]. Therefore, vision-based systems are limited to specific environments in which such visual disturbances can be controlled. Thus, this review emphasizes sensor-based HAR. With the development of Micro Electro Mechanical System (MEMS) technologies, wearable sensors integrated with inertial, acceleration and magnetic sensors are becoming increasingly less expensive, smaller, and lighter. Currently, MEMS sensors are widely applied for human activities recognition, behavior classification and human activity monitoring domains (139,14,177).

As people become older and older, the majority of elderly persons have some typical old-age-related problems such as high blood pressure, high blood cholesterol, cerebral thrombosis, and so on. Therefore, it is necessary to develop real-time physiological status monitoring systems (e.g., electrocardiogram (ECG), body temperature, blood pressure, blood oxygen concentration, and so forth) to ensure their quality of life, safety and well-being. These data can be transmitted to a smartphone or personal computer (PC) by a cable or wireless signals [18]. On one hand, these data can be used to monitor health status without requiring the intervention of a doctor or other caregiver. When the data signify an obvious problem from which an elderly person may be at risk, the monitoring system can immediately trigger an alarm that results in a rapid intervention by medical or civil protection services personnel. On the other hand, these data can also be collected by authorized entities or governmental organizations to evaluate the global or national health status in order for the promotion of reasonable policies. Thus, such health monitoring systems can help to reduce the costs of healthcare by forecasting disease risks and can improve the quality of life and safety of the elderly by helping to manage existing conditions (66.71)

ICT ENABLED CARE

The way patients access care and interact with health care systems is rapidly changing through the use of information and communication technology (ICT). Health care is being transformed through digital innovations, such as wearable technology, remote monitoring, patient portals, mobile applications (apps), and new service models such as telemedicine and virtual visits. Through a review of the current literature, this work presents the use of digitally enabled tools and ICT, including electronic health records, telehealth, remote patient monitoring, and mobile health apps. These effective and innovative digitally enabled tools have expanded options for patients interested in actively engaging in their own health. Information and communication technology can improve health outcomes, enhance the patient experience, and curtail costs. Providers must stay fluent with ICT options to best collaborate with patients. Although providers recognize that patient-centered care can improve effectiveness and efficiency, many have been slow to incorporate digital therapeutics, or “digiceuticals,” into practice (171).

The rapid growth of ICT-enabled service (Information Communication Technologies) usage in our daily life brings intensive interactions between friends and family members. Benefit from the synergy of ICT and caring service, we are used to accept these novel channels for express our feelings and caring to whom we love. ICT-enabled caring services make our world more warm and feel well-being. In order to understand how these ICT-enabled caring service systems could fulfill our needs and understand the performance of feeling expression and propagation, a measurement matrix is necessary.

ICT-Design for care home residents: Dealing with ‘CONTEXT’

The topic “ICT development for old people” and especially in the context of residential homes has not been extensively studied. Indeed, it is sometimes argued that the topic is often neglected, trivialized or treated as merely usability challenges [5,121]. Other researchers report on experiences we also have had, namely being confronted with rather cynical questions about whether it is worthwhile engaging in ICT-design for these old people [12,66]. They are, in other words, classic exemplars of the ‘digital divide’.

But there are several reasons for going on with research in this domain. Besides the fact that digital – and social – exclusion remains a vibrant research topic, demographic changes mean that it will become more, not less, important. The fact of an increasing number of single households and increased geographical mobility means that residential care will become an alternative for more elderly citizens in the future. If so, then solutions to the social problems the elderly face will become urgently sought. Such solutions will need to address sociality and ‘quality of life’ issues as much as those of health and security (for examples of the latter, see [38]). Moreover, ‘parachuting’ ICT into a care home is unlikely to have the desired effects since issues of the institutional framework, professional practice, family rights and responsibilities and so on will all be relevant.

Developing technologies specifically for an elderly population is justified when taking future demographic trends into account. It is indeed possible to anticipate quite precisely the inevitable aging of Western populations, a major transformation in contemporary societies. This is clearly illustrated by data from Europe, the United States and Japan (106) which indicate a dip in the demographic curve and significant growth in the number of people above the age of 80, designated by the category of “elders” or “the dependent elderly” 1 (99). Whether physical or mental, their dependency is characterized by their inability to live alone in ordinary housing. This implies the need for a supportive presence at home or even being placed in a specialized institution.

If the desire to age while remaining in one's home for the longest time possible is a wish shared by the majority, it nonetheless appears as a difficult and costly reality due to the lack of adapted medical, social and familial structures and resources (193). However, if living in specialized institutions, such as an RHCU (residential home care unit), represents a comfortable and safe solution, as much for the elderly person as for their social circle, it also highlights some paradoxical side effects. Feelings of solitude are more strongly experienced than at home, with decreased autonomy and quality of life (208). In such conditions, the possibilities presented by information and communication technologies (ICT) allow for innovative solutions to assist and support the dependent elderly living in such institutions.

Benefits of ICT on quality of life and social support

Gerontechnology

In current research, the term "gerontechnology" represents "the study of technology and aging with the intention of developing better living and working conditions as well as adequate medical care for dependent people" 2 (106, 55 and 207). Studies on standard ICT, such as telephone and Internet services, social networks, online forums and messaging systems, or even more innovative ones, such as ambient and ubiquitous technologies (441), highlight their diverse objectives such as allowing for the elderly to remain in their own homes and developing autonomy (220). Other studies show that ICT can be used to rehabilitate and reduce certain deficiencies, whether they are motor or perceptive (32), cognitive, psychological (315) or social (78). More generally, the aim of such technology is to improve the quality of life of the elderly (87).

Using ICT amongst the elderly: what impact on their quality of life?

Quality of life can be defined as a global evaluation of the satisfaction a person gets from their life, based on their own criteria (99). Quality of life includes two types of factors (312):

- objective or situational determinants which are external to the person, such as the nature of hobbies, standard of living, social and family support,

- and subjective or positional determinants which are specific to the person, such as personality-related traits like optimism and pessimism, feeling isolated or autonomous, self-esteem and health.

Various studies show that ICTs are likely to have beneficial effects on both of these dimensions of quality of life. We will highlight research primarily focused on implementing ICT with the objective of allowing the elderly people to remain in their own home. This

choice is mainly due to the lack of studies, to our knowledge, that have been carried out on the effects of ICT in RHCUs.

1) First, at the external level, ICTs are considered to lead the elderly to open up and become (re)integrated into society (88 and 413). Taking part in social activities (such as hobbies or workshops) or being part of a social network is thought to reduce their self-isolation and withdrawal into their homes. For instance, certain technologies try to offer an alternative to the "surveillance or assistance" they are subjected to (such as distance surveillance) by turning friends and family into a possible source of moral and material support for the elderly (for an example see the "Whereabout Clock system", 191). Other technologies aim to transform the elderly's home, initially considered as an isolating shelter, into a centre of social connectivity and virtual openness towards the outside world. For example, Internet teleservices for information, interaction and games offered via accessible media (such as an interactive TV) aim to reinforce social cohesion and help them to go, virtually, out of their home.

2) On a more personal level, other studies have shown how ICT could get the elderly to gain greater autonomy by restoring their self-confidence in their learning capacity and through the use of innovative systems. A study by [192] shows that the elderly who use ICT perceive their aging process differently, as feelings of finiteness become less present and oppressive, altering their perspective of their past and future. A study by [311], conducted with psychologically fragile elders who use the Internet, demonstrates that those who belonged to discussion groups had a greater chance of coping with their weaknesses than those less connected. However, he states that people who learn with the help of a nurse have better results in terms of self-esteem and decreased depression than those who learn by themselves.. Very few studies have been conducted with elderly subjects living in RHCU-type institutions. We can, however, point to the study conducted by [415], which showed that being taught how to use computers helped enhance residents' feelings of self-efficacy and self-evaluation of their competencies and independence. The study conducted by [377] analyses residents' needs and expectations about assistance tools supposed to help them in their

RHCU everyday life. Results show that there is no regularity and each specific life experience modifies the needs. [43] shows that technology can be used in RHCUs as a complementary activity useful for supporting the informational and social aims of the more active residents. Indeed, usuallyactivities proposed in RHCUs are designed for the weakest residents and so can lead to understimulated or bored active residents. Technologies are so viewed, as we have done in the case of the MNESIS projet, as a means to maintain or stimulate their capacity.

However, these benefits have been called into question by results from other studies that show no major improvement in the quality of life of the elderly after having used ICT. For example, [59] conducted a longitudinal study analysing the impact of Internet use on the development of well-being and autonomy amongst 191 seniors, yet their results show no impact, either positive or negative. (188) carried out a major literature review on the topic, point out that the analyses are usually incorrectly carried out and conclusions are often only partial and limited. Furthermore, it is difficult to distinguish between the effects related to the social interaction stimulated by computer courses, and that directly induced by computer use, as indicated by [255]. We also identified results that were incorrectly generalized for different age categories 3 which each have very distinct features, such as age groups with or without deficiencies and those who are either socially integrated or isolated. Moreover, a methodological review highlights the limits of data collection techniques, which are usually quantitative, based on questionnaires and/or interval scales. These provide only a partial representation of how individuals understand their own social cohesion and self-perception. In addition, these methods are not sufficient to explain the social and subjective experiences of an elderly person in their actual living conditions. The impact of ICT is generally measured directly following the subject's participation in a training course on using the Internet, after which they are immediately asked how they benefit or could benefit from these technologies. The temporal component of such evaluations is not accounted for in a rushed data collection process, failing to apprehend the actual long-term impact.

Quality of life in most countries has been increasing a lot over the several few decades due to significant improvements in medicine and public healthcare. Consequently, there is a huge demand for the development of cost-effective remote health monitoring, which could be easy to use for elderly people. The remote health-care monitoring includes sensors, actuators, advanced communication technologies and gives the opportunity for the patient to stay at his/her comfortable home instead in expensive health-care facilities. These systems monitor the physiological signs of the patients in real time, can assess some health-conditions and gives the feedback to the doctors. Why these systems are so comfortable and necessary to use? The first reason is that they are portable, easy to use, with small sizes and light weight. A typical example is a Health-care Monitoring System (HMS) that mostly uses a microcontroller, which tracks and processes health data and sends an SMS to a doctor's mobile phone or any family member who could provide emergency aid. The main advantage of this system is that a person could carry it everywhere because the device is small, light and wireless. Another advantage of these systems is that they can monitor health conditions in real time and all the time. People use HMSs in hospitals, for home care, and to track the vitals of athletes (heart rate, blood pressure, and body temperature). All this data can be processed by various sensors integrated into the systems.

Health monitoring systems can use microcontroller, wearable sensors or FPGA.
A transmitter receives physical signals of the heartbeat, processes the data and sends through Wi-Fi to the ZigBee. Then the data is transferred by the receiver to the computer. The transmitter uses a microcontroller which detects the patient's pulse and converts it to a voltage signal and then displayed. The idea is the same with HMS with wearable sensors, the difference comes in the fact that here the sensors which detect body temperature, blood pressure or a heartbeat rate are located on patient's body with no wires. For wireless data transmission in short distances protocols such as Bluetooth or ZigBee are used. The wireless sensor device contains respiration sensor, electro dermal activity sensor (EDA sensor) and electromyography sensor (EMG sensor). FPGA means field-programmable gate array, which could be programmed after production through HDL (hardware description language). A Health-care monitoring system using this technology contains a low-cost, analogue-to-digital converter. Digitization allows users to connect the FPGA to the entire system. [76]

E-health Monitoring Architecture can be divided into three main layers.
Perception layer contains different medical and environmental sensors that are collecting data in real-time. Medical sensors measure patient's vital signs while environmental one's measure indicators, which affect a patient's condition, such as the oxygen level or room temperature.
API layer includes various application programming interfaces (APIs). The data is stored through cloud technologies providing access to patient's health data and current health records. The API layer is a layer that stores new patient health information by generating a profile using one API, and displays existing medical information for a previously registered patient data using another API.
Service layer contains an e-health application, which analyses the received data and suggests methods to improve patient's condition or give a prescription. The data is analysed by integrated

algorithm and can be compared to other patient's experiences or previous health status of the same patient. This layer is responsible for alarming the medical staff in case of emergency.
HMS is an efficient instrument that can save human lives. It is compatible and can be configured depending on patient's needs, which make it cost-effective and useful not only for hospitals but also for home use.

Identification and Sensing Technologies

The evolution of semiconductor VSLI technologies has led to the appearance of low-power processors and sensors as well as intelligent wireless networks coupled with Big Data analytics. These are the basic building blocks of the prosperous notion of Internet of Things (IoT) in which context arises the development of identification and sensing technologies. At its core, Internet of Things is about connecting devices (things) and letting them communicate with other devices and applications. Hence, the IoT paradigm requires for networking and sensing capabilities.
At present, the objective is to transduce (sense), acquire (collect), and analyze (process) information from various objects around us in order to ensure optimal resource consumption. The solution to this request is the Internet of Things which represents the capability of connecting every applicable device to the Internet. The huge amount of generated data could be processed by using cloud services, i.e. effective and accessible data frameworks that are able to provide computing as a service.(90).
In the last two decades networking has been well developed and widely spread as a solution to dealing with information of any kind. In brief, the objectives of information technology are to make not just information machines, but information environments that are allowing the access to information from everywhere. The combination of semiconductor and information technologies enabled the use of huge amounts of sensors to be deployed anywhere, not just where electronics and power infrastructure exists, but anywhere valuable information is gathered regarding variety of characteristics a given object or thing.(41)
The notion of controlling things such as rail cars, machines, pumps, pipelines with sensors and SCADA systems is well-known to the industrial world for a century. Dedicated sensors and networks are already deployed in industrial setups ranging from oil refineries to manufacturing lines. But historically these networked sensor control systems have operated as separate networks with their high-level reliability and security.
Contemporary technology advancements, including electronics, digital embedded systems, wireless communications, and signal processing, have made it possible to develop sensor nodes with sensing, control, data processing, and networking features. Connecting these sensor nodes in networks enables the backbone for the Internet of Things and Big Data era.

Smart Sensors

Sensors' importance is constantly growing as a component of overall solutions for environment monitoring and assessment, eHealth (digital healthcare) and Internet of Things (IoT). Besides, there are plenty of appearing sensor applications to spread across large areas while retaining flexibility and comfortability. The sensor market will exceed trillion sensors per year soon. Therefore, for smart sensor development, the manufacturing should be low cost, high output and with short fabrication cycles [15].

Smart sensor is a device that samples signals taken from the physical environment and processes them with its built-in computing resources before passing them to a centralized sensor hub. Smart sensors are key integral elements of the IoT notion. One implementation of smart sensors is as components of wireless sensor networks (WSNs) whose nodes can number in thousands, each of which is connected with other sensors and with the centralized hubs.

Smart sensors have numerous applications including scientific, military, civil, and home applications.

Gas Sensors

Gas sensors are a class of chemical sensors. Gas sensors determine the concentration of gas in its neighborhood. Gas sensing systems are increasingly investigated for applications in environmental monitoring (air quality control, fire detection), automotive industry (fuel combustion monitoring and polluting gases of automobiles), industrial production (process control automation, detection of gases in mines, detection of gas leakages in power stations), medical applications (e.g., electronic noses, alcohol breath tests), boiler control, home safety, etc (49).

Different types of gas sensors exist such as optical, surface acoustic wave (SAW), electrochemical, capacitive, catalytic, and semiconductor gas sensors. Gas sensing methods can be split into two categories: based on variation of electrical properties and based on variation of other properties [5]. The electrical variation methods rely on the following substances as a sensing material: metal-oxide-semiconductor (MOS) stacks, polymers, moisture absorbing materials, and carbon nanotubes. MOS-based sensors are detecting gases via redox reactions between the target gas(es) and the oxide surface; the variation of the oxide surface is transformed into a change of the sensor's electrical resistance [8]. MOS based sensors have been widely utilized as they are low cost and have high sensitivity. However, some MOS sensors need high operating temperature, which restricts their application. The problem is solved by implementing microsensor components with microheaters produced by VLSI CMOS technology [2]. Another issue is the relatively lengthy time needed for the gas sensor to recover after each gas exposure, which is impractical for applications where gas concentration changes quickly. Studies of MOS nanodimension structures (e.g. nanowires and nanotubes) have shown that they could provide a solution to overcome these disadvantages (210)

Polymer-based sensors are detecting gases using a polymer layer that is changing its physical properties (mass, dielectric properties) upon gas absorption. Polymer sensors detect volatile organic compounds such as alcohols, formaldehyde, aromatic compounds or halogenated compounds. The detection process is occurring at room temperature (as opposed to MOS sensors). Polymer gas sensors possess benefits such as high sensitivities and short response times. Their shortcomings include lack of long-term stability, reversibility and reduced selectivity [26].

Carbon nanotube sensors overcome the problem of insufficient sensitivity at room temperature observed at MOS sensors. The properties of carbon nanotubes (CNTs) allow the development of high-sensitive gas sensors. CNT sensors demonstrate ppm-levels response for a range of gases at room temperature, which makes them perfect for low power applications. Their electrical properties carry high sensitivity to very small quantities of gases such as carbon dioxide, nitrogen, ammonia, oxide, and alcohol at room temperature (unlike MOS sensors, which should be heated by a supplementary heater in order to operate normally) [11]. CNTs could be categorized in two: single-walled carbon nanotubes (SWCNTs) and multiwall carbon nanotubes (MWCNTs). Single-walled CNTs are mainly used in RFID tag antennas for toxic gas detection (249) Multiwall CNTs have been employed for remote sensing of carbon dioxide (CO2), ammonia (NH3), and oxygen (O2) (334). To enhance selectivity and sensitivity of sensing, CNTs are often combined with other materials.

Moisture absorbing materials could be embedded with RFID tags for detection of moisture, because their dielectric constant might be altered by the water content in the environment. They can be used also as a substrate of the RFID tag antenna because the dielectric constant of moisture absorbing materials could be regulated by the moisture of the neighboring air. The tags enveloped by moisture absorbing material are appropriate for mass production and low cost (33).

The methods for gas sensing that are based on variation of non-electrical properties include optical, calorimetric, gas chromatograph, and acoustic sensing. Optical sensors rely on spectroscopy, which uses emission spectrometry and absorption. The principle of absorption spectrometry is based on absorption of the photons at specific gas wavelengths; the absorption depends on the concentration of photons. Infrared gas sensors operate on the principle of molecular absorption spectrometry; each gas has its own particular absorption properties to infrared radiation with different wavelengths. In general, optical sensors could attain better selectivity, sensitivity, and stability in comparison to non-optical methods. Still, their applications are limited due to their relatively high cost and the need for micro sizes (88).

Calorimetric sensors are solid-state devices. The sensitive elements consist of small ceramic “pellets” with varying resistance depending on the existence of target gases. They are detecting gases with a substantial variation of thermal conductivity with reference to the thermal conductivity of air (e.g. combustible gases).

Gas chromatograph is a classic analytical method with exceptional capabilities for separation as well as high selectivity and sensitivity (199). However, gas chromatograph sensors are expensive and their miniaturization still requires technology advancement.

Ultrasonic based acoustic sensors are principally classified as (1) ultrasonic, (2) attenuation, and (3) acoustic impedance. Best studied is the ultrasonic category, i.e. the measurement of sound speed. The major method for detection of sound velocity is to determine the time-of-flight that measures the travel time of ultrasonic waves at a known distance to calculate their speed of propagation. The measured gas speed is used for (1) identification of gases by determining gas properties such as gas concentration, which is related to the difference of sound propagation time, and for (2) determining the components or the molar weight of various gases in mixtures proceeding from thermodynamic considerations (13). Generally, ultrasonic sensors can overcome some shortcomings of gas sensors such as short lifetime and secondary pollution.

Attenuation is the energy loss due to thermal losses and scattering when an acoustic wave propagates through a medium. Each gas demonstrates particular attenuation, which is giving the means to determine target gases. Gas attenuation can be utilized together with sound velocity to find gas properties (210). However, the attenuation method is not so reliable as the method of sound speed because it is prone to the presence of particles and droplets or the turbulence in the gas.

Acoustic impedance is typically employed for assessment of gas density. Therefore, by the quantified acoustic impedance and speed of sound, the density of a gas could be found out. In any case, the quantification of the acoustic impedance of gases is remarkably troublesome, particularly in a process environment and consequently it is rarely used in practice.

Biochemical Sensors

Biochemical sensors can convert a biological or chemical amount into an electrical signal. The biosensor includes a receptor (usually a biocomponent such as analyte molecule which performs the actual molecular detection of the targeted element), chemically sensitive layer, transducer and electronic signal processor.

We may categorize biochemical sensors in several aspects. Considering the observed parameter, sensors can be categorized as chemical or biochemical, taking into account their structure they can be disposable, reversible, irreversible, or re-usable. With respect to their external form, they can be classified as planar or flow cells. Biochemical sensors intended for detection of electrical signal either directly sense the electric charges (amperometric sensors) or they sense the electric field induced by electric charges (potentiometric sensors) (346).

System-on-chip (SoC) biosensors are integrated on-chip and connected the active circuitry. SoC biosensors have numerous improvements with respect to sensors based on principles such as mechanical, optical and other methods. A major advantage is the ease of integration in CMOS integrated circuits that provides compact size, immunity to noise, potential to multiple detection of the biomolecules, etc. For cost-efficient commercialization of SoC sensors, it is crucial that all manufacturing processes are completely compatible with CMOS technologies (67).

Planar semiconductor (CMOS technology) devices can be used as the foundation for biological and chemical sensors where sensing can occur optically or electrically. Planar Field Effect Transistors (FETs) can be converted to chemically sensitive sensors by adjusting their gate oxide with membranes or molecular receptors to sense an analyte of interest. Fundamental rule of the molecular detecting is the selective attraction between the test molecules and the target molecules. As the target molecules have electrical charges in the electrolyte solution, the nearby channel conductance is affected by these electric charges via the field effect. The electric charges have dissimilar shape depending on the biochemical reactions associated with the particular detection. Interaction of a charged probe will result in accumulation or depletion of carriers within the transistor structure, which can be electrically detected by observing a direct variation in conductance or related electrical property (199).

Most of the electrical biosensor chips are based on CMOS and MEMS technology. MEMS systems are a combination of electronics and mechanical structures at a micro- and nanometer scale. The reason for using these technologies is the ease of integration onto a CMOS chip in which the electrical signals are processed. Typical applications include poly-silicon nanowire-based DNA or protein sensors, cantilever-based DNA sensors, pH sensors based on Ion-Sensitive-FET, glucose sensors, temperature sensors, etc.

Generally, the characteristics of a sensor include sensitivity, detection limit, and noise. The limit of detection is characterized as the minimum concentration of the target molecules to be detected by the sensor. Noise can originate from non-selective tying between the noise molecules and the test molecules because in practice, the noise molecules are significantly more in number than the target molecules so that the avoidance of the non-selective tying is crucial for biosensor operation [417]. Another class of biochemical sensors transduce the chemical tying into mechanical deformation. Chemical reactions provoke mechanical deformation adherent to the nature of nanotechnology, e.g. the ion channels in a cell membrane are proteins that control ionic permeability on lipid bilayer film and the activity of this protein is managed by the mechanical surface stress induced by chemical reaction (201).

One approach to utilize chemical-mechanical transformation is to use micro or nanometer scale cantilevers. Micro and nanocantilevers exhibit change of surface stress caused by a particular biomolecular interaction, for example, self-assembled monolayer arrangement, hybridization of DNA, cellular and antigen-antibody binding. These methods are barely accomplished into a compact gadget because of the massive optical detection equipment and poor selectivity performance (381).

Implementation of membrane technology is an alternative surface stress sensing mechanism. Polymer transducers with thin membrane are capable to exhibit of biomolecular sensing. The variation of adsorption quantity on the resonator is determined by detection of resonance frequency detection. Thin membrane transducers have a couple of valuable characteristics: (1) they are stronger and more solid than cantilever beams and they are very responsive to surface reaction, which allows easy functionalization by using mainstream printing techniques, and (2) the sensing surface is physically separated from the electrical detection surface, which is suitable for accurate low-noise measurements of capacitance (541).

In addition to the conventional field effect transistor CMOS technology, printed thin-film transistor (TFT) technology could be used for sensor development as well. In contrast to the silicon SMOS technology where MOSFETs are made on silicon substrate, TFTs could be fabricated on substrates such as plastic, glass, paper, etc. With printable TFT innovation, it is possible to incorporate an extensive variety of organic, inorganic, nanostructure functional materials for electronics, batteries, energy harvesting and sensor and display devices through coating or printing processes. This enables a new generation of low-cost, large-area flexible electronics generally unachievable with conventional silicon IC technologies. Nevertheless, there is an extensive trade-off in the device performance and integration density if using TFT technology compared to traditional Si-microelectronics (300).

Different selections of solution processable semiconductor materials are existing for TFTs: metal oxide, organic semiconductors, carbon nanotubes. The quick advances in materials widens the opportunities for manufacturing organic transistors and circuits using printing processes. Of all these, the organic semiconductors are distinguished for its mechanical flexibility, fast processing at low temperatures, and great potential for further performance improvement (378).
For practical sensor development, a hybrid integration of transducer circuits composed of printed transistors and a common read-out and signal processing chip might be employed. Various sensing materials together with an antenna can be incorporated into the transducer in the printing processes (77).

Wireless Sensor Networks

Current developments of Micro Electro Mechanical Systems (MEMS) technology and communications allowed for the advent of low-cost, low-power sensor nodes having multiple functions in a compact formfactor. They are the basis of wireless sensor networks.
Wireless Sensor Networks (WSNs) comprises huge number of sensor nodes (also called motes) that are spatially distributed autonomous devices that can accept input information from the connected sensor(s), process the information and transmit the output to other devices via a wireless network. WSNs were driven initially by military applications (e.g. battlefield surveillance), but now they are transformed in civil applications inspired by the IoT notion, such as home and building automation, traffic control, transport and logistics, industrial automation, environment monitoring, health monitoring, agricultural and animal monitoring, etc (90).

Nowadays, wireless sensor networks are allowing a level of integration between computers and the physical world that has been unthinkable before. Advances in microelectronics and communications industries have been a key enabler of the development of huge networks of sensors. Nevertheless, wireless connectivity of sensors might be considered an application facilitator rather than a feature of the sensors (511). This is due to the fact that wired sensor networks on the scale that is required would be too expensive to set up and maintain, which means they are unusable for applications such as monitoring of the environment, health, military, etc (592).

Typically, a WSN node contains one or more sensors attached, embedded microprocessor with limited computational ability and memory, transceiver unit, and power unit (83). These units allow each node to communicate with the network. Communication between the nodes is centralized – it can be a networking platform of dedicated servers or remote (cloud) servers. This network architecture corresponds to the core of the IoT, that is to provide immediate access to information at any time and any place.

The sensor is sampling the physical measure of interest into a signal that is processed by the subsequent microcontroller giving analogue to digital conversion as well as computational capability and storage. Next, the result is passed to the wireless transceiver unit for connecting to the network (51).

The sensor transducer converts physical quantities into electrical signals. Sensor output signals may be either digital or analogue which requires for the latter case to have an Analog to Digital Converter (ADC) included (either built-in or attached to the sensor) in order to digitalize the information to let the CPU to process it. The microprocessor unit consists of an embedded CPU and memory; the latter includes program memory, RAM and optionally non-volatile data memory. A distinctive characteristic of processors in motes is that they have several modes of operation – typically active, idle, and sleep. The purpose is to preserve power without obstructing the CPU operation when it is required. The transceiver unit allows the communication between the sensor nodes and the communication with a centralized hub. The WSN communication standards include Bluetooth, ZigBee, and 6LoWPAN but the use of infrared, ultrasound and inductive communication has also been studied. The power unit consists of an energy source for supplying power to the mote. The energy source is usually an electrochemical battery but an energy harvester can also be implemented to convert external energy (such as kinetic, wind, thermal, solar, electromagnetic energy) into electrical energy for recharging the battery; an external power generator may also be used for recharging (175).

Depending on the actual implementation, motes typically (1) realize data-logging, processing, and transmitting sensor information or (2) they are operating as a gateway in the wireless network composed of all the sensors that are sending data to a hub point. Sensor nodes are described by several parameters ranging from physical weight, size, and battery life to electrical characteristics for the embedded CPU and transceiver unit in the respective node architecture. The parameters being monitored by the motes' sensors include temperature, sound, vibration, light, pressure, pollutants, etc., which means different sensors, should be implemented: thermal, acoustic, vibration, optical, pressure, etc (235).

One approach for handling the data generated by the networks of sensors is to use a platform of dedicated servers for collecting and processing information originating from the sensors. Another approach is to rely on cloud computing service. Typically, general purpose IoT applications rely on cloud computing which inherently provides remote access via Internet (59).

The most popular communication standard is the IEEE 802.15.4 standard (ZigBee and 6LoWPAN). The protocol stack for WSN integrates power with routing aspects. It is composed of 5 layers (physical, data link, network, transport, application) and 3 planes (power management, mobility management, task management) to ensure reliable and power efficient data transmission through the wireless medium (15 and 99).

WSNs usually operate in various environments, which make them significantly different from other wireless networks such as cellular mobile networks or ad hoc networks, etc. In addition, WSNs normally have strict requirements for power, computation, and memory. All these constraints predetermine the cost of sensor devices and network topology and pose specific WSN design challenges. The most important design factors include reliability (fault tolerance), density of nodes (network size), network topology and scalability, power consumption, hardware specifications, quality of service, security of communications (30).

Foremost among all is the factor of security. Many WSNs are intended to collect sensitive data (e.g. personal health, confidential manufacturing data of a company, etc.). The wireless character of the sensor networks greatly complicates detecting and avoiding of snooping on the data. Best choice for ensuring WSN security is to implement hardware-based encryption rather than software encryption, which is advantageous in terms of speed and memory handling for network nodes (265)

RFID

Radio Frequency IDentification (RFID) is a notably evolving technology for automated identification based on near-field electromagnetic tagging. It is a wireless method for sending and receiving data for various identification applications. Compared to other identification systems (e.g. smart cards, biometrics, optical character recognition systems, barcode systems, etc.) RFID has many advantages since it is cost and power efficient, withstands severe physical environments, permits concurrent identification, and does not require line-of-sight (LoS) for communication. A RFID can turn common daily objects into mobile network nodes that might be followed and monitored, and can respond to action requests. All these perfectly fit the notion of Internet of Things.

A RFID system typically consists of 3 major components: (1) an application host, which provides the interface to encode and decode the ID data from data reader into a personal computer or a mainframe, (2) an RFID tag, which stores the identification information or code, and (3) a tag reader or tag integrator, which sends polling signals to an RFID transponder (transmitter-responder) or to a tag that should be identified (222).

A tag (analogous to a barcode) is a unique entity that can be attached to an object or a person and thereby enables information environments to remotely distinguish objects and individuals, track their position, detect their status, etc. The RFID tag is a microchip with programmed identification plus an antenna. The distance between the tag and the tag reader (in fact the reader is the base station) should be short enough so that the signal could be coupled. In reality, there is no true antenna because no far-field transmission is employed. The tag communicates with the tag reader by electromagnetic coupling via radio frequencies. Parts of the tag and parts of the reader are coupled together in a way that is analogous to the transformer windings (inductive coupling) or as opposing plates in a capacitor (capacitive coupling). Generally, the information acquired by the tag is further processed by a more complex computer equipment. In fact, the tag is a kind of low-level network, which enables the transmission of sensor data.

The principle of operation is so that the tag behaves as an electrical load on the tag reader. Hence, the tag can transfer information to the reader by altering its own impedance. The RFID tag changes the value of the impedance via an electronic chip that is effectively an active switch. In result, the tag is not required to create a transmitted signal, and the impedance switching sample is utilized to encode the data in the tag. At any random moment, a tag reader can just read one tag in its locality and a tag must be read by one tag reader (55).

Tags might be either active or passive. Active tags have a dedicated power supply (a battery). They possess extended processing functionalities and have some capabilities for pressure or temperature sensing. Active tags are characterized with an operating perimeter of hundred meters and a relatively lower error rate.

On the contrary, passive tags have a limited operating perimeter of up to several meters and they are characterized with a pretty high error rate. Passive tags are cheaper and that is why they are most common in the RFID marketplace. They have no physical power source as they are powered by the near-field coupling between the reader (the radio waves caused by the reader) and the RFID tag.

Passive tags have limited processing and communication capabilities but have no sensing capabilities for the information-carrying medium (181).

RFID technology has numerous applications such as tracking of assets and people, healthcare, agriculture, environment monitoring, etc. Many tracking RFID applications are based on the universal communication and computing technologies available (13, 90, 99 and 334).
A prospective area for development of applications is the integration of RFID systems and wireless sensor networks (WSNs). So far these are relatively separate areas of research and development. The combination of RFID and WSNs would open new scientific and industrial fields by utilizing the benefits of these technologies.

RFID systems are primarily used for identification of objects or tracking their location without delivering information about the object and its physical condition. In numerous applications the location or the identity of an object is not enough and extra information is needed – it can be extracted from other parameters characterizing the environmental conditions. Sensor networks could help in such cases. WSNs are systems consisting of small sensor nodes that can collect and deliver information by detecting environmental conditions, for example, temperature, humidity, light, sound, pressure, vibration, etc [38]. Nevertheless, the identity and location of an object is still vital information and it can be extracted by RFID techniques. In these situations, the ideal arrangement is to combine both technologies in order to ensure extended capabilities, portability, and scalability (413).

Sensors with integrated RFID tags can be classified in two categories: (1) tags communicating with RFID readers only and (2) tags communicating with each other and creating an ad hoc network (331). RFID systems can be combined with wireless sensor networks by integrating the sensor nodes with RFID readers (288). Another option for integration is the so-called mixed architecture where the sensor nodes and the RFID tags remain physically separate but they exist together and they operate separately in an integrated network. Accordingly, it is not necessary to design a separate hardware device in order to integrate the benefits of both technologies.

Movement monitors:

Caregiving from a distance comes with its own set of unique challenges. But you may find peace of mind and a helping hand thanks to new technology, like caregiver alert systems and elderly monitoring devices.

To help monitor elderly parents remotely, caregivers can invest in senior monitors with specialized sensors to become their eyes and ears. Elderly monitoring devices alert caregivers to potential health or safety issues from a few or thousands of miles away.

According to our intensive research, there are top five senior monitoring devices and we explain below how to find the right one for your loved one.

What do elderly monitoring systems do?

All devices are unique but generally track:
- Comfort
- Health
- Location
- Safety
- Wellness

Elderly monitoring systems collect a range of data like movement, temperature, behavioral and sleep patterns and more (28). The information provides caregivers and medical professionals with important insights into a senior's health and daily life.

Medical alert devices can be used at care homes, private homes or in a senior living community, depending on the community's regulations. Many include emergency buttons, or they use sensors to detect emergencies like fires or falls. Calls to the police or caregiver can usually be made directly or indirectly depending on the elderly monitoring system.

Fall Prevention Motion Sensor Alarms For The Elderly

Aging in place helps to improve the quality of life of seniors. But there is no doubt that it comes with its own set of challenges. In such a scenario, using technologies such as remote motion sensors that help in delivering care efficiently and affordably will help alleviate a lot of safety concerns. Motion sensors can be used in place of sensor pads and floor mats in settings where these additions might not be appropriate. When placed along the bedside, near chairs or doorways, it will immediately notify the caregiver when the resident tries to vacate the bed.
With the use of motion sensors, caregivers can attend to the needs of seniors even during the times when they are not present in their room. These sensors send a notification to caregivers when

residents attempt to get out of their beds, thus helping to reduce the possibility of falls and wandering.

Wireless motion sensors are great additions in a senior’s home because there is no danger of getting tangled in cords. The resident can enjoy a sound sleep without being disturbed by wires or alarms near his or her bedside. Moreover, caregivers can also attend to their other responsibilities at a distance, without having to worry about the senior’s safety.

Benefits Of Using Motion Sensor Alarms

Motion sensor alarms come with a number of wide-ranging advantages for both the resident as well as the caregiver. Here are some of them:

- **Motion sensors reduce the risk of nasty trips.**There is no possibility of tripping because of exposed wires as these devices are cordless. Unlike floor mats and sensor pads, these do not come in the way of the resident or the caregiver.

- **Wireless motion sensors also function as anti-wandering devices.**People living with Alzheimer’s often wake up confused and wander away.Motion sensors with remote alarms will help prevent such occurrences as the caregiver will be alerted as soon as they get up from the bed or pass the doorway. This entirely depends on the sensor’s placement in the room.

- **Motion sensors do not disturb the senior.**Wireless motion sensors with silent alarms don’t scare the seniors by abruptly sounding the alarm by their bedside. Instead, the alarm is activated away from the resident so that he or she is not startled. They can get the assistance they require without having to call for help every time.

- **Remote motion sensors enhance the senior’s sense of well-being.**Often, the senior’s sense of independence is threatened when there are a lot of visible supportive devices in the room, leading to frustration. In such cases, getting motion sensors might help because they are small, compact, and can be simply placed near the bedside.

- **Motion sensors with remote alarms help caregivers to attend to their duties without losing peace of mind.**This is an effective piece of equipment that can help in avoiding caregiver burnout. Most caregivers don’t get to sleep well at night when they offer palliative care to seniors. But with the addition of motion sensor alarms for the elderly, they won’t have to keep checking on the resident every 5 minutes but at the same time, they will be able to provide 24/7 support and care.

What’s more, motion sensors are user-friendly and easy to install as well. A number of them can be set up in a matter of minutes. If you need any help with choosing a motion sensor as per the needs and health condition of the patient, get in touch with us.

Bed And Chair Alarms For Fall Prevention

Kerr Medical's Bed and Chair Alarm packages below all feature "Long Term" Sensor Pads, meaning that the pads have the longest life expectancy and manufacturer warranty available, a period of one year from purchase. When selecting a system from any source, it is wise to read the product description to see what type of pad is included, *as many other vendors are selling systems with "Short Term" Sensor Pads with only 30 or 45 day life expectancies/warranties without clarifying that life expectancy*.

Being responsible for someone’s safety and health 24/7 can be mentally, emotionally, and physically tasking. However, primary caregivers are known to prioritize the needs of seniors and those who require supervision and supportive care. To make their lives easier and also to aid them in providing better assistance to seniors, Kerr Medical offers Bed and Chair Alarm packages that can alert them whenever seniors need help.

Investing in a bed and wheelchair alarms come with a host of benefits both for the caregiver as well as the senior. Let’s look at some of them:

Caregivers can deal with other responsibilities

Caring for someone who requires round the clock supervision can be daunting, especially when you have to do household chores, cook, and get groceries as well. So naturally, you might not be in their room at all times. Depending on the model of bed and chair alarm for seniors that you choose, it will immediately alert you f they get up from their bed or wheelchair. This is a huge advantage because you will be able to carry out your daily tasks without having to constantly keep an eye on the senior you’re looking after.

Helps prevent falls and slips

Seniors are prone to falling when they try to stand up after sitting or sleeping for a substantial amount of time because of weak muscles and bones. Also, individuals with dementia who have mobility issues might forget that they are unable to walk without support. As a caregiver, this issue must be one of your main concerns. With the help of the best bed alarms for the elderly, you will be able to prevent this as these have sensor pads that are activated as soon as the person gets up.

Stop them from wandering away

Most people who suffer from Alzheimer's disease get confused or scared when they are unable to recognize their surroundings. They might unintentionally wander away, outside the home or the assisted living facility. In such a scenario, patient chair alarms will emit a sound so that you are informed of their movement right away. To enhance their safety and to monitor their activity, invest in different types of alarms so that the worst does not happen.

Alerts caregivers when patients need to use the bathroom

Those living with dementia often forget that they need assistance to use the bathroom. If you are not in the vicinity, they might just try to get up from their wheelchair or bed to use the facility themselves. But this changes when you have bed alarms for dementia patients. You will be able to guide them and provide support as per their condition. Peace of mind and a good night's sleep is also assured because no longer will you have to stay up all night worried that the senior might need his or her help to use the bathroom.

Kerr Medical strives to make aging in place more comfortable for seniors as well as those who walk the extra mile to ensure that they are comfortable. Unlike other vendors who offer packages with sensor pads that fizzle out after 35-40 days, our Bed and Chair Alarm packages are designed to last and come with a one-year manufacturer warranty.

Caregiving Packages For Fall Prevention

Choose from Kerr Medical's wide range of caregiver packages that are designed to increase every caregiver's freedom while significantly enhancing the quality of life of seniors. These devices and products not only make assisted living facilities safer, but they are also perfect for those who prefer aging in place with the help of in-home caregivers.

With our fall prevention aids and emergency alert systems, help is always close by. We have a variety of items ranging from wireless bed alarms, floor mats, wheelchair alarms, motion sensors, and alarm pagers that are built to keep seniors out of harm's way. But that's not all. Most caregivers prioritize the well-being of elderly patients at the cost of their mental and physical health. In such scenarios, caregivers benefit immensely when they have supplementary devices to help supervise someone who is aged, suffers from ill health, has a disabling condition, or faces issues with memory.

Using medical alert systems is not only beneficial, but it is also necessary when one is caring for seniors requiring palliative care. As they might need help with routine, everyday tasks such as going to the bathroom, getting dressed, standing up from the wheelchair, and eating, caregivers have to be on their toes 24x7. Understandably, there might be times when the senior is in need of help but the caregiver is busy running errands. In such times, these devices will immediately alert them that they are needed.

Here are the other benefits of getting comprehensive caregiver packages and senior care devices:

1. Placing a smart caregiver floor mat near their bed will help the caregiver to relax as they know that if the senior wakes up at night, they will be informed
2. If the caregiver is looking after more than one senior, it will help them to attend to the needs of both better without losing peace of mind
3. Caretaking will not be interrupted when the caregiver is away in another room as these packages include caregiver call buttons with pagers that are meant for those seniors who know when to call for help. These devices have a range of 150 feet and send signals to the pager in the caregiver’s possession upon being pressed
4. Smart caregiver bed alarm and sensor pads help to prevent falls and slips that might have life-threatening repercussions. Such devices sense movement the moment the patient tries to get up. Subsequently, it sends an alarm to the caregiver that does not disturb others in the home
5. Smart caregiver wireless bed alarms also function as anti-wandering devices. These are extremely important in homes that have seniors with Alzheimer’s disease. They might not know whom to ask for help and wander away unintentionally after waking up from sleep. Having such sensors in place will ensure that the senior’s movements do not have to be severely restricted within the home for their own safety

All of these emergency alarm systems are also non-invasive in nature, meaning that they are not attached to the patient in any way. The senior will definitely sleep better without having monitoring devices poking him or her all the time

Pressure sensing bed pads for elderly loved ones and patients are so much more than just products. When manufactured to the highest standards of quality, pressure sensing bed pads being used in conjunction with alarm units for seniors can make all the difference to both a patient's and a caregiver's daily quality of life - offering comfort and fall prevention to the senior, and reliable safety monitoring and peace of mind to the caregiver.

As a leading provider of home care and nursing home products at reasonable prices, Kerr Medical has sought out the highest quality pressure sensor bed pads for seniors, including easy to use corded systems, cordless systems and wireless systems. These pressure sensing bed pads for elderly users are compatible with alarms that can signal to a caregiver if the patient is trying to get out of bed. Choose the system that is best for your needs; alarms can sound alongside the patient or only in the caregiver's room to avoid startling the patient.

Pull string alarms are an economical alternative to other styles of monitoring systems. Attach a clip to a garment worn by the patient, and then hang the pull string on the back of the chair. When the patient leans forward to rise, the magnet is pulled from the monitor and the alarm will sound to alert the caregiver!

These cordless/wireless devices can help you monitor your patient without frustrating cords that can break or get tangled! Our cordless/wireless products also allow you to place an Alarm unit away from your patient, in another area, so that you can hear the alarm while they are not disturbed by the noise!

Best Bed Sensors for Elderly

When you or your loved ones reach a certain stage in life or health, the fear of falls gets more and more real. As we age, it is likely that our bodies will become weaker and more fragile. A fall can lead to bruises, soreness, and even broken bones. Bed sensors are a great way to detect the movement of someone while they are in their bed, so you can be available to help them should the need arise. Read on to discover a few of the best options for these products.

Monitoring seniors without the help of automated technology can be very demanding given that they need very close supervision throughout. You hardly ever settle down to rest unless they are asleep. And while they are asleep, you would still need to be on the alert lest they wake up to answer the call of nature and trip as they make their way to the washroom. If you have managed close monitoring, you are not far from burn out.

Manually turning and positioning a bedridden or immobile patient can be a whole lot of struggle for any caregiver. Most complain of backache and fatigue after doing it a couple of times and some have even been injured while assisting their loved ones. This is why it is a must for one to consider getting a patient turning aid. Patient turning devices are assistive devices that help caregivers turn their patients with ease making it a comfortable experience for both the patient and the caregiver. They can also be used to transfer a patient from one surface to another.

Advantages of using a patient turning device

The topmost advantage of a turning device is that it allows the caregiver to turn an immobile patient without needing the assistance of a second person. This is very practical for every family as they often cannot afford to have more than one caregiver attending to one patient. With a turning device, they can easily turn their patients when cleaning them, changing, feeding them or positioning them

during toileting. The second advantage is that it requires minimal training and so anyone can use it. Most of the devices come with a manual but even without, learning how to use it is pretty straightforward. You can even watch video tutorials on Youtube if you are unsure.
Thirdly, it reduces any risks of causing strain or injury to the caregiver from constantly turning the patient. You don't need to lift or carry the whole weight of the patient when positioning them or turning, you just turn the patient using the straps of the device. The patient is also not at risk of skin friction from manual positioning. Lastly, it is affordable, portable and space-efficient. Just about every reason to get a turning device. It is also very easy to set up and use and you can readily find one on Amazon among other places. A turning device can be used along with other assistive devices both at home and in the hospital. It can be used along with urination devices, incontinence liners or bedpans among others.

Falling is among the most serious clinical problems faced by older adults, occurring in 19% to 49% of the elderly population. Falls can have major consequences, such as fractures and other injuries and have a negative impact on social and psychological well-being. Moreover, mortality is increased in individuals with falls. Parkinson's disease (PD) is a prime example of a progressive neurological condition where falls are common,presumably because many risk factors coincide in this disorder. Specifically, persons with PD have both balance and gait deficits (including freezing episodes) and commonly also cognitive deficits. Epidemiological studies and evaluations of novel interventions are difficult to design because fall detection in daily life is difficult. The typical methodology for capturing real-life fall events is the use of diaries. However, diaries have poor reliability, and compliance is suboptimal. Consequently, the outcomes usually correlate poorly with real-life behavior. Modern technology offers new possibilities to overcome those limitations, for example, by using body-worn wearable sensors. Such sensors can potentially detect falls automatically, quantitatively, and, importantly, continuously in the patient's own environment, thus providing an attractive alternative to self-reported burdensome and unreliable diaries. Some promising examples of the use of wearable sensors to quantify fall events in controlled settings and free-living environments were reported in PD. Moreover, sensors can be used together with a personal emergency response system built into the sensor box, thus providing patients with rapid access to emergency assistance, if needed, for example, when they experience difficulty rising after a fall.

Care Call Carbon Monoxide Detector

The Care Call Carbon Monoxide Detector is a compact, battery powered CO monitor that can alert the Care Call Pager or SignWave when dangerous levels of Carbon Monoxide are detected.

Carbon Monoxide (CO) is a colourless, tasteless and odourless gas that can cause harmful and potentially fatal effects. A carbon monoxide (CO) alarm should be fitted in any home that contains a fuel burning appliance, like a boiler, and tested regularly to ensure that it is working. Caring for a patient of a loved one is a full time job, and it can easily feel like the home you once felt safe in is now full of danger. A slippery floor could lead to falls, an open door is a massive risk for those prone to wandering, the stairs during the night can lead to any number of injuries, even an unlocked window could be a serious threat. Carbon Monoxide, however, is a threat to everyone present in your home and being aware of the levels present is paramount to your safety. Whether you are caring for one individual or work in a care environment, it can seem like you simply don't have enough eyes to make sure you are keeping your patient safe at all times, especially when it comes to a chemical you can't even see! Care Call's system means that 24/7 care is as simple as a pager small enough to fit in the palm of your hand, or even smaller monitors discreetly and easily installed around your home.

When activated, the alarm sends a signal to the Pager or SignWave to alert the user. The alarm will also sound a horn and the red indicator will flash at different speeds to indicate the presence of different levels of CO gas (slow flashes indicate low levels & rapid flashes indicate high levels).

Care Call, Wherever You Need It, Whenever You Need It

Care Call offers an incredible range of care alarms and has been doing so for the past 10 years. Don't let the simple, discreet design of their Signwave mislead you, its great many applications and range of up to 1000 metres in open air means Care Call is a leading name in care Signwave technology.

With DIY installation and setup the Care Call system fills the gap between expensive entry level border alarms and nurse call station systems. The Signwave is easily held and emits a high volume alert as well as an LED strobe so carers are alerted when patients or loved ones require assistance.

Ideal for the care of people with:

- Alzheimer's
- Mobility Problems
- A tendency to fall
- A tendency to wander or sleepwalk

How Do I Change the Batteries?

When the batteries are low, it's important that you replace them as soon as possible to ensure that your detector continues to work. The detector takes 3 x AA batteries, and the user guide in the PDF below explains how to change them.

Epileptic bed seizure detection alarm for care homes

The Medpage MP2v2+ uses a patented movement sensor, which is positioned under the patient's mattress (including airflow and memory foam types) roughly at a shoulder height position. The monitor is powered by a mains AC adaptor and has a 100 + hour battery backup in case of mains power failure or interruption. The sensor has a sensitivity and body movement control to allow for adjustment for patient body weight and bed mattress type.

Bedside Sensor Controller

■Suitable for Tonic/Clonic complex seizures, Myoclonic, seizure types.
■Quick and easy to set up (less that 60 seconds) and use
■Suitable for use on all bed types and mattresses including airflow and memory foam
■Full fault and status reporting to pagers
■Can integrate with other Medpage care sensors (see P32.)
■Silent alarm at patient bedside.
■CE marked in accordance with Medical Directive EEC 93/42/EEC as amended by 2007/47/EC.
■Sensor dimensions 300mm x 200mm x 10mm. Interconnecting lead 3M
■Monitor dimensions: 150mm x 105mm x 45mm.
■Monitor transmitter range 400M (line of sight).
■For multiple patient monitoring at home, hospital or care home to identify seizures in progress
■Tamper proof settings, monitored connections, fault reporting to pagers.
■3 Year warranty.
■No maintenance or servicing required.
Name of product
Type of seizures it may detect and who it's for
What it monitors
How it alerts people

Embrace 2 epilepsy sensor
Tonic-clonic
Adults and children
Movement and changes in temperature and certain properties of the skin including sweat, related to tonic-clonic seizures
Not restricted to home

App sends text message to mobile phone

Stores data

Also gives GPS

Brio epilepsy monitor

Sleep seizures

Changes in heart rate

Home use

Sends information to your phone (must be bluetooth compatible) Stores data

Pulseguard MK-11

Worn during sleep. Suitable for aged 6 months and above

Measures change in heart rate

Sends alert to pager within house

Epi-care wrist worn sensor Standard

Tonic-clonic seizures

Aged 10 plus

Movement

Sends alert to pager within house

Can be linked to careline

Epi-care mobile wrist worn sensor mobile

Tonic-clonic seizures

Aged 10 plus

Movement

Not restricted to home

Sends alert to android phone via bluetooth

Includes GPS

Stores data

Medpage Ultra Sensitive Children's Epileptic Seizure Movement Detector Alarm MP5-UT
(1)

- Alarm monitor to detect epileptic seizures in bed
- Ideal for all ages– babies through to adults
- Alarm delay to eliminate false alarms due to normal movements
- Sends an alert to parents and carers via two included radio pagers

Emfit Epilepsy Tonic Clonic Seizure Monitor with Bed Sensor Mat
(1)

- Detects when a Tonic-Clonic Seizure is taking place
- Sounds an alarm when a seizure is detected to alert a carer
- Can be used as a bed leaving monitor device as well
- Adjustable volume on the control unit for ease of use

Alert-iT Wired Companion Seizure Monitor with Enuresis Detection System

- Advanced epileptic seizure monitor
- Movement sensor distinguishes between seizures and normal bed movements
- Additional moisture sensor for detecting seizures indicated by vomiting or incontinence

- Wired system - requires the use of a nurse call lead

Emfit Epilepsy Tonic Clonic Seizure Monitor with Bed Sensor Mat and Vibrating Pillow Pad

- Detects when a Tonic-Clonic Seizure is taking place
- Sounds an alarm when a seizure is detected to alert a carer
- Can be used as a bed leaving monitor device as well
- Alerts a deaf carer through vibrations

Wireless Care Alarm Kit with Large Bed Leaving Sensor Mat

When caring for elderly or infirm individuals, there is a very real danger of falls when they get up from a bed. Falls can cause serious injuries, so it's vital that you can do everything in your power to reduce the risk of falls occurring.

This full Wireless Alarm Kit with Bed Sensor Mat includes a bed sensor mat, transmitter and pager (receiver). It's a bed leaving alarm ideal for monitoring an elderly patient prone to, or at risk of leaving their bed unattended. This helps you ensure that the risk of falls is as minimal as possible.

Easy to Set-Up

The wireless alarm kit is easy to set up straight out of the box. Simply place the sensor mat on a bed you wish to monitor, plug the cable from the mat into the transmitter box and turn the transmitter and pager on. You instantly have a bed monitor sensor mat with a wireless pager to alert you if a person gets up out of their bed.

Instant Alert

When the sensor mat is triggered, the transmitter sends a signal to the pager, which will instantly alert you. The pager can be set to utilise sound, light and vibration to ensure that you get the alert. This enables you to quickly rush to the aid of those who need it, reducing the risk of falls and helping you provide a more streamlined level of care.

Versatile Sensor Mat

The included bed sensor mat can be switched to alert when pressure is removed from the pad (when a person gets up out of their bed) or when pressure is applied to the pad (for instance if placed under a door mat, and this is walked on). This gives you an incredible level of versatility of use, helping you provide the best level of care possible. The bed sensor mat is suitable for most beds.

Specifications of the Wireless Care Alarm Kit with Large Bed Leaving Sensor Mat

The specifications of the Wireless Care Alarm Kit with Large Bed Leaving Sensor Mat are:

- Transmitter power: 2 x AAA batteries (not included)
- Pager power: rechargeable battery charged by charging dock (included)
- Pager and transmitter dimensions:
- Height: 9.5cm
- Width: 6.2cm
- Depth: 1.7cm
- Bed sensor mat dimensions:
- Length: 75cm
- Width: 25cm
- Max range: 30 metres

Care and Maintenance of the Large Bed Sensor Mat

- Do not fold or bend the mat and store flat
- Do not immerse the mat in any liquid/solution
- Wipe clean only with a non-caustic sanitising solution
- The mat should be cleaned before use and regularly during use
- To minimise the risk of infection, single patient use is recommended

Epilepsy Sensor

Epilepsy sensors are used to monitor people with epilepsy while they sleep. Patented sensor technology detects a person’s movement in bed and is able to differentiate normal movements from epileptic seizures enabling tonic clonic seizures to be detected the moment they occur, ensuring carers can respond quickly if they are needed, but otherwise do not disturb the user’s sleep.

Epilepsy sensors can be used in individual homes or assisted living environments. They are portable and simple to use, supporting carers and protecting users.

Features

- Patented sensor technology - reduces number of false calls
- Sensitivity adjustment - enables the adjustment of the sensor to the individual's

Requirements

- Transmission to Class One receiver ensuring alarms are reliably received
- Automatic radio trigger low battery warning - ensures optimum operation

Benefits

- Unobtrusive - minimises user disruption
- Plug and play registration - eases programming
- Compatible with Lifeline home units and other Tunstall telecare enabled systems
- Operates on the dedicated social alarm frequency - for reliable future proof operation

Literature review: Telecare & telemonitoring

Introduction

The average life expectancy in 2017 was 72 years; as an ongoing trend, we can assume that it will continue to rise worldwide. If a person is born in 2060-2065, he or she will live an average of 78.85 years (United Nations 2017). Due to this higher life expectancy, the proportion of senior citizens is increasing; this will be a challenge for relatives, carers and also for society as a whole: a decrease in the ratio of potential carers and supporters, and an increasing prevalence of chronic diseases (Jaana, Sherrard & Paré 2018; Alleman & Poli 2020; Noel & Ellison 2020; Vandeweerd et al. 2020), as well as the accordingly increased need for care creates a social, societal and economic burden. In this regard, solutions that are suitable for the home are particularly welcome. A such, the demographic development is one of the key drivers for the development of technical solutions supporting care and independent living (Alleman & Poli 2020; Morley 2016; Norris, Stockdale & Sharma 2009; Pecina et al. 2012).

There are different ways in which older adults receive care today: through care institutions/homes where they receive full inpatient care, or in their own home, either through support via outpatient care services or relatives. Regardless of how care is provided for older adults, it is clear that their carers will need more support in the future.

As mentioned by Lindberg et al. (2019) in their call for "Inclusive innovation in telehealth", digital technologies promise great opportunities to overcome existing problems and challenges in the care sector, such as a shortage of skilled workers and, simultaneously, an increasing demand for long-term care owing to demographic change.

The WHO mentioned already in 2011 Artificial intelligence (AI), together with Information and Communication Technologies (ICT) and Internet of Things (IoT), as one of the possible solutions to meet this challenge (World Health Organization 2011). ICT tools can be used to access a wide variety of technological solutions for communication – from gathering and monitoring data, to text messaging, diagnosis and treatment at distances, and retrieving electronic health records. Interest has primarily focused on the use of ICT tools in the healthcare sector and for the treatment of severely chronically ill people, since it enables the interaction between patients and health service providers or peer-to-peer communication between patients and/or health professionals (Lindberg et al. 2013). In a Smart Home setting, such technologies allow ageing in place, as desired by the majority of older people (VandeWeerd et al. 2020).

However, while the additional support of ICT in healthcare has been researched and applied for some time, it is still in its infancy in care for the elderly. In recent years, however, it has been driven by several factors. Here, Barnett and Livingston listed three intersected meta influences: the rapid development of new technologies in this field, the constantly growing older population and the desire by politics to reform the care sector (Barnett & Livingston 2019).

As a further driver of this development, a recent phenomenon in particular has also been mentioned in the literature: telemedicine adoption has rapidly accelerated since the onset of the COVID-19 pandemic. Telemedicine[1] in general provides improved access to health care while minimising the risk of infection through personal contact. This is especially important for older people as they are particularly vulnerable (Hare & Bansal 2020). Accordingly, there is a lot of recent literature to be found on the effects of this pandemic and its influence on telemedicine, telemonitoring and ICT in the care sector.

Within the field of ICT, telehealth, especially in form of remote patient telemonitoring (or 'mhealth'), can enhance surveillance of chronic conditions, and improve quality of and access to care. Telemonitoring as such is defined as the use of ICT to monitor healthy individuals or chronically ill patients remotely. Patients are equipped with devices to measure vital signs data (e.g., weight, blood pressure, heart rate), which are able to transmit this data directly to a medical caregiver. This can be the family doctor, a specialist or a telemedical centre. In the event of life-threatening conditions, the doctor can be automatically alerted so that life-saving help can be arranged under certain circumstances. In addition, there may be a communication device in telemonitoring for the patient, such as a specially equipped mobile phone or a Personal Digital Assistant. Therefore, it enables care providers to determine health-related status virtually, and outside of clinical settings – in people's homes or whatever location they happen to be visiting (Wang, Car & Zuckerman 2020).

Telemonitoring via sensors is generally considered as not intrusive (Barnett & Livingston), and can allow older adults to live independently while providing their supporters with peace of mind regarding their safety. Therefore, it is seen as one of the most expedient answers to the strong need for preventive care imposed by the rapidly aging society (Barnett & Livingston 2019). The following main part will outline the technical structure of telemonitoring and the advantages and barriers found.

Background and Methodology

To answer crucial questions and address the project's objectives on ICT in care homes, with focus on telemonitoring for older adults, SYNYO carried out a systematic review of the scientific literature. We identified assessment studies of telemedicine that reported patient outcomes, administrative changes or economic assessments and evaluated the quality of that literature.

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[1] Telemedicine is a generic term and refers to all efforts to provide medical care using communication and information technologies. The critical factor is the physical distance between the parties involved. Telemonitoring is considered a subcategory of this.

A systematic electronic search for articles published between 2015 and early 2020 was carried out, using the databases Scopus, SAGE, Web of Science, and Pub Med. A total of 98 scientific articles were identified using the search terms “telemonitoring”, “care”, “ICT” and “care home” respectively and in combination. Further articles were identified by consulting reference lists of published review articles.

Based on a review of the abstracts, the full-text articles were obtained for closer inspection. Of these, 56 described the general use of ICT und telemonitoring in healthcare. They did not focus on older adults, nor did they exclude them from their research. The remaining 42 articles focused on telemonitoring for older adults in various care scenarios.

79 of the articles assessed at least some positive clinical results regarding the use of telemedicine; 2 specifically focussed on barriers and problems of telemedicine, the remaining 8 were mainly economic analyses. At least seven of the available articles referred specifically to pilot projects and their short-term outcomes, and therefore could not give any results concerning a long-term study. The departments considered covered almost all areas of healthcare. As shown in the Figure below, about 17% of the articles focused on telemedicine and telemonitoring itself; 11% were dedicated to care and about 10% each on ageing and COVID-19. “Specific disease” refers to studies that dealt with concrete diseases (like diabetes or heart disease), "other" includes all other keywords that did not fit into the mentioned groups.

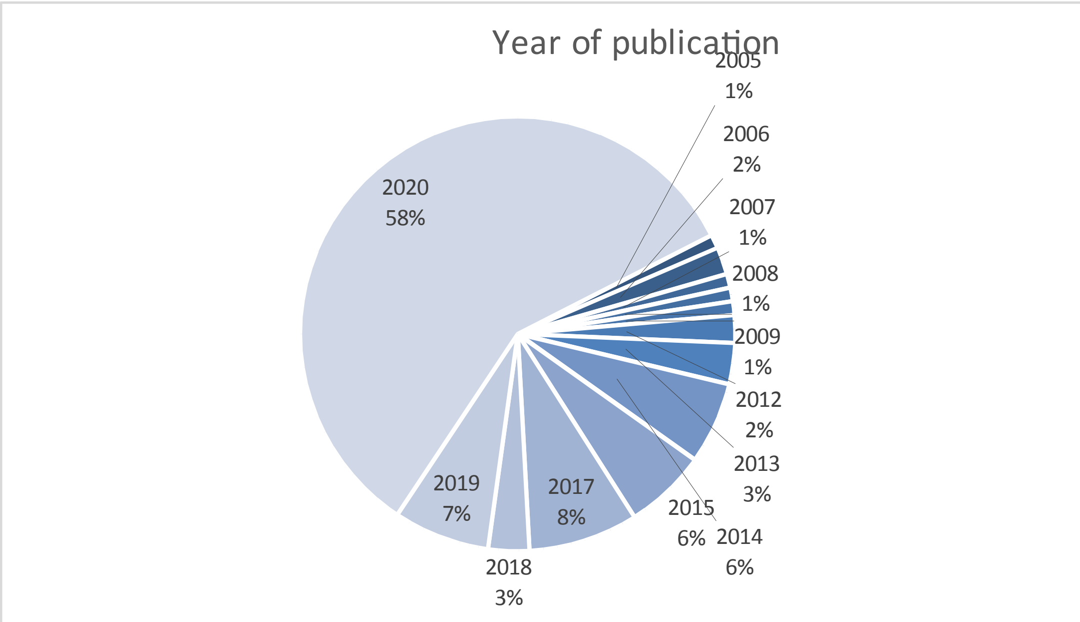


Figure 1. Distribution of keywords among the analysed articles

Although a positive result was generally assumed (70 of 98 articles) for the use of telehealth and telemonitoring in the care sector, most articles (66) indicated that further research and more studies are required to obtain a clear result in the long term.

As mentioned above, COVID-19 has been identified as one of the drivers in the development of telemedicine and telemonitoring. Indeed, our literature review shows a steady increase of publications on the topic, with the majority of publications (56%) published in 2020.

Telemonitoring in care (homes)

For ICT in the care sector, as well as in health care, a range of technical aspects and equipment is used. In this context, it is necessary to mention how the various devices and techniques work and what they are used for. Depending on the clinical picture, type of care or goal, these can vary considerably in detail, so only the basics will be outlined here.

Telehealth in general promises reduced adverse health outcomes, care coordination needs, and may even reduce risk of long-term hospitalization or institutionalization as long-term monitoring and consultation can be provided from home (Noel & Ellison 2020; Morley 2016). In general, telemonitoring should make it possible to simplify the patient's life by living as independently as possible. However, this requires a lot of data processing and computing power. As the number of patient data increases, proper management and analysis of this data by IoT devices is helpful to both doctors and the healthcare industry.

Telemonitoring: Technical aspects

Telemonitoring describes in general terms the remote examination, diagnosis and monitoring of the patient. However, the boundaries to other areas of ICT are quite fluid, since data storage, processing and presentation also play an important role. In this regard, different types of technology must be combined into a reasonable architecture in order to process and use it in a meaningful way. Depending on the desired data and approach, various types of technology may be required (Hilbert & Hindricks 2020). Questions of interoperability are, thus, crucial, and one of the barriers in successful implementation (Filipova 2015). The following aspects were named in literature.

Sensor and measurement technologies are usually at the beginning of the information transmission chain: they can be divided into permanently installed devices in the patient's environment and so-called ’wearables’, i.e. sensors that monitor vital data and are worn directly on the body. They are indispensable for case prevention or detection, for example. This can also be combined with more common devices such as smart watches or mobile phones. **Augmented reality** and **virtual reality** are possible additions, but still underrepresented. They can be used as support, for example, when it comes to training: both physical and mental health can be trained comfortably from home, while vital statistics are measured (Hilbert & Hindricks 2020).

Collected data is forwarded to various external **digital nodes** and IoT **telemonitoring platforms**, which gather and process the data. This is done wirelessly and can be connected via the cloud (El

Attaoui & Largo 2021). Artificial intelligence is a necessary part of the system, as the mass of data can hardly be handled by traditional processing tools. As especially different technologies, like digital health data have to be combined with read-out behaviour patterns, this is absolutely necessary to achieve a fast and intuitive result. However, in this context it should be mentioned that AI is defined by algorithms written and shaped by humans. They are therefore seldom free of biases, which can be a problem in the field of age management (Hajkowicz & Dawson 2018).

In addition, regarding data privacy and security, the further development of **blockchain components** to guarantee data security is currently underway. This enables rapid data exchange without the need for an intermediary and therefore has the potential to revolutionise the sharing and management of health data (Barnett & Livingston 2019). In this matter, Sixsmith & Hine (2007) listed five preferred key characteristics for the selection of sensors:

- *Unobtrusiveness*: Sensors should not impinge on the privacy of patient; as an example, the use of cameras and microphones should be avoided.
- *Passiveness*: Sensors should not be dependent on the person, for example, wearing devices or tags.
- *Cost-effectiveness*: The system should be a generally affordable solution within the very price-sensitive care market.
- *Reliability*: Minimal maintenance should be required, while being usable in the everyday home environment.
- *Low powered*: By reducing the power requirements of a sensor they can be run from batteries which will also lower any ongoing maintenance costs.

General advantages

Telehealth has one big disadvantage: implementing the technical measures of telehealth is time-consuming and initially costly, which a lack of financial incentives or affordable and effective technology (Filipova 2015). Training of nurses and staff is also usually required to ensure smooth and supportive monitoring. Nevertheless, changing the practice of medicine, as Noel & Ellison (2020) describe, can bring several advantages at once, including a reduction of adverse health out-comes, care coordination needs, and even risks for long-term hospitalisation; as well as an increase of safety (see e.g., Janowski, Schnijahn & Wahl 2017). Despite the initial costs, telehealth interventions are found to be cost-effective, as well as fast and useful (Kavradim, Özer & Boz 2019).

ICT use cases in general, and telemonitoring in particular, can already be found in virtually every area of the health sector. In the reviewed literature, however, its application was found in concrete terms in connection with the following disciplines: Dentistry (Ghai 2020), Orthopaedic surgery (Pasipanodya 2020), Cardiology (Yanicelli 2020; Turan 2019; El Fezazi 2020), Respiratory medicine (O'Donnell 2020; Vitacca & Comini 2019), Sports medicine (El Fezazi 2020; Jaly & Iyengar 2020), Ophthalmology (Walker & Kopp 2017), Oncology (Nimako & Lu 2013), Multimorbidity (Lang et al. 2019), Neurology (Furlanis & Ajčević 2020), Psychiatry (Stip & Rialle 2005), Gynaecology (Pal, Aniket & Nadiger 2020; Jongsma & van den Heuvel 2020), Geriatrics (van Doorn-van Atten & de Groot 2019; Lunardini & Borghese 2020), and Internal medicine (Dourado & Magno 2020). These disciplines are reported particularly suitable for telemonitoring in the reviewed literature.

As Noel & Ellison mentioned, telemedicine is especially beneficial where the following factors play a major role: a) chronic illnesses that require ongoing monitoring, b) repetitive follow-up examinations after treatment (often post-operative), c) conditions where it is necessary to check whether a deterioration occurs and further measures have to be taken. Especially the post-operative control or post-treatment after an inpatient hospital stay is central (Noel & Ellison 2020). In addition, exceptional situations where patients have reduced mobility can be named. This was especially the case during the COVID-19 pandemic, but there are also other examples in the literature (such as management during wildfires and earthquakes) that refer to general exceptional situations in necessary isolation (Nogueira 2020).

Especially for older people, all of the factors mentioned above are relevant, even if they are not exclusively related to them in the literature. The scenarios mentioned will be explained in more detail below using concrete examples.

Periodic check – nutritional intake

Nutrition plays an important role in healthy ageing and resilience in later years. Nevertheless, studies show that 31-38% of all seniors are at risk of becoming undernourished, while 5-8% of seniors are already undernourished. Similar figures are also found among residents of care homes. This shows how underestimated the problem really is. In this sense, telemonitoring is proposed as a valid tool for convenient and continuous monitoring of nutritional values. As an example, Van Doorn and de Groot (2019) were able to show, that nutritional intake combined with telemonitoring was a feasible answer to chronic undernutrition.

Chronic disease management – self monitoring

About 56 million people in Europe live with diabetes; the number of senior citizens with diabetes is steadily increasing, the majority of them suffering from type 2 (Daikeler 2015). For the patients, this disease requires constant monitoring to keep the blood sugar at the right level. Improper management of the disease can lead to hyperglycemia, microvascular complications, and heart disease, but also psychological distress. In this regard, a recent study concluded, that diabetes self-management behaviours, physical functioning, and psychological distress were significantly improved when paired with automated telemonitoring (Aikens & Rosland (2015).

Limited healthcare access during isolation

Disasters (natural, man-made, as well as the corona pandemic) have made the situation difficult for people who need treatment. Individuals with disabilities restricting mobility are particularly challenged in such a situation, as they have little or no access to local health services – they must be presented alternatives. As Pasipandoya & Shem (2020) describe, telemedicine has already been effectively used to mitigate the impact of such disasters: it enables healthcare visits when in-person visits would be otherwise inconvenient. Not only does it help with physical care, but also mentally, as affected patients usually experience psychological problems in their isolation.

Independent supported living

Since care is not only about physical but also social and mental well-being, the support of an independent lifestyle in old age is another important aspect. Studies have shown that smart applications make life at home easier, safer and more self-determined and can therefore also contribute to the well-being of older people (see e.g., Sundgren, Stolt & Suhonen 2019). Some technologies have been developed specifically for this purpose: sensors can measure and report a fall, voice controlled smart applications can receive commands and virtual reality can provide inhabitants with a comfortable workout, while the vital data can be measured and forwarded to medical specialists. In this way, independent living and health can be guaranteed at the same time (Barnett & Livingston 2019). Studies have also shown that telemonitoring can improve patients' confidence in their ability to evaluate their symptoms, to address them, and evaluate the effectiveness of measures taken to address these symptoms (Jaana, Sherrard & Paré 2018). However, in terms of autonomy, technology has been assessed as both a restricting and enhancing factor; it is part of an ethical debate between the poles of paternalism and the rights of older people (Sundgren, Stolt & Suhonen 2019).

In general, care combined with ICT, AI and IoT will not be able to replace the holistic care of senior citizens, but these technologies are ideally suited for supporting and complementary measures. As already mentioned, their flexibility makes it possible to create a comprehensive control situation, which can also take place independently of an outpatient or inpatient visit (El Attaoui & Largo 2021). Telehealth also plays an important role in maintaining regular and continuous communication between doctor or caregiver and patient/care receiver, and can also be applied for monitoring, training and consulting (Kavradim, Özer & Boz 2019).

Overall, the following advantages of telemonitoring were mentioned by El Attaoui & Largo 2021:

- **Reduction of the movement** of the patient to different places (like hospital, examination station, laboratory), since health data can be supervised comfortably from distance.
- **Faster results** to the doctor or hospital as well as feedback on the condition in real time. This also enables a quicker response, if necessary.
- **Immediate alert** in case of rapid change or deterioration of vital data, as well as in case of a reported accident (like a fall).
- **Lower costs** for patients who are spared the commute as well as the medical personal that receives the results already evaluated.
- **Lower risk of infection** or disease transmission for the patient as there is no need to visit a potential hotspot like a hospital.
- **Storage and combination** of data happens automatic and allows an understandable comprehensive view.
- **Reduced workload** on the part of the control centres, as the data is automatically collected for each model and only relevant information is passed on.

In general, experience with the implementation of ICT in the care sector has been very positive, but it was regularly noted that further studies were needed to gain a clearer picture. In addition, some concerns that prevent the full implementation of ICT in the care sector were also mentioned.

Concerns and challenges

Apart from the advantages listed, there are also barriers to the implementation as well as possible disadvantages of the technological aspect, which are repeatedly mentioned in literature. Depending on the specific area they concern, the use of ICT in care can pose different problems – however, four key areas were to be identified by Barnett & Livingston (2019):

- Data protection and privacy (see also Sundgren, Stolt & Suhonen 2019);
- Consumer acceptance;
- Usability (and user-friendliness, see also Jonker et al. 2020);
- Lack of policy and planning regarding the adoption.

These concerns are often linked; one of the main obstacles is **user acceptance**: when doubts arise that general data protection is not respected, people are less willing to trust the new aid. Trust in ICT as an aid is particularly low when people are less familiar with new technologies in general, which is more often the case with older people (Lunardini & Borghese 2020). User acceptance is also connected to a fear of losing human contact; and a fear (of both categivers and older people) of transforming their relationship from genuine to superficial (Sundgren, Stolt & Suhonen 2019). The acceptance of health care providers is another issue; it has been mentioned as one of the key barriers to telemedicine's implementation (Pecina et al. 2012).

Data protection, privacy and data security as such is a concrete issue for many to use digital solutions: while there exists a legal base for processing of personal data in telemedicine in which the extent to which data is used and processed is also precisely regulated, many users do not seem to know whether the handling of data is trustworthy (Gusarova 2012). Both older people and healthcare professionals voiced concerns about invasive monitoring technologies (Sundgren, Stolt & Suhonen 2019); monitoring is experienced as both constraining and enabling (Essén 2008).

A further obstacle to implementation was that participants in the studies simply showed **too little interest** in ICT opportunities. Lang et al. (2019) stressed that many studies were thus abandoned prematurely, because the applications offered little variety and interest quickly waned. In some cases, there was no subjective need for the application, no concrete added value was assumed due to the expense. This shows above all that many older patients, despite their existing illnesses, still regard themselves as too active and capable to make use of telemedical care. In order to ensure improved care for these patients with the help of accompanying telemedical care, the experienced added value or the subjectively felt additional benefit for their own needs and health care is of great importance (Lang et al 2019).

In order to counteract the mistrust in data protection or the lacking interest in new applications, it was recommended by Lunardini & Borghese (2020) to improve the transparency and user management. Accordingly, the systems developed should be able to collect data in a reliable way without being too privy to privacy. Familiarity of the equipment can also be achieved by incorporating it into everyday objects – such as walking sticks, or smart inlays (which can measure steps and vital data). In order to promote personal fitness, designs are recommended that promote training and rehabilitation in a playful manner, as well as games that can take measurements (Lunardini & Borghese 2020).

As a further obstacle to implementation, it was evaluated in one article that not only the patients but also the **care personnel** (relatives or nurses) can be **dissatisfied** with the applications, as they require additional workload, for example, because the handling of the technology itself has to be learned. In this regard, monitoring aids should generally be designed in such a way that patients themselves can use them, and learn their use easily, without the need of help (van Doorn-van Atten & de Groot 2019).

Furthermore, current applications very often simply fail because of a disregard in the usability design regarding the respective **abilities of seniors** in general: Allemann & Poli (2020) mention that because of possible cognitive, sensory or physical limits (e.g., reduced vision, higher forgetfulness, auditory and tactile impairment; see also Jonker et al. 2020), a use of common ICT equipment is hardly feasible. These factors should therefore be taken into account when technologies are developed: ICT development in the care sector for senior citizens must be separate from general patient care. In this sense, possible reminder aids or guided self-explaining features should be applied. While it is to be expected that future generations will be able to handle modern technology better, as the digital divide is narrowing and we can observe an increase of use of ICT by older people, the development of further technologies should generally focus on more frail older adults. Currently many applications are too general in their development (Allemann & Poli 2020).

Another important obstacle that was frequently mentioned concerns the **implementation of ICT** in care: as Barnett & Livingston mentioned among others, in many respects, there is currently no concrete programme to introduce ICT support aids in the care sector, there are no subsidies or incentives to promote them. Politically, this development is often not advanced enough to start a real movement and development of the scene. Further training programmes for personnel etc. are hardly given. Accordingly, the field and an expansion generally develop very slowly – further incentives for development, implication, and promotion of support must therefore also be strengthened from top-down (Barnett & Livingston 2019).

Conclusions

Telemedicine holds great potential especially in the care sector; many studies have shown that a positive resonance was achieved through the use of telemonitoring and similar equipment. Rehabilitation exercises were carried out more often, medication was taken more often, vital data was checked faster. However, in many areas the results are manifold.

In terms of costs, it can be seen that, depending on the study, telemonitoring can reduce costs or increase them through increased additional expenditure. This is partly explained by the fact that the way in which telemonitoring was used can vary greatly (depending on the illness or form of care). There is also the problematic fact that the literature does not distinguish between formal and informal care - there could be considerable differences. However, the quality of care has usually been improved (Aguilar & Campbell 2014).

In terms of outcomes, while many studies measured positive clinical outcomes (better health, more reliable self-monitoring or faster reaction to changes), most of them concluded that further studies are needed to underline the effects. However, in five medical fields with chronic diseases (management of diabetes mellitus, cardiovascular disease, chronic respiratory disease, cancer, and stroke), positive effects for ICT in the care sector were definitely identified (Wildevuur & Simonse 2015). In general, it was found that conditions which require constant monitoring are more suitable for ICT than others, since it supported the wellbeing of patients. It was also mentioned that more long-term studies are needed to understand how behaviour change is established through telemonitoring interventions (van Doorn-van Atten et al. 2018).

It is certainly important to merge the telemonitoring services with the existing care, so that they form synergies; a parallel existing programme beside the standard care would be a hindrance. Caregivers must be involved and trained in all points. Here it is also important to note that acceptance and skills with the approach can change depending on the character of the person being cared for – here again, communication is important to make clear whether the technology will bring about an improvement in living conditions at all. Finally, an effective and secure use of data must be guaranteed. Although increasing improvements have been continuously developed over the last years, a full exploitation of the data can often not be guaranteed. This needs to be further improved and work needs to be done to secure private data (Aguilar & Campbell 2014).

In concrete terms, it needs to be noted that for the development of telehealth for care, the necessary requirements for older patients have – so far – hardly been explored, as they often have more demanding requirements than younger patients. Jonker et al. (2020) recommend further studies focusing on possible barriers of implementation, provider and patient satisfaction, regulations concerning safety and privacy, and exclusion of patients with low digital literacy In addition, there is also the problem of too specific studies or projects, which only provide results for a certain scenario or short-term results. As an example, in the specific case of Shamsabadi & Delbari, a study was carried out to design future monitoring systems for older people – however, it was aimed as a specific design for the country of Iran which takes also into account its cultural necessities. It is therefore not generally applicable as a standardized formal for all (Shamsabadi & Delbari 2019). Most of the findings to date can often only be drawn from individual studies or projects – interdisciplinary long-term studies hardly exist as such – and since foci were set different in each case the results should be viewed with caution. Ethical and privacy concerns are another issue that need to be researcher further along the development of telehealth and telemonitoring technologies (Sundgren, Stolt & Suhonen 2019).

ICT in care is still in its infancy, despite the fact that it had major advancements in healthcare over the last years. However, with the outbreak of the COVID-19 pandemic, it was strongly driven by the need to develop alternative treatment strategies. If in future more studies should focus on care for the elderly in general there is nothing standing in the way of widespread implementation.

DEFINITION OF THE ELDERLY POPULATION AND COMORBIDITIES

Ageing populations are a global phenomenon. According to the World Health Organization (WHO), in almost all countries the number of people older than 60 is growing more rapidly compared to other age ranges. It is estimated that in 2050 people older than 60 will reach 2 billion (three times as much compared to 2005), representing almost a quarter (22%) of the world population.

Especially in the EU countries, people older than 64 will increase greatly: in the next 40 years, it is estimated that this figure will double, going from 87 to 148 million people.

In Italy people aged 65 or older make 20% of the total population residing in the country, and this number is projected to get to 35% by 2051.

As populations age, people aged 85 or older will also increase, going from today's 2.3% to 7.8% of the total population (ISS, 2013).

The coexistence of multiple pathologies, often without the possibility to identify the most relevant one in terms of prognosis and therapy, is a great challenge of our times. This brings new health necessities because the patient is "new" himselfe, also known as "complex patient".

Elderly people with multimorbidity (multiple concurrent diseases) are heterogeneous in terms of disease seriousness, functional state, prognosis, and risk of adverse effects, also when the same condition pattern has been identified. Therefore, treatment priorities also vary (American Geriatrics Society Expert Panel, 2012).

When it comes to the most frequent chronic diseases, 57% of the elderly suffer from arthritis, 55% from hypertension, 38% have breathing problems, 17% have diabetes, 17% have cancer, and 16% have osteoporosis. Diabetes, cancer, Alzheimer's, and senile dementia are increasing steadily compared to the past.

Multimorbidity can be found in a third of the adult population and its incidence increases with age, reaching 60% among individuals aged 55-74. Moreover, this trend is growing, and it has been proven that some of the pathologies tend to form "clusters".

Globally, multimorbidity is estimated to range between 55% and 98%, depending on the studies and the cases considered - making it an important issue from an epidemiological point of view (Ministero della Salute, 2013).

TELEMEDICINE IN GERIATRICS

Considering the demographic aspect described before, which shows that ageing population is on the rise and, as a consequence, a higher number of chronic diseases needs to be treated, it's clear to see how important it is to reorganize health systems. An exploration of new assistance and treatment models is necessary.

In particular, the health system's strategy needs to establish diagnostic-therapeutic-rehabilitation processes that are as individualized as possible, with a good cost-efficacy ratio.

Such models need a major involvement of the patient's responsibility and their family, and the setup of an assistance system that continuously involves hospitals, local, and health bodies to help the elderly.

People living in Residential Aged Care Facilities (RACF) represent the cohort of the most fragile people with the highest rate of social disability. Most of them suffer from chronic diseases that can make their assistance needs very complex, sometimes making admissions to Long Term Care Facilities (LTCF) a necessity.

Most chronic diseases among the elderly living in social-health facilities (RSA) are represented by sensorial loss (80%), dementia (60%), chronic pain (40%-80%), urinary incontinence (50%), sleep disorders (45%), and depression (30%-40%) (Fur-Musquer *et al.*, 2012).
Considering these aspects, life expectancy can also help health professionals to start planning essential treatments promptly. This is paramount to assess the relational aspect of prognosis communication to resident seniors, their families or caregivers, as well as to assess the prognosis accuracy and to monitor lifestyle improvements in both objective and subjective life conditions.

The development of Information and Communication Technologies (ICTs) has created new opportunities to assist older patients who live in their homes or in specialized facilities.
In this context, a multidisciplinary field which combines gerontology and technology - "Gerontechnology" - aims to improve the life and well-being of the elderly.
Gerontechnology studies and develops useful instruments that can improve monitoring and treatment of diseases, autonomy, physical capacity, and rehabilitation in order to facilitate their presence at home. It is proven that between 7 and 67% of hospitalization requests can be avoided.
Gerontechnology can be analyzed in different contexts, such as social fragility, psychology, education, and rehabilitation.
Especially the systematic introduction of these technologies can help limit hospitalization of older people thanks to prevention processes in place.

In the context of gerontechnology and the aforementioned quadrants, relevancy of telemedicine and its impact on society and health have been acknowledged at an international level.
Telemedicine allows treatment and assistance services in such contexts where distance is a critical aspect for every health professional who uses IT technologies and communication to exchange information.

Moreover, it is an instrument that contributes to an improved continuity of treatment and management of chronic diseases. Telemedicine has shown to be effective in treating patients with heart diseases, as the continuous monitoring helps improve treatment.
Moreover, telemedicine facilitates treatment and fosters collaboration among specialists.

The Communication from the Commission of the European Communities on telemedicine for the benefit of patients, healthcare systems and society COM (2008)689, issued by the European Commission on 4 November 2008 aims to support member states to establish telemedicine services on a large scale.
The Communication underlines that health system users (patients and health professionals alike) need to be involved at a national level in the definition of developmental and financial processes related to telemedicine and its new technologies (COM, 2008).
In this document, telemedicine services are classified in the following macro categories: tele-visit (long-distance patient/physician interaction), tele-consultation (consultation among physicians) and health tele-cooperation (assistance given by a physician or health professional to another physician or health professional).
The Digital Agenda for Europe 2020 presented by the European Commission and finalized on 19 August 2010 plans a specific "key action", on which the European Commission aims to put its efforts by involving member states and stakeholders to spread telemedicine services.
To assess the most appropriate measure to meet the patient's needs, it is necessary to first look at their medical history considering a series of parameters.
These are the most common ones: Cumulative Illness Rating Scale (CIRS), Cognitive Performance Scale (CPS), Activities of Daily Living (ADL), Instrumental Activities of Daily Living (IADL), Short Portable Mental Status Questionnaire (SPMSQ), Mini Nutritional Assessment (MNA Short), Exton-Smith, bladder and intestinal incontinence, symptoms with pain detection scales, possible appearance of skin lesions or bedsores, psychosocial functioning related to reactions based on other people's behavior, adjustment to routine changes, and analysis of the main stress factors (ten Koppel *et al*., 2018).

The analysis of the state of the art allows us to plan a process that will reduce social isolation and enhance the support to psychological difficulties in a living space provided by the public administration or in social health facilities (RSA) (Hibbert *et al*., 2019).

Gerontechnology will be analyzed in the following chapters in relation to social fragility, education, rehabilitation, clinical, and psychological quadrants.

CLINICAL APPLICATIONS (clinical quadrant)

Telemedicine is an important tool to support and guide patients towards prevention and management of common pathologies among older people. These include breathing pathologies (amyotrophic lateral sclerosis, disabling neuromuscular diseases, COPD, breathing problems during sleep), heart pathologies (heart ischemia, heart failure with ejection fraction >40% or <40%, cerebrovascular pathologies), kidney failure, and diabetes mellitus.

In relation to diabetes mellitus, data collected from a study carried out on a group of patients affected by type 2 diabetes proved that implementation of a tele-coaching program brings numerous benefits to patients affected by this pathology (De Vasconcelos *et al*., 2018).

In some cases, telemedicine can transmit clinical parameters such as blood pressure, heart rate, electrocardiogram, peripheral oxyhemoglobin saturation, body weight, spirometry, and glycemia.

Sharing this data with the medical staff can bring about great benefits in terms of diagnosis and prescription, as well as control over therapy adherence. This information can be used to promote lifestyle changes in obese or hypertensive older patients.

Moreover, data collection over time will give immediate indications on the evolution of the clinical state of the patient during therapy, helping reduce emergency interventions.

Finally, telematic data transmission helps reduce patient visits to the hospital.

A study carried out in Quebec showed that telemonitoring parameters that identified heart attacks reduced hospitalization by 60% (Ahmed *et al*., 2014).

Registration and transmission of some data categories can be directly owned by the patient using wearable devices, which can be interfaced via smartphones wirelessly.

The diffusion of such devices was possible thanks to great technology advancements made in the sensor, microelectronic and wireless communication fields.

Wearable devices belong to the Internet of Things (IoT) category and allow remote, real-time monitoring of multiple clinical parameters. They also provide a valid tool to promptly alert users and caregivers about situations that require medical assistance.

For this reason, wearable devices are a technological support that can be usefully integrated within telemedicine practices. Moreover, they put the patient in a proactive position when tackling their own health status.

In this context, a telemedicine project called “E-Care” was developed, which aims to identify risk situations in patients with heart conditions early on.

“E-Care” was the first project developed for older patients with heart conditions (average age 72 years). It is based on a monitoring platform made of interconnected devices such as tablets, sensors for hypertension detection, heartbeat, oxygen saturation, and weight. With this platform it is possible to interact and educate patients about therapeutic treatments, diet, and lifestyle (Andrès *et al.*, 2016).

Dermatology is an additional field of application in telemedicine.
In 2003, a study carried out by the American Telemedicine Association (ATA) defined two telemedicine application methodologies in dermatology. The first one involves remote communication between patient and physician with image and clinical information exchange; the second one, a teleconsultation via videoconference.
In this context, an experiment that involved 19 patients aged on average 82 years and 6 nursing homes was carried out. The study dealt with teleconsultation applications for patients affected by bedsores, trophic vascular ulcers, and trauma-induced wounds. It showed a significant improvement in the healing process of the patients’ wounds.
Moreover, it has shown that teleconsultations removed the need of in-person consultations for 79% of patients (Salles *et al.*, 2013).

TELEREHABILITATION (rehabilitation quadrant)

Telemedicine is an important tool also in treating musculoskeletal pathologies, both acute or chronic, such as arthritis, osteoporosis, and rheumatoid arthritis.
An important application field for telemedicine is telerehabilitation (TR).
TR is intended as a remote rehabilitation service supply.
Such services can be integrated using different types of technology such as assistive robotics [11].
TR implementation enables a better accessibility and continuity of care, while reducing costs at the same time (Shishehgar *et al.*, 2019). TR application fields involve mostly rehabilitation of patients affected by chronic heart diseases, neurological pathologies, and situations where physiotherapy is deemed necessary (Peretti *et al.*, 2017).

TELEMENTAL HEALTH (psychological and social frail quadrant)

Services finalized for the socialization of elderly people are performed alongside with those related with medical care. These services are part of the social politic reforms pursuing the goal of social inclusion and active citizenship.

Thus, elders do not only represent a passive target of treatment but they play an active role in treatment delivery. In order to reach such goals of differentiation of the local social services the following factors are key: the presence of a strong and developed third sector, the integration between healthcare and welfare services, technological innovation to aid elders in practical every day activities as well as relational matters. Instruments such as videocall and chat services are proven to increase brain activity reducing depression

Within this context, another specialization of telemedicine known as Telemental Health (TMH) was developed. Such discipline allows to provide a range of services with the aim of enhancing the mental well-being of elderly patients. (Donald *et al.*, 2013).

TMH, used for older patient, has the potential to increase access to specialist services. A systematic review found 68 studies supporting the use of TMH in elderly patients in the areas of screening and diagnosis of cognitive disorders, treatment of depression and psychotherapy. (Melanie *et al.*, 2019).

Within this context, the DETECT project analyzed the use of telemedicine for the management of psych-bhavioral disorders in geriatric patients living in long-term care facilities (LTCFs).

In such facilities neuropsychiatric symptoms (NPSs) in elderly patient with dementia are frequent. Telemedicine was shown to be an emerging way to provide consultation and care to dependent LTCF residents, who may not have easy access to specialty services. The DETECT study, which lasted 24-month, involved 20 LTCF and more than 200 patients (Piau *et al.*, 2018).

TOOLS TO EVALUATE THE EFFICACY OF TELEMEDICINE

Literature proposes several tools useful to evaluate the clinical efficacy of telemedicine.

The model known as MAST (Model for Assessment of Telemedicine) is a framework to assess the impact of telemedicine.

Such model was developed by users and stakeholders of telemedicine to produce the information that healthcare managers need for making decision on investment in telemedicine (Kidholm *et al.*, 2012).

Moreover, the use of a wide range of clinical indicators makes it possible to evaluate the effectiveness of the services delivered through telemedicine.

Among the indicators of frailty and health there are: : SF-36, HSAD or WHOQOL, Experiences in Close Relationship Scale, Short Form (ECR-S), The Brief Illness Perception Questionnaire, Multi-Dimensional Health Assessment Quest (R808 NP2), Experiences in Close Relationship Scale-Short Form (ECR-S).

The category of objective indicators includes the evaluation of weight, physical activity, sleep and Sefac lifestyle questionnaire.
Finally, the subjective indicators are: SF12 (health/quality of life), proxy indicators (indirect factors) such as SSPS (social safety pleasure scale), Security Perception, UCLA loneliness scale, Friendship scale (social isolation) and selfcare management ability measured by EMA and General Self-Efficacy.

A further analysis method is known as Social Return on Investment (SROI). The SROI method is applicable within a context in which result are strictly dependent on the collaboration of an high number of actors, and the impact on the health of the assisted people depend on the development of a network around the patient formed by formal and informal caregivers.
With reference to informal caregivers the following parameters are taken into consideration: level of worry in the elder's health status, number of visits based on the elder's health and its autonomy or lack thereof, level of confidence in the services, reduction of conflict, improvement feedbacks and major transparency in communication.
Concerning formal caregiver the following parameters are evaluated: numbers of hours needed to monitor/treat the patient, numbers of interventions carried out to promote the health of the elderly, the variation of the perceived load related to the treatment and monitoring activity reported by caregivers, time gained due to less travel needs, and the reduction of costs associated to care.

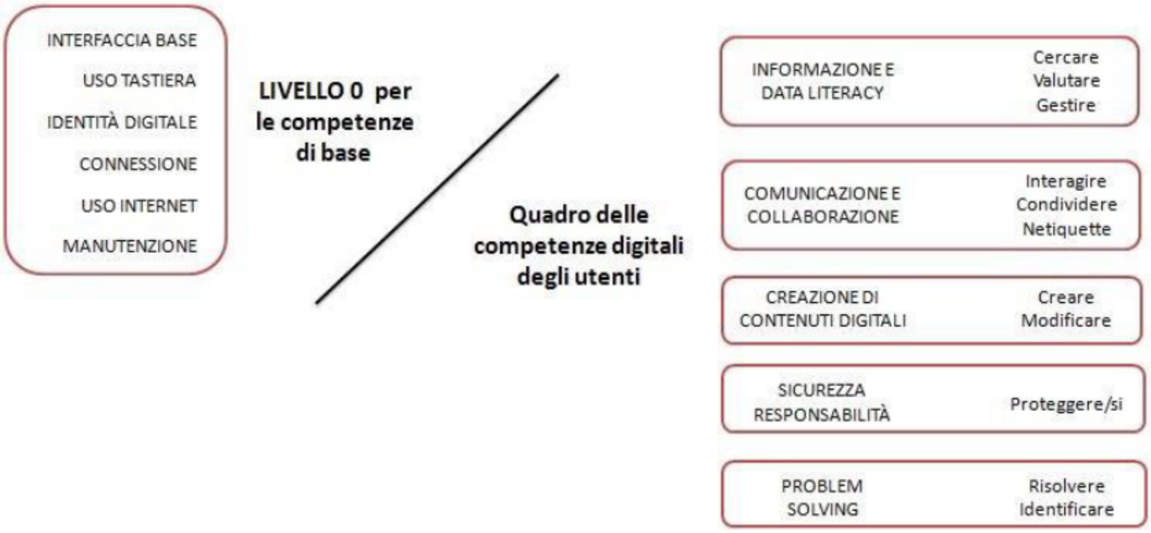
DIGITAL LITERACY OF ELDERLY PEOPLE

To ensure that telemedicine spreads among elders, which generally have little familiarity with technologies, the design of user-friendly platform become essential alongside with adequate training to promote the development of digital skills.
The geriatric digital literacy was the subject covered in a recent European project called "Elderly home Care Residential Engagement" (E.CA.R.E, 2020).
The "0 Level" of this project lists the basic hardware and software expertise that elders should develop to interact using the Information and Communication Technologies (ICT).
The second step consist of five sub-levels: information and data literacy, communication and sharing, creation of digital content, security and responsibility, problem solving.
Information and data literacy covers the skills necessary to identify, locate, retrieve, archive, organize and analyze the digital content, while teaching users to assess its relevance and credibility; communication and sharing covers the skills necessary to communicate in digital environment,

share resources using online tools and connect with others; digital content creation covers the skills needed to create and edit new content; security and responsibility includes those competences relevant to personal and data protection; finally, problem solving includes the skills necessary to identify digital resources, make informed decisions on the most appropriate digital tools based on purpose or need, and solve technical problems (Table 1).

Starting from these assumptions, the creation of a training model must conceive the training intervention, including health training interventions, associated with coaching and remote assistance as an opportunity for co-operation with the user. The user's ability to self-determine is therefore encouraged and emphasized, so that the validation of the results will be based on specific quality of life indicators, on a cost / benefit analysis, and on the effect of reducing the cost of producing social and health services.

Table 1 E.CA.R.E digital competence system matrix (Toolkit for the digital literacy of older adults)



COVID-19 EMERGENCY

The global health emergency resulting from the widespread of COVID-19 has configured an unprecedented catastrophe in the contemporary age: an international pandemic.

The propagation of the virus required a heavy intervention from different point of view: social, economic, and political.

The everyday life has radically changed because of the preventive measure and the economic and government system had to face a severe recession, safety challenges and unprecedented intervention.

Such catastrophic event has revealed even more clearly those pre-existing conditions of vulnerability. In fact, during the pandemic it was possible to identify a group of population particularly affected by the emergency, both from a medical-health, psychological and relational point of view: the older adults and in particular the frail older adults (Kamin *et al.*, 2020).

Nowadays the condition of the elderly population is at the center of the public interest for the health implication in the event of contagion (the risk for sever illness from COVID-19 increases with age, with older adults at highest risk) and the difficulties in carrying out the daily life activities due to the social isolation.

The emergency requires a rethinking both of the frail elderly sociological category and the interventions necessary to deal with this phenomenon within a highly risky health and social context.

The strategic document of the Global Humanitarian Response Plan (OCHA, 2020) shows a particular attention to the most vulnerable group of population.

The priority of the strategy, aimed at containing the pandemic and reducing morbidity and mortality, is the preparation of the population and the social health system in order to reduce risks and protect vulnerable groups, including elders and people affected by previous pathologies.

In this document the use of telemedicine has been widely promoted to decrease the access to health facilities and therefore reduce the risk of contagion. This strategy was particularly used by England and United States. Most of the other states do not have a regulatory system for the provision of telemedicine services. Italy, for example, does not include telemedicine among the services provided by the National Healthcare System. (Ohannessian *et al.*, 2020).

During the emergency period, the Italian “Istituito Superiore della Sanità” published a report titled “Interim indications for telemedicine assistance services during the COVID-19 health emergency” (Rapporto ISS COVID-19 n.12/2020). This document describes which are the needs that can be addressed using telemedicine during COVID-19. Among the recipients of these services it is possible to find the category of people which suffer from chronic disease and people in frail condition. The main needs that can be met remotely are the personalized surveillance of the basic clinical conditions and the dispense of specialist checkup through video-calls.

GARTNER HYPE CYCLE FOR DIGITAL CARE

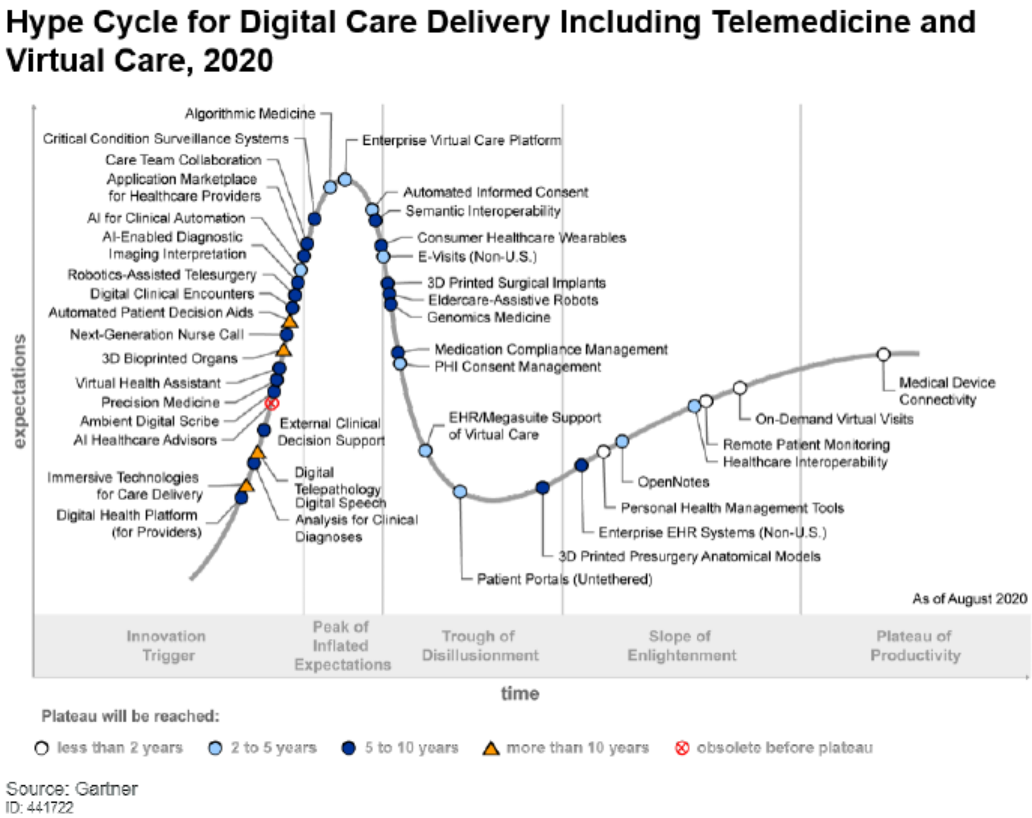
The impact of telemedicine on the National Healthcare System is underlined by the paradigm shift in healthcare systems.

The paradigm shift therefore entails a different focus in the levels of care and health pathways of the healthcare market, which sees the transition from the centrality of the hospital for intensive care, to the territory up to home assistance.
The new model requires a Healthcare system that is committed to create increasingly holistic and personalized solutions. Moreover, it promotes the use of devices for monitoring vital parameters, the prevention, and the patient well-being; to become effective, this model has to be good enough in combining quality aspects with economical ones.

In this context, Italy is experiencing a certain delay compared to other Western European countries.
To evaluate the healthcare digital market, the variable used in the “Hype Cycle for Digital Care Delivery Including Telemedicine and Virtual Care, 2020” (Hakkennes *et al*., 2020) have been taken into consideration. The variables Trigger of Innovation are: Digital Health Platform (for Providers), Immersive Technologies for Care Delivery, Digital Speech Analysis for Clinical Diagnoses, Digital Telepathology, External Clinical Decision Support, AI Healthcare Advisors, Ambient Digital Scribe, Precision Medicine, Virtual Health Assistant, 3D Bioprinted Organs, Next-Generation Nurse Call, Automated Patient Decision Aids, Digital Clinical Encounters, Robotics-Assisted Telesurgery, AI-Enabled Diagnostic Imaging Interpretation, AI for Clinical Automation, Application Marketplace for Healthcare Providers, Care Team Collaboration.

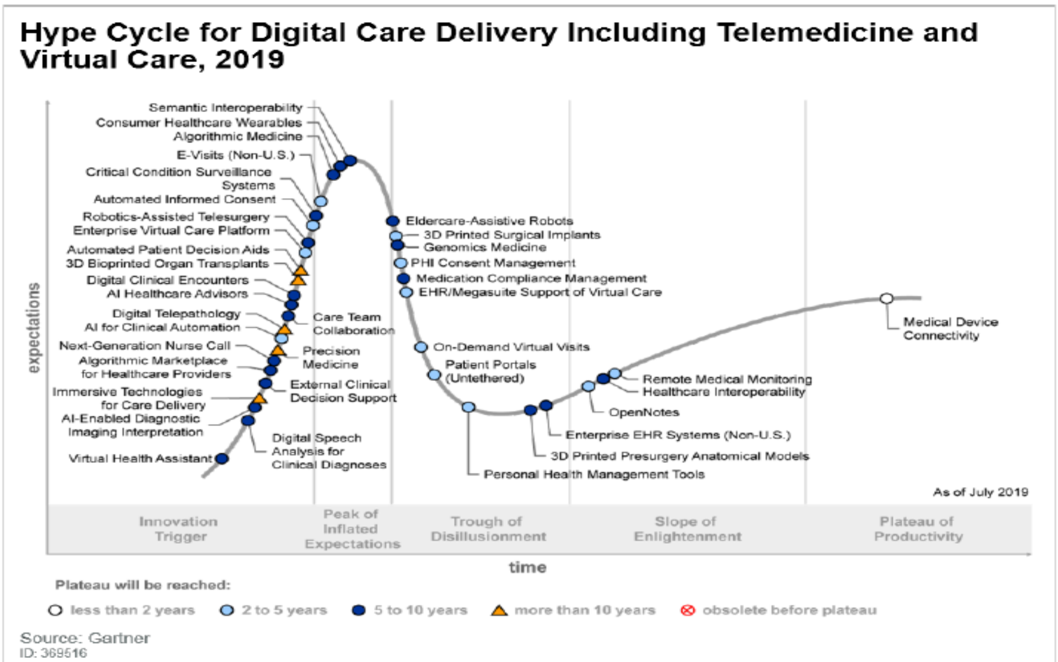
While, technologies that are no longer the “Innovation Trigger” are: Critical Condition Surveillance Systems, Algorithmic Medicine, Enterprise Virtual Care Platform, Automated Informed Consent Semantic Interoperability, Consumer Healthcare Wearables, E-Visits, 3D Printed Surgical Implants, Eldercare-Assistive Robots, Genomics Medicine, Medication Compliance Management, PHI Consent Management, EHR/Megasuite Support of Virtual Care, Patient Portals (Untethered), 3D Printed Presurgery Anatomical Models, Enterprise EHR Systems, Personal Health Management Tools, OpenNotes, Healthcare Interoperability, Remote Patient Monitoring, On-Demand Virtual Visits, Medical Device Connectivity (Figure 1).

Figure 2 Hype Cycle for Digital Care Delivery Including Telemedicine and Virtual Care, 2020



For example, in the 2018 analysis the “Eldercare-Assistive Robots” variable was at the peak of the “Hype Cycle for Digital Care Delivery Including Telemedicine and Virtual Care, 2018” (Jones *et al.*, 2018). In only two years many variables changed their position in the curve ().

Figure 3 Hype Cycle for Digital Care Delivery Including Telemedicine and Virtual Care, 2019



CONCLUSIONS

In view of the current demographic change due to an aging population, the social and health system should adapt in a dynamic and timely manner to meet new needs, limiting the necessity of hospitalization and preferring local interventions.

In this context, prevention and education policies become fundamental.

Moreover, the social and health system should foresee the existence of a service network based on the interaction of different professional roles (medical doctors, nurses, physiotherapist, social assistant, ecc.) in order to outline a personalized intervention program, using tools such as geriatric assessment scales and the Individualized Care Plan (PAI).

An interdisciplinary system can offer a better service to the patient, thanks to the fact that healthcare information is shared among professionals. This allows to reduce the time required for medical decisions, which is a particularly important factor during emergencies.

In this context, gerontechnology becomes an important tool in support of the traditional care process. Telemedicine plays a leading role in gerontechnology and it is currently the subject of many studies to evaluate its applicability and benefits (Zulfiqar *et al.*, 2020).

As outlined in this paper, telemedicine appears to be a valid tool to diagnose and monitor patients that suffer from cardiological, respiratory, kidney and diabetes disease. Moreover, it can be useful to support patients that suffer from social and psychological issues.

The remote and continuous assistance of telemedicine allows to reduce response times in case of worsening of chronic diseases and provides an increased sense of safety for elders and their families.

The flexibility of Telemedicine has the potential to increase the access to proper healthcare services to people living in remote locations thanks to the decentralization of its offered services.

Moreover, it helps to distribute in an optimal way the human and technological resources assuring the continuity of services on the territory.

Furthermore, the current situation related to the COVID-19 pandemic, points out the need to reorganize the healthcare system in a much more technological manner, centralizing the role of telemedicine.

The monitoring of patient through sensors which sends clinical information to the general care physician can make patient management more efficient and effective and improve the prognosis of the disease, which means lowering the use of intensive care.

The healthcare system needs to be revolutionized as soon as possible keeping in mind that at least two years are required to see the results of a reorganization. It is necessary to reproject the local services network, reevaluating the role of the general practitioners and introduce technology to perform remote assistance to patients (Mannheim *et al*., 2019). In order to activate telemonitoring both at home and at healthcare facilities becomes necessary to provide specialized training for both physicians and nurses, and disclose guidelines through newsletter, scientific papers, meetings, online and face-to-face events.

The use of e-Health solutions connected to the Internet introduce new matters to attend to such as privacy and security of the patient along with the quality, resiliency, and the need to certify the solutions (Kim *et al*., 2017).

Another important aspect will be the use of big data and deep learning techniques to implement predictive and preventive medicine. Access to a complete set of clinical data can help the physician in having a complete analysis of the patient's history thanks to the support of decision algorithms. (Sapci *et al*., 2019).

TELE-HEALTH

1. What is it?

The research for the new methods of treatment for the most fragile patients should not surprise, especially if we consider the demographic trend in contemporary society: more complicated needs to satisfy, percentage of the elderly citizens and patients with permanent pathologies in constant growth.

Considering that nowadays technological development is increasing very rapidly, the desire to use new technologies also in the field of healthcare seems almost obvious. Since new technologies have been used in many health and social care fields (for example for rehabilitation and for production of specific equipment for the disabled people), not being in favor of them and not making use of them is perceived almost as an error.

With a view to fostering the use of the new technologies and seeking to meet the needs of modern reality, the telemedicine , that is the revolution in providing health services had come. The concept of telehealth, or "telemedicine", was introduced in the 70s by the American Thomas Bird to indicate "the practice of medicine without the usual physical contact between doctor and patient, using an interactive multimedia communication system."[2] This term indicates a system of therapeutic and

[2] Companion Series, "Telemedicina: ieri e oggi", Retrieved from: http://www.networksecondoparere.it/data/repository/2622019a1db68b6f9/vadal_latelemedicinaierieoggi.pdf, page 4, last access: 18.02.2018

information technology based methods thanks to which it is possible to provide health services (treatment, diagnosis, medical consultation, etc.) by telephone, internet, radio or other telecommunication systems. In this way, the assistance provided both to people who are unable to move independently (chronically ill, elderly or seriously disabled patients), and to those who live in the suburban areas of the city, becomes more effective as it is "deliver" more rapidly . In online mode, that is, using a device with the Internet connection, telehealth also allows everyone who is interested to participate in a series of medical lessons or consult experts from any country in the world without having to go out from home.

Thanks to telehealth and telecommunication systems, hospital management can be considerably improved by monitoring different data, such as patient bookings, bed availability, medical reports, etc.

The concept of remote assistance on which telemedicine is based is really simple and could originate from the past: in fact, it is believed that the idea dates back to the smoke signals which African tribes used to warn foreign populations about the spread of epidemic diseases in the area of their residence, in order to keep them away from these territories, avoiding therefore the spreading of the infection. Another practice, in which the roots of this innovative approach can be sought, derives from the beginning of the last century, when the inhabitants of certain isolated areas of Australia used the energy produced by a bicycle’s dynamo to get in touch with the pilots of the National Health service.

Telehealth methods, understood in a modern way, have been used and tested in extreme conditions, for example on oil platforms or during space expeditions. The increasingly rapid development of technology has enabled the transmission of constantly increasing amount of data which are every time more complex (including ,therefore, radiography or ECG heart trace).

2. Examples of services provided in terms of telemedicine include:

• *Videoconference with the specialist*: the possibility of consulting the doctor via the internet, in a convenient way, that is, staying at home. In this way, even patients with reduced mobility receive adequate and high- quality service without having to present oneself in the hospital or in a medical clinic in person.

• *Record of symptoms on a personal device remotely*: using a computer or smartphone it is possible to record the data concerning your health condition, for example the blood pressure or glucose reading. In this way, certain information concerning individual's health condition and their impact on his or her daily life can be stored and subsequently sent to the medical staff who will evaluate whether to modify the therapy implemented or not.

• *Training and stimulation of self-determination*: Having made enquiries about his/her health condition, a patient can share this knowledge with people who have the same symptoms or the same pathology. This sharing of experiences between contemporaries, so-called "peer-to-peer education", has an important additional quality in comparison to the conventional learning methods, resulting from the fact that a certain situation is experienced personally. The interested person is given a unique opportunity to obtain true information based on the experiences of others.

• *Medical indications online*: the internet is a fairly reliable source of information, if you check the authenticity of the medical data and the source from which you learn the information. One of the methods to check the reliability of a web page is to go on the website www.it.european-lung-foundation.org/guide and read the publication "A guide to finding the reliable health site."[3]

• The number of *call centers* which provide medical information by the phone is constantly increasing. Thanks to the considerable development in this sector, patients have more and more opportunities to get a medical consultation remotely. The task of the healthcare professional is to determine the severity of the patient's problem and suggest the most appropriate solution to it.

From the aforementioned telemedicine services we can deduce that the main objective of this approach is to increase the self-sufficientness of patients. Gaining more and more awareness of your health condition you are able to monitor it correctly from home, and therefore, to contribute to the reduction of the number of people in hospitals as well as of expenses from the Health Service. "An in-depth analysis of the attitude of Italians in this context (CENSIS, 2007) proves that 53.4% believe it is convenient to obtain as much information as possible to decide autonomously on their health."[4] This desire to take care of one's health is more and more present in contemporary society, and can be considered as something positive, but it is necessary to underline the importance of consulting the specialists since only they can confirm or deny patients' hypotheses. According to the latest data provided by Censis (Institute of Socio-Economic Research), as many as four million Italians search the Internet for information and explanations regarding their health (Corriere della Sera, 22 July 2001). Without a doubt, over time, the internet will become increasingly crucial tool in the medical practice. Stimulated by the rapid development of technology, healthcare professionals put at the disposal of the patients a growing number of online services, such as communication via e-mail o digital platforms.

3. Telemedicine in Italy: history and analysis of its use

Italy was among the first countries in the world to make use of the technologies in the health sector: one of the first Italian telemedicine applications was invented as early as in the 1976, when an

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3 European Lung Fundation, "Telemedicina", Retrieved from: https://www.europeanlung.org/assets/files/it/publications/telemedicine-it.pdf, page 1,last access: 25.02.2020

4 Michele Zagra , Stefania Zerbo , Antonina Argo, "Informatica, web e telemedicina", Retrieved from: https://core.ac.uk/download/pdf/53283303.pdf, page 125, last access: 28.02.2020

attempt to send a clinical diagram via telephone was made. In essence, in the 1980s this service, managed by Società Italiana per l'Esercizio Telefonico (the Italian Society for Telephone Operations) had become a "cardiotelephone". Subsequently, ”Centro Studi e Laboratori Telecomunicazioni (CSELT) (the Center for Telecommunications Studies and Laboratories, CSELT) started searching for the transmission characteristics thinking about hospital emergency department.”[5]

Various experiments were carried out afterwards to comprehend the potential of telemedicine, and therefore, to guarantee a better quality of services also for patients residing in suburban areas. Thanks to the development of communication methods, such as video calls or applications for sharing information and diagnostic images, the number of telemedicine services increase, what is more, they prove to be considerably useful and effective. Consequently, on the initiative of various scientific societies in collaboration with both the National Research Council(CNR) and with the Ministry of Health, a series of seminars, meetings, conferences and university masters have been set up, aimed at supporting the development of telemedicine in Italy as well as broadening the knowledge about it.

According to the data from 2002, " in Italy there are about 12,000 tele-assisted patients every year, while the companies which work in this sector are about fifty."[6]

Despite being a pioneering country in the phase of creating and testing telemedicine services, in reference to numerous surveys carried out by the European Union from the 1990s onwards, Italy cannot boast about a considerably high amount of concrete implementations. ”Only in Japan, in the USA and in some European countries, and exclusively for certain specific application fields, such as *teleradiology*, *telecardiology*, *telepathology*, *telesurgery*, *teleconsultation* and *medical teledidactics”*[7], telemedicine services have proven to be consistently effective, sometimes completely replacing traditional practices.

Most of the experiments were carried out thanks to the funding from various local and European institutions: Ministry of Education, University and Research, Ministry of Health, National institute for Prevention and Workplace Health Promotion and National Research Council.

Other experiments which stands out are: teleconsultation with the smaller islands, clinical and cardiac monitoring for prisoners, clinical monitoring of the Italian soldiers in the Balkans, instrumental tests and medical support for boats at sea, remote cardiac monitoring of participants

[5] Giovanni Serpelloni, “Dalla telemedicina alla web clinic (Wc): Internet Come “Infrastruttura”, Retrieved from: http://www.giovanniserpelloni.it/pdf/pdf188.pdf,page 184, last access: 26.02.2020

[6] Scuola Zanichelli Online, “Telemedicina”, Retrieved from: https://online.scuola.zanichelli.it/fare/files/2008/09/6685_paci_fare_telemedicina.pdf,page 1, last access: 26.02.2020

[7] Michele Zagra , Stefania Zerbo , Antonina Argo, “Informatica, web e telemedicina”, Retrieved from: https://core.ac.uk/download/pdf/53283303.pdf, page 128, last access: 28.02.2020

athletic races for professionals, radiological consultation and medical monitoring of specific cases. Although extremely encouraging on a scientific level, the abovementioned practices have not been tested in the favourable circumstances, always being somehow neglected, and therefore, not stimulating effective development of telemedicine. Only with the establishment of the Emergency medical services in Italy (Servizio Sanitario di Urgenza ed Emergenza in Italia, SSUEM), in the early 90's, the telemedicine services started to be used on a larger scale, involving the areas of cardiology, nephrology and even hematology.

After decades of experimentation, it can be affirmed that the most advanced sector of telemedicine application is that of coordination services: "coordination centers are defined as *information gathering* centers providing details on types of social and medical services available and their local distribution. These centers can be contacted on request”[8], therefore, taking into consideration the individual needs of patients. Most of these centers are connected both to emergency department and medical services as well as to reference institutions for transplantations.

Currently, the main task of telemedicine in Italy is to implement an operative system which is able to cope with emergency situations and allows the access to adequate measures for stimulating the decentralization of specialist skills guaranteed by the Law no. 833/78 on the basis of which the National Health Service is founded.

4. Why turn to telemedicine?

Given the growing demand for effective and high quality social assistance methods, the implementation of health-related solutions based on the new technologies, that is telemedicine, seems to be the most convenient decision.

The main reasons why it is convenient to turn to innovative technological systems:

- difficulties resulted from the management of medical assistance which requires the consultation with external specialists and / or rapid exchange of information between professionals in order to resolve a medical problem, i.e.: exchange of information between hospital structures about the availability of beds in the hospitals, healthcare professionals out of office, etc.

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[8] La fondazione Istud,“Telemedicina e doctor web: l'eHealth che rinnova la Sanità”, Retrieved from: http://service.istud.it/up_media/pw_scienziati/telemedicina.pdf,page 24, last access: 28.02.2020

- isolation of residents of suburban or remote areas, or of large metropolitan cities, unable to move independently: elderly patients and people who suffer from chronic pathologies or have very serious disabilities.
- possibility of providing refresher courses (distance learning) to medical staff, healthcare professionals and volunteers who dedicate their time to work in the medical field.
- necessity of people with motor impairments to access to medical services or health centers which are not physically accessible; thereby telemedicine will support inclusion.

Nowadays the Italian socio-economic situation considerably encourages the improvement of telemedicine, especially considering these circumstances:

- new objectives of the managers of the healthcare companies regarding better use of resources and quality improvement.
- importance of the final receivers, most of whom possess the appropriate education to deal with telecommunication devices.
- innovative management methods aimed at strengthening the systems used daily at work in order to optimize them.
- further technological development, such as human-computer interfaces, telecommunication networks.

On account of the increasingly common request for decentralization of medical services, healthcare companies are currently turning towards the possibility of assisting patients remotely through remote monitoring. In this way patients with chronic degenerative diseases, such as diabetes, heart failure, arrhythmia, hypertension, lower extremity ulcers or respiratory failure, can receive high quality treatment at home, without the necessity to go to the hospital or health centre. Undoubtedly, it is the patient who takes the biggest advantage of this solution, not being forced to stay in the healthcare facility and avoiding excessive drives from home to treatment centers and back.

Considering the continuous development of telecommunication systems, management and access to new technologies are no longer perceived as an obstacle. On the contrary, the main difficulties are present in the bureaucratic field, given the lack of specific regulations which can be included among the services provided by the Italian National Health Service. Digitization is one of the essential components of an effective organization, planning all procedures in accordance with "disease management", that is "the use of a direct, systematic approach based on the population to identify individuals at risk, intervene with specific treatment programmes and measure clinical outcomes."[9]

[9] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2663707/ website accessed on 21/04/2020.

Consequently, telemedicine becomes a way of supporting the executive regulations of disease management and processes related to diagnoses and treatments, having been applied:

- effectively for medical assistance through videos;
- to the execution of specialized analysis, for example: telecardiology and teledialysis;
- during remote instrumental monitoring, for example: cardiac telemonitoring;
- to support emergency situations, such as telecardiology in emergency department;
- to the optimization of information technology services dedicated to citizens, e.g., standardized booking system for medical check-ups and visits, creation of the electronic archives of integrated diagnoses;
- to instruct healthcare professionals: distance learning, exchange of information between hospital departments and consultations regarding scientific research with university faculties.

5. The difficulties related to telemedicine and possible measures to overcome them

The difficulties related to the improvement and development of telemedicine result primarily from a general opposition to innovations. Not even the familiarity of healthcare professionals with the new technologies favours the creation of advantageous conditions for the advancement of telemedicine. To change this situation it is necessary to take concrete measures, that is:

- focus on young operators who possess broader teleinformatics knowledge;
- learn more about the field of telemedicine and e-Health;
- approfondire le questioni legate alla sicurezza dei dati e la privacy sul Web;
- investigate matters related to data security and Internet privacy thoroughly.

Requiring the presence of many different professional figures, including doctors, software packaging engineers and hardware manufacturers, telemedicine is a very complex method of assistance. Moreover, a substantial contribution on the part of auxiliary medical staff and specialised centres which support guarantees a high quality of telemedicine, should not be underestimated.

Pharmacies also make their contribution to the development of this innovative sector: ”indeed, in light of the decree 153/2009, the new role assigned to pharmacies by the legislator emerges firmly and effectively.”[10]

Therefore, the latter will perform a crucial function, assuming a role of real territorial medical care centres, spread largely all over Italy, some of which will remain open 24 hours a day. Furthermore,

10 La fondazione Istud,“Telemedicina e doctor web: l'eHealth che rinnova la Sanità”, retrieved from: http://service.istud.it/up_media/pw_scienziati/telemedicina.pdf, page 26, last access: 28.02.2020)

they will contribute significantly to prevention activities: since inside the structures it will be possible to carry out relevant medical screening interventions on citizens in order to check cholesterol level, blood pressure readings, etc. By discovering potential citizens' health problems before they become serious diseases, this system will not only help treat patients effectively but also will allow the National Health Service to save significant amount of money. In addition, anyone who registers himself or herself, using a health insurance card, will be allowed to view his or her medical record in any pharmacy which has joined the service. Once the patient's authorization has been received, the pharmacy will be able to add data on new treatments, prescriptions, interactions between medicines, etc. As far as the patients with physical disabilities are concerned, it will be their family member or their assistant, after being authorised by the person interested, to be allow to carry out the aforementioned actions. The pharmacies, thanks to homecare systems, will provide a wide range of healthcare services, such as physiotherapy or help of nursing staff directly in the patient's home. It is clear, however, that in order to prove to be truly operative, such a multifaceted process will have to be based on effective collaboration between the parties involved.

6. In conclusion

Telemedicine enables to foster the development and improvement of the quality of medical care, allowing remote access to therapies, diagnostic methods and consultations with the specialists. In addition, the new technologies make it possible to continuously monitor vital signs, thereby significantly reducing the possibility of unexpected deterioration in health condition of patients at risk. Telemedicine permits to have at disposal technological equipment which is widely accessible and to assign suitable roles to healthcare professionals. In this way, the needs of medical staff regarding professional skills, which are often insufficient, can be fulfilled in all Italian regions. It is therefore essential to undertake initiatives aimed at fostering the progress of telemedicine in a concrete way on the whole territory.

The first conclusions can be drawn from the research and evaluation of telemedicine experimentation carried out in Italy and worldwide. Telemedicine improves the Italian National Health System through:

- increase of medical care at patient's home;
- performing and sending diagnoses remotely;
- remote consultation among members of medical staff and better communication with social workers
- rising number of qualified health workers.

The products as well as services created and launched on the market thanks to telemedicine have guaranteed effective and easier solutions to meet the needs which have been so far unsatisfied.

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