New technologies in elderly care

Nowe technologie w opiece nad starszymi osobami

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KEYWORDS:

- aging
- place of living
- care
- modern supporting technologies

ABSTRACT

The aging society in the European Union (EU) is a long-lasting trend and it is reflected in transformations of the age structure of the European population. These changes lead and will continue to lead to an increasing demand for care and support for elderly persons in the foreseeable future. Bearing this in mind, it is important to define the health and social needs of the elderly subpopulation in order to properly plan and implement actions within the broadly understood senior policy. Advanced age and the related diseases as well as geriatric syndromes are associated with a gradual deterioration of mobility and loss of independence that lead to disability and lower quality of life. According to the Public Opinion Research Centre (CBOS) the second most frequently indicated source of satisfaction of seniors are their ties with the "small homeland". Responsible senior policy recognizes the fact that the stay of older people in a well-known, friendly environment with which they are emotionally connected, improves their well-being and, if the place of residence is properly adapted to their needs, improves the quality of life. The above rule complements and clarifies the assumptions of the model of community support for seniors taking into account the principles of independence, participation, care, self-fulfilment and dignity. The use of modern supporting technologies such as telecare and telemedicine or mobile phone applications allow for monitoring and support of the elderly, including the chronically ill, using teleinformation tools in their home setting. Since we are still a country with a relatively low level of advancement in terms of economy and digital society, it is necessary to undertake actions aimed at eliminating the existing social divisions through profiling targeted assistance.

SŁOWA KLUCZOWE:

- starzenie się
- miejsce zamieszkania
- opieka
- nowoczesne technologie wspierające

STRESZCZENIE

Starzenie się społeczeństwa w Unii Europejskiej (UE) jest tendencją długoterminową, widoczną w przekształceniach struktury wiekowej populacji europejskiej. Zmiany te prowadzą i w przewidywalnej przyszłości będą nadal prowadzić do zwiększającego się zapotrzebowania na opiekę i wsparcie osób w starszym wieku. Z tych powodów ważne jest zdefiniowanie potrzeb zdrowotnych i społecznych subpopulacji ludzi w podeszłym wieku, aby prawidłowo zaplanować i realizować działania w ramach szeroko rozumianej polityki senioralnej. Zaawansowany wiek i występowanie chorób z nim związanych, a także wielkich zespołów geriatrycznych, wiąże się ze stopniowym obniżaniem sprawności ruchowej i utratą samodzielności życiowej, co skutkuje niepełnosprawnością i obniżeniem jakości życia. Jak wynika z badań przeprowadzonych przez Centrum Badania Opinii Społecznej (CBOS) drugim najczęściej wskazywanym źródłem satysfakcji osób w podeszłym wieku są ich więzi z „małą ojczyzną". Odpowiedzialna polityka senioralna dostrzega fakt, że pobyt osób starszych w dobrze znanym, przyjaznym otoczeniu, z którym osoby te są emocjonalnie związane, wpływa na poprawę ich samopoczucia i przy właściwym dostosowaniu miejsca zamieszkania do ich potrzeb poprawia jakość życia. Powyższa zasada uzupełnia i doprecyzowuje założenia modelu wsparcia środowiskowego osób starszych uwzględniającego zasadę niezależności, uczestnictwa, opieki, samorealizacji i godności. Zastosowanie nowoczesnych technologii wspierających, takich jak teleopieka i telemedycyna czy aplikacji na telefony komórkowe pozwalają na nadzorowanie i wspieranie osób starszych, również chorych przewlekle przy wykorzystaniu narzędzi teleinformatycznych w ich środowisku domowym. Ponieważ nadal jesteśmy krajem z stosunkowo niski poziomem zaawansowania w zakresie gospodarki i społeczeństwa cyfrowego konieczne jest podejmowanie działań mających na celu niwelowanie istniejących podziałów społecznych poprzez profilowanie pomocy kierowanej

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Published and financed by Centre of Postgraduate Medical Education; https://doi.org/10.36553/wm.131.

Introduction

The aging society in the European Union (EU) is a long-lasting trend that results in transformations of the age structure of the European population and is reflected in the increasing share of older people combined with a declining share of the working-age population in the total population. These changes lead and will continue to lead to an increasing demand for care and support for elderly persons in the foreseeable future. It also means that the financial burden on the working age population in relation with social services indispensable to provide seniors with appropriate living conditions will continue to grow. Considering the above, it appears crucial to determine health and social needs of an elderly subpopulation as well as to schedule and manage reasonable actions aimed at supporting the elderly in broadly understood senior politics, which recognizes the fact that the stay of older people in a well-known, friendly environment with which they are emotionally connected, improves their well-being and, if the place of residence is properly adapted to their needs, improves the quality of life.

Demographic data

The estimated number of the EU citizens on 1 January 2019 was 446.8 million. Young people (aged 0-14) accounted for 15.2% of the EU population, working age people (aged 15-64) accounted for 64.6% and the percentage of the elderly (aged 65 and above) was 20.3%, which represents an increase of 0.3 percentage points in comparison with the previous year and an increase of 2.9 percentage points in comparison to the period 10 years ago. In Poland the percentage of people aged 65 and above in the overall population was 17.7% however, the aging trend appears to be more and more visible in our country. The increase in the relative share of elderly population in overall population might by justified by higher life expectancy; this pattern was visible for several decades with increasing average life expectancy. These changes are often referred to as "aging at the top" of the population pyramid. On the other hand, decades long low fertility rates, resulting in lower numbers of births, have brought about a decreasing share of young people in the total population. This process, known as "bottom aging", causes the base of the population pyramid to narrow.

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According to the Eurostat the ratio of demographic burden of the elderly in 2019 was 31.4%, which means that there were only more than three persons of working age for each person over 65. Also in this case the situation appeared only slightly better in Poland, where in 2019 this ratio was 26.4%. However, the persistently low rate of births (even for the European standards) leads to a rapid increase in the relative number of elderly population in Poland and also affects these proportions.

As part of trend analyses of the aging EU society in the future Eurostat has produced a set of projections regarding the numbers of people in 2019-2100. The number of EU population is predicted to peak at 449.3 million by 2026. In the following years, this number is expected to gradually decline to 416.1 million in 2100. The forecasts also predict that by 2100 the population pyramid will take a more block shape, significantly narrowing at half its height (around the age of 45-54). These changes will be combined with the progressive aging of the older part of the population itself, as the relative size of very old people is growing faster than any other age segment of the EU population. It is estimated that the percentage of people aged 80 and above in relation to the total EU population will be increasing from 5.8% to 14.6% between 2019 and 2100, and the percentage of people aged 65 and above will increase up to 31.3% of the total EU population, compared with 20.2% in 2019. The elderly population dependency ratio in the EU is also projected to almost double from 31.4% in 2019 to 57.1% by 2100. These changes lead and, as shown in the analyses presented, will continue to lead to an increasing demand for care and support for the elderly in the foreseeable future. It also means that the financial burden on the working age population in relation to social services necessary to provide seniors with appropriate living conditions will continue to grow (1).

Health and care specificity needs of the elderly age

The average life expectancy of Poles is increasing thanks to improved standards of living. According to The Polish Central Statistical Office (GUS) the average life expectancy in 2019 was 74.1 years for a man and 81.8 years for a woman. This means that in Poland in 2019 a man aged 60 had an average of over 19 years of life ahead of him, and a woman at that age over 24 years. However, apart from life expectancy its quality is also key importance and this has been shown in multiple statistical analyses as the average number of years without disability (2).

As it appears from Eurostat 2018 statistics, in Poland a man and a woman aged 65 expect to live on average 15.8 more years and 20.1 more years respectively, including 8.2 years and 8.8 years of healthy life, respectively (3).

Considering the above, it is important to define the health and social needs of the elderly subpopulation in order to properly plan and implement rational actions within the broadly understood senior policy.

Health needs of an elderly population result from the overlapping of three factors: a physiological process of aging, an individual pathology of old age and socio-economic conditions. All these factors require a thorough and integrated evaluation and relevant action to be taken in order for an elderly person to be independent and stay in their natural environment as long as possible.

Seniors are not a homogeneous group. Its heterogeneity results, on the one hand, from the individual aging process, and on the other, from the presence of other chronic disease processes (leading to organ dysfunctions) as well as specific medication therapies.

Physiological consequences of the process of aging include primarily: changes in body composition, dysfunction of signalling networks related to homeostasis and neurodegeneration. These changes lead to lower functional reserves, reduction of the wound healing capacity and resistance to stress, and consequently to increased susceptibility to diseases and, finally, the appearance of weakness characterized by a rapidly progressing deterioration of physical and cognitive performance and high mortality (4).

Aging is the highest risk factor for the majority of chronic diseases that increase with age progression. Thus, elderly

patients often develop multimorbidity and, as a consequence, multi-drug therapy. Medications are often taken not in accordance with a doctor's prescription (lower compliance) or without medical indications.

With age progression, physiological changes related with aging overlap with health conditions and these result in specific occurrence and progression of diseases, which often hinder diagnosis and treatment of elderly patients delaying proper diagnosis and implementation of appropriate therapy, which results in a worse prognosis.

Moreover, this situation is further complicated by the fact that elderly people often do not report the symptoms of chronic diseases as they treat them as something natural, age-related, and this also impedes the diagnosis and treatment. Apart from that, multi-morbidity and multi-drug therapies involve a greater risk of iatrogenic syndromes.

Another consequence of aging and inability to adapt to stressful situations is the so-called domino effect. This means that in case of one organ failure the risk of further multi-organ dysfunctions is significant.

Advanced age and the occurrence of related diseases (e.g., dementia, depression, cerebral stroke, cardiac failure, renal failure, complications of atherosclerosis, cancers, osteoarthritis, osteoporosis) as well as the so-called geriatric syndromes are associated with decreasing mobility and vital independence leading to disability and lower quality of life. Geriatric diseases therefore require combining pharmacological treatment with early physical rehabilitation in periods of acute illness and convalescence (the principle of early mobilization).

The multi-morbidity occurring in old age hinders rehabilitation since for each of the pathologies present, the indications and contraindications for each type of therapy should be considered independently and then they all should be included in the planned treatment regimens (5).

Both acute and chronic elderly age diseases lead to deterioration of financial and social situation of the affected person, who requires costly pharmacological therapies, hearing aids, dentures, glasses etc. Moreover, elderly patients require nursing care at home or home adaptation to the needs of the disabled. Thus, health needs are closely related with social and communal needs. This requires tight cooperation between health care and social care facilities.

Considering the above problems elderly people should undergo regular health exams, which should involve not only conversation with a patient but also a physical examination (even if a patient does not report any symptoms) and verification of currently taken medications. In the broadly understood everyday practice a general practitioner usually plays the role of a first-line geriatrician and is assisted by a community nurse.

Specific features of old age are also feminization, i.e., over-representation of women, singularization, i.e., a high percentage of elderly people who run their households single-handedly as well as longevity and double aging of the society, i.e., a rapid increase of people aged 80 and above in overall elderly population (6). These features often cause loneliness, social isolation, a deterioration of living standards, exacerbation of physical condition and general marginalization of seniors.

Elderly people, similarly to a younger generation, need social integration, education, cultural, sport and religious activities. The barrier is often their disability, loneliness, financial shortages, architectural obstacles, difficulties getting on public transportation or even discrimination.

An elderly person in their environment

Although, according to the research conducted by the Public Opinion Research Centre (CBOS), elderly people most often find satisfaction in their family life, the second indicated source of satisfaction among the seniors are their ties with a small homeland, i.e., a place of residence, as well as with friends and acquaintances (7).

Responsible senior policy recognizes the fact that the stay of older people in a well-known, friendly environment with which they are emotionally attached to, improves their well-being and, if the place of residence is properly adapted to their needs, also the quality of their life. The above principle complements and clarifies the assumptions of the model of community support for the elderly, taking into account the principles of independence, participation, care, self-fulfillment and dignity. These principles have been further emphasized in the European Social Charter where art. 23 obliges the Member States of the European Council to enable elderly people to freely choose their lifestyle and independent existence in the familiar environment as long as they wish and are able to do so by:

a) providing flats adapted to their needs and health conditions or providing adequate assistance in flat adaptation;
b) providing medical care and services that are required by the elderly (8).

The Recommendation of the Committee of Ministers to the EU Member States on the promotion of the rights of older people has a similar wording, particularly the section on autonomy and participation, which in item 9 states that elderly people have the right to live independently, in a self-determined and autonomous manner. It includes the right to take decisions on all matters relating to them, including the place of residence. Item 23 is worded in a similar way, highlighting that Member States should ensure adequate support to enable elderly people to adapt their homes to present and future needs, and item 30 requiring community services to enable elderly people to stay in their homes as long as possible (9).

The concept of creating the conditions for equal, active life of seniors in local communities is also reflected in multiple documents of international organizations. One of them is the Resolution No. 46/91 adopted by the General Assembly of the United Nations containing the Principles of Action for the Elderly, the International Action Plan on Aging and the Regional Strategy for the Implementation of the International Action Plan on aging. All these resolutions and recommendations confirm the fact that the Home for every person is a place of special significance where they should feel safe and self-sufficient. Having recognized the significance of choosing the place of living the United Nations included the right to housing in the catalogue of the rights of an individual in the Universal Declaration of Human Rights. Moreover, considering the right to respect for private and family life defined in Article 8 (10) by the European Convention on Human Rights the change of place of residence by the person to be assisted should be last resort measures (11).

The features of a safe senior's place of living

A contemporary person spends inside buildings 90% of their life. Elderly people, professionally inactive, spend the vast majority of this time in their own flats. A flat adopted to the needs of an elderly person, allowing for the most

independent lifestyle, is crucial in ensuring their well-being. A concept of a safe and friendly flat, especially with regard to elderly users who live alone appears to be of crucial importance. Seniors' higher sensitivity to many barriers makes everyday obstacles, caused by inappropriately adapted architecture and equipment to the diminishing physical and psychological abilities of elderly people, particularly burdensome. The rule of a safe senior's flat should be based on the ability to neutralize new limitations that arise with time through appropriate adaptation and furnishing of the flat.

A safe home should allow for detection and notification of dangers as well as emergency calls thanks to sensors and help-summoning devices. The very layout of a flat should be designed in such a way that does not obstruct the access to an elderly person during a rescue operation. It is also advisable to fit the flat with a visible board that could present all important information of the resident; their name and surname, basic information about their health condition, medications and contact details to relatives who look after this person.

Apart from passages and corridors that should be at least 120 cm wide rectangular rooms are recommended, where one of the dimensions does not exceed twice the size of the other. The number of doors in a flat should be also as low as possible. They should be located only in places necessary for privacy reasons, and have a minimum width of 90 cm (recommended 100 cm).

In every room there should be at least one maneuver area of 150 cm diameter for a wheelchair. The rule of functional zones of 150 cm width should be applied also in a bathroom, in a kitchen along all cupboards, in a hall and in bedrooms.

An important feature of a safe flat are handrails, designed to provide support in the most commonly used communication routes as well as handles enabling additional support during potentially dangerous maneuvers in a toilet and a bathroom.

The need to use a larger number of electronic devices means that a safe flat should have an increased number of sockets and power points for additional equipment. Power sockets should be placed not lower than 40 cm above the floor, and should be safe, resistant to plug and cord jerks, and do not require the use of force when plugged in. Electrical protections should be located in a panel accessible to a person on a wheelchair.

Due to the fact that nowadays more and more devices and applications supporting the independent functioning of elderly persons require access to the wireless network an appropriately located router also needs to be considered. A flat should be equipped with individual water and energy meters with the possibility of remote data reading in order to analyze and warn in case of abnormal levels of consumption. It is recommended to equip a flat with solenoid valve on the water connection enabling water cut off by the building management system or servicing staff (12).

Model of social support for elderly people in the living environment

Social support is important for people of all ages but elderly people need it especially. The gradual loss of independence, the more frequent occurrence of disability and chronic diseases, correlated with age, means that an individual must use support, although individual people need it in various forms and to a different extent, depending on a dynamically changing condition of an elderly person.

With an increasing verticalization of a family network, i.e., a lower number of people of the same generation and a higher number of generations living simultaneously, the available support within a family is limited. The inability to meet certain needs related to old age makes it necessary to use various types of assistance that can be provided by the developing technology and IT. It is crucial that all actions aimed at providing support, apart from taking into account the elderly subpopulation heterogeneity (13), consider their cultural resources, family situation, stage of life and economic status as well as the fact that this need changes both with regard to an individual (personal situation of an elderly patient) and collective dimension.

The Polish Social Assistance Act of 12 March 2004 with further amendments its goal is to enable the elderly to continue (as long as possible) living in their current environment.

The specific objectives of the act are to maintain the independence or independence of seniors, to keep the elderly active, prepare older people for old age as a phase of life, to prevent loneliness and social isolation as well as marginalization and exclusion of the elderly, and to provide seniors with a favorable living environment (tailored to their needs) (14).

An own flat providing shelter, a sense of security and satisfaction of the majority of needs is the most important place for an elderly person and their primary point of reference. Enabling the elderly to stay in their own environment requires activities carried out in a financial, organizational and social spheres. The first one is to adapt the premises to the needs of their residents, the second to gradually increase the range of services provided at home, as needed, based on an integrated system of cooperation and collaboration between specially founded institutions and organizations. The third one is associated with the use of local support networks involving informal caretakers, neighbors and volunteers. Social support should be of continuous nature, which means that support activities, although of different extent, should involve all seniors.

Home carers

Long-lasting care for a senior results in psychological consequences for family members, who are confronted with living in prolonged stress associated with responsibility for persons under their care. Moreover, there are also physical burdens, which result from duties connected with running a household and obligation to assist an elderly person in everyday activities. On top of that there are social burdens associated with various forms of isolation of a caregiver. These burdens are significantly aggravated in the absence of help from other people (15, 16). The use of modern technologies supporting both the areas of independence of elderly people and relieving their caregivers may significantly lower the risk of physical, emotional and psychological exhaustion, which appear in persons who provide long-term care, especially for chronically ill elderly people (17).

IT solutions as part of senior's support

One of the most common solutions aiding elderly people are stair lifts (18) enabling them to climb stairs without the risking of falling, since climbing up and down stairs becomes more and more difficult, especially in cases when elderly people have locomotion and balance disturbance,

significant osteoarticular lesions, a history of a stroke with a consequential paresis (paralysis) or increased circulatory and respiratory failure. Stair lifts come in a variety of shapes and sizes to meet varied needs.

Automated and robotic wheelchairs for disabled elderly persons (19) are another element supporting seniors. They are subject to improvements in order to increase their mobility, extend working time and the ability to move around in a variety of terrain. A significant progress has also been made in both traditional and alternative control systems related to controlling the movements of the wheelchair by means of voice or bioelectric signals. The introduction of artificial intelligence (AI) systems, geonavigation and other systems for recognition and avoidance of obstacles allowed them to be used by people with significant functional limitations. An additional benefit is the possibility to fit the wheelchairs with manipulators that allow for activities such as grasping and holding objects, carrying them and placing in a desired place by a robotic chair user. The problem associated with ensuring the safety to the users of automated and robotic wheelchairs is the need to ensure regular technical inspections of both their technical condition and the way they are used as well as the development of secondary lesions (e.g., bedsores) that may occur in the users (20).

A medical exoskeleton is a wearable robotic device that is used as a prosthetic suit (21), which actively aids or replaces the movements of a user. The majority of exoskeletons are capable of climbing stairs or inclinations and some are able to drive motor vehicles. The exoskeleton serves as a support for the body, replaces the damaged elements of the skeletal or nervous system. The exoskeleton is controlled on the basis of movement patterns and individual positions programmed for a given patient during the very process of adjusting the exoskeleton (i.e., arming) and real-time readings from the sensors related to user's intentions as well as the location of individual parts of the exoskeleton. Due to the high complexity of the medical exoskeleton control systems they are equipped with emergency stop devices, accessible to disabled users, as well as other functions based on the data obtained from monitoring of the user, e.g., automatic stop of the exoskeleton in the event of user's fainting along with notification of this event (22).

Integrated environments of disabled people

Ill elderly people with disabilities who rely on assistive technologies may enjoy significant benefits from using integrated environments of disabled persons, enabling adaptation of the support to the needs of the user. Shared use of communication and control infrastructure, lower costs and facilitated modernization are just a few examples of the so-called smart homes*. An important advantage of integrated environments with regard to medical applications is the possibility to combine telemedicine functions with monitoring function operating "in the background".

Rehabilitation robots

The use of rehabilitation robots, particularly as part of home convalescence process, primarily in cardiac or orthopaedic rehabilitation (23) may partially replace physiotherapists in their tedious and repetitive tasks. Additionally, they may improve precision during the performance of certain, repetitive exercises. The possibilities of rehabilitation robots are increased by equipping them with Artificial Intelligence (AI), which allows for adjustment of therapeutic parameters to the changing condition of a patient (24). A growing number of disabled and chronically ill elderly patients as well as difficulties in meeting the ever-growing needs of home rehabilitation, stimulate the development of rehabilitation robotics.

Artificial intelligence

The challenges related to still insufficient support of seniors with the use of broadly understood robotic appliances.

Polish scientist have long years of experience in creating and developing medical robots, yet, only very limited numbers of Polish devices of this type are available on the market. A significant part of work is still at the stage of research or development, and the number of successful commercializations in this field remains insufficient (25).

One of the examples of a successful application of a design thought to manufacturing of a working product is an artificial, bionic hand (26), combining elements of the open Japanese HACKberry project and proprietary solutions for improved control systems. A band with muscle sensors is placed on a forearm, on the site where the nerve and muscle plexuses are found, and in a wireless manner it connects with a prosthesis, studies tensions of muscles and thus controls the movements of the hand. Other projects concern hybrid solutions that will allow for a wireless use of any controller, including voice commands (27).

Both in case of medical robots as well as the mobile ones (care, transportation robots, etc.) there is a noticeable need for them to gain more and more autonomy. This can be achieved by more advanced operation algorithms and human-machine interfaces (Human Machine Interface, HMI) and human-to-robot (Human Robot Interface, HRI) interfaces.

They, for example, help to motivate the patient in the process of their rehabilitation, control this process and learn the condition of the patient (by a robot) and adjust exercises to user’s current physical abilities. Additionally, the system responds to patient's changing conditions and records the data on their progress of exercises. It is also equipped with a function of sending reports to a human coordinator. However, it is still a challenge to design such a navigation system, which would not cause fear, especially of senior users, when robots perform operations with regard to a supported user or a group of users. Inappropriate "behaviour" of a robot may arouse negative emotions and discourage the further use. There are also opinions that there is a risk of replacing human caregivers with mechanical ones (28) and comments that even if robots may support the autonomy of the elderly and assist them in changing clothes and bathing, which is positive, they may also force an elderly person if the designers programmed it to proceed with activities against the wishes of the user. When Artificial Intelligence (AT) robots force users to take a particular course of action because the programmers believe they know what is best for users there is a risk of development of undesired paternalism.

Also, there are concerns that the users may become so dependent on robots that this could weaken their ability of self-caring and lower their independence (29). However, it should be noted that concerns regarding dependence on robots have also been raised in case of human caregivers. Due to the above reasons it appears necessary to develop principles of human – robot cooperation. This applies to various groups of people; elderly persons,

children, patients as well as medical and care personnel. Such principles will certainly increase acceptance of robots among various social groups (30).

Home telemedicine care

The increase in the number of elderly people who require periodic or permanent medical supervision puts an increasing burden on organizational and financial systems of social and health care. The failure of these systems to keep up with the needs compels further works on the development of new, more efficient methods that would enable the ongoing control of the health condition of a large group of people and quick response in the event of an emergency. Such possibilities are created by telecare and telemedicine. These dynamically developing forms of care require a thorough cooperation between medicine and information and communications technologies as well as hands-on input from medical professionals as well as participation of technical means, sensors and software used for data acquisition and analyses that are provided by engineers and IT specialists.

The World Health Organization (WHO) defines telemedicine as "the delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of patients" (31). Telemedicine may be also treated as the exchange of medical information between two locations using electronic methods of communication, including wireless tools, e-mails, bidirectional video, smartphones and other telecommunication technology methods to improve patient's health. Thus, apart from the direct health benefits of constant supervision and quick access to services telemedicine has some additional advantages, crucial from public health perspective, in the form of providing equal opportunities regarding the access to these services by these groups of people who are less privileged due to their residence in areas less densely populated, far from stationary health care facilities or unable to reach a treatment facility due to their health condition. Simultaneously it lowers the physical involvement of medical personnel in situations where it is indispensable, for example while prolonging indications or prescriptions for chronically ill patients in a stable condition. The key advantage of telecare and telemedicine for elderly people is the possibility to prolong their stay at home and in their environment as well as to delay the need to use inpatient treatment or institutional care. The related increase in the sense of security and quality of life is not without significance (32).

There are several types of e-health services that directly apply to elderly care (33):

1. Telecare and telediagnostics used for permanent or periodic supervision over chronically ill patients or patients with functional limitations. They can reduce the need for institutional care and lower the number and length of hospital stays by monitoring the patient's health at home. They involve conducting supervision with the use of appropriate sensors that can monitor body weight, body position (fall?), the level and type of physical activity and basic vital parameters such as heart rate, blood pressure, oxygen saturation, respiratory rate. Moreover, they can test blood glucose levels, perform an ECG, control the work of a pacemaker or an ear implant, and at the same time, with the use of appropriate software, they may correct the functions of such devices (34, 35, 36). These and other devices that are easy to use and do not pose any problems in the daily life of a patient automatically collect and send data for analysis and ensure its safe transmission. Ideally, the initial data analysis should be performed by specialized software at monitoring centers, and in the event of suspected deviations from the norm, the data should be sent for evaluation by medical professionals. Then, if there is a need for quick intervention the patient could seek assistance in an appropriate form (from on-line consultation through personal consultation to ambulance calling).
2. Online consultation/teleconsultation i.e., the possibility to conduct consultations in real time via telephone or audio-video with a primary care physician, specialist doctor or other specialist providing services within the scope of broadly understood health care, for example with a physiotherapist. Teleconsultation is not recommended at the first visit, during which the patient should be examined personally by a doctor, but is extremely useful during routine consultations aimed at verifying the health of a patient known to the service provider or extending the indications or issuing a prescription. The quality of this type of service is increased by the data obtained during the monitoring of relevant parameters within telcare and telediagnostics. Teleconsultation shortens the appointment time, thanks to which a doctor can consult a larger numbers of patients. Moreover, it significantly saves the time of a patient, who does not have to go to the clinic in person. On the other hand, this form of contact for some people, especially the elderly, for whom a visit to a doctor is an important element of their social life, may not be satisfactory and may not provide them with a sense of security.
3. Telerehabilitation – a service supporting a patient in their rehabilitation at a distance, provided through interactive telecommunication technologies. A rehabilitation session may be conducted by a specialist supervising the performance of exercises via a camera. The patient can also perform the exercises on their own, using interactive software, for example, based on biological feedback (bio-feedback). In such a case, they immediately obtain information if the exercise was performed correctly. In telerehabilitation, virtual reality equipment can also be used, which is effective, for example, in neurological rehabilitation. Telerehabilitation cannot completely replace all rehabilitation activities, because many of them require the personal involvement of a therapist and physical contact with the patient, but it can be very useful in cases that do not require constant contact and as a supplement and home continuation of standard therapy in patients requiring long-term rehabilitation who cannot or may not need to see a specialist frequently (37, 38).
4. Teleteaching enables a patient to gain knowledge about their problems and possible management through appropriate platforms and knowledge portals.

Currently, as a result of the need to adapt to the COVID-19 pandemic conditions, teleconsultations, especially in the field of primary health care, have become more common. Despite this, it cannot be argued that the market of telemedicine services in Poland is developed. Much of these services, going beyond basic teleconsultations, are given by private

healthcare providers who also offer "traditional" medical services. These services are financed by private patients' funds. On the other hand, in 2015, the National Health Fund introduced the procedure of "cardiac or geriatric council" to the guaranteed benefits package, enabling cardiac and geriatric teleconsilia (39). Before the COVID-19 pandemic, only a few publicly-owned healthcare entities decided to use telemedicine solutions in the care of their patients. For example, the Institute of Cardiology in Anin conducts remote ECG consultations and remote cardiac rehabilitation, the Silesian Center for Heart Diseases conducts remote control of pacemakers and cardioverter devices and enables teleconsultation, while the Institute of Physiology and Pathology of Hearing in Kajetany, through the national teleaudiology network, can conduct telerehabilitation classes, correct the function of ear implants and provide teleconsultation.

Initially, telemedicine services require very high financial investment. The most expensive procedure is to organize efficiently functioning monitoring centers. It is estimated that such a center should look after 10,000 patients in order to start generating profits instead of losses. The costs of the sensors themselves, sometimes very sophisticated, which are passed on to patients (or which are purchased by them), are significantly lower. Taking into account the low level of income of elderly people in Poland, it should be assumed that in order for e-health services to become widely available for this group of people, they should be included in the basket of guaranteed benefits in a broader scope, much greater than at present in the COVID-19 era and be financed from public funds. On the other hand, public and private entities providing telecare services and with the use of telemedicine should be able to contract them with a public payer. The legislator and other decision-making bodies should recognize another advantage of this type of services, apart from promotion of health and facilitation of the social and medical care organization, i.e., the reduction of costs of care for elderly persons related to their implementation and mass application. It is possible especially because one good monitoring center can provide services to many providers who purchase the service, significantly reducing unit costs. In addition, proper supervision, quick response and prevention of problems can greatly reduce the need for expensive medical services resulting from the need to treat a person with a neglected, advanced disease and its complications (40).

Another problem hampering the development of telemedicine services is the low public awareness and the lack of trust in this form of contact with service providers, especially on the part of elderly people, who are used to face-to-face contact (41). They perceive a telephone or computer conversation as dehumanizing, they do not feel that their problems are taken "seriously" and are unable to receive non-verbal stimuli. As a result they feel that their interlocutor is less engaged in the conversation. The problem of "digital exclusion", especially affecting the oldest people, is not without significance here; according to the report "Digital exclusion in Poland" in 2015 only 15% of people aged 65 and above used the Internet (42). It should be noted, however, that in younger age groups, Internet use is more common and the problem of digital exclusion of older people will be decreasing spontaneously over time. Digital exclusion involves a few factors. First of all, elderly people believe that there is no need to use the Internet, and even if they see advantages of its application, they do not have the skills to do so (43). Secondly, in many regions of Poland, the lack of access to optical fibres is an obstacle. Thirdly, although some local governments offer such access for free, the rule is, how-ever, that the users need to purchase a data package, which creates a financial barrier. An additional financial obstacle for many seniors is a high price of a smartphone or a computer. Yet, digitally excluded people still have the possibility to obtain teleconsultation. However, they cannot use more advanced teleconsultation and telecare or telerehabilitation services, which require a smartphone or a computer and access to broadband Internet.

Currently, various sensors, receiving devices and software are available on the market, which are used by service providers (so far in Poland only to a small extent) offering teleservices. Therefore, another problem that must be faced when planning the development of telemedicine is the need to determine standards and integrate infrastructure and software into one unit that works at all levels.

The amendment to the Act on the Information System in Health Care and some other acts, which entered the legal circulation in 2015, made it possible to provide remote health services in a legal manner. Moreover, the amendment to art. 42 of the Act on the Profession of Doctor and Dentist has been also introduced. Thanks to that, physicians can now make judgments about a patient's health after examining them in person or via teleinformation or communication systems. Similar changes were made to other acts regulating the work of other professional health care workers, such as nurses, midwives and paramedics (44).

In conclusion, telecare services and telemedicine services in Poland are still not widespread and are usually financed from private sources. However, in view of the quickly approaching demographic changes, telecare and telemedicine should become one of the elements of an effective set of health services. Therefore, it is urgent to create and update the law enabling the widespread use of e-health care services, design monitoring centers, increase the reach of broadband Internet and conduct mass training courses that reduce digital exclusion of the oldest members of our society.

New technologies for elderly persons with diabetes

The market of mobile phone applications supporting diabetes management is developing very dynamically. They offer functions that assess the most important elements of diabetes treatment, including analyses of glycaemia, nutrition, body weight, physical exercise, insulin dose calculation and diabetes management education (e.g., MySugar, Health, Accu-Check Connect, Contour Diabetes, forDiabetes). These applications enable patients to manage the diabetic condition autonomously (45).

The increasing incidence of diabetes, combined with a growing global shortage of health care workers and the SARS-CoV-2 virus pandemic, compel the need for new methods of providing diabetes care, which could widen the access to medical care and reduce the burden on diabetic people (46), e.g., by sending data from application to a diabetes clinic for further discussion of the results of treatment during a teleconsultation (e.g., Accu-Check Connect, X-Drip, Dexcom). Thanks to the application, it is possible to fill an e-prescription at a pharmacy without leaving your home, to remind a patient of a doctor's appointment or to contact a qualified educator who helps in the treatment of diabetes (e.g., Diabdis). Many applications are featured with multiple functions, which may seem overwhelming and difficult for the elderly to learn. Some of them are paid, which can pose an obstacle for patients.

In view of the growing market of mobile applications for people with diabetes, a joint report by The European Association for the Study of Diabetes (EASD) and The American Diabetes Association (ADA) Diabetes Technology Working Group was published (47). A meta-analysis of clinical trials (2018) on the effectiveness of mobile phone applications in modifying lifestyle in various subtypes of diabetes showed a statistically significant reduction in the average HbA1c level only in type-2 diabetic patients using applications (48). A greater reduction of HbA1c by − 0.96% was observed among patients using applications containing educational and coaching programs (49). A systematic review (2020) analyzing the results of six previous meta-analyses on the effects of mobile applications on HbA1c, body weight and BMI found their combined beneficial effect in terms of health (50). The cumulative score for self-care behaviors is considered significantly higher among diabetic application users (compared to non-application users), and the score for the three individual components of self-care, namely blood glucose monitoring, diet and physical exercise, is significantly higher among diabetic application users than among patients who do not use them, and higher among persons with type-2 diabetes (51).

Due to the disadvantages related to the frequency and quality of self-performed glucose measurements, new technologies and devices for the assessment of blood glucose were sought after. Therefore, following the era of glucose meters, glucose sensors and devices for continuous glucose monitoring (CGM) and flash glucose monitoring (FGM) started to gain popularity (52).

A review and meta-analysis of studies on the effects of self-monitoring of glycaemia on diabetes control has shown that it is a very effective tool for the detection, prevention and treatment of hypoglycaemia, as well as for the improvement of glycaemic control expressed by reduction of HbA1c values (53, 54). The use of these devices improves metabolic compensation and reduces the risk of developing micro -and macrovascular complications. Also in case of lowering blood glucose levels, the alarmed patient may eat an additional meal, and the doctor may modify the treatment more precisely. Observation of postprandial glycaemia trends allows for diet balancing and the analysis of post-exercise glycaemia allows for adjustment of meals to a physical activity.

These systems include a sensor, a receiver and a monitor. The sensors measure glucose concentration in subcutaneous tissue fluid. The signal from the electrode is transmitted via radio waves to the storage device, a receiver (transmitter). Blood glucose values are displayed on a special monitor worn separately by a patient or in the application on their phone, either continually (CGM) or when approximated to the sensor (FGM). Glucose data may be submitted for retrospective analysis by a physician. Importantly, the glucose concentration at the time of measurement in the tissue fluid differs from the blood glucose concentration, but the delay of the glucose concentration reading by the CGM with regard to the blood concentration in the currently available systems takes only a few minutes.

Several devices for monitoring glycaemia are available on the Polish market (e.g., Dexcom, Guardian Medtronic, Eversense, FS Libre). CGM/FGM system calibration or validation measurements should continue to be performed despite the use of a blood glucose monitoring device. Individual systems differ from each other in the size of a sensor, the duration of use (7-180 days), the way the sensor is applied, the size of the injection and transmitter, and the presence of alarms corresponding to glycaemic trends (55).

In Poland, due to the high costs the use of CGM devices is very limited. These solutions are not reimbursed for adults, despite the fact that expert bodies recommend their use (56).

Digital technologies and digital maturity

E-health related to the use of digital technology for remote care is applicable in both the health and social care sectors. Telehealth, telecare, telemedicine, telecoaching or mobile health as well as telemedicine home care (tele-homecare) are integrated and comprehensive modes of supervision of chronically ill patients and elderly persons with the use of teleinformation tools in their home environment. They include both remote contact of a patient with a doctor, nurse or medical caregiver in the form of teleconsultations or videoconference, monitoring of life parameters as well as falls and fainting or other situations potentially dangerous to health or life, using the so-called alarm sensors.

Along with the growing importance of modern technologies, in particular modern information technologies, the ability to use them often becomes a necessary condition for the full participation of individuals in a community, while the inability to use these technologies leads to a gradual exclusion and deepens existing inequalities in a society. Apart from wealth, education level, place of residence and degree of urbanization, one of the most important factors influencing the possibility of using modern technologies is the age of people who want to use them (57).

In Poland, in 2014-2018, the percentage of people aged 65-74 using computers regularly, i.e., at least once a week, was constantly increasing (from 20.1% to 27.9%) but it was still significantly lower than in the group of pupils and students, in which in 2018 this percentage was 97.4%. Elderly people still have a low level of digital competences; in the group of people aged 65-74, the percentage of persons with basic and higher digital skills amounted to 9.1%, and in the population aged 16-74 it was 45.9% (58). Despite a continuous improvement, the situation in the field of digital skills in Poland is considerably worse than in most EU countries.

Low level of digital skills may be associated with both internal (e.g., lack of motivation, poor health) and external (e.g., lack of access to training, limited access to broadband Internet) reasons, which lead to a significant disproportion between urban and rural areas, and are the main obstacle in the implementation of modern technologies in the elderly care.

It should be emphasized that involving elderly people in various activities, including the development of digital skills, should allow them to maintain their self-esteem and sense of belonging to a modern society. Moreover, intellectual training through development of digital skills can help elderly people to stay active in terms of cognitive functions. It can therefore be said that the development of digital skills can significantly improve the quality of life of the elderly.

Political initiatives

Strategic document "Social policy for Older People 2030. Safety – Participation – Solidarity ", was adopted by the government in October 2018 (59). The program concentrates

on the development of various services, tailored to the needs and capabilities of elderly people, and indicates priority goals in the social policy regarding the elderly, including the improvement of architectural, digital and organizational accessibility of public institutions, e.g., under the "Accessibility Plus" program and the development of various community-based forms of day care for the elderly, among the others as part of "Senior+" program (60).

Summary

There are many obstacles in Poland that hinder the development of modern technologies in the area of elderly care, one of the reasons being that we are still a country of low advancement in terms of economy and digital society. There are large territorial disparities in access to networks between urban and rural areas, as well as significant differences in digital skills between various groups depending on age and education. Therefore, it is necessary to undertake activities aimed at eliminating the existing social divisions by profiling the directed aid (61).

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