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REVIEWS

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Modern technologies for improving elderly patients' compliance

ANNA SUSŁO[1, A, B, D–F], MÁRIA BELOVIČOVÁ[2, B, D], SYLWIA MIZIA[3, B, F]
ORCID ID: 0009-0004-6771-9682 ORCID ID: 0000-0001-7397-6133 ORCID ID: 0000-0001-5922-7750

[1] St Luke's Hospital in Boleslawiec, Boleslawiec, Poland
[2] Faculty of Public Health, Slovak Medical University, Bratislava, Slovakia
[3] Epidemiology and Health Education Unit, Population Health Department, Faculty of Public Health, Wroclaw Medical University, Wroclaw, Poland

A – Study Design, **B** – Data Collection, **C** – Statistical Analysis, **D** – Data Interpretation, **E** – Manuscript Preparation, **F** – Literature Search, **G** – Funds Collection

Summary Ageing is associated with decreasing psychomotor skills and an increasing dependency upon others. Family bonds in modern societies are often weakened or broken, and thus the traditional primary source of support for the elderly has largely ceased to exist. Progressive multimorbidity means that elderly patients often have to adhere to multiple overlapping drug regimens, involving long-term or even indefinite medication protocols. Such chronic polypharmacy is likely to adversely affect patients' adherence. We performed a literature review with the aim of identifying, first, the problems associated with compliance with medical directions among people 60 years of age and older and, second, the solutions to this problem now available due to modern technological advances. The gold standard of therapy in elderly patients is personally observed or directed therapy, but in practice, this is often unavailable. The phenomenon of the ageing of society challenges the healthcare system with an increasing number of community-dwelling elderly people who are increasingly dependent upon others, which negatively impacts their level of adherence to therapy. Considering the deepening scarcity of medical personnel and the limited availability of caregivers, only broad application of solutions based on modern technologies will be able to significantly improve patients' compliance, and thus the effectiveness of their treatment.
Key words: patient compliance, medication adherence, cooperative behavior, information technology, aged, drug therapy.

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Background

Ageing is associated with decreasing psychomotor skills and an increasing dependency upon others. Family bonds in modern societies are often weakened or broken, and thus the traditional primary source of support for the elderly has largely ceased to exist, increasing their risk of being subject to neglect, self-neglect [1] or even suicide [2]. In this situation, although the vast majority of people 65 years of age or older tend to still live in their communities, the number of institutionalized older people increases with age [3]. The number of facilities providing inpatient social care is gradually increasing in Poland, but the rate of this is far too small to meet the rapid increase in demand that can be attributed to the ageing of society [4]. Among the various impairments that may affect the elderly, psychomotor disorders (including dementia) are of special significance, as they make technology-based improvements difficult to introduce because of the patient's frequent failure to cooperate; this often progressing to the point of full dependency upon others and a need for permanent supervision [1]. Similar problems arise from the variety of psychiatric ailments that affect elderly people, including depression (commonly underdiagnosed) [5] and psychiatric representations of somatic disturbances [6, 7], which can limit patients' capabilities to express their will [8], such as effectively giving consent to medical treatment [9]. Deterioration of the senses, especially visual impairment, play a similar role in limiting the level of the older people's ability to care for themselves; these can only be overcome to a limited extent, even with the use of the latest medical advances, at least outside of a few notable examples, such as highly efficient cataract treatment [10]. One factor that sets elderly patients apart from most other patient groups is that they are affected by frailty syndrome [11], predisposing them to the development of acute illness, to exacerbations of preexisting chronic conditions and to complications during diagnosis and treatment. Consequently, even successful alleviation of the symptoms of a single health condition [12] is often not sufficient to allow an elderly person to maintain his or her functional independence in everyday life [13], because with age comes the increasing risk of the coexistence of multiple health problems, called multimorbidity, which significantly increases the cost of medical care [14] and the difficulty of providing secure social care [15]. The complex set of problems affecting the elderly population requires the acceptance not only of an individual and holistic approach [16] but also of an organised and systemic approach [17]. In the absence of this, it can be expected that elderly patients' basic needs will not be met and that limitations will affect their chances of maintaining an acceptable quality of life and level of health safety [18] (which will be restricted by availability [19]), their access to adequate medical diagnostics and treatment [20], their access to health education [21] and prevention advice [22], their equal access to benefits [23], their safety from unnecessary risks [24] and abuse [25] and their compensation in case of suffering harm [26, 27].

Material and methods

We performed a literature review in order to identify both the problems associated with compliance with medical directions among people 60 years of age and older and the solutions made available by modern technological advances.

Results

Adherence to the treatment regimen is one condition necessary for the efficacy of therapy. Unlike in younger age groups, in older patients (who are often retired), adherence to treatment and the therapeutic efficacy it produces does not translate into health-related productivity [28]. Its importance thus tends to be underrated, which is unjustified given that the cost of treatment per patient is higher in older age groups [14] and ineffective treatment in the initial stages of diseases increases their risk of rapid progression [29], resulting in premature multimorbidity. The lack of adherence to the treatment regimen among the elderly may lead to serious complications, demanding significant and costly medical interventions, and may result in life-threatening outcomes, such as falls [30]. Nonadherence to a therapeutic scheme may occur in a variety of ways [31], ranging from shifts in drug administration time, to lowering or missing some doses, to pausing or halting therapy with some or all prescribed medications; it may also involve taking prescribed medications more often or in greater doses, or taking prescription drugs that have not been prescribed to the patient, instead being sourced from alternative sources – such as medications received or stolen from others, or even purchased on the black market.

Progressive multimorbidity means that elderly patients often have to adhere to multiple overlapping drug regimens involving long-term or even indefinite medication protocols. Such chronic polypharmacy is likely to adversely affect patients' adherence [32]. Elderly patients' compliance with medication regimes tends to be decreased by the complexity of some schemes [32], especially when patients are less well educated [33], are ignorant of the disease or its complications [34] and are less aware of the treatment's nature [35] or justification [32, 33]; additionally, coexisting dementia [36], cognitive [37] or other functional impairments, disability [32] and economic problems [32, 38] often translate into unfilled prescriptions [39]. Besides low socioeconomic status [40], there are negative effects that arise from the lack of family or social support [41] or the lack of regular follow-up visits by the physician [42]. Self-medication with over-the-counter drugs or home remedies [43], as well as participation in complementary or alternative medicine, may cause patients to disobey the physician's directions for therapy [44]. A lack of compliance is likely to be observed, especially in cases when the patient suffers from adverse effects of treatment [33] or where some degree of improvement of symptoms has already been achieved, giving the patient the subjective perception that the leading ailments have been to some extent alleviated [32]. Surprisingly, problems with therapy regime compliance are not only common in less-symptomatic chronic diseases, such as diabetes [45], hypertension [46], metabolic syndrome [47] and osteoporosis [48], but also in conditions where demonstrable symptoms prevail, such as asthma [49] and chronic pain [50]. Only about 80% of geriatric patients fully follow the recommended therapy to the first check-up visit [32]. The extent of patients' compliance can be objectively evaluated using structured questionnaires, including the five-item Medication Adherence Rating Scale (MARS), the eight-item Modified Morisky Adherence Scale (MMAS) and the thirteen-item Strathclyde Compliance Risk Assessment Tool (SCRAT), especially in order to identify patients who may require assistance in managing their medications [51].

The gold standard of therapy in elderly patients is personally observed or directly observed therapy (DOT) [52]. Unfortunately, this is practically unavailable in most cases due to the scarcity of medical and caregiving personnel [53]. Long-acting drugs available in forms that can be administered under supervision once every few days, weeks or even months are still rarely available [54]. Modern technologies have become ubiquitous [55] and, as such, are potentially capable of significantly improving patients' treatment compliance. However, in order to utilise their full potential, a certain level of familiarity with programmed products and computer skills, known as digital literacy, is desirable [56]. The widening scope of available technologies include: the monitored use of electronic medication boxes [57], reminders from live operators, automated phone calls, SMS text messages [58], MMS multimedia messages [59], chatbot messages [60], smartphone app reminders [61], real-time video directly observed therapy (VDOT) [52] or recorded video observed therapy (VOT) [62] or even ingestible sensors [57]. Besides drug-related interventions, patients' adherence to other prevention and therapy options, like directed physical exercise, may also be supported by means of modern technologies [63], including wearable physical activity trackers [64], accelerometers [65] or pedometers [66].

A single-pill once-a-day regimen is a gold standard of treatment [67] that is unreachable for the vast majority of patients nowadays, especially for elderly people with multimorbidity. Pill boxes are a classic approach to monitoring and improving compliance in self-managed therapy, especially with multidrug regimens [68], along with other methods such as regularly questioning the patient, counting pills used and remaining in packaging and blood sampling for drug levels [69]. The addition of electronics to pill boxes has opened new horizons, as their contents and exact day and time of their usage can be recorded [70] or even monitored remotely around the clock by medical personnel or caregivers, even triggering an audible reminder or a customised audiovisual alarm on the patient's smartphone [71]. Such recordings alarmingly reveal that more than 20% of patients omit more than 20% of medication doses, and only 2% of them take drugs precisely at the set time; 25% of patients are acceptably accurate, while 44% of patients take their pills irregularly, and 8% show no pattern at all in taking their medication [72].

So far, SMS and MMS messaging systems have been tested for a wide variety of health-related conditions that demand especially high adherence to prolonged prevention or therapy regimens, including tuberculosis treatment [58], antiretroviral therapy [73], hormonal contraception [74] and primary [75] and secondary prevention [76] of cardiovascular incidents. They have proven to be a convenient and cost-effective way of improving patients' efficacy in self-managed therapy adherence [77] or in keeping healthcare appointments for regular prescription and renewal of drugs [78]. However, unidirectional mobile phone-based interventions seem to be less effective than interactive methods [79].

The use of automated phone services and chatbots is on the rise as a way to provide more personalised care to patients with less input from scarce medical personnel [80]. Internet websites and web-based smartphone applications have shown positive results in supporting patients with high digital literacy to monitor their health-related quality of life (HRQoL) and symptoms and to obtain personalised feedback and tailored support and treatment options [81].

Numerous smartphone apps available for the main operating systems support medication self-management [61] and therapy regimen adherence [82]. The level of complexity of such software varies widely, from simple medication lists and reminders to advanced interactive virtual assistants that not only send medication reminders to patients and their caregivers but also track patients as they take medication or miss doses, while also allowing notes to be taken on reported symptoms, side effects and other treatment topics [83]. Such approaches have been tested in the treatment of numerous conditions, mainly chronic, including diabetes [84], arterial hypertension [85], cardiovascular disease [86], heart failure [87], ankylosing spondylitis [88], postoperative pain [89], cancer [90] pain, food allergies and intolerances [91] and sleep disturbances [92]. These smartphone apps are already commonly used for positive lifestyle modifications, including starting and maintaining healthy and slimming diets [86].

Video observed therapy, whether in real-time (VDOT) or recorded (VOT), can replace directly observed therapy (DOT). Unfortunately, the high demand for personnel and the need for properly operated technical equipment means its use it limited to the few cases where adherence to the therapy regimen is of critical importance and where direct observation by medical personnel is unavailable, as in the case of tuberculosis treatment [52] or buprenorphine [93] or methadone-based take-home opioid dependence treatment programmes [94]. However, recent technological advances mean that photo and video recording and remote transmission with smartphones [95] via telecommunication networks, including the Internet, has become inexpensive and easily available to virtually anyone in society, which potentially transforms such therapies into efficient and practical healthcare and public health options [96, 97], including in the case of elderly patients with limited self-care capabilities.

The efficacy of wearable trackers as tools for objectively measuring, reporting and directing physical activity [98] has been shown among healthy individuals on health education programmes aimed at increasing exercise participation [99], as well as in patients with a wide variety of health-related problems, including diabetes [100] and other cardio-metabolic conditions [101], including among the community-dwelling elderly [102].

Discussion

Modern technologies allowing patients to take drugs under supervision [52, 57, 62], on prompts from human operators [58] or upon the advice of programmed computer systems [59–61] are becoming the new normal. However, with all the networked means of monitoring therapy, a new approach to maximising compliance among patients may be to merge these solutions with various technological means of influence in an attempt to maximise effectiveness through the gamification of therapy, transforming it into a positively engaging contest of sorts, where scores are kept and compared with others, while positive or negative points can be gained for fulfilling therapy-related tasks in a timely manner [103], and task-related and score-related feedback, motivation and incentives can be received [104]. Gamification-based interventions have been used with the aim of modifying habits of significance for public health, including, at first, short-term smoking abstinence [105] and then smoking cessation [106]. This approach is already well-known from smartphone applications that track physical activity and which have proven to be effective in altering users' behaviour and keeping them using the app [107].

Artificial Intelligence (AI) is rapidly becoming ubiquitous in all aspects of the life of the modern patient, and the use of AI-assisted chat has already been explored in lifestyle modification [108]. AI-based interactive ChatGPT-like assistants are already supporting treatment and medication adherence [109]. Ensuring that they are available and connected to devices that monitor drug therapy and dispense pills at home may, for the moment, be science-fiction, but this is unlikely to remain so for too long.

Conclusions

The ageing of society is confronting healthcare systems with an increase in the number of community-dwelling elderly people who are increasingly dependent upon others, which negatively impacts their level of adherence to therapy. Considering the deepening scarcity of medical personnel and the limited availability of caregivers, only the broad application of present and emerging solutions based on modern technologies will be able to significantly improve patients' compliance, and thus the effectiveness of their treatment.

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Address for correspondence:
Anna Susło, MD
Zespół Opieki Zdrowotnej w Bolesławcu
Szpital św. Łukasza w Bolesławcu
ul. Jeleniogórska 4
59-700 Bolesławiec
Polska
Tel.: +48 757380200
E-mail: anna.suslo@hotmail.com