

The Role of Occupational Therapy in Enhancing Independent Medication Management and the Usage of Self-Administered Drug Delivery Devices Among Elderly Patients

Asma Ibrahim Alfayez¹, Munira Mutlaq Alharbi², Sulaiman Mohammed Aldawsari¹, Layla Abdulaziz Almusaad³, Hassan Sulaiman Alrasheed^{1*}

¹Occupational Therapy, Prince Sultan Military Medical City, Riyadh, Saudi Arabia.

²Occupational Therapy, Sultan bin Abdulaziz Humanitarian City, Riyadh, Saudi Arabia.

³Occupational Therapy, King Abdulaziz Medical city (NGHA), Riyadh, Saudi Arabia.

Abstract

Background: Aging is associated with multimorbidity, polypharmacy, cognitive decline, and functional limitations that impair medication management and increase the risk of medication errors and poor adherence. Occupational therapy (OT) plays an important role in promoting safe and independent medication use among older adults.

Objective: To review the role of occupational therapy in enhancing independent medication management and the use of self-administered drug delivery devices in the elderly.

Methods: This narrative review summarizes current evidence on medication management challenges in older adults, occupational therapy assessments and interventions, assistive technologies, and emerging drug delivery systems that support medication adherence and independence.

Results: Occupational therapists improve medication management through functional and cognitive assessments, individualized interventions, environmental modifications, caregiver education, and integration of medication routines into daily life. The use of adaptive devices, smart medication technologies, and advanced drug delivery systems further enhances adherence, safety, and independence.

Conclusion: Occupational therapy is essential for improving medication adherence, reducing medication-related risks, and promoting independent living in older adults. Integrating occupational therapy into multidisciplinary geriatric care can improve health outcomes and quality of life, although further research is needed to strengthen the evidence base.

Keywords: Occupational therapy; Medication management; Older adults; Geriatric care; Medication adherence;

How to cite this article: Alfayez AI, Alharbi MM, Aldawsari SM, Almusaad LA, Alrasheed HS. The Role of Occupational Therapy in Enhancing Independent Medication Management and the Usage of Self-Administered Drug Delivery Devices Among Elderly Patients. *Int J Drug Deliv Technol.* 2026;16(72s): 1335-1348. DOI: 10.25258/ijddt.16.72s.144

Source of support: None **Conflict of interest:** None

INTRODUCTION

Aging has chronological, social and psychological dimensions and it is a physiologically inevitable process. Aging can be defined as the time-related deterioration of the physiological functions necessary for survival and fertility.¹

The causes of aging can be summarised as follows:

1. **Oxidative damage**²: According to this theory, aging is a result of normal metabolism; no mutations are required. About 2–3% of the oxygen atoms taken up by the mitochondria are reduced insufficiently to reactive oxygen species (ROS). These ROS include the superoxide ion, the hydroxyl radical, and hydrogen peroxide. The reactive oxygen species that are generated can oxidize and damage cell membranes, proteins, and nucleic acids. Thus, contributing to aging.
2. **General wear-and-tear and genetic instability**³
As one gets older, minute traumas to the body build up. Point mutations increase in number, and the efficiencies of the enzymes encoded by our genes decrease. Moreover, if a mutation occurs in a part of

the protein synthetic apparatus, the cell would make a large percentage of faulty proteins. Moreover, genetic defects in DNA repair mechanisms can produce premature aging syndromes in humans⁴

3. Telomere shortening

Telomeres are repeated DNA sequences at the ends of chromosomes. Most mammalian somatic tissues lack telomerase, so it has been proposed that telomere shortening could be a “clock” that eventually prohibits the cells from dividing any more. When human fibroblasts are cultured, they can divide only a certain number of times, and their telomeres shorten. If these cells are made to express telomerase, they can continue dividing.^{5,6} This indicates a role of telomere in aging.

4. Genetic controlled aging mechanism

Several genes have been shown to affect aging. In humans, Hutchinson-Gilford progeria syndrome causes children to age rapidly and to die (usually of heart failure) as early as 12 years,⁷ so genetically

controlled mechanisms can lead to aging and early death.

5. **Epigenetic alterations** : they are changes in gene expression patterns that are not caused by changes in the DNA sequence itself. They are alterations in genomic regulation not directly encoded by DNA, i.e., alterations that do not change the DNA sequence but instead control gene operations. These changes can contribute to the development of age-associated diseases.⁸
6. **Loss of proteostasis**: Proteostasis denotes protein homeostasis, which includes the maintenance of stable functional proteins. Its loss refers to the gradual breakdown of protein homeostasis or the ability of cells to maintain their proper protein folding and degradation. Upon aging, proteostasis weakens. It results in diseases such as Alzheimer's and Huntington's diseases.⁹
7. **Dysregulated nutrient sensing**: The body's ability to sense and respond to changes in nutrient availability becomes impaired with age, which can lead to metabolic dysfunction and an increased risk of age-associated diseases such as diabetes.¹⁰ There are four nutrient sensing pathways and there can be a defect in any of these:
 - Insulin and IGF-1 signaling (IIS)
 - Mechanistic target of rapamycin (mTOR)
 - AMP-activated protein kinase (AMPk)
 - Sirtuins
8. **Mitochondrial dysfunction**: Mitochondria are the powerhouses of the cell and play a critical role in energy production. With age, mitochondrial function can decline, leading to decreased energy production efficiency and more oxidative stress, therefore an increased risk of age-related diseases.¹¹
9. **Cellular senescence**: Cellular senescence denotes cells that have entered a status of arrested growth in reaction to cellular damage. Cellular senescence leads to a permanent growth arrest that can contribute to the aging process. Thus, senescent cells lose productiveness and no longer divide; they also trigger growth in inflammation, which can aggravate aging.¹¹
10. **Stem cell exhaustion**: Stem cells have a potential to maintain the cell population. They have the capability to differentiate into various different cell types and play a critical role in tissue repair and regeneration. With age, the number and function of stem cells decline, leading to decreased tissue repair and an increased risk in the age-related diseases. Thus, its exhaustion leads to a continuous decrease in tissue renewal, as well as by compromised tissue repair upon injury which ultimately leads to healing^{12,13}

11. **Altered intercellular communication**: The process of aging implicates alterations at the level of intercellular interaction, including endocrine, neuroendocrine, or neuronal communication.¹¹

Recently, additional mechanisms of aging related to lipid metabolism have been implied:

- **Accumulation of sphingolipids**: Ceramides, a common class of sphingolipids, accumulate in aging muscle and reduce its function, impacting the functional capacity of older adults.¹⁴
- **Dysregulation of cholesterol metabolism**: Senescent cells accumulate cholesterol in the lysosomes to support the senescence-associated secretory phenotype (SASP).¹⁵

Common physiological features of aging reported are as follows:

1. **Decline in immune function**: Upon aging, an increased risk of infections and certain types of cancer is seen because the immune system becomes less effective at fighting off infections and diseases¹⁶
2. **Hormonal changes**: The levels of many hormones in the body change upon aging, e.g., the levels of growth hormone, testosterone, and oestrogen tend to decrease, while levels of cortisol (the stress hormone) tend to increase.¹⁷ All this negatively affects the body and hastens the process of aging.
3. **Changes in body composition**: With age, there is a tendency to lose muscle mass and gain fat, thereby predisposing to an increase in the risk of metabolic disorders such as type 2 diabetes and cardiovascular disease.¹⁸
4. **Decreased cognitive function**: Cognitive decline has been widely observed upon aging, particularly in areas such as memory and processing speed.¹⁹
5. **Increased risk of falls and fractures**: as already mentioned aging is associated with a decline in cognitive function, Also with age, bones become weaker and balance may decline, increasing the risk of falls and fractures.²⁰

EFFECT OF AGING ON VARIOUS BODY SYSTEMS:

- **Cardiovascular system**: Cardiovascular diseases are the most frequent cause of death in older adults. This class mainly includes coronary artery disease, congestive heart failure, and arrhythmia. Vascular stiffening and remodelling are known to take place throughout normal aging and it's an important cause of age related cardiovascular diseases.²¹ Atherosclerosis progresses as cholesterol, fat, and other substances in blood form plaques, which cause narrowing of the arteries. This decreases the supply of oxygen-enriched blood to tissues and organs in the body. Atherosclerosis triggers inflammation and further vascular changes, thus enhancing risk for cardiac and cerebrovascular disorders, peripheral

vascular disease, cognitive impairment, and other cardiovascular damage.^{21,22}

Hypertension, the most common chronic disease of older adults, is the major promoter of atherosclerosis²³

- **Cerebrovascular disease (stroke)** is another common age-related disease. Stroke happens when blood stops flowing in an area of the brain as a consequence of a disruption of a blood vessel. It is a very critical condition because brain cells deprived of oxygen die quickly, so it can cause death or serious disability.²⁴
 - **Cancer** is the second leading cause of death in older adults, most common contributors are lung, breast, prostate, and colorectal cancers. Slow-growing tumors are common in this age group. Response to cancer treatment is better related to the physiological status rather than the age.²⁵
 - **Osteoarthritis** is a very common chronic disorder among older adults, with higher prevalence in females as compared to males. It is a frequent cause of chronic pain and disability. Obesity is a risk factor for osteoarthritis, with increasing rate of severe hip and knee arthritis.²⁶
 - **Diabetes** rates are on the rise in the aging population. Diabetes is a strong risk factor for cardiovascular disease in older adults. It is also related to peripheral arterial disease and peripheral neuropathy.²⁷
 - **Osteopenia/Osteoporosis.** Osteopenia is normal loss of bone density upon aging. Older adults frequently suffer from osteoporosis, a harsher deterioration of bone density. Osteoporosis is associated with an increased rate of bone fractures.²⁸
 - **Sarcopenia** is a type of muscle atrophy primarily caused by the natural aging process, it is a age-related gradual loss of muscle mass and strength. It is one of the most important causes of functional decline and loss of independence in older adults. Being physically inactive and eating an unhealthy diet can contribute to the disease.²⁹
 - **Chronic obstructive pulmonary disease (COPD)** is a common age-related disease. It is typified by a reduction of airflow into the lungs due to the inflammation of airways, thickening of the lungs lining, and an overproduction of mucus in the air tubes.³⁰
 - **Cognitive decline** produces mild short-term memory loss, difficulty finding words, and slower processing, which are all normal features of aging. Deviations from normal brain aging may lead to dementia, manifesting as memory loss, mood changes, confusion, communication difficulties, or deprived judgment. Rates of dementia rise with age. Alzheimer's disease is the most common cause of dementia, but a number of other disorders can trigger it as well.³¹
- Due to all the physiological and physical changes that occur in the elderly, some activities of the individuals are restricted. These restrictions can

cause individuals to feel unhappy and especially affect the quality of life in terms of their health.^{32,33}

In the old age, the negativity of individual characteristics (poor socio-economic situation, low education level, gender, etc.), functional disorder, decrease in level of daily living activity, decrease in mobility, falling anxiety due to movement and vision problems, sleep problems, cognitive changes, other conditions and situations cause disability lead to decrease in quality of life and social participation.^{34,35} So, comes the role of an occupational therapist along with health care providers.

Occupational therapy and role in geriatric population

The health of the growing older adult population is influenced by several factors which includes personal factors, health behaviours, individual factors such as age-related changes to body systems (eg, sensory, muscle, and vestibular), and higher risks of chronic health problems and hospitalizations.³⁶⁻³⁸ Occupational therapy is a healthcare profession that aims to enable individuals, communities, and populations to participate in daily life activities, or occupations. Occupational therapy is holistic and considers the relationship between daily activities, body functions (ie, strength, endurance), environments, habits, skills, and values, and the impact those can have on health.³⁹ Occupational therapy is a type of rehabilitation therapy, Occupational therapy is done by specially trained professionals called occupational therapists (OTs).

Some of the roles of occupation therapist in geriatric population are as follows:⁴⁰⁻⁴⁸

- **Physical development:** Occupational Therapy can help with fine and gross motor skills, balance, posture, and muscle tone.
- **Maintaining mobility and balance:** regular physical activity strengthens muscles and improves coordination, which can reduce the risk of falls. Occupational therapists play a role in designing and implementing falls prevention strategies and exercise programs specific to the needs of older adults. These programs specifically focus on improving strength, balance, flexibility, and coordination to reduce the risk of falls and promote overall physical well-being.
- **Preserving independence:** staying physically active maintains strength, flexibility, and endurance, which are vital for performing everyday tasks. Occupational Therapy can help with emotional, social, and physical needs.
- **Cognitive development:** Occupational Therapy can help with focus, problem-solving, and information processing. Physical stimulation boosts blood flow to the brain and can help slow cognitive decline, including in conditions like Alzheimer's and dementia. Occupational therapists work with older

adults experiencing cognitive decline or impairment, such as dementia or Alzheimer's disease. They employ cognitive rehabilitation techniques to improve memory, attention, problem-solving, and decision-making skills. These interventions aim to maximize independence and functional abilities while maintaining safety and quality of life.

- **Social and emotional development:** Occupational Therapy can help with social skills, communication, and self-calming techniques. Group activities like walking clubs or fitness classes can provide social interaction and promote social engagements.
- **Preventing chronic disease:** exercise helps manage and prevent conditions like heart disease, type 2 diabetes, osteoporosis, and certain cancers
- **Improving mood and mental health:** physical activity releases endorphins and reduces symptoms of depression and anxiety
- **Enhancing sleep quality:** exercise can help regulate sleep patterns, leading to better rest and improved daytime functioning
- **Daily life skills:** Occupational Therapy can help with basic life skills like bathing, getting dressed, and brushing teeth.
- **Improves independence:** Occupational Therapy can help people regain independence in all areas of their lives.
- **Recovering from an illness, accident, or injury:** Occupational Therapy can help adults regain independence and return to work or home life. They can help develop new skills for daily tasks, like personal care and household chores. They can also help make changes to the home or work environment to make it safer and easier.
- **Improving quality of life for older adults:** Occupational Therapy can help older adults maintain their independence and enhance their quality of life. They can help with problems that develop with aging, like difficulty getting out of bed. Occupational Therapists can also suggest equipment and home adaptations, or new techniques that may be helpful.
- **Improving mental health:** Occupational Therapy can help improve life satisfaction, pain control, and overall mental health.
- **Helping with cognitive problems:** Occupational Therapy can help improve cognitive skills, such as memory and attention. They can also provide strategies for managing day-to-day tasks.
- **Assessing home safety:** Occupational Therapists can assess the home for hazards and make recommendations to ensure home safety.
- **Telehealth :** Occupational Therapists can provide remote consultations, therapy sessions, and follow-ups through telehealth platforms. This can be especially beneficial for adults who live in remote areas or have mobility challenges.
- **Role in independent medical management:** Occupational therapists help older adults manage their own medicines safely by assessing their daily habits, suggesting adaptive tools, and setting up clear schedules.
- **Activities of daily living (ADLs) training:** Occupational therapists assess and address the individual's ability to perform essential self-care tasks, such as bathing, dressing, grooming, toileting, and feeding. With the help of ADL training, therapists help older adults regain or maintain their independence in these activities, considering a decline in their physical, cognitive, and emotional capabilities.
- **Instrumental activities of daily living (IADLs) support:** IADLs encompass more complex tasks that are necessary for independent living, such as meal preparation, housekeeping, managing medications, transportation, and managing finances. Occupational therapists assist older adults in developing strategies, modifying their environment, and using adaptive equipment to facilitate successful engagement in IADLs .
- **Fall prevention and safety assessments:** Falls are a significant concern for older adults. Occupational therapists conduct comprehensive assessments of the home environment to identify potential hazards and make appropriate recommendations for modifications. They also provide education on fall prevention strategies, balance training exercises, and recommend assistive devices to reduce the risk of falls.
- **Adaptive equipment and assistive technology:** Occupational therapists evaluate the need for and recommends appropriate adaptive equipment and assistive technology to enhance older adults' independence. This may include mobility aids like walkers or wheelchairs, home modifications, grab bars or devices that improve communication and safety, such as emergency call systems or medication reminders .
- **Energy conservation and activity pacing:** Older adults may have limited energy levels or chronic conditions that affect their stamina. Occupational therapists teach energy conservation techniques and activity pacing strategies to help individuals prioritize tasks, manage fatigue, and optimize their ability to engage in meaningful activities throughout the day.
- **Caregiver education and support:** Occupational therapists provide education and support to family caregivers, equipping them with the knowledge and skills to assist older adults in their care. This includes training in safe transfers, proper body mechanics, effective communication strategies, and stress management techniques.
- **Palliative care and end-of-life support:** Occupational therapists address the unique needs of older adults receiving palliative or end-of-life care. They focus on comfort, dignity, and maximizing

quality of life during this stage. Therapists may provide recommendations for positioning, pain management, communication strategies, and emotional support for both the individual and their family.

- **Tailored health care:** Occupational therapists collaborate with other members of the healthcare team, including physicians, nurses, social workers, and physical therapists, to develop comprehensive care plans tailored to the specific needs and goals of older adults.

The Occupational Therapist's Role in Medication Management

Medication management refers to the instrumental activity of daily living (IADL) of taking medications as prescribed.⁴⁹ Medication management is a complex activity with many components, including negotiating with the provider for a prescription, filling the prescription at the pharmacy, interpreting complicated health information, taking the medication as prescribed, and maintaining an adequate supply of medication for ongoing use.

Medication adherence is often described as a percentage indicating the ratio of pills consumed to those prescribed. An adherence rate of 100% indicates perfect adherence to the drugs prescribed, with higher percentages indicating overdosing and lower percentages indicating underdosing.

Medication management interprofessional team refers to the health care professionals involved in supporting medication management and medication adherence. Most commonly, the team includes one or more prescribers, pharmacy staff, nursing staff, and occupational therapy practitioners. In some settings, the team includes other professionals as well.

Medication Reconciliation: it is the process of comparing a patient's medication orders to all of the medications that they have been taking. This is important to prevent medication errors, because as per previous literature hospitalized patients are subject to at least one medication error per day, which stems from an inadequate reconciliation at admit, handoff, or transfer.⁵⁰

Occupational therapy practitioners address the performance of the discrete activities required to manage one's medications. When patients experience problems performing any aspect of medication management, medication adherence may be negatively affected. Occupational therapists can contribute effectively to medication management by identifying the problems that make it difficult for elderly to adhere to medication routines and by helping them to integrate medication administration into their individualized daily life

routines.⁵¹⁻⁵³ Occupational therapy addresses decreased ability of an elderly person to engage in daily activities, including taking medication as prescribed. Occupational therapy's distinct contribution to medication management is the actual address of the performance of these management activities in the context of the their daily life. Occupational therapists role is to analyze, assess, and address the performance of discrete activities associated with medication management.⁵⁴

An occupational therapists in collaboration with the client and the interprofessional team develops an elderly patient-centered, evidence-based plans to improve their performance of medication management.

Occupational therapy practitioners implement these plans in coordination with the interprofessional care teams. Occupational therapy practitioners do not alter the advice of prescribers or pharmacists. They have an important role in screening, evaluation, and intervention.⁵⁴

A. Screening :

1. Lawton IADL Assessment⁵⁵

The Lawton-Brody Instrumental Activities of Daily Living Scale (Lawton IADL) was invented as a measurement tool to evaluate the level of functional independence in the general elderly population. The Lawton IADL is widely used to monitor disease progression, evaluate treatment effectiveness and plan care services in clinical and community settings. It can be used with the older adult population in a variety of clinical settings; community, clinic, or hospital.

It evaluates 8 IADLs activities; ability to use the phone, shopping, food preparation, housekeeping, laundry, mode of transportation, medication management, and managing finances.

It scores patients on a scale of 0 (dependent/does not complete) to 1 (manages independently). However a modification comprises scoring from 0 to 8 scale⁵⁶

2. MedMaIDE

MedMaIDE stands for the Medication Management Instrument for Deficiencies in the Elderly, a practical tool used to find out if older adults can safely take their own medicines.

It is an assessment used to determine a patient's competence with their medications. It assesses what the patient knows about their medication, if they know how to take their medication, and gives a tool for patients to use to keep track of their medications. The tool also provides a section for the individual's complete medication list. This tool was developed by Denise Orwig, PhD, Nicole Brandt, PharmD, and

Ann Gruber-Baldini, PhD. A recent article has provided good reliability of this tool.⁵⁷

3. Medi-Cog⁵⁸

The Medi-Cog is a seven-minute tool, which can be used by health care providers or the occupational therapists to assess cognitive literacy and pillbox skills in order to optimize medication safety since Occupational therapist can also address safety concerns and performance skills that may be altered by medication side effects.⁵⁹ The tool is a combination of the Mini-Cog®, a validated cognitive screen, and the Medication Transfer Screen (MTS), a pillbox skills test. This tool was developed by Katherine Anderson, PharmD. It assess three item : recall, clock drawing, and a medication transfer ability.

4. Morisky Medication Adherence Scale (MMAS)-4⁶⁰⁻⁶¹

A quick screen to determine how aware a patient is of their medication adherence. The MMAS is a generic self-reported, medication-taking behavior scale in which the specific health issue (high blood pressure, diabetes, elevated cholesterol, HIV, contraception, etc.) is inserted for the “health concern”. The MMAS consists of four items with a scoring scheme of “Yes” = 0 and “No” = 1. The items are summed to give a range of scores from 0 to 4. It allows practitioners to get a deeper understanding of a patients perceived understanding of their adherence. Another version, the Morisky Medication Adherence Scale-8, that asks further questions.

5. Medication Record

Many premade medication logs exist in order to better organize a patients medications by medication name, dosage, frequency, and any other special instructions related to medication. e.g. AARP , which many geriatric patients have a membership to, has an example of a medication log on their website. Can be a good visual reminder for patients with cognitive deficit having troubles remembering their medication.

6. MedHerent⁶²

Medherent, is a remote medication adherence platform built specifically for individuals with behavioral health conditions or intellectual & developmental disabilities to help them achieve independence. It can be used as a screening tool by the occupational therapist.

B. Evaluation:

Occupational therapists evaluate clients’ ability to manage their medications using a combination of

interview, skilled observation, and assessment of selected aspects of performance. While obtaining an occupational profile, the occupational therapist elicits information about existing medication routines and the context of medication management.⁶³ Occupational therapists then analyse specific aspects of the medication management tasks. Performance based assessments may be used to identify the components of medication management causing dysfunction.⁶⁴⁻⁶⁶ Skills affecting medication management, such as hand dexterity, vision, functional cognition, motivation, health literacy, and numeracy, may also be directly assessed.^{51,67}

C. Intervention

Occupational Therapy Medication Management Intervention Approaches:⁵⁴

1. Create, promote
 - a. Promote health literacy by facilitating elderly patients ability to translate medication-related health instructions to performance of specific tasks
 - b. Educate elderly patient regarding effects of medications that may affect or be affected by performance of other daily activities, in coordination with the health care team
 - c. Educate and empower elderly patients to advocate for their needs
 - d. Evoke and promote change talk associated with effective medication management
2. Establish, restore
 - a. Develop strategies to integrate medication management activities into existing routines
 - b. Remediate impairments to improve elderly patients capacity to manage medications
3. Maintain
 - a. Maintain independence in medication management in elderly patients with degenerative conditions through assistive technology and task modifications
4. Modify
 - a. Advocate with prescribers and coordinate with pharmacists for medication regimens compatible with elderly patients capacity for medication management
 - b. Train caregivers in strategies and techniques to support elderly patients participation in medication management
 - c. Train elderly patients in the use of assistive devices to compensate for cognitive and motor limitations affecting medication management
 - d. Train elderly patients in techniques to compensate for cognitive or motor limitations affecting medication management
5. Prevent
 - a. Maintain ongoing communication with the health care team regarding concerns or performance problems associated with medication management

- b. Adapt home, clinic, and policy environments to improve medication management performance and prevent medication errors

Use of self-administered drug delivery devices in elderly patients

With aging the burdens of chronic diseases increases and with multimorbidity comes polypharmacy, and it is defined as the concurrent use of 5 or more medicines.⁶⁸ A large European cohort study found that 32% of citizens aged 65 years or older were taking five or more medicines.⁶⁹

Polypharmacy has been linked to a range of negative outcomes in older people, including drug-related problems, adverse drug events, impact on physical and cognitive function, hospitalization and mortality.⁷⁰ Managing medicines poses multiple challenges to older patients and those who support them. Older patients, for example, have been found to face difficulties in filling prescriptions, especially after an unplanned hospitalization, in reading and understanding medicines' instructions, in opening containers and retrieving medications, in swallowing pills, in taking the right medicines at the right time and in detecting and reporting adverse reactions.⁷¹

Moreover, older patients prescribed many medicines are likely to have to manage a complex medicine regimen, often with no or limited support. According to George and colleagues, regimens are complex

when medicines come in different forms (e.g., pills, injections, drops), have different dosing frequencies and come with additional instructions that guide administration.⁷² Among the older population, patients living with frailty have been found to be particularly vulnerable to adverse events associated with complex medicine regimens.⁷³

Another important thing to be addressed in elderly is medicine self-management. Bailey and colleagues define medicine self-management as 'the extent to which a patient takes medication as prescribed, including not only the correct dose, frequency and spacing, but also its continued, safe use over time'.⁷⁴ This requires a range of knowledge, skills and behaviours and elderly patients must follow six steps to safely and effectively use their medication in primary care:

- (1) filling (getting hold of the medicines prescribed at the right time),
- (2) understanding,
- (3) organizing,
- (4) taking,
- (5) monitoring
- (6) sustaining.

However, many recent studies have shown elderly patients to have a reduced medication self-management skills.^{75,76} Managing many medicines can be challenging and requires a wide range of skills. Each time a new condition is diagnosed, or a symptom deteriorates, patients need to adapt the way they cope. Living with multiple long-term conditions demands increasing efforts to organize and remember multiple medications, to manage healthcare appointments, to perform self-care and change lifestyles and routines.⁷⁷⁻⁷⁹

Interventions that can be adapted over time are therefore preferable, as they will be able to provide support both when people's needs change (e.g., loss of dexterity or vision) and when new challenges or opportunities arise in the healthcare system (e.g., medical practices accepting only medicine orders online).⁸⁰

The impact of polypharmacy on older adults' lives consists of three main aspects.

- Practical burden:⁸¹ The physical and logistical challenges of managing multiple medications, including opening child-resistant containers, interpreting complex dosing schedules, administering different formulations such as injections, inhalers, and eye drops, and managing refills along with the costs.
- Psychological burden:⁸² The emotional distress, anxiety, and sense of dependence associated with taking multiple daily medications, often serves as a constant reminder of illness and functional decline.
- Social burden:⁸² The impact on social activities, travel, and daily routines since medication schedules must be accommodated, and the social labelling sometimes associated with visible medication use.

The clinical problems of polypharmacy extend far beyond the obvious risks of adverse drug events. They can be summarised as follows.

1. Adverse drug events and drug-drug interactions:⁸³
2. Falls and fractures: Polypharmacy is strongly associated with an increased risk of falls in older adults, particularly that involving psychotropic medications.^{84,85}
3. Cognitive impairment: There is growing evidence which links medication burden to cognitive decline.⁸⁶
4. Frailty and functional decline: Polypharmacy and frailty frequently coexist, with evidence suggesting that medication burden may contribute to the development of frailty over time.⁸⁷
5. Hospitalization and mortality: The cumulative effects of polypharmacy contribute to increased healthcare utilization and poorer survival outcomes in older adults.⁸⁸

Easy tools for drug administration in elderly tools

a. Prescriber's Tools

1. Lists and Indexes

The most known are those based on lists of medications that should not be used (or that should be initiated) in older individuals, such as the Beers⁸⁹ or the Screening Tool to Alert to Right Treatment (START)/Screening Tool of Older Persons' Prescriptions (STOPP) criteria.⁹⁰ The medication appropriateness index (MAI) is often used during the medication review process.⁹¹ The Fit FOR The Aged (FORTA) list has classified all the medications used to treat chronic diseases in older adults.⁹² Apart from these many other lists exist but they are most popular.

2. Medication Review in Team⁹³

Although physicians have the main role and responsibility in prescribing medicines, optimization of drug use in older adults needs support from other healthcare professionals, especially for chronic therapies. The medication review process can be split into different steps, and trained nurses and clinical pharmacists may be active in some of these, with well-defined roles

3. Electronic Tools Supporting Appropriate Prescription

4. Web Resources on Adverse Reaction Prevention

b. Patient's Tools

1. Digital Tools for the Patient

Many new mobile applications focus on monitoring body parameters using microsensors (e.g., physical activity, blood pressure, vocal markers).

2. Dose-Dispensing Tools

Poor medication adherence is a common issue for older individuals. Sometimes, especially in older adults, unintentional non-adherence occurs because of physical, mental, or psychological barriers leading to the inability to manage their treatment.⁹⁴ The purpose of dosing aids is thus to assist patients in taking their medications and improve their adherence to medication.⁹⁵

Dosettes or pillboxes are storage devices for oral medications that also serve as a tool to remind patients to take their medications at the right time⁹⁶ Smart pill dispensers have been developed to help manage complex pharmacotherapies, such as pillboxes with visual and sound alarms that will alert the user to take the medication at the time it must be taken, or other sending email or notifications if a dose is skipped or taken at the wrong time.⁹⁷ e.g. Fookkun® is a pill dispenser in which single doses of several medications intended to be taken simultaneously are sealed in single film bags rolled onto a medication rotating drum. The system makes musical alert sounds when it is time for the patient to take the medications.⁹⁸

3. PILL POPPER

Patients can use this tool to increase independence with getting pills out of a bubble pack. Some patients that may benefit from this include: patients with decreased hand strength patients with decreased fine motor strength patients at risk for developing a repetitive strain injury

4. Med Box

It comes in a variety of styles to support patient's needs. It is beneficial for keeping drugs organized and acts as a visual reminder if medication was taken.

5. Ez-Grip Opener

It enlarges the surface to downgrade opening medications. It functions as a magnifying glass as well to ensure that patients can read their prescription labels correctly.

6. Modified Lids

An adaptation that can be made by the pharmacy for patients who have a decreased hand strength, tremors, fine motor coordination, or other neurological dysfunction.

Advanced Drug Delivery Systems in geriatric patients

The unique physiological, functional, and cognitive challenges faced by older adults have led to the development of innovative drug delivery systems designed to improve medication adherence, safety, and therapeutic outcomes. These systems aim to reduce dosing frequency, simplify administration, bypass barriers to oral delivery, and enable personalized therapeutic approaches.⁹⁹

1. Modified Oral Formulations

They are particularly useful for patients who experience swallowing difficulties such as those suffering from Alzheimer's or Parkinson's disease.¹⁰⁰

2. Transdermal Delivery Systems

Transdermal delivery systems offer several advantages for geriatric patients, including bypassing gastrointestinal absorption issues, avoiding first-pass metabolism, providing sustained drug release over extended periods, and eliminating the need for swallowing or injection.¹⁰¹

3. Long-Acting Injectable Formulations

Long-acting injectable (LAI) formulations provide sustained drug release over weeks or months, dramatically reducing dosing frequency. Chronic conditions requiring long-term treatment (e.g., antipsychotic therapy in older adults with schizophrenia or bipolar disorder) require these systems.

4. Implantable and Depot Systems

Implantable devices offer extended drug release over months to years, making them attractive for chronic age-related conditions. These systems frequently employ biodegradable polymers, hydrogel matrices, osmotic pumps, or bioresponsive biomaterials engineered to achieve sustained and predictable release kinetics. Choe et al. (2025) further reviewed advanced delivery systems for AMD, including

hydrogels, nanocarriers, biologically derived vesicles, microneedles, ultrasound-mediated systems, magnetically guided systems, and 3D bioprinted implants.¹⁰² These technologies aim to reduce injection frequency and improve therapeutic outcomes.

5. Nanotechnology-Based Delivery

Nanotechnology-based drug delivery systems (NDDS) offer precise targeting, controlled release, and enhanced bioavailability—advantages particularly relevant for aging related diseases. In neurodegenerative disorders, Gao et al. (2025) reviewed nanoparticle systems capable of crossing the blood–brain barrier (BBB), including polymeric nanoparticles, inorganic nanomaterials, liposomes, and biomimetic carriers.¹⁰³

6. Smart Drug Delivery and Digital Health Integration

Closed-loop drug delivery constitutes one of the most advanced forms of this approach. In such systems, real-time physiological feedback (e.g., glucose levels, cardiovascular parameters, or neural activity) is integrated with automated dosing algorithms capable of adjusting therapy with minimal clinician intervention. While closed-loop insulin delivery systems are the most clinically established example, parallel concepts are being actively explored for a range of other conditions, including neurological disorders (e.g., epilepsy and Parkinson's disease), pain management, and cardiovascular disease.¹⁰⁴

Furthermore, most AI-driven medication optimization models have been trained using datasets that underrepresent frail older adults with

multimorbidity, potentially limiting external validity and increasing risk of biased recommendations.¹⁰⁵

Another smart delivery approach is represented by the memory incorporating Internet of Things (IoT) technology. Fujita et al. (2026) compared medication management behaviors in healthy older adults and Alzheimer's disease patients using IoT devices.¹⁰⁶ Operational errors occurred in both groups. Among common success factors were comprehension of spoken language and prospective memory, while disorientation and attention deficits specifically affected the AD group.

7. Personalized Medicine and AI

The development of personalized and precision medicine strategies has been motivated by the considerable interindividual variability in drug response observed in older adults. The aim of these approaches is to move beyond traditional “one-size-fits-all” prescribing toward individualized therapy that optimizes efficacy while minimizing toxicity and adverse drug reactions.^{107,108}

CONCLUSION

Occupational therapy plays a vital role in promoting safe, effective and independent medication management among older adults by addressing functional, cognitive, and environmental barriers in the elderly. Through individualized assessment, training, and the use of adaptive strategies, occupational therapists enhance medication adherence and support the effective use of self-administered drug delivery devices. Although technological advances have improved medication self-management, their success depends on appropriate patient education and functional support. Further high-quality research is needed to strengthen the evidence base and optimize occupational therapy interventions in this area. Integrating occupational therapy into multidisciplinary geriatric care has the potential to improve health outcomes, maintain independence, and enhance the quality of life of elderly patients.

Reference

- Mathur A, Taurin S, Alshammary S. New insights into methods to measure biological age: a literature review. *Front Aging*. 2024 Dec 16;5:1395649. doi: 10.3389/fragi.2024.1395649. PMID: 39743988; PMCID: PMC11688636.
- Gilbert SF. *Developmental Biology*. 6th edition. Sunderland (MA): Sinauer Associates; 2000. *Aging: The Biology of Senescence*. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK10041/>
- Weismann, A. 1891. The duration of life. In E. B. Poulton, S. Schonland and A. E. Shipley, (eds.), *Essays on Heredity and Kindred Subjects*, 2nd Ed. Oxford University Press, Oxford, pp. 163–256.
- Sun H, Jarow J K, Hickson D, Mazels N. The Blooms syndrome helicase unwinds G4 DNA. *J. Biol. Chem*. 1998;273:27587–27592.
- Harley C B, Futcher A B, Greider C W. Telomeres shorten during ageing of human fibroblasts. *Nature*. 1990;345:458–460.
- Vaziri H, Benchimol S. Reconstitution of telomerase activity in normal human cells leads to elongation of telomeres and extended replicative lifespan. *Curr. Biol*. 1998;8:279–282.
- Gordon LB, Brown WT, Collins FS. Hutchinson-Gilford Progeria Syndrome. 2003 Dec 12 [Updated

- 2025 Mar 13]. In: Adam MP, Bick S, Mirzaa GM, et al., editors. GeneReviews® [Internet]. Seattle (WA): University of Washington, Seattle; 1993-2026. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK1121/>
8. Lee J.-H.; Kim E. W.; Croteau D. L.; Bohr V. A. Heterochromatin: an epigenetic point of view in aging. *Exp. Mol. Med.* 2020, 52, 1466–1474. 10.1038/s12276-020-00497-4.
 9. Taylor R. C.; Dillin A. Aging as an event of proteostasis collapse. *Cold Spring Harbor Perspect. Biol.* 2011, 3, a004440. 10.1101/cshperspect.a004440.
 10. Efeyan A.; Comb W. C.; Sabatini D. M. Nutrient-sensing mechanisms and pathways. *Nature* 2015, 517, 302–310. 10.1038/nature14190.
 11. Mylonas A.; O’Loughlin A. Cellular Senescence and Ageing: Mechanisms and Interventions. *Front. Aging* 2022, 3, 866718. 10.3389/fragi.2022.866718
 12. Coutin J. What Causes Aging? How Much Have We Learned in Recent Years? <https://medium.com/@jessecoutin/what-causes-aging-how-much-have-we-learned-in-recent-years-93b85e6a594a> (accessed Feb 16, 2023).
 13. Oh J.; Lee Y. D.; Wagers A. J. Stem cell aging: mechanisms, regulators and therapeutic opportunities. *Nat. Med.* 2014, 20, 870–880. 10.1038/nm.3651.
 14. Laurila P.-P.; Wohlwend M.; Imamura de Lima T.; Luan P.; Herzig S.; Zanou N.; Crisol B.; Bou-Sleiman M.; Porcu E.; Gallart-Ayala H.; et al. Sphingolipids accumulate in aged muscle, and their reduction counteracts sarcopenia. *Nature Aging* 2022, 2, 1159–1175. 10.1038/s43587-022-00309-6.
 15. Roh K.; Noh J.; Kim Y.; Jang Y.; Kim J.; Choi H.; Lee Y.; Ji M.; Kang D.; Kim M.-S.; et al. Lysosomal control of senescence and inflammation through cholesterol partitioning. *Nat. Metab.* 2023, 5, 398. 10.1038/s42255-023-00747-5.
 16. Weyand C. M.; Goronzy J. J. Aging of the Immune System. Mechanisms and Therapeutic Targets. *Ann. Am. Thorac Soc.* 2016, 13 (Suppl. 5), S422–S428. 10.1513/AnnalsATS.201602-095AW.
 17. van den Beld A. W.; Kaufman J. M.; Zillikens M. C.; Lamberts S. W. J.; Egan J. M.; van der Lely A. J. The physiology of endocrine systems with ageing. *Lancet Diabetes Endocrinol* 2018, 6, 647–658. 10.1016/S2213-8587(18)30026-3.
 18. Ponti F.; Santoro A.; Mercatelli D.; Gasperini C.; Conte M.; Martucci M.; Sangiorgi L.; Franceschi C.; Bazzocchi A. Aging and Imaging Assessment of Body Composition: From Fat to Facts. *Front. Endocrinol. (Lausanne)* 2020, 10, 861. 10.3389/fendo.2019.00861.
 19. Deary I. J.; Corley J.; Gow A. J.; Harris S. E.; Houlihan L. M.; Marioni R. E.; Penke L.; Rafnsson S. B.; Starr J. M. Age-associated cognitive decline. *Br. Med. Bull.* 2009, 92, 135–152. 10.1093/bmb/ldp033.
 20. Montero-Odasso M.; van der Velde N.; Martin F. C.; Petrovic M.; Tan M. P.; Ryg J.; Aguilar-Navarro S.; Alexander N. B.; Becker C.; Blain H.; et al. World guidelines for falls prevention and management for older adults: a global initiative. *Age Ageing* 2022, 51, afac205. 10.1093/ageing/afac205.
 21. Wang J. C.; Bennett M. Aging and atherosclerosis: mechanisms, functional consequences, and potential therapeutics for cellular senescence. *Circ. Res.* 2012, 111, 245–259. 10.1161/CIRCRESAHA.111.261388.
 22. Alexander R. W. Theodore Cooper Memorial Lecture. Hypertension and the pathogenesis of atherosclerosis. Oxidative stress and the mediation of arterial inflammatory response: a new perspective. *Hypertension* 1995, 25, 155–161. 10.1161/01.HYP.25.2.155.
 23. Wright J. T. Jr.; Williamson J. D.; Whelton P. K.; Snyder J. K.; Sink K. M.; Rocco M. V.; Reboussin D. M.; Rahman M.; Oparil S.; Lewis C. E.; et al. A Randomized Trial of Intensive versus Standard Blood-Pressure Control. *N. Engl. J. Med.* 2015, 373, 2103–2116. 10.1056/NEJMoa1511939.
 24. Stroke. <https://medlineplus.gov/stroke.html> (access ed Mar 15, 2023).
 25. Gorina Y.; Goulding M. R.; Hoyert D. L.; Lentzner H. R. Trends in causes of death among older persons in the United States. *Aging Trends* 2005, 1.
 26. Older Americans 2016: Key Indicators of Well-Being. The Federal Interagency Forum on Aging-Related Statistics, 2016; <https://agingstats.gov/docs/LatestReport/Older-Americans-2016-Key-Indicators-of-WellBeing.pdf>
 27. Odden M. C.; Shlipak M. G.; Whitson H. E.; Katz R.; Kearney P. M.; deFilippi C.; Shastri S.; Sarnak M. J.; Siscovick D. S.; Cushman M.; et al. Risk factors for cardiovascular disease across the spectrum of older age: the Cardiovascular Health Study. *Atherosclerosis* 2014, 237, 336–342. 10.1016/j.atherosclerosis.2014.09.012.
 28. Padilla Colón C. J.; Molina-Vicenty I. L.; Frontera-Rodríguez M.; García-Ferré A.; Rivera B. P.; Cintrón-Vélez G.; Frontera-Rodríguez S. Muscle and Bone Mass Loss in the Elderly Population: Advances in diagnosis and treatment. *J. Biomed.* 2018, 3, 40–49. 10.7150/jbm.23390.
 29. Walston J. D. Sarcopenia in older adults. *Curr. Opin. Rheumatol.* 2012, 24, 623–627. 10.1097/BOR.0b013e328358d59b.
 30. Basics About COPD. <https://www.cdc.gov/copd/basics-about.html>
 31. Blazer D. G.; Yaffe K.; Karlawish J. Cognitive aging: a report from the Institute of Medicine. *JAMA* 2015, 313, 2121–2122. 10.1001/jama.2015.4380.
 32. Balogun JA, Katz JS. Physiological changes and functional limitations associated with aging: A critical literature review. *Turkish Journal of Physiotherapy and Rehabilitation.* 2002;13(1):37-59

33. Tajvar M, Arab M, Montazeri A. Determinants of health-related quality of life in elderly in Tehran, Iran. *BMC Public Health*. 2008;8:323
34. Çalıştır B, Dereli F, Ayan H, Cantürk A. Muğla il merkezinde yaşayan yaşlı bireylerin yaşam kalitelerinin incelenmesi. *Turkish Journal of Geriatrics*. 2006;9(1):30-33
35. Aslan D. Yaşlılık döneminde yaşam kalitesi kavramı: Kadınsağlığı bakışı. *Yaşlanan Kadın Sempozyumu 2009*. Erişim Tarihi. 2014. http://www.huzurevleri.org.tr/docs/Yaslilik_Doneminde_Yasam_Kalitesi_Kavrami.pdf
36. Older Adults - Healthy People 2030 | Health.gov. Accessed May 1, 2025. <https://health.gov/healthypeople/objectives-and-data/browse-objectives/older-adults>
37. World Health Organization. International Classification of Functioning, Disability and Health: ICF. World Health Organization; 2001. [Google Scholar]
38. American Occupational Therapy Association. Occupational therapy in the promotion of health and well-being. *Am J Occup Ther*. 2020;74(3):3-8. doi: 10.5014/ajot.2020.743003
39. American Occupational Therapy Association. Occupational therapy practice framework: domain and process (4th ed.). *Am J Occup Ther*. 2020;74(2):7412410010. doi: 10.5014/ajot.2020.74S2001
40. Shikhah Abdullah Saleh Alawad, Amira Ajib Abdullah Al-Ajib, Rageed Ebrahim Abdualmohsen Alabdualwahab, & Fatimah Abdu Ahmed Jawkhab. (2023). OCCUPATIONAL THERAPY IN GERIATRIC CARE: ENHANCING QUALITY OF LIFE AND INDEPENDENCE. *Journal of Population Therapeutics and Clinical Pharmacology*, 30(2), 966-970. <https://doi.org/10.53555/jptcp.v30i2.5585>
41. Nshimiyimana J, Kanyoni M, Muhigirwa JC. Occupational Therapy Role in Improving Health and Slowing down age-related declines: A systematic review. *Rwanda J Med Health Sci*. 2022 Dec 20;5(3):350-360. doi: 10.4314/rjmhs.v5i3.10. PMID: 40642344; PMCID: PMC12240433.
42. Schnell-Inderst P, Conrads-Frank A, Stojkov I, Krenn C, Kofler LM, Siebert U. Occupational therapy for persons with cognitive impairments. *Ger Med Sci*. 2023 Apr 4;21:Doc02. doi: 10.3205/000316. PMID: 37260919; PMCID: PMC10227641.
43. Royeen C (2024). The Role of Occupational Therapy in Promoting Social Skills Development in Individuals with Autism Spectrum Disorder. *Autism-Open Access*. 14:405.
44. Stotz NL, Steiner V, Polavarapu M, Czaja E. Occupational Therapy's Role in Population Health With Older Adults. *Inquiry*. 2025 Aug 26;62:00469580251366149. doi: 10.1177/00469580251366149. PMCID: PMC12381440.
45. Ding J, Yang Y, Wu X, Xiao B, Ma L, Xu Y. The telehealth program of occupational therapy among older people: an up-to-date scoping review. *Aging Clin Exp Res*. 2023 Jan;35(1):23-40. doi: 10.1007/s40520-022-02291-w. Epub 2022 Nov 8. PMID: 36344805; PMCID: PMC9640899.
46. Somerville E, Bollinger R, Keleman A, Haxton M, Sarraimi B, Chen SW, Holden B, Yan Y, Stark S. Tailored medication management intervention delivered by occupational therapists for older adults: A study protocol. *Br J Occup Ther*. 2023 Apr;86(4):257-264. doi: 10.1177/03080226221135366. Epub 2023 Mar 21. PMID: 40337485; PMCID: PMC12033853.
47. Leong C, Donaldson A, Macasieb CFE, et al. The effectiveness of activities of daily living retraining programmes for older adults in hospital: A systematic review and meta-analysis. *British Journal of Occupational Therapy*. 2026;0(0). doi:10.1177/03080226261421053
48. Fricke, J., Unsworth, C. Occupational Therapists' Conceptions of Instrumental Activities of Daily Living in Relation to Evaluation and Intervention with Older Clients. *Scand. J. Occup. Ther*. 5, 180–191 (1998). <https://doi.org/10.3109/11038129809035744>
49. Eckman, T. A., Liberman, R. P., Phipps, C. C., & Blair, K. E. (1990). Teaching medication management skills to schizophrenic patients. *Journal of Clinical Psychopharmacology*, 10, 33–38. <https://doi.org/10.1097/00004714-199002000-00006>
50. Barnsteiner JH. Medication Reconciliation. In: Hughes RG, editor. *Patient Safety and Quality: An Evidence-Based Handbook for Nurses*. Rockville (MD): Agency for Healthcare Research and Quality (US); 2008 Apr. Chapter 38. PMID: 21328749.
51. Cole, J. (2011). Extending the role of the occupational therapist in the promotion of collaborative medication management to facilitate occupation. *British Journal of Occupational Therapy*, 74(11), 540-542. <https://doi.org/10.4276/030802211X13204135680983>
52. Schwartz, J. K., & Smith, R. O. (2017). Integration of medication management into occupational therapy practice. *American Journal of Occupational Therapy*, 71(4), 710436001p1- 710436001p7. <https://doi.org/10.5014/ajot.2017.015032>
53. Renda, M., Lee, S., Keglovits, M., & Somerville, E. (2016, August 22). The role of occupational therapy in reducing hospital readmission. *OTPractice*, CE5-CE6.
54. Kannenberg, K., Schwartz, J., & Siebert, C. (2017). Occupational Therapy's Role in Medication Management. *American Journal of Occupational Therapy*, 71, 71124100251-711241002520. <https://doi.org/10.5014/ajot.2017.716S02>
55. M.P. Lawton, E.M. Brody *Gerontologist*, 9 (1969), pp. 179-186

56. Vittengl, J. R., White, C. N., McGovern, R. J., & Morton, B. J. (2006). Comparative validity of seven scoring systems for the instrumental activities of daily living scale in rural elders. *Aging & Mental Health*, 10(1), 40–47. <https://doi.org/10.1080/13607860500307944>
57. Orwig, D., Brandt, N., & Gruber-Baldini, A. L. (2006). Medication Management Assessment for Older Adults in the Community. *The Gerontologist*, 46(5), 661–668.
58. Marks TS, Giles GM, Al-Heizan MO, Edwards DF. Can Brief Cognitive or Medication Management Tasks Identify the Potential for Dependence in Instrumental Activities of Daily Living? *Front Aging Neurosci*. 2020 Feb 20;12:33. doi: 10.3389/fnagi.2020.00033. PMID: 32153383; PMCID: PMC7045342.
59. Guariglia, S., & Smallfield, S. (2015, March). The role of occupational therapy in medication management in acute care. *Gerontology Special Interest Section Quarterly*, 38(1), 1–3.
60. Morisky, D. E., Ang, A., Krousel-Wood, M., & Ward, H. J. (2008). Predictive validity of a medication adherence measure in an outpatient setting. *The Journal of Clinical Hypertension*, 10(5), 348–354. (link)
61. Martinez-Perez, P., Orozco-Beltrán, D., Pomares-Gomez, F., Hernández-Rizo, J. L., Borrás-Gallen, A., Gil-Guillen, V. F., Quesada, J. A., Lopez-Pineda, A., & Carratala-Munuera, C. (2021). Validation and psychometric properties of the 8-item Morisky Medication Adherence Scale (MMAS-8) in type 2 diabetes patients in Spain. *Atención Primaria*, 53(2), 101942.
62. Nguyen A, Uppal S, Pereira MM, Pluti A, Gualtieri L. MedHerent: Improving Medication Adherence in Older Adults With Contextually Sensitive Alerts Through an Application That Adheres to You. *Mayo Clin Proc Digit Health*. 2023 Dec 14;2(1):1-7. doi: 10.1016/j.mcpdig.2023.11.001. PMID: 40206667; PMCID: PMC11975706.
63. Law, M., Baptiste, S. A., Carswell, A., McColl, M. A., Polatajko, H. J., & Pollock, N. (2014). Canadian Occupational Performance Measure (5th ed.). Ottawa: Canadian Association of Occupational Therapists.
64. Anderson, K., Jue, S. G., & Madaras-Kelly, K. J. (2009). Identifying patients at risk for medication mismanagement: Using cognitive screens to predict a patient's accuracy in filling a pillbox. *Consultant Pharmacist*, 23, 459–472. <https://doi.org/10.4140/TCP.n.2008.459>
65. Baum, C. M., Connor, L. T., Morrison, T., Hahn, M., Dromerick, A. W., & Edwards, D. F. (2008). Reliability, validity, and clinical utility of the Executive Function Performance Test: A measure of executive function in a sample of people with stroke. *American Journal of Occupational Therapy*, 62, 446–455. <https://doi.org/10.5014/ajot.62.4.446>
66. Cairns, A., Hill, C., Dark, F., McPhail, S., & Gray, M. (2013). The Large Allen Cognitive Level Screen as an indicator for medication adherence among adults accessing community mental health services. *British Journal of Occupational Therapy*, 76, 137–143. <https://doi.org/10.4276/030802213X13627524435180>
67. Rogers, A. T., Bai, G., Lavin, R. A., & Anderson, G. F. (2016). Higher hospital spending on occupational therapy is associated with lower readmission rates. *Medical Care Research and Review*. Advance online publication. <https://doi.org/10.1177/1077558716666981>
68. Masnoon N, Shakib S, Kalisch-Ellett L, Caughey GE. What is polypharmacy? A systematic review of definitions. *BMC Geriatr*. 2017;17(1):230. doi:10.1186/s12877-017-0621-2
69. Midão L, Giardini A, Menditto E, Kardas P, Costa E. Polypharmacy prevalence among older adults based on the survey of health, ageing and retirement in Europe. *Arch Gerontol Geriatr*. 2018;78:213-220. doi:10.1016/j.archger.2018.06.018
70. Wastesson JW, Morin L, Tan ECK, Johnell K. An update on the clinical consequences of polypharmacy in older adults: a narrative review. *Expert Opin Drug Saf*. 2018;17(12):1185-1196. doi:10.1080/14740338.2018.1546841
71. Dijkstra NE, Sino CGM, Schuurmans MJ, Schoonhoven L, Heerdink ER. Medication self-management: considerations and decisions by older people living at home. *Res Soc Admin Pharm*. 2022;18(3):2410-2423. doi:10.1016/j.sapharm.2020.09.004
72. George J, Phun YT, Bailey MJ, Kong DC, Stewart K. Development and validation of the medication regimen complexity index. *Ann Pharmacother*. 2004;38(9):1369-1376. doi:10.1345/aph.1D479
73. Schoonover H, Corbett CF, Weeks DL, Willson MN, Setter SM. Predicting potential postdischarge adverse drug events and 30-day unplanned hospital readmissions from medication regimen complexity. *J Patient Saf*. 2014;10(4):186-191. doi:10.1097/PTS.0000000000000067
74. Bailey SC, Oramasionwu CU, Wolf MS. Rethinking adherence: a health literacy-informed model of medication self-management. *J Health Commun*. 2013;18:20-30. doi:10.1080/10810730.2013.825672
75. Howell EH, Senapati A, Hsieh E, Gorodeski EZ. Medication self-management skills and cognitive impairment in older adults hospitalized for heart failure: a cross-sectional study. *SAGE Open Med*. 2017;5:2050312117700301. doi:10.1177/2050312117700301
76. Maidment I, Lawson S, Wong G, et al. Towards an understanding of the burdens of medication management affecting older people: the MEMORABLE realist synthesis. *BMC Geriatr*. 2020;20(1):183. doi:10.1186/s12877-020-01568-x

77. Denford S, Frost J, Dieppe P, Cooper C, Britten N. Individualisation of drug treatments for patients with long-term conditions: a review of concepts. *BMJ Open*. 2014 Mar 26;4(3):e004172. doi: 10.1136/bmjopen-2013-004172. PMID: 24670429; PMCID: PMC3975745.
78. Rees S, Williams A. Promoting and supporting self-management for adults living in the community with physical chronic illness: A systematic review of the effectiveness and meaningfulness of the patient-practitioner encounter. *JBI Libr Syst Rev*. 2009;7(13):492-582. doi: 10.11124/01938924-200907130-00001. PMID: 27819974.
79. Eton D, Ramalho de Oliveira D, Egginton J, et al. Building a measurement framework of burden of treatment in complex patients with chronic conditions: a qualitative study. *Patient Relat Outcome Meas*. 2012;3:39-49. doi:10.2147/PROM.S34681
80. Previdoli G, Cheong V-L, Alldred D, et al. A rapid review of interventions to improve medicine self-management for older people living at home. *Health Expect*. 2023;26:945-988. doi:10.1111/hex.13729
81. Sav, A.; King, M.A.; Whitty, J.A.; Kendall, E.; McMillan, S.S.; Kelly, F.; Hunter, B.; Wheeler, A.J. Burden of treatment for chronic illness: A concept analysis and review of the literature. *Health Expect*. 2015, 18, 312–324.
82. Xin, G.; Yuanxing, W.; Jiaming, W.; Xue, H. Medication multiple experiences of elderly patient with multiple chronic condition: A qualitative meta-synthesis. *PLoS ONE* 2025, 20, e0331753.
83. Erhan, T.; Wastesson, J.W.; Fastbom, J. Trends in Drug Duplications in Swedish Older Adults: A Nationwide Register Study from 2006 to 2021. *Drugs Aging* 2024, 41, 775–781.
84. Seppala, L.J.; Wermelink, A.M.A.T.; de Vries, M.; Ploegmakers, K.J.; van de Glind, E.M.M.; Daams, J.G.; van der Velde, N. EUGMS task and Finish group on fall-risk-increasing drugs Fall-Risk-Increasing Drugs: A Systematic Review and Meta-Analysis: II. Psychotropics. *J. Am. Med. Dir. Assoc*. 2018, 19, 371.e11–371.e17.
85. Hanlon, J.T.; Schmadler, K.E.; Koronkowski, M.J.; Weinberger, M.; Landsman, P.B.; Samsa, G.P.; Lewis, I.K. Adverse drug events in high risk older outpatients. *J. Am. Geriatr. Soc*. 1997, 45, 945–948.
86. Richardson, K.; Fox, C.; Maidment, I.; Steel, N.; Loke, Y.K.; Arthur, A.; Myint, P.K.; Grossi, C.M.; Mattishent, K.; Bennett, K.; et al. Anticholinergic drugs and risk of dementia: Case-control study. *BMJ* 2018, 361, k1315, Erratum in *BMJ* 2019, 367, l6213. <https://doi.org/10.1136/bmj.l6213>.
87. Veronese, N.; Stubbs, B.; Noale, M.; Solmi, M.; Pilotto, A.; Vaona, A.; Demurtas, J.; Mueller, C.; Huntley, J.; Crepaldi, G.; et al. Polypharmacy Is Associated With Higher Frailty Risk in Older People: An 8-Year Longitudinal Cohort Study. *J. Am. Med. Dir. Assoc*. 2017, 18, 624–628.
88. Li, Y.; Zhang, X.; Yang, L.; Yang, Y.; Qiao, G.; Lu, C.; Liu, K. Association between polypharmacy and mortality in the older adults: A systematic review and meta-analysis. *Arch. Gerontol. Geriatr*. 2022, 100, 104630.
89. American Geriatrics Society American Geriatrics Society 2019 Updated AGS Beers Criteria® for Potentially Inappropriate Medication Use in Older Adults. *J. Am. Geriatr. Soc*. 2019;67:674–694. doi: 10.1111/jgs.15767.
90. O'Mahony D., O'Sullivan D., Byrne S., O'Connor M.N., Ryan C., Gallagher P. STOPP/START criteria for potentially inappropriate prescribing in older people: Version 2. *Age Ageing*. 2014;44:213–218. doi: 10.1093/ageing/afu145.
91. Maher R.L., Hanlon J., Hajjar E.R. Clinical consequences of polypharmacy in elderly. *Expert Opin. Drug Saf*. 2014;13:57–65. doi: 10.1517/14740338.2013.827660.
92. Kuhn-Thiel A.M., Weiß C., Wehling M., FORTA Authors/Expert Panel Members Consensus validation of the FORTA (Fit FOR The Aged) List: A clinical tool for increasing the appropriateness of pharmacotherapy in the elderly. *Drugs Aging*. 2014;31:131–140. doi: 10.1007/s40266-013-0146-0.
93. Lunghi C, Trevisan C, Fusaroli M, Giunchi V, Raschi E, Sangiorgi E, Domenicali M, Volpato S, De Ponti F, Poluzzi E. Strategies and Tools for Supporting the Appropriateness of Drug Use in Older People. *Pharmaceuticals (Basel)*. 2022 Aug 8;15(8):977. doi: 10.3390/ph15080977. PMID: 36015125; PMCID: PMC9412319.
94. Amorim W.W., Passos L.C., Gama R.S., Souza R.M., Oliveira M.G. Factors associated with older patients' misunderstandings of medication dosage regimen instructions after consultation in primary care in Brazil. *J. Eval. Clin. Pract*. 2021;27:817–825. doi: 10.1111/jep.13480.
95. Hersberger K.E., Boeni F., Arnet I. Dose-dispensing service as an intervention to improve adherence to polymedication. *Expert Rev. Clin. Pharmacol*. 2013;6:413–421. doi: 10.1586/17512433.2013.811829.
96. Smith D.L. Compliance Packaging: A Patient Education Tool. *Am. Pharm*. 1989;29:42–53. doi: 10.1016/S0160-3450(15)31856-0.
97. Stip E., Vincent P.D., Sablier J., Guevremont C., Zhornitsky S., Tranulis C. A randomized controlled trial with a Canadian electronic pill dispenser used to measure and improve medication adherence in patients with schizophrenia. *Front. Pharmacol*. 2013;4:100. doi: 10.3389/fphar.2013.00100.
98. Suzuki R, Takahashi E, Tofukuji I. Improved Medication Adherence of an Elderly Diabetic Patient at a Dwelling Home Using a Pill Dispenser and Personal Health Records. *Healthcare (Basel)*. 2024 Feb 19;12(4):499. doi:

- 10.3390/healthcare12040499. PMID: 38391874; PMCID: PMC10887850.
99. Rzeczycki, P.; Pęciak, O.; Plust, M.; Drożdżik, M. Molecular Aspects of Geriatric Pharmacotherapy. *Cells* **2025**, *14*, 1363.
 100. Fujita, T.; Notoya, M.; Kato, K.; Kimura, D. Differences in Response Between Healthy Older Adults and Patients with Alzheimer's Disease When Using Memory Aids to Manage Medication and Factors Influencing Their Success. *Exp. Aging Res.* **2026**, *52*, 294–312.
 101. Nakamura, Y.; Kurokawa, T.; Terashima, S.; Nishimura, A. Efficacy and safety of a novel, extended-release rivastigmine transdermal patch (TW-4752N) in patients with Alzheimer's disease: A 24-week randomized, double-blind trial with a 28-week open-label extension. *J. Alzheimer's Dis.* **2026**, *109*, 1007–1019.
 102. Choe, S.; Ye, J.; Zhang, T.; Gao, J. Advanced Drug Delivery Systems for Age-Related Macular Degeneration Treatment: Latest Trends and Future Prospects. *Adv. Healthc. Mater.* **2026**, *15*, e03757.
 103. Gao, L.; Wang, J.; Bi, Y. Nanotechnology for Neurodegenerative Diseases: Recent Progress in Brain-Targeted Delivery, Stimuli-Responsive Platforms, and Organelle-Specific Therapeutics. *Int. J. Nanomed.* **2025**, *20*, 11015–11044.
 104. Leng, Y.; Sun, R. Multifunctional Biomedical Devices with Closed-Loop Systems for Precision Therapy. *Adv. Healthc. Mater.* **2025**, *14*, e2500860.
 105. Vamadevan, A.; Vijayan, V.; Cole, C.; Jayasudha, K.; Yusuf, N.; Walker, L.E. A NASSS framework-guided systematic review and exploratory modelling of digital health interventions for polypharmacy management in older adults. *BMC Geriatr.* **2025**, *25*, 1032.
 106. Fujita, T.; Notoya, M.; Kato, K.; Kimura, D. Differences in Response Between Healthy Older Adults and Patients with Alzheimer's Disease When Using Memory Aids to Manage Medication and Factors Influencing Their Success. *Exp. Aging Res.* **2026**, *52*, 294–312.
 107. Kondrakhin, A.P.; Abdullaev, S.P.; Sychev, I.V.; Bochkov, P.O.; Tuchkova, S.N.; Mirzaev, K.B.; Maksimov, M.L.; Sychev, D.A. Impact of Xenobiotic Detoxification Gene Polymorphisms on Steady-State Plasma Concentrations of Apixaban and the Development of Hemorrhagic Complications in Older Patients with Non-Valvular Atrial Fibrillation. *Genes* **2025**, *16*, 1179.
 108. Deng, W.; Zhang, L.Y.; Yue, J.R.; Huang, X.L. The future of multimorbidity management in the older adults: Transforming AI-enabled precision medicine. *Front. Public Health* **2026**, *13*, 1691682.