BRITISH JOURNAL OF HOSPITAL MEDICINE

REVIEW

Polypharmacy in Older Patients

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Abstract

Polypharmacy is common among older people and is associated with multiple adverse outcomes. Assessing whether it is appropriate or inappropriate for an individual is more informative than relying on a simple pill count. Modern medicine is based on single disease guidelines that promote prescribing but tend not to have deprescribing criteria. Barriers to deprescribing promote the accumulation of medicines over time. Clinical trial data have limitations due to the selected populations recruited. Some evidence suggests older people with multi-morbidity may benefit less and people with frailty are at increased risk of harm. Prescribing can be inappropriate if it is not evidence-based, harm is likely to exceed the benefit, includes hazardous medications or combinations of medicines, the patient experiences therapeutic burden, there is reduced adherence or prescribing cascades. Medicines optimisation aims to improve prescribing quality for an individual patient and may include deprescribing. It is a complex process that includes shared decision-making, careful follow-up, and communication of any resulting prescription changes.

Key words: polypharmacy; geriatrics; deprescribing; therapeutics; medicines optimisation

Submitted: 4 July 2024 Revised: 25 July 2024 Accepted: 22 August 2024

Introduction

Polypharmacy is the taking of multiple regular medications, which is very common among older people in developed countries. In England, more than half of people aged over 85 are prescribed five or more medications, and a quarter are prescribed eight or more (NHS Digital, 2016). The underlying reason for this is the accumulation of long-term conditions, such as hypertension, as we age. Multimorbidity, defined as having two or more long-term conditions, affects around 85% of people aged over 85 (Chief Medical Officer, 2023). Prescribing guidelines for each long-term condition act as a bond between these two components. Being prescribed multiple medications is associated with many adverse outcomes but this may simply be a feature of the pathological conditions that led to prescribing, rather than polypharmacy itself being harmful. Older people with multimorbidity and polypharmacy frequently require healthcare services and represent a large proportion of hospital in-patient care. Their optimal management has become a core component of modern hospital medicine.

This article will first explore a practical definition of polypharmacy and how we recognise it affects our patients. Next, there will be consideration of whether this is a success or failure of modern medicine, and how we got to where we are.

How to cite this article:
Woodford HJ. Polypharmacy in Older Patients. Br J Hosp Med. 2024. https://doi.org/10.12968/hmed.2024.0388

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Table 1. Examples of inappropriate polypharmacy.

Examples
Prescribing is not evidence-based
Harm is likely to exceed the benefit
Hazardous medications or combinations of medicines (e.g., interactions)
The patient is experiencing a therapeutic burden
Reduced adherence
Prescribing cascades

Then there will be a discussion about the risks and benefits of medications for older people with polypharmacy. There will be examples of when additional prescribing can be inappropriate. Finally, the evidence base and practical implementation of medicines optimisation and deprescribing will be outlined.

Defining Polypharmacy

Studies on the prevalence of polypharmacy typically define it as taking five or more medications, although there is no universal agreement on this threshold (Masnoon et al, 2017). Five or more medications may set the bar too low as this applies to most people aged over 85. Sometimes the term 'hyper-polypharmacy' (or severe/excessive) is used for people taking 10 to 14 medications per day, and the term 'mega-polypharmacy' for people taking 15 or more. Five or more medications are also considered best practice for the management of some single conditions, such as heart failure with reduced ejection fraction (McDonagh et al, 2021). A simple pill count may not be the best assessment method. In clinical settings, it is more useful to consider whether the combination of medications taken is appropriate or not for the individual patient. When appropriate, the benefits of medications clearly exceed the risks and prescribing is in alignment with the patient's owns goals and preferences. Examples of inappropriate, or problematic, polypharmacy are listed in Table 1 (Duerden et al, 2013).

Is Polypharmacy a Good or Bad Thing?

Polypharmacy is associated with adverse drug events, drug interactions, reduced medication adherence, cognitive impairment, functional impairment, falls, hospital admission, and mortality (Hung et al, 2024). But people who take more medications have more illnesses and are already at increased risk. Medications could still be having a net beneficial effect. Assessing appropriateness involves a degree of subjectivity. One person's polypharmacy is another person's optimal multimorbidity management. But three numbers suggest we often get the balance wrong. Firstly, the World Health Organisation estimates that in developed countries long-term adherence to therapies is only around 50% (World Health Organisation, 2003). Secondly, approximately a sixth of medical hospital admissions are related to adverse drug reactions (ADRs) (Osanlou et al, 2022). This proportion could be higher among older people where the contribution of medications to presentations such as falls or delirium can go unrecognised. Finally, when asked, around 85%

of older people with polypharmacy are willing to stop at least one medication if possible (Hung et al, 2024). Taken together, these statistics present a compelling case that there is much room for improvement in the care we currently provide.

How We Got Here

Long-term conditions can't be cured and accumulate over our lifespan. Medications may be taken to control symptoms (e.g., loop diuretics and heart failure), replace things we have become deficient in (e.g., levothyroxine) or prevent future deterioration (e.g., statins for vascular disease). In modern healthcare, many prescriptions are in this latter group. They provide no obvious day-to-day benefit, but clinical trials suggest future adverse events may be reduced if taken for prolonged periods. However, clinical trials have limitations. The people included are carefully selected and tend to be younger than seen in clinical practice (Rossello et al, 2015). For example, the average age of participants in osteoporosis trials is around 64, but the average age of hip fractures is around 84 (McGarvey et al, 2017). They also, on average, have fewer co-morbidities (Tan et al, 2022). These differences are promoted by trial exclusion criteria, which can be explicitly stated in the protocol (e.g., over 80 years old, care home residence or diagnosis of dementia) or implicit to the population screened for eligibility (e.g., recruiting only from cardiology outpatient clinics). Many people seen in hospital practice with a particular condition would not meet the entry criteria. For example, only around 13 to 25% of older people hospitalised due to heart failure would have been eligible for the major clinical trials (Masoudi et al, 2003).

Another potential problem is the duration of therapy (Rossello et al, 2015). Clinical trials typically last between one and five years, so for how long should the medication be prescribed? Antidepressants, bisphosphonates and proton pump inhibitors are only recommended for limited periods. Yet these medications may be given for much longer than originally intended, a scenario termed 'legacy prescribing' (Mangin et al, 2018). In addition to clinical trial limitations, knowledge of evidence-based medicine among healthcare professionals could be improved. Clinicians tend to overestimate the benefits and underestimate the harms of treatments (Hoffmann and Del Mar, 2017). This may be partly due to the common practice of reporting relative risk reduction (RRR) rather than absolute risk reduction (ARR). Trials are not designed to detect ADRs and recruit populations at lower risk of harm, i.e., younger and with fewer co-morbidities.

Guidelines exist for the management of most long-term conditions and aim to standardise care. They promote prescribing and usually don't include deprescribing criteria. Polypharmacy is a consequence of the rate of prescribing exceeding that of deprescribing, but both should be components of the normal prescribing cycle. Reported barriers to deprescribing include the fear of negative consequences of stopping a 'life saving' medication, lack of education or knowledge, patient expectations 'for life', lack of time/resource, suboptimal communication or collaboration between prescribers, and disease-specific guidelines favouring prescribing (Hung et al, 2024).

Risks and Benefits of Medications

Some data suggest that medications could be less effective in older people. For example, a systematic review of hypertension trials showed a reduction in all-cause mortality for the subgroup of people aged 60 to 79 but not for those aged 80 and over (Musini et al, 2019). Although cardiovascular mortality and morbidity in the group aged over 80 were reduced, the ARR was 2.9% over a mean follow-up of 2.2 years, giving a number need to treat per year (NNT/y) of 76 to prevent one adverse cardiovascular outcome. A meta-analysis of statin trials found the NNT/y per mmol/L reduction in LDL cholesterol was 200 to prevent one cardiovascular adverse event for people aged 75 and over (Cholesterol Treatment Trialists' Collaboration, 2019). This value was higher than any other age group. In addition, due to a higher prevalence of multi-morbidity, competing causes of death may attenuate any potential survival benefit for older people. In a meta-analysis of statin trials, a higher risk of non-cardiovascular death negated the all-cause mortality benefit (Kim and Kim, 2015). Other factors that could reduce medication efficacy in older people include frailty (i.e., biological ageing impairing organ response to medications), co-morbidity (e.g., Parkinson's disease plus cerebrovascular disease), and reduced adherence in the context of polypharmacy and therapeutic burden.

Using NNT/y, rather than RRR, may assist in understanding of individual risk. But putting NNT/y into context also requires consideration of life expectancy. For example, the average life expectancy for care home residents in the UK aged over 80 years is three to four years for women and two to three years for men (Office for Statistics, 2022). It has been estimated that around 46% of people aged over 85 who are admitted non-electively to hospital will die within the following year (Clark et al, 2014). Obviously, these are estimated averages and there will be much variation between individuals. Recognising people with limited life expectancy can be aided by assessment tools (Supportive and Palliative Care Indicators Tool, 2024).

Clinical trials are not usually designed to detect ADRs and tend to emphasise the beneficial effects of medications, sometimes grouping them together to form composite outcomes. The same is not true for adverse effects that are variably detected and reported, which makes meta-analysis of risks difficult. People recruited to clinical trials are less likely to have frailty, which is a recognisable state of vulnerability due to advanced biological age. People with frailty are more likely to experience ADRs. The reasons for this are summarised in Table 2. Much data support increased risk of harm for older people exposed to medications, such as cough with angiotensin converting enzyme (ACE) inhibitors (Brugts et al, 2014), statin intolerance (Bytyçi et al, 2022) and greater risk of bleeding with anti-platelet drugs (Li et al, 2017). Perhaps due to differences between trial populations and the people prescribed medications in clinical practice, the risk of some adverse effects is uncertain. One example is fall risk-increasing medications where expert consensus and trial data are not fully aligned (Albasri et al, 2021; Seppala et al, 2019). Another possibility is the emergence of adverse effects after years of exposure beyond the duration of trials. For example, the association of a doubling of the risk of developing dementia with anticholinergic medications (Taylor-Rowan et al, 2021).

Table 2. Reasons for increased vulnerability to medications in older people with frailty.

Reasons	Comment
Change in body composition	Increased proportion of body fat Reduced proportion of body water Reduced muscle mass
Altered drug clearance	Reduced hepatic metabolism Reduced renal elimination
Vulnerability to toxicity	Increased permeability of the blood-brain barrier
'Atypical' presentations	Falls/delirium may not be initially recognised as medication-related
Polypharmacy	Increased risk of drug-drug interactions, e.g., aspirin and serotonin specific reuptake inhibitors both increasing gastric bleeding risk
Multimorbidity	Increased risk of drug-disease interactions, e.g., opiates worsening constipation

Inappropriate Medications

Inappropriate polypharmacy occurs for a variety of reasons (see Table 1) but often features the prescription of potentially inappropriate medications (PIMs), which are defined as having evidence of inefficacy, unacceptably high risk of adverse effects or where better alternatives exist. Several PIM lists for older people have been published but with incomplete agreement between them (Perpétuo et al, 2021). These lists commonly include sedatives, antipsychotics, anticholinergics, and non-steroidal anti-inflammatory drugs (NSAIDs). Such PIM lists are lengthy and don't cover all aspects of medicines optimisation. For example, they don't detect drug-drug interactions or prescribing cascades, and don't promote individualised care, which results in limited practical value.

Prescribing and deprescribing should be part of an ongoing dynamic process responding to the changing clinical picture. Medications are rarely 'for life'. All medicines have the potential to become inappropriate if not regularly reviewed. See Table 3 for examples. These things need to be considered on an individual patient basis and cannot be replicated by a simple guideline or list. For example, a person who now has very limited mobility may no longer experience angina. Due to the development of frailty, therapeutic targets can change. For example, more lenient blood pressure control for people with hypertension or more lenient glucose control for people with type 2 diabetes (National Institute for Health and Care Excellence, 2015; National Institute for Health and Care Excellence, 2019). Patient goals can change, such as favouring symptom control in the context of limited life expectancy. The evidence base for medical treatments can also change over time, for example, in the age of primary coronary intervention the widespread use of beta-blockers following myocardial infarction no longer appears beneficial (Yndigegn et al, 2024).

Table 3. Examples of inappropriate medicines.

Problem	Examples
Duration of benefit exceeded 'legacy prescribing'	Antidepressants, bisphosphonates, proton pump inhibitors used beyond the intended period
Change in evidence base	Beta-blockers following myocardial infarction
Prescribing cascades	Calcium channel blockers and loop diuretics; cholinesterase inhibitors and bladder anticholinergics
Hazardous medications	High risk of harm: antipsychotics, anticholinergics, sedatives, NSAIDs
Lack of indication	Indication resolved—e.g., no longer experiencing angina Medication not the best solution—e.g., challenging behaviour and dementia
Change of therapeutic target	Blood pressure or glucose control in a person who has developed moderate to severe frailty
Change affecting the ability to safely/effectively take medication	Renal impairment raising the risk of toxicity with digoxin Swallow impairment affecting the ability to safely take oral bisphosphonates Cognitive impairment affecting inhaler technique
Not in alignment with patient goals/wishes	Medications not taken for symptomatic benefit in the context of end-of-life care Patients experiencing therapeutic burden Reduced medication adherence

NSAIDs, non-steroidal anti-inflammatory drugs.

Polypharmacy is likely to be inappropriate when there is evidence of reduced medication adherence. Taking medications as prescribed requires the capability (e.g., swallow ability, memory, inhaler technique), motivation, and opportunity (e.g., access to healthcare). Reduced adherence may be intentional, perhaps when the patient's goals are not aligned with the prescriber's goals, or in the context of experiencing an ADR. Medication adherence can be improved by medication review (i.e., simplification, alignment with personal goals, detecting ADRs), education regarding possible benefits, or administration assistance (e.g., aids, carers, prompts, accessible packaging, inhaler type, drug formulation). Experiencing therapeutic burden can affect medication adherence. The burden may be related to consuming many drugs or the associated monitoring and follow-up appointments.

Prescribing is also inappropriate when medicines are not the best solution. One example is prescribing cascades where the adverse effect of a medication is wrongly interpreted as a new condition, which leads to further prescribing. Common examples include calcium channel blockers causing peripheral oedema that is misdiagnosed as heart failure and treated with a loop diuretic, or cholinesterase inhibitors precipitating urinary incontinence that is misdiagnosed as over-active bladder leading to prescribing of bladder anticholinergic medication. Non-pharmacological ap-

proaches are sometimes better than pharmacological ones. For example, mobilising a patient to the toilet rather than requiring laxatives to use a bedpan, or antipsychotics for challenging behaviour in dementia where a person-centred approach is preferable.

Evidence Base for Addressing Polypharmacy

Several studies have assessed interventions to improve prescribing quality for people with polypharmacy. Overall, there is evidence showing small reductions in both inappropriate prescribing and inappropriate therapeutic omissions (Keller et al, 2024). But there is little to suggest that these interventions improve important patient outcomes such as falls, hospitalisation or mortality. Similarly, the evidence base for deprescribing to address polypharmacy in older people is limited (Hung et al, 2024). Some studies suggest it could improve quality of life. There is no consistent evidence to support a reduction in falls, hospitalisations or mortality. Completed studies tend to have few participants ($n < 200$ in a third), short duration (most 12 months or less), and various outcomes making meta-analysis difficult. Notably, the effect size of the intervention is usually small. Despite starting with high average numbers of medication per person (7 to 17), most interventions achieved only small reductions compared to the control group, typically less than one fewer. So far, these studies have shown that deprescribing is possible, isn't associated with net harm, and the same outcomes can be achieved with fewer medications. Hopefully, ongoing and future studies will provide more insight.

Medicines Optimisation

Deprescribing is the treatment for inappropriate polypharmacy. Medicines optimisation can still be relevant even if the patient's polypharmacy is appropriate. Sometimes this will involve starting a new medication. Symptom relief is a valid goal in all clinical scenarios. Regarding preventative medications, decisions need to be individualised considering patient wishes/goals, illness trajectory, and whether taken for primary or secondary prevention. Medicines optimisation can also include changing the dose or formulation. For example, reducing dose in the context of renal impairment, switching a tablet to a liquid, or changing a medication that is taken three times a day to a modified release version taken just once daily. It is a complex process with no easy shortcuts.

Several deprescribing tools and protocols have been proposed (Reeve, 2020). These range from general guidance on good prescribing to protocols specific to single medication types. This latter group typically includes practical advice for drug dose tapering, when appropriate (Canadian Deprescribing Network, 2024). Various resources are available to support patient decision-making but limitations, such as health literacy requirements or unbalanced data regarding risks and benefits, diminish their practical value (Fajardo et al, 2019). A non-randomised study suggests that applying deprescribing protocols to older people with polypharmacy could be safe and effective in reducing the number of medications (McKean et al, 2016). But they may not be of practical value in clinical settings (Warmoth et al, 2024).

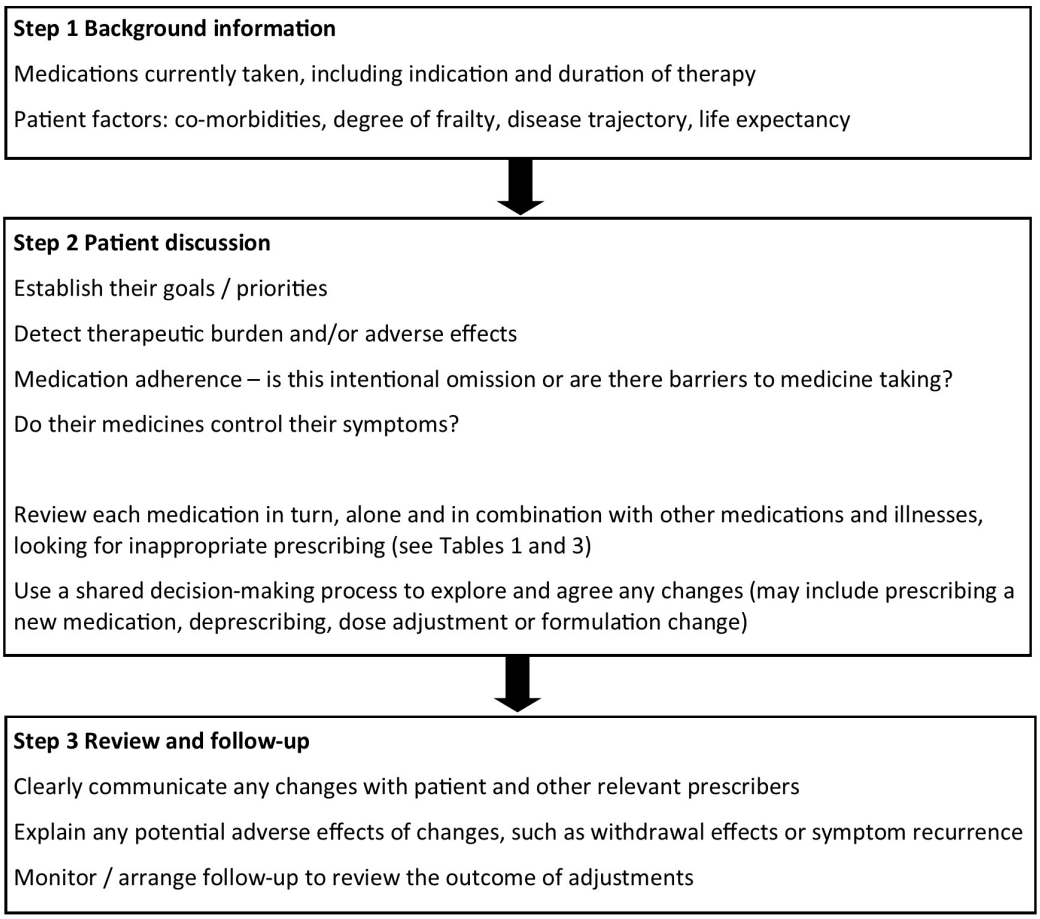

Fig. 1. A suggested scheme for medication optimisation.

Medicines optimisation should be viewed as a three-stage process (see Fig. 1). First, some background information should be sought, including an accurate list of medicines taken, the rationale for prescribing and the duration of therapy. In addition, a list of co-morbidities, and consideration of frailty status, disease trajectory and life expectancy are pertinent. The next stage involves a discussion with the patient. What is important to them? Do they feel a sense of therapeutic burden? Have they experienced adverse effects or are they concerned about developing them? Don't assume that everything is taken as prescribed. "Tell me about your medications" is a reasonable place to start. Do they ever miss a dose? If so, does that impact on their symptom control? You are trying to establish if the polypharmacy is problematic (i.e., working through the items in Tables 1 and 3). Each medicine needs to be considered in the context of their frailty status (i.e., risk of harm), other illnesses and other medications. Having gathered this information, a shared decision-making process can be followed. The four components of this are shown below (Jansen et al, 2016). As discussed earlier, accurately establishing the risks and benefits of the different options is challenging due to the limitations of clinical trials. Considering individual life-expectancy can help to contextualise data like NNT/y.

(1) Create awareness that options exist (i.e., prescribing, deprescribing, non-drug options and doing nothing);

(2) Discuss the options—both the potential benefits and harms;

(3) Explore patient preferences for the different options;

(4) Make the decision together.

When deprescribing, some situations favour withdrawal of one medication at a time (e.g., out-patient clinics when the situation is stable) whereas others may favour withdrawal of several medications simultaneously (e.g., medical admission unit with acute illness). Some drugs can be stopped abruptly but others require gradual dose reduction (e.g., long-term benzodiazepines or antidepressants). The final component of medicines optimisation is review and follow-up. Sometimes discontinuing a medication will result in withdrawal effects or symptom recurrence. On some occasions, the best option will be to restart the medication. This is ok. There will always be uncertainty about the effect. Sometimes reducing a medication is the only way to know if it is having ongoing symptomatic benefit. Labelling the process as a 'drug holiday' or 'trial without' may help patient understanding. Communication of any agreed changes, along with the rationale, with the other healthcare professionals involved in their care is also vital. This can prevent a futile cycle of de- and re-prescribing.

Conclusion

Polypharmacy is common in modern medicine and often affects older people. In some situations, it can be inappropriate or problematic. Prescribing guidelines promote standardised care but people with complex combinations of multimorbidity and frailty need an individualised approach. Evidence suggesting a need for change includes suboptimal medication adherence, the high number of hospital admissions related to ADRs, and many patients expressing a desire to take less. Clinical trials recruit selected populations and don't give all the information we would find helpful. The balance of risks and benefits may change in older age. Multimorbidity and reduced life expectancy could reduce beneficial effects. Frailty is associated with an increased risk of harm. The answer to these uncertainties is careful medication review and open conversations leading to a shared decision-making approach to give patients the best chance of getting the desired outcomes from their medicines. Sometimes this will involve deprescribing. Any changes need to be reviewed and communicated. The medicines optimisation process requires skill and time but is key to tackling inappropriate polypharmacy, which is frequently encountered in modern hospital medicine.

Key Points

- Polypharmacy commonly affects older people and can be inappropriate or problematic.
- Data suggest we could do better: suboptimal adherence, medication adverse effects causing hospital admissions, and patients wanting to take fewer tablets.
- Multimorbidity and reduced life expectancy could attenuate the benefits of medications for some older people.
- Frailty, a state of vulnerability, increases the risk of harm from medications.
- Medications can be inappropriate for a wide range of reasons.
- Medication optimisation through shared decision-making can help individualise care and enable people to get the balance right for themselves.

Availability of Data and Materials

Not applicable.

Author Contributions

All the work was completed by HJW alone.

Ethics Approval and Consent to Participate

Not applicable.

Acknowledgement

Not applicable.

Funding

This research received no external funding.

Conflict of Interest

The author declares no conflict of interest.

References

Albasri A, Hattle M, Koshiaris C, Dunnigan A, Paxton B, Fox SE, et al. Association between antihypertensive treatment and adverse events: systematic review and meta-analysis. BMJ (Clinical Research Ed.). 2021; 372: n189. https://doi.org/10.1136/bmj.n189

Brugts JJ, Arima H, Remme W, Bertrand M, Ferrari R, Fox K, et al. The incidence and clinical predictors of ACE-inhibitor induced dry cough by perindopril in 27,492 patients with vascular disease. International Journal of Cardiology. 2014; 176: 718–723. https://doi.org/10.1016/j.ijcard.2014.07.108

Bytyçi I, Penson PE, Mikhailidis DP, Wong ND, Hernandez AV, Sahebkar A, et al. Prevalence of statin intolerance: a meta-analysis. European Heart Journal. 2022; 43: 3213–3223. https://doi.org/10.1093/eurheartj/ehac015

Canadian Deprescribing Network. Deprescribing guidelines and algorithms. 2024. Available at: https://www.deprescribing.org (Accessed: 1 July 2024).

Chief Medical Officer. Chief Medical Officer's annual report 2023: health in an ageing society. 2023. Available at: https://www.gov.uk/government/publications/chief-medical-officers-annual-report-2023-health-in-an-ageing-society (Accessed: 1 July 2024).

Cholesterol Treatment Trialists' Collaboration. Efficacy and safety of statin therapy in older people: a meta-analysis of individual participant data from 28 randomised controlled trials. Lancet. 2019; 393: 407–415. https://doi.org/10.1016/S0140-6736(18)31942-1

Clark D, Armstrong M, Allan A, Graham F, Carnon A, Isles C. Imminence of death among hospital inpatients: Prevalent cohort study. Palliative Medicine. 2014; 28: 474–479. https://doi.org/10.1177/0269216314526443

Duerden M, Avery T, Payne P. Polypharmacy and medicines optimisation: making it safe and sound. The King's Fund: London. 2013. Available at: https://www.kingsfund.org.uk/insight-and-analysis/reports/polypharmacy-and-medicines-optimisation (Accessed: 1 July 2024).

Fajardo MA, Weir KR, Bonner C, Gnjidic D, Jansen J. Availability and readability of patient education materials for deprescribing: An environmental scan. British Journal of Clinical Pharmacology. 2019; 85: 1396–1406. https://doi.org/10.1111/bcp.13912

Hoffmann TC, Del Mar C. Clinicians' Expectations of the Benefits and Harms of Treatments, Screening, and Tests: A Systematic Review. JAMA Internal Medicine. 2017; 177: 407–419. https://doi.org/10.1001/jamainternmed.2016.8254

Hung A, Kim YH, Pavon JM. Deprescribing in older adults with polypharmacy. BMJ (Clinical Research Ed.). 2024; 385: e074892. https://doi.org/10.1136/bmj-2023-074892

Jansen J, Naganathan V, Carter SM, McLachlan AJ, Nickel B, Irwig L, et al. Too much medicine in older people? Deprescribing through shared decision making. BMJ (Clinical Research Ed.). 2016; 353: i2893. https://doi.org/10.1136/bmj.i2893

Keller MS, Qureshi N, Mays AM, Sarkisian CA, Pevnick JM. Cumulative Update of a Systematic Overview Evaluating Interventions Addressing Polypharmacy. JAMA Network Open. 2024; 7: e2350963. https://doi.org/10.1001/jamanetworkopen.2023.50963

Kim CA, Kim DH. Statins Provide Less Benefit in Populations with High Noncardiovascular Mortality Risk: Meta-Regression of Randomized Controlled Trials. Journal of the American Geriatrics Society. 2015; 63: 1413–1419. https://doi.org/10.1111/jgs.13476

Li L, Geraghty OC, Mehta Z, Rothwell PM, Oxford Vascular Study. Age-specific risks, severity, time course, and outcome of bleeding on long-term antiplatelet treatment after vascular events: a population-based cohort study. Lancet. 2017; 390: 490–499. https://doi.org/10.1016/S0140-6736(17)30770-5

Mangin D, Lawson J, Cuppage J, Shaw E, Ivanyi K, Davis A, et al. Legacy Drug-Prescribing Patterns in Primary Care. Annals of Family Medicine. 2018; 16: 515–520. https://doi.org/10.1370/afm.2315

Masnoon N, Shakib S, Kalisch-Ellett L, Caughey GE. What is polypharmacy? A systematic review of definitions. BMC Geriatrics. 2017; 17: 230. https://doi.org/10.1186/s12877-017-0621-2

Masoudi FA, Havranek EP, Wolfe P, Gross CP, Rathore SS, Steiner JF, et al. Most hospitalized older persons do not meet the enrollment criteria for clinical trials in heart failure. American Heart Journal. 2003; 146: 250–257. https://doi.org/10.1016/S0002-8703(03)00189-3

McDonagh TA, Metra M, Adamo M, Gardner RS, Baumbach A, Böhm M, et al. 2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure. European Heart Journal. 2021; 42: 3599–3726. https://doi.org/10.1093/eurheartj/ehab368

McGarvey C, Coughlan T, O'Neill D. Ageism in Studies on the Management of Osteoporosis. Journal of the American Geriatrics Society. 2017; 65: 1566–1568. https://doi.org/10.1111/jgs.14840

McKean M, Pillans P, Scott IA. A medication review and deprescribing method for hospitalised older patients receiving multiple medications. Internal Medicine Journal. 2016; 46: 35–42.

https://doi.org/10.1111/imj.12906

Musini VM, Tejani AM, Bassett K, Puil L, Wright JM. Pharmacotherapy for hypertension in adults 60 years or older. The Cochrane Database of Systematic Reviews. 2019; 6: CD000028. https://doi.org/10.1002/14651858.CD000028.pub3

National Institute for Health and Care Excellence. Hypertension in adults: diagnosis and management. NICE guideline 136. 2019. Available at: https://www.nice.org.uk/guidance/ng136 (Accessed: 1 July 2024).

National Institute for Health and Care Excellence. Type 2 diabetes in adults: management. NICE guideline 28. 2015. Available at: https://www.nice.org.uk/guidance/ng28 (Accessed: 1 July 2024).

NHS Digital. Health Survey for England. 2016. Available at: https://www.digital.nhs.uk (Accessed: 1 July 2024).

Office for Statistics. Life expectancy in care homes, England and Wales: 2021 to 2022. 2022. Available at: https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/lifeexpectancies/articles/lifeexpectancyincarehomesenglandandwales/2021to2022 (Accessed: 1 July 2024).

Osanlou R, Walker L, Hughes DA, Burnside G, Pirmohamed M. Adverse drug reactions, multimorbidity and polypharmacy: a prospective analysis of 1 month of medical admissions. BMJ Open. 2022; 12: e055551. https://doi.org/10.1136/bmjopen-2021-055551

Perpétuo C, Plácido AI, Rodrigues D, Aperta J, Piñeiro-Lamas M, Figueiras A, et al. Prescription of Potentially Inappropriate Medication in Older Inpatients of an Internal Medicine Ward: Concordance and Overlap Among the EU(7)-PIM List and Beers and STOPP Criteria. Frontiers in Pharmacology. 2021; 12: 676020. https://doi.org/10.3389/fphar.2021.676020

Reeve E. Deprescribing tools: a review of the types of tools available to aid deprescribing in clinical practice. Journal of Pharmacy Practice and Research. 2020; 50: 98–107. https://doi.org/10.1002/jppr.1626

Rossello X, Pocock SJ, Julian DG. Long-Term Use of Cardiovascular Drugs: Challenges for Research and for Patient Care. Journal of the American College of Cardiology. 2015; 66: 1273–1285. https://doi.org/10.1016/j.jacc.2015.07.018

Seppala LJ, van der Velde N, Masud T, Blain H, Petrovic M, van der Cammen TJ, et al. EuGMS Task and Finish group on Fall-Risk-Increasing Drugs (FRIDs): Position on Knowledge Dissemination, Management, and Future Research. European Geriatric Medicine. 2019; 10: 275–283. https://doi.org/10.1007/s41999-019-00162-8

Supportive and Palliative Care Indicators Tool. 2024. Available at: https://www.spict.org.uk (Accessed: 1 July 2024).

Tan YY, Papez V, Chang WH, Mueller SH, Denaxas S, Lai AG. Comparing clinical trial population representativeness to real-world populations: an external validity analysis encompassing 43 895 trials and 5 685 738 individuals across 989 unique drugs and 286 conditions in England. The Lancet. Healthy Longevity. 2022; 3: e674–e689. https://doi.org/10.1016/S2666-7568(22)00186-6

Taylor-Rowan M, Edwards S, Noel-Storr AH, McCleery J, Myint PK, Soiza R, et al. Anticholinergic burden (prognostic factor) for prediction of dementia or cognitive decline in older adults with no known cognitive syndrome. The Cochrane Database of Systematic Reviews. 2021; 5: CD013540. https://doi.org/10.1002/14651858.CD013540.pub2

Warmoth K, Rees J, Day J, Cockcroft E, Aylward A, Pollock L, et al. Assessing deprescribing tools for implementation in care homes: A qualitative study of the views of care home staff. Research in Social & Administrative Pharmacy. 2024; 20: 379–388. https://doi.org/10.1016/j.sapharm.2023.11.008

World Health Organisation. Adherence to long-term therapies: evidence for action. 2003. Available at: https://iris.who.int/bitstream/handle/10665/42682/9?sequence=1 (Accessed: 1 July 2024).

Yndigegn T, Lindahl B, Mars K, Alfredsson J, Benatar J, Brandin L, et al. Beta-Blockers after Myocardial Infarction and Preserved Ejection Fraction. The New England Journal of Medicine. 2024; 390: 1372–1381. https://doi.org/10.1056/NEJMoa2401479