

TOPIC 8



HEALTH QUALITY & SAFETY
COMMISSION NEW ZEALAND
Kupu Taurangi Hauora o Aotearoa

Medicines: balancing intended benefits and increased falls risk

How you can use Topic 8	1
Key messages in Topic 8	2
What Topic 8 covers	2
How older people, polypharmacy and adverse drug events are related	2
How medicines increase the risk of falls	3
How modifying medicine use might reduce falls and related harm	6
60 minutes of professional development	8
Recommended reading	9
Additional resources	9
Resources about medicines optimisation review	9
Professional development: questions to test your knowledge	10
References	11

How you can use **Topic 8**

Use Topic 8 as:

- an information resource that explains the evidence and rationale for critically thinking about any medicines an older person is taking that increase their risk of falling
- an introduction to medicines optimisation review to help avoid inappropriate prescribing
- a 60-minute professional development exercise (see [60 minutes of professional development](#) in this resource).

**LIVE STRONGER
FOR LONGER**

PREVENT FALLS & FRACTURES

newzealand.govt.nz



Key messages in Topic 8

- Medicines have many physiological effects that can increase the risk of an older person falling. The risk of falls can increase if the older person's medicines are not reviewed regularly to ensure the medication is right for them as their health condition, physiology, routine or lifestyle changes.
- Some medicines are associated with increasing the risk that an older person will fall or suffer falls-related injuries. Also, adverse drug events are recognised causes of hospitalisation, morbidity and mortality.
- We should do four things if an older person is taking medicines that increase their risk of falling: (1) regularly review the reasons for prescribing the medicine and its continuation; (2) educate older people and their families/whānau about the risks associated with medicines; (3) put in place individualised strategies to prevent an older person falling and (4) emphasise why a medical review of the older person is important after even a minor fall.
- We may be able to reduce falls by an older person through reviewing the medicines they are taking and modifying therapy to balance benefits of the medicines and risks of falling. Medicines optimisation review is explained in the [New Zealand National Pharmacist Services Framework](#) (page 6).



What Topic 8 covers

Some medicines are associated with increased falls and falls-related injuries in older people, but particular approaches for reviewing and modifying medicine use can reduce falls. We need to balance the benefit of using a medicine against the risks of taking it. So which medicines should we consider and what processes are evidence based?

Topic 8 provides an overview of medicines associated with an increased risk of falling or falls-related harm and looks at how reducing or changing the use of the medicines can reduce falls. The required reading covers general considerations in [managing medicines in older people](#) and [stopping medicines](#) as part of medicines optimisation review and modification.



How older people, polypharmacy and adverse drug events are related

Polypharmacy: Polypharmacy is often defined as taking four or five medicines (or more) concurrently (Patterson et al 2012). Polypharmacy is associated with falls and falls-related fractures (Narayan and Nishtala 2015; Pan et al 2014; Richardson et al 2014).

In clinical practice the question needs to be addressed on an individual basis because it is specific to each older person:

Are there many medicines (appropriate polypharmacy to manage complex comorbidities) or **too many** medicines (inappropriate or problematic polypharmacy) (Cooper et al 2015)?

HOW OLDER PEOPLE, POLYPHARMACY AND ADVERSE DRUG EVENTS ARE RELATED *Continued*

Inappropriate polypharmacy can result from:

- a prescribing cascade, when one medicine is added to combat the unwanted effects of another medicine
- failure to review medicines.

Adverse drug events (ADEs): ADEs are broadly undesirable experiences associated with medicines, cover falls and falls-related injuries. ADEs include injuries causally linked to a medicine (or lack of an intended medicine), drug interactions, adverse drug reactions (side effects) and harm from medication errors (Zolezzi and Parsotam 2005).

In older people, ADEs are recognised causes of hospitalisation, morbidity and mortality (Petrovic et al 2012). In particular:

- the risk of ADEs increases as a person ages and their physiology and metabolism change, and they experience general functional and cognitive decline, meaning drugs affect them in different ways (Petrovic et al 2012; Klotz 2009)
- the potential for ADEs increases with the number of medicines being taken: 13 percent of older people taking two medicines suffer an ADE, increasing to 58 percent when taking five medicines and 82 percent when taking seven or more medicines (Patterson et al 2012)
- just one inappropriate medicine can place an older person at risk of an avoidable ADE (Beers and Ouslander 1989).

Many medicines are known to increase the risk of falls, and a New Zealand study demonstrated the association between the use of potentially inappropriate medicines (PIMs) and falls. Polypharmacy, defined here as taking more than five medicines, was also associated with falls, as noted in New Zealand health data sets (Narayan and Nishtala 2015). ♦



How medicines increase the risk of falls

The risk of falls can increase if medicines are not reviewed regularly to ensure therapeutic safety as an older person's health condition, physiology, routine or lifestyle changes. Medicines can increase the risk of an older person falling due to the effects of medicines on their blood pressure, gait/movement, cognition and toileting routine.

Blood pressure: Medicines that cause hypotension (whether as an intended therapeutic effect or an ADE) increase the risk of falls (Butt et al 2013; de Groot et al 2013). Medicines inducing postural hypotension include psychotropics, anticholinergics, opioids and antihypertensives. Postural hypotension can cause light-headedness, dizziness and syncope (fainting). Older people are particularly susceptible to falls related to postural hypotension. This is because compensatory systems in the body, which help to regulate changes in posture, decline with age. For example, serious falls appear to increase over the short term when an older person starts taking, or increases, their use of anti-hypertensive medicines (Shimbo et al 2016).

Gait/movement: Medicines that adversely affect balance, hearing, vision, coordination and muscle tone can disrupt an older person's normal and coordinated gait and movement. This increases their risk of falling (de Groot et al 2013).

HOW MEDICINES INCREASE THE RISK OF FALLS *Continued*

Cognition: Medicines that change or impair perception (including sedatives) increase the risk that an older person will fall. This is because such medicines affect a person's coordination and reduce their ability to identify hazards.

Toileting routine: The use of diuretics and laxatives can lead to a person needing to use the toilet urgently. This urgency may make an older person try to get up and move more quickly than is safe for them.

Managing medicines-related falls risks

Certain medicines are associated with an increased risk of falls and increased harm (see next page). This means we should do four things when an older person is prescribed these medicines (Landi et al 2005).

1. Regularly review the reasons for prescribing the medicine and continuing its use. Consider **de-prescribing** medicines.
2. Educate the older person and all those involved in their care (family/whānau, caregivers and staff) about the risks associated with these medicines, particularly when the older person starts taking the medicines or increases the dose.
3. Ensure strategies to prevent the older person from falling are appropriate and individualised to them. For example, **assess the older person's environment and make it as safe as possible**. Also make sure **appropriate intervention strategies** have addressed any **risk factors identified in a full assessment** of the older person.
4. Tell the older person, their family/whānau and/or their caregivers about the importance of **seeking medical attention and assessment after even a minor fall** to check whether any medicines they are taking contributed to the fall. ♦

Psychotropics increase falls in older people by up to 47 percent (Landi et al 2005)

HOW MEDICINES INCREASE THE RISK OF FALLS *Continued*

Medicines that increase the risk of falling					Medicines that increase the risk of injury
PSYCHOTROPICS	MEDICINES WITH ANTICHOLINERGIC EFFECTS	ANTIHYPERTENSIVES AND DIURETICS	ANTI-EPILEPTICS	OPIOIDS	ANTICOAGULANTS
<p>Psychotropics increase falls in older people by up to 47 percent (Landi et al 2005). They do so by causing sedation and postural hypotension, and causing or worsening impairments in movement and cognition.</p> <ul style="list-style-type: none"> Falls risk increases with higher doses and additional psychotropics (Sano et al 2012). Risk appears greatest in the first three days after the person starts, or increases the dose of, their medicine (Echt et al 2013), but the risk continues while the older person is being treated. <p>Anti-psychotics (eg, risperidone, quetiapine, haloperidol) are often used to treat behavioural and psychological symptoms of dementia (BPSD). Dementia increases the risk of an older person falling, no matter if they are taking any medicine (Allan et al 2009). Anti-psychotics further increase the risk (Hill and Wee 2012).</p> <ul style="list-style-type: none"> Anti-psychotics are similar in terms of falls risk despite varying ADE profiles. (Mehta et al 2010) <p>Antidepressants (eg, citalopram, venlafaxine, amitriptyline) are used to improve mood and reduce anxiety. Antidepressants increase the risk of the older person falling (Woolcott et al 2009) and also increase the risk of fracture. This is possibly due to the role that serotonin plays in bone metabolism (Iaboni and Flint 2013).</p> <ul style="list-style-type: none"> Fracture risk is highest in the first two weeks of therapy, but increased risk continues throughout treatment (Iaboni and Flint 2013) – with higher doses linked to increased fracture rates (Vestergaard et al 2013). Antidepressant use is also associated with recurrent falls (Marcum et al 2016). <p>Hypnotics and sedatives (eg, benzodiazepines such as diazepam, lorazepam, triazolam; zopiclone), used to treat anxiety or insomnia, increase the risk of a fall, especially in older people with cognitive impairment or who have fallen previously (Gallagher et al 2008).</p> <ul style="list-style-type: none"> Both long-acting and short-acting agents increase the risk of falling (Landi et al 2005). Hypnotics have only a small and limited positive effect in improving sleep (Glass et al 2005). <p>MANAGING THE BALANCE BETWEEN BENEFIT AND RISK</p> <ul style="list-style-type: none"> Start using psychotropics only if the potential benefits outweigh the risks. Use the lowest dose possible, for the shortest duration. Review therapy regularly; when using psychotropics for BPSD, taper down and/or stop as soon as possible. Educate caregivers and families/whānau (Fossey et al 2006) and the older person (Salonja et al 2010) about the adverse effects of using psychotropics. Reducing a dose or stopping use might not cause any behavioural issues to re-emerge. 	<p>Numerous medicines have anticholinergic activity which is often distinct from their therapeutic mechanism of action. Such medicines include antipsychotics, tricyclic antidepressants, antispasmodic agents (eg, oxybutynin and hyoscine) and sedating antihistamines. Anticholinergic activity increases the risk of ADEs, including falls (Berdot et al 2009) by causing postural hypotension, cognitive impairment and delirium.</p> <ul style="list-style-type: none"> Anticholinergic burden differs within pharmacological groups of medicines, and those with a lower burden have fewer ADEs (Rudolph et al 2008). <p>MANAGING THE BALANCE BETWEEN BENEFIT AND RISK</p> <ul style="list-style-type: none"> Avoid medicines with significant anticholinergic action when possible. Choose a medicine with a lower anticholinergic burden (eg, nortriptyline has less anticholinergic activity than amitriptyline). 	<p>Antihypertensives (eg, metoprolol, felodipine, cilazapril) are used to treat hypertension, ischaemic heart disease and atrial fibrillation, and for secondary prevention of cardiovascular disease.</p> <p>Diuretics are used to reduce fluid retention (eg, furosemide) and reduce blood pressure (eg, benndroflumethiazide).</p> <p>Appropriate long-term use of antihypertensives to maintain blood pressure at guideline-directed levels does not appear to raise the risk of falls, provided that appropriate caution is taken immediately after starting them or adjusting the dosage. Diuretics should be used cautiously, and the first 24 hours of antihypertensive use or adjustment is the key period for increased risk of falling (Kahlaee et al 2017; Weiss et al 2017).</p> <p>MANAGING THE BALANCE BETWEEN BENEFIT AND RISK</p> <ul style="list-style-type: none"> The important consideration, which requires critical thinking and clinical judgement, is to evaluate the risks and benefits of various antihypertensives for each individual. Check whether therapy continues to be clinically indicated (eg, earlier angina or an earlier oedema may no longer exist or trouble the older person). Perform lying and standing blood pressure checks to exclude postural hypotension and/or educate the older person in how to manage it. Check the older person's blood pressure routinely, and reduce the dose of medicine if their blood pressure is consistently below normal limits. Blood pressure targets for older people may be higher than those for younger people. However, the impact of blood pressure goals on falls may be slight. 	<p>Anti-epileptics (eg, phenytoin, carbamazepine, sodium valproate, gabapentin) are used to control seizures, stabilise moods and control neuropathic pain.</p> <p>Anti-epileptics increase the risk of falls, in addition to the increased risk associated with epilepsy (Ahmad et al 2012) by causing dizziness, ataxia and unsteady gait (Carbone et al 2010).</p> <ul style="list-style-type: none"> Anti-epileptics alter bone metabolism and reduce bone mineral density, which increases the likelihood of falls-related fractures (Ahmad et al 2012). The risk of fracture increases with enzyme-inducing anti-epileptics (eg, phenytoin, carbamazepine) and multiple anti-epileptics (Carbone et al 2010) and longer duration of anti-epileptic use (Ahmad et al 2012). <p>MANAGING THE BALANCE BETWEEN BENEFIT AND RISK</p> <ul style="list-style-type: none"> Review the anti-epileptic therapy regularly, especially if it is being used for non-seizure-related indications. Discuss stopping anti-epileptic therapy with the older person if they are not driving, are free of seizures, and are taking only one anti-epileptic medicine. 	<p>Opioids (eg, morphine, tramadol, codeine, oxycodone, fentanyl) are used to manage moderate to severe pain. Opioids can increase the risk of falls by inducing postural hypotension, sedation and dizziness (Gallagher et al 2008).</p> <ul style="list-style-type: none"> The use of opioids is associated with an increase in falls in older people, with one additional fall-related trauma expected for every 29 opioid prescriptions (Daoust et al 2018). However, this risk needs to be balanced against the benefit of providing adequate and appropriate analgesia (O'Neil et al 2012). <p>MANAGING THE BALANCE BETWEEN BENEFIT AND RISK</p> <ul style="list-style-type: none"> Balance the risks against the benefits of treating pain. Taper down and stop opioids as soon as possible if used to manage acute pain (eg, after a fracture). For severe pain, administer paracetamol regularly in addition to opioids. Use non-pharmacological methods of pain relief where possible (eg, massage, orthotics and heat packs). 	<p>Anticoagulants (eg, warfarin, dabigatran) are used to reduce the risk of blood clots. They increase the risk of bleeding in falls-related injuries.</p> <ul style="list-style-type: none"> Among older people hospitalised after a fall, haemorrhage is more common in those on long-term anticoagulants compared with non-users (Pieracci et al 2007). However, warfarin treatment for atrial fibrillation is under-prescribed (by about 50 percent) for older people, and risk of falling is the most commonly cited reason for not prescribing. Even in older people at risk of falling, the benefits of warfarin can outweigh the potential risk of falls-related bleeding (Jones et al 2017). <p>MANAGING THE BALANCE BETWEEN BENEFIT AND RISK</p> <ul style="list-style-type: none"> Educating older people and their caregivers about anticoagulation helps to reduce the risk of bleeding risk (Garwood and Corbett 2008). <p>PROTON PUMP INHIBITORS</p> <p>Proton pump inhibitors (PPIs) (eg, pantoprazole, omeprazole) are acid-suppressive medicines commonly prescribed to treat conditions such as gastro-oesophageal reflux (GORD).</p> <p>PPIs have now been linked to an increased risk for falls (Lapumnuaypol et al 2019). Previous research linked PPIs with increased risk of fractures (Yu et al 2011), but the mechanism was unclear. Guidance from bpac^{ca} states that PPIs should be used only when there is a specific clinical indication, at the lowest effective dose, for the shortest period of time (bpac^{ca} 2019).</p> <p>MANAGING THE BALANCE BETWEEN BENEFIT AND RISK</p> <ul style="list-style-type: none"> Review the use of PPIs regularly: often short courses (6–8 weeks) are sufficient to treat GORD or an ulcer. Stop PPIs prescribed to prevent potential medicine-induced bleeding (eg, related to warfarin, ibuprofen and other NSAIDs) when the original medicine is stopped.



How modifying medicine use might reduce falls and related harm

A medicines optimisation review is a process designed to optimise the benefits of medicines and help prevent a person being harmed. The review complements medicines reconciliation, which aims to communicate a correct and current list of a person's medicines. This is particularly important at transitions in the person's care.

How to perform medicines optimisation review

The medicines optimisation review process involves assessing a person's medicines to:

- consider appropriateness to the person's goals of therapy and self-management (Geurts et al 2012)
- identify risks that the medicines may pose for the older person to prevent harm occurring
- identify and reduce or stop inappropriate medicines: **de-prescribing** is a planned process of **stopping medicines** that may no longer be of benefit or may be causing harm
- identify medicines (or non-pharmacological alternatives) that would be beneficial
- ensure the person is being appropriately monitored (such as checking blood pressure and arranging laboratory tests)
- act on the results of that monitoring
- use medicines optimisation review in conjunction with **asking the person if they have slipped, tripped or fallen lately**.

A useful tool is **the screening tool of older people's prescriptions (STOPP) and screening tool to alert to right treatment (START) criteria** (O'Mahony 2015). Another source that lists potentially inappropriate medication in older people is the updated American Geriatrics Society Beers Criteria (American Geriatrics Society 2015 Beers Criteria Update Expert Panel 2015).

How reviewing and modifying medicine use works to help to reduce falls

Reviewing and modifying medicines can reduce the older person's chance of suffering harm and inappropriate prescribing (Patterson et al 2012). The review process is part of good care for older people (Gillespie et al 2012; Huang et al 2012). Examples are noted below.

- The rate of falls per patient was found to be lower following medicines optimisation review in a meta-analysis of randomised controlled trials (Huiskes et al 2017).
- Medicines optimisation review for older people living in the community reduces the use of prescription of medicines that increase the risk of falls (Blalock et al 2010; Weber et al 2008).
- In ARC, a systematic review and meta-analysis found across 41 studies that deprescribing interventions significantly reduced the number of residents with potentially inappropriate medication by 59 percent. Subgroup analysis showed that medication review-directed deprescribing interventions reduced all-cause mortality by 26 percent, and the number of fallers by 24 percent (Kua et al 2019).
- Medicines optimisation review by clinical pharmacists, which involved the older person and their carer, reduced the rate of falls in aged residential care facilities (Zermansky et al 2006).
- Importantly, variations in how medicines optimisation review (using the STOPP/START screening tool) is implemented may determine its effectiveness. Only one of three randomised controlled trials showed a reduction in falls in one meta-analysis (Hill-Taylor et al 2016). In this study a physician applied the criteria directly. In other studies the physician received the recommendations from others. It may be that clear communication practices could improve outcomes.

Targeting and modifying falls risk-increasing medicines reduces falls (Huang et al 2012; Gillespie et al 2012)

HOW MODIFYING MEDICINE USE MIGHT REDUCE FALLS AND RELATED HARM *Continued*

Any medicine that changes or impairs cognition, vision, gait, balance, perception or blood pressure can increase the risk of falls, even if standard screening tools don't identify the medicine.

Review of an older person's use of medicines – and modifying use as appropriate – is especially important after a fall because medicines that increase falls are often not stopped, despite the older person having fallen.

Stopping or reducing medicines that 'raise a red flag' may help to prevent the older person from falling. You don't need to wait until they've fallen to review their medicine use.

The Health Quality & Safety Commission's [Atlas of Healthcare Variation polypharmacy in older people domain](#) gives information about prescribing of multiple medications in older people across various district health boards (DHBs). ◆



60 MINUTES OF PROFESSIONAL DEVELOPMENT

This learning activity equals 60 minutes of your professional development.

You can add it to the personal professional record you keep to check off your competence framework requirements.

To complete this learning activity, first read the whole topic and the two required readings, then assess your learning with the **10 self-test questions**.

Learning objectives

Reading and reflecting on Topic 8 and the materials in this teaching and learning package will enable you to:

- explain the relationship between complex health conditions in older people, polypharmacy and adverse drug events
- describe ways to reduce or manage falls-related risks associated with various medicines
- outline what is involved in medicines optimisation review and modification.

Teaching and learning package

Gather up the resources you'll need. Use the hyperlinks in this topic, or download or print the reference material.

Required reading

These two readings will help you form evidence-informed perspectives about how to use medicines while balancing the benefits and the risks of falls.

- 1 bpac^{nz}. 2012. Managing medicines in older people. *Best Practice Journal* 47: 6–15, via [webpage](#) or [pdf](#).
- 2 bpac^{nz}. 2018. Stopping medicines in older people: the flip side of the prescribing equation. Dunedin: Best Practice Advocacy Centre: <https://bpac.org.nz/2018/stopping.aspx>.

RECOMMENDED READING

Mangoni AA, Jackson SH. 2004. Age-related changes in pharmacokinetics and pharmacodynamics: basic principles and practical applications. *British Journal of Clinical Pharmacology* 57(1): 6–14, via [webpage](#) or [pdf](#).

Huang AR, Mallet L, Rochefort CM, et al. 2012. Medication-related falls in the elderly: causative factors and preventive strategies. *Drugs & Aging* 29(5): 359–76 (see abstract [here](#)).

bpac^{nz}. 2014. Polypharmacy in primary care: Managing a clinical conundrum. *Best Practice Journal* 64: via [webpage](#).

ADDITIONAL RESOURCES

Ministry of Health. 2011. *Medicines Care Guides for Residential Aged Care*. Wellington: Ministry of Health, via [webpage](#) or [pdf](#).

Duerden M, Avery T, Payne R. 2013. *Polypharmacy and Medicines Optimisation*. London: The King's Fund, via [webpage](#) for summary or [pdf](#).

Consumer leaflet: [Taking your medicine safely](#).

RESOURCES ABOUT MEDICINES OPTIMISATION REVIEW

Further information on de-prescribing can be found [here](#).

See [New Zealand National Pharmacists Services Framework page 6](#) for an overview of the medicines review services that pharmacists in New Zealand provide.

The Royal Australian and New Zealand College of Psychiatrists provides a clinical practice guideline on [Antipsychotic medications as a treatment of behavioural and psychological symptoms of dementia](#), which outlines the limited circumstances for their use.

American Geriatrics Society 2015 Beers Criteria Update Expert Panel. 2015. [American Geriatrics Society 2015 Updated Beers Criteria for Potentially Inappropriate Medication Use in Older Adults](#).

10 QUESTIONS

TOPIC 8 Professional development: questions to test your knowledge



PROFESSIONAL DEVELOPMENT ACTIVITY

ANSWER these questions to check that you have retained the knowledge reviewed in this topic and readings

1	The required reading Managing medicines in older people cites a New Zealand study finding that the number of medicines prescribed for an older patient after being admitted to hospital: decreased stayed the same increased
2	The required reading Stopping medicines in older people: the flip side of the prescribing equation argues that we should give as much thought to starting medicines as to stopping them. true false
3	Mrs Jones is an 87-year-old taking the medicines listed below. A digoxin 62.5microgram daily B simvastatin 20mg daily C bendroflumethiazide 2.5mg daily D risperidone 500microgram nocte E warfarin as per INR Which medicines are likely to increase her risk of falls and/or injury from falling? C and D C, D and E A, D and E B, C, D and E
4	Mr Smith, a 92-year-old, was admitted to your unit a week ago and tells you he is having trouble sleeping, but does not want to take a sleeping pill. Which one of these responses would be most likely to increase his risk of falling? Ask Mr Smith about his usual bedtime routine and how you can help him make it work here. Review his daytime activities to see whether he could increase activity and reduce naps during the day. Ensure that night sedation is prescribed and persuade Mr Smith it is safe and wise to take it. Remind the night staff about the importance of a quiet night-time environment in the unit.

ANSWER

ASSESS the processes used for the review of an individual's medicine regimen in your care setting

5	In the most recent year reported in the Health Quality & Safety Commission Atlas of Healthcare Variation polypharmacy in older people domain , what was the rate of prescribing in your DHB area for people aged 75–84 for antipsychotics and benzodiazepines/zopiclone? (Click here for help with the Atlas). _____ per 1000 were prescribed an antipsychotic _____ per 1000 were prescribed a benzodiazepine or zopiclone Compared with other DHB areas, what factors could explain the similarities and differences in rates?
6	What process does your care setting use to review medicines for older patients/residents/clients? What would need to be modified in the use of medicines in your care setting, to better balance risk and benefit for older people?
7	Describe three specific things you already do (or could do) to review and modify medicines for your patients/residents/clients? 1. 2. 3.

ASSESS

Outline three learnings or insights and how you will APPLY them in your practice

8	My first learning/insight is: I will apply it in practice by:
9	My second learning/insight is: I will apply it in practice by:
10	My third learning/insight is: I will apply it in practice by:

APPLY

LEARNER	NAME:	PROFESSION:	DESIGNATION:
DATE:	REGISTRATION ID:	WORKPLACE:	

Validation that learner has completed this professional development activity		Signature:	
NAME:	PROFESSION:	CONTACT:	
DATE:	REGISTRATION ID:	WORKPLACE:	

REFERENCES

- Ahmad BS, Hill KD, O'Brien TJ, et al. 2012. Falls and fractures in patients chronically treated with antiepileptic drugs. *Neurology* 79(2): 145–51.
- Allan LM, Ballard CG, Rowan EN, et al. 2009. Incidence and prediction of falls in dementia: a prospective study in older people. *PLoS one* 4(5): e5521.
- American Geriatrics Society 2015 Beers Criteria Update Expert Panel. 2015. American Geriatrics Society 2015 Updated Beers Criteria for Potentially Inappropriate Medication Use in Older Adults. *Geriatric Soc* 63(11): 2227–46.
- Beers MH, Ouslander JG. 1989. Risk factors in geriatric drug prescribing. *Drugs* 37(1): 105–12.
- Berdot S, Bertrand M, Dartigues J-F, et al. 2009. Inappropriate medication use and risk of falls—a prospective study in a large community-dwelling elderly cohort. *BMC Geriatrics* 9(1): 30.
- Berry SD, Mittleman MA, Zhang Y, et al. 2012. New loop diuretic prescriptions may be an acute risk factor for falls in the nursing home. *Pharmacoepidemiology and Drug Safety* 21(5): 560–3.
- Blalock SJ, Casteel C, Roth MT, et al. 2010. Impact of enhanced pharmacologic care on the prevention of falls: a randomized controlled trial. *The American Journal of Geriatric Pharmacotherapy* 8(5): 428–40.
- bpac^{nz}. 2019. *Stopping proton pump inhibitors in older people*. Dunedin: Best Practice Advocacy Centre. URL: <https://bpac.org.nz/2019/ppi.aspx>.
- Butt D, Mamdani M, Austin P, et al. 2013. The risk of falls on initiation of antihypertensive drugs in the elderly. *Osteoporosis International* 24(10): 2649–57.
- Carbone LD, Johnson KC, Robbins J, et al. 2010. Antiepileptic drug use, falls, fractures, and BMD in postmenopausal women: findings from the women's health initiative (WHI). *Journal of Bone and Mineral Research* 25(4): 873–81.
- Cooper J, Cadogan C, Patterson S, et al. 2015. Interventions to improve the appropriate use of polypharmacy in older people: a Cochrane systematic review. *BMJ Open* 5(22): e009235.
- de Groot MH, van Campen JP, Moek MA, et al. 2013. The effects of fall-risk-increasing drugs on postural control: a literature review. *Drugs & Aging* 30(11): 901–20.
- Echt MA, Samelson EJ, Hannan MT, et al. 2013. Psychotropic drug initiation or increased dosage and the acute risk of falls: a prospective cohort study of nursing home residents. *BMC Geriatrics* 13(1): 19.
- Fossey J, Ballard C, Juszcak E, et al. 2006. Effect of enhanced psychosocial care on antipsychotic use in nursing home residents with severe dementia: cluster randomised trial. *British Medical Journal* 332(7544): 756–61.
- Gallagher P, Ryan C, Byrne S, et al. 2008. STOPP (Screening Tool of Older Person's Prescriptions) and START (Screening Tool to Alert doctors to Right Treatment). Consensus validation. *International Journal of Clinical Pharmacology and Therapeutics* 46(2): 72–83.
- Gebara MA, Lipsey KL, Karp JF, et al. 2015. Cause or effect? Selective serotonin reuptake inhibitors and falls in older adults: A systematic review. *American Journal of Geriatric Psychiatry* 23(10): 1016–28.
- Geurts MM, Talsma J, Brouwers JR, et al. 2012. Medication review and reconciliation with cooperation between pharmacist and general practitioner and the benefit for the patient: a systematic review. *British Journal of Clinical Pharmacology* 74(1): 16–33.
- Gillespie LD, Robertson MC, Gillespie WJ, et al. 2012. Interventions for preventing falls in older people living in the community. *Cochrane Database Syst Rev* 9(11): CD007146.
- Glass J, Lanctôt KL, Herrmann N, et al. 2005. Sedative hypnotics in older people with insomnia: meta-analysis of risks and benefits. *British Medical Journal* 331(7526): 1169.
- Gribbin J, Hubbard R, Gladman J, et al. 2011. Risk of falls associated with antihypertensive medication: self-controlled case series. *Pharmacoepidemiology and Drug Safety* 20(8): 879–84.
- Hill KD, Wee R. 2012. Psychotropic drug-induced falls in older people. *Drugs & Aging* 29(1): 15–30.
- Hill-Taylor B, Walsh KA, Stewart S, et al. 2016. Effectiveness of the STOPP/START (Screening Tool of Older Persons' potentially inappropriate Prescriptions/Screening Tool to Alert doctors to the Right Treatment) criteria: systematic review and meta-analysis of randomized controlled studies. *Journal of Clinical Pharmacy & Therapeutics* 41(2): 158–69.
- Huang AR, Mallet L, Rochefort CM, et al. 2012. Medication-related falls in the elderly. *Drugs & Aging* 29(5): 359–76.
- Huiskes VJ, Burger DM, van den Ende CH, et al. 2017. Effectiveness of medication review: a systematic review and meta-analysis of randomized controlled trials. *BMC Family Practice* 18(5): doi: 10.1186/s12875-016-0577-x.
- laboni A, Flint AJ. 2013. The complex interplay of depression and falls in older adults: a clinical review. *The American Journal of Geriatric Psychiatry* 21(5): 484–92.
- Jones NR, Hobbs FDR, Taylor CJ. 2017. Underuse of anticoagulation therapy for atrial fibrillation: Are we failing our patients? *Can Fam Physician* 63(12): 943–4.
- Kahlaee HR, Latt MD, Schneider CR. 2017. Association between Chronic or Acute Use of Antihypertensive Class of Medications and Falls in Older Adults. A Systematic Review and Meta-analysis. *Am J Hypertens* 31(4): 467–79. DOI: 10.1093/ajh/hpx189. [Epub ahead of print]
- Klotz U. 2009. Pharmacokinetics and drug metabolism in the elderly. *Drug Metabolism Reviews* 41(2): 67–76.
- Kua CH, Mak VSL, Huey Lee SW. 2019. Health Outcomes of Deprescribing Interventions Among Older Residents in Nursing Homes: A Systematic Review and Meta-analysis. *Journal of the American Medical Directors Association* 20(3): 362–72.
- Landi F, Onder G, Cesari M, et al. 2005. Psychotropic medications and risk for falls among community-dwelling frail older people: an observational study. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences* 60(5): 622–6.
- Lapunnayapong K, Thongprayoon C, Wijarnpreecha K, et al. 2019. Risk of fall in patients taking proton pump inhibitors: a meta-analysis. *QJM: Monthly Journal of the Association of Physicians* 112(2): 115–21. DOI: 10.1093/qjmed/hcy245.
- Marcum ZA, Perera S, Thorpe JM, et al. 2016. Antidepressant use and recurrent falls in community-dwelling older adults: findings from the Health ABC Study. *Annals of Pharmacotherapy* 50(7): 525–33.
- Mehta S, Chen H, Johnson ML, et al. 2010. Risk of falls and fractures in older adults using antipsychotic agents. *Drugs & Aging* 27(10): 815–29.
- Narayan SW, Nishtala PS. 2015. Associations of potentially inappropriate medicine use with fall-related hospitalisations and primary care visits in older New Zealanders: a population-level study using the updated 2012 Beers Criteria. *Drugs-real world outcomes* 2(2): 137–41.
- O'Mahony D, O'Sullivan D, Byrne S, et al. 2015. STOPP/START criteria for potentially inappropriate prescribing in older people: version 2. *Age & Ageing* 44(2): 213–8.
- O'Neil CK, Hanlon JT, Marcum ZA. 2012. Adverse effects of analgesics commonly used by older adults with osteoarthritis: focus on non-opioid and opioid analgesics. *The American Journal of Geriatric Pharmacotherapy* 10(6): 331–42.
- Pan H-H, Li C-Y, Chen T-J, et al. 2014. Association of polypharmacy with fall-related fractures in older Taiwanese people: age-and gender-specific analyses. *BMJ open* 4(3): e004428.
- Patterson SM, Hughes C, Kerse N, et al. 2012. Interventions to improve the appropriate use of polypharmacy for older people. *The Cochrane Library* 16(5): CD008165.
- Petrovic M, van der Cammen T, Onder G. 2012. Adverse drug reactions in older people. *Drugs & Aging* 29(6): 453–62.
- Pieracci FM, Eachempati SR, Shou J, et al. 2007. Use of long-term anticoagulation is associated with traumatic intracranial hemorrhage and subsequent mortality in elderly patients hospitalized after falls: analysis of the New York State Administrative Database. *Journal of Trauma and Acute Care Surgery* 63(3): 519–24.
- Richardson K, Bennett K, Kenny RA. 2014. Polypharmacy including falls risk-increasing medications and subsequent falls in community-dwelling middle-aged and older adults. *Age and Ageing* 44(1): 90–6.
- Rudolph JL, Salow MJ, Angelini MC, et al. 2008. The anticholinergic risk scale and anticholinergic adverse effects in older persons. *Archives of Internal Medicine* 168(5): 508–13.
- Salonjoja M, Salminen M, Aarnio P, et al. 2010. One-time counselling decreases the use of benzodiazepines and related drugs among community-dwelling older persons. *Age and Ageing* 39(3): 313–9.
- Sano T, Harada M, Sugawara T, et al. 2012. Use of psychotropics and the risk of falls in hospitalized psychiatric patients. *Yakugaku zasshi: Journal of the Pharmaceutical Society of Japan* 133(8): 897–903.
- Shimbo D, Bowling CB, Levitan EB, et al. 2016. Short-term risk of serious fall injuries in older adults initiating and intensifying treatment with antihypertensive medication. *Circulation: Cardiovascular Quality and Outcomes* 9(3): 222–9.
- Tanaka M, Suemaru K, Ikegawa Y, et al. 2008. Relationship between the risk of falling and drugs in an academic hospital. *Yakugaku Zasshi* 128(9): 1355–61.
- Vestergaard P, Prieto-Alhambra D, Javaid MK, et al. 2013. Fractures in users of antidepressants and anxiolytics and sedatives: effects of age and dose. *Osteoporosis International* 24(2): 671–80.
- Weber V, White A, McIlvried R. 2008. An electronic medical record (EMR)-based intervention to reduce polypharmacy and falls in an ambulatory rural elderly population. *Journal of General Internal Medicine* 23(4): 399–404.
- Weiss J, Freeman M, Low A, et al. 2017. Benefits and Harms of Intensive Blood Pressure Treatment in Adults Aged 60 Years or Older: A Systematic Review and Meta-analysis. *Ann Intern Med* 166(6): 419–29.
- Woolcott JC, Richardson KJ, Wiens MO, et al. 2009. Meta-analysis of the impact of 9 medication classes on falls in elderly persons. *Archives of Internal Medicine* 169(21): 1952–60.
- Yu E, Bauer SR, Bain PA, et al. 2011. Proton pump inhibitors and risk of fractures: a meta-analysis of 11 international studies. *The American Journal of Medicine* 124(6): 519–26.
- Zermansky AG, Alldred DP, Petty DR, et al. 2006. Clinical medication review by a pharmacist of elderly people living in care homes – randomised controlled trial. *Age and Ageing* 35(6): 586–91.
- Zolezzi M, Parsotam N. 2005. Adverse drug reaction reporting in New Zealand: implications for pharmacists. *Journal of Therapeutics and Clinical Risk Management* 1(3): 181–8.

**LIVE STRONGER
FOR LONGER**

PREVENT FALLS & FRACTURES