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Optimising Medications to Minimise Falls in Older People

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NSW Fall Prevention and Healthy Ageing Network Annual Forum May 1st 2026

Disclosures

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- Sarah Hilmer is an inventor of the Drug Burden Index. Software developed with her research group to calculate Drug Burden Index is under consideration for commercialisation.
- Sarah Hilmer is employed by Northern Sydney Local Health District, NSW with a conjoint appointment at The University of Sydney, Australia.
- Her research is funded by government and institutional grants and by philanthropy.

Key Messages

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Medications affect healthy ageing positively and negatively

Medications are one of the commonest and most modifiable risk factors for falls

Medication review is never a waste of time

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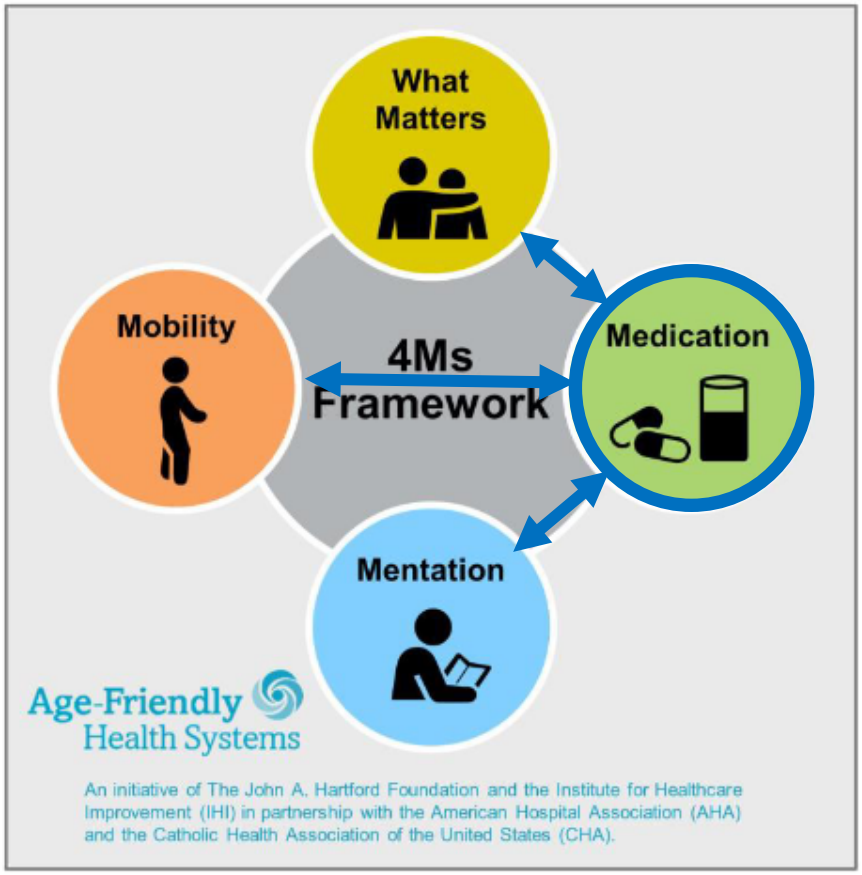
Medication review is central to age-friendly health systems, healthy ageing, and falls prevention

Figure 1. 4Ms Framework of an Age-Friendly Health System



What Matters

Know and align care with each older adult's specific health outcome goals and care preferences including, but not limited to, end-of-life care, and across settings of care.

Medication

If medication is necessary, use Age-Friendly medication that does not interfere with What Matters to the older adult, Mobility, or Mentation across settings of care.

Mentation

Prevent, identify, treat, and manage dementia, depression, and delirium across settings of care.

Mobility

Ensure that older adults move safely every day in order to maintain function and do What Matters.

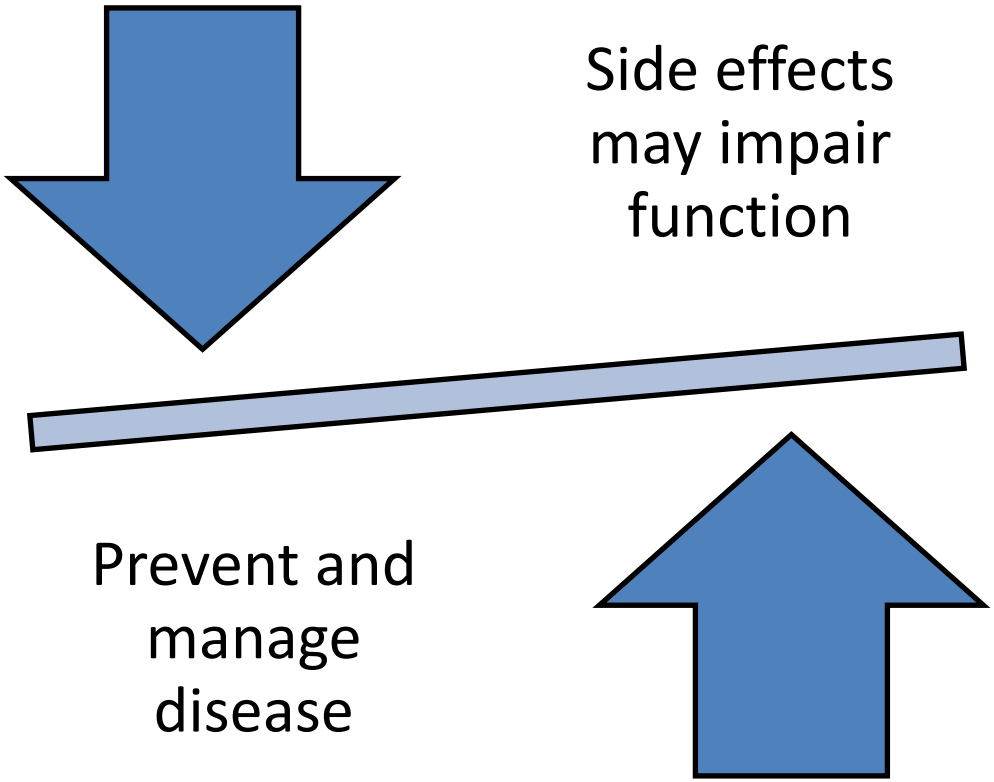
AUSTRALIAN COMMISSION ON SAFETY AND QUALITY IN HEALTH CARE

The Falls Guidelines provides recommendations and good practice points to address personal and environmental risk factors for falls.

A tailored approach to preventing falls and harm will consider the following risk factors:

- Fall risk assessment
- Continence
- Dizziness and vertigo
- Environmental risks
- Restrictive practices
- Vitamin D and calcium
- Balance and mobility
- Feet and footwear
- Vision
- Medicine and Medicines Review
- Hip protectors
- Post-fall management
- Cognitive impairment
- Syncope
- Hearing
- Osteoporosis
- Monitoring and observation

Role of Drugs in Healthy Ageing



Hilmer et al., Drugs & Aging 2025

World Falls Guidelines: Polypharmacy, Fall Risk Increasing Drugs and Falls

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- We recommend assessing for fall history and the risk of falls before prescribing potential fall risk increasing drugs (FRIDs) to older adults.
- We recommend the use of a validated, structured screening and assessment tool to identify FRIDs when performing a medication review or medication review targeted to falls prevention in older adults.
- We recommend that medication review and appropriate deprescribing of FRIDs should be part of multidomain falls prevention interventions.
- We recommend that in long-term care residents, the falls prevention strategy should always include rational deprescribing of fall-risk-increasing drugs.

All Strong Recommendations. Evidence Intermediate or Low Quality.

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Medication Reviews and Deprescribing as a Single Intervention in Falls Prevention: Key Points from a Systematic Review and Meta-Analysis

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- A medication review with the aim of deprescribing is an important component of a multifactorial falls prevention strategy.
- However, there is uncertainty related to the effectiveness of these interventions as a single intervention for falls prevention.
- In meta-analyses, no significant associations between medication reviews and fall outcomes were found in any of the settings.
- However, there was a trend for a lower number of fallers in the meta-analysis assessing medication reviews in **long-term care**.
- In a **frail subgroup** of older persons, medication review might be effective even as a single intervention.

Seppala LJ et al., Age Ageing 2022

Medication Review Considerations in Primary or Secondary Falls Prevention

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- Goals of care
- Minimising falls risk
- Minimising injury risk
- Intersection of medications with other interventions that reduce falls risk

Medications and exercise

- Exercise can reduce need for medications, e.g. cardiometabolic disease, musculoskeletal disease)
- Exercise can reduce ADRs, e.g. anorexia, osteoporosis, orthostatic hypotension, muscle atrophy
- Medications can affect ability to exercise, e.g. impair cognition, balance, cardiovascular response

Izquierdo et al., Lancet Healthy Longevity 2025

Whose job is medication review? Perceptions of hospital clinicians

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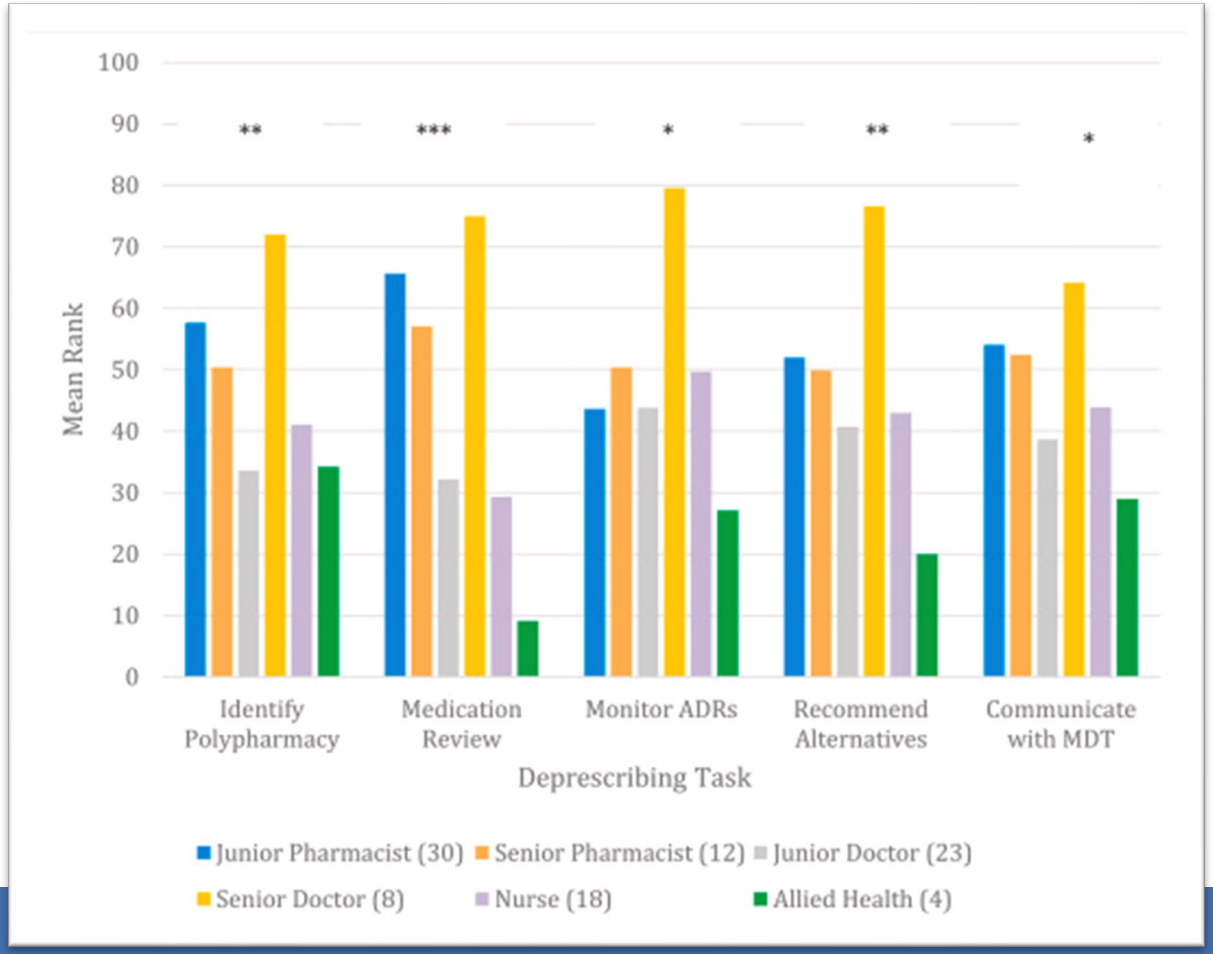

Ng B et al., RSAP 2021

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Polypharmacy and Deprescribing

Why is Polypharmacy Important in Older Adults?

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- More than half of older adults use polypharmacy (≥ 5 medications daily), often to manage multimorbidity*
- Polypharmacy increases the risks of falls, frailty and delirium

*Arch Gerontol and Geriatrics 124, 2024, 105465

Risks of Polypharmacy in Older Adults

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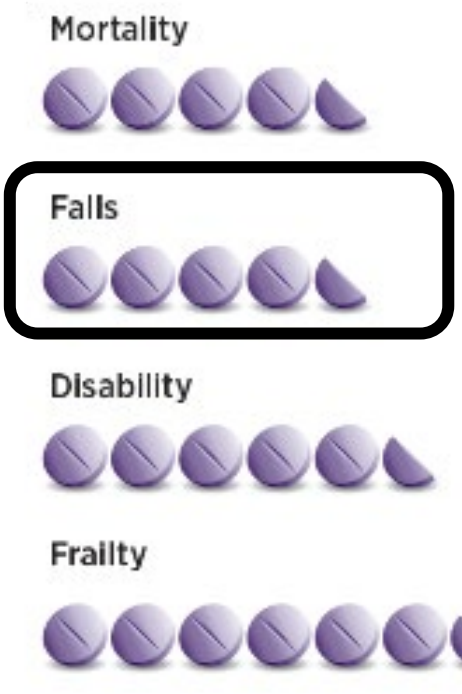

NPS MEDICINEWISE

- Pharmacological risks
  - 'Inappropriate' prescribing
  - Drug interactions
  - Prescribing cascade
- Clinical risks
  - Adverse drug reactions
  - Geriatric syndromes (including falls)
  - Hospitalisation and health care utilisation
  - Institutionalisation and death
- Patient/carer burden
  - Administration time
  - Cost

Observational pharmaco-epidemiologic evidence

Hilmer & Gnjidic, Clin Pharmacol Ther 2009
Gnjidic *et al*., J Clin Epidemiol. 2012

Deprescribing

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Deprescribing is the process of withdrawal of an inappropriate medication, supervised by a health care professional with the goal of managing polypharmacy and improving outcomes

Deprescribing: Achieving Better Health Outcomes for Older People Through Reducing Medications

Michael C Woodward

JOURNAL OF Pharmacy Practice and Research

Official Journal of the Society of Hospital Pharmacists of Australia

2003

Aging • THEME

Prescribing in older people

Australian Family Physician

2004

Reeve, Gnjidic, Long, Hilmer, BJCP2015

Why is deprescribing important for older people?

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1. Limited evidence of benefits of prescribing medications in older people with multimorbidity, polypharmacy and frailty
2. Known risks of polypharmacy in older people
3. Person centred

Deprescribing in geriatric medicine

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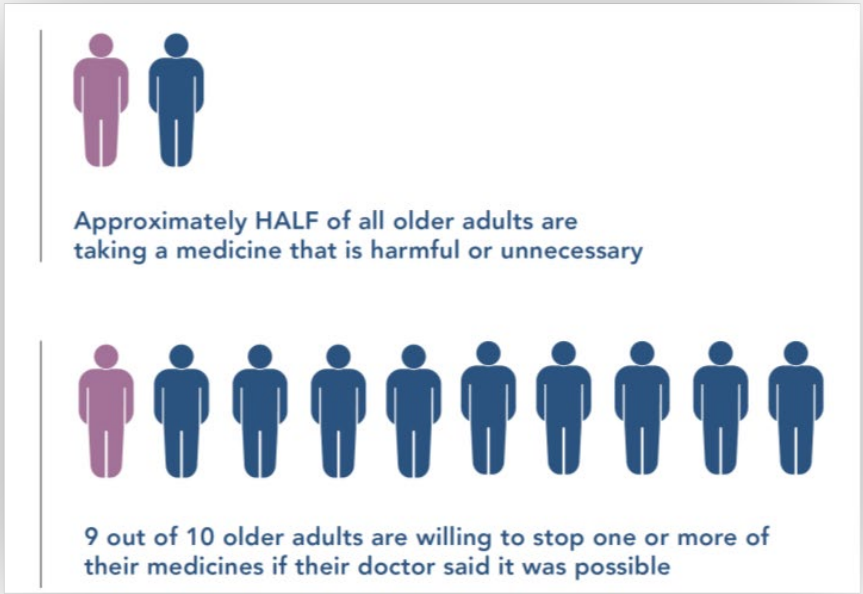

Once noticed, a side effect of a drug is probably the single most reversible affliction in all of geriatric medicine.

Avorn and Shrank, BMJ 2008

https://cdpc.sydney.edu.au/wp-content/uploads/2019/06/quality-use-of-medicines.pdf

Effects of Deprescribing

Benefits

- Less adverse drug reactions
- Less treatment burden from taking medicines

Harms

- Adverse drug withdrawal reactions
- Return of underlying condition or failure to prevent condition
- Pharmacokinetic and pharmacodynamic effects on remaining medicines

Randomised controlled trials of deprescribing:
- Single drug classes: feasible, safe, some improved clinical outcomes
- Inappropriate polypharmacy: feasible, safe, limited evidence of clinical impact

Iyer et al., Drugs Aging 2008; Kutner et al., JAMA Internal Medicine, 2015; Reeve et al., Cochrane Database Syst Rev 2020; Reeve et al., Aust Prescr. 2024; Quek et al., BJCP 2024; Veronese N et al., Ageing Research Reviews 2024

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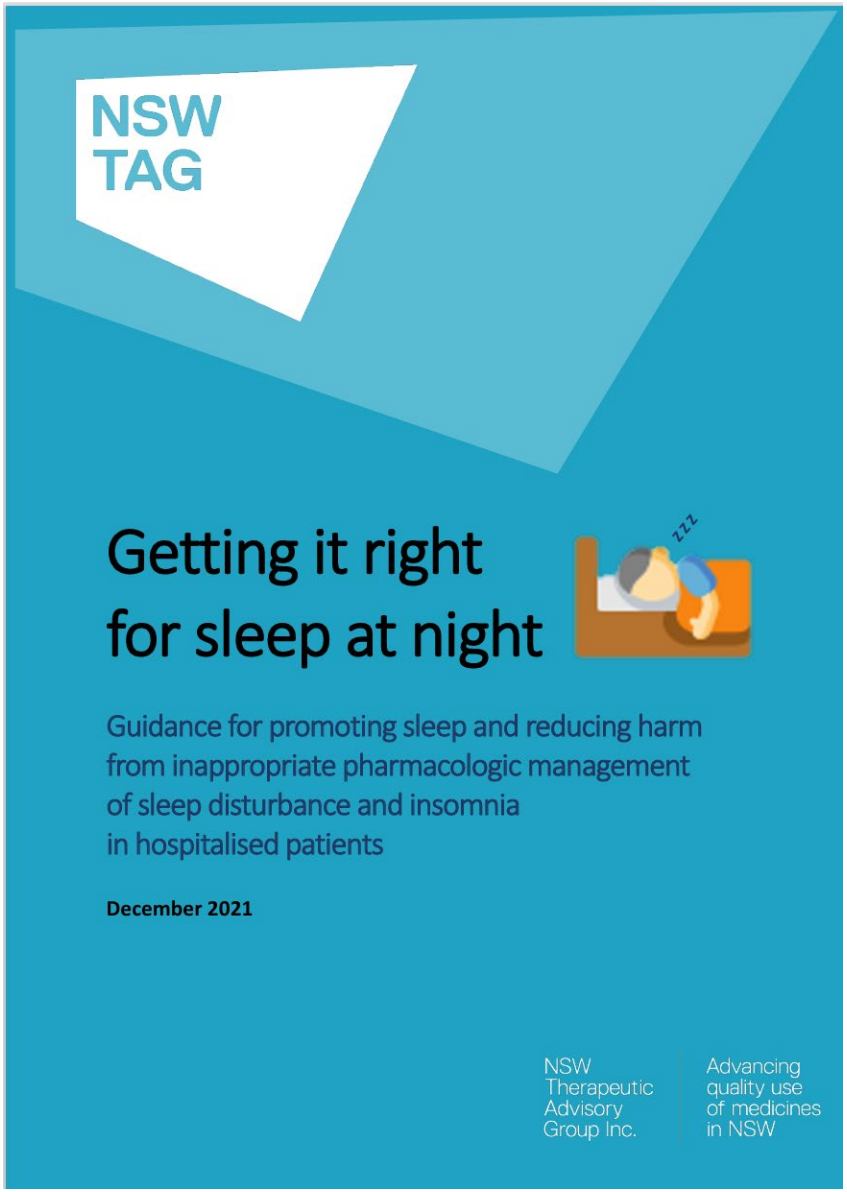
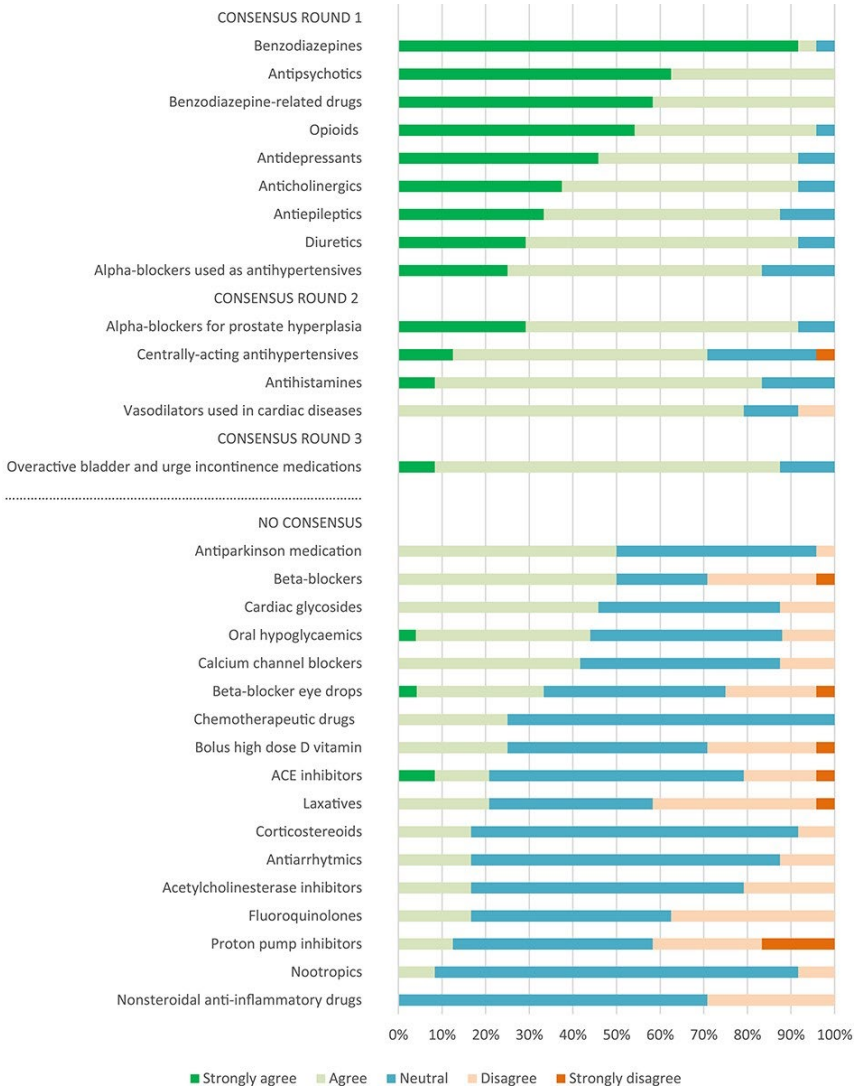
Not just the number of drugs, but also the type and dose of drugs increases falls risk

Falls Risk Increasing Drugs (FRIDS)





STOPPFall

Seppala et al., Age Ageing 2020

The Drug Burden Index

The Drug Burden Index (DBI) is a **pharmacological measure** of an older person's total exposure to medicines with anticholinergic and sedative effects that impair physical and cognitive function

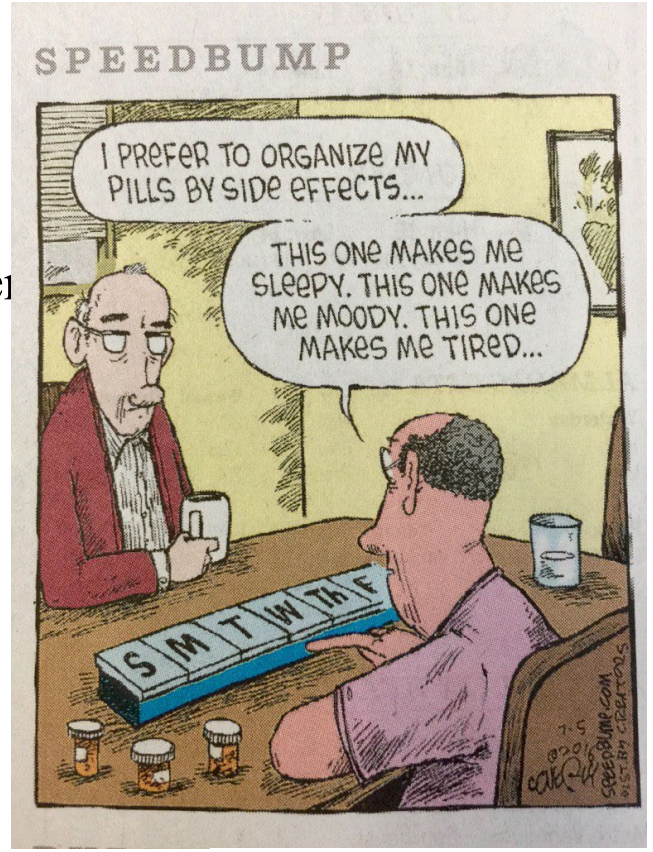
$$\frac{E}{\alpha} = \sum \frac{D}{\delta + D}$$

D, daily dose taken, δ, minimum registered dose (estimate DR50)

Evaluated in older people from community, retirement homes and hospitals internationally

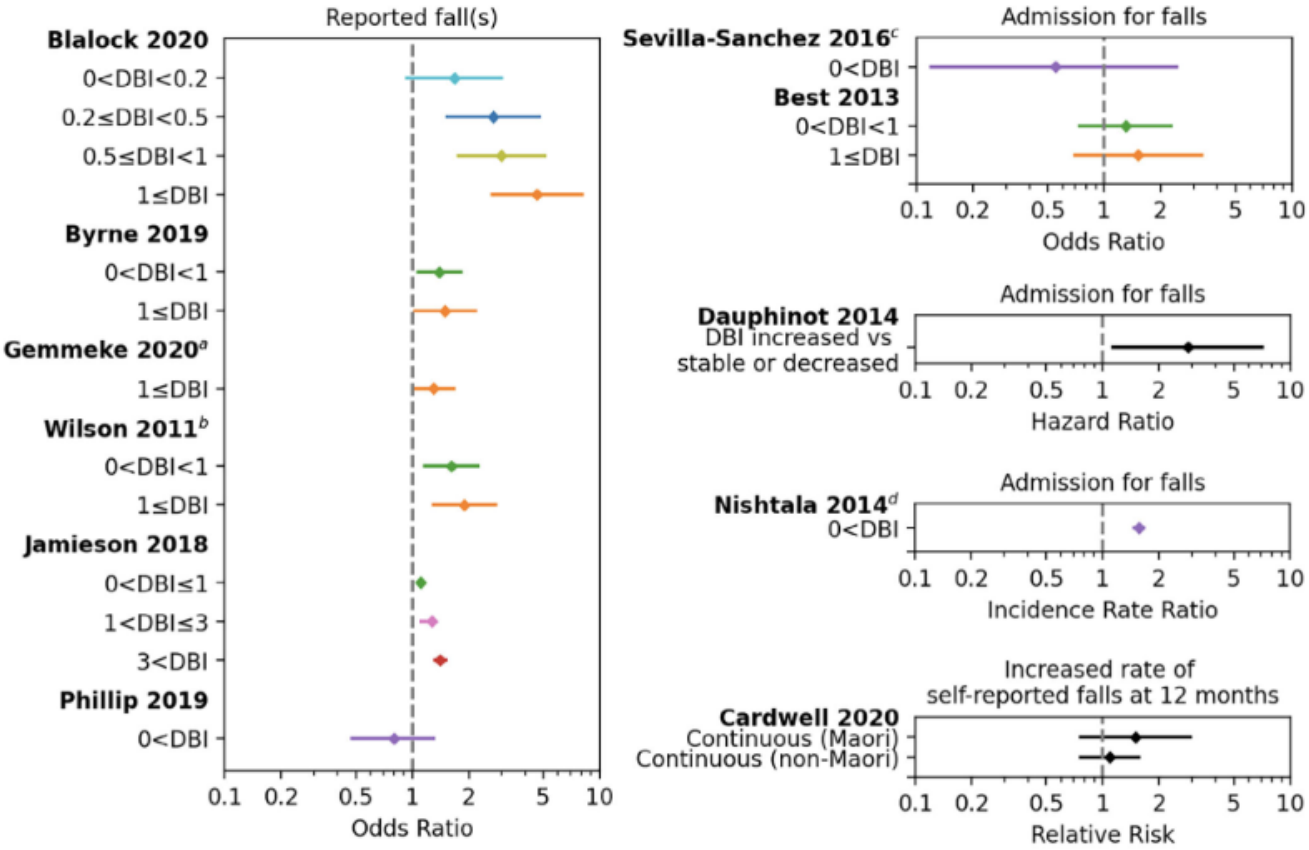
DBI exposure associated with:

- Impaired physical function
- Falls
- Frailty
- Hospitalisation and GP visits
- Mortality



Arch Intern Med. 2007;167:781-787

Association between the DBI and Falls



11 observational studies with 14 fall-related outcomes

Liu B et al., JAGS 2024

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Causation, reversibility and mechanisms of the effects of polypharmacy with increasing DBI on frailty and function in old age

Outstanding Clinical Questions

1. Are the associations between chronic medication use and adverse geriatric outcomes causative?
2. Is it the number of drugs or the type and dose of drugs (e.g. DBI) that causes adverse geriatric outcomes?
3. Are these effects reversible with deprescribing?

Use mouse models to determine the effects of chronic treatment with:

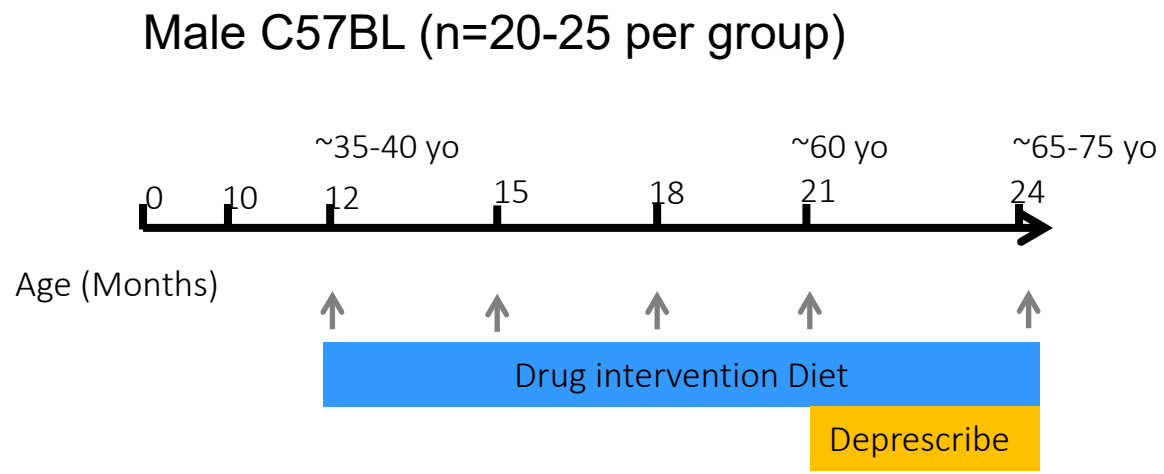
- Polypharmacy regimens with different DBIs;
- Monotherapies; and
- Deprescribing;

on translatable outcomes in ageing mice

Methodology

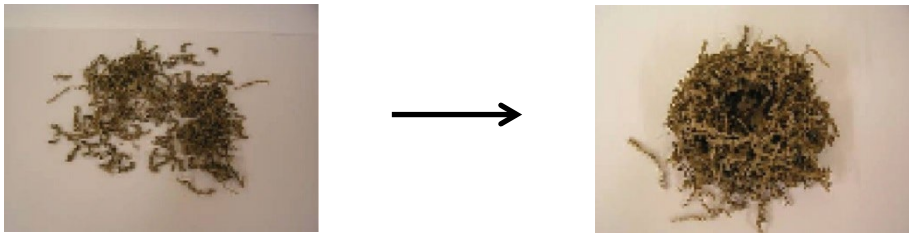
J Gerontol A Biol Sci Med Sci. 2021 May 22;76(6):1010-1018. doi: 10.1093/gerona/glaa060.

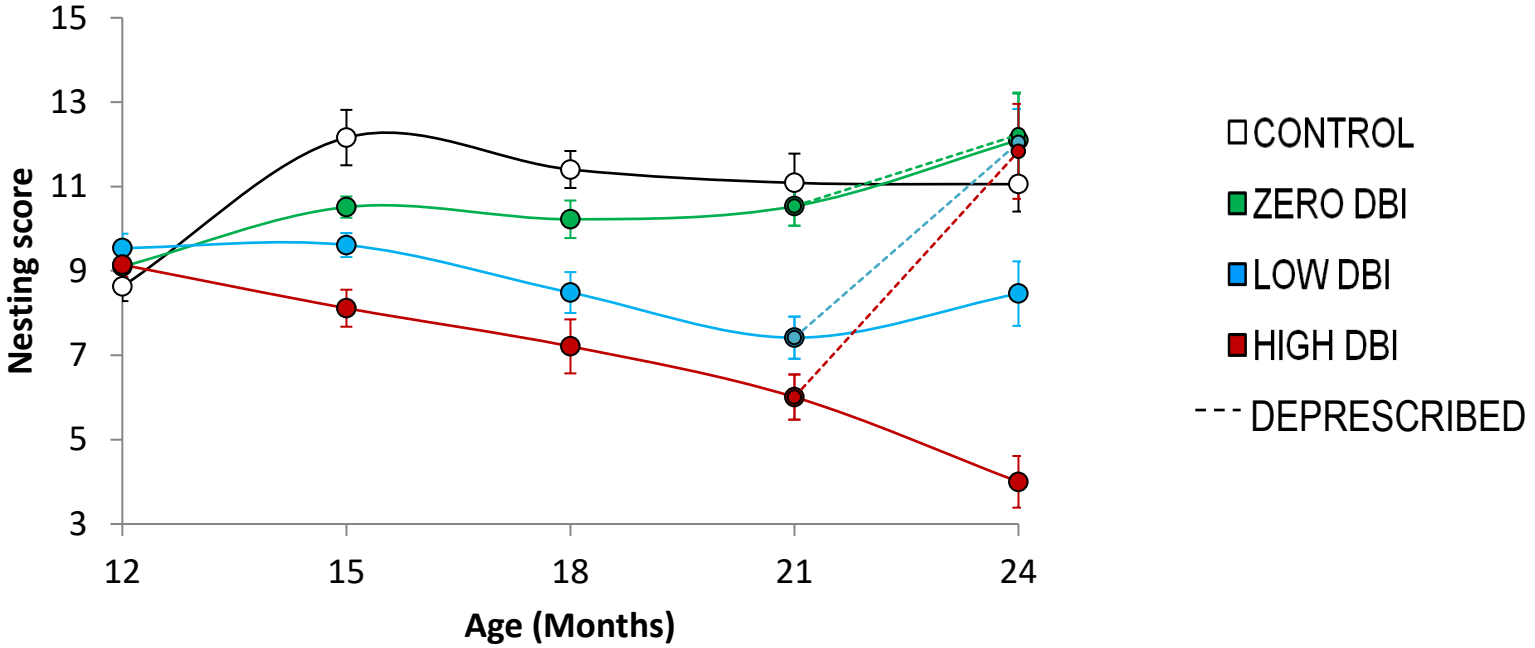
Chronic Polypharmacy with Increasing Drug Burden Index Exacerbates Frailty and Impairs Physical Function, with Effects Attenuated by Deprescribing, in Aged Mice



Control	Zero DBI Polypharmacy	Low DBI Polypharmacy	High DBI Polypharmacy
	Simvastatin	Simvastatin	Simvastatin
	Metoprolol	Metoprolol	Metoprolol
	Omeprazole	Omeprazole	Oxybutynin
	Paracetamol	Paracetamol	Oxycodone
	Irbesartan	Citalopram	Citalopram

Effects of Polypharmacy, DBI and Deprescribing on Nesting





DBI, not number of drugs impairs function in old age: reversible on deprescribing

Mach et al., Journals of Gerontology: Biological Sciences 2021

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Does exposure to anticholinergic and sedative medications impair gait and is this reversible with deprescribing?

Preclinical data

Observational clinical data

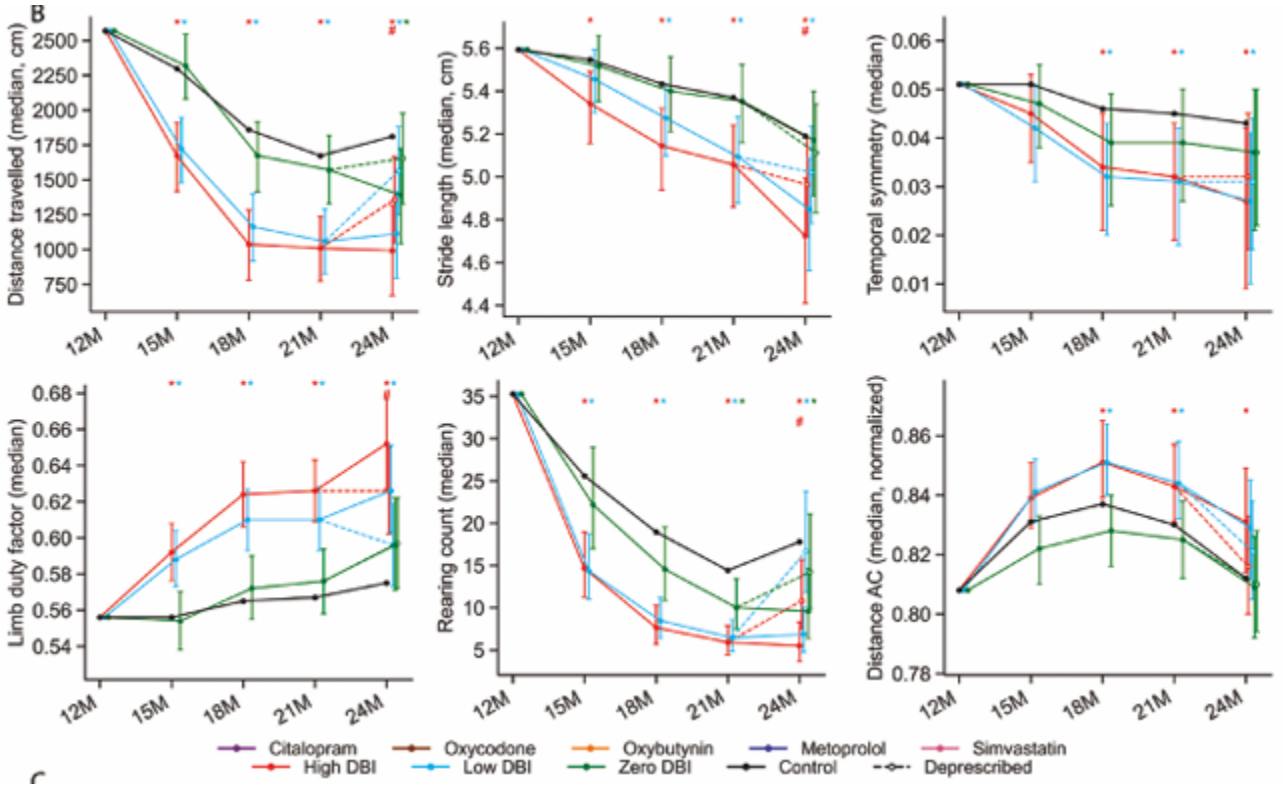
Interventional clinical data

Basic Science Research on Polypharmacy, Deprescribing and Gait (Open Field)

The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences, 2025, **80**(6), glaf049
https://doi.org/10.1093/gerona/glaf049
Advance access publication: 4 March 2025
Original Article

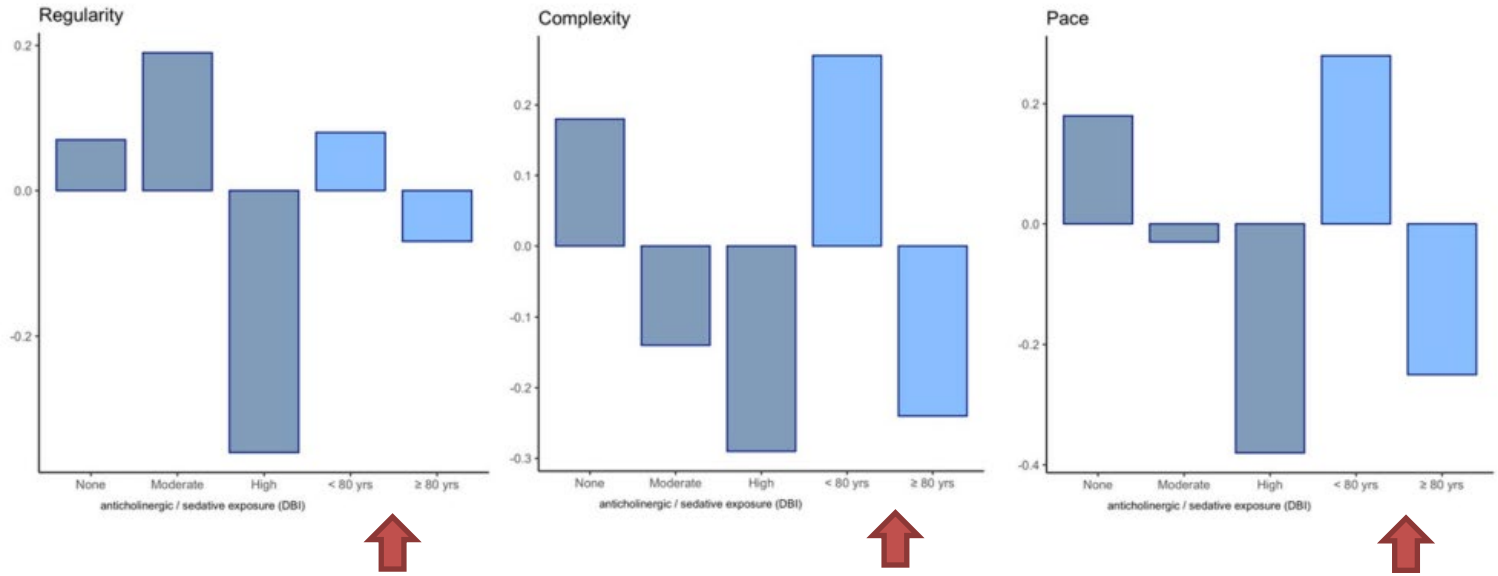
Using Computational Video Analysis in Aging Mice to Evaluate the Effects of Chronic Monotherapy, Polypharmacy, and Deprescribing Over Time

Kenji Fujita, PhD,[a] John Mach, PhD,[a] and Sarah N. Hilmer MD, PhD*[,a]



Anticholinergic and Sedative Medications and Dynamic Gait Parameters in Older Patients: Observational Cohort Study

- Associations between DBI and accelerometer-based dynamic gait parameters
- Outpatients of a diagnostic geriatric day clinic who underwent a comprehensive geriatric assessment (n=184)

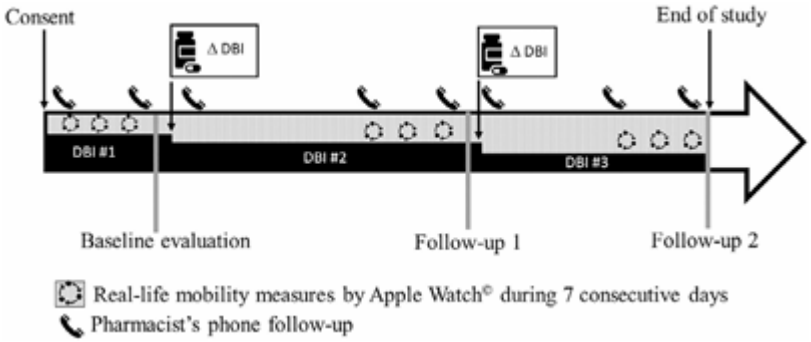


Hans Wouters et al, Drugs and Aging 2021; 38:1087-1096

Clinical Intervention Research

Impact in older adults of reducing anticholinergic and sedative medication burden on physical function measured by gait analysis and wearables

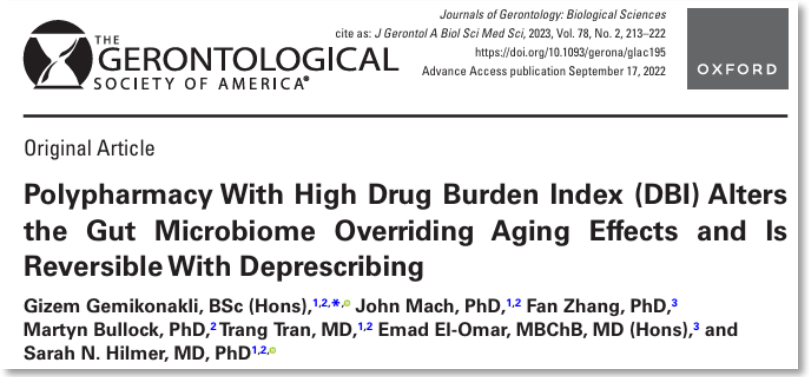
- Measure gait before and after deprescribing
- Feasibility study (n=5) followed by clinical trial



Cossette, B., Boissy, P., Milot, M.-H., Hilmer, S.N., *et al*. (2025).
Feasibility of Measuring Physical Function by Wearable Devices During Deprescribing of Anticholinergic and Sedative Medications.
Canadian Journal on Aging / La Revue canadienne du vieillissement 44(2), 254–261.

CIHR IRSC

Deeper understanding of mechanism of effects of polypharmacy and reversibility with deprescribing



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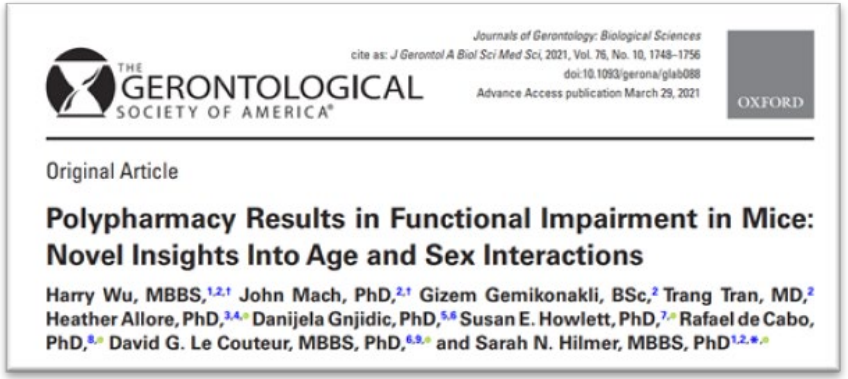
Journals of Gerontology: Biological Sciences
cite as: J Gerontol A Biol Sci Med Sci, 2023, Vol. 78, No. 2, 213–222
https://doi.org/10.1093/gerona/glac195
Advance Access publication September 17, 2022

OXFORD

Original Article

Polypharmacy With High Drug Burden Index (DBI) Alters the Gut Microbiome Overriding Aging Effects and Is Reversible With Deprescribing

Gizem Gemikonakli, BSc (Hons),[1,2,*] John Mach, PhD,[1,2] Fan Zhang, PhD,[3] Martyn Bullock, PhD,[2] Trang Tran, MD,[1,2] Emad El-Omar, MBChB, MD (Hons),[3] and Sarah N. Hilmer, MD, PhD[1,2]



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Journals of Gerontology: Biological Sciences
cite as: J Gerontol A Biol Sci Med Sci, 2021, Vol. 76, No. 10, 1748–1756
doi:10.1093/gerona/glab088
Advance Access publication March 29, 2021

OXFORD

Original Article

Polypharmacy Results in Functional Impairment in Mice: Novel Insights Into Age and Sex Interactions

Harry Wu, MBBS,[1,2,†] John Mach, PhD,[2,†] Gizem Gemikonakli, BSc,[2] Trang Tran, MD,[2] Heather Allore, PhD,[3,4] Danijela Gnjidic, PhD,[5,6] Susan E. Howlett, PhD,[7] Rafael de Cabo, PhD,[8] David G. Le Couteur, MBBS, PhD,[6,9] and Sarah N. Hilmer, MBBS, PhD[1,2,*]

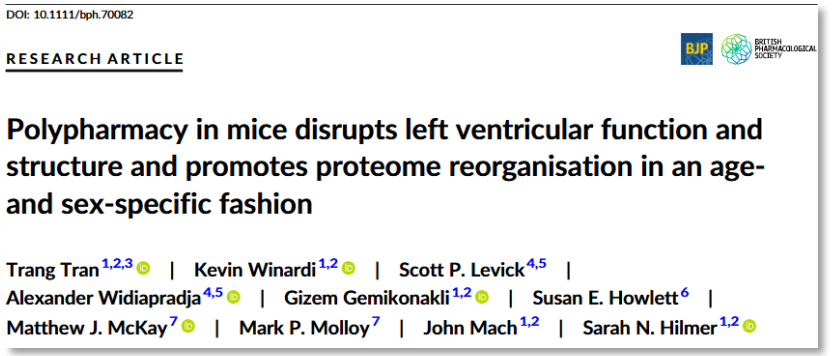
Received: 8 February 2024 | Revised: 9 August 2024 | Accepted: 16 September 2024
DOI: 10.1111/acel.14357

RESEARCH ARTICLE

Aging Cell — WILEY

Chronic polypharmacy, monotherapy, and deprescribing: Understanding complex effects on the hepatic proteome of aging mice

Kevin Winardi[1] | John Mach[1] | Matthew J. McKay[2] | Mark P. Molloy[2] | Sarah J. Mitchell[3] | Michael R. MacArthur[4] | Catriona McKenzie[5,6] | David G. Le Couteur[7,8,9] | Sarah N. Hilmer[1]



DOI: 10.1111/bph.70082

RESEARCH ARTICLE

BJP — BRITISH PHARMACOLOGICAL SOCIETY

Polypharmacy in mice disrupts left ventricular function and structure and promotes proteome reorganisation in an age- and sex-specific fashion

Trang Tran[1,2,3] | Kevin Winardi[1,2] | Scott P. Levick[4,5] | Alexander Widiapradja[4,5] | Gizem Gemikonakli[1,2] | Susan E. Howlett[6] | Matthew J. McKay[7] | Mark P. Molloy[7] | John Mach[1,2] | Sarah N. Hilmer[1,2]

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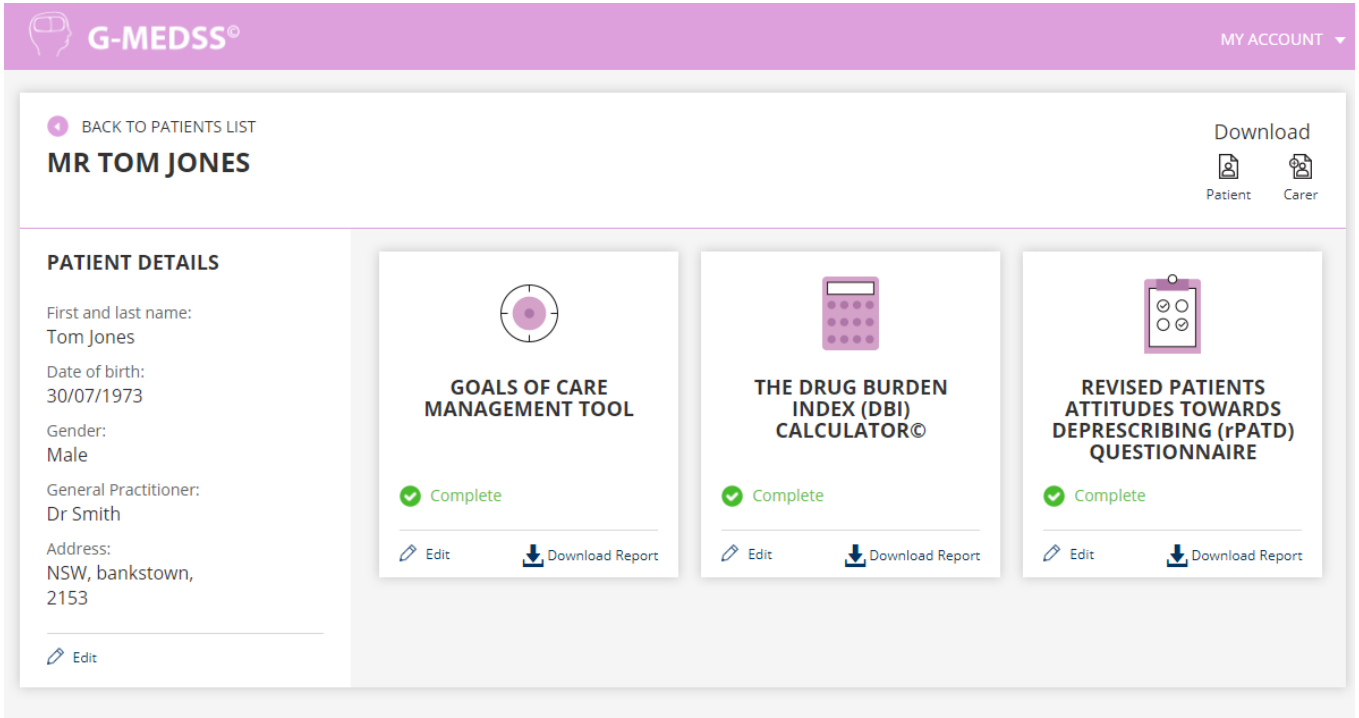
Use of the DBI to guide medication review in clinical interventional research and practice

Using Software to Support Patient-Centred Deprescribing



- Evaluated in Cluster RCT including process evaluation
- Now freely available to registered Australian healthcare practitioners for clinical care (www.gmedss.com)
- National implementation in primary care and nursing homes

COGNITIVE DECLINE PARTNERSHIP CENTRE

NPS MEDICINEWISE

Kouladjian-O'Donnell et al., British Journal of Clinical Pharmacology, 2020
Sawan et al., Research in Social and Administrative Pharmacy, 2020

The Drug Burden Index as a risk assessment in older inpatients

TO HOME

2000 patients aged over 75 years consecutively discharged from General Medicine, Aged Care or Rehabilitation at 6 NSW hospitals 2016-17

Received: 2 August 2022 | Revised: 12 February 2023 | Accepted: 15 February 2023
DOI: 10.1111/bcp.15727

ORIGINAL ARTICLE

Towards Optimizing Hospitalized Older adults' MEdications (TO HOME): Multi-centre study of medication use and outcomes in routine care

Sarah N. Hilmer[1] | Sarita Lo[1] | Patrick J. Kelly[2] | Rosalie Viney[3] | Fiona M. Blyth[2] | David G. Le Couteur[4] | Andrew J. McLachlan[5] | Sheena Arora[3] | Lutfun Hossain[3] | Danijela Gnjidic[5]

Prevalence on admission:

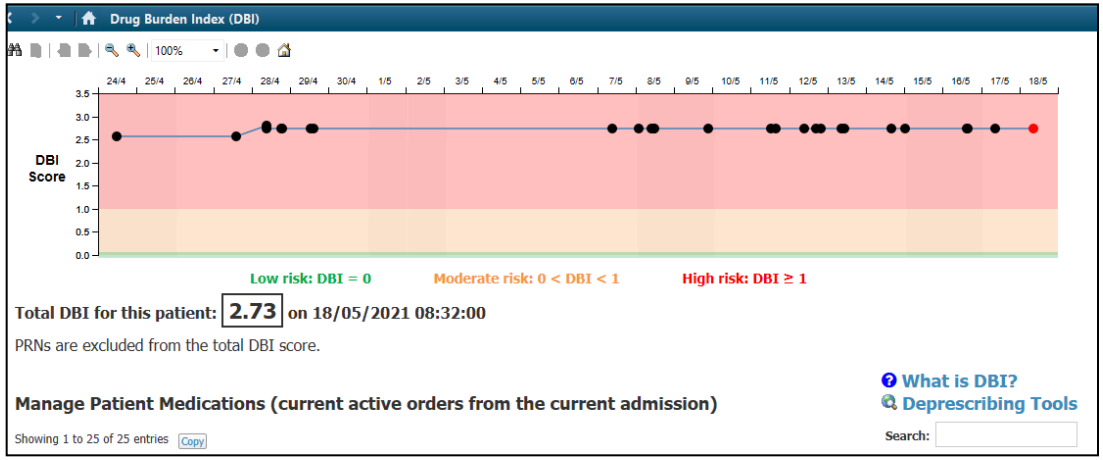
- Mean (SD) DBI score 0.48 (0.63)
- Prevalence of DBI >0 = 53%

DBI independently predicted

- ADRs in hospital Adj OR 1.90 (1.55, 2.15)
- Falls Adj OR 1.12 (1.00, 1.46)
- Delirium Adj OR 1.42 (1.19, 1.71)

The DBI Hospital Intervention Bundle

1



2

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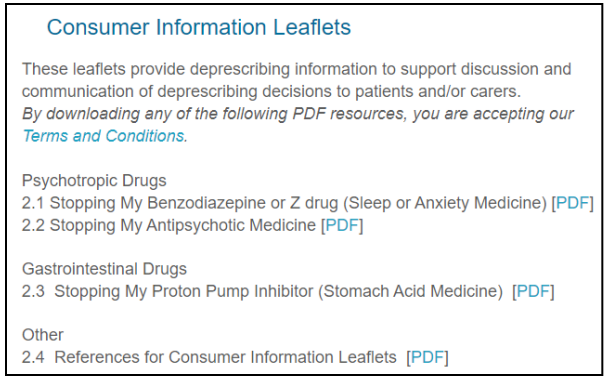


https://www.nswtag.org.au/deprescribing-tools/

4 **HETI Polypharmacy in Older Inpatients Module**

https://www.heti.nsw.gov.au/education-and-training/courses-and-programs/polypharmacy-in-older-inpatients-

5 **TAG Polypharmacy Indicators for Australian Hospitals**

https://www.nswtag.org.au/polypharmacy-qum-indicators-and-resources/

Designed and validated → Pilot and 6 hospital RCT

NSW GOVERNMENT Health
TRGS
NHMRC

Jocanovic N et al., BMJ Open, 2019 Dec 11; 9(12); Duong M et al., Drugs Aging 2020; Ng B et al,. RSAP, 2021; Baysari M et al., 2021 BMC Medical Informatics and Decision Making

DEPRESCRIBING TOOLS

The following deprescribing resources have been developed, by a translational research project team led by Prof Sarah Hilmer, for clinicians to support deprescribing in older hospital patients.

NSW TAG NSW Therapeutic Advisory Group Inc.

1. Deprescribing guides

These guides provide deprescribing information that can be applied to written and/or verbal communication between clinicians, patients and/or carers.
By downloading any of the following PDF resources, you are accepting our Terms and Conditions.

Deprescribing Guide for:

Psychotropic Drugs
1.1 Benzodiazepines and Z Drugs [PDF]
1.2 Antipsychotics for Treatment of Behavioural and Psychological Symptoms of Dementia [PDF]
1.3 Selective Serotonin Reuptake Inhibitors (SSRIs) and Serotonin Noradrenaline Reuptake Inhibitors (SNRIs) [PDF]
1.4 Tricyclic Antidepressants (TCAs) [PDF]

Neurological Drugs
1.5 Anticholinergic drugs for Parkinsonism [PDF]

Genitourinary Drugs
1.6 Anticholinergic drugs for Urinary Incontinence (Antimuscarinics) [PDF]

Allergy and Anaphylaxis Drugs
1.7 Sedating Antihistamines [PDF]

Analgesic Drugs
1.8 Regular Long Term Opioid Analgesic Use in Older Adults [PDF]

Gastrointestinal Drugs
1.9 Proton Pump Inhibitors (PPIs) [PDF]

https://www.nswtag.org.au/deprescribing-tools/

The DBI in the Pharmacists' Patient List

A.	Location	Encounter	U...	DBI	Pharmacy Demographics	M...	Pathology		C.	M.	Pharmacy Handover (Pharmacy view o...	I.
	1E 105 - 1	LOS: 1 day ADM DT: Mar17, 2022	2	1.25	IBW 61 kg CrCl -	--	Potassium Level Sodium Level INR	3.6 mmol/l 136 mEq/L 1.3	--		--	
	2E 201 - 1	LOS: 4 days ADM DT: Mar 17, 2022	7	1.15	IBW: 65 kg CrCl: -	--	Potassium Level Sodium Level INR	4.1 mmol/l 135 mEq/L - 1	--		--	
	1E 102 - 2	LOS: 22 months ADM DT: Apr 3, 2019	6	1	-- IBW 69 kg CrCl -	--	Potassium Level Sodium Level INR	3.2 mmol/l 137 mEq/L 0.9	--		--	
	1E 109 - 1	LOS: 8 days ADM DT: Feb 1, 2021	14	0.83	IBW 64 kg CrCl -	--	Potassium Level Sodium Level INR	3.7 mmol/l 146 mEq/L 1.1	--		--	
	1E 108 - 2	LOS: 3 days ADM DT: Mar 18, 2022	4	0.8	IBW 52 kg CrC -	--	Potassium Level Sodium Level INR	3.6 mmol/l 136 mEq/L 1.3 2	--		--	
	1E 108 - 1	LOS: 13 days ADM DT: Mar 8, 2022	1	0.67	IBW 61 kg CrC -	--	Potassium Level Sodium Level INR	3.6 mmol/l 132 mEq/L 1.0	--		--	
	1E 101 - 1	LOS: 6 days	1	0.67	IBW: 78 kg	--	Potassium Level Sodium Level	4.6 mmol/l 139 mEq/L	--		--	

Prioritise patients with higher DBI scores for medication review

Monitoring and reporting within hospital and on transitions of care

Quality Use of Medicines Indicators

- Identification, review and communication of inappropriate polypharmacy
- Patient Reported Experience Measures (PREMS)

INTERNAL MEDICINE JOURNAL

doi:10.1111/imj.15707

ORIGINAL ARTICLE

Patient-reported experience measures in deprescribing for hospitalised older patients: a prospective, multicentre, observational study

Keat Ngui,[1,2] Patrick Lam,[3] Mishael Materne[4] and Sarah N. Hilmer[5,6]

Overall, 20% of older patients/carers were

- aware of reduction or cessation of their usual medications on discharge; and
- reported involvement in decision-making; and
- receiving enough information to reduce or stop one or more of their usual medications

INTERNAL MEDICINE JOURNAL

doi:10.1111/imj.15208

ORIGINAL ARTICLE

Communicating deprescribing decisions made in hospital with general practitioners in the community

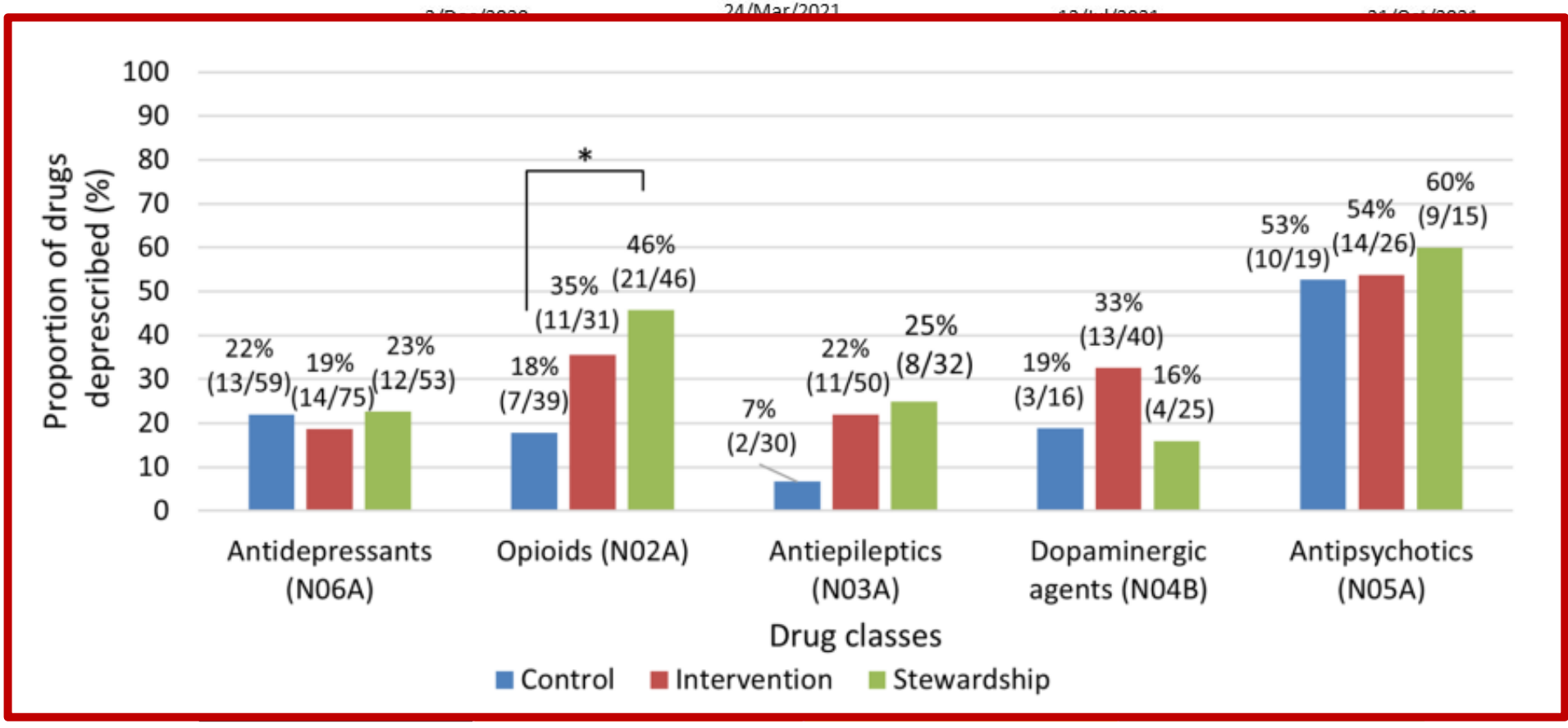
Amy D. Nguyen,[1,2] Melissa T. Baysari,[3,1] Mai Duong,[4] Wu Yi Zheng,[3,1] Brendan Ng,[4,5] Sarita Lo,[4] Fiona Robinson[6,7] and Sarah N. Hilmer[4,8]

Medication Reconciliation on Admission and Discharge Medication Changes Made in Hospital

Optimising discharge communications and continuation of medication care at transitions of care			
8.5	Percentage of older patients at high risk of medication-related harms with a recommendation for a post-discharge medication review, when hospital-based medication review is not performed.	Judicious selection Safe and effective use	30
8.6	Percentage of older patients whose discharge summaries contain a current, accurate and comprehensive list of medicines, including explanations for any medication therapy changes and, if applicable, details of a deprescribing plan.	Appropriate choice Safe and effective use	34
8.7	Percentage of older patients who receive a current, accurate and comprehensive medication list, including explanations for any medication changes and, if applicable, details of a deprescribing plan, at the time of hospital discharge.	Safe and effective use	38

Pilot Evaluation

Population: 1188 patients, 1375 visits (1102 Aged Care, 272 Gen Med)



†: Adjusted for age, sex, length of stay and the number of DBI-contributing medications at admission

Masnoon N, Lo S, Hilmer S. British J Clin Pharmacology 2022

Fujita K et al., Drugs and Aging 2023

NHMRC | NSW Government eHealth | NSW Government Health Northern Sydney Local Health District

Step-Wedge Cluster RCT of Stewardship Pharmacist to Implement Medication Review Using the DBI in 6 NSW Hospitals, with outcomes stratified by frailty.

Australian Government
National Health and Medical Research Council
NHMRC

One of many trials of deprescribing polypharmacy at scale with prescribing and clinical outcomes

Co-Frail

OPTIMIZE

OPERAM

Senator

MedSafer

ShedMeds

Optimising Medications to Minimise Falls Risk in Older People

KOLLING INSTITUTE
Bridging Medical Research and Health

Why? Common, preventable and reversible cause of falls

What? Screen and minimise FRIDS; optimise drugs to minimise risk of injury and to facilitate engagement with other falls risk interventions

When and where? Primary and secondary prevention in community, residential aged care homes and hospitals

Who? Clinical multidisciplinary team and patient/carer

How? Integrate into workflows – e.g. assessment forms on admission/transitions of care, falls huddles, eMR tools

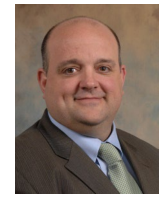
KOLLING
INSTITUTE
Bridging Medical Research and Health

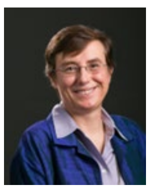
Medication review is never a waste of time

Acknowledgements





















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