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POLYPHARMACY AND POTENTIALLY INAPPROPRIATE MEDICATIONS IN ELDERLY INPATIENTS USING BEERS CRITERIA

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Abstract

Older people admitted to hospital often take many medicines, and some of those medicines carry more risk than benefit at their age. The Beers criteria are the most widely applied explicit tool for flagging such potentially inappropriate medications. This narrative review summarises the published literature on polypharmacy and Beers-defined inappropriate prescribing in elderly inpatients, covering definitions, criteria, reported prevalence, commonly implicated drug classes, patient and system determinants, clinical and economic outcomes, and interventions. Prevalence estimates vary widely with criteria version and setting, and evidence linking flagged drugs to hard outcomes is mixed. This is a review of published work and reports no new patient data.

1. INTRODUCTION

A ward round on a general medical unit will usually turn up the same picture: an eighty-year-old with six or seven chronic conditions, a drug chart as long as a forearm, and at least one entry that nobody can quite justify. Ageing changes how the body handles drugs, and it changes what the patient can tolerate. Renal clearance falls, body fat rises relative to water, the brain becomes more sensitive to sedatives and anticholinergics, and homeostatic responses such as postural blood pressure control are blunted [1]. Medicines that are reasonable in a fifty-year-old can become hazardous in an eighty-year-old without any change in the drug itself.

Two linked problems follow. Polypharmacy, loosely the use of many medicines at once, raises the chance of interactions, adverse reactions and errors in taking the regimen [2, 3]. Potentially inappropriate medications (PIMs) are drugs whose risks probably outweigh their benefits in an older patient, particularly where a safer alternative exists. The two overlap but are not the same. A person can take ten well-chosen medicines, and another can take two inappropriate ones. Hospital admission is a useful moment to look, because the drug list is reviewed, changes are made and the patient is, for a few days, closely observed [4, 5].

The Beers criteria have been the main explicit tool for identifying PIMs for three decades. Originally developed for nursing home residents [6], they have been revised several times and are now maintained by the American Geriatrics Society [7, 8, 9]. Studies using them in hospital populations are numerous, but they are scattered across countries and use different versions, so the headline numbers are hard to compare. This review gathers what the published literature says about polypharmacy and Beers-defined PIMs in elderly inpatients: how they are defined, how common they are, which drugs and patients are involved, what follows clinically, and what has been tried to reduce them. It reports no new data.

The scale of the problem is recognised at the level of global health policy. The World Health Organization chose medication safety as the focus of a global patient safety challenge, naming polypharmacy and poorly managed transitions of care as two of the main sources of avoidable harm, and older people are prominent among those exposed [10]. Behind this sits a plain statistical fact. People over 65 take a disproportionate share of all prescribed medicines in most health systems, and they are admitted to hospital more often than younger adults. Any weakness in how drugs are chosen for them therefore shows up quickly in ward workload, readmissions and, in the worst cases, preventable deaths [2, 3, 10].

The topic has a particular urgency in countries where populations are ageing quickly and where hospital pharmacists and geriatricians are in short supply. The World Health Organization named unsafe medication practices, including polypharmacy and transitions of care, among the main sources of avoidable harm in its global patient safety challenge [10]. For older patients that harm is both common and often preventable. It is therefore worth being careful about what the evidence does and does not say, since decisions to stop a drug have consequences of their own, and a list of flagged drugs is a prompt for thought rather than a command.

2. DEFINITIONS AND CRITERIA

There is no single accepted definition of polypharmacy. A systematic review of definitions found that the most common was a numerical threshold, usually five or more medicines, with others using six, ten or more and some adding a duration [11]. Counting rules differ too: whether over-the-counter products, vitamins, topical agents and as-needed drugs are included changes the totals considerably. Gnjidic and colleagues reported that five or more medicines identified community-dwelling older men at higher risk of several adverse outcomes, which helps explain the popularity of that cut-off [12]. Qualitative definitions, such as the use of more drugs than clinically indicated, avoid arbitrary numbers but are harder to apply in a retrospective audit [2, 11].

The first Beers list was published in 1991 and aimed at nursing home residents [6]. The 1997 and 2003 versions extended it to all adults aged 65 and over and added drugs considered inappropriate for specific conditions [13]. In 2012 the American Geriatrics Society took over the process, introduced a structured literature review and graded the strength of evidence for each recommendation [9]. The 2015 and 2019 updates added lists of drugs to be avoided in particular combinations or adjusted for kidney function, and the 2019 version made explicit that some entries apply to drugs to be used with caution rather than avoided entirely [7, 8]. The criteria are organised into drugs to avoid regardless of diagnosis, drugs to avoid in specific diseases or syndromes, and drugs to use with caution.

Other explicit tools exist and are often used beside Beers or instead of it. The STOPP/START criteria, developed in Ireland and revised in 2015, list potentially inappropriate drugs in physiological system order and, unusually, include potential prescribing omissions, meaning beneficial drugs that are missing from the regimen [14, 15]. Implicit tools such as the Medication Appropriateness Index rate each drug on criteria such as indication, effectiveness and duplication, requiring clinical judgement and time [16]. The Drug Burden Index measures cumulative exposure to anticholinergic and sedative drugs and has been linked to functional decline [17]. Reviews of assessment tools note that they differ in scope and have rarely been compared directly [18, 19].

Practical guidance on drug interactions and appropriate prescribing in older adults offers a useful complement to formal lists. Wallace and Paauw point out that the greatest risks in clinic and ward alike come from a small set of high-hazard combinations, for example an anticoagulant with an interacting antibiotic or an angiotensin-converting enzyme inhibitor with potassium-sparing agents and anti-inflammatories, and that these are not always captured by criteria built around single drugs [20]. Their advice to review every new symptom as a possible drug effect before adding a treatment echoes the prescribing cascade concept. It is simple counsel, but it addresses a pattern that explicit lists are poor at detecting [2, 20].

Explicit lists have clear strengths. They are quick to apply, reproducible between raters and suitable for large database studies. They also have limits that are worth stating plainly. They are based mostly on expert consensus and observational evidence, they reflect prescribing patterns in the United States, and they cannot capture the individual patient's circumstances [4, 7]. A flagged drug may be the right choice for a particular person: a benzodiazepine in a long-term user at risk of withdrawal seizures is one example. Conversely, a regimen can pass every explicit check and still be unsuitable, because the criteria do not cover underuse, dosing errors or adherence problems [4, 19].

Operational choices in an audit make a further difference. Some groups apply criteria to the drug list on admission, some to the list at discharge, and some to every drug ever prescribed during the stay. Counting a single dose of a sedative given on one night is not the same as counting a regular prescription, yet both may appear as exposure. Studies that classify drugs by whether they were new, continued or stopped during admission give a more useful picture of what the hospital team contributes, as against what the patient brought in [5, 21]. Such distinctions are not always reported, which makes it hard to decide whether a high inpatient rate reflects the hospital or the community [22, 23].

3. PREVALENCE IN HOSPITALISED PATIENTS

Reported prevalence of PIMs in older people varies a great deal. In primary care and community settings across Europe, systematic reviews have found rates that differ several-fold between studies, driven by the criteria applied, the country and the age group [22, 24]. Nursing home populations tend to have high rates, with a review of the long-term care literature finding that a large fraction of residents were exposed to at least one PIM [25]. Hospital patients sit somewhere between these settings, being older and sicker than community residents but subject to a more active medication review [23, 26].

Studies of inpatients using the Beers criteria generally report that a substantial minority to a majority of older patients receive at least one flagged drug at some point in the admission, either on arrival or at discharge. The wide spread reflects real differences between countries as well as methods. Comparisons of Beers and STOPP in the same cohorts usually find that STOPP flags more patients, which is partly because it includes more items that can be applied from drug lists [21, 23]. Hill-Taylor and colleagues, reviewing studies that used STOPP/START, found high prevalence of both inappropriate prescribing and omissions across settings [23].

Polypharmacy in hospital populations is common and is not simply a reflection of

illness severity. Observational studies show that the number of drugs rises with the number of chronic conditions, but also with the number of prescribers and with transfers between care settings [2, 26]. Fried and colleagues reviewed the outcomes associated with polypharmacy in community-dwelling older adults and found associations with adverse events, falls and functional decline, though with wide differences in how the exposure was defined [26]. In inpatients, the admission itself often adds drugs, such as stress ulcer prophylaxis, sedatives for sleep or antipsychotics for agitation, and these may be carried through to discharge without a decision to continue them [5, 27].

Administrative database studies offer large numbers and consistent definitions but depend on dispensing data, which indicate that a drug was supplied and not that it was taken. A systematic review of these studies noted high variation in the drugs and criteria used and in the quality of reporting [28]. Inpatient exposures are particularly difficult to capture from such sources, since hospital supply does not always appear in claims data. For this reason, much of the best inpatient information comes from chart reviews and prospective cohorts in single centres, which are smaller but record what was ordered and administered [28, 29].

The evidence on the relationship between polypharmacy and PIM use is consistent in direction. The more drugs a patient takes, the more likely it is that one will be flagged, partly for arithmetic reasons and partly because long lists accumulate drugs that were started for a reason that has since lapsed [2, 3, 22]. It would be wrong, though, to treat the number of medicines as a proxy for inappropriateness. Some patients with heart failure, diabetes and previous myocardial infarction legitimately need many drugs, and reducing the count without regard to indication may do harm. Studies that adjust for comorbidity find that the association between number of drugs and PIM use weakens but does not disappear [22, 26].

The published findings on criteria and prevalence are brought together in table 1, which lists the main groups of evidence in this review together with a short statement of what each reports. The balance of entries across categories is shown in fig. 1. Criteria and tools make up the largest group, which is itself informative: a good part of the literature is concerned with how to measure the problem, and rather less with what reduces it. The table is a synthesis of published findings, and no entry represents an original analysis [7, 14, 23].

Table 1: Main groups of published evidence on polypharmacy and Beers-defined inappropriate prescribing in older inpatients

Topic	Reported finding	Ref.
Beers criteria original version	Developed by consensus in 1991 to identify inappropriate drugs in nursing home residents.	[6, 13]
Beers criteria 2012 to 2019 updates	Evidence-graded updates added drug interaction and renal dosing lists.	[7, 8, 9]
STOPP/START criteria	Lists inappropriate drugs and prescribing omissions by physiological system.	[14, 15]
Polypharmacy definitions	Most reviews use a count of five or more medicines, with large variation in counting rules.	[11, 12]
Community and nursing home prevalence	PIM rates differ several-fold between studies, higher in long-term care.	[22, 25]
Hospital prevalence	A large share of older inpatients receive at least one flagged drug; STOPP usually flags more than Beers.	[21, 23]
Anticholinergic drugs	Cumulative strong anticholinergic exposure linked with cognitive impairment and dementia.	[30, 31]
Sedatives and psychotropics	Associated with falls in older adults across several drug classes.	[32]
Clinical and cost outcomes	Associations with adverse events and health care use are mixed for Beers, firmer for STOPP.	[21, 33, 34]
Deprescribing and review	Structured review improves prescribing appropriateness; effects on clinical endpoints less clear.	[27, 35, 36]

Some caution is needed with international comparisons. The Beers criteria were

developed for the American drug market and several flagged drugs are not marketed in other countries, while some drugs commonly used elsewhere are absent from the lists. Studies in Europe and Asia have therefore adapted the criteria or used STOPP/START, which was designed with European prescribing in mind [14, 22]. Seen from this angle, a lower PIM rate in one country may partly reflect which drugs are on the market rather than better prescribing, and a high rate may reflect the opposite [19, 22].

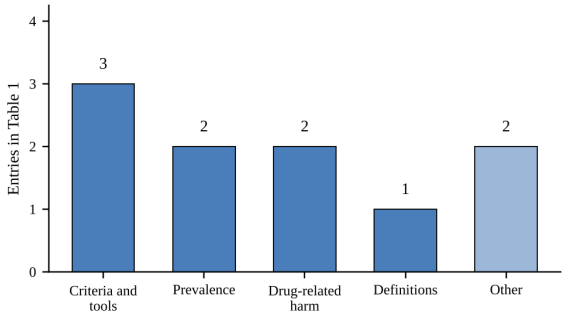


Fig. 1: Number of entries in table 1 by topic group

4. DRUGS, PATIENTS AND SYSTEMS

Certain drug groups appear again and again in the published lists of PIMs. Long-acting benzodiazepines and other sedative-hypnotics, including the so-called Z-drugs, are cited in nearly all studies, because of their links with falls, fractures, delirium and cognitive impairment in older adults [7, 32]. First-generation antihistamines, tricyclic antidepressants and bladder antimuscarinics bring a strong anticholinergic burden. Non-steroidal anti-inflammatory drugs are flagged for gastrointestinal bleeding, kidney injury and fluid retention. Antipsychotics are flagged for use in dementia because of the increased mortality and stroke risk. Proton pump inhibitors used continuously for longer than needed are another common item in recent versions [7, 8].

The evidence for harm is strongest for a few of these groups. A meta-analysis of nine medication classes found that antidepressants, sedatives and hypnotics, antipsychotics, benzodiazepines and antiepileptics were associated with increased falls in older people, with odds ratios in the region of one and a half [32]. Prospective cohort data have linked cumulative exposure to strongly anticholinergic drugs with an increased risk of dementia [31], and population-based work has related anticholinergic use to cognitive impairment [30]. These findings lend support to the Beers entries for these drug classes, though observational data cannot fully separate drug effect from the indication for which it was prescribed [30, 31].

Patient factors associated with PIM use have been explored in many cohorts. Higher number of comorbidities and drugs, greater age, polypharmacy, previous hospital admission and living in a nursing home recur as risk factors [22, 24, 25]. Cognitive impairment and depression are frequently associated with psychotropic prescribing. Female sex is sometimes found to be associated with greater risk, though results are inconsistent across studies. Frailty complicates the picture, because frail patients are both more likely to be given PIMs and more likely to be harmed by them [5, 26]. None of these factors is unique to Beers-based studies, and the same patterns appear with other criteria.

The inpatient phase has its own pattern of drug-related problems. Proton pump inhibitors started for stress ulcer prophylaxis in an intensive care unit are often continued on the general ward and then into the community, long after the original indication has passed. Sliding-scale insulin regimens in older patients with diabetes have been criticised for producing hypoglycaemia without better control, and appear in the Beers lists as a drug-use pattern to avoid [7, 8]. Opioids and sedating antiemetics given for short periods can precipitate delirium in vulnerable patients. These examples show that some PIMs are created by hospital practice, and not simply inherited from the outpatient list [5, 27].

System factors matter at least as much as patient factors. Fragmented care, with a general practitioner, several specialists and a hospital team each adding to the regimen, is an established driver of polypharmacy [2, 4]. Prescribing cascades, in which an adverse effect is misread as a new condition and treated with another drug, are a recognised route to inappropriate additions. Discharge

summaries that omit the reason for starting a drug make later review harder. Guidelines written for single diseases push towards additive treatment in patients with multiple conditions, and few trials enrol the oldest and most complex patients, so the evidence base for them is weak [3, 4].

Pharmacokinetic and pharmacodynamic change gives the biological rationale for many entries. Reduced renal function raises exposure to renally cleared drugs, and reduced hepatic blood flow slows clearance of drugs with high extraction. Altered volume of distribution lengthens the half-life of lipophilic drugs such as diazepam, and increased central nervous system sensitivity means that the same plasma concentration produces a greater effect [1]. The practical consequence is that dose adjustment alone may not make a drug safe, and that for some drug classes the sound advice is to choose an alternative [1, 7]. Beers criteria since 2015 list a number of drugs for which kidney function should guide dose or avoidance [7, 8].

Hospital-specific processes also contribute. Acute illness and unfamiliar surroundings provoke insomnia and agitation, which are often treated with short-term hypnotics or antipsychotics that then continue after discharge. Medication reconciliation at admission can miss drugs or record wrong doses. Incomplete records of previous adverse reactions lead to repeated exposure. Time pressure at discharge discourages the review of long-standing medicines [5, 27]. Several authors suggest that hospital inpatient care offers a window for deprescribing precisely because patients are observed and because a new regimen can be started with proper monitoring [27, 36].

5. OUTCOMES AND INTERVENTIONS

Does flagging a drug as inappropriate predict harm? The answer in the literature is cautious. A systematic review of studies using the Beers criteria found that associations between PIM use and adverse outcomes were inconsistent, with some studies finding increased adverse drug events, hospitalisation or mortality and others finding no association [34]. The criteria were built from expert consensus rather than from outcome data, and some listed drugs are probably less hazardous than assumed. In contrast, studies using STOPP found stronger links with adverse drug events in older hospitalised patients, which may reflect its focus on prescribing that is clinically contraindicated [21].

Hospital utilisation and cost data are more modest. A systematic review of health care use and cost among older adults taking PIMs reported that PIM exposure was associated with more hospital admissions, emergency visits and longer stays in several studies, but cost findings were mixed, partly because few studies measured costs that could be attributed to the drugs themselves [33]. Dalleur and colleagues examined admissions of frail older patients and judged that a meaningful fraction was at least partly related to inappropriate prescribing as defined by STOPP/START [5]. Such attributions depend heavily on clinical judgement and should be viewed as estimates.

Interventions to reduce PIMs have been tried in several designs. A randomised trial in Ireland found that applying STOPP/START to hospitalised older patients improved appropriateness of prescribing at discharge compared with usual care [35]. Pharmacist-led medication review, computerised decision support, educational outreach and multidisciplinary geriatric assessment have all been examined, with generally positive effects on prescribing appropriateness but weaker and more variable effects on clinical outcomes [4, 19]. Reviews of this literature comment that few studies were large enough or long enough to show changes in mortality, readmission or quality of life [4, 36].

Studies that use Beers-defined PIMs as a marker of broader prescribing quality raise a different point. Lund and colleagues found that older adults receiving Beers-listed drugs were also more likely to receive other medications not on the list but still of questionable value [29]. If so, a PIM flag identifies a prescribing environment rather than a single error, and a review triggered by it should look at the whole regimen. This view fits clinical experience, where one obviously poor choice often goes with several less visible ones, and it supports the use of

explicit criteria as an entry point for pharmacist-led medication review in hospital rather than as an end in themselves [4, 29].

Nurses and pharmacists are often the first to notice a problem, and their role is easy to overlook in reviews that focus on prescribers. Nurse observations of sedation, confusion, falls or reduced oral intake give early signs that a drug is not suiting the patient, and ward pharmacists see the whole regimen at once. Models in which pharmacists attend ward rounds or review charts against explicit criteria have been reported to improve prescribing appropriateness [4, 35]. How far these models can be extended depends on staffing, which varies greatly between hospitals and countries, and on whether prescribers accept the advice offered; acceptance rates are rarely reported in the published trials [4, 19].

Deprescribing, the planned and supervised withdrawal of drugs that may no longer be of benefit, has become the organising idea for these interventions. A widely cited five-step process asks the prescriber to list all drugs and their indications, assess the risk of harm for each patient, judge which drugs are least useful or most hazardous, prioritise for withdrawal and monitor [27]. A systematic review and meta-analysis concluded that deprescribing is feasible and was not clearly harmful in most trials, with some evidence for reduced mortality in selected groups but low certainty [36]. Withdrawal syndromes, relapse of the original condition and patient reluctance are the practical hurdles [27, 36].

Limited evidence should not be mistaken for evidence of no effect. Stopping a long-acting benzodiazepine, an anticholinergic bladder drug or a nonsteroidal in a patient with renal impairment is unlikely to cause harm and may well prevent some, and in such cases the hospital team does not need trial data to act sensibly [7, 27, 32]. The stronger case for caution applies to drugs where withdrawal carries risks, such as antiepileptics, beta-blockers after infarction or long-term antipsychotics. For these, flagging by an explicit list is the start of a conversation, not its conclusion [4, 36].

Another practical question is how long an intervention effect lasts. Improvements in prescribing appropriateness measured at discharge may fade after return to primary care if the community team does not receive or act on the recommendations. Few of the trials followed patients beyond a few months, and rates of restarting stopped drugs are seldom reported [35, 36]. Transitional care models that include pharmacist follow-up, shared electronic records and direct communication with general practitioners are plausible solutions but have only partial evidence behind them [4, 27]. It is a gap worth filling, since a well-performed hospital review that is undone within weeks wastes the effort of everyone involved.

Patients and carers belong in this process. Surveys of older adults suggest that many would be willing to stop a drug if their doctor said it was possible, though attitudes depend on how long they have taken it and on their fear of relapse. Shared decision making is hard to carry out during an acute admission, with the patient unwell and time short, so it may be better to start the conversation in hospital and complete it in primary care. Clear communication in the discharge letter, naming the drugs stopped and the reason, helps the next prescriber to avoid restarting them [5, 27]. This aspect is poorly documented in studies of PIM interventions, which seldom report patient views.

6. LIMITATIONS AND FUTURE DIRECTIONS

The published literature has several limitations that affect how its conclusions can be used. Cross-sectional audits dominate, so the direction of association between PIM use and outcomes is often unclear. Differences in criteria versions, data sources and populations make pooling difficult [19, 22]. Many studies come from high-income countries, and the applicability of Beers to drug markets elsewhere is uncertain. Outcome studies seldom adjust fully for the severity of illness, so that sicker patients, who receive more drugs, appear to do worse because of both factors [26, 34]. Reviewers have also noted publication bias towards studies reporting high prevalence [22, 25].

Several priorities for future work follow from these gaps. Trials of deprescribing

interventions need clinical endpoints and enough follow-up to detect them, rather than counts of drugs stopped [36]. Tools should be tested for their predictive value for patient outcomes as well as their agreement with expert judgement [18, 19]. Reporting standards for PIM studies would improve comparability, particularly clear statements of which items were assessed and how exposure was defined [22, 28]. Combined use of explicit lists with patient-level information on life expectancy, goals and function is a promising but under-studied direction [4, 27].

Measurement of the exposure itself deserves more care than it usually gets. Most audits count prescriptions, yet what matters pharmacologically is the dose, the duration and the timing relative to other drugs. A single low dose of a flagged antihistamine used for a day is a different exposure from months of a strongly anticholinergic antidepressant, even though both register as one PIM. Indices that weight drugs by anticholinergic or sedative potency, such as the Drug Burden Index, address part of this problem and are associated with functional outcomes [17, 30]. Wider adoption in hospital studies would make findings more informative, and would allow dose-response relationships, which are currently almost absent from the inpatient literature, to be examined [31, 32].

For practice, the literature supports a measured approach. Beers criteria are useful as a screening aid in hospital pharmacy, particularly for the drug classes for which harm is well documented. They are best applied within a structured medication review that considers indication, dose, renal function and patient priorities [4, 7]. Electronic alerts should be used sparingly to avoid fatigue. Education for prescribers and nurses on the main hazards, and a clear route to review in primary care after discharge, are low-cost additions. Whether such steps change outcomes beyond prescribing quality is something future studies must show [19, 35].

7. CONCLUSION

Polypharmacy and potentially inappropriate prescribing are common among older hospital patients, and the Beers criteria provide a convenient, widely used way of finding the most worrying drugs. The literature shows that prevalence depends strongly on which criteria and which setting are used, that a small number of drug classes account for much of the flagged exposure, and that sedatives and anticholinergics have the clearest support as causes of harm [7, 30, 32]. Hospital stays are a real opportunity to review regimens, and some structured interventions improve prescribing quality [27, 35].

Several things remain uncertain. The link between Beers-flagged drugs and patient outcomes is inconsistent [34], cost evidence is limited [33], and trials of deprescribing rarely reach hard endpoints [36]. For clinicians, the sensible reading is that explicit criteria are a prompt for individual review, not a replacement for it, and that dropping a drug needs the same thought as starting one. Better-designed trials and more consistent reporting are the main needs of future research [19, 22].

8. ABBREVIATIONS

AGS-American Geriatrics Society, DBI-Drug Burden Index, PIM-Potentially inappropriate medication, STOPP-Screening Tool of Older Persons' Prescriptions, START-Screening Tool to Alert to Right Treatment, WHO-World Health Organization

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10. AUTHORS CONTRIBUTIONS

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11. CONFLICT OF INTERESTS

Declared none

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