

Inappropriate prescribing in hospitalized elderly patients

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ABSTRACT

Inappropriate prescribing (IP) is a major healthcare problem in elderly patients. The risk of this problem increases during hospitalization. This is due to increase morbidity and thus increases the use of medications by the inpatients. This study will clarify the problem of IP for elderly people during hospitalization and will identify the different types of it. It also will highlight some tools that are used to assess the different types of IP and the prevalence of it in elderly patients during hospitalization. Finally, the study will address the consequences of IP in the elderly inpatients and the risks associated with the use of some potentially inappropriate medications (PIMs) in the elderly.

Keywords: Consequences, Elderly patients, Hospitalization, Inappropriate prescribing

INTRODUCTION

Optimal prescribing is a crucial aspect of gerontology. The main aim of prescribing is to cure disease, eliminate or reduce symptoms relating to an underlying disease state and improve functional capacity of the patients.¹ Inappropriate prescribing (IP) has become an area of major concern in the older population. It encompasses the use of medications that introduce a significant risk of adverse drug events (ADEs) when there exists evidence for an equally or more effective but lower-risk alternative therapy for treating the same medical condition.² Additional situations of IP include overuse of medications at a higher frequency or for longer durations than clinically indicated, under-use of medically indicated medications based on irrational reasons, and use of multiple medications (polypharmacy) that have documented drug-drug interactions (DDIs) or Drug-disease interactions.² Inappropriate prescribing (IP) is

particularly relevant for elderly people (65 yrs or older), as they have the highest susceptibility to the effects of drugs. They experience age-related physiological changes, which often influence the pharmacokinetic (PK) and pharmacodynamic (PD) status of drugs.³ It might be particularly relevant among hospitalized elderly patients, who are usually 'frail' and present with acute diseases, which may increase their susceptibility to adverse medication effects and raise the severity of drug related illnesses.⁴ A large proportion of IP is preventable by adherence to prescribing guidelines, suitable monitoring and regular medication review.⁵ Screening tools have been developed to help clinicians improve their prescribing such as Beers' criteria, screening tool for older people potentially inappropriate prescriptions (STOPP)/screening tool to alert doctors to right therapy (START) and the medication appropriateness index (MAI).⁶⁻⁸ These tools can investigate different types of IP which will be studied.

CHRONIC DISEASES AND MULTI-MORBIDITY IN HOSPITALIZED ELDERLY PATIENTS

Aging seldom comes alone; it is often accompanied by chronic diseases, comorbidity, disability, frailty and social isolation.⁹ Data have shown that having three or more comorbidities can increase the risk for having a severe ADEs by 2.9-12.6 fold.¹⁰ The pervasiveness of comorbidity is especially apparent in hospitals. In a study in the U.S., it was shown that, nearly 60% of all hospitalizations had at least one comorbidity and 37% had two or more. The leading comorbidities were hypertension (HTN) 29.4%, chronic obstructive pulmonary disease (COPD) 12.1%, diabetes mellitus (DM) 11.8%, fluid/electrolyte disorders 11.7%, iron deficiency/anemia 7.9%, and heart failure 5.7%. With each comorbidity comes additional exposure to a larger number of medications as well as new prescribers and specialists.¹¹

MEDICATION USE IN HOSPITALIZED ELDERLY PATIENTS

Drug treatment is an essential component of medical care to prevent, cure and control disease. Its purpose is to decrease morbidity and mortality and to increase health-related quality of life. While medications can improve outcomes, they are a double-edged sword and, if used inappropriately they may be associated with ADEs. Evidence suggests that the use of drugs in elderly people is often inappropriate partly because of the complexities of prescribing as well as other patient's, provider's, and health-system's factors.¹² Opportunities for improving the treatment can occur at several steps of the medication use process.

Medication use in general is greater in hospitals. In a study of 1416 elderly inpatients (median age 81 years) on medical and aged care wards at nine hospitals in Victoria, the average number of drugs prescribed per patient was eight.¹³ Hospitalization is also a time when many changes are made to medications, and often the number of prescribed drugs increases.¹⁴ One Australian study has reported that an average of five to seven changes are made during hospitalization, including cessation of two to three drugs and initiation of three to four.¹⁵ This contributes to increase risk of drug-related problems during and immediately following hospitalization.¹⁴ The inpatient setting can be particularly hazardous regarding ADEs due to the problem of multiple prescribers, medication reconciliation issues, poor communication between outpatient and inpatient providers and limitations imposed by hospital formularies.⁸ This can lead to IP of medications. In a qualitative study in five acute wards for care of elderly patients in Belgium, Spinewine et al.¹⁶ identified several factors contributing to IP of medications in hospitals. Firstly, review of treatment was driven by acute considerations, the transfer of information on medicines from primary to secondary care was limited, and prescribing was often not tailored to

elderly patients. Secondly, some doctors had a passive attitude towards learning: they thought it would take too long to find the information they needed about medicines and lacked self directed learning. Finally, a paternalistic doctor-patient relationship and difficulties in sharing decisions about treatment between prescribers led to inappropriate use of medicines.

TYPES OF INAPPROPRIATE PRESCRIBING IN ELDERLY PEOPLE

Underprescribing

Failure to prescribe drugs that are needed.^{1,12} It can be the result of doctors lacking adequate training in geriatric pharmacotherapy or due to a phenomenon called ageism. Ageism is the refusal to prescribe a drug or increase a dose solely because the patient is old.¹⁶ Failure on the part of doctors to prescribe drugs that are clearly indicated and likely to benefit the patient is called prescribing omission. This can increase harm to elderly patients. Some examples of prescribing omissions are as follows: failure to prescribe antiplatelet therapy (aspirin or clopidogrel or ticagrelor) with a documented history of coronary, cerebral or peripheral vascular disease, failure to prescribe statin therapy with a documented history of coronary, cerebral or peripheral vascular disease, unless the patient's status is end-of-life or age is >85 years, and finally failure to prescribe folic acid supplement in patients taking methotrexate.⁷

Overprescribing

Polypharmacy, relates to the practice of prescribing multiple medications or more medications than are clinically required.^{1,12} Polypharmacy has been defined in numerous ways. One of the most commonly used definitions of polypharmacy is the concomitant use of five or more drugs.¹⁷ Another definition for polypharmacy is the prescribing, administration or use of more medications than is clinically indicated in a given patient.¹ This definition means that only unnecessary drug can lead to adverse events that could have been avoided, and equally excludes an arbitrary minimum number of drugs. Hajjar et al looked at both definitions of polypharmacy at hospital discharge.⁸ Those drugs that were inappropriate regarding indication, efficacy, or therapeutic duplication were defined as unnecessary. Among 384 patients studied, it was reported that 41.4% were on at least 5-8 medications, and 37.2% were on 9 or more. Forty-four percent of patients had at least one unnecessary drug, with the most common reason being lack of indication. The most commonly prescribed unnecessary drug classes were gastrointestinal, central nervous system, and therapeutic nutrients/minerals.

Polypharmacy is often an adverse consequence of prescribing cascade, which involves the clinician's failure to recognize a new medical event as an adverse drug reaction (ADR). In this case, another drug is

unnecessarily prescribed to treat the adverse event instead of withdrawing the drug responsible, creating a vicious circle and adding further risks.¹⁸

Polypharmacy (use 5 or more drugs) can negatively influence medication adherence (compliance). Non compliance can result in suboptimal therapeutic effectiveness and can have major clinical consequences.¹⁹ If the existence of non-compliance is not recognized, the physician may increase the dose of the initial medication or add a second agent. This will increase both the risk and the cost of treatment.²

Misprescribing

Misprescribing refers to incorrectly prescribing a drug that is needed. This includes; choice of medication, drug interactions, dose, duration of therapy, duplication and follow up.²⁰

Choice of medication

A potential inappropriate medication (PIM) is a medication which possesses an unfavorable risk-benefit ratio. This means that the risks associated with using this medication outweighs its benefits, especially when there are more effective and safer alternatives available.² Some examples of PIMs for elderly patients include the use of spironolactone >25mg/day in heart failure as there is higher risk of hyperkalemia, the use of skeletal muscle relaxants such as orphenadrine, chlorzoxazone and cyclobenzaprine which are poorly tolerated by elderly people, because of their anticholinergic adverse effect, and the use of antiarrhythmic drugs such as amiodarone which associated with multiple toxicities, including thyroid disease, pulmonary disorders, and QT interval prolongation.⁶

Table 1: Examples of common drug-drug interactions in elderly people.

Drug	Selected drug interactions	Mechanism/comment
Omeprazole	Ketoconazole	Decrease ketoconazole absorption; omeprazole increase gastric pH and ketoconazole requires an acidic environment for dissolution and solubility. ^{24,25}
	Clopidogrel	Omeprazole decreases the effect of clopidogrel by inhibiting the hepatic enzyme CYP2C19 metabolism, and thus decreasing the formation of the active antiplatelet metabolite of clopidogrel. ²⁵
Potassium Chloride	Angiotensin-converting enzyme (ACE) inhibitors Spironolactone	Increase serum potassium concentration. ^{24,25}
Digoxin	Non steroidal anti inflammatory drugs (NSAIDs)	Increase digoxin serum concentration; NSAIDs can decrease Glomerular filtration rate (GFR) in older patients. ²⁴
Atorvastatin	Erythromycin	Increase atorvastatin serum concentration by inhibiting hepatic/intestinal enzyme CYP3A4 and P-glycoprotein multi drug resistance (MDR1) efflux transporter. ^{24,25}
	Clarithromycin 40 mg per day	Clarithromycin inhibit hepatic/intestinal enzyme CYP3A4 metabolism and P-glycoprotein MDR1 efflux transporter. This may result in increasing the level or effect of atorvastatin, notably rhabdomyolysis. ²⁵
	Digoxin	Atorvastatin increase digoxin serum concentration by inhibiting P-glycoprotein MDR1 efflux transporter. ^{24,25}
Celecoxib	ACE inhibitors	Decrease antihypertensive effects; NSAIDs can increase blood pressure. ²⁴
	Furosemide	NSAIDs can decrease natriuretic effects of furosemide. ²⁴
Clopidogril	NSAIDs	Increase gastrointestinal bleeding; decrease platelet aggregation. ²⁴
Theophylline	Quinolone antibiotics	Some quinolones such as ciprofloxacin can decrease the metabolism of theophylline leading to theophylline toxicity. ^{24,25} If quinolone is needed levofloxacin and moxifloxacin are good alternatives that do not affect theophylline metabolism. ²⁴
Warfarin	Macrolide antibiotics	Increase bleeding risk from enhanced warfarin activity. Macrolides can inhibit the metabolism of warfarin. Monitor international normalized ratio (INR) closely and adjust the warfarin dose accordingly. ²⁴
Ciprofloxacin	Hydrocortisone	Coadministration of quinolone antibiotics and corticosteroids may increase risk of tendon rupture. ²⁵
	Glyburide	Ciprofloxacin increases effects of glyburide by pharmacodynamic synergism. Careful monitoring of blood glucose is recommended. ²⁵

Drug interactions in elderly people

Inappropriate prescribing (IP) also encompasses the prescribing of medications with high inherent risk of adverse drug-drug or adverse drug-disease interactions.² Drug-drug interactions (DDIs) may broadly be categorized as PK (delivery of the object drug to its site of action is altered by the precipitant) or PD (response of the object drug is modified by the precipitant without changes in the PK of the object drug) in nature.²¹ The main types of PK interactions are metabolism-based DDIs or transporter-based DDIs which in both cases can be inhibited or induced leading to clinical consequences. This is relevant especially for co-administered drugs with a narrow therapeutic index or a steep dose-response curve. On the other hand, PD interactions take place at the pharmacologic drug binding sites, and the consequences of the interaction may be additive, synergistic or antagonistic.²² Drug-drug interactions (DDIs) are desirable if they reduce adverse effects or improve the efficacy of the combined agents. Conversely, they are undesirable if they hinder treatment by increasing ADRs and/or reducing treatment effectiveness.²³ Table 1 shows some common examples of DDIs in elderly people.^{24,25}

Drug-disease interactions are more common in elderly because of their multiple chronic diseases and use of multiple medications. They can be defined as exacerbations by medications of preexisting diseases, conditions, or syndromes.²⁶ Benzodiazepines and corticosteroids can induce or worsen delirium in elderly patients having it. Peripheral alpha blockers such as doxazosin and prazosin can increase the risk of orthostatic hypotension in patients have syncope.⁷ Finally, oral antimuscarinics for urinary incontinence such as oxybutynin, and nondihydropyridine calcium channel blockers (CCB) such as diltiazem and verapamil have the ability to worsen chronic constipation.⁶

Duplication of therapy

Therapeutic duplication is defined as two or more medications in the same therapeutic class prescribed to the patient and resulting in unnecessary therapeutic duplication.²⁷ Drug duplication can result in patient overdose with unpredictable or undesirable effects. Furthermore, there is a significant waste of healthcare resources.²⁸ Some examples include the use of two concurrent NASIDs or ACE inhibitors or selective serotonin reuptake inhibitors.⁷

Dose and duration

Inappropriate prescribing (IP) also includes the misuse of medicines regarding dose and duration.²⁰ Medications can be prescribed at higher doses or frequencies for periods longer than are clinically indicated.² Failure to adjust doses in elderly people is common.^{13,29} A general approach when prescribing drugs to elderly people would

be to start with a small initial dose and titrate this dose to a clearly defined therapeutic response.³⁰ Conventional wisdom supports the use of lower doses when prescribing drug treatment for elderly patients. The degree to which the dose is reduced depends on the medication and the clinical situation. For some medications, such as thiazide diuretics for the treatment of uncomplicated hypertension, low doses have been evaluated in clinical trials and found to be effective. For other medications, such as β -blockers for secondary prevention of myocardial infarction, a low dose is probably the appropriate starting point, but the optimal dose is unknown. Finally, for drugs such as warfarin, the use of low doses should not be confused with the need to reach the target therapeutic range.³¹

Follow up in elderly people

Monitoring of drug therapy in elderly patients is often suboptimal. An Australian study conducted by Roughead et al among 1000 patients living in the community illustrated that one in three people were found to require additional monitoring.²⁹ Cardiovascular drugs, especially digoxin and diuretics, were the most common medications requiring additional monitoring. Monitoring drug use involves: documenting the indication for a new drug, keeping a current list of drugs used by the patient in medical records, monitoring for achievement of therapeutic goals and other responses to new drugs, monitoring necessary laboratory tests for efficacy or adverse effects, and finally periodically reviewing drugs for continued need. Lack of close monitoring in elderly patients, especially after new drugs are prescribed, increases risk of adverse effects and ineffectiveness.³²

Tools that assess IP in elderly patients

Potentially inappropriate medications (PIMs) continue to be prescribed and used as first-line treatment for the most vulnerable of elderly people, despite evidence of poor outcomes from the use of PIMs for them.⁶ Several tools were used to assess IP in elderly patients such as Beers' criteria, screening tool for older people potentially inappropriate prescriptions (STOPP)/screening tool to alert doctors to right therapy (START) and the medication appropriateness index (MAI).⁶⁻⁸ Beers' criteria is a list of PIMs divided into three categories: PIMs and classes to avoid in older adults, PIMs and classes to avoid in older adults with certain diseases and syndromes that the drug listed can exacerbate, and finally medication to be used with caution in older adults. The criteria can be used for all setting of geriatric care. Thoughtful application of the Criteria will allow for closer monitoring of drug use, application of real-time e-prescribing and interventions to decrease ADEs in elderly, and better patient outcomes.⁶ Regarding STOPP/START criteria are a list of PIMs (STOPP criteria) and potential prescribing omissions (PPOs) (START criteria). Concerning STOPP criteria, they assess drug-drug and drug-disease interactions, drugs

that adversely affect elderly patients at risk of falls, indication, duration and duplication. The three later elements of IP need clinical judgment to be assessed.⁷ The MAI assesses ten elements of prescribing: indication, effectiveness, dose, correct directions, practical directions, DDIs, Drug-disease interactions, duplication, duration, and cost. Clinical judgment is needed to assess inappropriateness.⁸ STOPP/START can be used during hospitalization to improve medication appropriateness and reduce ADRs in elderly people.⁷

The prevalence of IP among elderly patients during hospitalization

Data from many studies have shown a high prevalence of IP among elderly patients during hospitalization. It ranges from 14.6% to 91.9%.³³⁻⁴⁰ This difference relates to the several methodological aspects used. The highest prevalence of overall IP was found by Hanlon et al (91.9%).³⁷ They used the MAI to assess IP for 397 hospitalized frail elderly patients at 11 Veterans Affairs Medical Centers. The most common problems involved expensive drugs (70.0%), impractical directions (55.2%), and incorrect dosages (50.9%).

Table 2: Summary of some studies that assessed IP in hospitalized elderly patients.

Study	Country	Care setting Age categories	Number of patients	Criteria	Outcomes
Gallagher and O'Mahony	Ireland	Patients admitted with acute illness to a university teaching hospital ≥ 65years old	715	STOPP and Beers' criteria	STOPP Criteria identified 336 PIMs affecting 247 patients (35%). Beers' Criteria identified 226 PIM affecting 177 patients (25%).
Rothberg et al	U.S.	384 US hospitals Inpatients ≥ 65 years old.	493,971	Beers' criteria	About 49% of the patients received at least 1PIM, and 6% received 3 or more.
Liu et al	Taiwan	Hospital setting Inpatients ≥ 65years old	520	STOPP & START criteria	The prevalence of PIM according to STOPP criteria was 36.2% and the prevalence of PPOs was 41.9%
Gallagher et al	Six European countries (Switzerland, Spain, Belgium, Italy, Czech Republic and Ireland)	Six university teaching hospitals in Geneva, Madrid, Oostende, Perugia, Pargue and Cork. Patients ≥ 65years old	900 patients, 150 patients per hospital.	STOPP, Beers' criteria, & START criteria	The prevalence of PIMs was 51.3 % using STOPP criteria varying among centers and 30.4% using Beers' criteria. The omission of beneficial drugs was 59.4%.
Hanlon et al	USA	Inpatient setting	397 frail elderly inpatients	MAI	About 91.9% of patients had ≥ 1 IP determined by MAI criteria.
Massoud et al	Palestine	Inpatient setting Elderly patients aged 65 years or old	380 elderly inpatient	DDIs, drug contra-indications (CI), duplication of therapy, Beers' criteria	About 44.2% of patients had at least one IP. Around 33.2% of the patients had DDIs, 19.2% had IP according to Beers' criteria and 1.1% had drug CI (drug-disease interactions). There was no duplication of therapy.
Onder et al	Italy	Inpatient setting Older adults, mean age 79 years	5734 patients	Beers' criteria	The prevalence of IP was 14.6%.
Frankenthal et al	Israel	Geriatric hospital Elderly patients aged 65 years or old	359 patients	STOPP/START	About 67.7% of patients had IP according to STOPP criteria, 34% of them had PPOs identified by START criteria.
Barry et al	Ireland	Inpatient setting Elderly patients aged 65 years or old	600 patients	START	The prevalence of PPOs was 57.9%.

The prevalence of PPOs is also high during hospitalization. It ranges from 34% to 59.4%.^{35,36,40,41} Using START criteria, Barry et al found one or more prescribing omissions in 57.9% of elderly patients admitted with acute illness to a teaching hospital.⁴¹ The most common prescribing omissions were: statins in atherosclerotic disease, warfarin in chronic atrial fibrillation, anti-platelet therapy in arterial disease and calcium/vitamin D supplementation in symptomatic osteoporosis. Another study conducted by Gallagher et al. among elderly patients admitted with acute illness to the acute geriatric medicine units of six teaching hospitals in the cities of Geneva, Madrid, Oostende, Perugia, Prague

and Cork reported the highest PPOs (59.4%), ranging from 51.3% in Cork to 72.7% in Perugia. Increasing comorbidity and age ≥ 85 years significantly predicted PPOs.³⁶ Table 2 shows summary of some studies that assessed IP and PPOs in hospitalized elderly patients using different criteria.

Consequences of IP in elderly inpatients

Inappropriate prescribing (IP) in elderly people is associated with an increased risk of ADEs, morbidity, mortality and healthcare utilization.⁴²

Table 3: Selected examples of PIMs and the risks of their uses in elderly people.

Example	Risks of uses
Non selective NSAIDs, e.g. oral Aspirin >325 mg/day, Diclofenac, Diflunisal, Etodolac, Ibuprofen, Meloxicam, Piroxicam, Sulindac	-Increases risk of gastro-intestinal (GI) bleeding and peptic ulcer disease in high-risk groups, including those aged > 75 years old or taking oral or parenteral corticosteroids, anticoagulants, or antiplatelet agents. -In hypertension or in severe heart failure (risk of exacerbation of these diseases)
Cox-2 selective NSAIDs with concurrent cardiovascular disease	-Increased risk of myocardial infarction and stroke
NSAIDs and vitamin K antagonist	-Risk of major gastrointestinal bleeding
NSAIDs if eGFR < 50 ml/min/1.73m ²	-Risk of deterioration in renal function
Anticholinergics, e.g. first generation antihistamines, antispasmodics	-Increased risk and toxicity of anticholinergic effects -Can worsen constipation -Risk of exacerbation of cognitive impairment in patients with delirium or dementia
Metoclopramide	-Can cause extrapyramidal effects including tardive dyskinesia -In parkinsonism, it can exacerbate parkinsonian symptoms
Benzodiazepines	-Increase risk of cognitive impairment, delirium, falls, fractures, and motor vehicle accidents in older adults -In history of falls or fractures, it can produce ataxia, impaired psychomotor function, syncope, and additional falls
Alpha1 blockers, Doxazosin, Prazosin	-High risk of orthostatic hypotension (risk of syncope, falls)
Sulfonylureas long duration, e.g. Glyburide, chlorpropamide, glimepiride)	-There is greater risk of prolonged hypoglycemia in older adults with type 2 diabetes mellitus
Beta-blockers in diabetes mellitus with frequent hypoglycaemic episodes	-Risk of suppressing hypoglycaemic symptoms
Loop diuretics for treatment of hypertension (HTN)	-May exacerbate incontinence in patients with concurrent urinary incontinence -As first-line treatment for HTN Safer, more effective alternatives are available
Thiazide diuretic with current significant hypokalemia, hyponatraemia, hypercalcaemia or with a history of gout	-Hypokalemia, hyponatraemia, hypercalcaemia and gout can be precipitated
Long-term aspirin at doses greater than 160mg per day	-Increased risk of bleeding, no evidence for increased efficacy
Antipsychotics (i.e. other than quetiapine or clozapine)	-Risk of severe extra-pyramidal symptoms in those with parkinsonism (worsen parkinsonian symptoms)
Metformin	-Risk of lactic acidosis, if eGFR<30ml/min/1.73m ²
Digoxin at long-term dose greater than 125 µg/day	-If eGFR <30 ml/min/1.73m ² (risk of digoxin toxicity if plasma levels not measured)
Oral elemental iron doses greater than 200 mg daily (e.g. ferrous fumarate > 600 mg/day, ferrous sulphate > 600 mg/day, ferrous gluconate > 1800 mg/day)	-No evidence of enhanced iron absorption above these doses

Table 3 shows some selected examples of PIMs and the risks of their uses in elderly people. These PIMs include some drugs identified by Beers' criteria and STOPP criteria.^{6,7} Some examples are combined between both Beers' criteria and STOPP criteria.^{6,7}

In hospitals, the adjustment of patients' drug regimens while they are hospitalized present problems because the patients may not fully understand why they are taking new drugs or why an old drug has been discontinued, which can be very confusing for them and lead to issues with adherence, and the indications for the initiation of new drugs during hospital admissions may not be clear. Such discrepancies between the medications patients are prescribed before and after hospital admissions may pose significant threats to their health that may exacerbate risks such as falls.⁴³

Passarelli et al found that the prevalence of ADRs during hospitalization was 46.2%.⁴⁴ This results was one of the highest ever reported. Almost a quarter of the patients presenting an ADR were prescribed drugs considered inappropriate for elderly patients. They concluded that the main reason for this relates to drug prescription patterns in Brazilian public hospitals, where unfortunately the use of drugs which considered being inappropriate for older population is almost routine because there are often no other options for the treatment of some diseases. Among the ADRs identified during hospitalization, the most prevalent was hypokalaemia associated with diuretics, followed by acute renal insufficiency as a result of use of antibacterial or captopril, and symptomatic hypotension as a result of excessive antihypertensive effect or skin rashes caused by antibacterial, aspirin (acetylsalicylic acid) or captopril.

CONCLUSION

Inappropriate prescribing (IP) is relevant for elderly patients due to PK and PD changes. Aging is accompanied by many diseases. This can be shown more in hospitals and can lead to consume more medications by the patients prescribed by different healthcare providers. Hospitalization can increase ADEs due to multiple prescribers, medication reconciliation issues and restrictive hospital formularies. Three types of IP are identified; under prescribing, overprescribing and misprescribing. Several tools are used to assess IP in elderly patients, such as Beers' criteria, STOPP/START criteria and the MAI. These tools can identify PIMs that have an increased risk when used for elderly patients. By using them to assess IP during hospitalization, many studies have shown a high prevalence of IP in elderly inpatients. Finally, IP in elderly people is associated with an increased risk of ADEs, morbidity, mortality and healthcare utilization, and the medications discrepancies occurred before and after hospital admissions poses significant threats to the patients.

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