



Current status of the potentially inappropriate medications and omissions of medicines among older adults in Hubei Province

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ABSTRACT

Background: Potentially inappropriate medications (PIMs) and omissions of medicines among older adults are increasingly popular with the aging population in China.

Objective: PIMs and omissions of medicines among older adults in the community were assessed via three distinct evaluation criteria, thus providing a basis for standardizing medication management in the elderly.

Methods: From April 2021 to June 2021, older adults in the 12 communities were selected from streets or villages in Wuhan, Yichang, Qianjiang and Zhijiang City of Hubei Province (3 streets/villages from each city by cluster sampling). PIMs and omissions of medicines among older adults were evaluated by the 2023 American Geriatrics Society (AGS) Beers Criteria, the 2014 STOPP (Screening Tool of Older Persons' Prescriptions)/START (Screening Tool to Alert to Right Treatment) Criteria, and the 2017 Chinese PIM Criteria for Older Adults.

Results: A total of 1011 eligible older adults in the community were enrolled, including 420 (43.08%) male and 591 (57.92%) female patients. Significant differences were detected in the number of medications across subgroups based on the sex, age, and chronic diseases ($P < 0.05$). Evaluated by the 2023 AGS Beers Criteria, there were 294 (29.08%) cases of PIMs. A total of 189 (18.69%) cases of PIMs and 229 omissions of medicines were identified by the 2014 STOPP/START Criteria. Using the 2017 Chinese PIM Criteria for Older Adults, 296 (29.28%) cases of PIMs were screened out. Nifedipine immediate release (IR), and nifedipine were the most frequently detected drugs of PIMs by the 2023 AGS Beers Criteria, and the 2017 Chinese PIM Criteria for Older Adults, respectively. Evaluated by the 2014 STOPP/START Criteria, non-steroidal anti-inflammatory drugs (NSAIDs) were the leading type of PIMs, and type 2 diabetes mellitus (T2DM) patients without metformin treatment was the top one item of omitted medicine.

Conclusion: PIMs and omissions of medicines among older adults in the community in Hubei Province should be highly concerned, which can be effectively identified via a combination of three evaluation criteria.

Introduction

Physical function and drug metabolism gradually decline in older adults, leading to an increased risk of drug accumulation-induced adverse events.¹ Additionally, use of multiple medications against common chronic diseases in older adults is prone to drug interactions, resulting in medication risks. At present, potentially inappropriate medications (PIMs) are particularly common in the elderly.² The 2023 American Geriatrics Society (AGS) Beers Criteria, and the 2014 STOPP (Screening Tool of Older Persons' Prescriptions)/START (Screening Tool to Alert to Right Treatment) Criteria are two important tools to

evaluate PIMs, and the 2017 Chinese PIM Criteria for Older Adults has been frequently applied to screen out PIMs in China.³⁻⁵ These criteria are formulated based on the pharmacological risks, clinical indications, and patient comorbidities, reflecting a complicated interplay between medications and patients.⁶ PIMs are closely linked with falls, delirium, cognitive function decline and hospitalization rates in the elderly,⁷ which can be prevented via pharmacy intervention, comprehensive evaluation and prescription optimization.⁸

So far, great strides have been made on the research and intervention of PIMs in China, although a gap in evaluation tools exists when compared with measures adopted in developed countries.⁹ In the

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present study, we evaluated PIMs and omissions of medicines among older adults in the community from Hubei Province using the three distinct tools, namely the 2023 AGS Beers Criteria, the 2014 STOPP/START Criteria, and the 2017 Chinese PIM Criteria for Older Adults, thus providing references for medication management and rational drug use among older adults in the community.

Methods

Participants

From April 2021 to June 2021, older adults in 12 randomly selected communities from 3 streets or villages each in Wuhan, Yichang, Qianjiang and Zhijiang City of Hubei Province. Sampled cities were selected by the cluster sampling. Inclusion criteria: (1) older adults aged 60 years and above and lived in the community for a long period; (2) clinical diagnosis of hypertension or diabetes mellitus and medications against the chronic disease for a minimum of 3 months; (3) well-cooperated; (4) written informed consent was provided. Excluded were those with acute complications, poor physical conditions, or unable to be cooperated.¹⁰ This study was approved by the Ethics Committee of the Tongji Medical College of HUST (No. 2020S223).

Evaluation tools

A self-designed questionnaire was used to survey baseline characteristics, including the age, sex, chronic disease, number of medications, etc. In addition, the following three tools were used to screen out PIMs and omissions of medicines among older adults. First, the 2023 AGS Beers Criteria is a 36-item scale that focuses on 8 types of PIMs, in which medications or medication classes that should be used with caution or avoided in older adults with 38 types of diseases or conditions were recorded.⁴ Second, the 2014 STOPP/START Criteria is an 81-item scale that can be divided into the STOPP and START categories. The former category is organized into 13 broad classifications, and the latter lists 34 criteria for potential prescribing omissions.³ Third, the 2017 Chinese PIM Criteria for Older Adults is categorized into 13 classifications, encompassing a total of 72 medications or medication classes that should be avoided in older adults, and 44 medications or medication classes as PIMs under 7 specific morbid states.⁵

Evaluation process and quality of control

Investigators were pre-trained for instructing and guiding participants, including the objective, significance, survey contents, confidentiality principles, and voluntary participation. The question-and-answer method was adopted due to the advanced age or cultural limitations in participants, thus minimizing distortion of information. Any questions would be explained by investigators in a unified guide to ensure that the survey contents were not influenced. Distributed questionnaires were collected on the spot, and investigators were independently responsible for checking missing items, writings, and logical errors, and revised immediately by participants. Invalid questionnaires, including those with missing data of demographics or drug use information, multiple logical contradictions, wrong answers, or self-reported difficulties in understanding the questionnaire content, or refused to answer questions, were excluded. Finally, all valid questionnaires were independently verified by two investigators, and saved using a unified coding system.

Statistical analysis

Data were extracted from questionnaires and stored in Microsoft Office Excel 2016 to create a database. Statistical analysis was performed using SPSS 24.0. Measurement data within a normal distribution were expressed as mean \pm standard deviation ($\bar{x} \pm s$), and

enumeration data were counted as percentage (%). Differences between groups were compared by the independent samples *t*-test or one-way ANOVA, if appropriate. A significant difference was determined by a *p*-value of less than 0.05.

Results

Baseline characteristics

A total of 1011 older adults in the community were enrolled, including 420 (43.08 %) male, and 591 (57.92 %) female patients with an average age of 68.56 ± 8.62 years. Among them, there were 450 (44.51 %) individuals in the age groups of 60–69 years, 453 (44.81 %) in the 70–79 years, 103 (10.19 %) in the 80–89 years, and 5 (0.49 %) in the ≥ 90 years. In our cohort, each individual had an average of 2.07 ± 1.15 types of chronic disease. There were 322 (31.85 %) older adults with one chronic disease, 394 (38.97 %) with 2 chronic diseases, and 295 (29.18 %) with 3 or more chronic diseases. Hypertension (906/1011, 89.61 %) was the most common chronic disease, followed by diabetes mellitus (362/1011, 35.81 %), and cardiac disease (216/1011, 21.36 %).

Enrolled older adults in the community were medicated with an average of 3.08 ± 2.16 types of drugs, with the maximum of 18 drugs. The majority (809/1011, 80.02 %) took 1–4 drugs, and 192 (18.99 %) and 10 (0.99 %) older adults were medicated with 5–9, and ≥ 10 drugs, respectively. Western medicine (646/1011, 63.91 %) was the most common drugs used in older adults, followed by traditional Chinese medicine or patent medicines (281/1011, 27.79 %), and medical products/supplies (84/1011, 8.30 %). Significant differences were detected in the number of medications across subgroups based on the sex, age, and chronic diseases ($P < 0.05$, Table 1).

PIMs among older adults in the community

Evaluated by the 2023 AGS Beers Criteria, there were 294 (29.08 %) cases reporting a total of 390 PIMs. Specifically, 230 (78.23 %) older adults suffered from 1 PIM, 35 (11.90 %) developed 2 PIMs, 26 (8.84 %) accompanied 3 PIMs, and 3 (1.02 %) faced 4 PIMs. Totally, 189 (18.69 %) older adults developed 231 PIMs that were identified by the 2014 STOPP/START Criteria. The majority (162/189, 85.71 %) reported 1 PIM, and only 2 (1.06 %) older adults suffered from 4 PIMs. Using the 2017 Chinese PIM Criteria for Older Adults, 296 (29.28 %) older adults with 318 PIMs were screened out. Among them, the vast majority (274/296, 92.57 %) had 1 PIM, and 22 (7.43 %) developed 2 PIMs. It is found that the 2017 Chinese PIM Criteria for Older Adults outperformed the other two criteria in screening out PIMs among older adults in the community, and the worst performance was observed when using the 2014 STOPP/START Criteria (Table 2).

Table 1

Number of medications influenced by the sex, age, and chronic diseases among older adults in the community (n = 1011).

Project	Number of medications	χ^2	<i>P</i> value
Sex		3.882	0.049
Male	3.05 \pm 2.16		
Female	3.07 \pm 2.01		
Age		3.004	0.030
60–69 years	3.15 \pm 2.11		
70–79 years	2.83 \pm 1.85		
80–89 years	3.22 \pm 2.14		
≥ 90 years	4.20 \pm 3.49		
Number of chronic diseases		14.526	0.001
1	2.58 \pm 1.56		
2	3.27 \pm 2.21		
≥ 3	3.26 \pm 2.31		

Table 2

PIMs among older adults in the community screened out by three distinct criteria.

Number of PIMs	The 2023 AGS Beers Criteria	The 2014 STOPP/START Criteria	The 2017 Chinese PIM Criteria for Older Adults
1	230	162	274
2	35	14	22
3	26	11	0
4	3	2	0
Total	294	189	296

Note: PIMs: potentially inappropriate medications; AGS: American Geriatrics Society; STOPP: Screening Tool of Older Persons' Prescriptions; START: Screening Tool to Alert to Right Treatment.

Recommendations for PIMs among older adults by the 2023 AGS beers criteria

Evaluated by the 2023 AGS Beers Criteria, nifedipine immediate release (IR) (192/390, 49.23%) was the most common drug for PIMs among older adults in the community (Table 3). PIM-associated drug-disease interactions were identified in 60 older adults. Among them, non-steroidal anti-inflammatory drugs (NSAIDs) and cyclooxygenase-2 (COX-2) inhibitors (37/60, 61.67%) were the most common drugs to be avoided (Table 4). PIMs used with caution were found in 76 older adults, and diuretic drugs accounted for the vast majority (74/76, 97.37%) (Table 5). Seven older adults were found with drug-drug interactions, especially PIMs of the anticholinergics-anticholinergics, alpha-1 adrenergic receptor antagonists-loop diuretics, and corticosteroids-NSAIDs combinations (Table 6).

Recommendations for PIMs and omissions of medicines among older adults by the 2014 STOPP/START criteria

Eight distinct PIMs were identified among older adults in the community by the 2014 STOPP Criteria, where the top 3 items were the use

Table 3

Specific types of PIMs among older adults in the community screened out by the 2023 AGS beers criteria.

Drugs	Strength of evidence	Class of recommendation	n
Nifedipine IR	Moderate	Strong	192
Aspirin	Moderate	Strong	103
Long-acting sulfonylureas (glimepide/glibenclamide)	High	Strong	57 (55/2)
PPIs (pantoprazole/omeprazole/rabeprazole)	High	Strong	21 (9/10/2)
NSAIDs (diclofenac/ibuprofen/piroxicam)	Low	Strong	6 (2/2/2)
Terazosin	Low	Strong	3
Digoxin	Insufficient	Strong	3
Benzodiazepines (estazolam/diazepam)	Low	Strong	2 (1/1)
Antipsychotics (olanzapine)	Low	Strong	1
Antiparkinsonian agents (trihexyphenidyl)	Low	Strong	1
Androgen (testosterone)	Low	Weak	1
Total			390

Note: IR: immediate release, PPIs: proton pump inhibitors; NSAIDs: non-steroidal anti-inflammatory drugs.

Table 4

PIMs in drug-disease interactions among older adults in the community screened out by the 2023 AGS beers criteria.

Drugs	Disease/syndrome	Strength of evidence	Class of recommendation	n
Thiazolidinediones	Heart failure	Moderate	Strong	7
NSAIDs & COX-2 inhibitors		Insufficient	Strong	37
Non-COX-2 selective NSAIDs	History of gastric or duodenal ulcer	Low	Strong	16
Total				60

Note: COX-2: cyclooxygenase-2.

Table 5

Drugs used with caution among older adults in the community screened out by the 2023 AGS beers criteria.

Drugs	Recommendation	Strength of evidence	Class of recommendation	n
Diuretics	Use with caution	Low	Strong	74
Oxcarbazepine	Use with caution	Low	Strong	1
Antipsychotics	Use with caution	Low	Strong	1
Total				76

of NSAIDs for moderate-to-severe hypertension (159/231, 68.83%), use of NSAIDs for heart failure (37/231, 16.02%), and use of NSAIDs in older adults with a history of gastric or peptic ulcer or gastrointestinal bleeding without applying H₂ receptor antagonists, proton pump inhibitors (PPIs) or misoprostol (14/231, 6.06%) (Table 7). Determined by the START Criteria, omissions of medicines were found in 229 cases, particularly in the situation of type 2 diabetes mellitus without metformin treatment (Table 8).

Recommendations for PIMs among older adults by the 2017 Chinese PIM criteria for older adults

Evaluated by the 2017 Chinese PIM Criteria for Older Adults, nifedipine (213/318, 66.98%), clopidogrel (33/318, 10.38%), and reserpine (25/318, 7.86%) were the dominant PIMs among older adults (Table 9). PIMs with specific disease states were found in 104 cases, and the top 3 items were use of NSAIDs for heart failure (45/104, 43.27%), use of reserpine for hypertension (23/104, 22.12%), and use of NSAIDs for older adults with a history of peptic ulcers (14/104, 13.46%) (Table 10).

Discussion

By data mining of 1011 older adults in the community in Hubei Province, this study demonstrated that the number of medications

Table 6
Drug-drug interactions to be avoided among older adults in the community screened out by the 2023 AGS beers criteria.

Drugs	Interacted drugs	Strength of evidence	Class of recommendation	n
Anticholinergics	Anticholinergics	Low	Strong	2
Alpha-1 adrenergic receptor antagonists	Loop diuretics	Low	Strong	2
Corticosteroids	NSAIDs	Low	Strong	3
Total				7

Table 7
PIMs among older adults in the community screened out by the 2014 STOPP criteria.

PIMs	n
1. Monotherapy of loop diuretics as the first-line treatment for hypertension (safer and more effective regimens are optional).	6
2. Use of thiazide diuretics in older adults with a history of gout (risk of aggravation of gout)	5
3. Use of aspirin in older adults with a history of gastrointestinal ulcers but without applying H ₂ receptor antagonists, PPIs or misoprostol (risk of bleeding).	12
4. Use of aspirin in older adults without coronary artery, cerebrovascular, peripheral vascular disease, or arterial occlusion events (no indications).	11
5. Use of NSAIDs in older adults with a history of peptic ulcer or gastrointestinal bleeding, unless H ₂ receptor antagonists, PPIs, or misoprostol are used concurrently.	14
6. Use of NSAIDs for moderate-to-severe hypertension (risk of exacerbation of hypertension)	159
7. Use of NSAIDs for heart failure (risk of aggravation of heart failure)	37
8. Use of glibenclamide or chlorpropamide for T2DM (risk of persistent hypoglycemia).	1
Total	231

Note: T2DM, type 2 diabetes mellitus.

Table 8
Omissions of medicines among older adults in the community screened out by the 2014 START criteria.

Omissions of medicines	n
1. Metformin treatment in older adults with T2DM regardless of metabolic syndrome (no renal dysfunction).	219
2. ACEI or ARB treatment in older adults with diabetic nephropathy regardless of renal injury suggested by serum biochemical indicators.	10
Total	229

Note: ACEI, angiotensin-converting enzyme inhibitors; ARB, angiotensin receptor blockers.

Table 9
Specific types of PIMs among older adults in the community screened out by the 2017 Chinese PIM criteria for older adults.

Drugs	Strength of risk	n
Nifedipine	Low	213
Clopidogrel	Low	33
Reserpine	High	25
Spirolonactone	Low	10
Zhenju antihypertensive tablets (containing clonidine)	High	10
Warfarin	Low	4
Ibuprofen	Low	3
Digoxin	Low	3
Theophylline	Low	2
Diclofenac	Low	2
Piroxicam	High	2
Combination of ≥ 2 NSAIDs	High	2
Glibenclamide	Low	1
Trihexyphenidyl	High	1
Estazolam	Low	1
Nicergoline	Low	1
Diazepam	High	1
Chlorpromazine	High	1
Clozapine	High	1
Olanzapine	Low	1
Phenytoin	High	1
Total		318

against chronic diseases increased with aging, and that was greater in older adults suffering from two or more chronic diseases than those with only one chronic disease.

In Hubei Province, the incidence of PIMs among older adults in the community was 29.08 %, 18.69%, and 29.28 % as screened out by the 2023 AGS Beers Criteria, the 2014 STOPP/START Criteria, and the 2017 Chinese

PIM Criteria for Older Adults, respectively. The high incidence of PIMs should be alerted and urged to be improved. Yang et al.¹¹ reported that the incidence of PIMs in 216 older adults ≥ 65 years in the community from Beijing, identified by the 2015 AGS Beers Criteria, is 26.4 %. The lower statistics than our data could be probably attributed to differences in the sample size, education level, and criteria.¹² Evaluated by the 2014 STOPP/START Criteria, and the 2017 Chinese PIM Criteria for Older Adults, the incidence of PIMs in 795 older adults in the community from Beijing is 18.5 % and 28.9 % respectively, and the estimates were similar to ours.¹³ Generally, the incidence of PIMs among older adults screened out by the 2003–2012 AGS Beers Criteria ranges from 18.3 % to 87.3 %, ^{14,15} and that screened out by the 2014 STOPP/START Criteria ranges from 21.4 % to 41.2 %.^{14,16} The variations are caused by subject characteristics, regions, and drug use habits.

In a comparison of three distinct criteria, the 2017 Chinese PIM Criteria for Older Adults outperformed than others in identifying PIMs among older adults, followed by the 2023 AGS Beers Criteria, and the 2014 STOPP/START Criteria. In line with national conditions, the 2017 Chinese PIM Criteria for Older Adults can sensitively detect PIMs in Chinese elderly. Consistent with previous findings, our data showed a higher incidence of PIMs detected by the AGS Beers Criteria than the 2014 STOPP/START Criteria.^{17,18} Based on the sorting of physiological systems, the 2014 STOPP/START Criteria can be more detailed and practical. However, the criteria classify the disease/syndrome into a certain classification, resulting in a failure to match all aspects to standardized contents. Additionally, the 2014 STOPP/START Criteria is less frequently updated than the AGS Beers Criteria, and it is therefore unable to reflect latest developments in medication and clinical practice. PIMs in drug-disease interactions evaluated by the 2023 AGS Beers Criteria, and the 2014 STOPP/START Criteria were less overlapped. We therefore recommended their combination to guide rational drug use in the elderly.^{1,19–22}

Table 10

PIMs in drug-disease interactions among older adults in the community screened out by the 2017 Chinese PIM criteria for older adults.

Disease/syndrome	Drugs	Recommendations	n
Heart failure	Pioglitazone	Avoided to be used	7
	NSAIDs	Avoided to be used	45
Hypertension	NSAIDs	Change to acetaminophen or aspirin, and monitor blood pressure closely.	7
	Reserpine	High dosage of reserpine may cause depression and extrapyramidal symptoms.	23
Chronic renal disease	Triamterene	Avoided to be used	1
Peptic ulcers	NSAIDs	Avoid a long-term use, and use it only when other drugs are not effective and in combination with gastric mucosal protective agents.	14
	Corticosteroids	Use with caution	4
Diabetes mellitus	Corticosteroids	Use inhaled corticosteroids, and monitor blood sugar levels closely.	1
Gout	Thiazide diuretics	Aggravated or cause gout.	3
Total			104

Nifedipine IR, NSAIDs, and nifedipine were the most frequently detected drugs of PIMs by the 2023 AGS Beers Criteria, the 2014 STOPP/START Criteria, and the 2017 Chinese PIM Criteria for Older Adults, respectively. T2DM patients without metformin treatment was the dominant cause of omitted medicine. All the abovementioned drugs were common in treating chronic diseases among older adults. In clinical setting, monitoring and evaluation of these drugs should be highly concerned by healthcare providers.

Evaluated by the three distinct criteria, NSAIDs were highly risk for a potential inappropriate use in treating older adults with heart failure, and hypertension, and those with a history of peptic ulcers. The CYP2C9 enzyme in the liver has significantly decreased activity among older adults, leading to an increased risk of gastrointestinal adverse events in NSAIDs-treated elderly.²³ Celecoxib or naproxen can be an alternative to NSAIDs in individuals with a high cardiovascular risk. Notably, celecoxib, as a COX-2 inhibitor, was determined as a PIM by the 2023 AGS Beers Criteria. Overall, drug use of NSAIDs should be particularly cautious in older adults with cardiovascular risk, hypertension, and gastrointestinal adverse events.²⁴

Conclusion

This study assessed the prevalence of PIMs among elderly patients in community settings in Hubei Province, China, based on the Beers Criteria (2023 edition), the STOPP/START criteria (2014 edition), and the Chinese PIM Standards for the elderly (2017 edition). It provides a reference for community healthcare workers in prescribing and reviewing medical advice. Additionally, it is essential to train community healthcare workers on the common PIM issues faced by elderly patients, thereby promoting rational pharmacotherapy within community health service institutions, reducing the risk of inappropriate medication use and the incidence of adverse drug reactions in elderly patients, and ensuring the safety of their medication.

Limitations should be noted. First, PIMs can be evaluated by other criteria to validate our findings. Second, traditional Chinese medicine or patent medicines are frequently used by older adults in the community,^{25–27} while they have not been evaluated by all the three criteria.

Declarations

Not applicable.

Authors' contributions

W. Li, H. Ge, Z. Jin: Data curation, methodology, formal analysis, and visualization. R. Tursun, J. Li, A. Wei: Article review and editing. D. Feng: Conceptualization, supervision, project administration, and overall project responsibility.

Ethics approval and consent to participate

This study was approved by the Ethics Committee of the Tongji Medical College of HUST (No. 2020S223).

Consent for publication

Not applicable.

Availability of data and materials

Not applicable.

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Declaration of Competing Interest

The authors declare that they have no competing interests.

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Authors' other information

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