

Identification of Potentially Inappropriate Medications (PIMs) by Beers Criteria in Geriatric Patients at RSA UGM Yogyakarta

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ABSTRACT

PIM (Potentially Inappropriate Medications) is one of the primary concerns leading to adverse health outcomes, higher risk of Adverse Drug Reactions (ADEs), decreased therapeutic effects, hospitalization, and unnecessary healthcare costs in the geriatric population. Therefore, this study aimed to determine the prevalence PIMs, and to identify the most common PIMs prescribed to hospitalized geriatric patients admitted at RSA UGM, Yogyakarta based on Beers Criteria 2019. A cross sectional study using electronic medical records data was conducted in geriatric patients aged >60 years admitted to the internal medicine ward. PIMs were identified using the Beers criteria 2019. Descriptive statistics were used to describe patient and drug characteristics. Total 70 geriatric patients met the inclusion criteria. The results revealed that the geriatric patients who received PIM were male (65.71%), in the age group of 60-65 years (51.42%), had comorbidities and polypharmacy between 5-9 (48.5%) and 61.42% respectively. The overall prevalence of PIMs was 77.1%, followed by prevalence of PIMs to be used with caution (70 percent), and PIMs avoided in geriatric patients (62.8%). The most commonly prescribed PIMs were diuretics (48.5%) and sliding scale insulin (24.2%). A high prevalence of PIMs was found in this study, which is alarming. The prescription of PIMs can be overcome by encouraging strategies, such as close monitoring of the patient's condition for potential ADEs, gender and pharmacokinetic/pharmacodynamic consideration when prescribing drug therapy to geriatric patients.

Keywords: PIM; geriatric patients; Beers Criteria 2019; RSA UGM

INTRODUCTION

People aged 60 and above are regarded as a prestigious community for an entire social structure. It brings them less attention by lower them in society. Globally, the trend toward the ageing population is increasing at an unprecedented rate, and it is predicted to speed up in the following years, especially in developing countries (Lim *et al.*, 2016). The worldwide population of geriatric individuals is expected to be more than twofold by 2050, making it more urgent than ever to address inappropriate medication use among the geriatric population (Nothelle *et al.*, 2019). WHO categorizes the older population as individuals aged 60 years and above (WHO, 2008). Geriatric individuals are prone to problems associated with drug therapy because of alterations in the pharmacokinetics and pharmacodynamics parameters, comorbidities, polypharmacy, and lack of sufficient guidelines for the treatment (Sharma *et al.*, 2020). Geriatric people are four times more susceptible to an ailment than younger individuals. 80% of the geriatric population suffer from at least 1 chronic disease, resulting in an increased probability of getting over 5 medications, resulting in polypharmacy (Vatcharavongvan *et al.*, 2021).

Polypharmacy is one of the significant contributors to drug interactions and unwanted drug effects. The geriatric population is considered a particular group, often excluded from clinical trial studies. As a result, the prescription of rational medication for the geriatric population becomes more challenging (Khader *et al.*, 2021).

PIMs in the geriatric population can be broadly defined as "medications that should not use in patients aged 65 years or older because they are less therapeutically effective or pose a high risk when more effective and safe alternatives exist." PIM is one of the primary concerns leading to adverse health outcomes, higher risk of ADEs, decreased therapeutic effects, hospitalization, and unnecessary healthcare cost in the geriatric population (Alshammari *et al.*, 2021). Prescription of

PIM, when the risks outweigh the benefits, is a prevalent practice in the geriatric population, with prevalence rates ranging from 11.5 to 85.1 percent in several countries (Azayzih *et al.*, 2019).

Presently, developed countries have taken several initiatives to promote the rational use of drugs and have introduced several evidence-based tools and criteria to identify and prevent PIM in geriatric patients. Beers Criteria is one of the most widely adopted criteria. In 1991, Beers Criteria was established, and it was the first time it was noticed and brought into an open measurement level for helping patients who are in their 60s by prescription. The following years 1997, 2003, 2012, 2015, and 2019 were defined as years of compiling and updating versions of the Beers Criteria for geriatric patients. Besides this, several countries have developed their criteria according to country-specific treatment guidelines to identify PIMs to improve treatment efficacy and safety (Hytinen *et al.*, 2019).

The prevalence of PIMs under the Beers criteria ranges from 23 to 66.8% in many countries (Sharma *et al.*, 2020). In a study on UAE geriatric population, the prevalence of PIMs based on Beer Criteria 2019 was 34.7% (Ahmed *et al.*, 2021). The prevalence of PIM identified by Beers criteria 2019 in an Indian tertiary care hospital was 61.9% (Sharma *et al.*, 2020). Similarly, the prevalence of PIMs was 49.2% in Jordanian geriatric patients (Khader *et al.*, 2021). This study aimed to determine the prevalence of potentially inappropriate medications (PIMs) and to identify the most common PIMs prescribed to hospitalized geriatric patients admitted at RSA UGM, Yogyakarta according to the Beers Criteria 2019.

METHOD

Study design

A cross-sectional study was conducted. Data collection was carried out using an electronic database of prescription drug use and medical record data for geriatric patients admitted at RSA UGM, Yogyakarta for the period January – June 2021. The Ethical Committee of the Institutional Review Board (IRB) of the Faculty of Medicine Gadjah Mada University approved the study.

Subject of the study

Subject of the study was hospitalized geriatric patients at the Internal Medicine ward with the inclusion criteria: 1. aged > 60 years, 2. Have laboratory data for serum creatinine, and 3. received drug therapy at internal medicine department from January - June 2021. Patient who died / were forced discharged / referred to other places, cancer and infection patients who were placed in the isolation room were excluded from the study. The samples taken were medical record data of 100 patients and 70 patients met the inclusion criteria. The minimal sample size calculated by the formula was 50 patients.

The data extracted from medical records was the patient's name, age, gender, diagnosis, type of drug, dose of drug, frequency of drug, and the number of drugs prescribed and comorbidities. Other supporting data used was creatinine clearance data. Microsoft Excel software was used to record the extracted data from EMR.

Outcome of the study

The outcomes measured in this study were the prevalence of PIM and the category of PIMs most commonly prescribed to geriatric patients. Beers Criteria 2019 applied to assess PIMs use in geriatric patients. PIMs based on the Beers Criteria 2019 are divided into 5 categories (AGS, 2019): Drugs that should be avoided; PIMs incidence because of interactions between disease and drugs; Drugs that can still be used, but with special attention or caution; PIMs event due to drug interactions, and Drugs that should be avoided or reduced in dose based on kidney function.

DATA ANALYSIS

Data analysis was carried out from the data collection sheets, namely the patient profile. Patient characteristics, drug characteristics, and incidence of PIMs were tabulated. Median and range (total and interquartile) were used to describe continuous variables. Data analysis was done by the descriptive method. Percentage of patient and drug characteristics was calculated based on the number per category, namely age, gender, diagnosis, the number of drugs, comorbidities and creatinine clearance (CrCl).

RESULTS AND DISCUSSION

In this study, 70 geriatric patients fulfilled the inclusion criteria. Table I shows the patient characteristics admitted at RSA UGM Yogyakarta. Most of the respondents were aged 60-65 years (51.42%). The age group with the least number of patients was ≥ 80 years, namely 3 patients (4.28%). According to Indonesian population statistics for the years 1971-2035, the geriatric population aged 60-64 years has increased compared to other age groups. Meanwhile, the age group >75 years was less but is expected to double from 2020 to 2035 (Adioetomo & Mujahid, 2015). Several studies have reported ageing as a significant cause of PIM use. Ageing related physiological modifications in geriatric patients that affect drug pharmacokinetic and pharmacodynamic parameters increase the incidence of ADRs (Scott *et al.*, 2015).

Characteristics of geriatric patients by gender showed that the number of male patients was 65.71% more than female patients, namely 34.28%. Even though, other studies have revealed that female patients have a slightly greater incidence of PIMs compared to men. The current study, however, found that male patients were more exposed to PIMs than were females. The study findings are comparable to 1 study conducted in India by Sharma *et al.*, (2020) where male patients were most likely candidates for PIMs. In a study by Rawle *et al.*, (2018) stated that men are more prone to cardiovascular prescriptions than women. Which contribute to cardiovascular polypharmacy and ultimately potential for inappropriate prescription in geriatric men.

It was observed that most of the patients had comorbidities between of 5-9 (48.5%, $n = 34$). In addition, 43% ($n = 30$) and 8.5% patients ($n = 6$) had comorbidities in the range of 1-4 and ≥ 9 , respectively. This study found that the most of geriatric patients were administered multiple drugs owing to several comorbidities. With increasing age, the number of chronic diseases increases, so the number of drugs also increases in prescription along with the possibility of unwanted drug events (Thorell *et al.*, 2020).

Patients who were prescribed 1-4, 5-9 and ≥ 10 drugs were 2 patients (2.85%), 25 patients (35.71%) and 43 patients (61.42%) respectively. According to United Kingdom statistics, 20.8 percent of patients with 2 diagnoses were given 4-9 drugs, while 10.1 percent were given 10 or more drugs (Lewek *et al.*, 2021).

The usual range of creatinine clearance is >120 , but this study showed that 65.71% of the geriatric patients ($n = 46$) had $\text{CrCl} < 30$ mL/min, 20% ($n = 14$) between 31-60 ml/min; 11.42% ($n = 8$) between 61-90 ml/min; and only two patients (2.85%, $n = 2$) had $\text{CrCl} > 120$ ml/min. According to the Beers Criteria 2019, creatinine clearance is an important factor and should be considered when treating geriatric patients.

PIMs Based on Beers Criteria 2019

As shown by Beers Criteria 2019, the overall incidence of PIMs in this study was 77.1 % (54/70). To the author's knowledge, this is the first study to report the incidence of PIMs in RSA UGM Yogyakarta using Beers Criteria 2019. A total of 119 PIMs in 54 patients were identified, which are mentioned in Table II. It is also known that the incidence of PIM continues to increase, due to an increase in the number of PIMs reported in recent years. Drugs listed in Beer's Criteria should be administered with caution, otherwise, avoided, because the risks and side effects outweigh the benefits when used in geriatric patients (AGS, 2019). The overall prevalence of PIM use according to the Beers Criteria 2019, was very high.

Using the Beers Criteria 2019, the study found that "PIMs to be used with caution" (70%) were the most frequently encountered PIMs category. "PIMs in older adults" (62.8%), "drug-disease and drug-syndrome PIMs" (21.4%), "PIMs based on kidney function" (14.2%) and "drug-drug interactions" (1.4%) were also prevalent as shown in Table II. A study by Tao *et al.*, (2021) showed similar results. The most commonly prescribed PIMs were furosemide, sliding scale insulin, aspirin, ketorolac, spironolactone, and tramadol.

Diuretics (Furosemide and Spironolactone) were the most frequently encountered PIMs in this study and should be used with caution corresponding to 48.5 % and 7.1% of all PIM use respectively. Similar findings were stated in a study on the Chinese population. Spironolactone and furosemide are commonly used in patients with oedema. In a study on 583 patients, it was reported

Table I. Description of Geriatric Patients Characteristics

Variable	Overall (n=70)		PIM (n=54)		Non-PIM (n=16)	
	N	%	N	%	N	%
Gender-n (%)						
Male	46	65.71%	35	64.81%	11	68.75%
Female	24	34.28%	19	35.18%	5	31.25%
Age (years)						
60-65	36	51.42%	30	55.55%	6	37.5%
66-70	20	28.57%	14	25.92%	6	37.5%
71-75	5	7.14%	3	5.55%	2	12.5%
76-80	6	8.57%	4	7.40%	2	12.5%
≥81	3	4.28%	3	5.55%	0	0
Age (yrs) (median [IQR])					60-65	
Drugs Prescribed-n (%)						
1-4	2	2.85%	0	0	2	12.5%
5-9	25	35.7%	16	29.62%	9	56.25%
≥10	43	61.42%	38	70.37%	5	31.25%
Drugs Prescribed (median [IQR])					≥10	
Comorbidities -n (%)						
1-4	30	42.85%	20	37.03%	10	62.5%
5-9	34	48.57%	28	51.85%	6	37.5%
≥9	6	8.57%	6	11.11%	0	0
Comorbidities (median [IQR])					5-9	
CrCl -(ml/min)						
<30	46	65.71%	37	52.85%	9	12.85%
31-60	14	20%	11	15.71%	3	4.28%
61-90	8	11.42%	5	7.14%	3	4.28%
>120	2	2.85%	1	1.42%	1	1.42%

IQR=interquartile range; PIM=potentially inappropriate medication, CrCl=Creatinine Clearance

that 7.8% of PIMs were associated with furosemide (Bhardwaj, 2021). According to the Beers Criteria 2019, diuretic drugs should be used with special care, namely by monitoring sodium levels, changing doses because they can exacerbate or can cause the syndrome of inappropriate antidiuretic hormone secretion (SIADH), or hyponatremia. When starting or altering diuretic dosages in an older adult, electrolyte levels should always be checked.

Apart from diuretics, this study found that the PIMs associated with the Sliding Scale Insulin were relatively high. For diabetic individuals, the Sliding scale insulin is approved, but, in geriatric patients, there is a higher incidence of hypoglycemia than better management of hyperglycemia. In this study, 17 PIMs out of 119 (24.2 percent) were found to be associated with Sliding Scale Insulin. Besides clear guidelines, the use of Sliding Scale Insulin is common. The findings of this study are in line with research by Sharma *et al.*, (2020) which states that 19.7% of PIMs are linked with Sliding Scale Insulin based on Beers Criteria 2015 and 2019. In a cohort study, 76 percent of patients were given sliding-scale insulin, which not only failed to manage hyperglycemia but also resulted in more incidences of hypoglycemia and increased length of stay (Queale *et al.*, 1997)

Some drugs, such as ranitidine, tramadol, colchicine, and spironolactone require dose modification or reduction for geriatric patients based on creatinine clearance (CrCl) data. If a patient's CrCl is 30 ml/min, there is a possibility of increased mental status changes because of the risk of bleeding. Ranitidine has a threefold longer elimination half-life in individuals with impaired renal function. As a result, as renal function worsens, ranitidine dose should be reduced based on Beers Criteria (Garg *et al.*, 1986). When spironolactone is prescribed at dose higher than usual, it can cause kidney injury and hyperkalemia. So frequent monitoring of patient's potassium levels is required (Butler *et al.*, 2002). Similarly, Tramadol and colchicine at a standard dose in geriatric

Table II. PIMs Based on Beers Criteria 2019

PIM Category	Name of Drugs	N=70			
		QE	SR	Number of Patients	Percentage %
Category 1	Alprazolam	Moderate	Strong	2	2.9
	Sliding Scale Insulin	Moderate	Strong	17	24.2
	Ketorolac	Moderate	Strong	7	10
	Chlorpromazine	Moderate	Strong	2	2.8
	Diphenhydramine	Moderate	Strong	3	4.2
	Atropine	Moderate	Strong	1	1.4
	Diazepam	Moderate	Strong	1	1.4
	Clonidine	Low	Strong	3	4.2
	Glimepiride	High	Strong	1	1.4
	Metoclopramide	Moderate	Strong	2	2.8
	Digoxin	Moderate	Strong	2	2.8
	Trihexyphenidyl	Moderate	Strong	2	2.8
	Rapid acting Insulin	Moderate	Strong	1	1.4
Subtotal				44	62.8
Category 2	Aspirin	Moderate	Strong	9	12.9
	Pioglitazone	High	Strong	1	1.4
	Cilostazol	Low	Strong	2	2.9
	Risperidone	Moderate	Strong	2	2.9
	Fluoxetine	High	Strong	1	1.4
Subtotal				15	21.4
Category 3	Furosemide	Moderate	Strong	34	48.5
	Aspirin	Moderate	Strong	5	7.1
	Tramadol	Moderate	Strong	4	5.7
	Spironolactone	Moderate	Strong	5	7.1
	Haloperidol	Moderate	Strong	1	1.4
Subtotal				49	70
Category 4	Dexamethasone-Aspirin	Moderate	Strong	1	1.4
Subtotal				1	1.4
Category 5	Ranitidine	Moderate	Strong	2	2.8
	Colchicine	Moderate	Strong	1	1.4
	Spironolactone	Moderate	Strong	3	4.2
	Tramadol	Low	Weak	4	5.7
Subtotal				10	14.2

patients cause toxicity in the Central nervous system and GI and bone marrow respectively. Therefore, geriatric patients with impaired kidney function require dose adjustment based on CrCl (AGS, 2019). Despite the clear indications in Beers Criteria for CrCl, 10 PIMs were identified in this category. Despite a drop in CrCl, patients were administered regular doses of ranitidine, tramadol, colchicine, and spironolactone. The findings of this study are consistent with (Sharma *et al.*, 2020) who found 41 PIMs in category 5. Similar findings have been found in other studies^{33,34}. In a study by (Cardone *et al.*, 2010) it was found that 36% of geriatric patients were given standard dose based of their estimated GFR.

According to Beers Criteria, some diseases can interact with drugs. In this study, the most frequent interactions in patients with heart failure and kidney failure receiving nonsteroidal anti-inflammatory drugs (NSAIDs) were ketorolac and aspirin in 7 (10%) and 9 (12.9%) respectively. Ketorolac increases the incidence of gastrointestinal (GI) bleeding/peptic ulcer disease and kidney

injury in geriatric patients. NSAIDs should be avoided in geriatric patients with a history of heart failure because of the potential for worsening heart failure. Using NSAIDs in heart failure might potentially trigger fluid retention and exacerbation of heart failure. In PIMs category 2, geriatric patients with renal disease and CrCl <30 ml/min should be avoided NSAIDs because of increased incidence of renal injury and decrease renal function (AGS, 2019).

Drugs used by geriatric patients can interact with other drugs. In this study, the potential interaction that occurred was between the corticosteroid class (dexamethasone) and NSAIDs (aspirin). Combination with NSAIDs should be avoided or if this is not possible, gastrointestinal protection should be given because this therapy increases the risk of gastritis, gastric ulcers, bleeding and dyspepsia (AGS, 2019; Liu *et al.*, 2013)

This study has few limitations. First, this study has a retrospective design so, the impact of PIMs or the occurrence of ADRs cannot be determined. Second, the study only analyzed the medical records of 70 patients in one hospital, results cannot be generalized. It is recommended to conduct a prospective study in other hospitals in Yogyakarta as well. Third, sample size of the study is not enough to identify significant relationship between variables.

CONCLUSION

A high prevalence of PIMs was found in this study (77.14%), which is alarming. Most of the PIMs identified by the Beers criteria 2019 were furosemide (48.5%) and sliding scale insulin (24.2%). It is critical that healthcare providers consider appropriate treatment to avoid and minimize ADEs. Therefore, pharmacist must play an active role in the drug selection and monitoring. The prescription of PIMs can be overcome by encouraging strategies, such as close monitoring of the patient's condition for potential ADEs, gender and pharmacokinetic/pharmacodynamic consideration when prescribing drug therapy to geriatric patients.

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REFERENCES

- American Geriatrics Society. (2019). American Geriatrics Society 2019 Updated AGS Beers Criteria for Potentially Inappropriate Medication Use in Older Adults. *Journal of the American Geriatrics Society*; 67; 1-21.
- Ahmed, A., Faris, A., Jamal, K., Rafeea, B., Aljawamis, D., & Al, J. (2021). Potentially inappropriate medications in older adults according to Beers criteria 2019 : Prevalence and risk factors. *Int J Clin Pract., March*, 1-8.
- Abdelwahed, A. A., El-Dahiyat, F., Aljawamis, D., Al Ajimi, J., & Bin Rafeea, K. J. (2021). Potentially inappropriate medications in older adults according to Beers criteria 2019: Prevalence and risk factors. *International journal of clinical practice*, 75(11), e14715.
- Alshammari, H., Al-Saeed, E., Ahmed, Z., & Aslanpour, Z. (2021). Reviewing Potentially Inappropriate Medication in Hospitalized Patients Over 65 Using Explicit Criteria: A Systematic Literature Review. *Drug, healthcare and patient safety*, 13, 183-210.
- Al-Azayzih, A., Alamoori, R., & Altawalbeh, S. M. (2019). Potentially inappropriate medications prescribing according to Beers criteria among geriatric outpatients in Jordan: a cross sectional study. *Pharmacy practice*, 17(2), 1439.
- Butler, J. V., McAvoy, H., McEnroy, D., & Mulkerrin, E. C. (2002). Spironolactone therapy in older patients--the impact of renal dysfunction. *Archives of gerontology and geriatrics*, 35(1), 45-49.
- Bhardwaj, A. (2021). Prevalence of Polypharmacy and Potentially Inappropriate Medications in Elderly Patients : Cross Sectional Study Based on Updated Beer ' s Criteria 2019. *Journal of Clinical Pharmacology and Therapeutics*, 2, 2017-2022.
- Cardone, K. E., Bacchus, S., Assimon, M. M., Pai, A. B., & Manley, H. J. (2010). Medication-related problems in CKD. *Advances in chronic kidney disease*, 17(5), 404-412.

- Garg, D. C., Baltodano, N., Jallad, N. S., Perez, G., Oster, J. R., Eshelman, F. N., & Weidler, D. J. (1986). Pharmacokinetics of ranitidine in patients with renal failure. *Journal of clinical pharmacology*, 26(4), 286–291.
- Hyttinen, V., Jyrkkä, J., Saastamoinen, L. K., Vartiainen, A. K., & Valtonen, H. (2019). Patient- and health care-related factors associated with initiation of potentially inappropriate medication in community-dwelling older persons. *Basic & clinical pharmacology & toxicology*, 124(1), 74–83.
- Kurczewska-Michalak, M., Lewek, P., Jankowska-Polańska, B., Giardini, A., Granata, N., Maffoni, M., Costa, E., Midão, L., & Kardas, P. (2021). Polypharmacy Management in the Older Adults: A Scoping Review of Available Interventions. *Frontiers in pharmacology*, 12, 734045.
- Khader, Hasoun, L. Z., Alsayed, A., & Abu-Samak, M. (2021). Potentially inappropriate medications use and its associated factors among geriatric patients: a cross-sectional study based on 2019 Beers Criteria. *Pharmacia*, 68 (4), 789–795.
- Liu, D., Ahmet, A., Ward, L., Krishnamoorthy, P., Mandelcorn, E. D., Leigh, R., Brown, J. P., Cohen, A., & Kim, H. (2013). A practical guide to the monitoring and management of the complications of systemic corticosteroid therapy. *Allergy, asthma, and clinical immunology : official journal of the Canadian Society of Allergy and Clinical Immunology*, 9(1), 30.
- Lim, Y. J., Kim, H. Y., Choi, J., Lee, J. S., Ahn, A. L., Oh, E. J., Cho, D. Y., & Kweon, H. J. (2016). Potentially Inappropriate Medications by Beers Criteria in Older Outpatients: Prevalence and Risk Factors. *Korean journal of family medicine*, 37(6), 329–333.
- Lewek, P., Jankowska-pola, B., Giardini, A., & Granata, N. (2021). Polypharmacy Management in the Older Adults : A Scoping Review of Available Interventions. *Front. Pharmacol*, 12(November), 1–15.
- Nothelle, S. K., Sharma, R., Oakes, A., Jackson, M., & Segal, J. B. (2019). Factors associated with potentially inappropriate medication use in community-dwelling older adults in the United States: a systematic review. *The International journal of pharmacy practice*, 27(5), 408–423.
- Queale, W. S., Seidler, A. J., & Brancati, F. L. (1997). Glycemic control and sliding scale insulin use in medical inpatients with diabetes mellitus. *Archives of internal medicine*, 157(5), 545–552.
- Rawle, M. J., Richards, M., Davis, D., & Kuh, D. (2018). The prevalence and determinants of polypharmacy at age 69: A British birth cohort study. *BMC Geriatrics*, 18(1), 1–12.
- Sharma, R., Bansal, P., Garg, R., Ranjan, R., Kumar, R., & Arora, M. (2020). Prevalence of potentially inappropriate medication and its correlates in geriatric hospitalized patients: A cross-sectional study based on Beers criteria. *Journal of family & community medicine*, 27(3), 200–207.
- Scott, I. A., Hilmer, S. N., Reeve, E., Potter, K., Le Couteur, D., Rigby, D., Gnjjidic, D., Del Mar, C. B., Roughead, E. E., Page, A., Jansen, J., & Martin, J. H. (2015). Reducing inappropriate polypharmacy: the process of deprescribing. *JAMA internal medicine*, 175(5), 827–834.
- Thorell, K., Midlöv, P., Fastbom, J., & Halling, A. (2020). Use of potentially inappropriate medication and polypharmacy in older adults : a repeated cross-sectional study. *BMC Geriatrics*, 1–9.
- Tao, L., Qu, X., Gao, H., Zhai, J., Zhang, Y., & Song, Y. (2021). Polypharmacy and potentially inappropriate medications among geriatric patients in the geriatric department at a single-center in China: A retrospective cross-sectional study. *Medicine*, 100(42), e27494.
- Vatcharavongvan, P., Prasert, V., Ploylearmsang, C., & Puttawanchai, V. (2021). Prevalence and Factors that Influence Potentially Inappropriate Medication Use among Thai Geriatric in Primary Care Settings. *Canadian Geriatrics Journal*, 24(4), 332–340.
- World Health Organization. (2008). The world health report 2008: primary health care now more than ever.