ORIGINAL ARTICLE

Medication Appropriateness among Older Persons Admitted to a General Hospital in Malaysia

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ABSTRACT

Introduction: Many tools have been developed to determine medication appropriateness in older persons including the 2015 American Geriatric Society (AGS) Beers criteria and the Screening Tool of Older People's Prescriptions (STOPP) criteria. We aimed to determine and compare the prevalence of potentially inappropriate medications (PIMs) based on the Beers criteria 2015 and the STOPP criteria v2 among older persons admitted to a general hospital in Malaysia. **Methods:** A cross-sectional study comprising of 160 patients aged 65 years old and above admitted to the general medical wards of a tertiary teaching hospital were recruited. Beers criteria 2015 and the STOPP criteria v2 were used to evaluate participants' medication list on admission, during hospitalisation and on discharge for PIMs. Prevalence of PIMs which was calculated as the total number of patients with one or more PIMs over the total number of patients. **Results:** The prevalence of PIMs identified by Beers criteria 2015 on admission, during hospitalisation and on discharge were 54.85%, 64.40% and 48.80% respectively. The prevalence of PIM based on STOPP criteria v2 were 33.08%, 47.50% and 42.50% respectively. The most prevalent PIMs according to Beers criteria 2015 and STOPP criteria v2 were diuretics, tramadol, ticlopidine, proton pump inhibitor, benzodiazepines and antipsychotics. **Conclusion:** The prevalence of PIMs use is high among hospitalised older persons in Malaysia. While it is not possible to avoid all PIMs listed in the Beers and STOPP criteria, clinicians should exercise caution in prescribing drugs such as benzodiazepines, antipsychotics and proton pump inhibitors for older persons weighing the risk versus benefit of the drugs.
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Keywords: Aged, Inpatients, Geriatrics, Potentially Inappropriate Medication List, Prevalence

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INTRODUCTION

Older persons are especially vulnerable to medication errors (MEs) and adverse drug events (ADEs). This is mainly due to the physiological changes associated with increasing age, multi-comorbidities and polypharmacy. More than 50% of the people aged 75 years old and above have multiple chronic concurrent medical conditions, while 25–80% of older population are affected by polypharmacy (1, 2).

ADEs in health care can cause several deleterious impacts. ADEs lead to increased mortality, higher morbidity and increased risk of hospitalisation. A recent meta-analysis reported that ADEs leading to hospitalisations account for about 8.7% of hospitalisations in older persons (3). This also translates into increased health care expenditure associated with hospitalisation and medication cost; there was at least $3.5 billion per year spent on ME-related injuries in hospitals (4). This highlights the importance of detecting, understanding and preventing MEs and ADEs to improve patient safety and prevent its economic implications.

However, detecting and understanding ADEs and MEs have not been easy tasks. In clinical settings, ADEs and MEs are generally under reported due to the fear of being held accountable and shamed. In Malaysia, more than 80% of community pharmacists fail to report ADEs (5). Hence, researchers have opted for other measures to reflect the extent of MEs and ADEs such as medication appropriateness. Since then, many tools have been developed to determine the medication appropriateness for a given patient. This includes the American Geriatric Society (AGS) Beers criteria, the Screening Tool of Older People's Prescriptions (STOPP) criteria, the Screening Tool to Alert to Right Treatment (START) criteria, and

the Medication Appropriate Index.

The AGS Beers criteria were developed using the modified Delphi technique, and the first version was published in 1991 (6). Since then, the AGS Beers criteria was revised again in 2003, 2012, 2015 and 2019 (7, 8). The Beers criteria have been widely used in both clinical and research work in determining potentially inappropriate medications (PIMs) in older persons, and were found to be suitable across settings, ranging from aged care home, community and hospitals. The STOPP criteria is another tool that has been increasingly used to determine the prevalence of PIMs among older persons. The STOPP criteria was developed in 2008 through consensus by 18 experts using the Delphi process. It was then updated in 2015 (STOPP v2) (9). The STOPP criteria is preferred over Beers criteria by some researchers and clinicians as they have been shown to be better correlated with ADEs (10).

The Beers criteria provide a list of medications arranged according to physiological systems which should be avoided or used with caution in older persons while the STOPP criteria provide a list of PIMs in older persons according to physiological systems (8, 9). Both Beers and STOPP criteria emphasize the higher risk of ADEs in older people with the use of long-acting benzodiazepines, tricyclic antidepressants, anticholinergic drugs, and non–cyclooxygenase 2–selective nonsteroidal anti-inflammatory drugs. Both sets of criteria also focus on several common potential adverse drug-disease and drug-drug interactions in older people. However, STOPP criteria place special emphasis on duplicate drug class prescription, whereas Beers criteria do not. STOPP criteria also contain several common instances of PIMs that are not mentioned in Beers criteria such as the use of oestrogens with a history of venous thromboembolism (11).

According to studies conducted in various countries, PIMs are highly prevalent among older patients based on these two criteria. The prevalence of PIMs use ranged from 16.5% to 82.6% based on Beers criteria (12-15). Meanwhile, the STOPP criteria detected that between 18.7% to 84% of patients having at least one inappropriate medication (12-16). Many articles demonstrated that the prevalence of PIMs determined using the Beers or STOPP criteria, decreased from admission to discharge in hospitalised patients (12, 13). On the other hand, some studies reported that prevalence of PIMs use increased from admission to discharge (14). Hence, it is debatable whether the proportion of PIMs reduces during the hospital stay or vice versa.

A recent Malaysian study reported that PIMs were significantly higher among older inpatients compared to outpatients across different evaluation tools including the Beers criteria (65% vs 57%), STOPP criteria (57.4% vs 17.0%) and the Medication Appropriateness Index (1.76 ± 1.08 and 1.10 ± 0.34) (17). How these PIMs changes from admission to discharge among these older inpatients is not known and this information will be useful in determining the point at which PIM use is high and requires attention. This study aimed to compare the prevalence of PIMs among older persons on admission, during hospitalisation and on discharge based on the Beers criteria 2015 and STOPP criteria v2.

MATERIALS AND METHODS

Study design, setting and duration

This cross-sectional study was conducted at an urban tertiary teaching hospital in Malaysia over 12 weeks from August to October 2018. The hospital utilises an electronic prescribing system where the doctors prescribe the medications online and the prescription is transmitted to the pharmacy for dispensing. However, the medications prescribed at the emergency department are by written prescriptions.

Participants and sampling

The sample size was calculated using an online sample size calculator (http://powerandsamplesize.com/) for each specific objectives, where the largest sample size required was 153 patients. Included were all patients aged 65 years old and above admitted to the three general medical wards of the hospital. These wards take acute admissions directly from the emergency department. Exclusion criteria were critically ill patients admitted to the intensive care unit and patients whose medication chart (electronic and written) were not available for review by the researcher for any reason. Critically ill patients were excluded as they were very heterogenous in characteristics and may require a higher level of symptom control including pain, nausea, dyspnoea and agitation. A few of the critically ill patients may undergo palliative care where the PIMs criteria would not be valid. Convenience sampling were performed where all eligible patients meeting the inclusion and exclusion criteria during the study period were included.

Data collection

The researcher (fourth-year pharmacy student) screened the inpatient list of the general medical wards every morning to identify patients being discharged from the hospital on that day, who met the inclusion and exclusion criteria of the study. Both written prescriptions and electronic medication records of eligible patients were reviewed by the researcher. Patients' age, gender, weight, activities of daily living (ADL), relevant laboratory data, length of hospital stay, information on co-morbidities and diagnoses as well as medication list on admission, during hospitalisation and on discharge were recorded based on information available in the medical records. All medications including topical medications, as needed-dose, immediate-dose, over the counter, vitamins, parenteral medications, oral medications and inhaled medications were recorded. Creatinine

clearance was determined by using the Cockcroft Gault formula (18). The full version of the 2015 AGS Beers criteria (as 2019 AGS Beers criteria was not available at the time when this study was conducted in 2018) and the STOPP criteria v2 were used by two researchers (a fourth-year pharmacy student and a pharmacist in academia) independently to assess the PIMs for each patient. For drug-disease interactions, both acute and chronic diseases of the patient were considered. All medications prescribed during hospital stay, including all durations of use (single, as required, time-limited and regular doses) were evaluated for PIMs against the Beers criteria 2015 and STOPP criteria v2. For PPIs where the duration of prescription more than 8 weeks in both criteria and for benzodiazepines where the duration of prescription more than 4 weeks in the STOPP criteria were considered inappropriate, it was assumed that the medications exceeded the time frame specified, if the date of initial prescription could not be ascertained from medical notes, in the case of medications prescribed prior to admission. For PPIs and benzodiazepines newly commenced in hospital and upon discharge, the duration of prescription was known, so the assumption did not apply. Any discrepancies were discussed, and a decision was made through consensus. A third researcher (consultant geriatrician) was consulted if a consensus could not be achieved.

Table I: Demographic characteristics of study participants

Characteristics	N = 160
Age (Years), Median [Range]	79 [65-97]
Gender	
Female, N (%)	96 (60%)
Male, N (%)	64 (40%)
Weight	
Mean [SD] (kg) †	54.7 [18.9]
Activities of daily living	
Independent, N (%)	62 (38.8%)
Partially dependent, N (%)	19 (11.9%)
Dependent, N (%)	30 (18.8%)
Not stated, N (%)	49 (30.6%)
Death during hospitalisation, N (%)	14 (4.6%)
Number of comorbidities, Median [Range]	4 [0-9]
Length of hospital stay (Days), Median [Range]	8 (1-74)
Number of medications	
On admission, Median [Range]	4.5 [0-15]
During hospitalisation, Median [Range]	12.0 [2-33]
On discharge, Median [Range]	6.0 [0-17]
Primary Diagnosis	
Pneumonia, N(%)	34 (21.3%)
Stroke, N (%)	12 (7.5%)
Urinary tract infection, N (%)	12 (7.5%)
Delirium, N (%)	12 (7.5%)
Anaemia, N (%)	10 (6.3%)
Exacerbation of COPD/COAD/asthma, N (%)	10 (6.3%)
Falls and injury, N (%)	9 (5.6%)

†Only 74 (46.3%) participants had their weight stated in the medical records.
COAD = Chronic Obstructive Airway Disease; COPD = Chronic Obstructive Pulmonary Disease

Data analysis

Data analyses were carried out using the Statistical Package for Social Science (SPSS) programme version 22 at significance level of 0.05. Descriptive demographic data were reported as frequency, means with standard deviation (for data that was normally distributed) and median with interquartile range (for data that was not normally distributed). The prevalence of PIMs was calculated as the total number of patients with one or more PIM, over the total number of patients. PIMs assessed using the same tool (Beers criteria 2015 and STOPP criteria v2) on admission, during admission and at discharge were compared using the McNemar test as they represent repeated measures in the same population using the same tool. The prevalence of PIMs at each time point (on admission, during admission and at discharge) using different tools (Beers criteria 2015 and STOPP criteria v2) were compared using the Chi-Square test. Multivariate logistic regression was used to determine factors associated with the presence of PIMs in older inpatients on admission, during hospitalisation and on discharge, and the results were presented as odds ratios. Factors that were tested included patients' age, gender, weight, ADL, length of hospital stay, number of comorbidities and number of medications.

Ethical approval was obtained from the Medical Research Ethics Committee of University Malaya Medical Centre (No.2018-730-6539).

RESULTS

A total of 160 patients were recruited into this study. A majority (60%) of the patients were female with median (range) age of 79 (65-97) years old (Table I).

Table II summarises the prevalence of PIMs use based on both the Beers criteria 2015 and STOPP criteria v2. The prevalence of PIMs on admission was calculated based

Table II: Prevalence of potentially inappropriate medications use based on 2015 American Geriatric Society Beers criteria and Screening Tool of Older People's Prescriptions version 2

	Prevalence of PIMs [N (%)]	Prevalence of PIMs that should be used with caution [N (%)]	Number of PIMs per patient [Mean (SD)]
Beers criteria			
On admission†	103 (54.9)	40 (38.8%)	0.64 (0.87)
During hospitalisation	177 (64.4)	44 (24.9%)	1.11 (1.10)
On discharge	100 (48.8)	21 (21.0%)	0.63 (0.77)
STOPP criteria			
On admission†	58 (33.1)	-	0.36 (0.67)
During hospitalisation	122 (47.5)	-	0.76 (0.99)
On discharge	83 (42.5)	-	0.52 (0.70)

†Calculated using 133 patients' data.
PIM = Potentially Inappropriate Medications; STOPP = Screening Tool of Older People's Prescriptions.

on 133 patients' data as information on the previous medication history of 27 patients could not be retrieved.

The prevalence of PIMs at any time point detected by the Beers criteria 2015 were significantly higher than that detected by the STOPP criteria v2 (Table III). Using the Beers criteria 2015, the prevalence of PIMs was significantly higher during hospitalisation compared to on admission, and during hospitalisation compared to on discharge. Meanwhile, using the STOPP criteria v2, the prevalence of PIMs was significantly lower on admission than that of during admission and on discharge.

Table III: Comparison of the prevalence of potentially inappropriate medications according to the 2015 American Geriatric Society Beers criteria and Screening Tool of Older People's Prescriptions version 2 at different time points during the hospital stay

Beers criteria	STOPP criteria	p-value (Chi-Square test)
On admission (54.9%)	On admission (33.1%)	0.000*
During hospitalisation (64.4%)	During hospitalisation (47.5%)	0.000*
On discharge (48.8%)	On discharge (42.5%)	0.000*
Beers criteria	**Beers criteria**	**p-value (Mc-Nemar test)**
On admission (54.9%)	During hospitalisation (64.4%)	0.001*
On admission (54.9%)	On discharge (48.8%)	0.625
During hospitalisation (64.4%)	On discharge (48.8%)	0.001*
STOPP criteria	**STOPP criteria**	**p-value (Mc-Nemar test)**
On admission (33.1%)	During hospitalisation (47.5%)	0.000*
On admission (33.1%)	On discharge (42.5%)	0.003*
During hospitalisation (47.5%)	On discharge (42.5%)	0.302

*Significant at $p < 0.05$.
STOPP = Screening Tool of Older People's Prescriptions.

Overall, the drugs that were most commonly picked up by both the Beers criteria 2015 and STOPP criteria v2 were benzodiazepines, proton pump inhibitors, ticlopidine and antipsychotics (Table IV). Additionally, the Beers criteria 2015 picked up diuretics quite consistently whereas STOPP criteria v2 picked up tramadol most commonly.

The odds of a patient being prescribed with a Beers-PIMs on discharge was significantly associated with number of comorbidities (OR=1.41, 95% CI=1.04-1.92) (Table V). On the other hand, female gender (OR=6.89, 95% CI=1.64-29.00) and number of medications (OR=1.16, 95% CI=1.02-1.31) significantly predicted the prevalence of STOPP-PIMs during hospitalisation.

Table IV: Medications commonly used inappropriately based on 2015 American Geriatric Society Beers criteria and Screening Tool of Older People's Prescriptions version 2

Beers criteria	N (%)	STOPP criteria	N (%)
On -admission	*103 (100%)*	*On admission*	*58 (100%)*
Diuretics	29 (28.2%)	Proton pump inhibitor	21 (36.2%)
Proton pump inhibitor	20 (19.4%)	Tramadol	6 (10.3%)
Benzodiazepines	8 (7.7%)	Antipsychotics	6 (10.3%)
Antipsychotics	5 (4.9%)	Benzodiazepines	5 (8.6%)
Ticlopidine	4 (3.9%)	Ticlopidine	4 (6.9%)
During hospitalisation	*177 (100%)*	*During hospital-isation*	*122 (100%)*
Metoclopramide	38 (21.5%)	Tramadol	38 (31.1%)
Diuretics	31 (17.5%)	Benzodiazepines	32 (25.2%)
Benzodiazepines	18 (10.2%)	Antipsychotics	12 (9.8%)
Antipsychotics	15 (8.5%)	1st generation antihistamine	12 (9.8%)
Tramadol	11 (6.2%)	Other strong opioids	12 (9.8%)
On discharge	*100 (100%)*	*On discharge*	*83 (100%)*
Proton pump inhibitor	47 (47.0%)	Proton pump inhibitor	35 (42.2%)
Diuretic	15 (15.0%)	Tramadol	16 (19.3%)
Tramadol	8 (8.0%)	Antipsychotics	7 (8.4%)
Antipsychotic	4(4.0%)	Ticlopidine	4 (4.8%)
Ticlopidine	4 (4.0%)	Beta blockers with Diabetes Mellitus	4 (4.8%)

STOPP = Screening Tool of Older People's Prescriptions.

DISCUSSION

The prevalence of PIMs among hospitalised older persons identified by the Beers criteria 2015 in this study (48.80% - 64.40%) was higher compared to two other Malaysian studies conducted in nursing homes, which reported a prevalence of 17.6% and 36% respectively (19-21). These disparities may be because hospitalised patients require more intensive drug therapies to treat their acute illnesses, on top of their regular medications and this increases the risk of PIMs. The prevalence of PIMs identified by STOPP criteria v2 in this study (33.08% - 47.05%) was also higher compared to another Malaysian study conducted among hospitalised patients (27.0% on admission and 22.3% on discharge) (22). While this difference can be attributed to differences in participant characteristics and interpretation of the STOPP criteria between the two studies, it could also be due to the lack of the use of Beers and STOPP criteria by clinicians in their prescribing practice in our setting. The Beers and STOPP criteria are not well known outside of specialist geriatric medicine practice and the wards included in our study were general medical wards staffed by general medical officers, general medical and specialty physicians such as respiratory, gastroenterology, rheumatology, dermatology and endocrinology. A previous study in Malaysia showed that only 7.3% of a sample of physicians and pharmacists had ever applied the Beers and START/STOPP criteria in prescribing for older persons and 60% had never heard of either of the criteria (23). Clinicians also tend to follow the prescribing pattern at the hospital which include prescribing PIMs which are of lower cost. For example, chlorpheniramine is commonly prescribed in our setting for the symptomatic treatment of rhinitis or pruritus due to the lower cost compared to second generation

Table V: Factors associated with the use of potentially inappropriate medications based on 2015 American Geriatric Society Beers criteria and Screening Tool of Older People's Prescriptions version 2

	Beers criteria Odds ratio (95% CI)	p-value	STOPP criteria Odds ratio (95% CI)	p-value
On admission				
Age	0.96 (0.88-1.04)	0.287	0.96 (0.87-1.06)	0.416
Female	1.34 (0.42-4.31)	0.623	2.15 (0.47-9.95)	0.416
Length of hospital stay	0.99 (0.94-1.04)	0.524	1.00 (0.94-1.06)	0.896
Number of comorbidities	1.18 (0.88-1.58)	0.266	1.26 (0.89-1.06)	0.197
Number of medications	1.12 (0.94-1.33)	0.193	1.14 (0.93-.40)	0.203
During hospitalisation				
Age	0.97 (0.88-1.06)	0.434	0.96 (0.88-1.05)	0.398
Female	2.69 (0.83-8.69)	0.099	6.89 (1.64-29.00)	0.008*
Length of hospital stay	1.04 (0.97-1.12)	0.304	1.04 (0.97-1.12)	0.318
Number of comorbidities	1.15 (0.84-1.57)	0.392	1.25 (0.92-1.70)	0.159
Number of medications	1.01 (0.90-1.13)	0.882	1.16 (1.02-1.31)	0.021*
On discharge				
Age	0.94 (0.86-1.02)	0.128	0.95 (0.88-1.03)	0.236
Female	1.61 (0.50-5.15)	0.423	0.88 (0.30-2.55)	0.809
Length of hospital stay	1.06 (0.10-1.14)	0.085	1.01 (0.97-1.06)	0.529
Number of comorbidities	1.41(1.04-1.92)	0.026*	1.09 (0.84-1.41)	0.529
Number of medications	0.93 (0.77-1.12)	0.449	0.96 (0.82-1.14)	0.281

*Significant at $p < 0.05$.
STOPP = Screening Tool of Older People's Prescriptions.

antihistamines (21). Findings from this study could be a good start to create awareness among clinicians about the potential harm of these PIMs and to design measures to tackle the issue.

We found that the number of PIMs use on admission, during hospitalisation and on discharge was significantly higher for the Beers criteria 2015 than the STOPP criteria v2. Previous studies have demonstrated similar results where Oliveira, Amorim (24) reported that the Beers criteria were more sensitive than STOPP in detecting the prevalence of PIMs among nursing home patients. A recent study conducted in Lebanon among individuals recruited from community pharmacies also reported that the Beers criteria 2015 could identify more PIMs than STOPP criteria v2 because the STOPP criteria v2 are more specific and requires a more detailed patient's clinical profile (25). It is also important to highlight that the Beers criteria 2015 define the renal threshold for medications based on creatinine clearance and therefore some of the criteria in the Beers list rely on measures of weight. However, the estimated Glomerular Filtration Rate (eGFR) is used in the STOPP criteria v2. In the present study, we identified the poor recording of patients' weight where only 43.2% of the study participants had their weight recorded. This may be due to the difficulties in measuring the weight of bedridden patients. This could potentially lead to underreporting of Beers-PIMs in this study.

Using both the Beers criteria 2015 and STOPP criteria v2, the prevalence of PIMs was highest during hospitalisation. This is likely due to the increase in the number of medications prescribed to address acute illnesses experienced by patients during hospitalisation. We understand that although the medications may be in the PIMs list, they are not completely contraindicated in a patient in whom the medication is warranted for a certain symptom or diagnosis. However, being aware that said medications are on the PIMs list, may prompt clinicians to perform closer monitoring for ADEs. At the same time, we found that the prevalence of Beers-PIMs was significantly lower on discharge compared to during hospitalisation. This is an encouraging finding as this implies that the clinicians made efforts to review patients' ward medications prior to discharge. On the contrary, STOPP-PIMs were more prevalent on discharge compared to that of on admission. One reason for this could be the high use of tramadol during hospitalisation with which patients were discharged with. However, we did not examine how many of the PIMs at admission were resolved at the time of discharge and the number of new PIMs at discharge. Further studies are needed to look at this as it will give a better idea of the change in PIMs use among older inpatients and help in the design of targeted strategies in improving medication use and safety in this population.

Consistent with previous studies, we also found that benzodiazepines were the most common PIM detected according to the Beers criteria 2015 and STOPP criteria v2. A possible cause for this observation is that many older individuals were diagnosed with depression, insomnia or dementia as they age and psychoactive drugs were prescribed to address these conditions (10, 13, 16). However, benzodiazepines are associated with increased risk of falls, fractures, psychological and physical dependency among older patients and therefore should be avoided (26). In addition, several patients were also prescribed with neuroleptics to manage dementia or delirium in this study. Long term use of neuroleptics has been correlated with several adverse effects including sedation, increased stroke risk, gait instability and cognitive impairment (27). Both Beers criteria 2015 and

STOPP criteria v2 recommend that clinicians should try non-pharmacological treatments first instead of initiating antipsychotics in this group of patients. In this study, we assumed that all patients have not tried the behavioural intervention before being prescribed with neuroleptics as it was not documented in the medical records. This may have overestimated the rate of PIMs in our study. Next, although aspirin or clopidogrel is recommended as the first line agent for patients with vascular diseases (28), ticlopidine is still widely used in Malaysia (29). Despite its life-threatening potential hematological side effects such as thrombocytopenia, aplastic anemia and neutropenia (28), it is a cheaper option compared to clopidogrel (30).

Loop and thiazide diuretics were the most common Beers-PIMs identified on admission. Diuretics were also ranked as the second most prevalent PIM group during hospitalisation and on discharge. However, diuretics were always prescribed for valid reasons such as heart failure, fluid overload and hypertension in this study. Hence, diuretics were in fact appropriate in most of the cases. Diuretics were listed as drugs to be used with caution in the Beers criteria 2015 with the reason that they may exacerbate or cause syndrome of inappropriate antidiuretic hormone secretion (SIADH) or hyponatraemia. Therefore, it is recommended that the sodium level is monitored closely when starting or changing doses. This implies that criteria listed in these screening tools should not be used to totally replace clinical judgment but used as a guide taking patient's medical needs into consideration. Meanwhile, tramadol was the most prevalent PIM during hospitalisation and the second most frequent STOPP-PIM identified on admission and on discharge. Tramadol is considered as a strong opioid according to STOPP criteria v2 but it is classified as weak opioid according to the Ministry of Health Malaysia (29). Tramadol is the most common opioid prescribed in the Malaysian public hospitals, which is responsible for 92% of total weak opioid prescription in the country (29). The main reason for this is it is not regulated by the Dangerous Drugs Act (DDA), thereby allowing easy access to clinicians (29). However, based on STOPP criteria v2, WHO analgesic ladder monitoring is required for patients prescribed with tramadol. Unfortunately, a majority of the study participants on tramadol did not have their pain score recorded and this was therefore reported as a PIM in this study.

The possible use of proton pump inhibitors (PPIs) at full therapeutic dosage for more than eight weeks was one of the most common PIMs detected in this study by both Beers criteria 2015 and STOPP criteria v2. This is consistent with other studies, which reported PPIs as the most prevalent PIM (14). A study from Lebanon also reported that 40-80% of prescriptions for PPIs were inappropriate (31). Two of the most prevalent drugs prescribed in Australia in 2009 to 2010 were pantoprazole and esomeprazole (32). Similarly, the utilisation of PPIs in Malaysia has increased from 2011 to 2014 (29). The use of PPIs in older persons is considered as inappropriate as it is associated with increased risk of osteoporosis, Vitamin B12 deficiency and Clostridium difficile-associated diarrhoea when used long term (26). Hence, the recommendation is to stop the PPIs after eight weeks or to reduce the dose unless long term acid suppression therapy is indicated such as in patients with complicated erosive peptic oesophagitis and peptic ulcer disease. However, the prevalence of PPIs as a PIM can either be underestimated or overestimated. For example, one study assumed that all PPIs were prescribed to patients for more than eight weeks (33), while another Australian study did not take medications with duration criteria including PPIs into consideration (34).

In this study, an assumption was made that all PPIs prescribed to patients prior to admission were used for more than eight weeks when the duration of use was not recorded in the medical records. This could have led to an over-estimation of PPI use as a PIM on admission. However, we were able to determine the duration of prescription for the PPIs commenced in hospital or upon discharge so the possible overestimation of PPIs as PIMs was only for the prescriptions commenced prior to admission. We felt that it would have been better to overestimate the prevalence of PPIs as a PIM, rather than leaving them out completely leading to underestimation of PIMs and a missed opportunity to raise awareness. This strategy had also been adopted in another study as mentioned above (33). Other studies have shown that 52% of persons newly commenced on PPIs may have been prescribed inappropriately without documentation of approved indications (35), and up to 67% of persons on PPI fulfilled the criteria of overuse (36). These are indications of the potential heavy clinical and financial impact of inappropriate and overuse on patients and healthcare systems.

Similar to previous studies, we also found that the number of medications and number of co-morbidities were significantly associated with STOPP-PIMs (during hospitalisation) and Beers-PIMs (on discharge) (8, 15, 16, 27, 37). Age was not a risk factor for the occurrence of PIMs for both the Beers and STOPP criteria in our study compared to reports from other studies (15, 16). This could be due to the relatively smaller sample size of this study and the higher median age of our study participants.

Although this was a single centre study conducted at an urban tertiary centre which may not reflect the general practice at large, it is still a good reflection of the prevalence of PIMs among hospitalised older persons in Malaysia. The findings from this study should increase awareness among health care professionals of the high prevalence of PIMs in hospitalised older patients in Malaysia. This can prompt clinicians to

actively review the patients' medications to avoid and deprescribe PIMs where possible ideally with the help of a clinical pharmacist (38). Where it is not possible to avoid or deprescribe, be prompted to closely monitor for potential ADEs. A systematic review had found that deprescribing in older hospitalised patients was feasible, safe and generally effective in reducing PIMs. However, the clinical benefits achieved did not appear to reach statistical significance (39). Further work is required to determine the clinical, social and economic consequences of PIMs in older Malaysians.

CONCLUSION

The prevalence of PIMs among hospitalised older persons in Malaysia is high according to the Beers criteria 2015 and STOPP criteria v2. The choice to implement either criteria will rely on individuals' and institutions' preference and available resources. PIMs as identified through the Beers or STOPP criteria has shown to be an effective method to alert clinicians to improve their prescribing practices especially in medications such as benzodiazepines, neuroleptics, ticlopidine, diuretics, tramadol and PPIs in the older persons.

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REFERENCES

1. Junius-Walker U, Theile G, Hummers-Pradier E. Prevalence and predictors of polypharmacy among older primary care patients in Germany. Family practice. 2007;24(1):14-9. doi: 10.1093/fampra/cml067
2. Marengoni A, Winblad B, Karp A, Fratiglioni L. Prevalence of chronic diseases and multimorbidity among the elderly population in Sweden. American journal of public health. 2008;98(7):1198-200. doi: 10.2105/AJPH.2007.121137
3. Oscanoa TJ, Lizaraso F, Carvajal A. Hospital admissions due to adverse drug reactions in the elderly. A meta-analysis. European journal of clinical pharmacology. 2017;73(6):759-70. doi: 10.1007/s00228-017-2225-3.
4. Federwisch M, Ramos H, Adams SC. The sterile cockpit: an effective approach to reducing medication errors? The American journal of nursing. 2014;114(2):47-55. doi: 10.1097/01.NAJ.0000443777.80999.5c.
5. Karuppannan M. Adverse drug events in Malaysia: medication-related admissions and pharmacists' experiences. 2012.
6. Beers MH, Ouslander JG, Rollingher I, Reuben DB, Brooks J, Beck JC. Explicit criteria for determining inappropriate medication use in nursing home residents. UCLA Division of Geriatric Medicine. Archives of internal medicine. 1991;151(9):1825-32. doi:10.1001/archinte.1991.00400090107019
7. American Geriatrics Society updated Beers Criteria for potentially inappropriate medication use in older adults. Journal of the American Geriatrics Society. 2012;60(4):616-31. doi: 10.1111/j.1532-5415.2012.03923.x.
8. American Geriatrics Society 2015 Updated Beers Criteria for Potentially Inappropriate Medication Use in Older Adults. Journal of the American Geriatrics Society. 2015;63(11):2227-46. doi: 10.1111/jgs.13702
9. O'Mahony D, O'Sullivan D, Byrne S, O'Connor MN, Ryan C, Gallagher P. STOPP/START criteria for potentially inappropriate prescribing in older people: version 2. Age and ageing. 2015;44(2):213-8. doi: 10.1093/ageing/afu145.
10. Hamilton H, Gallagher P, Ryan C, Byrne S, O'Mahony D. Potentially inappropriate medications defined by STOPP criteria and the risk of adverse drug events in older hospitalized patients. Archives of internal medicine. 2011;171(11):1013-9. doi: 10.1001/archinternmed.2011.215.
11. O'Mahony D, Gallagher PF. Inappropriate prescribing in the older population: need for new criteria. Age and ageing. 2008;37(2):138-41. doi: 10.1093/ageing/afm189
12. Al Aqqad SM, Chen LL, Shafie AA, Hassali MA, Tangiisuran B. The use of potentially inappropriate medications and changes in quality of life among older nursing home residents. Clinical interventions in aging. 2014;9:201-7. doi: 10.2147/CIA.S52356
13. Blanco-Reina E, Garcia-Merino MR, Ocana-Riola R, Aguilar-Cano L, Valdellos J, Bellido-Estevez I, et al. Assessing Potentially Inappropriate Prescribing in Community-Dwelling Older Patients Using the Updated Version of STOPP-START Criteria: A Comparison of Profiles and Prevalences with Respect to the Original Version. PloS one. 2016;11(12):e0167586. doi: 10.1371/journal.pone.0167586.
14. Ni Chroinin D, Neto HM, Xiao D, Sandhu A, Brazel C, Farnham N, et al. Potentially inappropriate medications (PIMs) in older hospital in-patients: Prevalence, contribution to hospital admission and documentation of rationale for continuation. Australasian journal on ageing. 2016;35(4):262-5. doi: 10.1111/ajag.12312
15. Price SD, Holman CD, Sanfilippo FM, Emery JD. Are older Western Australians exposed to potentially inappropriate medications according to the Beers Criteria? A 13-year prevalence study. Australasian journal on ageing. 2014;33(3):E39-48. doi: 10.1111/ajag.12136.
16. Lim YJ, Kim HY, Choi J, Lee JS, Ahn AL, Oh EJ, et al. Potentially Inappropriate Medications by Beers Criteria in Older Outpatients: Prevalence and Risk Factors. Korean journal of family medicine. 2016;37(6):329-33. doi: 10.4082/kjfm.2016.37.6.329
17. Hasan SS, Burud IAS, Kow CS, Rasheed MK, Chan KSC, Tay PK, et al. Use of potentially inappropriate

medications among older outpatients and inpatients in a tertiary care hospital in Malaysia. International Journal of Clinical Practice. 2021;75(3):e13714. doi: 10.1111/ijcp.13714.
18. Cockcroft DW, Gault MH. Prediction of creatinine clearance from serum creatinine. Nephron. 1976;16(1):31-41. doi: 10.1159/000180580.
19. Liew NY, Chong YY, Yeow SH, Kua KP, Saw PS, Lee SWH. Prevalence of potentially inappropriate medications among geriatric residents in nursing care homes in Malaysia: a cross-sectional study. International journal of clinical pharmacy. 2019;41(4):895-902. doi: 10.1007/s11096-019-00843-1.
20. Hasan SS, Kow CS, Verma RK, Ahmed SI, Mittal P, Chong DWK. An evaluation of medication appropriateness and frailty among residents of aged care homes in Malaysia: A cross-sectional study. Medicine. 2017;96(35):e7929. doi: 10.1097/MD.0000000000007929
21. Chen LL, Tangiisuran B, Shafie AA, Hassali MA. Evaluation of potentially inappropriate medications among older residents of Malaysian nursing homes. International journal of clinical pharmacy. 2012;34(4):596-603. doi: 10.1007/s11096-012-9651-1.
22. Muhammad Eid Akkawi, Mohamad Haniki NM. Influence of hospitalization on potentially inappropriate prescribing among elderly patients in a Malaysian community Tropical Journal of Pharmaceutical Research 2018;17(1):151-60. doi:10.4314/tjpr.v17i1.21
23. Akkawi ME, Nik Mohamed MH. Are physicians and clinical pharmacists aware and knowledgeable enough about inappropriate prescribing for elderly patients? Findings from Malaysia. European journal of hospital pharmacy : science and practice. 2018;25(e1):e29-e34. doi: 10.1136/ejhpharm-2017-001391.
24. Oliveira MG, Amorim WW, de Jesus SR, Heine JM, Coqueiro HL, Passos LC. A comparison of the Beers and STOPP criteria for identifying the use of potentially inappropriate medications among elderly patients in primary care. Journal of evaluation in clinical practice. 2015;21(2):320-5. doi: 10.1111/jep.12319.
25. Vezmar Kovacevic S, Simisic M, Stojkov Rudinski S, Culafic M, Vucicevic K, Prostran M, et al. Potentially inappropriate prescribing in older primary care patients. PloS one. 2014;9(4):e95536. doi: 10.1371/journal.pone.0095536
26. Zhang X, Zhou S, Pan K, Li X, Zhao X, Zhou Y, et al. Potentially inappropriate medications in hospitalized older patients: a cross-sectional study using the Beers 2015 criteria versus the 2012 criteria. Clinical interventions in aging. 2017;12:1697-703. doi: 10.2147/CIA.S146009
27. Burke AD, Tariot PN. Atypical antipsychotics in the elderly: a review of therapeutic trends and clinical outcomes. Expert opinion on pharmacotherapy. 2009;10(15):2407-14. doi: 10.1517/14656560903200659.
28. Tran H, Anand SS. Oral antiplatelet therapy in cerebrovascular disease, coronary artery disease, and peripheral arterial disease. Jama. 2004;292(15):1867-74. doi: 10.1001/jama.292.15.1867.
29. Pharmaceutical Services Division, Ministry of Health Malaysia. Malaysian Statistics on Medicine 2011-2014. Kuala Lumpur 2017.
30. Pharmaceutical Services Division, Ministry of Health Malaysia. Consumer Price Guide [Available from: https://www.pharmacy.gov.my/v2/en/apps/drug-price.
31. Nawas GT, Nawas T, Malaeb D, Helou SE, Hallit S. Assessing the Appropriate Use of Proton Pump Inhibitors amongst the Outpatient Lebanese Population. Int J Curr Microbiol App Sci 2016;5(10):767-77. doi:10.20546/ijcmas.2016.510.083
32. Wahab MS, Nyfort-Hansen K, Kowalski SR. Inappropriate prescribing in hospitalised Australian elderly as determined by the STOPP criteria. International journal of clinical pharmacy. 2012;34(6):855-62. doi: 10.1007/s11096-012-9681-8.
33. Komagamine J. Prevalence of potentially inappropriate medications at admission and discharge among hospitalised elderly patients with acute medical illness at a single centre in Japan: a retrospective cross-sectional study. BMJ open. 2018;8(7):e021152. doi: 10.1136/bmjopen-2017-021152.
34. Roughead EE, Anderson B, Gilbert AL. Potentially inappropriate prescribing among Australian veterans and war widows/widowers. Internal medicine journal. 2007;37(6):402-5. doi: 10.1111/j.1445-5994.2007.01316.x.
35. Rьckert-Eheberg I-M, Nolde M, Ahn N, Tauscher M, Gerlach R, Gьntner F, et al. Who gets prescriptions for proton pump inhibitors and why? A drug-utilization study with claims data in Bavaria, Germany, 2010–2018. European journal of clinical pharmacology. 2021. doi: 10.1007/s00228-021-03257-z.
36. Metaxas ES, Bain KT. Review of Proton Pump Inhibitor Overuse in the US Veteran Population. J Pharm Technol. 2015;31(4):167-76. doi: 10.1177/8755122515575177.
37. Davidoff AJ, Miller GE, Sarpong EM, Yang E, Brandt N, Fick DM. Prevalence of potentially inappropriate medication use in older adults using the 2012 Beers criteria. Journal of the American Geriatrics Society. 2015;63(3):486-500. doi: 10.1111/jgs.13320.
38. Graabaek T, Kjeldsen LJ. Medication reviews by clinical pharmacists at hospitals lead to improved patient outcomes: a systematic review. Basic & clinical pharmacology & toxicology. 2013;112(6):359-73. doi: 10.1111/bcpt.12062.
39. Thillainadesan J, Gnjidic D, Green S, Hilmer SN. Impact of Deprescribing Interventions in Older Hospitalised Patients on Prescribing and Clinical Outcomes: A Systematic Review of Randomised Trials. Drugs & aging. 2018;35(4):303-19. doi: 10.1007/s40266-018-0536-4.