

Original Article

Potentially Inappropriate Medication Use Among Hospitalized Geriatric Patients: A Cross-Sectional Study in a Tertiary Care Hospital in Lebanon

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ABSTRACT

Background/Purpose: Potentially inappropriate medications (PIM) can lead to significant risks of adverse health outcomes and increased hospitalization risks. Geriatric patients are more prone to PIM due to polypharmacy and comorbidities. This study aims to assess PIM use among hospitalized geriatric patients and to identify the predictors of PIM in hospitals.

Methods: A cross-sectional study was performed in Lebanon over four months, targeting 268 geriatric patients admitted to the hospital's internal medicine department. Two clinical pharmacists used a uniform data collection sheet from patients' medical charts. PIM was assessed according to the updated Beers criteria of 2019.

Results: The sample was equally distributed between men (51.9%) and women (48.1%). A higher proportion of patients were between 75 and 84 years (49.3%), and most participants had two comorbidities. Medication overuse was reported among 69.4% of patients primarily due to insufficient proof of effectiveness and valid indication. Misuse and underuse of medication were found among 65.7% and 85.1% of patients, respectively, and were related to PIM, drug interactions, and the lack of effective treatment. Patients staying in the hospital for more than 8 days had 3.18 times higher odds of medication misuse than patients with a lower hospital stay. Those with mild or moderate renal functions had 70% and 67% lower odds of medication misuse than those with normal functions. Among others, antibiotics, antiplatelet drugs, and antidepressant prescriptions were associated with PIM.

Conclusion: A high prevalence of PIM use was found among geriatric patients, highlighting the importance of drug reassessment and management.

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1. INTRODUCTION

Aging is associated with an increase in the number of comorbidities and polypharmacy.¹ Older patients

are more susceptible to being hospitalized due to complications of multiple chronic conditions, leading to a substantial increase in health expenditures.² Potentially inappropriate medications (PIM) are

drugs that lead to significant risks of adverse health outcomes, such as emergency department visits, rehospitalization, and death³, in addition to higher odds of hospitalization.⁴ Explicit criteria were developed to facilitate the assessment of these drugs, but variations in the application of the different tools induced variations in findings among studies.⁵ Among others, the updated Beers criteria were endorsed by researchers worldwide and helped healthcare providers in treatment assessment.⁶ PIM use is common among geriatrics, particularly in hospital settings⁷, which can adversely affect hospital outcomes and extend hospital stays.⁸

Several sub-optimal prescription methods have been described among the elderly: excessive treatment "overuse", inappropriate prescription "misuse" and insufficient treatment "underuse".⁹ Incorrect dosage administration, therapeutic duplication, and underuse of drugs are the most commonly reported errors.¹⁰ The inappropriate drug may be justified by different factors, for example, the choice of prescribed medications is based on doctors' knowledge of drugs, and therefore geriatrics are vulnerable to an increased potential for harm due to multiple doctors' assessments.¹¹ Limitations in medication options are more frequent among the elderly, namely due to drug interactions, lack of evidence of effectiveness, and physiological changes that may affect the pharmacokinetics and pharmacodynamics of drugs.^{12,13}

To control duplicated treatments, the ministry of public health of Lebanon implemented the unified medical prescription policy in which doctors have to provide the pharmacological agent instead of the drugs' marketed names.¹⁴ This policy reduced inappropriate drug dispensing in community pharmacies but had limited impact in hospital settings.¹⁵ Understanding PIM use among geriatrics is crucial to optimize hospital management, reduce iatrogenic risk, and avoid unnecessary prescriptions.¹⁶ In Lebanon, many doctors can prescribe drugs to patients in the hospital¹⁷, which increases the risk of treatment duplication and as a result, affect patients' health. Life expectancy in Lebanon is high (81.2 years for women and 77.5 for men).¹⁸ Nevertheless, the health-related quality of life of geriatric patients can be improved with good hospital management. This study aims to assess PIM use among hospitalized geriatric patients and to explore the predictors of medication overuse, misuse, and underuse in hospitals.

2. METHODS

2.1. Study Design

An observational cross-sectional study was performed over four months (beginning of September- end of

December 2021) targeting geriatric patients admitted to the internal medicine floor or the intensive care unit of the hospital.

2.2. Study Sample and Sample Size

Patients aged 65 years or older arriving at the internal medicine department were asked to participate in the study irrespective of race, ethnicity, and reasons for hospitalization. Epi-info was used to calculate the required sample size, using the following equation:

$$n = \frac{(Z_{1-\alpha/2})^2 p(1-p)}{d^2}$$

where Z is a standard normal variate ($Z_{1-\alpha/2}=1.96$ at 95% confidence interval), d is the absolute accuracy or precision (5% margin of error), P is the expected proportion of the population with a specific outcome and was set at 0.55 (based on a multi-center study published in 2019¹⁹ with a design effect of 0.7). This yielded a required sample size of 267 patients.

2.3. Data Collection

Data were collected prospectively by two clinical pharmacy students using a uniform data collection sheet that was developed following a literature review, taking into account two experts' opinions. They approached geriatric patients from Monday to Thursday during their internship in the hospital (8 am-5 pm). Patients were interviewed for an average of 7 minutes per patient to fill out their personal information. Medication used and follow-up on patients' status was retrieved from their medical charts and updated during their stay.

2.4. General Characteristics of the Patients

These data included the sex, age, height, weight, and marital status of the patients (married or Single/widowed). Age was then categorized (65-74, 75-84, ≥ 85), and the Body Mass Index (BMI) was calculated by dividing the weight (kilograms) by the square of height (meters) and then categorized as recommended.²⁰ This section also recorded patients' level of education (illiterate, primary school, and secondary school or more), their source of income (no income and employed or benefited from retirement funds), and if they had medical insurance. Hospital stay accounted for the time between admission to the floor (excluding the emergency department admission) and the discharge time with a minimum hospital stay of 1.3 days and a maximum of 13.2 days. The reasons for hospitalization were collected and were: respiratory, cardiovascular disease (coronary heart disease, cerebrovascular disease, peripheral arterial disease, deep vein thrombosis and pulmonary embolism), renal failure, central nervous system disease, gastrointestinal, diabetic foot, or other reasons.

2.5. Medical History of the Patients and Medication Used in the Hospital

The number (None, one, two, and more than two) and types of comorbidities (hypertension, diabetes, cardiovascular disease, prostatic hypertrophy in men, dyslipidemia, chronic kidney disease, chronic obstructive pulmonary disease (COPD), anemia, osteoporosis, and asthma) were collected in this part (multiple answers were allowed). The names of the medication used in the hospital were recorded and then classified by the clinical pharmacists (See Table 2). Creatinine clearance (CrCl) was registered and used to generate the renal function of patients: normal (CrCl >90ml/min), mild (CrCl=60-90ml/min), moderate (CrCl=30-60ml/min), and severe (CrCl=15-30ml/min).

2.6. Potentially Inappropriate Medication Use Assessment

The updated Beers criteria of 2019 were used to assess the PIM use among geriatrics⁶, which graded the strength and quality of each PIM statement based on the level of evidence and strength of recommendation. These criteria reported the list of medications to be avoided by older adults in most circumstances or under specific situations, such as in certain diseases or conditions, by providing the rationale of the assessment, recommendations, and scientific evidence. Considering the classification of the institute of medicine²¹, PIM use was classified as overuse, underuse, or misuse in addition to the reasons for each pattern. Underuse represents the inability to provide a health care service despite its favorable outcome for the patient. Examples of underuse include under dosage and lack of effective treatment. Overuse represents a health care service provided under circumstances of higher harm than possible benefit. Overuse comprised contraindication, duplication, overdosage, lack of a valid indication or no proof of effectiveness. Misuse occurs when an appropriate service was provided. Still, preventable complication occurs and was not provided to the patient such as drug interactions, unadjusted dose to renal function, inappropriate with caution, drug/medical condition interaction, and potentially inappropriate medication.²¹

2.7. Statistical Analysis

Statistical analyses were performed using Statistical Package for Social Sciences (SPSS Inc, Chicago, Illinois) Version 27. Categorical variables are presented through frequencies and percentages. In contrast, the BMI, the length of hospitalization, and the number of drugs used during the hospital stay are given through Means and Standard Deviations (SD). Bivariate analyses were performed taking medication overuse, misuse, and underuse as dependent variables and patients' baseline characteristics

and type of medication used in the hospital as independent variables. Binary logistic regression analyses were done exploring the odds of medication overuse, misuse, and underuse by taking the baseline answer "No" which produced Odd Ratios with a 95% Confidence Interval (CI). A p -value <0.05 was considered statistically significant.

2.8. Ethical Considerations

This study used a data collection form as a tool without invasive procedures or interventions. The protocol, survey, and consent form were reviewed and approved by the institutional review board of the faculty of pharmacy of the Lebanese university. Data were anonymous and non-identifiable since no name or personal information were provided. Each patient was given a code to allow follow-up and data analyses were conducted by a different researcher. Data were stored following the university's general data protection regulation recommendations. Written informed consent was obtained from each patient. Findings were considered for research purposes only, and no financial incentives were provided.

3. RESULTS

3.1. General Characteristics of the Patients

Overall, 276 patients were approached and 268 (97.1%) agreed to participate in the study. All patients were alive at discharge. Table 1 represents the general characteristics of the study participants. The sample was equally distributed between men (51.9%) and women (48.1%). A higher proportion of patients were between 75 and 84 years (49.3%), and only 34 patients (12.7%) were 85 years or older. The mean BMI of the patients was 27.8 (5.5), distributed as follows: 84 patients (32.9%) had a normal BMI, 99 (38.9%) were overweight, and 72 (28.2%) were obese. Around two-thirds of patients had no income, and the rest (33.2%) were either employed or benefited from retirement funds. Patients were hospitalized for an average of 6.1 (2.2) days, with most of them hospitalized for 5-8 days (55.6%). The primary reasons for hospital admission were mainly respiratory (26.5%), renal failure (19.4%), and cardiovascular (18.7%).

3.2. Medical History and Medication Used in the Hospital

Table 2 shows the medical history of the patients and the characteristics of the medication used during hospitalization. Most patients (74.3%) had more than two comorbidities. Among others, hypertension (78.4%), diabetes (50.7%), and cardiovascular diseases (40.3%) were the most common comorbidities, followed by prostatic hypertrophy (25.2% of men) and dyslipidemia (18.3%). As regards renal function assessment, 33.2% of patients had moderate renal

function, and 19% had severe renal failure. The mean number of medications used in the hospital was 10.2 (3.7), with higher use of proton pump inhibitors (84.7%), anticoagulants (68.7%), antibiotics (62.3%), and antiplatelet agents (54.9%).

3.3. Assessment of Potentially Inappropriate Medication Use Among Geriatric Patients

Two-hundred forty-seven medication overuse were found among 186 patients (69.4%), 274 medication misuse among 176 patients (65.7%), and 237 medication underuse among 228 patients (85.1%). Figure 1 illustrates the reasons for the assessment of (a) overuse, (b) misuse, and (c) underuse of medication in the hospital. Overuse assessment was related to lack of proof of effectiveness for using the medication (37.2% of the overall medication overuse), lack of a valid indication (27%), and overdosage

Table 1. Distribution of the general characteristics of the patients

		Total (N=268)
		Frequency (%)
Sex	Men	139 (51.9%)
	Women	129 (48.1%)
Age (years)	65-74	102 (38.1%)
	75-84	132 (49.3%)
	≥85	34 (12.7%)
Body Mass Index (BMI) (kg/m²) (N=255)	Mean (SD)	27.8 (5.5)
	Normal weight (18.5-24.9)	84 (32.9%)
	Overweight (≥25)	99 (38.9%)
	Obese (≥30)	72 (28.2%)
Marital status	Married	132 (49.3%)
	Single/Widowed	136 (50.7%)
Level of education	Illiterate	145 (54.1%)
	Primary school	84 (31.3%)
	Secondary school or more	39 (14.6%)
Source of income	No income	179 (66.8%)
	Employed/retirement funds	89 (33.2%)
Length of hospitalization (days)	Mean (SD)	6.1 (2.2)
	1-4	79 (29.5%)
	5-8	149 (55.6%)
	>8	40 (14.9%)
Admission floor	Internal medicine	236 (88.1%)
	Critical care unit	32 (11.9%)
Medical insurance	Yes	215 (80.2%)
Primary reason for hospitalization	Respiratory	71 (26.5%)
	Cardiovascular	50 (18.7%)
	Renal failure	52 (19.4%)
	Central nervous system disease	20 (7.5%)
	Gastro-intestinal	21 (7.8%)
	Diabetic foot	16 (6.0%)
	Other reasons	38 (14.2%)

Results are given in frequency (percentage) or Mean±Standard Deviation. BMI: Body Mass Index; SD: Standard deviation

Table 2. Medical history of the patients and medication used during hospitalization

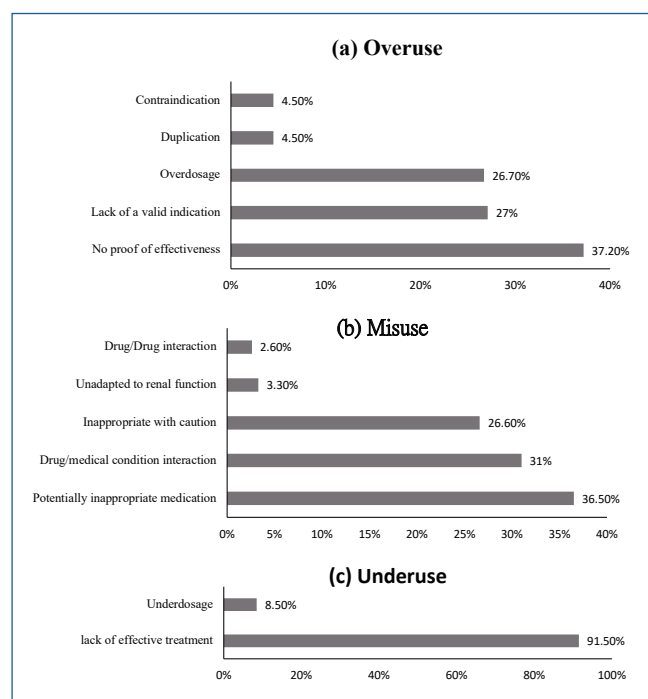
		Total (N=268)
Medical history		Frequency (%)
Comorbidities	Hypertension	210 (78.4%)
	Diabetes	136 (50.7%)
	Cardiovascular disease	108 (40.3%)
	Prostatic hypertrophy (among men)	35 (25.2%)
	Dyslipidemia	49 (18.3%)
	COPD	43 (16.0%)
	Chronic kidney disease	36 (13.4%)
	Anemia	22 (8.2%)
	Osteoporosis	16 (6.0%)
	Asthma	14 (5.2%)
	Depression	10 (3.7%)
	Hepatic cirrhosis	4 (1.5%)
Number of comorbidities	None	9 (3.4%)
	One	26 (9.7%)
	Two	34 (12.7%)
	More than two	199 (74.3%)
Renal function during hospitalization	Normal (CrCl >90ml/min)	60 (22.4%)
	Mild (CrCl=60-90ml/min)	68 (25.4%)
	Moderate (CrCl=30-60ml/min)	89 (33.2%)
	Severe (CrCl=15-30ml/min)	51 (19.0%)
Medication used during hospitalization		Frequency (%)
Number of medications	Mean (SD)	10.2 (3.7)
Type of drugs	Proton pump inhibitor	227 (84.7%)
	Anticoagulant	184 (68.7%)
	Antibiotic	167 (62.3%)
	Anti-platelet agent	147 (54.9%)
	Beta-blocker	143 (53.4%)
	Anti-hyperlipidemia	132 (49.3%)
	Anticholinergic	127 (47.4%)
	Corticosteroids	121 (45.1%)
	Insulin	121 (45.1%)
	Diuretic	112 (41.8%)
	Calcium channel blocker	76 (28.4%)
	Antalgic	61 (22.8%)
	Beta 2-adrenergic agonists	56 (20.9%)
	Aldosterone receptor antagonist	45 (16.8%)
	Oral antidiabetic	44 (16.4%)
	Antidepressant	32 (11.9%)
	Anti-arrhythmic	24 (9.0%)
	Antidepressant	20 (7.5%)
	Nitrated derivative	11 (4.1%)
	Non-steroidal anti-inflammatory drug	9 (3.4%)

Results are given in frequency (percentage) or Mean±Standard Deviation. COPD: Chronic Pulmonary Obstructive Disease; CrCl: Creatinine Clearance; SD: Standard Deviation

(26.7%). Misuse was primarily due to potentially inappropriate prescriptions for geriatric patients (36.5% of the overall medication misuse), interactions between drugs and medical conditions (31%), and the classification as inappropriate use with caution (26.6%). Underuse mainly was related to the lack of an effective treatment (91.5%), and only 8.5% of the overall underuse was related to underdosage.

The bivariate analyses showing the association between medication overuse, misuse, and underuse are presented in Table 3. No significant differences were noted with sex and age groups. Patients with secondary school or more (82.1%) had significantly higher medication misuse compared to illiterate (60.0%) or those with primary school (67.9%) ($p=0.032$). The more extended the hospital stay, the higher the association with medication misuse ($p=0.026$). Having two comorbidities was associated with a higher risk of overuse and misuse ($p < 0.001$). Medication overuse was significantly higher among geriatric patients with mild (82.4%) and normal renal functions (71.7%) ($p < 0.001$). In contrast, medication misuse was higher only among those with normal renal function (81.7%; $p < 0.001$). As regards the type of drugs, medication overuse was higher among patients using proton pump inhibitors (73.1%; $p=0.002$), antibiotics (73.7%; $p=0.050$), antiplatelet agents (76.2%; $p=0.008$) and anti-hyperlipidemia drugs (77.3%; $p=0.006$). Medication misuse was higher among patients using antibiotics (70.1%; $p=0.050$), anticholinergic drugs (74%; $p=0.006$), corticosteroids (72.7%; $p=0.027$), insulin (72.7%; $p=0.027$) and antidepressants (93.8%; $p < 0.001$).

Figure 1. Reasons for the assessment of (a) overuse, (b) misuse, and (c) underuse of medication among geriatric hospitalized patients



Medication underuse was higher among patients using insulin (90.1%; $p=0.037$) and oral antidiabetic drugs (93.5%; $p=0.035$). Nevertheless, it was significantly lower among users of proton pump inhibitors (83.3%; $p=0.050$), anticoagulants (82.1%; $p=0.041$) and aldosterone receptor antagonists (68.9%; $p < 0.001$).

3.4. Predictors of Medication Overuse, Misuse, and Underuse Among Geriatric Patients

Table 4 presents the predictors of medication overuse, misuse, and underuse among the study participants. The odds of medication overuse were 2.86 times higher among proton pump inhibitor drug users compared to other patients (OR 2.86, CI 1.45-5.63; $p=0.002$). These odds were also higher among geriatric patients using antibiotics (OR 1.69, CI 1.01-2.86; $p=0.050$), antiplatelet agents (OR 2.03, CI 1.20-3.44; $p=0.008$), and anti-hyperlipidemia drugs (OR 2.11, CI 1.23-3.59; $p=0.006$) during their hospitalization compared to non-users. The odds of medication misuse were 3.05 times higher among patients with secondary school education or more compared to illiterate (OR 3.05, CI 1.26-7.37; $p=0.013$). Moreover, those staying in the hospital for more than 8 days had significantly higher odds of medication misuse than patients with lower stay (OR 3.18, CI 1.30-7.77; $p=0.011$). Patients with mild (OR 0.30, CI 0.13-0.68; $p=0.004$) or moderate (OR 0.33, CI 0.15-0.72; $p=0.005$) renal functions had significantly lower odds of medication misuse than those with normal function. Nonetheless, these odds were higher among the users of antibiotics, anticholinergics, corticosteroids, insulin, and antidepressants than non-users ($p < 0.05$). The odds of medication underuse were 58% and 71% lower among patients using anticoagulants (OR 0.42, CI 0.18-0.98; $p=0.046$) and aldosterone receptor antagonists (OR 0.29, CI 0.14-0.62; $p=0.001$) respectively. However, medication underuse odds were higher among patients using insulin (OR 2.14, CI 1.04-4.41; $p=0.040$) and oral antidiabetic drugs (OR 4.29, CI 1.00-18.4; $p=0.050$).

4. DISCUSSION

The present study assessed medication overuse, misuse, and underuse among a sample of 268 hospitalized geriatric patients and provided the predictors of this PIM use. Medication overuse was reported among 69.4% of patients primarily due to the lack of proof of effectiveness and lack of valid indication. Misuse and underuse of medication were found among 65.7% and 85.1% of patients respectively and were related to PIM, drug interactions, and the lack of effective treatment. The use of certain drugs was associated with overuse or underuse of medication while the level of education and patients' renal function were also influencing the odds of medication misuse.

Table 3. Association between overuse, misuse and underuse with the characteristics of the patients and type of drugs used

	Overuse		Misuse		Underuse	
	Frequency (%)	p-value	Frequency (%)	p-value	Frequency (%)	p-value
Sex						
Men	96 (69.1%)	0.901	92 (66.2%)	0.854	119 (85.6%)	0.798
Women	90 (69.8%)		84 (65.1%)		109 (84.5%)	
Age (years)						
65-74	65 (63.7%)	0.285	63 (61.8%)	0.432	88 (86.3%)	0.852
75-84	96 (72.7%)		88 (66.7%)		112 (84.8%)	
≥85	25 (73.5%)		25 (73.5%)		28 (82.4%)	
Level of education						
Illiterate	98 (67.6%)	0.782	87 (60.0%)	0.032	121 (83.4%)	0.634
Primary school	60 (71.4%)		57 (67.9%)		74 (88.1%)	
Secondary school or more	28 (71.8%)		32 (82.1%)		33 (84.6%)	
Length of hospitalization (days)						
1-4	56 (70.9%)	0.800	44 (55.7%)	0.026	64 (81.0%)	0.125
5-8	101 (67.8%)		100 (67.1%)		126 (84.6%)	
>8	29 (72.5%)		32 (80.0%)		38 (95.0%)	
Number of comorbidities						
None	7 (77.8%)	<0.001	2 (22.2%)	<0.001	7 (77.8%)	0.754
One	18 (69.2%)		11 (42.3%)		20 (76.9%)	
Two	32 (93.3%)		27 (79.4%)		26 (76.5%)	
More than two	127 (63.8%)		129 (64.8%)		167 (83.9%)	
Renal function during hospitalization						
Normal (CrCl > 90ml/min)	43 (71.7%)	0.029	49 (81.7%)	0.014	50 (83.3%)	0.244
Mild (CrCl=60-90ml/min)	56 (82.4%)		39 (57.4%)		57 (83.8%)	
Moderate (CrCl=30-60ml/min)	55 (61.8%)		53 (59.6%)		73 (82.0%)	
Severe (CrCl=15-30ml/min)	32 (62.7%)		35 (68.6%)		48 (94.1%)	
Type of drugs						
Proton pump inhibitor	Yes	0.002	147 (64.8%)	0.458	189 (83.3%)	0.050
	No					
Anticoagulant	Yes	0.932	126 (68.5%)	0.152	151 (82.1%)	0.041
	No					
Antibiotic	Yes	0.050	117 (70.1%)	0.050	140 (83.8%)	0.463
	No					
Anti-platelet agent	Yes	0.008	104 (70.7%)	0.054	122 (83.0%)	0.292
	No					
Anti-hyperlipidemia	Yes	0.006	94 (71.2%)	0.060	109 (82.6%)	0.258
	No					
Anticholinergic	Yes	0.762	94 (74.0%)	0.006	107 (84.3%)	0.720
	No					
Corticosteroids	Yes	0.063	88 (72.7%)	0.027	102 (84.3%)	0.746
	No					
Insulin	Yes	0.428	88 (72.7%)	0.027	109 (90.1%)	0.037
	No					
Aldosterone receptor antagonist	Yes	0.935	27 (60.0%)	0.380	31 (68.9%)	<0.001
	No					
Oral antidiabetic	Yes	0.364	29 (65.9%)	0.971	42 (95.5%)	0.035
	No					
Antidepressant	Yes	0.121	30 (93.8%)	<0.001	26 (81.3%)	0.518
	No					

Results are given in frequency (percentage) or Mean ± Standard Deviation.
CrCl: Creatinine Clearance.

PIM use among geriatric patients was prevalent in this study. Previous research in hospitals also reported this finding with lower percentages of medication overuse, misuse, and underuse.²²⁻²⁴ The availability of clinical pharmacy services in Lebanon is still limited²⁵, which might have increased the odds of PIM use. Medication overuse was reported despite the lack of evidence of effectiveness or valid indication. A recent review found an overprescription of drugs in low and middle-income countries like Lebanon²⁶, possibly related to patients' fear of deprescribing unnecessary medication.²⁷ Medication misuse was higher among those staying for more than 8 days in the hospital, possibly due to the use of personalized treatments by doctors if they found traditional ones ineffective during the first days of hospitalization. Geriatric patients with normal renal function had higher risks of inappropriate drug use than other patients. This finding is in contrast with that of the literature.²⁸ Nevertheless, since those with abnormal renal function required more control in terms of drug assessment and dose adjustment²⁹, the corresponding risks were lower than patients with

normal renal function. Those with two comorbidities had a significantly higher risk for PIM use, namely medication overuse and misuse. Polypharmacy associated with the increase in comorbidities could explain this result, found to be adversely affecting hospital admission and the risk of falls among geriatric patients³⁰. The odds of PIM use were affected by the use of certain types of drugs. Geriatric patients using proton pump inhibitors had higher odds of medication overuse. The irrational use of these drugs was reported previously outside clinical recommendations without considering their consequences and cost-effectiveness.³¹ PIM use was higher among patients using antibiotics. The excessive use of self-prescribed antibiotics could have induced this result, knowing the risk of multi-drug resistant infections that can lead to overusing or misusing them.³² Significantly higher odds of medication misuse were noted among patients taking corticosteroids, possibly correlated with the high risk of adverse events and drug-medical condition interactions.³³ Insulin use was associated with higher odds of medication misuse or underuse. Underdosage

Table 4. Predictors of medication overuse, misuse, and underuse among geriatric patients

	Overuse		Misuse		Underuse	
	OR [95% CI]	p-value	OR [95% CI]	p-value	OR [95% CI]	p-value
Level of education						
Illiterate			1			
Primary school			1.41 [0.80-2.48]	0.236		
Secondary school or more			3.05 [1.26-7.37]	0.013		
Length of hospitalization (days)						
1-4			1			
5-8			1.62 [0.93-2.84]	0.090		
>8			3.18 [1.30-7.77]	0.011		
Renal function during hospitalization						
Normal (CrCl >90ml/min)		1	1			
Mild (CrCl=60-90ml/min)	1.85 [0.79-4.27]	0.153	0.30 [0.13-0.68]	0.004		
Moderate (CrCl=30-60ml/min)	0.64 [0.32-1.29]	0.214	0.33 [0.15-0.72]	0.005		
Severe (CrCl=15-30ml/min)	0.67 [0.30-1.48]	0.318	0.49 [0.20-1.18]	0.114		
Drugs used (Non-users as a reference)						
Proton pump inhibitor	Yes	2.86 [1.45-5.63]			0.26 [0.06-1.10]	0.067
Anticoagulant	Yes				0.42 [0.18-0.98]	0.046
Antibiotic	Yes	1.69 [1.01-2.86]	1.66 [1.00-2.79]	0.050		
Anti-platelet agent	Yes	2.03 [1.20-3.44]				
Anti-hyperlipidemia	Yes	2.11 [1.23-3.59]				
Anticholinergic	Yes		2.05 [1.22-3.44]	0.006		
Corticosteroids	Yes		1.78 [1.07-3.00]	0.028		
Insulin	Yes		1.78 [1.07-3.00]	0.028	2.14 [1.04-4.41]	0.040
Aldosterone receptor antagonist	Yes				0.29 [0.14-0.62]	0.001
Oral antidiabetic	Yes				4.29 [1.00-18.4]	0.050
Antidepressant	Yes		9.25 [2.16-19.6]	0.003		

* Medication overuse, misuse and underuse with baseline answer "no" **OR: Odds Ratio; CI: Confidence interval; CrCl: Creatinine Clearance.

of insulin in hospital settings could be explained by the high risk of hypoglycemia, its complications among geriatrics, and the use of some drugs, such as beta blockers, that can affect its management.^{34,35} Anticoagulant users had lower odds of medication underuse, in agreement with the findings of a cross-sectional study published in 2019 showing that only 8.3% of medication errors were related to the use of anticoagulants.³⁶ Findings of this study emphasize the importance of training clinicians and other healthcare providers to avoid prescribing PIMs for older adults whenever feasible. The continuing education programs should include PIM use and its consequences in the study curriculum.³⁷ Practical implications include the need for incorporating clinical pharmacists in treatment decisions and management to reduce the risk of medication overuse, misuse, and underuse in hospitals.

This study has limitations. Data were collected from medical charts, which may need to contain more information, such as drugs given without being registered and self-medication of patients. It only included patients from one hospital, which can limit the extrapolation of the findings to other settings. However, the study also has strengths. Using a uniform data collection form by trained pharmacists minimized the selection bias. Furthermore, a different researcher performed data coding and analysis. Findings from this study provide additional information on inappropriate medication use in hospitals, which can allow better inpatient management of this sensitive group.

5. CONCLUSION

This study found a high prevalence of PIM use. The main reasons for this assessment were the lack of proof of effectiveness or a valid indication, drug interactions, and the lack of effective treatment. The predictors of medication overuse and underuse were related to the administration of certain drugs such as proton pump inhibitors, anticoagulants, antibiotics, and oral antidiabetic agents, while they also included the level of education and patients' renal function when assessing medication misuse. Findings from this study highlight the need for incorporating clinical pharmacists in treatment decisions and management to reduce the risk of PIM use.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study protocol, questionnaire, and consent form were reviewed and approved by the institutional review board of the faculty of pharmacy of the Lebanese university.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

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AUTHORS' CONTRIBUTIONS

GH: Conceptualization, formal analysis, Validation, and Writing-original draft;
 ZS: Data curation, methodology, and writing-original draft;
 DK: Methodology, project administration, writing-original draft;
 SA and SR: Conceptualization, Methodology, and Writing-original draft;
 SZ: Conceptualization, data curation, methodology, Writing-review, and editing
 All authors read and approved the final manuscript.

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