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The impact of inappropriate medication and pressure ulcer on hospital outcomes among geriatric patients with critical illnesses: A prospective cohort study

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ABSTRACT

Background: Nowadays, global aging is phenomenal and drawing attention towards novel health perspectives. Geriatric syndromes have a crucial, but under-studied influence on critical care outcomes. This study aimed to assess the impact of potentially inappropriate medication (PIM) and pressure ulcer (PU) on hospital outcomes among geriatric patients with critical illnesses.

Methods: A prospective cohort study included 203 geriatric patients with critical illnesses at Ain Shams University geriatrics hospital. The 3rd version of the screening tool of older persons' prescriptions criteria and the 4th edition of international PU guidelines were implemented to define PIM and PU, respectively. A thorough clinical assessment was carried out. Comorbidity, demographic, and laboratory profiles were gathered upon admission. The age-adjusted Charlson comorbidity index measured multimorbidity. Patients were observed for mortality as the sequel hospital outcome. Statistical analyses were executed.

Results: Mean age was 75.00 ± 7.42 years. The most prevalent PU were of the second stage (40.4%) and sacrococcygeal site (26.7%). While the most frequent PIM were anticholinergics (51.30%) and opioids (27.60%). In-hospital mortality rate was 74.9%. Factors independently associated with mortality included serum albumin (odds ratio [OR] = .251, p =0.001, 95% confidence interval [CI] = 0.111-0.565) and the number of PIM (OR = 1.302, p = 0.037, 95% CI = 1.016-1.667). Use of > 1.5 PIM predicted mortality with 63.4% sensitivity and 51.7% specificity with an area under the receiver operating characteristic curve of 0.640, p = 0.005.

Conclusion: The study underscores the deleterious impact of PIM and PU as pervasive age-related conditions during critical illness. The number of PIM and serum albumin are independently associated with hospital mortality. However, the involvement of a restricted number of participants from a selected geriatrics hospital in Egypt limits the generalization of the findings and warrants further longitudinal research and external validation. Pertinent medication reconciliation and periodic skin evaluation should be routinely integrated within a holistic solicitation towards geriatric patients with critical illnesses.

Keywords: critical illness, geriatric syndrome, older adult, potentially inappropriate medication, pressure ulcer

INTRODUCTION

Senescence in nations is exponential with a substantial demographic alteration. In 2024, life expectancy surged and attained 73.3 years with a tendency towards longevity and refined survival [1]. Although aging is a limiting factor for overall survival, age-related syndromes have intangible impact on it especially in the context of critical illness [2].

Geriatric syndromes (GS) are complex age-related phenomena distinguished by multiple etiological elements, interacting pathological trails, manifesting in a cohesive demeanor. However, their comprehensive assumptions during critical illness are still confined with a nascent understanding [3]. Systemic vulnerability has been described as the key perpetrator of the consequential impact of various GS [4]. Older individuals with GS are more susceptible to diverse stressors due to reduced biological resilience. Accordingly, GS would aggravate clinical outcomes including lengthy hospitalization, readmission, functional dependency, and mortality [4, 5].

The health and retirement study (HRS) was a nationally representative study in the USA. It comprised six thousand geriatric patients with critical illnesses. HRS has confirmed the

negative predictive impact of multi-morbidity, disability, dementia, and frailty [6]. These GS share common pathogenesis with eloquent interactions. However, multi-morbidity has been described as a major culprit among older individuals due to the togetherness of two or several chronic conditions. It commonly involves physical and mental disorders resulting in a substantial risk of pressure ulcer (PU) and multiple medication use [6-8]. Accordingly, both PU and polypharmacy represent a cascade of GS among multi-morbid geriatric patients [9-11].

PU is a widespread GS causing major debility. It serves as a proxy of systemic/biological vulnerability and mandates interdisciplinary scheme [8, 9]. Critical illness among older individuals raises the risk of PU because of the complex synergy between multi-morbidity, acute illness stress, impaired cardiodynamics, restricted mobility, deficient oxygenation and polypharmacy [10].

Potentially inappropriate medication (PIM) use represents a unique detrimental outcome among poly-medicated and multi-morbid older patients. About fifty percent of PIM are first utilized during critical illness. PIM use in older patients can lead to delirium, falling, cognitive impairment, and higher risk of death. Accordingly, age-specified medication reconciliation tools/criteria are crucial for appropriate prescribing for older people [11]. The screening tool of older persons' prescriptions (STOPP) criteria is a validated explicit list of PIM. It helps geriatricians notice PIM and prevent challenging pharmacodynamic interactions. It is based on a Delphi consensus of European deft in geriatric pharmacotherapy. The preceding versions of STOPP criteria were liberated in 2008 and 2015. Recently, the 3rd version of STOPP (STOPP-V3) criteria is the 2023 updated list [12].

Targeting PIM and PU through a patient-focused intention is warranted to boost survival net-results [13]. In so doing, the current study focused on assessing the predictive impact of PIM and PU on hospital mortality among a sample of geriatric patients with critical illnesses in Egypt.

MATERIALS AND METHODS

Sample Size and Statistical Power

Power analysis and sample size 15 software/program was deployed to decide the recommended participants number for this study. Statistical power was set at 80% and an alpha risk at 5%. Based on previous research studies, a sample of 165 older patients were needed for a particular GS to predict an adverse hospital outcome with an expected sensitivity of 100% and specificity of 62% [5]. However, to raise the statistical power of this research study, all eligible geriatric patients admitted throughout the observational period were involved in analysis.

Ethical Concepts and Principles

Ethical procedures were accomplished before commencing data acquisition. The Institutional Ethical Committee of Faculty of Medicine at Ain Shams University has reviewed the research and accepted it on 4/8/2024 with a code: FMASU R181/2024. The ethical review board members in the geriatrics department perused the protocol and approved conducting the study at the geriatrics hospital. Informed consents were procured from participants or their proxies. The study was observational in design and did not include any interventional procedures. The research input was used only for its proposed objective and dealt with executed privacy. This study complied with the perspectives of the Declaration of Helsinki.

Study Design, Participants, and Setting

This prospective cohort research study involved geriatric patients, aged ≥ 60 years, hospitalized with critical illnesses at the geriatrics hospital of Ain Shams University. The study observatory period extended from November 1st, 2024, to February 3rd, 2025. The geriatrics hospital is a tertiary referral hospital customized for the management of acutely ill geriatric individuals. Patients with critical illnesses receive a special triage precedence before transferal to the geriatrics critical care unit at the hospital. These patients are conveyed from emergency department, geriatric palliative care unit, geriatric in-patients, or other hospitals. Patients who did not complete the management scheme because of transferal to other hospital or discharge based on their own preferences were excluded from the study.

The critical illness was defined as the existence of organ system compromise/failure or the systemic incapability to sustain normal vitals with an immanent risk of death irrespective of the reference clinical status. These patients are purported to be emergency cases or more demanding patients for meticulous medical surveillance and monitoring [14]. Critical illnesses were considered in accordance with the emergency severity index, a standardized measure for triage in emergency circumstances to rapidly risk stratify patients into five levels of clinical severity/acuity ranging from level one (most urgent/unstable/high risk) to level five (least urgent/more stable/low risk). Special geriatric contemplation was warranted for peculiar clinical presentations in old age due to tailored immunologic response and altered compensatory physiologic reactions especially in the context of polypharmacy [15].

Clinical and Biochemical Covariates

1. The primary diagnoses included altered mental status, acute stroke, acute kidney injury, acute cardiac failure, hepatic failure/encephalopathy, respiratory distress/failure, acute coronary syndromes, and miscellaneous conditions such as diabetic ketoacidosis, sepsis and electrolytes imbalances. These conditions were based on the clinical evaluation combined with an objective radiological and/or laboratory verification at the time of hospital admission. A dichotomous encoding of each diagnosis was conducted for data encryption.
2. Comprehensive clinical evaluation was performed to reveal:
   A. Demographic profile including age (years) and sex (male or female).
   B. Comorbidity profile including chronic diseases/conditions, consisting of diabetes mellitus, hypertension, dementia, thyroid disease, pulmonary disease, hepatic disease, peripheral arterial disease, and heart disease. A dichotomous encoding was offered for each disease entity.
   C. Multimorbidity: the age-adjusted form of Charlson comorbidity index (CCI) was applied to measure multimorbidity among participants. It is a

composite measure reliant on the 10th revision of international statistical classification of diseases and has been validated in patients with critical conditions. CCI has the privilege of assessing both the number and severity of different comorbidities compared to other measures counting the number of comorbidities alone. The total CCI score provides a prognostic and predictive risk stratification where higher CCI score reflects worse prognosis and predicts lower percent of ten-year survival [16].

3. Laboratory profile: blood specimens were gathered by the attending nursing personnel and analyzed in the Ain Shams university clinical laboratories. Laboratory parameters included C-reactive protein, complete blood count, blood urea nitrogen, creatinine, albumin, aspartate aminotransferase, total bilirubin, alanine aminotransferase, international normalized ratio (INR), and serum electrolytes included potassium, calcium, sodium, phosphorus, and magnesium. The study included benchmark laboratory results acquired on admission. Sequential laboratory results were not considered in the study.

Assessment of Potentially Inappropriate Medication

The present study applied the STOPP-V3 criteria on the utilized in-hospital medications during critical illnesses. Medications records were obtained from the clinical pharmacy unit. These records included the dispensed medications for each patient throughout hospitalization at the geriatric critical care unit. These records were checked and revised at the time of each participant discharge. Each utilized medication was checked for its potential inappropriateness based on STOPP-V3 criteria and in accordance with the participant clinical and laboratory profiles. The administration time ranged from 10 to 20 minutes per patient. STOPP-V3 criteria includes one hundred and thirty-three clinical benchmarks with comprehensive explanations. It is a standardized, European-based, explicit measure to facilitate proper medications selection and competent periodic review. STOPP-V3 criteria includes a physiological system-based comprehensive principles for evading PIM use in acute, sub-acute and long-term geriatric healthcare facilities [12].

Assessment of Pressure Ulcer

PU is a focal area of skin necrosis/injury usually affecting the underlying tissues or structures in various depths and severity. PU occurs because of combined pressure and shearing/tangential stress among incapacitated and bedridden individuals. Diagnosing PU was conducted in accordance with the 4th edition of the international PU guidelines, recently updated upon collaboration between the national PU advisory panel, the pan pacific pressure injury alliance, and the European PU advisory panel. These guidelines were built on the latest evidence-based data in the field of PU. Comprehensive head-to-toe skin examination was conducted within the first day of admission to diagnose and stratify PU according to its stage and site [10].

A. Staging of PU was determined based on the observed depth of injury/necrosis as follows:
   - First stage: unbroken/intact skin with a fixed erythema/non-fading red-color.
   - Second stage: partial-thickness/superficial skin loss affecting epidermis/dermis including blisters and bullous lesions.
   - Third stage: full-thickness/deep skin loss extending to the subcutaneous fatty tissue with an intact fascial sheath.
   - Fourth stage: full-thickness /deep skin loss extending to the subcutaneous tissue with exposure of the underneath structures including muscle, ligaments, tendons, and bone.
   - Unstageable PU: the depth of necrosis cannot be determined due to slough (a yellow friable tissue covering the ulcer) or eschar (a black hard tissue covering the ulcer).
   - Deep tissue injury: maroon or purple colored localized skin necrosis/injury [10].

B. Site of PU is a focal skin zone commonly located over a bony protrusion/prominence. These sites are more vulnerable to pressure necrosis on the body map and commonly recognized as pressure points including sacrococcyx, occiput, scapula, elbow, malleolus and heel. However, other miscellaneous and atypical sites are more common in older patients because of medical devices use, abnormal postures, poor maneuvers, and multiple procedures especially in the context of dementia and critical illness [10].

Hospital Outcome (Dependent Variable)

All patients were observed for the occurrence of in-hospital mortality as the target clinical outcome throughout the observational period of the study. Accordingly, patients were categorized as survivors or non-survivors.

Statistical Analysis and Data Processing

The 28th version of SPSS statistics program/software (Armonk, NY, USA) was employed. Initial data handling included data processing and encryption. Descriptive statistics summarized and conveyed the gathered data into numerical attributes and categories. Normally distributed numerical attributes were shown as mean (M) with a standard deviation (SD), while non normally distributed numerical attributes were shown as median with inter-quartile range (IQR). Categories were shown as frequencies and proportions (percentages = %). Proportions of different categories of PIM and PU among participants were presented in a declining frequency within the tables. Comparisons were executed by using either unpaired/independent t- (parametric) or Mann-Whitney (non-parametric) test. Chi-squared test was executed for comparing categories. It was replaced with the Exact test for the limited samples (frequency less than 5). Predictive statistical testing included univariate and multivariate regression modelling to detect the odds ratio (OR) of the variables associated with mortality (dependent variable). A receiver operating characteristic (ROC) curve was designed with area under curve (AUC) assessment to find the best threshold value of PIM use in number and serum albumin in grams per deciliter (g/dl) for detecting mortality. The confidence interval (CI) was settled in at 95% with an accepted margin of error at 5%. Accordingly, p-values less than 0.05 were assumed as statistically significant and highlighted in bold within the tables.

Table 1. Comparison between survivors and non-survivors regarding qualitative attributes

Qualitative attributes		Count (%)		p
		Survivors	Non-survivors	
Sex	Male	16 (31.4%)	67 (44.1%)	0.110
	Female	35 (68.6%)	85 (55.9%)	
Primary diagnosis	Altered mental status	11 (21.6%)	31 (20.4%)	0.836
	Respiratory distress/failure	23 (45.1%)	75 (49.3%)	
	Acute kidney injury	6 (11.8%)	8 (5.3%)	
	Acute stroke	3 (5.9%)	11 (7.2%)	
	Hepatic failure	1 (2.0%)	2 (1.3%)	
	Acute heart failure	1 (2.0%)	3 (2.0%)	
	Miscellaneous	6 (11.8%)	21 (13.8%)	
	Acute coronary syndrome	0 (0.0%)	1 (0.7%)	
Pressure ulcer on admission		18 (48.6%)	70 (56.5%)	0.403
Chronic comorbidity	Dementia	14 (27.5%)	39 (25.7%)	0.801
	Diabetes mellitus	30 (58.8%)	67 (44.1%)	0.068
	Hypertension	33 (64.7%)	78 (51.3%)	0.096
	Previous stroke	13 (25.5%)	51 (33.6%)	0.284
	Cardiac disease	24 (47.1%)	75 (49.3%)	0.778
	Pulmonary disease	13 (25.5%)	17 (11.2%)	**0.013**
	Hepatic disease	7 (13.7%)	26 (91.1%)	0.571
	Malignancy	12 (23.5%)	34 (22.4%)	0.864
	Peripheral artery disease	4 (7.8%)	7 (4.6%)	0.473
	Renal disease	12 (23.5%)	32 (21.1%)	0.710
	Thyroid disorder	5 (9.8%)	9 (5.9%)	0.348

Note. **Bold** numbers indicate statistical significance

Table 2. Comparison between survivors and non-survivors regarding quantitative attributes

Quantitative attributes	M ± SD		p
	Survivors	Non-survivors	
Age	74.92 ± 6.75	75.09 ± 7.64	0.891
Hemoglobin	9.55 ± 2.13	9.33 ± 1.87	0.535
Sodium	129.96 ± 22.58	138.33 ± 10.51	**0.002**
Potassium	4.69 ± 0.90	4.34 ± 1.00	0.068
Magnesium	2.06 ± 0.44	1.98 ± 0.55	0.549
Calcium	8.79 ± 0.93	8.96 ± 1.04	0.509
Phosphorus	3.42 ± 1.51	3.97 ± 2.04	0.274
Albumin	2.93 ± 0.66	2.44 ± 0.62	**< 0.001**
INR	1.29 ± 0.38	1.53 ± 0.48	**0.012**

Note. **Bold** numbers indicate statistical significance; INR: international normalized ratio, normal range of hemoglobin (12-15g/dl), sodium (136-145 mmol/l), potassium (3.5-5.1 mmol/l), magnesium (1.8- 2.6 mg/dl), calcium (8.6-10.3 mg/dl), phosphorus (2.5-5.0 mg/dl), albumin (3.5-5.4 g/dl); & INR (0.8 to 1.1)

RESULTS

Out of the 203 participants, 152 (74.9%) patients died at the hospital. Average age of participants was 75.00 ± 7.42 years. Females represented the majority (59.1%). Hypertension was the most common chronic comorbidity (72.6%). Furthermore, respiratory distress/failure was the most common primary diagnosis (45.1%). Non-survivors had a significantly higher prevalence of chronic pulmonary disease (p = 0.013). However, no significant differences were detected regarding other chronic comorbidities, sex, primary diagnoses and presence of PU as demonstrated in **Table 1**.

Non-survivors had significantly lower serum albumin (2.44 ± 0.62 vs. 2.93 ± 0.66, p < 0.001), higher serum sodium and INR with p-values of 0.002 and 0.012, respectively. Additionally, they had significantly higher serum bilirubin and total leukocyte count with p-values of 0.005 and 0.008, respectively. Non-survivors consumed a significantly higher number of PIM (3.00 vs. 1.00, p = 0.018) as expressed in **Table 2** and **Table 3**.

Table 3. Comparison between survivors and non-survivors regarding quantitative attributes

QA	Survivors			Non-survivors			p
	MD	FQ	TQ	MD	FQ	TQ	
NPIM	1.00	0.00	3.00	3.00	1.00	5.00	**0.018**
CCI	8.00	6.00	9.50	7.00	6.00	9.00	0.200
TLC	8.30	6.80	12.70	12.10	8.20	16.85	**0.008**
Platelets	206.00	154.00	300.00	199.50	135.50	284.50	0.528
CRP	70.00	32.00	112.00	95.00	54.50	157.00	0.165
BUN	44.00	24.00	60.00	42.50	26.00	78.50	0.114
Cr	1.64	0.86	3.90	1.52	0.90	2.83	0.662
AST	24.00	16.00	37.00	30.00	19.00	69.00	0.061
ALT	14.00	9.00	28.00	18.00	11.00	35.00	0.180
TB	0.50	0.30	0.60	0.80	0.40	1.40	**0.005**

Note. QA: Quantitative attributes; MD: Median; FQ:1st quartile; TQ: 3rd quartile; NPIM: Number of potentially inappropriate medication; TB: Total bilirubin; **Bold** numbers indicate statistical significance; TLC: Total leucocyte count; CRP: C-reactive protein; BUN: Blood urea nitrogen; Cr: Creatinine; AST: Aspartate aminotransferase; ALT: Alanine aminotransferase; & Normal range of total leukocyte count (4-10×10^3 /µL), platelets (150-410×10^3 /µL), CRP (< 6 mg/l), BUN (8-20 mg/dl), creatinine (0.6-1.2 mg/dl), AST (13-39 IU/l), ALT (7-52 IU/l), & TB (0.3-1mg/dl)

Table 4. Independent factors associated with mortality using logistic regression

Predictive factors	Univariate analysis		Multivariate analysis	
	p	OR (95% CI)	p	OR (95% CI)
Pulmonary disease	**0.015**	0.368 (0.164-0.825)		
Sodium	**0.014**	1.056 (1.011-1.102)		
Albumin	**0.001**	0.294 (0.143-0.605)	**0.001**	0.251 (0.111-0.565)
INR	**0.017**	5.891 (1.373-25.269)		
NPIM	**0.013**	1.302 (1.058-1.603)	**0.037**	1.302 (1.016-1.667)
TLC	0.103	1.047 (0.991-1.106)		
Total bilirubin	**0.022**	5.828 (1.287-26.383)		

Note. **Bold** numbers indicate statistical significance; INR: international normalized ratio; NPIM: Number of potentially inappropriate medication; & TLC: Total leucocyte count

Predictive statistical analyses revealed the significant attributes for in-hospital mortality. The number of PIM and serum albumin were independent predictors of mortality in the multivariate regression model with an OR = 1.302 (p = 0.037) and 0.251 (p = 0.001), respectively (**Table 4**).

ROC curves were designed for the number of PIM and serum albumin to disclose their utmost cut-offs for anticipating mortality. Utilizing > 1.5 PIM expected mortality with a sensitivity of 63.4% and specificity 51.7% with an AUC of 0.640, 95% CI: 0.542-0.739, p = 0.005 (**Figure 1**).

While lower serum albumin at a cut-off level < 2.75 g/dl discriminated mortality with a sensitivity of 70.9% and specificity of 70.4% with an AUC of 0.718, 95% CI: 0.611-0.826, p < 0.001 (**Figure 2**).

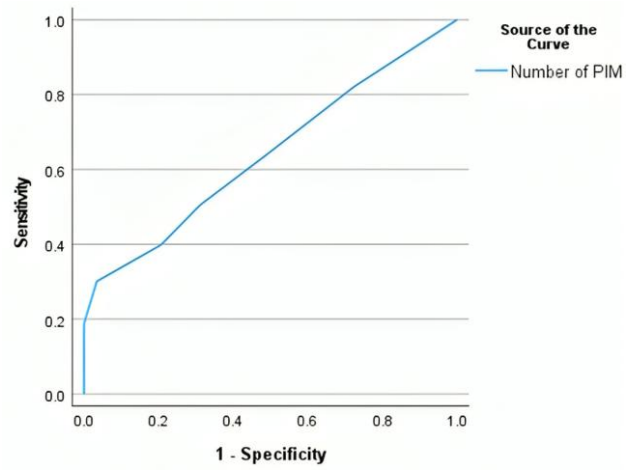

Figure 1. ROC curve for prediction of mortality using the number of PIM (Source: Authors' own elaboration)

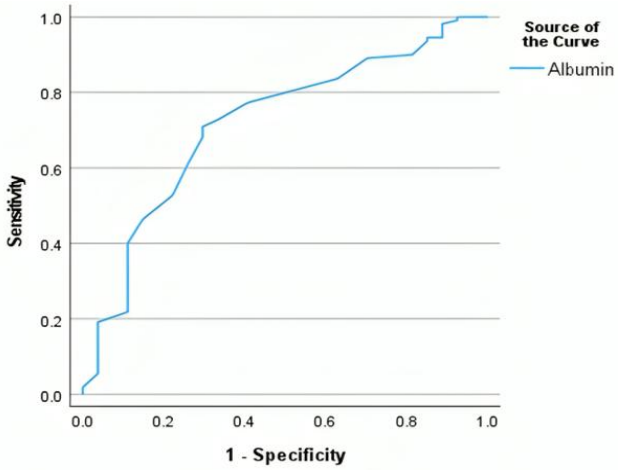

Figure 2. ROC curve for prediction of mortality using serum albumin (Source: Authors' own elaboration)

Table 5. Proportions of participants using PIM across STOPP-V3 criteria in a declining frequency

PIM according to STOPP-V3 criteria	Count (%)
Concomitant use of ≥ 2 anticholinergics	78 (51.30%)
Opioids (fentanyl, nalbuphine, tramadol) are used without a coexisting laxative	42 (27.60%)
Opioids (fentanyl, nalbuphine, tramadol) without a stepwise approach	42 (27.60%)
Levofloxacin or azithromycin in the presence of prolonged corrected QT interval	41 (27.00%)
Loop diuretic for oedema without confirmed renal failure, cardiac failure, or hepatic failure	28 (18.40%)
Amiodarone as a first-line medication for supraventricular tachyarrhythmia	21 (13.80%)
Aspirin or clopidogrel with factor Xa inhibitors in patients with atrial fibrillation	20 (13.20%)
Stains use for primary cardiovascular prevention among those ≥ 85 years or near the end-of-life	9 (5.90%)
Digoxin as a first line medication in atrial fibrillation	9 (5.90%)
Doxazosin or tamsulosin in the presence of syncope or orthostatic hypotension	7 (4.60%)
Duplicate prescription	5 (3.30%)
Midazolam for agitation or psychosis in dementia	5 (3.30%)
Apixaban with systemic ketoconazole or Itraconazole	4 (2.60%)
Apixaban use with an estimated glomerular filtration rate < 15 ml/min/1.73 m^2	4 (2.60%)
Aspirin with clopidogrel for long-term secondary prevention for stroke	4 (2.60%)
Ramipril with spironolactone without monitoring serum potassium status	4 (2.60%)
Bisoprolol as a monotherapy for uncomplicated hypertension	3 (2.00%)
Methyldopa for hypertension	3 (2.00%)
Theophylline as monotherapy for chronic obstructive pulmonary disease	2 (1.30%)
Loop diuretics for hypertension with concurrent urinary incontinence	2 (1.30%)
Dapagliflozin is used in the presence of hypotension	2 (1.30%)
Quetiapine prescribing in the presence of dysphagia	2 (1.30%)
Piracetam for treatment of dementia	2 (1.30%)
Spironolactone in the presence of hyperkalemia	2 (1.30%)
Oral elemental iron exceeding 200 mg per day	2 (1.30%)
Sertraline with recent gastrointestinal bleeding	1 (0.70%)
Donepezil with digoxin, metoprolol, or bisoprolol	1 (0.70%)
Sertraline in the presence of hyponatremia	1 (0.70%)

Descriptive statistics revealed the frequency and pattern of PIM and PU among participants. Anticholinergics (51.30%) were at the top of PIM followed by opioids (27.60%). PIM list in accordance with STOP-V3 criteria are proportioned in a decreasing order of frequency in **Table 5**.

The majority of PU were in the second stage (40.4%) and at the sacrococcygeal site (26.7%). Proportions of PU across different sites and stages with their impact on mortality are illustrated in **Table 6**.

DISCUSSION

The current study provided a novel synopsis of PIM and PU as pivotal geriatric phenomena in acute geriatric inpatients. The study showed that the number of PIM had a significant negative impact on surviving critical illness. Each increase of one PIM would increase the risk of death by 0.3 times. In addition, utilizing more than 1.5 PIM could anticipate hospital mortality with a sensitivity of 63.4% and specificity 51.7%. Accordingly, there was a proportional risk of death with the number of PIM. These results are alarming to tackle PIM during the daily geriatric critical care practice as avoiding PIM could give leverage to survival proportions in the geriatric healthcare facilities.

The study's conclusions were distinct for geriatric patients with critical conditions, a vulnerable cohort that had not been thoroughly studied in previous research. However, the deleterious impact of PIM on survival outcomes among older patients has been well-documented in numerous studies and

Table 6. Proportions of pressure ulcers across different sites and stages in a descending order with their impact on hospital mortality

Pressure ulcer	Total count (%)	Count (%)		p
		Survivors	Non-survivors	
Stage				
Second stage	65 (40.4%)	14 (37.8%)	51 (41.1%)	0.720
First stage	27 (16.8%)	8 (21.6%)	19 (15.3%)	0.368
Deep tissue injury	13 (8.1%)	1 (2.7%)	12 (9.7%)	0.301
Fourth stage	9 (5.6%)	0 (0.0%)	9 (7.3%)	0.120
Unstageable	8 (5.0%)	1 (2.7%)	7 (5.6%)	0.683
Third stage	6 (3.7%)	0 (0.0%)	6 (4.8%)	0.338
Site				
Sacrococcygeal	43 (26.7%)	11 (29.7%)	32 (25.8%)	0.636
Gluteal	37 (23.0%)	8 (21.6%)	29 (23.4%)	0.823
Trochanteric	27 (16.8%)	6 (16.2%)	21 (16.9%)	0.918
Miscellaneous	23 (14.3%)	5 (13.5%)	18 (14.5%)	0.878
Heel	16 (9.9%)	3 (8.1%)	13 (10.5%)	1.000
Back	15 (9.3%)	5 (13.5%)	10 (8.1%)	0.338
Mallular	3 (1.9%)	0 (0.0%)	3 (2.4%)	1.000

meta-analyses. A comprehensive meta-analysis of forty-four studies, including more than 2.1 million older individuals, found a significant association between PIM and mortality with an OR of 1.28, 95% CI of 1.20-1.36. Stratified analyses showed significant variations across different countries, age groups, diagnostic tools, and medications categories. These data highlighted the eminent need for appropriate medication selection and serial diligent reconciliation to curtail PIM use and preclude its poor sequential effects on short-term survival [17].

The study applied STOPP-V3 criteria and provided a detailed narrative of PIM, reflecting its categorical template among hospitalized acutely ill older patients in Egypt. It is noteworthy that the distribution of PIM varied widely between different studies based on ample determinants including institutional setting, diagnostic measure, physicians' expertise, clinical pharmacist integration, drug safety standards and prescribing inclination [17, 18]. The study endorsed critical prescribing decisions and depicted the ongoing prescribing prototypes where anticholinergics and opioids were the most frequent PIM categories within geriatric critical care inpatients. Anticholinergics describe a vast cluster of medications with antimuscarinic adverse reactions involving age-specific hazardous leftovers such as falls, constipation, delirium and mortality. Opioids use without an analgesic incremental approach, or a concomitant laxative use was frequently noticed among participants. This prescribing practice could induce delirium, fecal impaction, respiratory compromise and hospital death. Also, omitting important electrocardiogram parameters and/or dynamic alterations was noted in the study. Common medications such as antibacterials including levofloxacin or azithromycin could induce fateful sequels including "torsade de pointes", a fatal ventricular dysrhythmia in the coexistence of prolonged corrected QT intervals more than 500 milliseconds [12, 19].

Deliberating renal functions is fundamental to safe prescribing and proper dosage adjustment in old age. As evidenced in the study by the inappropriate use of apixiban, a new oral anticoagulant medication with an estimated glomerular filtration rate (eGFR) below 15 ml/min/1.73 m^2. The Cockcroft-Gault formula/equation could ascertain creatinine clearance (Cr.Cl.), a better alternative to eGFR in older adults. As, Cr.Cl. would be modified in accordance with sex, age and weight. Also, eGFR may be misleading as it could overstate renal function by 29 to 69% in geriatric patients. Accordingly, the British national formulary has affirmed Cr.Cl. for more precise dosing regimens among seniors. Additionally, serum electrolytes imbalance including altered serum potassium and sodium quantities could warn against prescribing angiotensin-converting enzyme inhibitors/angiotensin receptor blockers and selective serotonin reuptake inhibitors, respectively [12, 20].

The study narrated the potentially inappropriate use of conventional cardiac medications including amiodarone and digoxin for different supraventricular dysrhythmias. Also, inappropriate benzodiazepines (BZD) prescription was noted in the form of utilizing midazolam for managing agitation or psychosis in dementia. Additionally, antipsychotics were inappropriately prescribed in the form of quetiapine prescription in the coexistence of dysphagia. All these forms of PIM are associated with a higher risk of death, especially in the context of the concomitant consumption by the same patient [12].

These findings coincided with the retrieved data from an extensive systematic review of 25 related articles that reflected the pattern of PIM use in a large-scale analysis. Where, BZD were at the head of PIM followed by antipsychotics, proton pump inhibitors, digoxin, non-steroidal anti-inflammatory medications, and anticholinergic medicines [21]. The noticed discrepancy in PIM illustrations between disparate studies confirms the gaps in clinical practice and apprises clinicians of the necessity to construct a standardized prescribing initiative for hospitalized geriatric patients.

On the other hand, the study did not show a significant impact of PU on surviving critical illness. This finding contradicts a forgoing study among 20,280 septic patients from divergent age brackets, where PU was significantly associated with higher twenty-eight-day all-cause mortality with a hazard ratio of 1.3. Sepsis is a notorious sequel from PU with a high risk of death, especially among older patients with pertinent illnesses [22]. However, our study was not restricted to septic patients and was constrained to a geriatric cohort with critical conditions. Also, the analysis solely included PU on admission and did not assess either PU severity or progression during hospitalization. And the study did not evaluate hospital-acquired PU and/or PU infective complications during hospitalization. These disputes could markedly affect assessing the risk of PU-induced sepsis and its allied detrimental results on short-term survival.

A more comprehensive analysis of the impact of PU on clinical sequels was executed on 1.1 million patients involving diverse age groups. It investigated the association between PU characteristics and selected hospital outcomes. The stage of PU did not show a significant effect; however, the site and multiplicity of PU were strongly related to lengthy hospital admittance and mortality. These observations highlighted the importance of integrating these PU characteristics into red flags of severity within the existing PU assessment measures including the Norton and Braden scales/measures [9]. In addition, a prior study has formulated a predictive equation reflecting the severity of PU and described it as the PU locality stage (PULS) score. Recognizing PULS score could alert geriatricians towards risky PU to settle a confessable multidisciplinary strategy [9]. Periodic skin assessment is a crucial endeavor towards an optimal PU stewardship. As a

comprehensive head-to-toe cutaneous inspection could capture PU at the preliminary stages and alarm towards early determinants control. An individualized holistic constellation should target skin moisture from incontinence and control coexisting acute or chronic disease stressors. Besides, proactive nursing diligence includes efficient repositioning procedures, dispatch maneuvers and provision of convenient inflatable cushions.

Finally, serum albumin was the only laboratory parameter independently associated with hospital death. The study specified low serum albumin below 2.75 g/dl as a good discriminator between survivors and non survivors. This finding was firmly advocated by previous research that confirmed the prognostic utility of serum albumin as a profitable biomarker during critical illness and hospitalization [23, 24]. Serum albumin is the most abundant plasma protein, gauging about 60% of the total serum proteins. Accordingly, serum albumin represents a valuable and affordable biomarker for a timely predictive modeling due to its inverse correlation with the systemic inflammatory burden, organ disruption and acute illness rigor. Other studies proposed incorporating serum albumin with the sequential organ failure assessment score as a composite measure for superior prognostic accuracy among critically ill individuals [24].

Strengths and Limitations

This is the first study to apply the STOPP-V3 criteria and the 4th edition of international PU guidelines on critically ill older individuals. It documented sequential PIM use and provided a contextual insight into its clinical consequences. However, the study lacked a structured objective evaluation of frailty, dementia and disability because of its clinical sitting and critical circumstances. Although study comprehensively evaluated PU presence on admission but observational data on acquiring PU during the hospital course would be important as a potential predictor of mortality. Also, the study did not measure both critical illness and PU severity upon admission. The laboratory profile, while comprehensive, omitted crucial biomarkers such as serum lactate and arterial blood gas parameters, which limit the depth of the prognostic assessment. These missing covariates could have a confounding influence on the final analysis. Finally, the inclusion of a limited number of participants with some missing data from a single geriatric hospital would raise the chance of type two errors and limit the generalization of our conclusions. Future, large-scale/polycentric, longitudinal studies are suggested to further address distinctive GS with avoidance of the previous shortcomings.

Future Implications

The study provided a relevant analysis of PU and PIM in acute geriatric ambience. Both PU and PIM are preventable, aging-related phenomena and considered as key quality indicators in geriatric health services. Geriatricians should provide collaborative care, including periodic skin surveillance and careful medication selection & revision. Risky medications and black box notices should be involved within periodically updated digital records. The integration of qualified geriatricians, various medical disciplines, clinical pharmacists, and artificial intelligence models into routine prescribing protocols would enhance pharmacovigilance and yield more robust electronic systems.

CONCLUSION

PIM and PU are common preventable cascades of iatrogenesis in acute geriatric inpatients. Proactive strategies should include a systematic manner of appropriate prescribing policies followed by recurrent reconciliation procedures. It should be integrated within a holistic outlook on PU management. These measures would increase the chances of surviving critical conditions and improve the forthcoming health-related wellness among seniors.

This study provided practical insights into the burden of PIM and PU during critical illness. The increased number of PIM and hypoalbuminemia had a significant negative impact on survival from critical illnesses among the sample of geriatric patients involved. However, the limited sample size mandates future, polycentric, longitudinal research.

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REFERENCES

1. United Nations (2024). World Population Prospects 2024: Summary of Results. UN DESA/POP/2024/TR/NO. 9. New York: United Nations.
2. Vallet H, Guidet B, Boumendil A, et al. The impact of age-related syndromes on ICU process and outcomes in very old patients. Ann Intensive Care. 2023;13(1):68. https://doi.org/10.1186/s13613-023-01160-7 PMid: 37542186 PMCid:PMC10403479
3. Inouye SK, Studenski S, Tinetti ME, Kuchel GA. Geriatric syndromes: Clinical, research, and policy implications of a core geriatric concept. J Am Geriatr Soc. 2007;55(5):780-91. https://doi.org/10.1111/j.1532-5415.2007.01156.x PMid: 17493201 PMCid:PMC2409147
4. Brummel NE. Increasing vulnerability in older adults with critical illness: Implications for clinical care and research. Chest. 2022;161(6):1436-7. https://doi.org/10.1016/j.chest.2022.02.014 PMid:35680306 PMCid:PMC9168259
5. Anpalahan M, Gibson SJ. Geriatric syndromes as predictors of adverse outcomes of hospitalization. Intern Med J. 2008;38(1):16-23. https://doi.org/10.1111/j.1445-5994.2007.01398.x PMid:17542997
6. Cobert J, Jeon SY, Boscardin J, et al. Trends in geriatric conditions among older adults admitted to US ICUs between 1998 and 2015. Chest. 2022;161(6):1555-65. https://doi.org/10.1016/j.chest.2021.12.658 PMid: 35026299 PMCid:PMC9248079

7. Wu D, Xu J, Zhang H, Zhang K, Zhu Y. Multimorbidity characteristics in older adults and their associated factors in complex networks: A cross-sectional study. Front Public Health. 2025;13:1473572. https://doi.org/10.3389/fpubh.2025.1473572 PMid:40078767 PMCid:PMC11896846
8. Levine JM. Pressure injuries and chronic wounds. Clin Geriatr Med. 2024;40(3):xi-ii. https://doi.org/10.1016/j.cger.2023.12.007 PMid:38960542
9. Zikos D, Eappen P. Beyond staging: The role of pressure ulcer site and multiplicity in hospital mortality and length of stay. Healthcare (Basel). 2025;13(21):2815. https://doi.org/10.3390/healthcare13212815 PMid:41228182 PMCid:PMC12610137
10. National Pressure Injury Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance. Prevention and Treatment of Pressure Ulcers/Injuries: Quick Reference Guide. The International Guideline: Fourth Edition. Emily Haesler (Ed.). 2026. Available at: https://internationalguideline.com
11. Morandi A, Vasilevskis E, Pandharipande PP, et al. Inappropriate medication prescriptions in elderly adults surviving an intensive care unit hospitalization. J Am Geriatr Soc. 2013;61(7):1128-34. https://doi.org/10.1111/jgs.12329 PMid:23855843 PMCid:PMC3713508
12. O'Mahony D, Cherubini A, Guiteras AR, et al. STOPP/START criteria for potentially inappropriate prescribing in older people: Version 3. Eur Geriatr Med. 2023;14(4):625-32. https://doi.org/10.1007/s41999-023-00777-y PMid:37256475 PMCid:PMC10447584
13. Mate K, Fulmer T, Pelton L, et al. Evidence for the 4Ms: Interactions and outcomes across the care continuum. J Aging Health. 2021;33(7-8):469-81. https://doi.org/10.1177/0898264321991658 PMid:33555233 PMCid:PMC8236661
14. MINSA. Norma técnica de los servicios de cuidados intensivos e intermedios RM 489 2005 MINSA [Technical standard for intensive and intermediate care services RM 489 2005 MINSA]. Available at: https://www.gob.pe/institucion/minsa/normas-legales/252394-489-2005-minsa (Accessed: 18 February 2026).
15. Wolf L, Ceci K, McCallum D, Brecher D. Emergency severity index handbook. Emergency Nurses Association; 2023.
16. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: Development and validation. J Chronic Dis. 1987;40(5):373-83. https://doi.org/10.1016/0021-9681(87)90171-8 PMid:3558716
17. Zhou Y, Pan Y, Xiao Y, Sun Y, Dai Y, Yu Y. Association between potentially inappropriate medication and mortality risk in older adults: A systematic review and meta-analysis. J Am Med Dir Assoc. 2025;26(2):105394. https://doi.org/10.1016/j.jamda.2024.105394 PMid:39653327
18. Sadia H, Naveed S, Rehman H, Jamshed S, Dilshad H. Enhancing medication appropriateness: Insights from the STOPP (screening tool of older persons' prescriptions) criteria version 3 on prescribing practices among the older adults in Pakistan. Front Pharmacol. 2025;16:1551819. https://doi.org/10.3389/fphar.2025.1551819 PMid:40463903 PMCid:PMC12130026
19. Motta I, Cozzi SN, Pontali E. QT prolongation for old and new drugs: How much should we really worry? Int J Tuberc Lung Dis. 2022;26(4):298-301. https://doi.org/10.5588/ijtld.22.0072 PMid:35351233
20. Thomas O, Glidewell L, Alderson S, Raynor DK, Wood S. Widespread inappropriate prescribing for older people with reduced kidney function: What are the harms and how do we tackle them? A scoping review for primary care. BMJ Qual Safety. 2025. https://doi.org/10.1136/bmjqs-2025-018736 PMid:41057253
21. Alshammari H, Al-Saeed E, Ahmed Z, Aslanpour Z. Reviewing potentially inappropriate medication in hospitalized patients over 65 using explicit criteria: A systematic literature review. Drug Healthc Patient Saf. 2021;13:183-210. https://doi.org/10.2147/DHPS.S303101 PMid:34764701 PMCid:PMC8572741
22. Zhu Y, Lei JY, Zou J, Liu XF, Li WF, Cao F. Association between pressure ulcer and 28-day mortality in septic patients: A retrospective study based on the MIMIC-IV database. Eur J Med Res. 2025;30(1):634. https://doi.org/10.1186/s40001-025-02909-5 PMid:40665447 PMCid:PMC12265141
23. Mittal A, Sharma B, Kumar A, Sharma M, Shariq M. Study of serum albumin as a prognostic marker in critically ill patients. Indian J Public Health Res Dev. 2023;14(1):27-32. https://doi.org/10.37506/ijphrd.v14i1.18783
24. Hada S, Poriya H, Joseph D, Jha RK. Study of serial serum albumin as prognostic marker in critically ill patient. Eur J Cardiovasc Med. 2025;15(8):419-26. https://doi.org/10.61336/ejcm/25-08-81