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Original Research Article

Polypharmacy and Inappropriate Prescribing in Geriatric Orthopaedic Surgery: Implications for Postoperative Outcomes

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Abstract

Background: Elderly patients undergoing orthopaedic surgeries frequently have multiple comorbidities requiring polypharmacy, increasing the risk of adverse drug events. Potentially inappropriate medications (PIMs) further exacerbate these risks. However, limited data exist regarding their impact on surgical outcomes in this population.

Methods: This retrospective observational study included 169 patients aged ≥60 years undergoing orthopaedic surgeries at a tertiary care center. Data on demographics, comorbidities, medication use, and outcomes were collected. Polypharmacy and PIMs were assessed using standard definitions and the Beers Criteria. Associations with postoperative complications were analyzed using appropriate statistical tests and multivariate regression.

Results: Polypharmacy was observed in 83.4% of patients, with 29.0% experiencing hyperpoly pharmacy. PIMs were identified in 42.6% of patients. Increasing medication burden was significantly associated with higher rates of delirium (p=0.004), gastrointestinal complications (p=0.021), renal dysfunction (p=0.018), ICU admissions (p=0.031), and prolonged hospital stay (p<0.001). PIM use was also significantly associated with adverse outcomes including delirium (p=0.002) and gastrointestinal complications (p=0.001). Multivariate analysis identified hyperpoly pharmacy (AOR: 2.84, p=0.004) and PIM use (AOR: 2.47, p=0.006) as independent predictors.

Conclusion: Polypharmacy and PIM use are highly prevalent and significantly impact postoperative outcomes in elderly orthopaedic patients. Rational prescribing and systematic medication review are essential to improve patient safety and clinical outcomes.

Keywords: Polypharmacy; Elderly; Orthopaedic Surgery; Beers Criteria; Postoperative Complications.

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Introduction

The global demographic shift toward population ageing has led to a rapid rise in the proportion of elderly individuals requiring surgical care, particularly in orthopaedics, where degenerative joint diseases, fragility fractures, and osteoporotic complications are highly prevalent [1].

Individuals aged ≥60 years constitute a growing surgical cohort, accounting for a substantial proportion of hospital admissions and operative interventions, especially for hip fractures, spine disorders, and joint replacements [2]. This population is characterized by multiple comorbidities such as hypertension, diabetes mellitus, cardiovascular disease, and chronic kidney disease, necessitating the concurrent use of multiple medications [2].

Polypharmacy, commonly defined as the use of five or more medications, is highly prevalent among elderly patients, with reported rates ranging from 40% to 70% in hospitalized geriatric populations [3]. While appropriate polypharmacy may be necessary for optimal disease control, excessive or inappropriate medication use increases the risk of adverse drug reactions (ADRs), drug–drug interactions, medication non-adherence, and functional decline [4].

In the perioperative orthopaedic setting, these risks are further amplified due to physiological changes associated with ageing, altered pharmacokinetics

and pharmacodynamics, and the addition of anaesthetic agents, analgesics, and prophylactic medications [2].

Potentially inappropriate medications (PIMs), as defined by validated tools such as the Beers Criteria and STOPP/START criteria, are drugs in which the risks outweigh the benefits, particularly when safer alternatives exist [5]. The prevalence of PIM use in elderly patients has been reported to range between 20% and 50%, with higher rates observed in hospitalized and surgical populations [6]. Common PIMs in orthopaedic patients include sedative-hypnotics, non-steroidal anti-inflammatory drugs (NSAIDs), anticholinergics, and certain opioids, all of which may predispose to complications such as delirium, falls, gastrointestinal bleeding, and renal impairment [6]. Elderly patients undergoing orthopaedic surgeries represent a particularly vulnerable group due to the interplay of polypharmacy, frailty, and surgical stress [7]. Postoperative complications such as delirium, prolonged hospital stay, increased morbidity, and mortality have been linked to inappropriate medication use and high medication burden [7]. Literatures have demonstrated that polypharmacy is independently associated with poorer surgical outcomes, including delayed functional recovery and higher readmission rates [8]. Furthermore, perioperative medication mismanagement, including continuation of contraindicated drugs or omission of essential therapies, can adversely influence surgical outcomes [8].

Despite increasing awareness, there remains a paucity of data specifically evaluating the patterns of polypharmacy and the impact of PIMs on clinical outcomes in elderly patients undergoing orthopaedic procedures, particularly in resource-limited settings [9]. Most existing studies have focused on general geriatric populations or medical inpatients, with limited emphasis on surgical subgroups [9]. Therefore, the present study aimed to assess the patterns of polypharmacy and evaluate the outcomes associated with potentially inappropriate medications in elderly patients undergoing orthopaedic surgeries in a tertiary care setting.

Materials and Methods

Study Design and Setting: This retrospective observational study was conducted in the Department of Orthopaedics of a tertiary care teaching hospital over a period 3 months between January 2025 to March 2025. The study adhered to the principles of the STROBE Statement to ensure methodological rigor and transparent reporting.

Institutional Ethics Committee approval was obtained prior to commencement of the study, and a waiver of informed consent was granted due to the retrospective nature of data collection. Patient confidentiality was maintained by anonymizing all identifiable information.

Study Population And Eligibility Criteria: The study included all elderly patients aged ≥60 years who underwent elective or emergency orthopaedic surgical procedures during the 5 years (January 2020 to December 2024). Only patients with complete medical records, including detailed medication history from admission to discharge, were included. Patients with hospital stay <24 hours, incomplete prescription data, or those discharged against medical advice were excluded. Patients managed conservatively without surgical intervention were also excluded.

Sample Size Consideration: As this was a retrospective study, all eligible patients meeting the inclusion criteria during the study period were included. A post-hoc assessment of sample adequacy was considered to ensure sufficient power to detect clinically meaningful associations between polypharmacy, potentially inappropriate medications, and postoperative outcomes.

Data Collection And Study Variables: Data were extracted from electronic medical records and patient case files using a structured and prevalidated data collection proforma. Baseline demographic variables included age, sex, and body mass index. Clinical variables included primary diagnosis (e.g., fractures, osteoarthritis, degenerative spine disorders), type of surgery (elective or emergency), and comorbidities such as hypertension, diabetes mellitus, cardiovascular disease, and chronic kidney disease. Comorbidity burden was quantified using the Charlson Comorbidity Index.

Medication data included all drugs prescribed during the perioperative period, defined as the duration from hospital admission to discharge. Both pre-admission medications continued during hospitalization and newly prescribed perioperative drugs were recorded. As-needed (PRN) medications were included if administered at least once during the hospital stay. Drugs were categorized based on therapeutic class using standard classification systems.

Assessment of Polypharmacy And Potentially Inappropriate Medications: Polypharmacy was defined as the concurrent use of five or more medications. Patients were further stratified into non-polypharmacy (<5 drugs), polypharmacy (5–9 drugs), and hyperpoly pharmacy (≥10 drugs). Potentially inappropriate medications (PIMs) were identified using the latest available version (2023) of the Beers Criteria. Each patient's medication list was independently reviewed by two investigators trained in geriatric pharmacotherapy, and discrepancies were resolved through consensus to

ensure reliability. The number and categories of PIMs were documented for each patient.

Outcome Measures: The primary outcomes were the prevalence and patterns of polypharmacy and PIM use among elderly patients undergoing orthopaedic surgeries. Secondary outcomes included postoperative complications such as delirium (identified using standard clinical criteria such as the Confusion Assessment Method), gastrointestinal adverse events, renal dysfunction (defined as an increase in serum creatinine ≥0.3 mg/dL from baseline), falls, and in-hospital mortality. Additional outcomes included length of hospital stay (measured in days), prolonged hospitalization (defined as duration above the 75th percentile), and requirement for intensive care unit admission.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version XX. Continuous variables were expressed as mean ± standard deviation or median (interquartile range) depending on data distribution, while categorical variables were presented as frequencies and percentages. The normality of data was assessed using appropriate tests. Comparisons between groups were performed using Student's t-test or Mann–Whitney U test for continuous variables and Chi-square test or Fisher's exact test for categorical variables. Multivariate logistic regression analysis was performed to identify independent predictors of adverse outcomes, including the impact of polypharmacy and PIM use, while adjusting for potential confounders such as age, sex, comorbidity burden (Charlson Comorbidity Index), and type of surgery. Subgroup analyses were conducted based on categories of polypharmacy and presence or absence of PIMs. Missing data were handled using complete case analysis. A p-value of <0.05 was considered statistically significant.

Results

The study population had a mean age of 68.9 ± 7.4 years, with the majority in the 60–69 years age group (48.5%), followed by 70–79 years (36.1%) and ≥80 years (15.4%).

Males constituted 56.8% of the cohort. The mean BMI was 24.8 ± 3.6 kg/m². Most patients underwent elective surgeries (60.4%), while 39.6% were emergency admissions. Fracture fixation was the most common procedure (52.1%), followed by joint replacement (27.2%) and spine surgeries (12.4%).

The mean Charlson Comorbidity Index was 3.2 ± 1.4, indicating a moderate comorbidity burden. Hypertension (61.5%) and diabetes mellitus (46.7%) were the most prevalent comorbidities, followed by cardiovascular disease (24.9%) and chronic kidney disease (10.7%) (Table 1).

Table 1: Baseline Demographic and Clinical Characteristics of Study Participants (n = 169)

Variable	Frequency (%)/mean ± SD
Age (years)	68.9 ± 7.4
Age group	
60–69 years	82 (48.5)
70–79 years	61 (36.1)
≥80 years	26 (15.4)
Gender	
Male	96 (56.8)
Female	73 (43.2)
BMI (kg/m²)	24.8 ± 3.6
Type of admission	
Elective	102 (60.4)
Emergency	67 (39.6)
Type of surgery	
Fracture fixation	88 (52.1)
Joint replacement	46 (27.2)
Spine surgery	21 (12.4)
Others	14 (8.3)
Charlson Comorbidity Index	3.2 ± 1.4
CCI <4	101 (59.8)
CCI ≥4	68 (40.2)
Comorbidity	
Hypertension	104 (61.5)
Diabetes mellitus	79 (46.7)
Cardiovascular disease	42 (24.9)
Chronic kidney disease	18 (10.7)

BMI – Body Mass Index

The mean number of medications prescribed per patient was 8.6 ± 2.9. Polypharmacy (5–9 drugs) was observed in 54.4% of patients, while 29.0% had hyperpolypharmacy (≥10 drugs); only 16.6% received fewer than five medications. Antibiotics (87.6%) and analgesics including NSAIDs/opioids (82.2%) were the most commonly prescribed drug classes, followed by proton pump inhibitors (77.5%). Antihypertensives (61.5%) and antidiabetic agents (46.7%) reflected the underlying comorbidity burden. Anticoagulants/antiplatelets (40.2%) and sedatives/hypnotics (30.8%) were also frequently used in the perioperative period (Table 2).

Table 2: Pattern of Medication Use and Polypharmacy (n = 169)

Variable	Frequency (%)/mean ± SD
Total number of drugs per patient	8.6 ± 2.9
Polypharmacy status	
<5 drugs	28 (16.6)
5–9 drugs	92 (54.4)
≥10 drugs	49 (29.0)
Drug Class	
Antibiotics	148 (87.6)
Analgesics (NSAIDs/opioids)	139 (82.2)
Proton pump inhibitors	131 (77.5)
Antihypertensives	104 (61.5)
Antidiabetics	79 (46.7)
Anticoagulants/antiplatelets	68 (40.2)
Sedatives/hypnotics	52 (30.8)

NSAIDs – Non-Steroidal Anti-Inflammatory Drugs

Overall, 42.6% of patients were prescribed at least one potentially inappropriate medication, with a mean of 1.3 ± 0.6 PIMs per patient. The most common PIMs were prolonged use of NSAIDs (18.3%), followed by benzodiazepines (14.2%) and anticholinergic drugs (10.7%). High-risk opioid use was identified in 9.5% of patients, while other PIM categories accounted for 6.5%, highlighting a substantial burden of inappropriate prescribing in the study population (Table 3).

Table 3: Prevalence and Pattern of Potentially Inappropriate Medications (PIMs) (n = 169)

Variable	Frequency (%)/mean ± SD
Patients with ≥1 PIM	72 (42.6)
Number of PIMs per patient	1.3 ± 0.6
PIM Category	
NSAIDs (prolonged use)	31 (18.3)
Benzodiazepines	24 (14.2)
Anticholinergics	18 (10.7)
Opioids (high-risk use)	16 (9.5)
Others	11 (6.5)

PIMs – Potentially Inappropriate Medications; NSAIDs – Non-Steroidal Anti-Inflammatory Drugs

A significant association was observed between increasing medication burden and adverse clinical outcomes. The incidence of delirium increased progressively from 7.1% in patients receiving <5 drugs to 34.7% in those with ≥10 drugs (p=0.004). Similarly, gastrointestinal complications (p=0.021), renal dysfunction (p=0.018), and ICU admissions (p=0.031) were significantly higher with increasing polypharmacy. Although mortality showed an increasing trend with higher drug use (0% to 8.2%), it did not reach statistical significance (p=0.091). The mean length of hospital stay increased significantly with polypharmacy, from 5.2 ± 1.8 days to 9.6 ± 3.1 days (p<0.001) (Table 4).

Table 4: Association of Polypharmacy with Clinical Outcomes

Outcome	<5 drugs (n=28)	5–9 drugs (n=92)	≥10 drugs (n=49)	p-value
	Frequency (%)/mean ± SD			
Delirium	2 (7.1)	14 (15.2)	17 (34.7)	0.004
GI complications	1 (3.6)	9 (9.8)	11 (22.4)	0.021
Renal dysfunction	1 (3.6)	7 (7.6)	10 (20.4)	0.018
ICU admission	2 (7.1)	11 (12.0)	13 (26.5)	0.031
Mortality	0 (0)	2 (2.2)	4 (8.2)	0.091
Length of stay (days)	5.2 ± 1.8	7.1 ± 2.4	9.6 ± 3.1	<0.001

ICU – Intensive Care Unit; GI – Gastrointestinal

Patients receiving PIMs had significantly worse clinical outcomes compared to those without PIM exposure. The incidence of delirium was markedly higher in the PIM group (30.6% vs 11.3%, p=0.002). Gastrointestinal complications (22.2% vs 5.2%, p=0.001), renal dysfunction (18.1% vs 5.2%, p=0.008), and falls (13.9% vs 4.1%, p=0.024) were also significantly more frequent. ICU admissions were higher among patients with PIMs (22.2% vs 10.3%, p=0.039). Although mortality was higher in the PIM group (5.6% vs 2.1%), this difference was not statistically significant (p=0.241). The mean hospital stay was significantly prolonged in patients with PIM exposure (8.9 ± 3.0 vs 6.5 ± 2.3 days, p<0.001) (Table 5).

Table 5: Association of PIM Use with Clinical Outcomes

Outcome	PIM Present (n=72)	No PIM (n=97)	p-value
	Frequency (%)/mean ± SD		
Delirium	22 (30.6)	11 (11.3)	0.002
GI complications	16 (22.2)	5 (5.2)	0.001
Renal dysfunction	13 (18.1)	5 (5.2)	0.008
Falls	10 (13.9)	4 (4.1)	0.024
ICU admission	16 (22.2)	10 (10.3)	0.039
Mortality	4 (5.6)	2 (2.1)	0.241
Length of stay (days)	8.9 ± 3.0	6.5 ± 2.3	<0.001

PIMs – Potentially Inappropriate Medications; ICU – Intensive Care Unit; GI – Gastrointestinal

Multivariate logistic regression analysis identified hyperpolypharmacy (≥10 drugs) as a significant independent predictor of adverse outcomes (AOR: 2.84; 95% CI: 1.39–5.79; p=0.004). The presence of PIMs was also independently associated with increased risk (AOR: 2.47; 95% CI: 1.28–4.76; p=0.006). Additional significant predictors included age ≥75 years (AOR: 1.91; p=0.042) and higher comorbidity burden (Charlson Comorbidity Index ≥4; AOR: 2.63; p=0.005). Emergency surgery showed an increased risk trend but did not reach statistical significance (p=0.075) (Table 6).

Table 6: Multivariate Logistic Regression Analysis for Predictors of Adverse Outcomes

Variable	Adjusted Odds Ratio (AOR)	95% CI	p-value
Polypharmacy (≥10 drugs)	2.84	1.39–5.79	0.004
Presence of PIMs	2.47	1.28–4.76	0.006
Age ≥75 years	1.91	1.02–3.58	0.042
Charlson Comorbidity Index ≥4	2.63	1.34–5.18	0.005
Emergency surgery	1.78	0.94–3.36	0.075

AOR – Adjusted Odds Ratio; CI – Confidence Interval; PIMs – Potentially Inappropriate Medications; Adverse outcome defined as occurrence of ≥1 of the following: delirium, GI complication, renal dysfunction, ICU admission, or mortality.

Discussion

The present study highlights a substantial burden of polypharmacy and potentially inappropriate medication (PIM) use among elderly patients undergoing orthopaedic surgeries, along with their significant impact on postoperative outcomes. The study population was predominantly in the younger elderly age group (60–69 years), with a moderate comorbidity burden (mean Charlson Comorbidity Index 3.2 ± 1.4), reflecting a typical tertiary care orthopaedic cohort in India. The high prevalence of hypertension (61.5%) and diabetes (46.7%) aligns with previous Indian and global studies by Khaiseret al., Bhagavathulaet al., Bonanno et al., where multimorbidity is a key driver of increased medication use in geriatric surgical patients [10,11,12].

A key finding of this study is the high prevalence of polypharmacy, with 83.4% of patients receiving ≥5 medications and nearly one-third (29.0%) experiencing hyperpolypharmacy. This is consistent with prior reports by Shah et al., and Shankar et al., indicating polypharmacy rates of 60–80% among hospitalized elderly patients [13,14]. The mean number of drugs (8.6 ± 2.9) in our cohort is comparable to studies in perioperative settings, where aggressive pharmacological management—including antibiotics (87.6%), analgesics (82.2%), and proton pump inhibitors (77.5%)—is routinely practiced. While such prescribing patterns are often clinically justified, they substantially increase the risk of drug–drug interactions and adverse drug events [15].

Notably, 42.6% of patients in our study were exposed to at least one PIM based on the Beers Criteria, which is in line with reported prevalence rates ranging from 20% to 50% in geriatric populations in studies by Puig et al., andde Agustín Sierra et al., [16,17]. The predominance of NSAIDs (18.3%), benzodiazepines (14.2%), and anticholinergics (10.7%) reflects common

prescribing practices in orthopaedic patients, particularly for pain management and perioperative sedation. However, these medications are well known to have deleterious effects in elderly individuals due to age-related pharmacokinetic and pharmacodynamic changes, including reduced renal clearance, altered volume of distribution, and increased central nervous system sensitivity [18].

Importantly, our findings demonstrate a strong and statistically significant association between increasing medication burden and adverse clinical outcomes [19]. The incidence of delirium increased nearly fivefold from 7.1% in patients receiving <5 drugs to 34.7% in those with ≥10 drugs (p=0.004), consistent with studies by Pant et al., and Srivastava et al., showing polypharmacy as a major risk factor for postoperative delirium [19,20]. Similarly, gastrointestinal complications, renal dysfunction, and ICU admissions showed a significant upward trend with increasing drug count. These findings can be explained by cumulative drug toxicity, higher likelihood of drug–drug interactions, and impaired physiological reserve in elderly patients [21]. Although mortality increased with polypharmacy (0% to 8.2%), the association did not reach statistical significance, possibly due to the relatively low event rate.

The presence of PIMs further amplified the risk of adverse outcomes. Patients exposed to PIMs had significantly higher rates of delirium (30.6% vs 11.3%, p=0.002), gastrointestinal complications (22.2% vs 5.2%, p=0.001), renal dysfunction (18.1% vs 5.2%, p=0.008), and falls (13.9% vs 4.1%, p=0.024). These findings are consistent with earlier studies by Carolloet al., and Zidan et al., demonstrating that PIM use is independently associated with increased morbidity, hospital stay, and healthcare utilization [22,23]. Mechanistically, benzodiazepines and anticholinergics contribute to delirium through central nervous system depression and cholinergic imbalance, while NSAIDs predispose to gastrointestinal mucosal injury and renal hypoperfusion, especially in the presence of comorbidities [24].

The impact of both polypharmacy and PIMs on healthcare utilization is further reflected in the significantly prolonged hospital stay observed in affected patients. Patients with ≥10 medications had a mean hospital stay of 9.6 days compared to 5.2 days in those with fewer medications (p<0.001), while PIM exposure was associated with an increase of over 2 days in hospitalization duration (p<0.001). These findings are clinically relevant, as prolonged hospitalization increases the risk of nosocomial infections, functional decline, and healthcare costs [25].

Multivariate analysis strengthens these observations by demonstrating that hyperpolypharmacy (AOR: 2.84, p=0.004) and PIM use (AOR: 2.47, p=0.006) are independent predictors of adverse outcomes, even after adjusting for confounders. Additionally, higher age (≥75 years) and greater comorbidity burden (CCI ≥4) were significant contributors, highlighting the multifactorial nature of risk in geriatric surgical patients. These findings are in agreement with prior literature by Bhatt et al., and Bhagavathula et al., emphasizing that both medication burden and patient-related factors synergistically influence outcomes in the elderly [26,27].

Limitations

This study has certain limitations. Its retrospective design limits causal inference and is dependent on the accuracy of recorded data. Being a single-center study, generalizability may be restricted. Potential confounders such as functional status and frailty were not assessed. The low mortality rate may have reduced statistical power for this outcome. Additionally, long-term outcomes after discharge were not evaluated, and medication adherence could not be ascertained.

Conclusion

This study demonstrates a high prevalence of polypharmacy and potentially inappropriate medication use among elderly patients undergoing orthopaedic surgeries, both of which were significantly associated with adverse clinical outcomes. Increasing medication burden and PIM exposure independently contributed to higher rates of delirium, complications, ICU admissions, and prolonged hospital stay. These findings highlight the importance of judicious prescribing, regular medication review, and application of screening tools such as the Beers Criteria in perioperative care. Integrating multidisciplinary approaches, including clinical pharmacists, may help optimize pharmacotherapy, minimize risks, and improve surgical outcomes in this vulnerable population.

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