Research Square

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Postoperative complications in older patients with hip fracture: risk profiles and short-term outcomes from the GIOG 2.0

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Abstract

Purpose

To identify pre- and perioperative risk factors for postoperative complications and the impact of such complications on length of stay (LOS) and in-hospital mortality in older hip fracture (HF) patients.

Methods

the Italian GIOG 2.0, a multicenter, prospective, observational study including patients aged 65 years or more, with proximal HF and free from metastatic cancer, admitted in 14 Italian orthogeriatric wards. Associations of postoperative complications with patient and procedure-related factors and hospital short term outcomes were examined using uni- and multivariable regression analyses.

Results

A total of 1,637 patients were included; 76% were female, with a mean age of 83.6 years. Overall, 42% of patients experienced at least one complication, including postoperative delirium (POD) (28%), cardiac events (27%), pneumonia (19%), and urinary tract infection (UTI) (17%). Independent correlates of POD included age, dementia, psychoactive drug use, and ASA score > II. Pneumonia was independently associated with age, ADL disability, preoperative delirium, surgical delay, and urinary catheter (UC) use, and negatively with general anesthesia. Cardiac complications were associated with age, heart failure, COPD, polypharmacy, and UC use. UTI was strongly associated with UC use, with variability across enrolling centers ($p < 0.001$). All complications were associated with increased LOS, whereas only pneumonia independently increased in-hospital mortality (Odds Ratio 5.06, 95% CI 1.68–15.30, $p = 0.003$).

Conclusions

Postoperative complications in orthogeriatric patients are associated with adverse short-term outcomes. Potentially modifiable perioperative factors—particularly UC use, surgical delay, psychoactive medication exposure, anesthesia type, and polypharmacy—may represent targets for preventive strategies in older HF patients.

Key Points

Aim: To identify pre- and perioperative risk factors for postoperative complications and the impact of such complications on length of stay and in-hospital mortality in older hip fracture patients.

Results: 42% of patients developed at least one postoperative complication (delirium, cardiac events, pneumonia, UTI), each linked to longer hospital stay, while pneumonia alone was independently associated with higher in-hospital mortality. Patient-related, procedural and center-specific factors were differently associated with postoperative complications.

Message: The identification of modifiable risk factors may support early risk stratification and the implementation of targeted preventive strategies and tailored perioperative management to reduce complications and improve short-term outcomes after HF surgery.

Introduction

Hip fracture (HF) in older adults represents a major global health burden, particularly in the context of an aging population and increasing life expectancy. It is associated with high rates of morbidity, mortality, functional decline, and prolonged disability [1, 2]. Patients hospitalized for HF are often characterized by multiple comorbidities, polypharmacy, and varying degrees of cognitive and functional impairment that contribute to the elevated incidence of postoperative complications and in-hospital mortality [3]. Postoperative complications encompass a broad spectrum of conditions, with pneumonia being among the most frequent [4]. These complications negatively impact recovery trajectories, prolong hospitalization, and increase the risk of death during the acute phase [5, 6]. Traditional models of care often fall short in adequately identifying and managing the complex interplay of risk factors in this highly vulnerable population [7, 8]. To address these challenges, integrated orthogeriatric care models have been developed [9]. These models emphasize close interdisciplinary collaboration—particularly between orthopedic surgeons and geriatricians—and have demonstrated benefits in reducing postoperative infections, cardiovascular complications, hospital length of stay, and mortality rates [10]. However, despite these advances, postoperative complications remain a relevant issue even within orthogeriatric settings, indicating the need for further refinement of risk stratification strategies [11, 12]. To date, evidence is limited regarding the specific pre and perioperative factors that predispose patients to individual postoperative complications [13].

The aim of this study was to identify pre and perioperative risk factors associated with the most frequent postoperative complications in older patients with HF, and to evaluate the impact of postoperative complications on postoperative length of stay (P-LOS) and in-hospital mortality. The analysis was conducted within an integrated orthogeriatric care model, to avoid procedural limitations intrinsic to the traditional model of care.

Methods

Setting and sample selection

We used data from the Gruppo Italiano di OrtoGeriatria (Italian Group of Orthogeriatrics, GIOG 2.0) from July 2019 till December 2023. The GIOG2.0 is a multicenter, prospective, observational study collecting data of patients aged 65 years or more, with proximal HF and free from metastatic cancer, admitted in 14 Italian orthogeriatric wards with geriatric co-management [14]. The study protocol was centrally approved by the Brianza Ethics Committees and then ratified at all participating institutions.

A total of 1637 patients with complete data on key baseline variables, perioperative data, and outcomes were included in the final analysis (Fig. 1). Characteristics of included and excluded patients were compared to assess potential selection bias (Suppl. Table 1).

Study measures and outcomes

On admission, each patient underwent a Comprehensive Geriatric Assessment (CGA), including socio-demographic data, comorbidities (CharIson Comorbidity Index, CCI) [15], polypharmacy (presence of 5 or more drugs) [16], use of psychoactive drugs (including benzodiazepines, antipsychotics, gabapentionoids, antiepileptics, and antidepressants), premorbid functional status (Activities of Daily Living, ADL) [17], cognitive status (Short Portable Mental Status Questionnaire, SPMSQ) [18], presence of delirium (4AT) [19] and nutritional status (Mini Nutritional Assessment, MNA) [20].

During hospitalization, the following data were collected: the American Society of Anesthesiologists (ASA) Classification score [21], time between admission and surgery, type of HF, type of surgical intervention and anesthesia, the use of urinary catheter (UC), and need of peri-operative blood transfusions.

For the present study we selected potential predictors of postoperative complications, including demographic characteristics, comorbidities, and multidimensional domains derived from the CGA. In particular, functional status (ADL), nutritional status (MNA), dementia (CCI), polypharmacy, and preoperative delirium were considered proxies of frailty, reflecting patients' vulnerability to stressors such as surgery [22]. Although a formal frailty scale was not available, these variables capture the multidimensional construct of frailty commonly used in geriatric research [23].

Postoperative complications were defined as organ or system complication affecting the diagnosis, management, or treatment of patients [24]. Complications were assessed at the time of hospital discharge from the acute ward using a standardized checklist of relevant clinical post-operative complications known to impact length of stay and perioperative mortality [3]. The list included acute kidney injury, chronic obstructive pulmonary disease (COPD) exacerbation, cardiac arrhythmias, thromboembolism, heart failure/ischemia, cerebrovascular accident, postoperative delirium (POD), pneumonia, sepsis, urinary tract infection (UTI) and surgical site infection. From this list, we focused our analyses on the most common complications, *i.e.* those with a prevalence of at least 15%: pneumonia, UTI, cardiac complications (including heart failure, cardiac ischemia and arrhythmias), and POD.

Pneumonia was defined as the presence of a new or progressive infiltrate on chest radiography, in combination with clinical criteria.

UTI was defined based on the presence of clinical signs or symptoms suggestive of infection, in combination with microbiological confirmation. The different use of UC among centres was calculated using percentages and displayed in a stacked bar plot. In order to have a large scale experience, centres were included only if information on UC use was available for at least 40 patients.

Cardiac complications included myocardial infarction, acute decompensated heart failure (ADHF), new-onset severe arrhythmias, or cardiac arrest occurring during hospitalization. Myocardial infarction was defined as an elevation in cardiac troponin levels associated with clinical symptoms, electrocardiographic changes, and evidence of ventricular wall motion abnormalities on echocardiography. ADHF was diagnosed based on clinical signs and symptoms, elevated NT-proBNP levels, or radiographic evidence of pulmonary congestion or edema. New-onset severe arrhythmias were defined as the occurrence of previously undocumented ventricular tachycardia, atrial flutter, atrial fibrillation, paroxysmal supraventricular tachycardia, or the absence of a detectable cardiac rhythm or the presence of a life-threatening arrhythmia, defined as cardiac arrest. POD was defined as an acute, fluctuating disturbance of attention and awareness, with an associated change in cognition [25]. It was screened daily during the first 72 hours after surgery using the 4AT [19]; a score ≥ 4 indicated possible delirium and prompted formal clinical assessment in patients without evidence of preoperative delirium. P-LOS was the time from the surgical intervention till discharge, and in-hospital mortality was considered as the occurrence of death during hospitalization and after surgical intervention.

Analytical approach and statistical analysis

The main socio-demographical and clinical characteristics of the study cohort have been analyzed by descriptive statistics. Continuous variables were reported as mean with standard deviation (SD) or median with interquartile range (IQR). Conversely, categorical variables were presented with numbers and percentages. Comparisons were carried out with Chi-squared test, ANOVA or Kruskal-Wallis test, as appropriate. Baseline characteristics of included and excluded patients were additionally compared using standardized mean differences, with values < 0.1 indicating negligible differences, to account for the influence of sample size on statistical significance. Based on existing evidence, we hypothesized that distinctive risk factors contribute to the occurrence of specific postoperative complications, which in turn influence in-hospital mortality and length of stay [3, 26, 27].

Uni- and multivariable regression analyses were used to identify factors associated with the most common postoperative complications, i.e. POD, cardiac complications, pneumonia, and UTI. In multivariable logistic regression models for UTI we tested the interaction between UC use and time to surgery by including an interaction term, given the hypothesis that longer pre-operative periods could be associated with increased catheterization time and infection exposure. Finally, the associations of distinctive postoperative complications with postoperative in-hospital mortality, as well as with P-LOS,

were explored using generalized regression models (logistic and linear respectively). Variables associated with a p value < 0.10 at univariate analyses and those with a clinical rationale supporting a potential association with the outcomes were included in multivariable regressions. All analyses were performed using R statistics 4.2.0 (R Foundation for Statistical Computing, Vienna, Austria, www.R-project.org).

Results

The general sociodemographic and clinical characteristics of the study sample are reported in Table 1. Of 1637 older individuals with HF, the majority were women (76%), the mean age was 83.6 years, with a median CCI of 5, and a high prevalence of ADL disability (42%), dementia (31%), diabetes mellitus (21%) and polypharmacy (34%). .

Almost half (44%) subjects had at least an ASA III class, 87% received a spinal anesthesia and 77% underwent surgical intervention before 48h from hospital admission.

Overall, 688 (42%) patients experienced at least a complication after the surgical intervention. Among them, the most prevalent were POD (28%), cardiac complications (27%), pneumonia (19%) and UTI (17%).

The occurrence of POD was associated at univariate analysis with age, moderate-severe chronic kidney disease (CKD), dementia, psychoactive drug use, ASA score > II, blood transfusion, and use of UC (Suppl. Table 1). When adjusting for potential confounders, POD remained independently associated with age (aOR 1.02, 95%CI 1-1.05, p = 0.05), dementia (1.45, 95%CI 1.03–2.02, p = 0.032), use of psychoactive drugs (aOR 1.48, 95%CI 1.07–2.04, p = 0.017), and ASA score > II (aOR 4.56, 95%CI 1.87–15.07, p = 0.003; Table 2).

Cardiac complications were associated at univariate analysis with age, the presence of CHF, COPD, peripherical vascular disease, ADL disability, polypharmacy, an ASA score > II, the use of general anesthesia, the need for blood transfusion and the use of UC (Suppl. Table 2). From the multivariable regression analysis, only the following variables remained independently associated with the occurrence of cardiac complications: age (aOR 1.08, 95%CI 1.04–1.11, p < 0.001), CHF (aOR 2.72, 95%CI 1.73–4.21, p < 0.001), COPD (aOR 1.72, 95%CI 0.97–2.94, p 0.05), polypharmacy (aOR 1.6, 95%CI 1.08–2.37, p 0.02), and the use of UC (aOR 2.07, 95%CI 1.39–3.1, p < 0.001; Table 2).

Patients who experienced UTIs were more likely to be male and to have diabetes, peripherical vascular disease, malnutrition, an ASA score > 2 and to use psychoactive drugs and UC (Suppl. Table 3). When adjusting for potential confounders, only the use of UC (aOR 2.6 ,95%CI 1.76–3.87, p < 0.001) remained significantly associated to UTIs, whereas time to surgery > 48h remained inversely associated with UTI (Table 2). The interaction term between UC use and time to surgery was not statistically significant (p for interaction = 0.416). In stratified analyses, UC was associated with increased odds of UTI in both surgical

timing strata, with overlapping confidence intervals (Suppl. Figure 1). Moreover, the prevalence of use of UC significantly varied among the enrolling centers, thus representing a center-specific factor (Suppl. Figure 2).

Patients with a diagnosis of postoperative pneumonia were more likely to be older and male, and more frequently had functional decline, malnutrition, polypharmacy, psychoactive drug use, moderate-to-severe CKD, CHF, myocardial infarction, COPD, dementia, preoperative delirium, and time to surgery > 48h (Suppl. Table 4). However, after adjusting for confounding factors, only age (aOR 1.04, 95%CI 1.01–1.07, p 0.018), ADL score (aOR 1.64 95%CI 1.06–2.57, p 0.028), preoperative delirium (aOR 1.97, 95%CI 1.22–3.16, p 0.005), time-to-surgery > 48h (aOR 1.59, 95%CI 1.05–2.37, p0.024), and UC use (aOR 1.51, 95%CI 1.02–2.22, p 0.036) were independently associated with the occurrence of pneumonia, whereas general anesthesia, compared with spinal, was inversely associated with this outcome (aOR 0.25, 95%CI 0.09–0.58, p 0.004) (Table 2).

Regarding the impact of complications on in-hospital mortality, logistic regression models disclosed a significant association only with pneumonia (OR 5.06, 95%CI 1.68–15.3, p 0.003) (Table 3). Conversely, all the most prevalent complications were significantly associated with a prolonged P-LOS (beta + 1.73, 95%CI 0.82–2.64, p < 0.001 for UTI; beta + 1.88, 95%CI 0.42–3.34, p 0.01 for pneumonia; beta + 2.73, 95%CI 1.83–3.62, p < 0.001 for cardiac complications; beta + 1.16, 95%CI 0.42–1.90, p 0.002; Table 3).

Discussion

This multicenter, prospective study of older Italian HF patients admitted in orthogeriatric centers shows that almost half of the individuals experience postoperative complications, with POD, pneumonia, UTI and cardiac complications as the most frequent ones. Interestingly, patient-related (age, comorbidities, polypharmacy, functional dependence, preoperative delirium, ASA-score), procedural (type of anesthesia, time to surgery) and center-specific factors (use of bladder catheter) were differently associated with postoperative complications. Finally, all the studied complications were associated with a prolonged P-LOS, but only pneumonia with in-hospital mortality.

The incidence of complications after HF surgery varies among studies depending on the source data, and the variable definition, classification or assessment of complications [28]. The cumulative frequency of postoperative complications recorded in the GIOG study aligns with findings from a recent Spanish multicenter prospective study in orthogeriatric services [2]. On the other hand, a higher incidence of complications characterized usual care models [7, 24, 29, 30].

An independent association between delirium and pneumonia has been widely reported in HF patients [31–33]. Our study expands this observation by showing that delirium precedes and, then, likely is a risk factor for pneumonia. Indeed, patients developing delirium are usually characterized by an important burden of multimorbidity, malnutrition, cognitive, sensorial and functional problems which probably

contribute to patients' vulnerability to the surgical stress and the onset of major infective complications [34]. The relationship between postoperative pneumonia and pre-operative dependence status has been less well studied, but the current results are in keeping with the study of Zhang et al [35]. Indeed, preoperative dependence was related to postoperative pneumonia independently from the presence of dementia, a known risk factor for impaired swelling function and risk of aspiration. Functional decline might be related to respiratory muscles' weakness, ineffective cough and expectoration, likely contributing to an increased risk of pneumonia [36].

In our cohort, general anesthesia was independently associated with a significantly reduced risk of postoperative pneumonia. However, current evidence on this topic remains inconclusive.

The REGAIN trial, one of the largest RCTs in HF patients, found no significant difference in pneumonia or other respiratory events between spinal and general anesthesia [37]. This finding has been confirmed by similarly, several large-scale observational studies [38]. Our results might depend upon selection bias, whereby patients at higher baseline risk of respiratory complications (e.g., frailty, chronic lung disease, or greater comorbidity burden) may have been preferentially selected for spinal anesthesia. Moreover, residual confounding may have influenced both anesthetic choice and pneumonia risk. Finally, consistent with previous literature, our findings confirm that postoperative pneumonia has major prognostic relevance, being strongly associated with both increased in-hospital mortality and prolonged length of stay [39, 40].

POD was the most common complication among older patients with HF in our cohort. This rate is consistent with that reported in a companion GIOG 2.0 paper specifically focused on perioperative delirium phenotyping which identified isolated POD in 12.2% of patients [34]. The higher rates described in large observational studies and meta-analyses (19–26%) likely reflect broader delirium definitions encompassing both preoperative and postoperative phases[41, 42]. Well known risk factors for POD include advanced age, pre-existing cognitive impairment or dementia, higher ASA score, functional dependency, and perioperative factors [42]. Present findings are confirmatory besides stressing the role of psychoactive medications. The relationship between psychoactive drugs and POD appears to be bidirectional: not only do these medications increase delirium risk, but POD itself was shown to be an independent correlate of psychoactive drug deprescribing in the GIOG 2.0 cohort, suggesting that delirium onset may prompt clinicians to reassess and reduce psychotropic prescriptions during hospitalization [43].

Cardiac complications were the second most common complication in our cohort with an incidence of 11.3%. This rate appears slightly higher than that reported by Roche et al. in a prospective study of 2,448 orthogeriatric patients, as well as in more recent reports [29, 44, 45]. Consistently, we found that preoperative factors such as age, congestive heart failure (CHF), COPD, polypharmacy, and the use of UC herald cardiac complications, in keeping with the study of Ran et al. [46].

Finally, UC is the only independent correlate of UTI, in line with other studies [47]. We found a higher incidence of UTI with regard to studies made in the UK, where a strict adherence to national guidelines

likely limited UC during the perioperative period [29, 48]. Conversely, our results showed that the rate of UC use varied among the GIOG enrolling centers (Suppl. Figure 2), and this largely accounted for the variable incidence of UTI.

Moreover, in the present study, time to surgery beyond 48 hours was unexpectedly associated with a lower incidence of UTI. Interestingly, the interaction between surgical timing and UC use shows that the apparent protective effect of delayed surgery emerged only in non-catheterized patients suggesting that the lower UTI rate observed in patients with delayed surgery could be attributable to differences in perioperative urinary management.

The current study contributes to the current literature by showing that even in a standardized orthogeriatric model of care selected postoperative complications are highly incident and impact short-term outcomes [47]. Interestingly, the profile of risk for postoperative complications varies with the individual complication and variably includes patient-related and procedural factors. Among procedural factors, the use of UC is the leading risk factor for UTI, whereas time to surgery associates with the risk of pneumonia.

The detection of modifiable preoperative risk factors might help to prevent postoperative complications by planning targeted interventions. For instance, avoiding or removing timely the UC could prevent UTI and promote early mobilization as international guidelines emphasize the shortest duration, appropriate indications, and daily reassessment of UC to prevent catheter-associated infections [49, 50].

This study has several limitations. First, the orthogeriatric network did not share an anesthesiological policy limiting our insight into the relationship between type of anesthesia and complications. Second, important variables such as plasma biomarkers, and postoperative care practices (including nursing care and physiotherapy) were not assessed, although they may have contributed to the outcomes of interest. Third, excluded patients significantly differed from the analytical cohort in terms of UC use rates, which may have led to an underestimation of the overall incidence of complications such as UTI as well as of some predictor-outcome associations. Finally, as with any observational study, identified associations do not imply causality.

The strengths of this study include the prospective data collection, the large sample size, and wide representativeness of the participating centres, selected by size and geographical region, as a multicentric study. Additionally, all patients underwent a standardized GCA, and the recruitment process adhered to criteria ensuring procedural homogeneity.

Conclusions

More than one third of older patients receiving orthogeriatric care experienced postoperative complications. POD and cardiac complications were more frequent than infectious complications and were associated with prolonged hospital stay, whereas only pneumonia was associated with increased in-hospital mortality.

The identification of modifiable risk factors may support early risk stratification and the implementation of targeted preventive strategies and tailored perioperative management to reduce complications and improve short-term outcomes after HF surgery.

Abbreviations

POD
postoperative delirium
UTI
urinary tract infection
MNA
mini nutritional assessment
ADL
activities of daily living
CCI
Charlson comorbidity index
CKD
chronic kidney disease
CHF
congestive heart failure
COPD
chronic obstructive pulmonary disease
PVD
peripheral vascular disease
ASA
American Society of Anesthesiologists

Declarations

Competing interest: The authors have no relevant financial or non-financial interests to disclose.

Ethical approval: This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee Brianza Institutional Review Board on April 12th, 2019.

Informed consent: Informed consent was obtained from all individual participants included in the study.

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Data availability: Individual participant data cannot be made publicly available due to the sensitive nature of the personal health data col lected and privacy and confidentiality reasons. However, under cer

tain conditions, these data could be made accessible for statistical and scientific research. For further information, please contact the corre sponding author.

Authors' contributions: AC, ADV and RAI designed the study. AC, ADV performed the statistical analyses. All of the authors reviewed or contributed to the analysis and interpretation of the data, and preparation of the manuscript. Everyone who contributed significantly to the article has been included as an author providing final approval of the manuscript for publication.

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Tables

Table 1 Sociodemographic and clinical characteristics of study cohort

Variable	N
N patients	1637
Age (years)	83.6 (7.2)
Sex (Female)	1244 (76%)
Malnutrition (MNA)	168 (10%)
CCI, median(IQR)	5 (4-7)
Diabetes Mellitus	351 (21%)
CKD (Moderate-severe)	257 (16%)
CHF	199 (12%)
Myocardial Infarction	366 (22%)
COPD	142 (9%)
PVD	246 (15%)
Dementia	511 (31%)
ADL disability[a]	684 (42%)
Preoperative delirium	299 (18%)
ASA score	
I	171 (10%)
II	557 (34%)
III	718 (44%)
IV	189 (12%)
V	2 (0%)
Anesthesia	
General	183 (11%)
Spinal	1422 (87%)
Use of urinary catheter	612 (37%)
Time to surgery < 48h	1256 (77%)
Hospitalization length (days)	9 (7-13)
Postoperative days	7 (6-10)
Polipharmacy at admission	563 (34%)

Psychoactive drugs at admission	604 (37%)
Blood transfusion >= 1 *before and during surgery*	212 (13%)
Postoperative complications	688 (42%)
POD	192 (28%)
Cardiac complications[b]	185 (27%)
Pneumonia	129 (19%)
UTI	120 (17%)
Others[c]	62 (9%)

Continuous variables reported as mean (standard deviation, SD) or medians (25^{th}-75^{th} centile). Categorical variables expressed as numbers with percentage (%)

[a]Defined as the pre-existing loss of at least 2 activities of daily living

[b]Cardiac complications including heart failure and/or cardiac arrhythmias and/or ischemia

[c]Others: Acute kidney injury, acute COPD exacerbation, thromboembolism, cerebrovascular accident (CVA), sepsis, septic shock, skin infections, gastrointestinal, hemorrhages (not intracranial) and hematomas

Abbreviations: MNA, mini nutritional assessment; CCI, Charlson comorbidity index; CKD, chronic kidney disease; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; PVD, peripheral vascular disease; ADL, activities of daily living; ASA, American Society of Anesthesiologists; POD, postoperative delirium; UTI, urinary tract infection.

Table 2 Multivariable logistic regression analysis of perioperative variables associated with postoperative complications

	POD	CARDIAC	UTI	PNEUMONIA
Perioperative variables	aOR(95% CI), P	aOR (95% CI), P	aOR (95% CI), P	aOR (95% CI), P
Age (years)	1.02 (1-1.05), 0.054	1.08 (1.04-1.11), <0.001		1.04 (1.01-1.07), 0.018
Gender (Female)			0.61 (0.4-0.92), 0.017	0.74 (0.49-1.13), 0.153
Malnutrition (MNA)			1.5 (0.86-2.49), 0.135	0.96 (0.54-1.65), 0.896
ADL disability[a]		0.93 (0.62-1.39), 0.72		1.64 (1.06-2.57), 0.028
Diabetes Mellitus			1.38 (0.89-2.11), 0.141	
CKD (Moderate-severe)	0.78 (0.58-1.01), 0.09			1.52 (0.95-2.38), 0.075
CHF		2.72 (1.73-4.21), <0.001		1.41 (0.84-2.29), 0.178
Myocardial Infarction				1.15 (0.74-1.76), 0.533
COPD		1.72 (0.97-2.94), 0.052		1.69 (0.95-2.89), 0.065
PVD		1.02 (0.62-1.63), 0.932	1.25 (0.76-1.99), 0.366	
Dementia	1.45 (1.03-2.02), 0.032			0.81 (0.49-1.3), 0.378
Polypharmacy		1.6 (1.08-2.37), 0.02		1.34 (0.89-2), 0.163
Psychoactive drug	1.48 (1.07-2.04), 0.017		1.41 (0.95-2.08), 0.084	1.21 (0.8-1.83), 0.364
Preoperative delirium	-			1.97 (1.22-3.16), 0.005
Asa score >II	4.56 (1.87-15.07), 0.003	5.98 (1.28-106.7), 0.079	1.64 (0.71-4.8), 0.299	
General anesthesia		1.41 (0.82-2.34), 0.194	1.1 (0.63-1.86), 0.721	0.25 (0.09-0.58), 0.004

Time to surgery >48h			0.56 (0.32-0.92), 0.028	1.59 (1.05-2.37), 0.024
Blood transfusion [b]	1.26 (0.82-1.91), 0.274	1.45 (0.89-2.31), 0.129		
Urinary catheter	1.28 (0.93-1.76), 0.125	2.07 (1.39-3.1), <0.001	2.6 (1.76-3.87), <0.001	1.51 (1.02-2.22), 0.036

aOR = adjusted odds ratio; CI = confidence interval

Separate multivariable logistic regression models were developed for each complication. Variables with P <0.10 at univariate analysis were included in the corresponding model; therefore, covariates differed between models

[a]Defined as the pre-existing loss of at least 2 activities of daily living

[b]At least 1 blood transfusion before or during surgery

Abbreviations: POD, postoperative delirium; UTI, urinary tract infection; MNA, mini nutritional assessment; ADL, activities of daily living; CCI, Charlson comorbidity index; CKD, chronic kidney disease; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; PVD, peripheral vascular disease; ASA, American Society of Anesthesiologists

Table 3 Impact of postoperative complications on short-term outcomes

Outcome	Variable	NO	YES	p	OR (95%CI), p value
Postoperative inhospital mortality	UTI	24 (2%)	2 (2%)	1.0	1.05 (0.17-3.61), 0.94
	Pneumonia	7 (2%)	7 (10%)	0.004	5.06 (1.68 -15.3), 0.003
	Cardiac	22 (1%)	4 (3%)	0.24	2.3 (0.66-6.13), 0.131
	POD	25 (2%)	1 (1%)	0.341	0.3 (0.02-1.41), 0.235
Outcome	**Variable**	**NO**	**YES**	**p**	**Beta (95%CI), p value**
Post-operative length of stay (P-LOS)	UTI	7 (6-10)	9 (6-13)	0.002	+1.73 (0.82-2.64), <0.001
	Pneumonia	8 (6-11)	9 (7-14)	0.007	+1.88 (0.42-3.34), 0.01
	Cardiac	7 (6-10)	9 (7-14)	0.001	+2.73 (1.83-3.62), <0.001
	POD	7 (6-10)	8 (6-11)	0.09	+1.16 (0.42-1.90) 0.002

Continuous variables reported as medians (25^{th}-75^{th} centile). Categorical variables expressed as numbers with percentage (%)

Abbreviations: CI, confidence intervals; OR, odds ratio; UTI, urinary tract infection; POD, postoperative delirium

Figures

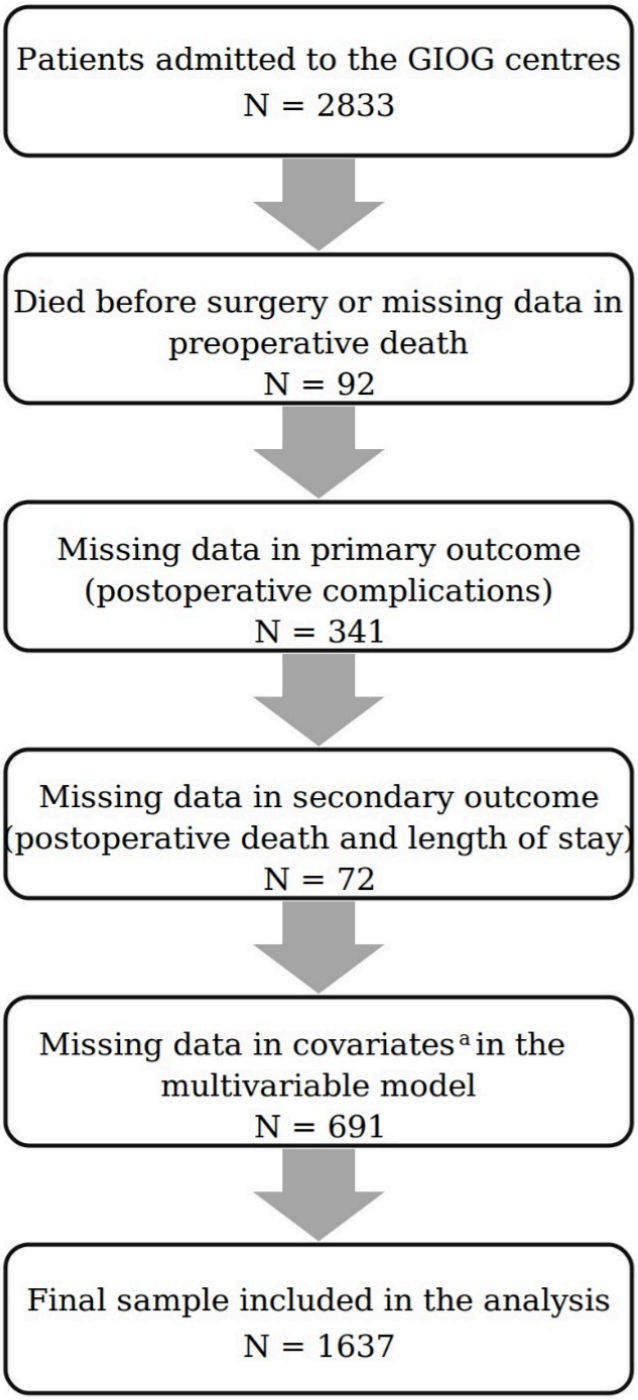


Figure 1

Flow chart of patient selection

[a]*Covariates: age, sex, MNA, CCI, ADL, polipharmacy at admission, psychoactive drugs at admission, preoperative delirium, ASA score, general anesthesia, time to surgery > 48h, blood transfusion, use of urinary catheter*

Supplementary Files

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