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TESI DI LAUREA

Which is the association between patient-related variables and type of hospital discharge in geriatric surgical patients? Findings from a retrospective study.

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Key points

- Preoperative functional status significantly influences hospital discharge destination for geriatric surgical patients.
- Impaired preoperative functional status correlates with a reduced probability of patients being discharged to their homes.
- Incorporating both sociodemographic and clinical factors promotes a more comprehensive approach to discharge planning.

Why does this paper matter?

This study corroborated the crucial impact of preoperative functional status on predicting hospital discharge destinations for geriatric surgical patients. To optimize discharge planning, standardized assessment tools for preoperative functional status should incorporate both the patient's clinical condition and social circumstances. This comprehensive approach would provide a more holistic view of the patient's situation, potentially leading to better-informed discharge decisions and improved patient outcomes.

ABSTRACT

Background: Geriatric surgical patients often present with clinical and social conditions that influence their discharge destination, such as lack of social support or poor preoperative functional status. During hospitalization, patients requiring personalized discharge plans are identified to facilitate home return and prevent prolonged hospital stays. This study aims to identify the main patient-related variables associated with home discharge in geriatric surgical patients.

Methods: A retrospective observational study was conducted, analyzing medical records of patients aged ≥65 years who underwent general, orthopedic, otolaryngologic, urologic, or vascular surgery in three northern Italian hospitals between January and December 2024. Preoperative functional status was assessed using the Barthel index, along with sociodemographic and clinical data. Univariate analysis and logistic regression were performed to identify predictors of home discharge.

Results: Of 2,015 patients, 77% were discharged home. Positive associations with home discharge were found for age (OR=1.040, $p<0.001$), higher Barthel scores at discharge (OR=1.028, $p<0.001$), and higher hemoglobin levels (OR=1.023, $p<0.001$). Conversely, male gender (OR=0.496, $p<0.001$), higher Barthel scores at admission (OR=0.983, $p<0.001$), orthopedic surgery (OR=0.118, $p<0.001$), and higher BRASS scores (OR=0.842, $p<0.001$) were associated with a lower likelihood of home discharge.

Conclusions: Functional status is a significant predictor of discharge destination in geriatric surgical patients. Standardized functional assessments should be integrated into preoperative evaluations to enhance discharge planning.

KEYWORDS

geriatric patients, preoperative status, hospital discharge, preoperative functional assessment, discharge planning, geriatric surgery

SUMMARY

INTRODUCTION

The number of geriatric patients undergoing surgical procedures is increased.[1] In geriatric surgical patients, various preoperative factors influence their discharge destination - whether returning home or requiring transfer to intermediate care facilities (ICFs) or skilled nursing facilities (SNFs) - with discharge planning focusing on identifying the most appropriate destination and assessing their needs for a safe transition between care levels.[2–4] Discharge planning decisions for geriatric surgical patients are a crucial aspect of perioperative care that impacts health care costs, and a coherent and efficient discharge plan is considered a measure of quality care, as it ensures safety, continuity of care, reduces the risk of complications and readmissions and improves the patient experience.[5–7]

Geriatric surgical patients often present unique challenges due to complex health profiles, including comorbidities and functional or cognitive impairments, which can impact surgical outcomes and discharge planning.[8,9] Factors like living alone, chronic comorbidities, and compromised preoperative functional status are predictors of non-home discharge for these patients.[2,6,10–12]

Several studies have examined the factors that influence discharge destinations for geriatric surgical patients. Han et al. reported in their systematic review that age does not influence on hospital discharge destination, but patients over 65 years of age can present frailty, which is a nonspecific state of vulnerability reflecting multisystem physiological changes that can compromise personal autonomy and is significantly associated with increased mortality, postoperative complications, prolonged stay, and discharge to residential care facility.[13] Ahn et al. conducted a retrospective study in United States (US) and reported that within their cohort of 1,232 patients, 248 (20%) were discharged to a non-home facility and these patients were more frequently over 65 years of age, partially or total dependent in Activity of Daily Living (ADL), diabetics and with the American Society of Anesthesiologists class (ASA) ≥ 3, which indicates severe systemic disease and worst.[5] Ayyala et al. conducted a retrospective study on a cohort of 4,595 geriatric patients, and they explained that patients with diabetes or hypertension had a 65% higher risk for non-home discharge, compared to patients without any of these comorbidities, and patients with dependent functional status had a nearly a 4.5 times higher risk of discharge to a facility.[10] Similarly, Hung et al. have conducted a retrospective study in US

within 44,219 geriatric subjects and they have highlight a statistically significative relationship between compromised preoperative functional status, categorized as indipendent, partially dependent and totally dependent, and discharge destination showing that patients who were partially dependent had five times higher odds of discharging to ICFs or SNFs, compared to patients who were independent, and patients who were totally dependent had three times higher odds of discharging to non home than patients who were independent.[2]

Most studies have primarily focused on clinical factors, overlooking the critical role of social determinants, such as living situations, caregiver availability, and socioeconomic status, which can significantly impact discharge planning. To date no data on the relationship functional status and discharge destination have been reported in the italian contenxt.

This study aims to identify the main patient-related variables associate with home discharge destination in geriatric surgical patients.

METHODS

Study design

A retrospective observational study was conducted, based on medical records. The study was reported according the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.[14]

Setting

Data were collected from three hospitals located in northern Italy: one hub hospital and two spoke hospitals. The hub-and-spoke organizational model organizes service delivery resources into a network, with a central establishment (hub) providing a comprehensive range of services. This model is supported by secondary locations (spokes) offering a narrower set of services and directing patients who require more specialized care to the hub for treatment.[15] In the study setting, these hospitals are situated in a mountainous, touristic area. The characteristics of the hospitals are described in Supplementary Table 1.

Population

These hospitals serve as a reference point for approximately 200,000 habitants. The sample consisted of patients aged 65 and older who underwent general, urologic, orthopedic, vascular, and otolaryngologic surgery and were discharged from the hospital between January 1, 2024, and December 31, 2024. Patients who lived in a facility before hospitalization (n = 103), died during hospitalization (n = 26), were transferred to hospice care (n = 8), or self-discharged (n = 5) were excluded from the study. In Figure 1, the sampling process of the study is presented.

Data collection

After obtaining formal authorization from the responsible authorities, a retrospective review of medical records was conducted to collect sociodemographic, clinical information, and discharge information. Sociodemographic variables included age, gender, and details about the patients' living situation prior to hospitalization. Clinical variables were collected to provide a comprehensive picture of each patient's health status and care trajectory. The preoperative functional status was assessed using Barthel index, to evaluate patients' level of independence

at both admission and discharge. The variables of interest are described in Supplementary Table 2. Medical records were extracted by a hospitals Data Manager and sheered with the research team anonymously.

Statistical analysis

Statistical analysis was performed using SPSS® software, v27 (IBM Corp., Armonk, NY). Descriptive statistics were used to describe the characteristics of the sample, reporting the mean and standard deviation (SD) for continuous data and frequencies and percentages for categorical data. A univariate analysis between patients discharged home and those discharged not at home was conducted using the t-test for continuous variables and the Chi-square test for categorical variables. A p-value < 0.05 was considered statistically significant. Binary logistic regression analysis was performed using a backward stepwise approach to identify predictors of discharge to home. A factor was considered statistically significant if the 95% confidence interval of its odds ratio (OR) did not include 1, the ratio was considered statistically significant.

Ethical statement

Ethical approval was obtained from the Ethics Committee of the northern area of Veneto region (Italy): CET ANV 2025-09 (January 30, 2025). This study adhered to the ethical standards and principles established by the Declaration of Helsinki October 2024. Protection of personal data was guaranteed in accordance with Regulation 2016/679 of the European Parliament (GDPR) and relevant legislation on data protection.

RESULTS

The sample consisted of 2,015 patients, of whom 1,551 (77.0%) were discharged at home and 464 (23.0%) were discharged not at home. Regarding the discharge destination, 48.1% ($n = 223$) of the patients not discharged at home were transferred to an ICF, 48.9% ($n = 227$) were discharged to an SNF, and 3% ($n = 14$) were discharged to another acute hospital. The sociodemographic characteristics were described in Table 1. Overall, the mean age of the sample was 78.4 years (SD ± 8.1). Patients discharged at home had a mean age of 77.6 years (SD ± 7.8), while those discharged not at home had a mean age of 81.0 years (SD ± 8.2; $p < 0.001$). Regarding gender, 51.7% of the total sample were female, with a higher proportion among those discharged not at home (58.4%) compared to those discharged at home (49.7%; $p = 0.001$).

Regarding the living situation before surgery, 66.6% ($n = 1342$) of the total sample lived with a caregiver, 24.3% ($n = 489$) lived alone with caregivers, and 9.1% ($n = 489$) lived alone. Patients discharged home were more likely to live with a caregiver (70.1%) compared to those discharged not at home (54.7%), while the latter were more likely to live alone (12.1% vs 8.2%) or alone with caregivers (33.2% vs 21.7%; $p < 0.001$).

The clinical characteristics of the sample are described in Table 2. The total mean of Barthel index score at admission was 75.1 (± 32.8), and at discharge it was 78.6 (± 23.4). Patients discharged home had higher mean Barthel Index scores at admission (81.7 ± 28.2) compared to those discharged not at home (53.3 ± 37.1; $p < 0.001$). Similarly, at discharge, patients discharged home had a higher mean score (84.5 ± 18.6) than those discharged not at home (58.9 ± 26.9; $p < 0.001$), indicating better functional autonomy.

The most common comorbidities in the total sample were hypertension ($n = 1452$; 72.0%), tumors ($n = 525$; 26%), and diabetes mellitus ($n = 409$; 20.3%). The mean number of comorbidities was 1.9 (± 1.1). The main surgical procedures were orthopedic surgery ($n = 962$; 47.7%), followed by general surgery ($n = 494$; 24.5%), vascular surgery ($n = 317$; 15.7%), and urological surgery ($n = 153$; 7.6%). Hemoglobin levels also showed significant differences. The total mean hemoglobin level was 125.3 g/L (SD ± 18.1), with lower levels in patients discharged not at home (115.9 ± 18.5 g/L) compared to those discharged home (128.1 ± 16.9 g/L; $p < 0.001$).

The total mean value of the BRASS index score was 10.4 (± 5.9). Patients discharged not at home had significantly higher BRASS index scores (15.5 ± 5.6) compared to those discharged home (8.8 ± 5.2; $p < 0.001$). The results of the binary logistic regression analysis identified several significant factors influencing the likelihood of home discharge (Table 3). Age was positively associated with the probability of returning home, with each additional year increasing the odds by 4% (OR = 1.040, 95% CI: 1.020–1.061). In contrast, male patients were significantly less likely to be discharged home compared to female patients (OR = 0.496, 95% CI: 0.371–0.664). A higher Barthel index at admission reduced the probability of home discharge (OR = 0.983, 95% CI: 0.977–0.989), whereas a higher Barthel index at discharge increased the probability (OR = 1.028, 95% CI: 1.019–1.037).

The presence of tumors (OR = 1.515, 95% CI: 1.071–2.145) and diabetes mellitus (OR = 1.547, 95% CI: 1.087–2.202) were both associated with a higher likelihood of home discharge. Surgical factors significantly influenced discharge outcomes. Patients undergoing orthopedic surgery were considerably less likely to be discharged home (OR = 0.118, 95% CI: 0.070–0.197), as were those who underwent vascular surgery (OR = 0.527, 95% CI: 0.283–0.980), when compared to those undergoing general surgery.

The hemoglobin levels were positively associated with home discharge (OR = 1.023, 95% CI: 1.015–1.032), suggesting that better overall physical condition contributed to a higher probability of returning home. Moreover, the BRASS index, with increasing scores indicating a higher risk of prolonged hospitalization and the need for specific discharge planning, showed that each additional point increased the probability of non-home discharge by 16% (OR = 0.842, 95% CI: 0.815–0.869).

DISCUSSION

This study aimed to investigate the association between patient-related variables associate with home discharge destination in geriatric surgical patients. The sample of the study included 2,015 patients. Our sample size is larger than other similar retrospective studies, such as the one conducted by Ahn et al., that involved 1,232 adult patients,[5] or the one performed by Cacciamani et al., which enrolled 1,153 geriatric patients.[6] These two studies involved patients undergoing general or urologic proceadures, while our study included several surgical specialties. A larger retrospective study that encompassed more than one surgical specialty, was performed by Hung et al., where over 44,219 geriatric patients in five years were enrolled.[2]

In our sample, for every year of age the probability of home discharge increased of 4%, indicating that older patients were more likely to be discharged home. This finding is consistent with the results of Han et al., who declared in their review that advanced age did not reduce the likelyhood of home discharge in geriatric surgical patients.[13]

Nowadays, healthcare assistance programs are designed to address the clinical, functional, and social needs of geriatric patients through interdisciplinary home-based care. This approach helps ensure continuity of treatment and support, making home discharge a feasible option even for elderly patients with multiple comorbidities.[16] Notably, this trend applies even to patients with tumors, highlighting the shift towards personalized and patient-centered care outside of hospital settings.[17]

Another key finding of this study is the impact of social support on discharge outcomes. Univariate analysis showed that patients living alone with caregiver were more likely to be discharged to a facility than those living with caregivers. However, logistic regression revealed no significant relationship between social support and home discharge. The lack of significant association between social support and home discharge appears to contradict previous research, that emphasized the strong link between a supportive home environment and postoperative outcomes, like the higher chance to be discharged home, the reduced risk of hospital readmission or the reduced mortality rates, and highlighted the importance of assessing not only the clinical status of geriatric patients but also their available support systems to optimize discharge planning.[18,19] A possible explanation of our findings is that the retrospective study may have limited the accuracy of data collection regarding caregivers and their physical, psychological

and socio-economic conditions. The data only indicated whether the patient lived with at least one caregiver, without specifying the nature of their relationship or the caregiver's potential limitations or inability to adequately assist the patient.

Our study analyzed the relationship between the Barthel index score and the likelihood of home discharge. Results indicate that a higher Barthel score at discharge is associated with an increased probability of home discharge (+2% per additional point), highlighting the importance of functional independence at discharge. Conversely, a higher Barthel score at admission appears to be inversely related to home discharge probability, suggesting that preoperative functional status does not necessarily predict discharge destination. This finding contrasts with previous studies;[2,10,20] which reported a positive association between higher preoperative functional status and home discharge likelihood.

The discrepancy may be due to differences in assessment timing and methodology. The Barthel index in our setting is measured at admission without considering pre-hospital conditions, which may lead to inaccuracies, particularly in trauma or emergency patients. Additionally, the Barthel index does not account for cognitive status, a key determinant in geriatric patient outcomes.[21,22] Even though the mentioned studies described the relationship between Barthel index and patients' outcomes, studies considering Barthel index as a specific predictor of discharge destination in geriatric surgical patients aren't available nowadays in our knowledge.

Regarding the type of surgery, orthopedic and vascular procedures were strongly associated with non-home discharge, while other surgical specialties showed no significant correlation. Orthopedic patients had the highest likelihood of requiring post-acute care, likely due to functional limitations from musculoskeletal procedures and trauma, consistent with previous studies.[6,23] Similarly, vascular patients had an increased risk of non-home discharge, as reported by Zil-E-Ali et al., likely due to multiple comorbidities, temporary loss of autonomy, and prolonged hospital stays.[24] These findings highlight the need for targeted postoperative care strategies for orthopedic and vascular surgical patients.

Lastly, higher BRASS index scores have been seen as strong predictors of non-home discharge, and the result is coherent with the analysis performed by Colognesi et al., who defined BRASS index as an useful tool to predict whose patients would need prolonged hospitalization or specific discharge planning.[7] Moreover, the retrospective study performed by Cunic et al.

defined BRASS index as a valid predictor of length of stay and need for comprehensive discharge planning in patients undergoing orthopedic surgery.[25]

The findings of this study highlight the importance of structured attention during the transition from hospital to primary care, ensuring adequate patient support after discharge. Strengthening social and familial support, with the active involvement of informal caregivers, is crucial. To this end, a structured assessment should be conducted not only for the patient—using tools such as the BRASS and Barthel index—but also for the primary informal caregiver to identify potential challenges and care needs. Given the lack of a significant difference between urgent and elective procedures, proactive intervention is particularly necessary in elective cases to optimize post-discharge planning, especially for specific pathways such as orthopedic and vascular surgery. Finally, the BRASS score confirms its role as a strong predictor of non-home discharge, emphasizing its usefulness in risk stratification and discharge planning.

This research has several strengths. First and foremost, preoperative functional status has been measured using a standardized and validated tool, the Barthel index, reducing variability, subjectivity and potential bias during data collection and analysis. The study presents high data quality, thanks to the absence of missing data. Moreover, many surgical specialties have been represented in the study, allowing a comparison between different types of patients. Lastly, including social support and many comorbidities as variables of interest has allowed a deeper exploration of an aspect that has been overlooked in previous studies about geriatric surgical patients and discharge destinations.

Despite these important findings, this study has some limitations. First, as a retrospective observational study, it is subject to potential biases inherent in data collection from clinical records. Additionally, it wasn’t possible to collect precise data about patients’ cognitive impairment. Lastly, the study investigated only patient-related variables, without focusing on organizational ones, as nurse-to-patient ratio or length of stay, that has been considered just as a context variable.

CONCLUSIONS

This study highlights the significant role of preoperative functional status in predicting hospital discharge destination among geriatric surgical patients. The findings confirm that patients with higher functional independence are more likely to be discharged home, whereas those with compromised functional status encounter an increased probability of requiring institutional care. By integrating objective patients' functional assessments and considering sociodemographic and clinical variables, this study contributes to a more comprehensive understanding of discharge planning for geriatric surgical patients.

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FIGURE 1 Flowchart of participant inclusion in the study

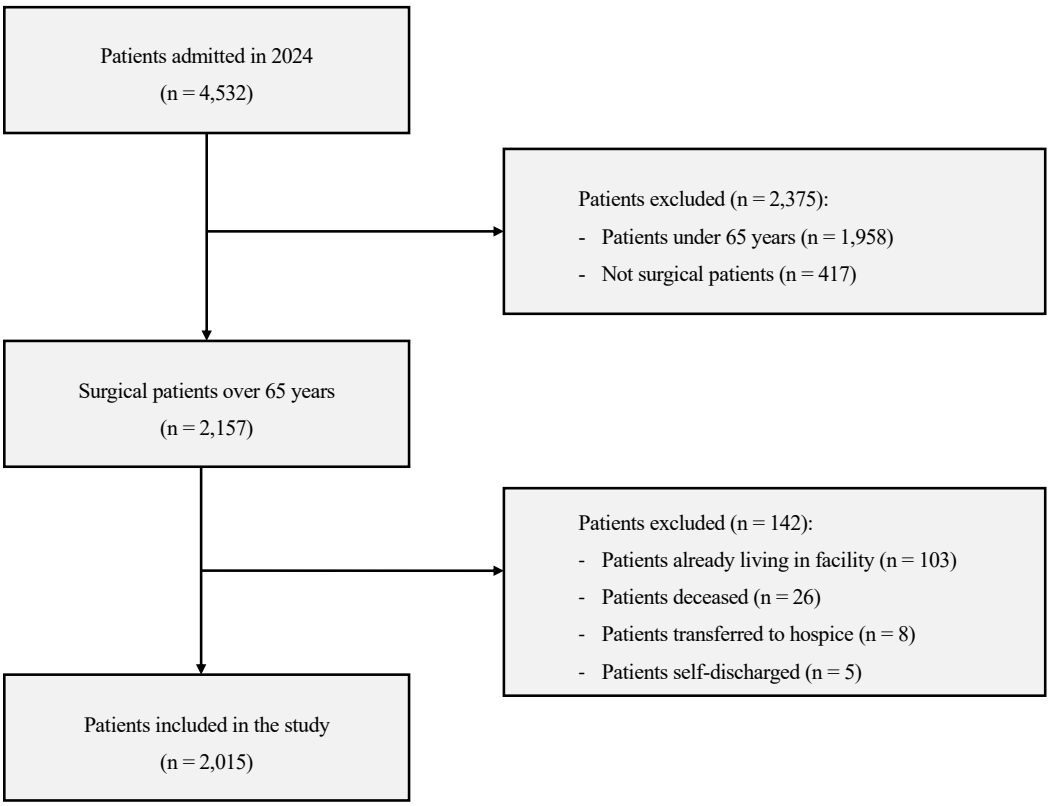

TABLE 1 Socio-demographic characteristics of sample

Variables	Discharged at home *N* = 1,551 (77%)	Discharged not at home *N* = 464 (23%)	Total *N* = 2,015 (100%)	*p*-value
Hospital, *n*, (%)				
Hub[a]	839 (54.1%)	210 (45.3%)	1,049 (52.1%)	< 0.001
Spoke[b]	712 (45.9%)	254 (54.7%)	966 (47.9%)	
Gender, *n*, (%)				
Female	771 (49.7%)	271 (58.4%)	1,042 (51.7%)	0.001
Male	780 (50.3%)	193 (41.6%)	973 (48.3%)	
Age in years, mean (SD)	77.6 (7.8)	81.0 (8.2)	78.4 (8.1)	
Age in classes of years, *n*, (%)				
65-74	633 (40.8%)	97 (20.9%)	730 (36.2%)	< 0.001
75-84	615 (39.6%)	223 (48.1%)	838 (41.6%)	
≥85	303 (19.6%)	144 (31.0%)	447 (22.2%)	
Living situation, *n*, (%)				
Living alone	128 (8.2%)	56 (12.1%)	184 (9.1%)	< 0.001
Living alone with caregiver(s)	335 (21.7%)	154 (33.2%)	489 (24.3%)	
Living with caregiver(s)	1,088 (70.1%)	254 (54.7%)	1,342 (66.6%)	

[a] The hub hospital is the central establishment, that provides a comprehensive range of services.
[b] The spoke hospitals are secondary establishments, that offer a narrower set of services, directing patients who require more specialized care to the hub for treatment

TABLE 2 Clinical characteristics of sample

Variables	Discharged at home *N* = 1,551 (77%)	Discharged not at home *N* = 464 (23%)	Total *N* = 2,015 (100%)	*p*-value
Barthel index, mean (SD)				
At admission	81.7 (28.2)	53.3 (37.1)	75.1 (32.8)	< 0.001
At discharge	84.5 (18.6)	58.9 (26.9)	78.6 (23.4)	< 0.001
Δ Barthel	2.8 (18.4)	5.7 (24.2)	3.5 (19.9)	0.006
Comorbidity, *n*, (%)				
Hypertension	1116 (71.9%)	336 (72.4%)	1452 (72.0%)	0.860
Tumor(s)	435 (28.0%)	90 (19.4%)	525 (26.0%)	< 0.001
Diabetes mellitus	330 (21.3%)	79 (17.0%)	409 (20.3%)	0.048
Smoke	303 (19.5%)	71 (15.3%)	374 (18.6%)	0.041
Heart failure	273 (17.6%)	121 (26.1%)	394 (19.5%)	< 0.001
Cerebrovascular disease	201 (12.9%)	103 (22.2%)	304 (15.1%)	< 0.001
COPD	134 (8.6%)	54 (11.6%)	188 (9.3%)	0.056
Chronic kidney failure	120 (7.7%)	45 (9.7%)	165 (8.2%)	0.178
Number of comorbidities, mean (SD)	1.9 (1.1)	1.9 (1.2)	1.9 (1.1)	0.319
Number of comorbidities in classes, *n*, (%)				
≤2	1155 (74.5%)	338 (72.8%)	1493 (74.1%)	
3-5	390 (25.1%)	124 (26.8%)	514 (25.5%)	0.781
≥6	6 (0.4%)	2 (0.4%)	8 (0.4%)	
Surgery type, *n*, (%)				
Orthopedic	570 (36.7%)	392 (84.5%)	962 (47.7%)	
General Surgery	470 (30.3%)	24 (5.2%)	494 (24.5%)	
Vascular	279 (18.0%)	38 (8.2%)	317 (15.7%)	< 0.001
Urology	148 (9.5%)	5 (1.1%)	153 (7.6%)	
Otolaryngologic	79 (5.1%)	3 (0.6%)	82 (4.1%)	
Multispecialty surgery	5 (0.3%)	2 (0.4%)	7 (0.3%)	
Admission type, *n*, (%)				
Elective surgery	923 (59.5%)	181 (39.0%)	1104 (54.8%)	
Urgent surgery	614 (39.6%)	278 (59.9%)	892 (44.3%)	< 0.001
Emergency surgery	14 (0.9%)	5 (1.1%)	19 (0.9%)	
ASA in classes, *n*, (%)				
Healthy patient	37 (2.4%)	1 (0.2%)	38 (1.9%)	
Mild systemic disease	961 (62.0%)	221 (47.6%)	1182 (58.7%)	< 0.001
Severe systemic disease	533 (34.3%)	233 (50.3%)	766 (38.0%)	
Life threatening condition	20 (1.3%)	9 (1.9%)	29 (1.4%)	
Hemoglobin, mean (SD)	128.1 (16.9)	115.9 (18.5)	125.3 (18.1)	< 0.001
Hemoglobin in classes[a], *n*, (%)				
In range	979 (63.1%)	167 (36.0%)	1146 (56.9%)	< 0.001
Under range	572 (36.9%)	297 (64.0%)	869 (43.1%)	
BRASS index, mean (SD)	8.8 (5.2)	15.5 (5.6)	10.4 (5.9)	< 0.001
BRASS index in classes[b], *n*, (%)				
≤9	1038 (66.9%)	69 (14.9%)	1107 (54.9%)	
10-19	439 (28.4%)	272 (58.6%)	711 (35.3%)	< 0.001
≥20	74 (4.7%)	123 (26.5%)	197 (9.8%)	

Note. ASA class; American Society of Anesthesiologists' classification; COPD: Chronic Obstructive Pulmonary Disease; BRASS: Blaylock Risk Assessment Screening.

[a]Hemoglobin levels were measured at patient's admission and is considered in range between 120 and 150 g/L for females and between 129 and 161 g/L for males, while under range is considered <120 for female and <129 for male, according to the local laboratory.

[b]BRASS index identify patients at risk of prolonged hospitalization requiring specific discharge planning: ≤9 (low risk); 10-19 (medium risk); ≥20 (high risk).

TABLE 3 Binary logistic regression analysis of predictors of home discharge

Variables	Odds ratio	95% CI		*p*-value
Age in years	1.040	1.020	1.061	<0.001
Male gender (Ref: Female)	0.496	0.371	0.664	<0.001
Living situation (Ref: Living alone)				
Living alone with caregiver(s)	0.924	0.579	1.476	0.743
Living with caregiver(s)	1.425	0.926	2.193	0.108
Barthel index				
At admission	0.983	0.977	0.989	<0.001
At discharge	1.028	1.019	1.037	<0.001
Tumor(s) (Ref: No)	1.515	1.071	2.145	0.019
Diabetes mellitus (Ref: No)	1.547	1.087	2.202	0.015
Surgery type (Ref: General surgery)				
Urology	2.210	0.757	6.456	0.147
Orthopedic	0.118	0.070	0.197	<0.001
Vascular	0.527	0.283	0.980	0.043
Otolaryngologic	2.879	0.701	11.826	0.142
Multispecialty surgery	0.215	0.026	1.796	0.156
ASA in classes (Ref: Healthy patient)				
Mild systemic disease	0.211	0.026	1.691	0.143
Severe systemic disease	0.155	0.019	1.269	0.082
Life threatening condition	0.404	0.036	4.461	0.459
Hemoglobin	1.023	1.015	1.032	< 0.001
BRASS index	0.842	0.815	0.869	< 0.001

Note. ASA: American Society of Anesthesiologists' classification; BRASS: Blaylock Risk Assessment Screening.

SUPPLEMENTARY TABLE 1 Characteristics of the setting

Hospitals	Departments	Medium LOS (in days)
HUB (63 beds)	General surgery	5.4
	Vascular surgery	9.6
	Orthopedic surgery	11.7
	Urologic surgery	7.3
	Otolaryngologic surgery	4.8
SPOKE 1 (48 beds)	General surgery	5.7
	Orthopedic surgery	8.1
	Urologic surgery	4.3
	Otolaryngologic surgery	5.2
SPOKE 2 (20 beds)	Orthopedic surgery	10.5

Note. LOS: Length Of Stay

SUPPLEMENTARY TABLE 2 Variables of interest

Variable	Description
Barthel Index score	This index considers a range of daily activities, assigning scores based on the degree of autonomy in performing each task, with a total score ranging from 0 (total dependence) to 100 (total independence) [26]
Comorbidities	Hypertension Diabetes mellitus Heart failure COPD Chronic kidney disease Previous cerebrovascular events Tumors Smoking status
ASA classification	This classification is used to assess preoperative physical status, in particular patient's pre-anesthesia medical co-morbidities, categorizing patients from level (normal healthy patient) to level V (moribund patient who is not expected to survive without surgery).
Preoperative hemoglobin levels	According to the local laboratory, values between 120 and 150 g/L were considered normal for females and between 129 and 161 g/L wew considered normal for males.
BRASS index	This tool, calculated within 48 hours of admission, allows for early identification of patients at risk of prolonged hospitalization or requiring complex discharge planning. The index consists of 10 items, each assigned a numerical value, generating a total score ranging from 0 to 40. Patients were classified into three risk categories: low risk (<10); medium risk (from 11 to 20), and high risk (>20) [27,28].
Surgery discipline	Distinguished among general, urologic, orthopedic, vascular, or otolaryngologic surgery.
Urgency of surgery	The urgency of the procedures was also classified as elective, urgent, or emergency.
Discharge destination	Home Home with home care assistance Transfer to ICF Transfer to SNF Transfer to another acute care

Note. COPD: Chronic Obstructive Pulmonary Disease; ASA: American Society of Anesthesiologists' classification; BRASS: Blaylock Risk Assessment Screening; ICF: Intermediate Care Facility; SNF: Skilled Nursing Facility.