

Perioperative Factors Affecting Length of Hospital Stay Among Elderly Patients

Gytė Damulevičienė¹, Vita Lesauskaitė¹, Jūratė Macijauskienė¹,
Kastytis Šmigelskas², Donatas Venskutonis³

¹Department of Geriatrics, Medical Academy, Lithuanian University of Health Sciences,

²Department of Health Psychology, Medical Academy, Lithuanian University of Health Sciences,

³Department of General Surgery, Medical Academy, Lithuanian University of Health Sciences, Lithuania

Key Words: elderly surgical patients; malnutrition; postoperative cognitive dysfunction; delirium; length of hospital stay.

Summary. Background and Objective. Timely assessment and prevention of risk factors for the main perioperative complications in elderly patients provide an opportunity to avoid them, decrease mortality, and diminish costs associated with longer hospital stay. The aim of this study was to estimate perioperative factors that could potentially predict the length of stay and to estimate their predictive value using a comprehensive geriatric assessment among elderly patients.

Material and Methods. The study population comprised 99 surgical patients aged 65 and more. The patients were followed up until discharge. Study data analysis included questionnaires, anthropometric measurements before surgery, assessment and interviews after surgery, and case histories. Univariate and multivariate logistic regression analysis was performed.

Results. Malnutrition was detected in 53.5% of the patients. Postoperative cognitive disorder was documented in 18.2% of elderly patients. The mean length of hospital stay was 10.1 days (SD, 9.14). Multivariate logistic regression analysis revealed that the best predictors for longer hospital stay in elderly patients were malnutrition (OR, 4.2; 95% CI, 1.5–11.8; $P=0.007$) together with postoperative cognitive impairment (OR, 9.2; 95% CI, 1.0–83.3; $P=0.048$). The total predictive value of the model was 70.5%.

Conclusions. Malnutrition and a postoperative cognitive disorder were independent risk factors for longer hospital stay, while depression, cognitive impairment, functional dependence, and poor physical status were not independently associated with longer hospital stay. A comprehensive geriatric assessment can help assess the risk factors for longer treatment and predict the length of hospital stay, thus enabling the planning of optimal healthcare management of elderly patients.

Introduction

In older age, a decline in functional reserve, impaired reaction to stress, and comorbidities lead to increased postoperative complication and rehospitalization rates, longer duration of postoperative treatment, and higher costs of treatment (1–6).

The length of hospital stay is a relevant outcome parameter in terms of morbidity and hospital costs (7). The timely assessment of risk factors for the main perioperative complications, such as delirium, respiratory tract infection, malnutrition, and cardiovascular complications, in elderly patients and timely prevention provide an opportunity to avoid them, decrease mortality, and diminish costs associated with longer hospital stay (4). For example, malnutrition has been shown to be associated with

higher postoperative complication rates and longer hospital stay (1, 8, 9). Other very important factors causing longer treatment duration are postoperative delirium and postoperative cognitive dysfunction, where delirium is associated with hospitalization longer by 60% (3, 10–14). Certain underlying diseases and conditions that are most typical of elderly adults and that might have an impact on the intraoperative and postoperative period can be overlooked if an examination is conducted superficially (3, 15, 16). The authors of the systematic review on a comprehensive geriatric assessment concluded that “significantly more older patients are likely to survive admission to hospital and return home if they undergo a comprehensive geriatric assessment while they are inpatients” (17). Therefore, a comprehensive geriatric assessment may allow certain adjustments in clinical practice, such as recommendations for scheduled surgery or surgery at smaller scope, risk reduction in preoperative treatment, and planning of postoperative care.

Correspondence to G. Damulevičienė, Department of Geriatrics, Medical Academy, Lithuanian University of Health Sciences, A. Mickevičiaus 9, 44307 Kaunas, Lithuania
E-mail: gytedamu@gmail.com

The aim of the study was to estimate perioperative factors among elderly patients that potentially predict the length of hospital stay and to estimate their predictive value using a comprehensive geriatric assessment.

Material and Methods

Study Population and Methods. This short-term follow-up study was performed at the surgical and urological units of 600-bed Kaunas Clinical Hospital (former Kaunas 2nd Clinical Hospital) from May 2006 to June 2007. The study participants were randomly selected (every third patient admitted during the investigation day). The patient was included if he/she was hospitalized to a surgical or urological unit, was waiting for surgery, and was aged 65 years and more. The exclusion criteria were shortness of breath (severe pulmonary or heart insufficiency) and inability to communicate (inability to speak and understand Lithuanian, deafness, any confusion or severe cognitive impairment according to the Mini-Mental State Examination [MMSE, score ≤ 10]). In total, 116 patients comprised the initial study population. Of them, 12 patients refused to participate, and 5 patients were excluded based on the criteria. The final study sample comprised 99 patients (85.3% of the preliminary sample). Signed informed consent was obtained from each participant. The study was approved by Kaunas Regional Ethics Committee for Biomedical Research.

The preoperative assessment involved the evaluation of sociodemographic and lifestyle characteristics, underlying diseases and used medications, and risk assessment of anesthesia (classification of physical status according to the American Society of Anesthesiologist [ASA]), cardiovascular complications (according to the recommendations of the American Heart Association [AHA] for noncardiac surgery patients, 1996), and thrombosis (according to the protocol "Treatment and prophylaxis of venous thrombosis," Lithuania, 2003) (18–20).

Preoperative laboratory tests were performed, and creatinine clearance was calculated according to the Cockcroft-Gault formula (21).

The Instrumental Activities of Daily Living (IADL) scale, the Mini-Mental State Examination (MMSE), and the Geriatric Depression Scale (GDS) were used for the assessment of functional status and cognitive function, and screening for geriatric depression (22–24).

Nutritional status was assessed by anthropometric measurements (body mass index [BMI] and mid-arm circumference [MAC]) and laboratory tests (serum albumin concentration, absolute lymphocyte count). For a quick, inexpensive, and simple indication of malnutrition, one of the following criteria was chosen: BMI < 20 kg/m² or MAC below

the 10th percentile of anthropometric standards or serum albumin concentration of < 35 g/L or lymphocyte count of $< 1.5 \times 10^9$ cells/L (16, 25–29).

Intraoperative and Postoperative Characteristics. Intraoperative complications, such as bradycardia, other conduction disturbances, hypotension, hypertension, cardiac arrhythmia, hypothermia, and clinical death, were documented (data collection from case histories). All the postoperative complications were evaluated based on medical records and daily patients' interviews and assessment. Delirium was diagnosed according to the Confusion Assessment Method (30). The MMSE was administered to patients before the surgery on the day of admission to hospital and on the second day after the surgery. Early postoperative cognitive dysfunction (EPCD) was indicated if the postoperative MMSE score was by 4 or more points lower than the preoperative MMSE score (31). If during the hospitalization period the patient was recognized with delirium or early postoperative cognitive dysfunction, he/she was considered as having a postoperative cognitive disorder.

Statistical Analysis. Statistical data analysis was performed using SPSS for Windows 17.0. Quantitative variables were described by mean and standard deviation, while qualitative variables, by percentages and absolute numbers. The Student *t* test was applied for the comparison of means between 2 groups, taking into account the Levene's test for equality of variances. For the comparison of more than 2 subgroups, the analysis of variance (ANOVA) was applied.

Associations between potential predictors and outcomes of interest (length of stay) were assessed using univariate and multivariate binary logistic regression models. As a binary outcome, the length of stay was chosen and dichotomized (based on the median treatment duration in surgical/urological departments) in the following manner: the length up to 6 days was considered as a short stay; 7 or more days, as a long stay. The cutoff for the factors to be entered into a multivariate regression model was set at $P < 0.20$ in univariate regression analysis. The Nagelkerke coefficient of determination was calculated. Statistical significance was set at $P < 0.05$.

Results

Preoperative Evaluation of Surgical Patients. The study sample was predominantly male (58%). The mean age of the patients was 76.2 years (SD, 6.3). Most of the study patients reported no alcohol consumption and were nonsmokers. More than half (55%) of the patients were married, 60% had a low educational level, 46% were in ASA class 3–4, 34% were at medium or high risk of cardiovascular complications, and 90% were at high risk of vein

Table 1. Preoperative Sociodemographic, Lifestyle, and Surgery Risk Characteristics of the Study Population

Characteristic	Value
Gender	
Male	57 (57.6)
Female	42 (42.4)
Age, mean (SD), years	76.2 (6.3)
Alcohol consumption	
Yes	24 (24.2)
No	75 (75.8)
Smoking	
Yes	5 (5.1)
No	94 (94.9)
Marital status	
Single	3 (3.5)
Married	54 (54.5)
Divorced	37 (37.4)
Widowed	5 (5.1)
Education	
Primary	36 (36.4)
Uncompleted secondary	23 (23.2)
Completed secondary or special professional	32 (32.3)
Higher	8 (8.1)
Department	
Surgical	74 (74.7)
Urological	25 (25.3)
Surgery risk	
ASA class 1	0 (0.0)
ASA class 2	53 (53.5)
ASA class 3	41 (41.4)
ASA class 4	5 (5.1)
Low risk of CC	65 (65.7)
Medium risk of CC	30 (30.3)
High risk of CC	4 (4.0)
Low risk of vein thrombosis	0 (0.0)
Medium risk of vein thrombosis	10 (10.1)
High risk of vein thrombosis	89 (89.9)
Emergency/urgent surgery	46 (51.1)

Values are number (percentage) unless otherwise stated. ASA, American Society of Anesthesiologist; CC, cardiovascular complications.

thrombosis. Table 1 summarizes sociodemographic, lifestyle, and surgery risk characteristics.

The most common causes of hospital admission among patients were cholecystitis and other disorders of the gallbladder or the biliary tract (37.4%) followed by urological diseases (malignant diseases and prostatic hyperplasia, 22.2%) and hernia (13.1%).

Based on the GDS, 39% of the patients were mildly or severely depressed. More than one-third (36%) of the patients had cognitive impairment; 60%, second-degree renal impairment; 48%, ischemic heart disease; and 62%, arterial hypertension. Nearly two-thirds (66%) used cardiovascular drugs before the operation, 25% used beta-blockers, and 20% used antiaggregants. Malnutrition was detected in 53.5% of the patients; 8% had BMI <20 kg/m² and 12% had hypoalbuminemia. Table 2 shows the details of preoperative assessment.

Surgery, Intraoperative and Postoperative Period, and Length of Hospital Stay. The majority (90.9%) of the elderly patients underwent surgery during the

Table 2. General Preoperative Clinical Characteristics of the Study Populations

Variable	Value
Underlying diseases, n (%)	
0–2 underlying diseases	77 (77.8)
≥3 underlying diseases	22 (22.2)
Ischemic heart disease (stable angina)	48 (48.5)
Arterial hypertension	61 (61.6)
Stroke	10 (10.1)
MI more than 6 months ago	12 (12.1)
Diabetes mellitus	11 (11.1)
Oncological disease	17 (17.2)
COPD	9 (9.1)
Polypharmacy (≥5 medications), n (%)	
Yes	17 (17.2)
No	82 (82.8)
Laboratory tests	
Potassium, mmol/L	4.4 (0.5)
Sodium, mmol/L	141.0 (3.0)
Glucose, mmol/L	6.2 (1.3)
Hemoglobin, g/L	128.9 (17.9)
Leukocyte count, ×10 ⁹ /L	8.6 (4.4)
Albumin, g/L	41.9 (6.0)
Creatinine, μmol/L	109.0 (45.4)
Creatinine clearance, mL/min	53.9 (8.8)
Lymphocyte count, ×10 ⁹ /L	1.4 (0.6)
Functional status according to the IADL	
Women	6.0 (2.3)
Men	4.3 (1.3)
Geriatric depression according to the GDS, n (%)	
Mild	26 (26.5)
Severe	12 (12.2)
Cognitive function according to the MMSE, score	25.1 (4.0)
Anthropometric characteristics	
Height, cm	166.6 (8.9)
Weight, kg	75.6 (14.4)
BMI, kg/m ²	27.2 (5.0)
Mid-arm circumference, cm	28.8 (3.8)
Nutritional status, n (%)	
Malnutrition	53 (53.5)
Obesity	32 (32.3)

Values are mean (standard deviation) unless otherwise stated. IADL, Instrumental Activities of Daily Living (max score of 5 and 8 for men and women, respectively); GDS, Geriatric Depression Scale; MMSE, Mini-Mental State Examination; MI, myocardial infarction; COPD, chronic obstructive pulmonary disease.

study. Major surgery was performed in 87.8% of the patients. The most common types of surgery were as follows: laparoscopic abdominal (26.3%), open abdominal (22.2%), and transurethral resection of the prostate (15.2%). General (48.9%) and spinal (38.9%) anesthesia was most commonly applied.

The most common intraoperative complications were hypotension (24.4%) and bradycardia (16.1%). The incidence of postoperative complications was 57.8%. The most common complications were constipation (21.1%), respiratory tract infection (14.4%), and anemia (10.0%). In general, 27.8% of the study patients experienced 2 or more postoperative complications, and 32.3% were admitted to the Intensive Care Unit.

A postoperative cognitive disorder (delirium or EPCD) was detected in 18% of the patients: 9% had

delirium and 9% had EPCD. A significant difference in the preoperative MMSE score was found comparing the patients with and without postoperative cognitive disorder (20.8 [SD, 2.6] and 26.3 [SD, 5.9], respectively; $P=0.002$). The preoperative MMSE score in the patients who developed delirium during the postoperative period was lower than in those who did not develop it (17.4 [SD, 5.9] and 25.9 [SD, 2.9], respectively; $P=0.004$).

The postoperative mortality rate among the patients was 2.2%. The mean length of hospital stay was 10.1 days (SD, 9.14); 58.6% of the patients were hospitalized longer than 6 days. The patients who had severe geriatric depression, poor functional status, mild or moderate cognitive impairment, and malnutrition before surgery or who were diagnosed with postoperative cognitive disorder stayed in the hospital significantly longer (Table 3).

In order to detect the factors that might influence the length of hospital stay, the univariate logistic regression analysis was performed. It revealed that the length of hospital stay was significantly associated with 5 factors (Table 4). The multivariate logistic regression analysis revealed that malnutrition and postoperative cognitive disorder were independent risk factors for longer hospital stay (Table 5).

Malnutrition and postoperative cognitive disorder showed the best predictive value in the multivariate regression model. A total predictive value for the model, shorter hospital stay, and longer hospital stay were 70.5%, 67.6%, and 72.2%, respectively. The inclusion of other factors to the predictive model did not result in a better total predictive value (Table 6).

Discussion

To date, the majority of studies examining surgical patients in Lithuania have addressed the aspects of treatment outcome, treatment duration, postoperative complications, and cognitive dysfunction, while the nutritional status of patients and comprehensive geriatric assessment have not been explored. However, even these aspects have not been extensively investigated among different popula-

Table 3. Perioperative Factors and Length of Hospital Stay Among the Study Patients

Characteristics	Treatment Duration, Days	P Value
Preoperative geriatric depression		
1. No depression	8.9 (6.6)	0.927 (1 vs. 2)
2. Mild	9.0 (6.1)	0.001 (1 vs. 3)
3. Severe	18.5 (18.4)	0.002 (2 vs. 3)
Preoperative functional status		
Good	8.4 (6.4)	0.001
Poor*	15.2 (13.5)	
Preoperative cognitive function		
1. Healthy function	8.2 (6.0)	0.015 (1 vs. 2)
2. Mild impairment	13.2 (12.0)	0.046 (1 vs. 3)
3. Moderate impairment	14.6 (14.0)	0.696 (2 vs. 3)
Preoperative obesity		
No	10.3 (9.5)	0.317
Yes	8.5 (5.5)	
Preoperative malnutrition		
No	7.3 (4.8)	0.002
Yes	12.6 (11.1)	
Postoperative cognitive disorder		
No	9.2 (8.7)	0.005
Yes	16.4 (10.3)	

Values are mean (standard deviation).

*IADL scores of ≤ 3 and ≤ 5 for men and women, respectively.

Table 4. Factors Associated With Length of Hospital Stay (Univariate Logistic Regression)

Factor	OR (95% CI)	P Value
Malnutrition	3.3 (1.4–7.6)	0.005
Preoperative cognitive impairment	2.4 (1.0–5.9)	0.049
Poor functional status	3.8 (1.3–11.2)	0.016
Poor physical status (ASA class 3–4)	2.4 (1.0–5.4)	0.041
Postoperative cognitive disorder	12.7 (1.6–101.3)	0.016

ASA, American Society of Anesthesiologists;

OR, odds ratio; CI, confidence interval.

Table 5. Factors Associated With Length of Hospital Stay (Multivariate Logistic Regression)

Factor	OR (95% CI)	P Value
Malnutrition	4.2 (1.5–11.8)	0.007
Preoperative cognitive impairment	1.0 (0.2–5.4)	0.969
Poor functional status	2.4 (0.8–7.1)	0.116
Poor physical status (ASA class 3–4)	1.4 (0.4–4.5)	0.572
Postoperative cognitive disorder	9.2 (1.0–83.3)	0.048

ASA, American Society of Anesthesiologists;

OR, odds ratio; CI, confidence interval.

Table 6. Predictive Value of Risk Factors for Length of Hospital Stay of the Study Patients (Multivariate Logistic Regression Model)

Predictor	R ²	Predictive Value for Shorter Length of Stay (%)	Predictive Value for Longer Length of Stay (%)	Total Predictive Value of the Model (%)
Malnutrition Postoperative cognitive disorder	0.266	67.6	72.2	70.5
Malnutrition Postoperative cognitive disorder Poor functional status Poor physical status (ASA class 3–4) Preoperative cognitive impairment	0.311	55.9	75.9	68.2

ASA, American Society of Anesthesiologists; R², Nagelkerke coefficient of determination.

tions of surgical patients. Therefore, the findings of this study have specific implications in the health-care process of elderly surgical patients.

General health status of the patient is one of predictors for perioperative mortality, complications, and longer hospital stay. Numerous studies have proven that the higher risk of complications and perioperative mortality is associated with polyopathy, urgency of operation, major operation, ASA classes 3 and 4, and malnutrition (10). Literature data show that 34%–50% of elderly surgical patients undergo urgent operations (32). In our study, almost half of patients were classified as ASA class 3–4 and almost all were at high risk of venous thrombosis. Major operation was performed almost for every patient; half of the patients underwent urgent/emergency operation. In our study, one-fifth of the patients had polyopathy (≥ 3 diseases), and more than one-third of the patients had mild or severe geriatric depression and cognitive impairment; more than half, renal impairment. Almost half of the patients had ischemic heart disease; more than half of the patients had arterial hypertension and used cardiovascular drugs. According to Zappula et al., 75% of older patients admitted for cholecystectomy had concomitant diseases (5). Story et al. found at least one concomitant disease in 68% of elderly surgical patients who were admitted for noncardiac surgery (32).

High variability in the prevalence of malnutrition is associated with a high heterogeneity of populations (differences in physical and functional status of elderly population) and criteria for the definition of malnutrition. The prevalence of malnutrition on hospital admission among the elderly is about 30%–78%, while among surgical patients, the prevalence reaches 35%–60% (33, 34). In the studies examining surgical patients irrespective of age, different authors indicated a different prevalence of malnutrition: Rasmussen et al. reported a prevalence of 57% (35); Pirlich et al., 14% (29); and Schiesser et al., 14% (8). Our findings on the prevalence of malnutrition rather support the results from the study by Rasmussen et al. BMI is an indirect indicator of malnutrition, and it rather gives a lower estimate of the prevalence of malnutrition, because in some cases, even subjects with normal BMI are malnourished. For comparison, the study by Söderström et al. reported that 8.6% of elderly patients admitted to the hospital had the BMI values of $<20 \text{ kg/m}^2$ (36), while the corresponding percentage in our study was 8.1%.

In our study, one-fourth of the patients developed 2 or more postoperative complications. Despite this, the perioperative mortality was low. According to the data by Hamel et al., 20% of elderly patients had at least one postoperative complication, with respiratory and urinary tract complications being most common (37). In the study by Story et al.,

20% of patients developed at least one complication within 5 days following surgery, and 5% died within 30 days after surgery (32). The study by Fukuse et al. examining patients older than 60 years reported that postoperative complications occurred in 16.7% of patients (16), while the study by Zappulla et al. analyzing patients aged more than 70 years indicated even a lower complication rate (10%) (5). The above data show that complication rates vary across different studies depending on different pathologies and complications analyzed. In our study, all possible complications were registered.

In our study, the complications of cognitive status were evaluated during the postoperative period. Both postoperative EPCD and postoperative delirium are frequent complications causing severe consequences in elderly patients (4). The incidence of postoperative delirium after the common surgical procedures can reach 10%–15%; and in older surgical patients, 15%–53%. The incidence of EPCD varies between 20% and 83% depending on the extent of surgical intervention, and the greatest incidence of EPCD has been registered after cardiac and orthopedic operations (31, 38). In 2010, the study by Norkiene et al. found that EPCD developed in 46% of patients after cardiac revascularization operations, and these patients were significantly older (39). These results corroborate the report by Rohan et al. where 47% of patients experienced EPCD (40). Contrary, Canet et al. in their study involving elderly patients after minor surgical procedures demonstrated that the prevalence of EPCD was only 6.8% (41). The results of our study are close to those of the latter report, i.e., only 9.1% of the patients in our study had EPCD. Most probably in our study, the incidence of EPCD was lower because the MMSE, rather than other more sensitive neuropsychological tests, was applied. Weissrock et al. in their study screened older patients scheduled for cardiac surgery with the MMSE and also reported a quite low incidence of EPCD (15%) compared with other studies (31).

In the study by Kalisvaart et al. investigating patients aged 70 years and more, who were admitted for hip surgery, the overall prevalence of PD was 12.3% (10). Valaviciene in the study of elderly patients operated on due to femoral neck fractures reported PD in 16.6% of cases (42). In our study, delirium was diagnosed only in 9.1% of cases. We studied postoperative cognitive disorder as the presence of one of disorders (delirium or EPCD), based on the common risk factors and consequences. Most probably, a low incidence of postoperative cognitive disorder together with a low mortality rate in our study could be caused by the relatively good patients' status and the type of surgery (not cardiac or orthopedic).

The length of stay among our patients was greater than the overall mean length of stay in the surgical department. The study by Venskutonis et al. showed that elderly patients operated on due to an acute surgical disease were hospitalized significantly longer than middle-aged patients (12.7 [SD, 9.6] and 6.4 days [SD, 3.6], respectively) (2).

The main aim of this study was to identify the risk factors for longer hospitalization. After the comprehensive geriatric assessment and the postoperative follow-up, the potential perioperative predictors for longer hospital stay were determined. Among them, malnutrition and postoperative cognitive disorder appeared to be independent risk factors.

Literature data have shown that postoperative delirium, as well as delirium manifesting with coexisting diseases, and late postoperative cognitive dysfunction are associated with higher morbidity and mortality, longer hospital stay, and a higher rate of institutionalization (4, 13). According to the data of our study, the length of hospital stay in patients with postoperative cognitive disorder was significantly longer as compared with patients having no postoperative cognitive disorder. Moreover, patients who had preoperative cognitive impairment as measured by the MMSE stayed in the hospital longer as well.

Malnourished patients have been shown to stay in the hospital 1.5–1.7 times longer than well-nourished patients (43). The length of hospital stay is prolonged due to immunodeficiency, decreased mobility after the operation, and more frequent infections caused by insufficient nutrition (1, 7, 8, 34). Pirlich et al. stated that the length of hospital stay among patients with malnutrition was longer by 43% (29). According to our data, malnutrition was associated with almost twice longer treatment.

Thus, summarizing, it can be stated that malnutrition and a postoperative cognitive disorder determined during the comprehensive geriatric assessment were the best predictors of longer hospital stay among elderly surgical patients.

It is known that good outcomes of surgical treatment among elderly patients are caused by a thor-

ough patient's preoperative assessment and preparation, modern surgical techniques, and accurate perioperative care. A comprehensive preoperative geriatric assessment includes not only a history evaluation, physical examination, and estimation of operative risk, but also the assessment of functional, emotional, cognitive, and nutritional status and laboratory testing (3). Some authors have pointed out that laboratory testing before surgery should be applied expediently when pathology is suspected. For example, patients with diabetes mellitus, arterial hypertension, or chronic kidney disease and those who receive diuretics or digoxin have to undergo the estimation of kidney function and the electrolyte test, and if malnutrition is suspected, albumin levels should be measured (44, 45), and a cost-effective preoperative evaluation is increasingly mentioned in the literature (46, 47). The findings of our study suggest that in the hospital providing similar surgical services, it is recommended to assess not only elderly patients' physical status and operative risk, but also functional and cognitive status; screening for depression and malnutrition is advisable as well. Malnutrition could be suspected from the assessment of the absolute number of lymphocytes or serum albumin concentration or BMI or mid-arm circumference (for bedridden patients).

Conclusions

Malnutrition and a postoperative cognitive disorder were found to be independent risk factors for longer hospital stay, while depression, cognitive impairment, functional dependence, and poor physical status were not independently associated with longer hospital stay. A comprehensive geriatric assessment can help assess the risk factors of longer treatment and predict the length of hospital stay, thus enabling the planning of optimal health care management of elderly patients.

Statement of Conflict of Interest

The authors state no conflict of interest.

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