Original Article

Predictors and preventers of postoperative bedridden status in the elderly ages over 75 after emergency general surgery: a retrospective cohort study

Kantoku Nagakawa,[1,2] Ken Taniguchi,[1] Aki Yukutake,[1] Yuta Kawaguchi,[1] Ryo Matsumoto,[1] Momoko Akashi,[1] Takanori Hirayama,[1] Masataka Hirabaru,[1] Chika Sakimura,[1] Shigeki Minami,[1] and Susumu Eguchi[2]

[1]Department of Surgery, Nagasaki Harbor Medical Center, Nagasaki, Japan, and [2]Department of Surgery, Nagasaki University Graduate School of Biomedical Sciences, Nagasaki, Japan

Aim: We investigated the proportion of bedridden patients after emergency surgery among the elderly ages over 75; defined as the latter-stage elderly in Japan, the associated factors, and interventions used to prevent it.

Methods: Eighty-two latter-stage elderly patients who underwent emergency surgery for non-traumatic illness between January 2020 and June 2021 in our hospital were included in the study. Backgrounds and various perioperative factors were compared retrospectively between the groups including patients who became bedridden from Performance Status Scale 0 to 3 before admission (Bedridden group) and those who did not (Keep group).

Results: Three cases of death and seven patients who were bedridden before admission were excluded. The 72 remaining patients were divided into the Bedridden group (n = 10, 13.9%) and the Keep group (n = 62, 86.1%). There were significant differences in the prevalence of dementia, pre- and postoperative circulatory dynamics, renal dysfunction, coagulation abnormality, length of stay in the high care unit/intensive care unit, and number of hospital days, with a relative risk of 13 (1.74–96.71), a sensitivity of 1.00, and a specificity of 0.67 for a preoperative shock index of 0.7 or higher being associated with the Bedridden group. Among patients with a preoperative shock index of 0.7 or higher, there was a significant difference in SI at 24 h postoperatively between the two groups.

Conclusion: Preoperative shock index may be the most sensitive predictor. Early circulatory stabilization seems to be protective against patients becoming bedridden.

Key words: acute care surgery, ADL, emergency treatment, geriatrics, physical and rehabilitation medicine

INTRODUCTION

ACCORDING TO THE 2022 World Population Prospects Report from the United Nations,[1] the population of people ages 65 years and over has been rising steadily since 1950. This is especially true in developed countries.[1] In Japan in 2021, the Ministry of Internal Affairs and Communications reported that 28.9% of the population was ages 65 and older, and that the 14.9% of the population was ages 75 years and older.[2] In Japan, people ages from 65 years old to 74 years old are defined as "the early-stage elderly" by Ministry of Health, Labor, and Welfare. People ages 75 years and older are defined as "the latter-stage elderly" and eligible for a different medical-care insurance system from people under 75 years old.[2,3] Aging of the Japanese population is the highest worldwide.[4] As a result, there is more demand for treating older adults in the field of not only elective surgery, but also acute care surgery (ACS).

In older patients undergoing elective surgery, there have been reports referring to deteriorating postoperative activities of daily living (ADL).[5] We believe that maintaining postoperative activity in older people is an issue to be addressed in emergency surgery as well. In daily practice, many patients and their families expect to maintain ADLs similar to that before surgery. At the same time, some point out over-treatment especially for older people in the later stages of life.[6] The predictors of ADL decline in older patients who undergo emergency surgery are unclear, and the predictors and interventions for reducing this decline need to be outlined. In this study, we investigated the development of the bedridden condition in patients and the

Corresponding: Kantoku Nagakawa, MD, Department of Surgery, Nagasaki University Graduate School of Biomedical Sciences, 1-7-1 Sakamoto, Nagasaki 852-8501, Japan. E-mail: asdr_k@hotmail.com.
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associated factors in emergency surgeries for the latter-stage elderly experienced at our hospital and examined whether there were predictors and interventions to prevent the occurrence of bedridden patients.

METHOD

Patients

LATTER-STAGE ELDERLY PATIENTS, ages 75 years and older, who underwent emergency surgery for non-traumatic acute illness at our medical center between January 2020 and June 2021 were included in the study. Patients who were active before admission were divided into two groups: those who became bedridden at discharge (Bedridden group) and those who did not become bedridden (Keep group), making this a retrospective cohort study.

Comparison items

The factors examined for association included age, sex, body mass index (BMI), prevalence of dementia, prehospital Performance Status Scale (PS), pre- and postoperative factors such as heart rate, systolic blood pressure, shock index (SI), lactate, ejection fraction, American Society of Anesthesiologists physical status,[7] blood tests (white blood cell, hemoglobin, platelet, C-reactive protein, total bilirubin, creatinine [Cre], albumin, prothrombin time–international normalized ratio [PT-INR], D-dimer), fibrin/fibrinogen degradation products, time of rehabilitation intervention, length of hospitalization, and length of stay in the high care unit (HCU) / intensive care unit (ICU). Activity was assessed using the data of PS,[8] evaluated on admission and at discharge routinely, and the condition of being completely bedridden was scored as PS4.

Statistical analysis

The statistical software JMP Pro 16 (SAS Institute, Cary, NC) was used for the analysis.

Univariate analysis was performed to compare each independent variable with deteriorating to PS4 at discharge. Comparisons between the groups were performed using the Wilcoxon rank-sum test for continuous variables and Pearson's χ^2 test for categorical variables.

Receiver operating characteristic curves were constructed, and the areas under the curves were compared to test the discriminatory ability of the different risk scales to predict deterioration to PS4 at discharge. Optimal cut-off values for the different scales were determined the Youden's index, which is the value that maximizes the sum of the sensitivity and specificity.

A P-value <0.05 was considered statistically significant.

RESULTS

EIGHTY-TWO PATIENTS WERE included, with a median age of 83 years (75–97). The male:female ratio was 36 (43.9%):46 (56.1%), and the diseases are shown in Table 1. There were three deaths. PS before admission was significantly correlated with age, and PS at discharge significantly deteriorated compared with that before admission (Fig. 1). Of the 82 patients, three who died and seven who were already PS4 before admission and PS4 at discharge were excluded. Seventy-two patients were divided into the Bedridden group (n = 10) and the Keep group (n = 62).

In terms of patient background, there were significant differences in the prevalence of dementia and pre-admission PS (Table 2). Perioperative data are shown in Table 3. As for the preoperative factors, the heart rate, systolic blood pressure, SI, and lactate level had significant differences. In blood tests, Cre, PT-INR, and D-dimer had significant differences. Regarding nutritional status, there were no significant differences in BMI or albumin level. Regarding operative factors, operative time, and blood loss were not significantly different. Although there was a significant difference in endoscopic surgery, 0% (0 cases) versus 38.7% (24 cases) (P < 0.01), presented as Bedridden group versus Keep group; cholecystectomy accounted for 50% (12 cases), and appendicitis accounted for 16.7% (4 cases). As for the postoperative factors, immediate-postoperative heart rate, SI, Cre, and PT-INR on postoperative day (POD) one had significant differences. There were also significant differences in the duration of HCU/ICU admission and hospitalization.

Table 1. The primary diseases that required surgery

Diseases	No. of patients	Percentage
Bowel obstruction	21	25.6
Colonic perforation	16	19.5
Cholecystitis	16	19.5
Incarcerated hernia	11	13.4
Gastrointestinal perforation	5	6.1
Appendicitis	5	6.1
Intestinal ischemia	3	3.7
Postoperative bleeding	2	2.4
Pneumothorax, pyothorax	2	2.4
Esophageal rapture	1	1.2

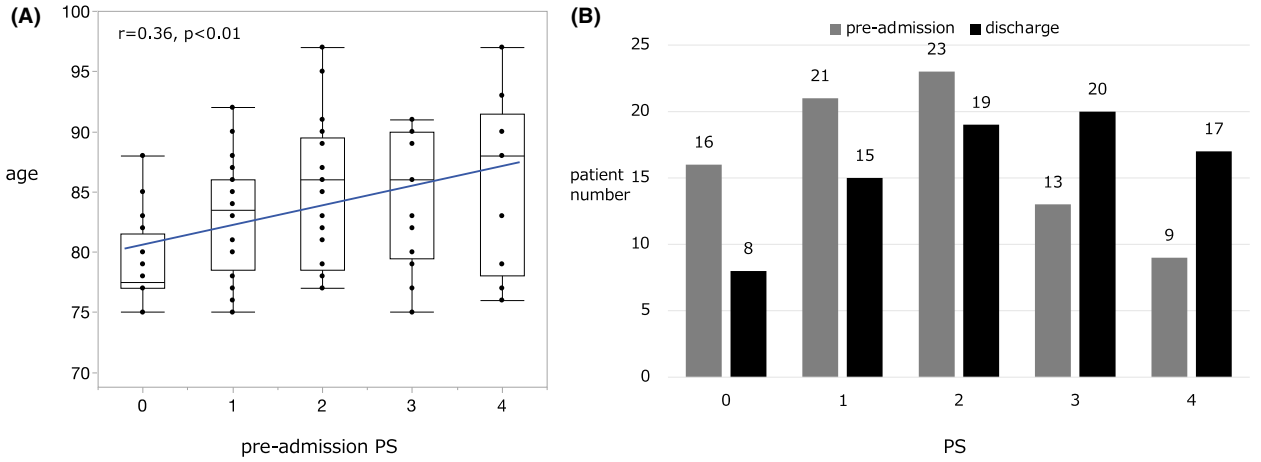

Fig. 1. A, The distribution of age based on pre-admission performance status (PS). The correlation coefficient between age and pre-admission PS was 0.36 ($P < 0.01$). B, The number of patients grouped by PS before admission and at discharge. There were three deaths. PS before admission became significantly worse at discharge ($P < 0.01$).

Table 2. The patient background

Comparison	Bedridden group	Keep group	*P* value
Case number	10	62	–
Age	84 (75–90)	82.5 (75–97)	0.719
Sex (M:F)	2:8	30:32	0.081
BMI	21.62 (15.21–26.73)	21.78 (13.24–36.92)	0.778
Dementia	7 (70%)	15 (24.2%)	<0.01
Pre-admission PS	3 (2–3)	1 (0–4)	<0.01

BMI, body mass index; F, female; M, male; PS, performance status.

There was no significant difference in the timing of rehabilitation intervention.

Among these significant factors, we performed logistic analysis of pre-admission PS, prevalence of dementia, pre-operative SI, preoperative serum Cre, and pre-operative PT-INR, and found that a pre-admission PS cut-off value of 3 was associated with a relative risk of 15.6 (95% confidence interval [CI], 3.73–65.63; $P < 0.01$), a preoperative cut-off value of SI of 0.7 was associated with a relative risk of 13 (95% CI, 1.74–96.71; $P < 0.01$), a relative risk of 6.88 (95% CI, 1.58–29.89; $P < 0.01$) with a preoperative Cre cut-off value of 1.18 mg/dL, and a relative risk of 5.14 (95% CI, 1.18–22.33; $P < 0.01$) with a preoperative PT-INR cut-off value of 1.08. A preoperative SI of over 0.7, had a sensitivity of 1.00 and a specificity of 0.67 for deteriorating to PS4 at discharge. For patients with dementia, the relative risk was 5.3 (95% CI, 1.51–18.62; $P < 0.01$) (Table 4).

The results of postoperative circulatory dynamics in patients with a preoperative SI of 0.7 or higher showed a significant difference in heart rate of 92 (62–140) versus 76.5 (53–106) bpm ($P = 0.03$) and SI of 0.80 (0.61–1.57) versus 0.62 (0.45–0.78) ($P < 0.01$) at 24 h postoperatively (Fig. 2).

DISCUSSION

IT IS ALREADY known that surgical treatment in the latter-stage elderly is associated with an increased risk of perioperative complications and postoperative death because of preoperative complications and systemic fragility, and that the emergency surgery itself is also a risk.[9,10] At the same time, the number of older patients who become bedridden continue to increase.[11] In the field of ACS, the problem of maintaining ADLs should be re-recognized. In a report on older patients who visited the emergency room for minor

Table 3. Perioperative data compared between Bedridden group and Keep group

Comparison	Bedridden group	Keep group	*P*-value
Preoperative factor			
HR (bpm)	104.5 (75–128)	81 (50–123)	<0.01
Systolic BP (mm Hg)	108.5 (78–153)	131.5 (81–204)	0.01
Shock index	0.85 (0.69–1.53)	0.61 (0.30–1.48)	<0.01
Lactate (mg/dL)	20.5 (14–58)	12 (5–62)	<0.01
Ejection fraction (%)	65 (42–70)	66 (39–80)	0.195
WBC (/μL)	8,000 (2000–15,700)	10,000 (2600–22,800)	0.053
Hb (g/dL)	12.65 (5.3–14.9)	12.55 (7–22.3)	0.52
Plt ($\times 10^6$/μL)	22.7 (9.8–32.6)	21.75 (9.7–66.9)	0.97
CRP (mg/dL)	3.43 (0.14–15.92)	6.99 (0.02–34.04)	0.42
T-Bil (mg/dL)	0.7 (0.2–6.5)	0.95 (0.2–5.7)	0.55
Cre (mg/dL)	1.64 (0.62–3.27)	0.95 (0.43–8.39)	<0.01
Alb (g/dL)	3 (2.7–3.5)	3.5 (1.6–4.6)	0.15
PT-INR	1.13 (0.96–1.93)	1.04 (0.89–3.33)	0.01
D-dimer (μg/mL)	9.29 (2.63–46.67)	2.36 (0.73–29.14)	0.03
Intraoperative factor			
ASA-PS	2 (2–3)	2 (1–3)	0.03
Operation time (min)	123.5 (58–207)	121 (38–413)	0.967
Blood loss (g)	20 (2–300)	17 (0–1,380)	0.835
Thoraco-/laparoscopic surgery	0 (0%)	2 / 22 (38.7%)	<0.01
Postoperative factor			
HR (bpm)	88 (70–120)	79.5 (53–117)	0.02
Systolic BP (mm Hg)	120 (73–184)	126 (80–192)	0.42
Shock index	0.75 (0.41–1.45)	0.62 (0.34–1.41)	0.03
Lactate (mg/dL)	13 (5–25)	8 (5–35)	0.11
WBC (/μL)	8,750 (3200–28,300)	9,250 (3300–31,400)	0.71
Hb (g/dL)	10.85 (9.5–14)	10.8 (7.8–19.4)	0.47
Plt ($\times 10^6$/μL)	19.1 (4.6–38.9)	18.1 (7.2–107)	0.18
CRP (mg/dL)	11.53 (2.85–33.87)	13.92 (0.92–48.75)	0.24
T-Bil (mg/dL)	0.6 (0.4–2.2)	0.8 (0.3–6.3)	0.19
Cre (mg/dL)	1.76 (0.69–3.96)	0.89 (0.5–9.38)	<0.01
Alb (g/dL)	2.65 (1.7–3)	2.55 (1.6–3.4)	0.80
PT-INR	1.37 (1.05–1.99)	1.20 (1.05–1.61)	0.02
D-dimer (μg/mL)	10.89 (3.55–66.36)	7.16 (1.07–15.02)	0.31
REH intervention from operation (POD)	1 (0–3)	1 (0–6)	0.42
HCU and ICU stay (days)	10 (1–65)	1 (0–33)	<0.01
Hospital stay (days)	27 (7–69)	11 (3–48)	<0.01

Alb, albumin; ASA-PS, American Society of Anesthesiologists physical status; BP, blood pressure; Cre, creatinine; CRP, C-reactive protein; Hb, hemoglobin; HCU, high care unit; HR, heart rate; ICU, intensive care unit; Plt, Platelet; POD, postoperative day; PS, performance status; PT-INR, prothrombin time–international ratio; REH, rehabilitation; T-Bil, total bilirubin; WBC, white blood cell.
Blood levels of D-dimer ranging from 0.00 μg/mL to 0.99 μg/mL are considered normal at our institution.

injuries, it was found that among the frail group with dementia, older patients who were still independent were at risk of rapidly declining ADLs after the discharge.[12] We believe that we are now entering a stage where emergency surgery for older adults should not only aim to rescue the patient, but also to maintain ADL and quality of life (QOL) after hospital discharge. For this purpose, it is important to investigate the predictive factors leading to patients becoming bedridden and interventional measures to prevent this occurrence.

The results of the present study, which compared older patients who became bedridden after emergency surgery with those who did not, suggests that prehospital PS, prevalence of dementia, perioperative circulatory dynamics, renal

Table 4. The result of logistic analysis about becoming bedridden status

Comparison	Cut-off value	AUC	RR	95% CI	*P*-value
Pre-admission PS	3	0.900	15.6	3.73–65.63	<0.01
Dementia	+	–	5.3	1.51–18.62	<0.01
Preoperative shock index	0.7	0.863	13	1.74–96.71	<0.01
Preoperative creatinine value	1.18	0.783	6.88	1.58–29.89	<0.01
Preoperative PT-INR	1.08	0.736	5.14	1.18–22.33	0.01

AUC, area under the curve; CI, confidence interval; PS, performance status; PT-INR, prothrombin time–international ratio; RR, relative risk.

dysfunction, and abnormalities in the coagulation-fibrinolytic system may be predictors of developing bedridden status. It is not difficult to predict that the worse the prehospital PS, the higher the risk of the patient becoming bedridden. The prevalence of dementia was similar to that reported by Provencher *et al.*[13] The results of the logistic regression analysis of these factors showed that the preoperative SI was the most sensitive predictor. An SI of 0.7 or higher immediately before surgery resulted in a PS4 at discharge with a sensitivity of 1.00 and specificity of 0.67, which shows that we should focus on cases that require active intervention. There were no significant differences in which corresponded to nutritional status.

As for the interventions in the high-risk group identified using this information, the results of this study showed that among the patients whose SI was above 0.7 immediately before surgery, there was a significant difference in SI 24 h after surgery between the Bedridden and Keep groups. Therefore, it seems that the management for the early stabilization of circulatory dynamics besides the appropriate surgery is important not only to rescue older patients, but also to prevent them from becoming bedridden. In addition, the length of stay in the HCU/ICU and hospitalization were significantly related to the deterioration in PS4, suggesting that we should aim for early discharge from the HCU/ICU and early discharge from the hospital. This is similar to the report about ICU-acquired weakness[14] and seems to be the same result from the viewpoint of the prognosis of the life and the cost of medical care. Needless to say, we should treat

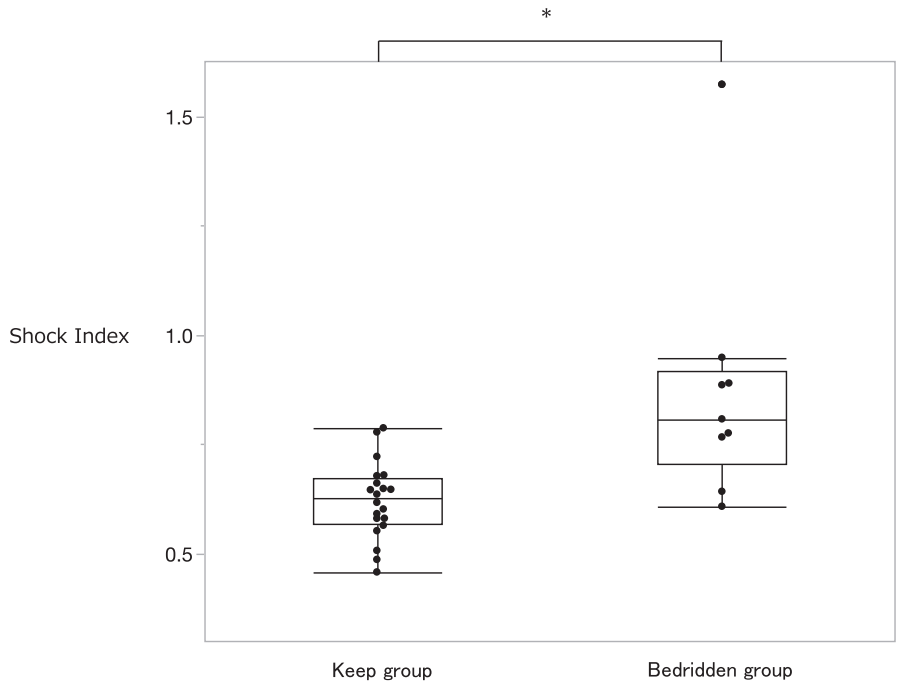

Fig. 2. The comparison of shock index (SI) at 24 h postoperatively between the Keep and Bedridden groups in the patients whose SI was over 0.7 before surgery. *Significant difference. Even if the SI before surgery was >0.7, the lower SI at 24 h postoperatively was significantly related to better performance status.

the primary disease and prevent complications to shorten the duration of HCU/ICU admission and hospitalization.

Rehabilitation is also an important aspect in the literature. Schweickert *et al*.[15] reported that early rehabilitation in the ICU significantly improved the independence at discharge, whereas Kayambu *et al*.[16] reported that early rehabilitation significantly reduced the duration of HCU/ICU admission and hospitalization. These reports suggest that early rehabilitation, defined as rehabilitation within 48 h after surgery, is useful. In addition, Morita *et al*.[17] reported that the duration of ICU stay was significantly shorter in the 7-day per week intervention of rehabilitation than in the 5-day per week intervention. It is important to ensure sufficient rehabilitation in terms of the quantity and time. Regarding the safety of early rehabilitation, Garzon-Serrano *et al*.[18] reported no adverse events in early rehabilitation in a surgical ICU; therefore, we do not believe this will be an issue. In the present paper, most of the patients started rehabilitation by POD1. Because of this, the comparison of the two groups was not significantly different, but at least the rehabilitation did not result in any adverse events.

We believe that this is an important study that statistically examined the predictors of latter-stage elderly patients who have undergone emergency surgery becoming bedridden at discharge. Each decision to pursue operative treatment for elderly patients should be a shared decision with the patient and their family with consideration of not only saving life, but also the patient's values and preferences. However, it can be difficult to prioritize them over saving lives for a life-threatening emergency illness that suddenly confronts them because of the time pressure, psychological stress, *etc*., in the emergency room. Maybe because of that, in the field of ACS, there is little mention of over-treatment for the latter-stage elderly patients in addition to the maintenance of post-operative ADL and QOL. It is also important to determine the strategy with considering about backgrounds, such as pre-existing disease and bedridden status, and expected general condition after surgical treatments; this is a question relating to the use enormous medical resources.[19] The prediction of functional prognosis, including ADL and life prognosis, may enable the selection of an appropriate treatment strategy for older patients with conditions requiring emergency surgery.[20]

The limitations of this study include its single-center nature, the small number of cases, and the fact that it was a retrospective study, which also limited our access to the details of the activity assessment. In addition, we did not investigate how to stabilize the hemodynamics and did not perform prospective study about rehabilitation. The level of evidence reported in our Therapeutic/Care Management study is Evidence Level III. Further accumulation of cases and prospective studies are required to confirm or alter the conclusions reported in our study.

In summary, it is important not only to rescue the elderly patients, but also to protect them against becoming bedridden after hospital discharge in an aging society. In the context of emergency surgery, prehospital PS, prevalence of dementia, perioperative circulatory dynamics, renal dysfunction, and abnormalities in the coagulation-fibrinolytic system can be predictors of bedridden status at discharge, with preoperative circulatory dynamics being the earliest and most sensitive marker. With regard to interventions, it seems to be essential to stabilize circulatory dynamics as early as possible, including with surgery, shorten the length of HCU/ICU stay and hospitalization by treating the primary disease, and reducing complications, and providing early and sufficient rehabilitation.

ETHICS STATEMENT

APPROVAL OF THE Research Protocol: This study was approved by the ethics committee of Nagasaki Harbor Medical Center (Approval no. R03-028).

Informed Consent: Opt-out consent was used in compliance with the regulations on the protection of personal information.

CONFLICT OF INTEREST

THE AUTHORS DECLARE no conflicts of interest.

AUTHOR CONTRIBUTIONS

KANTOKU NAGAKAWA, KEN Taniguchi, Aki Yukutake, Yuta Kawaguchi, Ryo Matsumoto, Momoko Akashi, Takanori Hirayama, Masataka Hirabaru, Chika Sakimura, Shigeki Minami, and Susumu Eguchi were involved in study design and data interpretation. Kantoku Nagakawa and Ken Taniguchi were involved in the data analysis. All authors critically revised the report, commented on the drafts of the manuscript, and approved the final report.

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