



Research Paper

Effect of emergency general surgery on postoperative performance status in patients aged over 90 years



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ABSTRACT

Background: Functional deterioration following emergency general surgery (EGS) poses a significant challenge in super-elderly patients. However, limited research has focused on assessing the deterioration in postoperative performance status (PS). This study aimed to investigate the impact of EGS on PS deterioration in super-elderly patients, and the extent to which deteriorated PS is recovered.

Methods: This historical cohort study comprised 77 super-elderly patients who underwent EGS between July 2015 and December 2020. Functional deterioration was evaluated by comparing preoperative and postoperative Eastern Cooperative Oncology Group Performance Status (ECOG-PS). The Emergency Surgical Score (ESS) was used as a risk-adjustment tool. Questionnaires were mailed to the patients and their families to assess post-discharge PS and obtain their impressions of EGS.

Results: Postoperative PS deteriorated in 35/77 patients (45.5 %). Significant differences were observed between the groups in terms of sex, serum C-reactive protein (CRP) levels, ESS scores, preoperative ECOG-PS, duration of operation, and major complications. Multivariate analysis of preoperative factors showed that ESS ≥ 7 (OR: 3.7, 95 % CI: 1.0–13), preoperative ECOG-PS ≤ 2 (OR: 5.9, 95 % CI: 1.7–21), and female sex (OR: 5.8, 95 % CI: 1.6–21) were associated with postoperative ECOG-PS deterioration. According to the questionnaire results, PS recovery post-discharge was observed in 6/36 (17 %) patients, and 34/36 (94 %) patients and their families expressed positive impressions of EGS.

Conclusions: EGS in super-elderly patients highly caused a deterioration in their PS, particularly in patients with maintained preoperative PS. PS hardly recovered; however, most patients and their families had positive impressions of the EGS.

Key message: We assessed the pre- and postoperative performance status of super-elderly patients who underwent emergency general surgery. Surgery caused a marked deterioration in patients' functional performance, which seldom recovered postoperatively.

Introduction

Super-aging has become a social issue in developed countries [1–4]: in 2020, the average life expectancy in Japan was 87.5 years for women and 81.5 years for men [5]. People older than 90 years are classified as super-elderly [3]. A significant proportion of super-elderly patients who undergo emergency general surgery (EGS) are at a high risk of mortality and morbidity [1]. Previous studies show that, for patients older than 90 years, the overall 30-day and in-hospital mortality rates after EGS are 9.7 %–20 % and 20 %–30 %, respectively [6–11].

EGS raises ethical concerns in the context of caring for super-elderly

patients due to their unpredictable prognosis [12,13]. While several risk-assessment tools are utilized, including the American Society of Anesthesiologists-Physical Status (ASA-PS) score, Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity, and American College of Surgeons National Surgical Quality Improvement Program [1,11] the Emergency Surgery Score (ESS), which uses only objective preoperative variables, is established as the most comprehensive risk-assessment tool for EGS [14–17], and enables physicians to predict morbidity and mortality in elderly patients who undergo EGS [6]. Even though the diversity of EGS poses challenges to research [18], the ESS is considered to be a risk-adjustment tool in

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several studies [6,15–17].

A deterioration in PS after EGS is a fundamental issue in patients older than 90 years as they require longer recovery periods and are more likely to remain in residual disability once they lose their function than younger patients, who can overcome postoperative dysfunction through rehabilitation [12,19–22]. Limited research has been conducted on the assessment of post-EGS PS deterioration specifically in super-elderly patients. In this study, we aimed to assess the impact of preoperative PS on postoperative PS deterioration using the ESS as an evaluation tool in super-elderly patients who underwent EGS. In addition, we conducted a postoperative survey using a questionnaire to examine the recovery of postoperative PS in patients and the impressions that patients and their families had of EGS.

Material and methods

This historical cohort study included 77 consecutive patients older than 90 years who underwent EGS between July 2015 and December 2020 at Amagasaki General Medical Center, Hyogo, Japan. The study was approved by the Ethics Board of Amagasaki General Medical Center (approval no. 3-45). Data on the following clinical variables were collected: age; sex; body mass index; transfer status; white blood cell and platelet counts; serum levels of C-reactive protein (CRP), albumin, total bilirubin, creatinine, alkaline phosphatase, blood urea nitrogen, aspartate transaminase, and sodium; prothrombin time-international normalized ratio; ASA-PS score; preoperative and postoperative Eastern Cooperative Oncology Group performance status (ECOG-PS) scores; and surgical indications. The following characteristics were also reviewed: surgical procedure, operative time, blood loss volume, postoperative complications, discharge status (home/rehabilitation/death), and postoperative hospital stay.

The ECOG-PS score, which indicates the degree of restriction in a patient's daily life [22], comprises six levels. PS deterioration was evaluated by calculating the difference between preoperative and postoperative ECOG-PS scores. The ECOG-PS score at discharge, as assessed by the medical team, was used as the postoperative ECOG-PS score. The ESS was calculated using 22 independent predictors of mortality in patients undergoing EGS, including three demographic variables, 10 comorbidities, and 9 preoperative laboratory variables [14]. Detailed data on preoperative weight loss were not available for any of the patients in the present study; therefore, all patients were categorized as having >10 % weight loss in the 6 months prior to surgery.

Surgical indications were categorized as perforation; infection other than perforation, such as cholecystitis and appendicitis; obstruction; or others. The surgical procedures were categorized as major or minor. Minor surgeries included appendectomy, cholecystectomy, colostomy, ileostomy, incarcerated hernia repair, and exploratory laparotomy without ischemia or perforation. Major surgeries included bowel resection, surgery for peritonitis, and other surgeries.

Postoperative complications were classified using the Clavien–Dindo classification, and a major postoperative complication was defined as a complication with a grade of ≥ 3 [23].

We mailed a questionnaire to each participant and their family to evaluate postoperative recovery of their PS, their impressions of EGS for the super-elderly patients. Patients and their families were asked to reassess the ECOG-PS at admission, discharge, and in December 2021. The impressions of EGS were obtained using a 5-point scale (1: excellent; 2: good; 3: fair; 4: poor; 5: unacceptable).

Continuous variables are expressed as mean \pm standard deviation and compared using Student's *t*-test. Categorical variables are expressed as proportions and compared using the χ^2 test. The length of hospital stay after EGS was compared using the log-rank test. All *P* values were two-sided, and a *P* value <0.05 was considered statistically significant. Receiver operating characteristic curve analysis was used to identify the optimal cutoff points for indicating a deterioration in the ECOG-PS score. Univariate and multivariate logistic regression analyses were

performed to identify preoperative factors associated with postoperative deterioration in the ECOG-PS score.

Results

Clinical variables

The clinical variables are summarized in Table 1. The mean ESS was 6.5. The breakdown of surgical indications (number of patients) was as follows: perforation: upper (8) and lower (8) gastrointestinal perforation; infection: acute cholecystitis (9), acute appendicitis (8), and intra-abdominal abscess (1); obstruction: neoplastic (7) and non-neoplastic (31) bowel obstruction and mesenteric ischemia (2); and others: bladder-colon fistula (1), ruptured liver cyst (1), and foreign body in the colon (1). Major surgeries included bowel resection (26), surgery for peritonitis (8), and hemostatic surgery with hepatic cyst fenestration (1). Minor surgeries included appendectomy (7), cholecystectomy (9), colostomy or ileostomy (10), hernia repair without bowel resection (12), and probe laparotomy (4). Fifteen patients (19.5 %) underwent laparoscopic surgery, including cholecystectomy (7), appendectomy (5), incarcerated hernia repair (1), surgery for peritonitis (1), and exploratory laparotomy (1). Sixty-two percent of patients had a preoperative ECOG-PS score of ≤ 2 , and 25 % had a postoperative ECOG-PS score of

Table 1
Clinical variables of the 77 participants.

Variable	Value
Age, years, mean	92.4 \pm 2.5
Sex, male	25 (32 %)
Body mass index, kg/m ² , mean \pm SD	20.5 \pm 3.8
Transfer from outside the emergency department	9 (12 %)
Transfer from acute care inpatient facility	9 (12 %)
White blood cell count, 10 ⁹ /L, mean \pm SD	9.96 \pm 4.67
C-reactive protein, mg/dL, mean \pm SD	10.1 \pm 11.7
Albumin level, g/dL, mean \pm SD	3.1 \pm 0.7
Platelet count, 10 ⁹ /L, mean \pm SD	22.6 \pm 9.7
Total bilirubin level, mg/dL, mean \pm SD	0.83 \pm 0.78
Creatinine level, mg/dL, mean \pm SD	1.34 \pm 1.02
Alkaline phosphatase, U/L, mean \pm SD	273 \pm 142
Blood urea nitrogen, mg/dL, mean \pm SD	31.6 \pm 15.1
PT-INR, mean \pm SD	1.18 \pm 0.45
Aspartate transaminase level, U/L, mean \pm SD	33.5 \pm 36.7
Sodium level, mmol/L, mean \pm SD	137 \pm 4.5
Emergency surgical score	6.5 \pm 2.2
ASA-PS score, ≥ 3 E	44 (57 %)
Preoperative ECOG-PS score ≤ 2	48 (62 %)
Postoperative ECOG-PS score ≤ 2	19 (25 %)
Surgical indication	
Perforation	16 (21 %)
Infection	18 (23 %)
Obstruction	40 (52 %)
Others	3 (4 %)
Surgical procedure, major	35 (45 %)
Operative time, minutes, mean \pm SD	123 \pm 59
Volume of blood loss, mL, mean \pm SD	180 \pm 386
Postoperative complications	23 (30 %)
Major postoperative complications	11 (15 %)
Discharge destination	
Home	31 (40 %)
Rehabilitation	41 (53 %)
Death	5 (6 %)
Length of postoperative hospital stay, days, median (95 % confidence interval)	15.5 (13–16)

SD, standard deviation; PT-INR, prothrombin time-international normalized ratio; ASA-PS, the American Society of Anesthesiologists-Physical Status; ECOG-PS, Eastern Cooperative Oncology Group-Performance Status.

≤2.

The postoperative complication rate was 30 %. Delirium (28.5 %) was the most common postoperative complication, followed by surgical site infection (10.4 %). The incidence of major postoperative complications was 15 %. The reoperation and in-hospital mortality rates were 8 % and 6 %, respectively.

Postoperative PS deterioration due to EGS

The postoperative PS deteriorated in 35 patients (45.5 %). Of the preoperative clinical variables, significant differences were observed between the groups in sex, serum CRP levels, ESS, and preoperative ECOG-PS scores. No statistically significant difference was found in the ASA-PS. The rate of deterioration in functional performance was higher in patients with a preoperative ECOG-PS score of ≤2 than in those with a preoperative ECOG-PS score of >2. No statistically significant differences were noted in surgical indications, surgical procedures, and operative times; however, postoperative ECOG-PS scores tended to deteriorate in cases involving perforation and longer operative times. As a postoperative clinical variable, major complications were significantly more common in patients with deteriorated PS than in those without. Although no statistically significant difference was observed between the groups for the length of postoperative hospital stay, patients without PS deterioration had a higher rate of discharge to home (Table 2).

Association of preoperative factors and deteriorations in postoperative ECOG-PS scores

In the univariate analyses, the cutoff values for serum CRP levels and ESS were 6.89 mg/dL and 7, respectively. In the multivariate analysis, an ESS of ≥7 (odds ratio [OR]: 3.7; 95 % confidence interval [CI]:

Table 2

Comparison of clinical variables between patients with and without deterioration in postoperative ECOG-PS scores.

Clinical variable	With deterioration (n = 35)	Without deterioration (n = 42)	P value
Age, years, mean ± SD	92.1 ± 2.7	92.6 ± 2.4	0.463
Sex, male	7 (20 %)	18 (43 %)	0.033*
CRP, mg/dL, mean ± SD	14.2 ± 13.5	6.6 ± 8.7	0.004*
Emergency surgical score, mean ± SD	7.4 ± 2.3	5.8 ± 1.9	0.001*
ASA-PS score ≥ 3E	19 (54 %)	25 (60 %)	0.653
Preoperative ECOG-PS score ≤ 2	29 (83 %)	19 (45 %)	0.001*
Surgical indications			0.056
Perforation	12 (34 %)	4 (10 %)	
Infection	8 (23 %)	10 (24 %)	
Obstruction	14 (40 %)	26 (61 %)	
Others	1 (3 %)	2 (5 %)	
Surgical procedure, major	18 (51 %)	17 (40 %)	0.337
Operative time, minutes, mean ± SD	136 ± 67	112 ± 50	0.069
Volume of blood loss, mL, mean ± SD	199 ± 337	164 ± 425	0.697
Postoperative complications	16 (70 %)	7 (30 %)	0.005*
Major postoperative complications	9 (26 %)	2 (5 %)	0.009*
Discharge destination			0.006*
Home	10 (29 %)	21 (50 %)	
Rehabilitation	20 (57 %)	21 (50 %)	
Death	5 (14 %)	0 (0 %)	
Length of postoperative hospital stay, days, median	16.5 (13–18)	13.5 (12–16)	0.066

SD, standard deviation; CRP, C-reactive protein; ASA-PS, American Society of Anesthesiologists-Physical status; ECOG-PS, Eastern Cooperative Oncology Group-Performance Status.

* P < 0.05.

1.0–13), preoperative ECOG-PS score of ≤2 (OR: 5.9; 95 % CI: 1.7–21), and female sex (OR: 5.8; 95%CI: 1.6–21) were significantly associated with a deterioration in the postoperative ECOG-PS scores (Table 3).

Postoperative survey regarding the ECOG-PS scores, and patients' and their families' impressions of EGS

Of the 77 participants and their families, 40 responded to the questionnaire mailed to them. Of these responses, 36 valid responses to the ECOG-PS questionnaire were received (Table 4). Compared with the preoperative ECOG-PS scores, the postoperative scores deteriorated in 22 of the 36 participants (61 %) at discharge and in 20 of the 36 patients (56 %) at December 2021. Compared with postoperative ECOG-PS scores at discharge, the scores at December 2021 deteriorated in 10 patients (six of whom died) and recovered in six. Of the six patients who showed recovery in their PS, four reported a recovery to the same level as their preoperative PS.

Thirty-seven valid responses were received regarding the impressions that patients and their families had of EGS for people older than 90 years. Table 5 shows the breakdown of the responses.

Discussion

The in-hospital mortality rate for this study was 6 %, which is lower than the 20 % to 30 % for post-EGS for super-elderly patients reported previously [10,11]. This rate might be subject to bias due to patient selection. However, the 30-day mortality rate for patients with an ESS of 6.5 has been reported to be 6.5 % to 8.9 % [14], which is almost the same as the in-hospital mortality rate of the present study. This demonstrates the validity of using the ESS as a risk-adjustment tool for patients older than 90 years with various comorbidities and backgrounds. In the current study, an ESS value of ≥6.5 was associated with a deterioration in the postoperative PS in super-elderly patients who underwent EGS. The ESS was associated not only with mortality, but also with poorer physical function in the patient cohort.

Major postoperative complications are a risk factor for postoperative functional deterioration [1], as observed in the present study. In addition, longer operative times tended to cause a reduction in postoperative functional performance. Therefore, the prevention and early detection of major postoperative complications are essential for improved functional outcomes after EGS in older patients [24]. In the present study, we did not examine whether any particular type of surgical technique is effective for super-elderly patients; this is a topic for future investigation.

We identified an association between female sex and postoperative deterioration in functional performance. Sex differences have been shown in many aspects of health care. One study reported no difference between the sexes in mortality for patients undergoing EGS [25]; however, no studies have examined sex differences in super-elderly patients undergoing EGS, and further investigation is required.

Table 3

Univariate and multivariate analyses for preoperative factors associated with poorer postoperative ECOG-PS scores.

Preoperative factor	Univariate analysis			Multivariate analysis		
	OR	95 % CI	P value	OR	95 % CI	P value
Female sex	3.0	1.1–8.4	0.036*	5.8	1.6–21	0.008*
CRP ≥ 6.89 mg/dL	3.8	1.5–9.7	0.006*	1.7	0.5–6.7	0.339
Emergency surgical score ≥ 7	5.4	2.0–15	0.001*	3.7	1.0–13	0.042*
Preoperative ECOG-PS score ≤ 2	5.8	2.0–17	0.001*	5.9	1.7–21	0.005*

OR, odds ratio; CI, confidence interval; CRP, C-reactive protein; ECOG-PS, Eastern Cooperative Oncology Group-Performance Status.

* P < 0.05.

Table 4
Results of the follow-up survey regarding the Eastern Cooperative Oncology Group-Performance Status of participants, *n* = 36.

Rating	Response from participant/family member
Preoperative ECOG-PS 0/1/2/3/4/5	6/7/8/14/1/0
Postoperative ECOG-PS 0/1/2/3/4/5	3/2/8/11/10/2
ECOG-PS at December 2021 0/1/2/3/4/5	3/4/4/13/4/8

ECOG-PS, Eastern Cooperative Oncology Group-performance status.

Table 5
Results of the follow-up survey regarding the impressions that participants or their family had of the emergency general surgery.

Impressions	All patients (<i>n</i> = 37)	Patients whose ECOG-PS deteriorated (<i>n</i> = 20)
Excellent	15	5
Good	20	13
Fair	1	1
Poor	1	1
Unacceptable	0	0

ECOG-PS, Eastern Cooperative Oncology Group-performance status.

Preoperative PS assessment provides critical information regarding frailty [26]. The ECOG-PS score is reportedly associated with 30-day postoperative mortality in patients undergoing high-risk EGS [26]. In the current study, EGS resulted in a high rate (45.5 %) of poorer postoperative functional performance in patients aged over 90 years, even though the in-hospital mortality rate was 6.5 %. Only 11 % of respondents to the questionnaire reported a recovery of postoperative functional performance to the same level as that of their preoperative performance. In addition, the rate of deterioration in PS was higher in patients who had a good preoperative ECOG-PS score than in those who did not. Therefore, our finding might indicate that super-elderly patients are unable to overcome surgical invasion. However, the patients and their families highly appreciated having the surgery. This is an encouraging finding for surgeons involved in EGS for super-elderly patients.

EGS in super-elderly patients highly caused a deterioration in their PS, especially among those with preserved preoperative PS. It is essential whether super-elderly patients return to their premorbid condition [4]. The results of this study are important not only for physicians but also for patients and their families, guiding decisions on emergency surgery suitability. This study is a retrospective study, and we have not been able to discuss what kind of intervention leads to PS maintenance. This is considered a future issue, and by designing a prospective study in line with the content of the ESS-Score, it may be possible to evaluate what kind of intervention such as indications for surgery, intraoperative factors, and postoperative support could prevent deterioration in postoperative functional performance.

The current study had several limitations. This was a retrospective study and data on some variables, such as body weight and frailty, were limited and the timing of the follow-up on patients after discharge was not the same for all patients. The cohort size was small since the study was conducted at a single center and the response rate to the questionnaire was low; these factors may have created response bias. The decision to perform EGS was based on the clinician's assessment; therefore, no standard criteria were applied for determining whether EGS should be conducted. Comparative data analysis was not performed between patients who underwent EGS and those treated with other approaches. The ECOG-PS was subjective, although we incorporated as

much third-party data as possible, such as nursing and rehabilitation records, to reduce subjectivity.

In conclusion, patients older than 90 years who underwent EGS experienced a high rate of deterioration in their postoperative functional performance; the in-hospital mortality rate was 6.5 %. In addition, higher ESSs, lower ECOG-PS scores, and female sex were associated with postoperative performance status deterioration in the patient cohort. Functional performance reduced after EGS, hardly recovered: the recovery rate was low at approximately 10 %. However, most patients and their families had good impressions of EGS for the super-elderly patients. Therefore, we should continue to devise ways to improve EGS outcomes for super-elderly patients.

Abbreviations

- ASA-PS American Society of Anesthesiologists-Physical Status
- ECOG-PS Eastern Cooperative Oncology Group Performance Status
- EGS emergency general surgery
- ESS Emergency Surgical Score

CRediT authorship contribution statement

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by KH and KY. The first draft of the manuscript was written by KH and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Ethics approval

This study was approved by the Ethics Board of Amagasaki General Medical Center (approval number 3-45).

Declaration of competing interest

There are no conflicts of interest to declare.

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