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Predictors of mortality in elderly patients in emergency abdominal surgery: A retrospective single-center study

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Ethics Committee Approval
The study was approved by Sisli Hamidiye Etfal Training and Research Hospital Ethics Committee (date: August 1, 2023, approval number: 4,025).
All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

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No conflict of interest was declared by the authors.

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Abstract

Background/Aim: Advancements in medical technologies and prolonged life expectancy have increased the number of surgical interventions for elderly patients. Despite this however, emergency surgical interventions remain associated with a high mortality rate. Managing an emergency abdominal surgery in elderly patients poses great challenges for both the surgeon and the anesthesiologist. However, knowing the risk factors that increase mortality may offer advantages to the clinician managing the treatment process. There are studies in the literature examining the mortality of emergency surgeries in elderly patients. However, there are very few studies that work with a specific patient group such as abdominal surgery and then analyze laboratory test results. Here, we aimed to identify the risk factors that can be used to predict mortality in elderly patients undergoing emergency abdominal surgery.
Methods: The study was designed retrospectively in a single center; 100 patients over the age of 80 who underwent emergency abdominal surgery were included in the study. The patients were divided into two groups as survivor and non-survivor. Demographic, surgical, and anesthetic characteristics, laboratory tests, American Society of Anesthesiologists (ASA) physical status scores, postoperative intensive care needs, and treatments of the groups were compared using the chi-squared and Mann Whitney U-test. Determining factors were investigated with logistic regression analysis.
Results: In multivariate analysis, ASA 3 and major surgery significantly increased mortality (*P*=0.041, *P*=0.011). Receiver operating characteristic (ROC) curve analysis showed that C-reactive protein with a cut-off value of >84 mg/L had a sensitivity of 58.8% and a specificity of 71.2% (AUC=0.636, *P*=0.004), while lactate with a cut-off value of >3.6 mmol/L had a sensitivity of 50% and a specificity of 95.5% in predicting mortality (AUC=0.776, *P*<0.001).
Conclusion: The magnitude of surgery and the ASA score were the best predictors of mortality in elderly patients undergoing emergency abdominal surgery.

Keywords: emergency abdominal surgery, mortality, lactate, c-reactive protein, elderly

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Introduction

The rise in life expectancy and advancements in medical technology in recent years has significantly increased the number of surgical procedures performed on elderly patients. In the United States, individuals over the age of 65 account for 15% of its population, which is expected to rise to 25% by 2060 [1]. Over 40% of all surgeries performed in the United States were on patients over the age of 65 [2].

Multicenter studies reported that patients who underwent emergency general surgery have a significantly higher risk of mortality and complications than patients undergoing elective general surgery [3]. Factoring in age, the risk of mortality and morbidity increases even more due to the frailty of elderly patients. Frailty is a modern concept in geriatric medicine and is defined by Campell et al. [4] as a medical syndrome characterized by decreased strength and endurance and reduced functional reserve of multiple organ systems, which increases an individual's susceptibility to injury and death.

Emergency surgical procedures for the frail elderly over 80 years of age poses enormous challenges for both the surgeon and the anesthesiologist, and thus a multidisciplinary approach is necessary for quickly planning perioperative procedures and postoperative treatment and care services. Risk factors as well as the surgical and anesthetic procedures must be assessed during planning. While several studies have evaluated the risk factors for emergency surgical procedures in geriatric patients [5,6], specific studies analyzing both emergency abdominal surgery and laboratory test results are limited [7,8].

Here, we evaluated the effects of demography, comorbidity, laboratory tests, surgical, and anesthesia procedures, and postoperative intensive care unit (ICU) treatments on the mortality of elderly patients (aged over 80 years) who underwent emergency abdominal surgery.

Materials and methods

This retrospective observational study was approved by Sisli Hamidiye Etfal Training and Research Hospital Ethics Committee (date: August 1, 2023, approval number: 4,025). All procedures were performed in accordance with the ethical standards of the Helsinki Declaration (2008) and the STROBE guidelines for reported retrospective cohort studies [9].

Emergency department records between 2015 and 2023 were screened from the hospital information recording system. Patients aged over 80 years who presented to the emergency department and underwent emergency abdominal surgery were included. Patients treated 24 hours after admission, those with missing data, those who do not have a life expectancy of more than 24 hours, and trauma patients were excluded.

Data on age, gender, comorbidity, and American Society of Anesthesiologists (ASA) physical status classification system scores were recorded. Comorbidities included hypertension, diabetes mellitus (DM), coronary artery disease (CAD), chronic obstructive pulmonary disease (COPD), heart failure, Alzheimer's disease, dementia, malignancy, hepatic cirrhosis, chronic renal failure (CRF), and cerebrovascular stroke (CVS). The laboratory test results of the first blood samples taken after the emergency room admission were screened for hemoglobin (Hgb), white blood cells (WBC), C-reactive protein (CRP), glucose, urea, creatinine, alanine aminotransferase (ALT), aspartate aminotransferase (AST), lactate dehydrogenase (LDH), Ph, partial carbon dioxide pressure (pCO_2), bicarbonate (HCO_3) and lactate levels.

The following characteristics related to the surgery were collected: the surgical diagnosis, time from admission to surgery, magnitude of surgery, and anesthesia method used (general anesthesia or neuraxial anesthesia). Procedures performed in the first 12 hours were defined as early surgery, and those performed between 12 and 24 hours were defined as late surgery. The magnitude of surgery classification was performed based on the magnitude of surgery samples included in the Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity (POSSUM) scoring system [10]. According to this scoring, surgical procedures were categorized as minor, intermediate, major, and major+ (Table 1).

Table 1: The magnitude of general surgery

Minor	Intermediate	Major	Major+
hernia	open cholecystectomy	laparotomy and small-bowel resection	abdominoperineal excision of rectum
varicose vein	laparoscopic cholecystectomy	colonic resection or anterior resection	aortic surgery
minor perianal surgery	appendectomy	major amputation	Whipple resection
scrotal surgery	excision of lesion requiring grafting or minor excision	nonaortic vascular surgery	radical total gastrectomy
minor transurethral resection of tumor	minor amputation	cholecystectomy and exploration of bile duct	
excision of large subcutaneous lesion	thyroid lobectomy	total thyroidectomy	

Patients' postoperative intensive care needs, need for mechanical ventilation (MV), hemodiafiltration (HDF), vasopressor support (VPS), and 90-day mortality were recorded. Patients were categorized by mortality into non-survivor and survivor groups, and all recorded data were compared. Univariate and multivariate regression analyses were performed on the significant data.

The primary outcome of the study was to analyze the effects of demographics, comorbidities, laboratory tests, surgical, and anesthesia procedures, and postoperative ICU treatments on mortality in patients over 80 years of age undergoing emergency abdominal surgery. The secondary outcome of the study was to describe the characteristics of the patients and the surgical and anesthesia procedures.

Statistical analysis

SPSS 15.0 (SPSS Inc., Chicago, IL, USA) for Windows was used for statistical analysis. Descriptive statistics were given in terms of number and percentage for the categorical variables and in terms of median and interquartile range for the numeric variables. The rates in groups were compared via the chi-squared test. Comparisons of two independent groups were made with the Mann-Whitney U-test because the numerical variables did not follow the normal distribution condition. The prognosis power of the inflammatory parameters to predict mortality was assessed based on the analysis of the receiver operating characteristic (ROC) curve. Determining factors were investigated with logistic regression analysis. The alpha significance level was defined at P-value <0.05.

Results

Baseline characteristics

Between 2015 and 2023, 173 patients over the age of 80 underwent emergency abdominal surgery. Of these, 100 patients (68% female) were included in the study because they met the study criteria. The mortality rate in the study population was 34%. Details are presented in Table 2. The non-survivor and survivor groups comprised 34 and 66 patients, respectively. ASA 4 was found to be statistically significantly higher in the non-survivor group (*P*<0.001). LDH, CRP, and lactate were significantly higher, and Ph was significantly lower in the non-survivor group (*P*=0.05, *P*=0.026, *P*<0.001, *P*=0.010) (Table 3). In the cut-off value examinations with ROC curve analysis for CRP and lactate levels in predicting mortality, a cut-off value of >84 mg/L with 58.8% sensitivity and 71.2% specificity was found for CRP (AUC=0.636, *P*=0.004) and >3.6 mmol/L with 50% sensitivity and 95.5% specificity for lactate (AUC=0.776, *P*<0.001) (Figure 1, Table 4).

Table 2: Demographic and clinical characteristics of the patient cohort

		Total (n=100)	Survivor (66%)	Non-survivor (34%)	*P*-value
Age (Median (IQR)		84 (82-88)	84 (82-87.25)	85 (81.75-88)	0.773*
Sex n (%)	Male	32 (32.0%)	22 (33.3%)	10 (29.4%)	0.690#
	Female	68 (68.0%)	44 (66.7%)	24 (70.6%)	
ASA n (%)					
1		1 (1.0%)	1 (1.5%)	0 (0.0%)	<0.001#
2		38 (38.0%)	32 (48.5%)	6 (17.6%)	
3		38 (38.0%)	26 (39.4%)	12 (35.3%)	
4		23 (23.0%)	7 (10.6%)	16 (47.1%)	
Hypertension		83 (83.0%)	53 (80.3%)	30 (88.2%)	0.317#
Diabetes mellitus		35 (35.0%)	24 (36.4%)	11 (32.4%)	0.690#
CAD		10 (10.0%)	6 (9.1%)	4 (11.8%)	0.731#
COPD		12 (12.0%)	8 (12.1%)	4 (11.8%)	1.000#
Cardiac failure		12 (12.0%)	8 (12.1%)	4 (11.8%)	1.000#
Alzheimer's		12 (12.0%)	11 (16.7%)	1 (2.9%)	0.054#
Dementia		2 (2.0%)	2 (3.0%)	0 (0.0%)	0.547#
Malignancy		14 (14.0%)	9 (13.6%)	5 (14.7%)	1.000#
Cirrhosis		3 (3.0%)	3 (4.5%)	0 (0.0%)	0.549#
CRF		4 (4.0%)	2 (3.0%)	2 (5.9%)	0.603#
CVS		15 (15.0%)	8 (12.1%)	7 (20.6%)	0.261#
Others		26 (26.0%)	15 (22.7%)	11 (32.4%)	0.299

#Chi Square Test, *Mann Whitney U Test

Table 3: Laboratory tests of the patient cohort

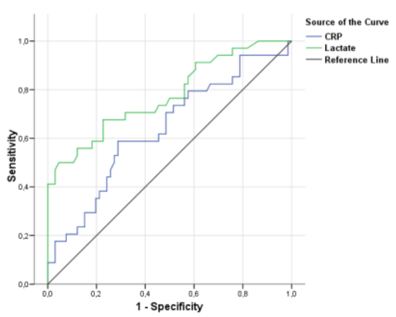
	Total (n=100)	Survivor (66%)	Non-survivor (34%)	*P*-value
CRP	53.47 (14-155.545)	29.8 (12.125-124)	106.37 (22.275-199)	0.026*
Hgb	12.35 (10.5-13.85)	12.1 (10.5-13.8)	13.1 (10.35-14.95)	0.189*
WBC	10.93 (8.33-16.68)	10.555 (8.58-16.6)	11.75 (7.33-17.18)	0.977*
Glucose	140 (115-176.5)	137.5 (112.5-172)	142.5 (118.75-186)	0.541*
Urea	57.5 (38.5-78)	49 (36.5-77)	72 (40.5-92)	0.062*
Creatinine	1.05 (0.76-1.485)	0.975 (0.74-1.26)	1.175 (0.78-1.85)	0.130*
Ph	7.4 (7.35-7.46)	7.42 (7.37-7.46)	7.35 (7.23-7.45)	0.010*
PCO_2	40 (32.15-42.975)	40 (32.25-42.35)	39.45 (31.43-45.65)	0.968*
HCO_3	23.35 (20.55-26.7)	23.85 (21.4-26.7)	21.15 (16.925-26.675)	0.032*
ALT	13 (10-21)	13 (9-21.25)	14 (10.75-21)	0.821*
AST	22 (16.25-33.9)	21 (16-30.5)	25 (19-40)	0.112*
LDH	234 (196.75-321.75)	218 (179-288.75)	266.5 (223.75-363.25)	0.005*
Lactate	1.98 (1.325-3.4)	1.795 (1.18-2.57)	3.53 (1.76-5.5)	<0.001*

#Chi Square Test, *Mann Whitney U Test

Table 4: Areas under the ROC curve (AUC) obtained for cut-off value analysis in detecting the mortality.

Area Under the Curve			
Test result variable(s)	Area	Asymptotic 95% Confidence Interval	
CRP	0.636	0.520	0.753
Lactate	0.776	0.675	0.877

Figure 1: CRP and lactate in ROC curve



Surgical characteristics

When the surgical characteristics were examined in all patients, ileus (29%), hernia (37%), and acute abdomen (18%) were the most common surgical diagnoses. Here, 34 (34%) were considered intermediate, 61 (61%) major, and 5 (5%) major+ according to surgery magnitude. General anesthesia was performed on 76 (76%) patients and spinal anesthesia on 24 (24%). When we look at the magnitude of surgery, major surgery was found to be statistically significantly higher in the non-survivor group (*P*<0.001). All details of the surgical characteristics are given in Table 5.

Postoperative characteristics

Seventy-six (76%) of the patients were transferred to the ICU in the postoperative period. The need for ICU, MV, HDF, and VP support was statistically higher in the non-survivor group (*P*<0.001, *P*<0.001, *P*=0.006, *P*<0.001) (Table 5).

In univariate analysis, ASA 4, CRP, lactate, LDH, Ph, major and major+, IMV, HDF, and VPS significantly increased mortality (*P*=0.006, *P*=0.021, *P*<0.001, *P*=0.017, *P*=0.004, *P*=0.001, *P*=0.004, P<0.001, *P*=0.017, *P*<0.001) (Table 6). In multivariate analysis, only ASA 4 and major surgery were significant in predicting mortality (*P*=0.041, *P*=0.011) (Table 7).

Table 5: Surgery and postoperative characteristics of the patient cohort

	Total (n=100)	Survivor (66%)	Non-survivor (34%)	*P*-value
Time from admission to surgery (Hour) Median (IQR)	6 (4-10)	5 (4-8)	7 (4-11)	0.133*
Surgery Timing n (%)				
Early (0-12)	83 (83.0%)	55 (83.3%)	28 (82.4%)	0.902#
Late (13-24)	17 (17.0%)	11 (16.7%)	6 (17.6%)	
Magnitude of Surgery n (%)				
intermediate	34 (34.0%)	33 (50.0%)	1 (2.9%)	<0.001#
Major	61 (61.0%)	31 (47.0%)	30 (88.2%)	
major+	5 (5.0%)	2 (3.0%)	3 (8.8%)	
Anesthesia n (%)				
General Anesthesia	96 (96.0%)	63 (95.5%)	33 (97.1%)	1.000#
Neuraxial Anesthesia	4 (4.0%)	3 (4.5%)	1 (2.9%)	
Postoperative ICU Need n (%)	76 (76.0%)	42 (63.6%)	34 (100%)	<0.001#
IMV n (%)	37 (37.0%)	9 (13.6%)	28 (82.4%)	<0.001#
HDF n (%)	7 (7.0%)	1 (1.5%)	6 (17.6%)	0.006#
VPS n (%)	34 (34.0%)	7 (10.6%)	27 (79.4%)	<0.001#

#Chi Square Test, *Mann Whitney U Test

Table 6: Mortality risk factors - univariate logistic regression analysis

	P-value	OR	%95 CI	
ASA (Ref:1-2)	0.002			
3	0.099	2.538	0.839	7.676
4	0.009	12.571	3.626	4.58
CRP	0.021	1.004	1.001	1.007
CRP (Ref: <84) >84	0.004	3.534	1.486	8.403
PH	0.004	0.003	0.000	0.163
LDH	0.017	1.006	1.001	1.011
Lactate	<0.001	2.091	1.438	3.039
Lactate (Ref: <3.6). >3.6	<0.001	21.00	5.503	80.13
Magnitude of Surgery, Ref:intermediatae	0.003			
major	0.001	31.935	4.104	248.516
major+	0.004	49.500	3.409	718.826
IMV	<0.001	29.556	9.570	91.282
HDF	0.017	13.929	1.602	121.123
VPS	<0.001	32.510	10.373	101.890

Ref: reference

Table 7: Mortality risk factors - multivariate logistic regression analysis

	P-value	OR	95% CI	
ASA Ref:1-2	0.052			
3	0.624	1.88	0.15	23.54
4	0.041	18.67	1.12	310.51
CRP	0.421	1.00	1.00	1.01
LDH	0.965	1.00	0.99	1.01
Lactate	0.102	1.88	0.88	4.00
Magnitude of Surgery, Ref: intermediate	0.038			
major	0.011	44.92	2.36	855.14
major+	0.070	77.24	0.70	8545.11
IMV	0.111	7.74	0.62	96.07
HDF	0.175	12.05	0.33	438.73
VPS	0.127	5.65	0.61	52.27

Hosmer and Lemeshow Test Chi-square: 6.991 *P*=0.538 Cox & Snell R Square 0.587, Ref: Reference

Discussion

We investigated the effects of demographics, comorbidities, laboratory, diagnostic, surgical, and postoperative treatments on mortality in patients over 80 years of age who underwent emergency abdominal surgery. The mortality rate of the study group seems to be high. However, some studies have reported mortality rates up to 50% [10,11]. Based on our results, ASA 4 and major surgery may be predictors of mortality.

Comorbidities that increase with age are an issue that should be meticulously investigated before all surgeries. In the present study, hypertension was as high as 83%, which may be associated with geography and dietary habits. However, none of the comorbidities we analyzed posed a risk for mortality on their own. Although comorbidity by itself is not significant as a risk factor, the number of these comorbidities, whether they are under control or not, affect the perioperative process along with many other similar risk factors. The scoring systems used to determine these risks in the perioperative period include the American Society of Anesthesiologists (ASA) Physical Status Classification, Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity (POSSUM), and Estimation of Physiologic Ability and Surgical Stress (E-PASS) [12-14]. However, these scoring systems are not specifically structured for elderly patients and are used for all ages and patient groups. In our study, we used the ASA Physical Status Classification System and Operative Severity Score—one of the sub-parameters of POSSUM scoring. We found that ASA 4 and major surgery increased mortality. Merani et al. [15] investigated a similar patient group and reported that ASA 3 and 4 increased mortality rates, which is consistent with our findings. Although there are studies on POSSUM in the literature, we did not find any studies focusing on the magnitude of surgery.

The increase in surgical interventions in elderly patients has resulted in an increase in clinical studies and published articles in this field. Although surgical characteristics, comorbidities, and postoperative complications are common in the literature, very few studies focused on the baseline laboratory results of patients, and only the baseline Hgb and WBC were included [8,16]. Bolger et al. [16] reported that anemia and WBC >10,000 values did not affect mortality, while Duron et al. [8] reported that anemia and WBC >10,000 could pose a risk for mortality. Here, we analyzed the hemogram, biochemistry, and blood gas of the patients and found that mortality rate was not affected by Hgb and WBC values but was impacted by increased lactate, CRP, and LDH levels as well as decreased Ph values. Lactate is the product of pyruvate metabolism in an anaerobic environment [17]. In patients with circulatory disorders, blood lactate levels are therefore increased. Infection due to perforation, sepsis, or primary cardiac pathologies may explain this situation in our patient cohort. The association of high lactate levels with mortality is not a new result. However, in a patient presenting with high lactate levels, the time to surgery may be informative in terms of intervening variables such as surgical methods and postoperative treatments.

C-reactive protein is a plasma protein increased in inflammation [18]. It is not surprising that all surgical indications in this study were elevated due to peritoneal inflammation. However, the fact that the sensitivity of CRP in predicting mortality in patients should be considered. We did not find any studies examining the predictive value of lactate and CRP for mortality in similar patient groups in our literature search.

The literature shows that the need for postoperative ICU in elderly patients undergoing abdominal surgery varies over a wide range. [8,19]. These disparate ratios may be associated with the experience of clinicians and the standard of care in hospital ward rooms. In some hospitals, inadequate and poor ward conditions require postoperative ICU follow-up. However, these frail patients do need postoperative ICU care after all emergency surgeries regardless of the conditions of the ward rooms. In our study, we found that treatments administered in the ICU had a significant association with mortality in univariate analysis, although it was not significant in multivariate analysis. While treatments such as failed surgery, sepsis, or multiple organ failure are all common to increased mortality, it is difficult for clinicians to select the appropriate treatment modalities and explain them to patients and their relatives—especially for patients with very low life expectancy. An urgent need for surgery can lead to a high survival expectancy for the patient and their relatives after surgery regardless of the patient's age and comorbidities. However, for patients who have no chance of survival despite surgery, quality of life should be prioritized in the selection of treatments, and relatives should be included in this process.

Limitations

Our study does have some limitations. First, changes in the hospital information management systems over time allowed us to only review the last eight years in retrospect. In addition, certain parameters could not be analyzed due to the small sample size. Furthermore, medical developments in recent years were not evenly distributed across all patients, and this could have disrupted the homogeneity of the study group. However, it is controversial to say that this is a research advantage. Second, sample surgery tables were used instead of blood loss, contamination, and presence of malignancy when calculating the magnitude of surgery in the POSSUM system due to a lack of data. The most important reason for such limitations is that they are based on retrospective data. Future prospective observational studies will make greater contributions to the literature.

Conclusion

Despite advancements in medical technology, the mortality rate for elderly patients who undergo emergency abdominal surgery remains very high. The risk factors that increase mortality should be identified when making surgical and medical treatment decisions. The magnitude of surgery and ASA score are the best predictors of mortality for this patient group.

In addition, the sensitivity of high lactate levels in predicting mortality should be considered. Prospective studies focusing on laboratory results will make significant contributions to the literature in this field.

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