

## ORIGINAL ARTICLE / ОРИГИНАЛНИ РАД

# Estimation of risk factors of early postoperative mortality in elderly patients who are subjected to emergency operations of the gastrointestinal tract

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**SUMMARY**

**Introduction/Objective** The elderly (age  $\geq 65$  years) comprise an increasing proportion of patients undergoing emergency general surgery (EGS) procedures nowadays.

The objective of the paper was to determine the intra-hospital mortality rate in elderly patients undergoing emergency gastrointestinal surgical procedures.

**Methods** 914 elderly patients ( $> 65$  years old) were examined, divided into two groups: emergency and elective surgery patients, treated for diseases (benign and malignant) of the stomach, duodenum, small intestine and colon. The patients were divided into four age groups and five American Society of Anesthesiologists (ASA) groups, taking into account the presence of chronic diseases, the values of some laboratory parameters, administering transfusion, and the occurrence of surgical complications during hospitalization.

**Results** The mortality rate among elderly patients was 17.8%. The univariate analysis in EGS patients revealed that gastro-duodenal surgical interventions ( $p < 0.001$ ), ASA  $\geq 3$  score ( $p < 0.001$ ), heart, lung, kidney diseases, and postoperative complications ( $p < 0.001$ ), as well as the white cell count  $> 10,000/\text{mm}^3$  ( $p = 0.043$ ) were independent risk factors for mortality. In the multivariate analysis, in EGS patients, the significant risk factors for mortality were gastric surgical interventions ( $p = 0.001$ ), ASA score of 4 ( $p < 0.001$ ), heart and kidney disease ( $p \leq 0.001$ ), and white cell count  $> 10,000/\text{mm}^3$  ( $p = 0.039$ ).

**Conclusion** The characterization of independent validated risk indicators for mortality in those patients is essential and may lead to an efficient specific workup, which constitutes a necessary step towards developing a dedicated score for elderly patients.

**Keywords:** elderly; gastrointestinal surgery; mortality

**INTRODUCTION**

Increase in the very number of people in the elderly population in developed societies, as well as the use of screening programs, increases the number of requests for surgical procedures in this group of patients. In people aged 65 or older, the patient's risk of requiring surgical procedures is three times higher than in the younger population, especially in the case of emergency conditions [1, 2, 3].

Surgeons are still generally reluctant to treat elderly patients, considering them more sensitive to surgical treatments due to lower physiological reserves, as well as more concealed diseases. The published data that indicate the poor outcome of surgical procedures in the elderly corroborate these facts [2, 3, 4].

Some studies suggest that surgery should often not be postponed in elderly patients. They conclude that the rate of mortality in the elderly can be reduced by performing elective surgical procedures, by carefully "selecting" patients with emergency conditions, thereby excluding the possibility of having inoperable patients, as well as by the participation of a large number of surgeons of various subspecialties during surgery [5].

The objective of the research was to determine the total rate of early postoperative mortality of elderly patients undergoing emergency surgical interventions on the gastrointestinal tract, with an overview of the impact of the American Society of Anesthesiologists (ASA) score, malignant diseases, septic conditions, associated chronic diseases, and the localization of a pathological process to the occurrence of the mentioned.

**METHODS**

The study, done in accord with standards of the institutional committee on ethics, included the examination of 914 elderly patients (65 years of age and those older than 65) in the period from January 1, 2013 to December 31, 2014 at the Clinic for General Surgery of the Clinical Center in Niš, divided into two groups: emergency and elective surgical care. Patients included in the study were surgically treated for diseases (benign and malignant) of the gastrointestinal tract, and were divided into the following groups: patients with gastric surgical diseases; patients with diseases which required duodenal surgery; patients with diseases which

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required small intestinal surgery; patients with diseases which required colon surgery. Owing to the increased incidence of patients with appendicitis, this group of patients was also isolated. During the research, the sex and age of the patients were also monitored, (four age groups of patients were examined): the first group of patients was 65–69 years of age; the second group of patients was 70–75 years old; the third group of patients was 76–80 years old; the fourth group of patients was over 80 years old. Particular attention was paid to the nature of the underlying disease (benign or malignant), associated chronic diseases (heart diseases, pulmonary function disorder, neurological diseases of the central nervous system, diabetes). In the study, the patients were also included in the ASA classification, and divided into five categories.

The study also included monitoring some laboratory parameters with their measurement on two occasions during patient hospitalization: before the surgery itself, and just before the end of the clinical treatment or before the fatal outcome. The tables show the average values of the tested parameters. The following values were monitored: serum creatinine, serum albumin, total proteins of the serum, erythrocyte values, leukocytes, serum hemoglobin, serum sodium and potassium values, serum parameters that indicate infection (C-reactive protein – CRP, procalcitonin – PCT), glycemic level.

Surgical treatment of the examined patients included surgery of the stomach, duodenum, small intestine and colon, appendectomy.

In the immediate postoperative period, the appearance of surgical complications was observed: laparotomy dehiscence, dehiscence of the primarily performed intestinal/gastro-intestinal anastomosis, postoperative bleeding.

Since surgical treatment, as well as the nature of the underlying disease, is accompanied by blood loss, a decrease in the blood cell count, a decrease in the serum levels of hemoglobin, albumin, and total proteins, the number of received transfusion units was also monitored in the examined patients.

### Statistical data processing

The data are presented in the form of an arithmetic mean and a standard deviation, or in the form of absolute and relative numbers. Frequency comparisons were done with the  $\chi^2$  test. The comparison of the continuous variables was done with the Mann–Whitney test. The correlation of potential risk factors with mortality was investigated with a univariate and multivariate (backward: Wald method) logistic regression analysis. The calibration ability of the model was tested with the Hosmer–Lemeshow test. The discriminatory ability of the multivariate model was tested on the basis of the receiver operating characteristic curve. The hypothesis was tested with a significance threshold of  $p < 0.05$ . The data analysis was performed with the SPSS version 16.0 software package (SPSS Inc., Chicago, IL, USA).

**Table 1.** Demographic and clinical characteristics of the examined population related to the type of operation

Risk factors	Emergency n = 458		Elective n = 456		p <sup>†</sup>
	n	%	n	%	
Patient characteristics					
Age					
65–69	208	45.4	71	15.6	< 0.001
70–74	101	22.1	117	25.6	
75–79	100	21.8	140	30.7	
80+	49	10.7	128	28.1	
Sex of the patients					
Male	417	91	155	34	< 0.001
Female	41	9	301	66	
Clinical characteristics					
Localization					
Stomach	44	9.6	64	14	0.049
Duodenum	53	11.6	5	1.1	< 0.001
Small intestine	176	38.4	2	0.4	< 0.001
Appendix	41	0	0	0	< 0.001
Colon	144	31.4	385	84.4	< 0.001
Type of surgical disease					
Malignant	99	21.6	397	87.1	< 0.001
Benign	359	78.4	59	12.9	
ASA					
1	21	4.6	0	0	< 0.001
2	207	45.2	329	72.1	< 0.001
3	139	30.3	114	25	0.083
4	76	16.6	13	2.9	< 0.001
5	15	3.3	0	0	< 0.001
Heart diseases	375	81.9	328	71.9	< 0.001
Respiratory diseases	52	11.4	61	13.4	0.407
Renal diseases	43	9.4	4	0.9	< 0.001
Neurological disorders	47	10.3	3	0.7	< 0.001
Diabetes mellitus	11	2.4	13	2.9	0.828
Transfusion	230	50.2	242	53.1	0.324
Surgical complications <sup>1</sup>	18	3.9	11	2.4	0.262
Mortality	129	28.2	34	7.5	< 0.001

ASA – American Society of Anesthesiologists scoring;

<sup>†</sup> $\chi^2$  test;

<sup>1</sup>laparotomy dehiscence, anastomose dehiscence, postoperative bleeding

**Table 2.** Biochemical parameters with regard to the type of surgery

Biochemical marker <sup>†</sup>	Emergency	Elective	p <sup>‡</sup>
Serum creatinine	160.67 ± 86.59	106.54 ± 37.77	< 0.001
Total proteins	61.42 ± 14.22	66.76 ± 8.28	< 0.001
Serum albumin	34.84 ± 10.67	40.45 ± 7.17	< 0.001
Erythrocyte count	4.22 ± 1.04	4.11 ± 0.46	0.003
Leukocyte count	11.57 ± 6.75	8.68 ± 3.16	< 0.001
Serum hemoglobin	125.25 ± 30.68	122.8 ± 16.66	0.003*
Serum sodium	133.95 ± 5.35	137.14 ± 3.04	< 0.001
Serum potassium	4.32 ± 0.71	4.37 ± 0.57	0.061
CRP	133.41 ± 93.23	82.46 ± 68.4	< 0.001
PCT	1.41 ± 9.02	0.27 ± 3.72	< 0.001
Glycaemia	18.36 ± 4.13	4.79 ± 6.08	< 0.001

CRP – C-reactive protein; PCT – procalcitonin;

<sup>†</sup>mean ± SD;

<sup>‡</sup>Mann–Whitney test;

\*t-test

**Table 3.** Risk factors of a fatal outcome with regard to the type of surgery (univariate logistic regression analysis)

Risk factors	Emergency procedure				Elective procedure			
	Death yes/no	OR	95% CI	p	Death Yes/no	OR	95% CI	p
Female	41/41	-		< 0.001	27/301	2.083	0.886–4.899	0.127
Male	88/417				7/155	Reference group		
<b>Age</b>								
65–69	28/208	Reference group			7/71	Reference group		
70–74	28/101	2.465	1.367–4.449	0.004	10/117	0.948	0.349–2.606	0.917
75–79	24/100	2.031	1.106–3.727	0.032	17/140	1.402	0.554–3.543	0.623
80+	49/49	-	-	-	0/128	-	-	-
<b>Localization of surg. dis.</b>								
Stomach	24/44	3.531	1.874–6.653	< 0.001	7/64	1.660	0.691–3.990	0.257
Duodenum	23/53	2.163	1.203–3.888	0.010	0/5	-	-	-
Small intestine	46/176	0.848	0.556–1.295	0.446	0/2			
Colon	36/144	0.792	0.506–1.240	0.308	27/385	0.690	0.288–1.651	0.404
Appendix	0/41	-			0/0			
<b>ASA</b>								
1	0/21				0/0			
2	4/207				11/329	Reference group		
3	41/139	21.232	7.395–60.955	< 0.001	10/114	2.780	1.148–6.732	0.023
4	69/76	500.250	142.112–1760.932	< 0.001	13/13	-	-	-
5	15/15	-	-		0/0	-	-	-
Heart diseases	114/375	1.980	1.086–3.611	0.026	33/328	14.207	1.922–105.00	0.009
Respiratory diseases	32/52	5.097	2.788–9.319	< 0.001	13/61	4.823	2.269–10.254	< 0.001
Renal diseases	32/43	9.537	4.634–19.628	< 0.001	4/4	-	-	-
Neurological disorders	13/47	0.972	0.495–1.908	0.935	3/3	-	-	-
Diabetes mellitus	11/11				3/13	3.987	1.043–15.240	0.043
Transfusion	114/230	13.955	7.783–25.022	< 0.001	31/242	10.333	3.111–34.320	< 0.001
Surgical complications <sup>1</sup>	15/18	13.965	3.970–49.117	< 0.001	5/11	12.012	3.458–41.790	< 0.001
Malignant surg. diseases	24/99	1.292	0.774–2.157	0.328	32/397	2.499	0.583–10.711	0.218
Leukocytes > 10,000	92/118	4.246	1.199–15.032	0.043	25/78	3.655	1.389–9.619	0.014

OR – odds ratio; CI – confidence interval; ASA – American Society of Anesthesiologists scoring; <sup>1</sup>laparotomy dehiscence, anastomose dehiscence, postoperative bleeding

**Table 4.** Risk factors for a fatal outcome with regard to the type of procedure (multivariate logistic regression analysis)

Risk factors	Emergency procedure			Elective procedure		
	OR	95% CI	p	OR	95% CI	p
Sur. diseases on the stomach	4.028	1.742–9.311	0.001			
ASA 3				1.899	0.757–4.762	0.171
ASA 4	65.896	26.913–161.343	< 0.001			
Heart diseases	5.032	1.928–13.138	0.001	8.029	1.055–61.085	0.044
Respiratory diseases				6.453	2.635–15.801	< 0.001
Renal diseases	27.714	10.110–75.977	< 0.001			
Malignant sur. diseases				0.177	0.032–0.974	0.047
Leukocytes > 10,000	2.781	1.596–36.097	0.039			
Hosmer–Lemeshow test	p = 0.633			p = 0.123		
C index	0.852, p < 0.001			0.863, p < 0.001		

OR – odds ratio; CI – confidence interval; ASA – American Society of Anesthesiologists scoring

**RESULTS**

It was determined that there is a statistically significant difference between emergency and elective procedures in the age categories (p < 0.001). Elective surgical procedures are statistically significantly more common in female patients (66% vs. 9%, p < 0.001). ASA score 2 is dominant in elective surgical procedures (p < 0.001). The elective surgical procedures are dominant in patients with diseases requiring colon surgery (84.4% vs. 31.4%, p < 0.001). Small intes-

tine surgery was statistically significantly more commonly performed in emergency surgical procedures (38.4% vs. 0.4%, p < 0.001). The incidence of heart disease, kidney disease, and neurological disorders is statistically significantly higher in patients undergoing emergency surgical procedures (p < 0.001). Malignant surgical diseases are statistically significantly more commonly treated as elective surgical procedures (p < 0.001). The death outcome was statistically significantly more common in emergency surgical procedures (p = 0.021). Surgical complications

were equal between emergency and elective surgical procedures ( $p = 0.262$ ).

In emergency surgical procedures, the following values were statistically more significant: serum creatinine ( $p < 0.001$ ), erythrocyte count ( $p < 0.001$ ), leukocyte count ( $p < 0.001$ ), hemoglobin ( $p < 0.001$ ), CRP ( $p < 0.001$ ), PCT ( $p < 0.001$ ), and glycaemia ( $p < 0.001$ ). In patients with performed elective surgery, statistically significant values were the following: total serum proteins ( $p < 0.001$ ), serum albumin ( $p < 0.001$ ), and serum sodium ( $p < 0.001$ ).

In emergency surgical procedures, in the univariate model, the statistically significant risk factors for fatal outcome were the following: age, surgical interventions on the stomach and duodenum, ASA 3 and ASA 4 score, comorbidity on the heart, lungs, kidneys, surgical complications, transfusion, and the value of leukocytes above 10,000 units/ml. In elective surgical procedures, in the univariate model, statistically significant risk factors for fatal outcome were the following: ASA 3 score, comorbidity on the heart, lungs, diabetes, surgical complications, malignant type of surgical disease, receiving transfusion, leukocyte value over 10,000 units/ml.

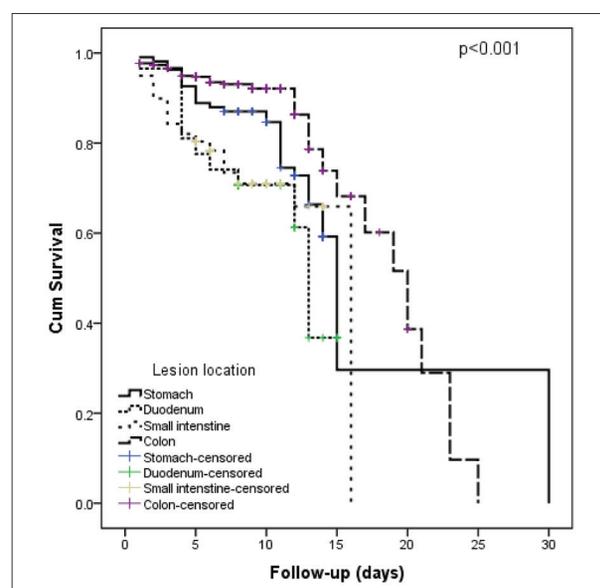
For emergency surgical procedures, in the multivariate model, the following were statistically significant risk factors, corrected for the other parameters in the model: surgical gastrointestinal diseases, ASA 4 score, heart and renal disease, and leukocyte level above 10,000 units/ml. For elective surgical procedures, in the multivariate model, the following were statistically significant risk factors for fatal outcome, corrected for the other parameters in the model: the ASA 3 score, heart and respiratory diseases, and malignant surgical diseases.

The patients who underwent emergency surgery had statistically significantly lower survival compared to patients treated with elective surgery ( $p < 0.001$ ) (Figure 1). The shortest survival was exhibited by patients with duodenal surgery, followed by surgery of the small intestine,

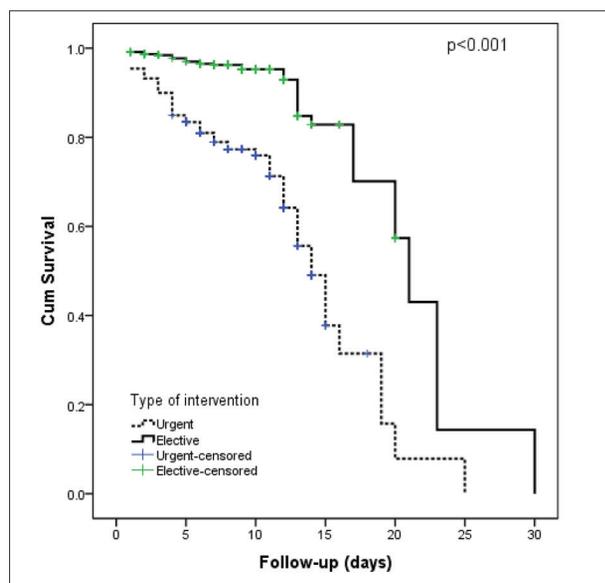
while the patients with surgical diseases of the stomach and colon had the longest survival. It has been established that there is a statistically significant difference in the length of intra-hospital survival compared to the localization of the surgical disease itself ( $p < 0.001$ ) (Figure 2). The patients with malignancies had statistically significantly shorter survival compared to the patients with benign diseases ( $p < 0.001$ ) (Figure 3).

## DISCUSSION

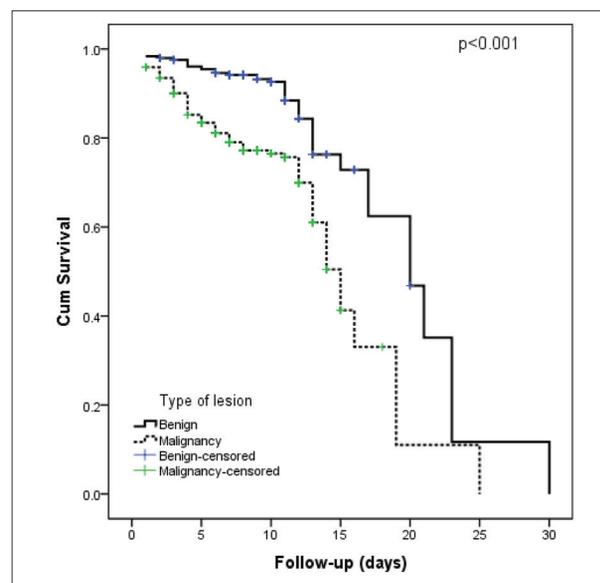
In people aged 65 years and older, the risk of death to the patient from the required surgical procedures is three times higher than to the younger population, especially in the



**Figure 2.** The Kaplan–Meier curve of intra-hospital survival with regard to the localization of the surgical disease in the whole population



**Figure 1.** The Kaplan–Meier curve of intra-hospital survival with regard to the type of surgery in the whole population



**Figure 3.** The Kaplan–Meier curve of intra-hospital survival with regard to the type of lesion in the whole population

case of emergency conditions [5]. Ozturk and Yilmazlar [6] did not show a statistically significant correlation between age and mortality of elderly patients undergoing gastrointestinal tract surgery, while in other authors' studies, the "age of the patients," as an independent risk factor of direct postoperative mortality, was statistically significant [7]. According to our data, it was found that the largest number of patients who underwent surgical care was 65–69 years of age. In addition, there is a statistically significant difference in age in relation to the fatal outcome, so in the group of emergency surgically treated patients, the group of 70–74-year-olds had an almost 2.5 times greater chance of a fatal outcome (OR 2.465) compared to the reference group (65–69), while in the group of elective surgically treated patients, the group of 75–79-year-olds had a 1.5% greater chance of a death outcome (OR 1.402) than the reference group (65–69).

Emergency surgery is a well-known risk factor [8–12]. It increases the operative mortality rate from three to as many as 10 times [10]. Ozturk and Yilmazlar [6] state that about 70% of the non-surviving patients were subjected to emergency surgery. Some authors indicate a better outcome in elderly patients who underwent elective surgery, compared to emergency surgical care patients [12]. Our data suggest that the fatal outcome was statistically significantly more common in emergency procedures ( $p = 0.021$ ).

The data obtained in our study show that elective surgical procedures were statistically significantly more frequent in female patients (66% vs. 9%,  $p < 0.001$ ). In the group of elective patients, female patients had a two times greater chance of death outcome (OR 2.083), compared to male patients, which was in correlation with some other studies [13].

Patients with a higher ASA score have a higher chance of fatal outcome [14]. In elective care patients, with an increase in the ASA score by 1, the chance of fatal outcome increases by almost three times (OR 2.780), while the chance is far greater in emergency care patients.

Some studies indicate that the primary preoperative factor for a poor surgical outcome in the elderly was the comorbidity itself rather than age [15]. Electively treated patients with respiratory diseases had an almost five times greater chance of fatal outcome (OR 4.823), while emergency care patients with respiratory and renal diseases had an almost five and nine times greater chance of fatal outcome, respectively (OR 5.097; OR 9.537).

In the category of "laboratory values," Visser et al. [13] reveal three statistically significant morbidity and mortality factors: an elevated level of serum creatinine, reduced preoperative albumin level and elevated leukocyte levels. In our study, serum creatinine values were statistically significantly higher in emergency procedures ( $p < 0.001$ ).

Hypoalbuminemia is a common laboratory abnormality in the elderly, which can lead to high morbidity and mortality [16]. In patients who underwent elective surgical procedures, the statistically significantly higher values were total serum proteins ( $p < 0.001$ ) and serum albumin ( $p < 0.001$ ).

In sepsis, the underlying problem is the high rate of mortality, which is even higher than in patients at the mo-

ment of myocardial infarction [17]. According to our data, the CRP values were statistically significantly higher in emergency procedures ( $p < 0.001$ ).

Neumayer et al. [18] report that the leukocyte value above 10,000 units/ml was statistically significant for the development of a serious infectious process, while, according to Davenport et al. [19], the value of leukocytes above 10,000 units/ml was statistically significant for the development of heart complications. Our data indicate that leukocyte values were statistically significantly higher in emergency surgically treated patients. Emergency surgically treated patients with values of leukocytes above 10,000 units/ml have a 2–4 times greater chance of fatal outcome (OR 2.781; OR 4.246), compared to patients of the same examined group without leukocytosis, while in cases of patients with elective surgical treatment, with leukocyte values above 10,000 units/ml, the chance of fatal outcome was 3.5 times higher (OR 3.655).

The serum hemoglobin concentration was higher in patients with emergency surgical treatment, compared to the elective ones, but not at the level of statistical significance, which was in correlation with previous studies [16].

Surgery of the upper part of the digestive tract increases the risk of heart and respiratory complication occurrence [20]. Our research has established that there is a statistically significant difference in the localization of the disease itself compared to fatal outcomes, so gastric surgical diseases were at the level of statistical significance ( $p < 0.001$ ). The shortest survival was exhibited in patients with duodenal diseases, followed by the ones with diseases of the small intestine, while the patients with stomach and colon diseases had the longest survival.

Many patients who develop surgical anemia receive a transfusion. The outcome of such patients is poor, and it is not clear whether this is due to bleeding, anemia, or the transfusion itself [21]. In our study, both in emergency and in elective surgical procedures, in the univariate model, the transmission of transfusion was also considered a statistically significant risk factor for fatal outcome. Patients receiving transfusion had a 14 times (OR 13.955) greater chance of fatal outcome in emergency cases and a 10 times (OR 10.333) greater chance of fatal outcome in elective care patients, compared to non-transfusion patients.

Duron et al. [22] indicate that the presence of a malignant surgical disease as a risk factor for immediate postoperative mortality is at the level of statistical significance. Malignant changes are statistically significantly more commonly operated on in the form of elective surgical procedures ( $p < 0.001$ ). Elective surgery-treated oncology patients have a three times greater chance of a fatal outcome, compared to non-oncology patients of the same group (OR 2.499).

Wound dehiscence is one of the most common early postoperative complications with a frequency of approximately 2% [23]. There is no unique cause that leads to laparotomy dehiscence, and, as a rule, there is a combination of several factors, such as old age, anemia, jaundice, uremia, diabetes, hypoalbuminemia, COPD, malignancy, steroid use, obesity, wound infection, intra-abdominal sepsis,

emergency surgery [24]. Among the postoperative complications, anastomosis dehiscence leads to greater pain and distress of the patient than any other surgical complication [25]. The percentage of anastomosis dehiscence depends on the location of occurrence: stomach 1–9%, small intestine 1–3%, colon 3–29%, and rectum 8–41% [26–30]. Owing to surgical complications, re-intervention was performed in 15 deceased emergency surgery-treated patients and in five deceased elective surgery-treated patients. Emergency surgery-treated patients with surgical complications had a 14 times greater chance of fatal outcome (OR 13.965), while in elective surgery-treated patients with surgical complications, this chance was 12 times higher (OR 12.012).

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## CONCLUSION

Our research suggests that fatal outcome was statistically significantly more common in emergency surgical procedures. Premorbid factors, characteristics of the disease, the preoperative condition of patients, and operative factors predict a poor surgical outcome.

The characterization of independent validated risk indicators for mortality in those patients is essential and may lead to an efficient specific workup, which constitutes a necessary step towards developing a dedicated score for elderly patients.

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## Процена фактора ризика ране постоперативне смртности болесника старијег животног доба подвргнутих хитним хируршким операцијама на гастроинтестиналном тракту

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### САЖЕТАК

**Увод/Циљ** Болесници старијег животног доба ( $\geq 65$  година) узимају све више удела као хитно хируршки збринуту болесници.

Циљ студије је био одредити стопу интрахоспиталне смртности болесника старијег животног доба, подвргнутих хитним гастроинтестиналним хируршким интервенцијама.

**Методе** Испитивано је 914 болесника старијег животног доба ( $> 65$  година) подељених у две групе – ургентно и елективно хируршки збринутих, а због болести (бенигних и малигних) на желуцу, дуоденуму, танком и дебелом цреву. Болесници су били подељени и у четири старосне групе и пет група које је дефинисало Америчко удружење анестезиолога (*American Society of Anesthesiologists – ASA*) уз осврт на присуство хроничних обољења, вредности неких лабораторијских параметара, давање трансфузије и појаву хируршких компликација током хоспитализације.

**Резултати** Укупна стопа смртности у испитиваној популацији била је 17,8%. Униваријантна регресиона анализа код

ових болесника открива да су гастродуоденалне хируршке интервенције ( $p < 0,001$ ),  $ASA \geq 3$  скор ( $p < 0,001$ ), срчана, респираторна, бубрежна обољења, постоперативне компликације ( $p < 0,001$ ), као и вредност леукоцита  $> 10.000/mm^3$  ( $p = 0,043$ ), представљали независне факторе ризика од смртности. У мултиваријантној анализи исте групе болесника статистички значајни фактори смртности били су: гастричне хируршке интервенције ( $p = 0,001$ ),  $ASA 4$  скор ( $p < 0,001$ ), респираторна и срчана обољења ( $p \leq 0,001$ ), вредност леукоцита  $> 10.000/mm^3$  ( $p = 0,039$ ).

**Закључак** Карактеризација независних прогностичких фактора ризика ове групе болесника је од суштинског значаја и може довести до ефикаснијег лечења, што представља неопходан корак у изради наменског бодовног система ових болесника.

**Кључне речи:** старија животна доб; гастроинтестинална хирургија; смртност