

## PREDICTORS OF POSTOPERATIVE COMPLICATIONS IN GASTROINTESTINAL SURGERY

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Surgical site infections and wound dehiscence are well-known postoperative complications that cause high mortality and morbidity. The aims of this study were to identify and evaluate the predictors of the following complications: infection and wound dehiscence.

This study was performed between Jan 2007 and Apr 2008, and a cohort of 525 consecutively operated patients was evaluated. The operations were performed at the Surgery Clinic, Clinical Center Nis. Of the total number, there were 338 (64,38%) elective and 187 (35,61%) emergency operations.

The analysis of factors associated with complications following elective surgery disclosed that smoking, comorbidity, blood loss, and type of operation were independent predictors. Multivariate subgroup analysis of the association between smoking and complications disclosed that smoking was independently associated with surgical site infections, as well wound dehiscence. In emergency surgery, male gender, peritonitis, operation, and multiple operations were independent predictors. The association between complications and blood loss disclosed a significant dose-relationship, signifying that a large blood loss yielded a higher risk of complications.

The risk factors of wound dehiscence can be predicted early and their number can be decreased before and after surgery by an experienced surgeon, leading to a lowered incidence of wound failure. *Acta Medica Medianae 2008;47(3):15-20.*

**Key words:** dehiscence, infection, risk factors

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### Introduction

Surgical site infections and wound and tissue dehiscence are well-known postoperative complications in gastrointestinal surgery, and general surgery as well. Evisceration is a complication associated with high morbidity, and high mortality as well, and the percentage in colorectal surgery still remains 2-3,5% (1-7). The infection is certain in 5-10%. The rupture of the abdominal wall occurs in 1% of the cases, however with a high mortality rate (15-45%) (8). The severity of these complications embraces mild cases needing local wound care and antibiotics to serious cases with multiple reoperations and a high mortality rate. In most cases, such complications prolong hospitalization, with a substantial increase in cost of care (9,10)

Traditionally, local factors such as the degree of contamination and the surgical technique have been regarded as strong predictors for surgical site infection and wound dehiscence (11,12).

More recent studies, however, have disregarded the significance of surgical technique, and others have identified systemic factors such as high age, gender, lifestyle, and coexisting morbidity as playing a significant role in the pathogenesis

of these complications (13,14). The significant risk factors that could lead to postoperative complications were the age over 65, lung diseases, hemodynamic instability, intrabdominal pressure (coughing, vomiting, distension). Significant systemic risk factors were hypoproteinemia, systemic infections, obesity, uremia, malignant diseases, ascites, steroid use and hypertension (15). There is a positive correlation between risk factors and the tissue and wound complications in gastrointestinal surgery.

The aim of this study was to identify and assess the factors predictive of postoperative tissue and wound complications when adjusting for potential confounders through multiple logistic regression analysis.

### Material and methods

The study was performed from January 2007 through April 1998, at the Surgery Clinic, Clinical Center Belgrade, and during that period 525 of patients were operated.

The operations included herniotomy, gastric, duodenal, pancreatic, and biliary surgery, as well as operations on the small bowel, appendix, colon, and rectum. Laparoscopic, anal, and perianal operations were excluded. Variables as listed in Table 1, with possible relation to postoperative complications were assessed. Data regarding patient history: family status, employment, smoking and drinking habits, and comorbidity were defined as a medical disease in current

treatment, and were collected from questionnaires completed prior to operation by the patient or surgeon. These data and data from the operation and clinical record were recorded on a database sheet by the surgeon pre- or postoperatively.

Table 1. Baseline characteristics connected with post operation complication

	Elective surgery n=338	Emergency surgery n=187
Anamnestic variables		
Age (median, interquartile range)	61 (46-74)	61 (32-77)
Male gender	203 (60,3)	88 (47,5)
Family status (single or widow)	121 (35,9)	86 (46,4)
Employed	124 (36,7)	53 (28,3)
Dependent functional status	26 (7,6)	34 (18,4)
Smoker	140 (41,4)	79 (42,4)
Alcohol abuser (more than 5 drinks per day)	14 (4,2)	10 (5,4)
Diabetes, cardiovascular disease, or lung disease	107 (31,7)	64 (34,6)
Liver cirrhosis or previous myocardial infarction or stroke	23 (6,8)	18 (9,7)
Physiologic variables		
Systolic blood pressure (<110 or >130 mm Hg)	40 (11,9)	24 (12,9)
Pulse (<50 or >80 beats per minute)	110 (32,7)	100 (53,9)
Electrocardiogram (not sinus rhythm)	16 (4,9)	17 (9,4)
Hemoglobin (<6.8 or >10.2 mmol/L)*	23 (6,9)	33 (18,0)
Leucocyte count (>10.1 or <4.0 billion/L)*	19 (5,6)	107 (57,7)
P-Potassium (<3.5 or >5.0 μmol/L)*	22 (6,5)	46 (24,6)
P-Sodium (<135 μmol/L)*	17 (5,0)	35 (18,5)
P-Creatinine (>125 μmol/L)*	11 (3,2)	23 (12,1)
Operative variables		
Hernia surgery	190 (56,5)	13 (7,0)
Gallbladder surgery	66 (19,7)	12 (6,5)
Gastric or duodenal surgery	6 (1,9)	23 (12,5)
Intestinal surgery	14 (4,1)	45 (24,3)
Appendix surgery	0 (0,0)	65 (34,7)
Colon or rectum surgery	58 (17,1)	28 (15,3)
Operative severity (difficult or very difficult)	59 (17,5)	53 (28,3)
Multiple operations	22 (6,5)	29 (15,4)
Blood loss (>100 mL)	75 (22,1)	66 (35,5)
Peritonitis (serous fluid, local, or diffuse)	5 (1,7)	56 (30,3)
Malignancy	51 (15,1)	22 (11,9)
Reoperation	18 (5,4)	23 (12,5)

\*Values are number of operations (with percentages in parentheses) unless stated in brackets

Postoperative tissue and wound complications were defined as surgical-site infections (superficial or deep wound infection, wound abscess, or intraabdominal abscess) or disruption of sutured tissue (wound, fascia, or anastomosis). At discharge, the surgical staff recorded complications and reoperations.

In case of admission to other departments of the hospital within 30 days, relevant data were extracted from retrieved clinical records and discharge letters. Thus, only complications needing hospitalization were recorded.

Statistical analysis was performed using the SPSS 15 software. Results were expressed as mean ± standard deviation. Categorical variables were compared using Chi-square test with Yates correction. Normality was analyzed with Shapiro-Wilk normality test. Logistic regression was used for calculating Odds Ratio like crude and adjusted. Statistical analysis was performed using the SPSS 15 software. Significance was set at  $p < 0,05$ .

## Results

A total of 525 operations entered the database, of which 338 or 64,38% were elective and 187 or 35,61% emergency operations. Variables as listed in Table 1, with possible relation to postoperative complications were assessed.

Table 2. Postoperative tissue and wound complications: infections and dehiscence

	Elective surgery N=338	Emergency surgery N=187	P Value*
Surgical site infections			
Superficial wound infection	7 (2,0)	9 (4,8)	
Deep wound infection	5 (1,4)	6 (3,2)	
Intraabdominal abscess	4 (1,2)	8 (4,5)	
Total	16 (4,6)	23 (12,5)	
One or more surgical site infections	14 (4,3)	21 (11,1)	<0,001
Wound or tissue disruptions			
Wound or fascial rupture	3 (0,9)	6 (3,7)	
Anastomotic leakage	5 (1,5)	7 (3,9)	
Total	8 (2,4)	13 (7,6)	
One or more wound or tissue disruptions	7 (2,3)	12 (7,2)	<0,001
Tissue and wound complications			
Total	23 (7,0)	38 (20,1)	
One of more tissue and wound complications	20 (6,0)	30 (16,3)	<0,001

Values are number of operations (with percentages in parentheses).

\* Hi square (2-sided).

The overall incidence of tissue and wound complications was 6% following elective operation (Table 2), and 44% of these patients (89/277) were admitted for more than 15 days after surgery. Following emergency operation, 16% had a tissue or wound complication (Table 2), and 52% (159/348) were admitted for more than 15 days following surgery.

The analysis of factors associated with tissue and wound complications following elective surgery disclosed that smoking, comorbidity, perioperative blood loss, and type of operation were independent predictors (Table 3). Multivariate subgroup analysis of the association between smoking and complications disclosed that smoking was independently associated with surgical site infections (OR 1.65; 1.16–2.37), as well as tissue and wound dehiscence (OR 1.82; 1.05–3.26).

Table 3. Variables associated with tissue and wound complications following elective operation analyzed by logistic regression: the final model

	Univariate		Multivariate	
	OR	95 %CI	OR	95 %CI
smoking status				
nonsmoker	1		1	-
smoker	1,70	1,16-2,26	1,77	1,39-2,45
comorbidity				
no	1	-	1	-
yes	1,34	1,28-1,88	1,49	1,38-2,03
blood loss				
<100 ml	1	-	1	-
100-500 ml	3,43	2,20-5,09	1,79	1,00-2,97
>500 ml	8,69	5,78-13,02	3,86	2,19-6,65
operation				
hernia surgery	1	-	1	-
biliary surgery	0,98	0,48-1,76	0,77	0,43-1,63
gastroduodenal surgery	3,54	1,13-10,65	2,17	0,58-7,48
small-bowel surgery	4,32	2,29-8,55	2,80	1,41-5,77
colorectal surgery	7,11	4,69-10,66	3,29	1,82-5,33

Variables which were significantly associated with tissue and wound complications in the univariate analysis, but failed to be significant in the final multivariate model were family status, multiple operations, malignancy, reoperation, and surgeon's training.

In emergency surgery, male gender, peritonitis, operation, and multiple operations were independent predictors of tissue and wound complications (Table 4).

The association between complications and perioperative blood loss disclosed a significant dose-relationship, signifying that a large blood loss yielded a higher risk of complication.

Table 4. Variables associated with tissue and wound complications following emergency operation analyzed by logistic regression the final model

	Univariate		Multivariate	
	or	95 %ci	or	95 %ci
GENDER				
Female	1		1	
Male	1,49	1,02-1,95	1,56	1,20-1,92
PERITONITIS				
None	1		1	
Serous fluid	1,10	0,76-1,58	0,88	0,49-1,22
Localized pus	2,40	1,65-3,54	2,07	1,35-3,19
Diffuse	2,93	2,09-4,34	1,86	1,24-2,87
OPERATION				
Hernia surgery	1		1	
Appendix surgery	2,11	6,88-4,54	1,67	0,76-3,79
Biliary surgery	2,19	0,95-5,25	1,97	0,72-7,74
Gastroduodenal surgery	3,43	1,67-7,33	2,53	1,25-5,76
Small-bowel surgery	4,08	1,93-8,43	2,80	1,37-6,18
Colorectal surgery	6,98	3,33-14,19	4,88	2,23-10,77
MULTIPLE OPERATIONS				
1 operation	1		1	
> 1 operation	2,99	2,20-4,15	2,34	1,63-3,28

Variables which were significantly associated with tissue and wound complications in the univariate analysis but failed to be significant in the final multivariate model were pulse, impaired sensorium, blood loss, malignancy, reoperation, and surgeon's training.

## Discussion

This study demonstrates a significantly higher incidence of postoperative tissue and wound complications in emergency than elective surgery, thus confirming previous reports (16–20). When present, infection and disruption of wounds and tissues were associated with a higher risk of reoperation, and a prolonged postoperative admission (21). Unlike other reports, no association between wound complications and mortality was found (21).

Common for all tissues subject to surgery is a disruption of the local vascular supply, thrombosis of the vessels, and tissue hypoxia (22). Once the blood supply is restored, several factors may complicate healing. The most important seems to be the proliferation of bacteria in the wound and tissue, which affects each process involved in healing and increases the risk of wound infection, delayed healing, and dehiscence (23).

In both elective and emergency surgery, large operations like colorectal and small-bowel operations were more strongly associated with complications when compared to smaller operations.

Wound infections, intraabdominal abscesses, and anastomotic leakage are known to occur more frequent following surgery on the lower than upper gastrointestinal tract (24,25). This observation is presumably due to a higher incidence of anastomotic dehiscence of colon and especially rectal anastomoses, where the intraluminal bacterial load is high (16,26). The presence of bacteria in the healing tissue affects all processes of healing and promotes impairment of collagen synthesis and release of proteolytic enzymes, which promotes dehiscence by decreasing the suture-holding capacity of the tissue (27).

Following elective operations, perioperative blood loss was a predictor of postoperative tissue and wound complications in a dose-dependent manner, when adjusting for other risk factors and confounders. This findings confirms previous reports (14,28), and suggests that hypovolemia and reduction of tissue oxygenation by loss of red blood cells is detrimental to healing and increases the risk of infection and tissue dehiscence (29,30). An immunomodulatory effect of allogenic blood transfusions to compensate for perioperative blood loss has been suggested as causative for postoperative wound infections (31).

Smoking and comorbidity such as diabetes, cardiovascular disease, and lung disease were associated with surgical site infections and dehiscence of tissue and wounds, thus confirming previous reports (25,32-36). Several pathogenetic mechanisms may be involved. Smoking, microvascular disease, and severe lung disease are known to cause peripheral tissue hypoxia (37,38) which increases the risk of wound infection and dehiscence (39). In addition, some studies suggest that hypoxia, smoking, and diabetes reduce collagen synthesis and oxidative killing mechanisms of neutrophils (40-44).

In emergency surgery, peritonitis in terms of localized pus or diffuse peritonitis was a strong predictor of wound and tissue complications. As shown by others, wound infection is likely to occur when peritonitis with a large intraabdominal bacterial load and bacteriemia is present, despite intravenous antibiotics administered perioperatively (11,14,16,24,45,46). Male gender

was a risk factor for postoperative complications following emergency operations, too. Especially wound disruption and anastomotic leakage has been reported as being more frequent (26,47,48). The reason is dubious but may be associated with a lesser collagen production and reduced wound-healing capacity in men (49,50). Multiple operations predict wound and tissue complications as well (51), presumably due to bacterial contamination of the wound and tissue and resuture of relatively avascular scar tissue of the fascia (52).

Retrospective study in Greece, through the period of 15 years, proved that (besides the predictors shown in our study) the predictors of great importance are hypoalbuminemia and the use of steroids.

### Conclusion

In conclusion, factors known to affect the process of tissue and wound healing, like smoking, diabetes, cardiovascular disease, lung disease, male gender, contamination of the surgical site, blood loss, and the operation itself, were independent predictors of wound and tissue complications, with the morbidity and mortality still very high. Those were the reasons to identify and clarify the risk factors, since recognized before and during the surgery, they are possible to prevent and eliminate.

Patients with a larger number of predictors are under the highest risk. In 30% of them with at least five risk factors, there will be dehiscence, and with eight identified risk factors there will be infections and wound dehiscence. Nine identified risk factors will lead to an exitus in one third of patients, while ten risk factors will cause death in all patients. Our findings provide data for preoperative identification of patients with a high risk of postoperative tissue and wound complications. Further, development of clinical pathways would prove valuable if the absolute risk of each patient could be estimated when planning surgery to specifically optimize the patient's preoperative condition to reduce the risk of complications.

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## PREDIKTORI POSTOPERATIVNIH KOMPLIKACIJA U GASTROINTESTINALNOJ HIRURGIJI

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Postoperativne infekcije i dehiscencija rane su prepoznatljive postoperativne komplikacije sa visokim morbiditetom i mortalitetom. Cilj ove studije bio je da se identifikuju i procene prediktori komplikacija: infekcija i dehiscencija rane.

Studija je sprovedena od januara 2007. do aprila 2008. godine na Klinici za hirurgiju Kliničkog centra u Nišu, gde je u navedenom vremenskom periodu operisano 525 bolesnika. Elektivno je izvedeno 338 ili 64,38% zahvata, dok su 187 ili 35,61% bile hitne hirurške intervencije.

Analiza faktora rizika u slučaju elektivnih operacija pokazala je da su pušenje, komorbiditet, gubitak krvi, kao i tip operacije nezavisni prediktori. Multivarijantna analiza dokazala je vezu između pušenja i komplikacija, tačnije da je pušenje povezano sa infekcijom i dehiscencijom rane. U slučaju hitnih intervencija kao nezavisni prediktori dobijeni su muški pol, peritonitis i višestruke operacije. Postoperativni gubitak krvi je u svim slučajevima dokazan kao veoma visok faktor rizika.

Osobe sa većim brojem faktora rizika su predisponirane za razvoj postoperativnih komplikacija, tako da je važno identifikovati ih na samom početku i sa takvim pacijentima pažljivo postupati. Ova i slične studije mogu da preporučie najadekvatnije operativne tehnike kojima bi se komplikacije u potpunosti eliminisale. *Acta Medica Medianae* 2008;47(3):15-20.

**Ključne reči:** dehiscencija, infekcija, faktori rizika