

Risk factors analysis concerning infections in general surgery

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ABSTRACT: *Background:* Postoperative infectious complications are important source of morbidity and mortality in surgical patients. Surgical Site Infection (SSI), is the most common followed by pneumonia, Central Venous Catheter (CVC) bloodstream infection and Urinary Tract Infection (UTI).

Methods: A case-control study was conducted in two general surgery departments trying to assess the risk factors for postsurgical infections.

Gender, age, co-morbidities (diabetes mellitus, liver failure, heart failure, respiratory failure, connective tissue disease, neoplasia), use of corticosteroids, use of chemotherapeutic agents, obesity (>30 kg/m²), malnutrition, time of operation (elective or scheduled), wound classification (clean, clean-contaminated, contaminated, dirty), duration of surgical procedure, ASA score, type of anesthesia (general, epidural, spinal), smoke abuse and alcohol abuse were defined as risk factors.

Results: SSI was the most common postsurgical infection in our study. The univariable logistic regression model revealed the following significant predictors ($p < 0.10$) for postoperative infections: diabetes mellitus, respiratory failure, obesity, time of operation, wound classification, ASA score, and male sex. However, in multivariable modelling, only diabetes mellitus, time of operation, ASA score >3 and male sex, retained statistical significance ($p < 0.05$).

Conclusions: Surgical site infection is the most common postinfectious complication in surgical patients. Risk factors as diabetes mellitus, male gender, ASA score >3 and emergency procedure, are considered statistically significant.

Key Words: General Surgery, Infections, Risk factors.

INTRODUCTION

Postoperative infections continue to be a major source of morbidity and mortality in surgical patients. Among them SSI is the most common reaching the incidence of 38% [1].

Age, inappropriate antimicrobial prophylaxis, abdominal drains [2], diabetes mellitus, male sex [3], American Society of Anesthesiologists (ASA) risk index score classification of IV or V [4], and increased Body Mass Index (BMI) [5], have been recognized as risk factors for postsurgical infections.

In our study we tried to assess the risk factors af-

fecting the incidence of infectious complications following general surgery.

MATERIALS AND METHODS

This is a case control study which was performed in both general surgical departments of a tertiary care hospital. The aim of the study was to define the risk factors affecting the incidence of infections occurred after surgery. The study was approved by the institutional ethics committee.

Cases consisted of patients who experienced an infection following general surgery while controls were

randomly selected among patients who had undergone the same type of surgery without subsequent infection. There were 62 elective procedures in cases patients. Of them 19 were oncology procedures (gastrectomy, colectomy, hepatectomy, pancreatectomy) and the rest 43 were hernias repair and colocystectomies (laparoscopic or open). Regarding the controls, 16 were oncology procedures (same type as above) and the rest 53 were also hernias repair and colocystectomies. In terms of emergency procedures (viscus perforation, trauma, ileus, appendectomy and hernias constriction) there were 55 in cases and 25 in controls.

We defined as risk factors the following: gender, age, co-morbidities (diabetes mellitus, liver failure, heart failure, respiratory failure, connective tissue disease, neoplasia), use of corticosteroids, use of chemotherapeutic agents, obesity ($>30 \text{ kg/m}^2$), malnutrition, time of operation (urgent or scheduled), wound classification (clean, clean-contaminated, contaminated, dirty), duration of surgery ($<120 \text{ min}$, $\geq 120 \text{ min}$), ASA score, type of anesthesia (general, epidural, spinal), smoke abuse, and alcohol abuse.

The definitions of infections are given below: Superficial incisional SSI involved only skin or subcutaneous tissue and at least one of the following: purulent drainage, with or without laboratory confirmation from the superficial incision or organisms isolated from an aseptically obtained culture of fluid or tissue from the superficial incision, or localized signs and symptoms of infection [6]

Deep incisional SSI involved deep soft tissues (e.g fascial and muscle layers) of the incision and at least one of the following: purulent drainage from the deep incision but not from the organ/space component of the surgical site, or, a deep incision which spontaneously dehiscid with localized symptoms plus fever, or an abscess or other evidence of infection involving the deep incision

Organ/space SSI involved any part of the anatomy (e.g organ or spaces) other than the incision, which was opened or manipulated during an operation and at least one of the following: purulent drainage from a drain that is placed through a swab wound into the organ/space, or organisms isolated from an aseptically obtained culture of fluid or tissue in the organ/space, or an abscess or other evidence of infection involving the organ/space.

Urinary tract infection was defined as urine culture >100.000 colony-forming units/ml (CFU/ml) plus uri-

nary symptoms (dysuria, frequency, urgency and/or suprapubic pain and/or fever).

Pneumonia was defined as fever plus radiological findings on chest X ray consistent with pneumonia.

Bacteremia was defined as positive blood culture obtained from peripheral vein yielded microorganism $>10^5$ CFU/ml.

Central venous catheter infection was defined as bacteremia due to central catheter infection with blood culture yielded the same microorganism ($>10^5$ CFU/ml) from both, peripheral and central vein.

STATISTICAL METHODS

The descriptive statistics of continuous characteristics are presented as mean \pm standard deviation. The distribution of continuous variables within cases and controls was compared using the Student's t statistic. Categorical characteristics are displayed as frequencies. The potential association between categorical variables was examined by the chi-squared test. The multivariable analysis was conducted using the logistic regression approach. The estimates derived from regression models were in the form of Odds ratios (OR), which are presented along with their 95% confidence intervals (CI).

The effect of the following factors were examined in multivariable analysis: gender, age, co-morbidities, use of corticosteroids or chemotherapeutic agents, obesity, malnutrition, time of operation, wound classification, duration of surgical procedure, ASA score, type of anesthesia, smoke or alcohol abuse. In the first step of the model selection strategy, we applied models containing each of the aforementioned variables one at a time. Variables that appeared significant from step one were incorporated concurrently in one model and, subsequently, those that did not remain important were dropped. Insignificant variables from step one were retested in the model derived from step two as they may become important in the presence of others.

All tests of significance were two-sided and a p-value less than 0.05 was indicative of statistical significance. In model selection, the p-value of 0.10 was used as a criterion for inclusion. All statistical analyses were performed using the package STATA 10.0.

RESULTS

The current study involved 117 cases and 94 controls treated in two general surgical departments of a tertiary care hospital in a two year period (2008-2010). Of the cases, 67 (57.26%) were males and 50 (42.74%) were females. Of the controls, 41 (43.62%) were males

Table 1. Characteristics and clinical parameters of the study population

	Cases (n=117)	Controls (=94)	P-value
Age			
Gender (males)	67	41	0.049
Liver failure	5	2	0.387
Heart failure	21	12	0.303
Diabetes Mellitus	30	13	0.034
Respiratory failure	22	9	0.060
Neoplasia	19	16	0.879
Connective tissue disease	1	1	0.876
Malnutrition	13	5	0.134
Obesity	27	12	0.055
Smoke	40	40	0.213
Alcohol	15	8	0.318
Corticosteroids	4	1	0.264
Chemotherapy	3	1	0.427
Emergency of surgical procedure			
Elective	62	69	0.002
Urgent	56	25	0.002
Wound classification			
Clean	11	18	0.041
Clean-contaminated / Contaminated / Dirty	106	76	
ASA			
1	58	63	0.001
2	36	28	
>=3	23	3	
Type of anesthesia			
General	110	90	0.806
Epidural	1	0	
Spinal	2	1	
Duration of surgery			
<120 min	65	64	0.102
>120 min	49	65	
Site of infection			
SSI	102		
Bloodstream infection	26		
Pneumonia	22		
Central Venous catheter infection	18		
Urinary Tract Infection	7		
Other	7		

and 53 (56.38%) were females. The mean age of the cases was 62.4 years, whereas the mean age of controls was 61.3 years.

Of the 117 cases, 37 (31.6%) had at least two infections. From the total of cases, 102 (87.1%) had incisional SSI (22 superficial and the rest 80 deep incisional), 26 (22.2%) had bacteremia, 22 (18.8%) had pneumonia, 18 (15.3%) had central venous catheter infection, 7 (5.9%) had urinary tract infection and 7 (5.9%) had other infection (3 cholangitis, 2 sinusitis, 2 viral infection). None of the patients had an organ/s-

pace SSI.

The detailed demographic and clinical characteristics of the participants are presented in table 1. Cases compared with controls were more obese (27 vs 12) or malnourished (13 vs 5), had a higher ASA score (23 vs 3), and they experienced more co-morbidities.

The univariable logistic regression model revealed the following significant predictors ($p < 0.10$) of post-operative infection: diabetes mellitus, respiratory failure, obesity, time of operation, wound classification, ASA score, and male sex. However, in multivariable

modelling, only diabetes mellitus, time of operation, ASA score >3 and male sex, retained statistical significance ($p < 0.05$).

DISCUSSION

Surgical site infection is the most common infection among surgical patients ranging from 2.8% up to 38% of all such infections and consists the third most common nosocomial infection reaching the incidence of 18%. [6, 7]. Two thirds of the SSI were reported as incisional and one third as organ space [8]. Diabetes mellitus, malnutrition, anemia, ASA score, advanced age, duration of surgery, obesity, wound classification, [8,9,10,11] were all recognized as risk factors for SSIs.

In our study, diabetes mellitus, male sex, time of operation, and ASA score >3 retained statistical significance ($p < 0.05$).

Preoperative glucose level ≥ 200 mg/dL in diabetic patients was an independent risk factor for SSI after coronary artery bypass [12]. In a study conducted by A.S. Dronge et al, good preoperative glycemic control (haemoglobin A1c {HbA1c < 7%}) was associated with a decrease in postsurgical infectious complications [13].

In two retrospective medical record review, higher

than normal glucose control was strongly associated with SSI in patients underwent colorectal and non-colorectal surgical operations.[14,15,].

Male gender along with other parameters such as ASA class, emergency surgery, operation time, was found to be a statistically significant risk factor for SSI. [16,17]. Operation time plus male gender were associated with increased incidence of SSI in laparoscopic sigmoid resection [18].

Urgent versus scheduled operation, consists one of the risk factors for SSIs. Two large retrospective studies [15,16] and one prospective cohort study [18], proved that emergency surgery on multivariate adjustment was statistically significant risk factor for SSI. Surgical site infection was more frequent in the group of patients underwent urgent appendectomy [19], whereas in a large retrospective analysis, patients underwent laparoscopic procedure was 72% less likely to experience SSI [20].

It is well known that the poor physical condition of a patient according to the ASA score, is directly associated with any type of postsurgical infection. Regardless of wound classification, patients with co-morbidities undergoing clean and clean contaminated general surgical procedures, have greater rates of SSI

Table 2. Results of univariable and multivariable logistic regression analysis.

Variable	Univariable analysis			Multivariable analysis ³		
	OR ¹	(95% CI) ²	P-value	OR	(95% CI)	P-value
Gender (Rc ⁴ : females)	1.73	(1.00, 3.00)	0.05	2.12	(1.16, 3.85)	0.01
Diabetes Mellitus (Rc: no)	2.15	(1.05, 4.40)	0.04	2.21	(1.12, 4.35)	0.02
Respiratory Failure (Rc: no)	2.19	(0.96, 5.01)	0.06	NS		
Obesity (Rc: no)	2.05	(0.98, 4.31)	0.06	NS		
Type of surgery (urgent or not) (Rc: no urgent)	2.53	(1.41, 4.54)	<0.01	2.43	(1.30, 4.53)	0.01
Wound classification (Rc: clean)	0.44	(0.20, 0.98)	0.05	NS		
ASA ⁵ (rc:1)						0.03
2	1.40	(0.76, 2.57)	0.28	1.20	(0.63, 2.29)	0.58
3	8.33	(2.37, 29.21)	<0.001	5.98	(1.63, 21.92)	0.01

¹ OR: Odds ratio

² CI: Confidence interval

³ The multivariable analysis includes all variables found statistically significant ($p < 0.10$) in univariable modeling

⁴ Rc: reference category

⁵ ASA: American Society of Anesthesiologists

than those without any co-morbidity [21]. Many publications in the literature identify ASA >2 as statistically significant risk factor for SSI [16,19]

In our study bacteremia is the second most common infection after SSI with an incidence rate of 22.2%. In the literature there are not clear evidence concerning the incidence of primary or secondary bacteremia due to other source except central venous catheter. Postoperative bacteremia is describing as a common complication of hepatectomy concerning biliary tract carcinoma and is usually primary [22]. However, bloodstream infection with primary source the urinary tract [23], the abdomen, [24], and even the pancreatic necrosis in patients underwent surgery for severe acute pancreatitis [25] have been described.

Central venous catheter related infections has an incidence rate in surgical patients ranging from 6% [26], up to 25,2% [27]. Parenteral nutrition, place of insertion, duration of catheterization [26], were recognized as risk factors for this kind of infection. We found an incidence of 15.3% of central venous catheter related infection which is within the range reported in the literature.

Nosocomial pneumonia is one of the most common infections, in surgical patients, and is associated with high morbidity and mortality reaching the incidence rate of 50% [28]. Risk factors involved in this group of patients are mechanical ventilation, treatment with broad spectrum antibiotics and duration of surgery [29]. Although none of our patients was under mechanical ventilation, we found an incidence rate of 17.8% concerning pneumonia. The duration of surgery was slightly longer in patients having pneumonia but unfortunately the antibiotic prophylaxis was not assessed as risk factor.

The risk of acquiring urinary tract infection with extended use of urinary catheter is well described. This risk increases by 5%-10% per catheter-day beyond the first 48 hours of catheterization. [30]. In a large retrospective cohort study, extended postoper-

ative use of indwelling urinary catheters was proved to be associated with poor outcomes for older patients [31]. We found that only 5.8% of patients experienced a UTI, maybe due to the short period of time retaining the catheter (mean=2.8 days).

We found a high incidence of SSI (87.1%) comparing to that reported in the literature. We did not include two risk factors though: Antibiotic prophylaxis and quality of surgical technique.

Misuse of antibiotic prophylaxis has been proven to be associated with a high incidence of SSI. [32]. One single dose of a narrow spectrum antibiotic is recommended 60 min before the incision. Prolongation of antimicrobial prophylaxis [33], as well as inappropriate antibiotic, are associated with SSI. On the other hand, meticulous surgical technique [7,8,34] as well as other factors like operating room environment, are considered as risk factors for SSI.

Since we did not analyze all risk factors, a possible explanation for the high incidence of SSI may be the misuse of antimicrobial prophylaxis, the kind of surgical technique or even operating room environment factors.

CONCLUSION

Surgical site infection is the most common infectious complication in surgical patients. Risk factors as diabetes mellitus, male gender, ASA score >3 and emergency procedure, are considered statistically significant.

Although antibiotic prophylaxis, surgical technique and operating room environment factors have not been assessed in our study, we believe that they are too important predictors for postsurgical infections.

Nonetheless, the surgeon can minimize the risk to the patient through specific perioperative and operative measures like glucose control for diabetics, nutritional support for malnourished patients, attention to technical details of the surgical procedure and careful patient selection.

Παράγοντες κινδύνου και μετεγχειρητικές λοιμώξεις στη γενική χειρουργική

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ΠΕΡΙΛΗΨΗ: Σκοπός: Οι λοιμώξεις που ακολουθούν τις χειρουργικές επεμβάσεις αποτελούν σημαντική πηγή νοσηρότητας και θνητότητας στους ασθενείς. Με σειρά συχνότητας καταγράφονται η λοίμωξη του χειρουργικού πεδίου, η πνευμονία, η βακτηριαιμία που σχετίζεται με τον φλεβικό καθετήρα και οι ουρολοιμώξεις.

Σε δύο τμήματα γενικής χειρουργικής τριτοβάθμιου νοσοκομείου διεξήχθη μελέτη ασθενών-μαρτύρων προκειμένου να εκτιμηθούν οι παράγοντες κινδύνου για τις μετεγχειρητικές λοιμώξεις.

Υλικά-Μέθοδοι: Ως παράγοντες κινδύνου καθορίστηκαν: το γένος, η ηλικία, η συννοσηρότητα (σακχαρώδης διαβήτης, ηπατική ανεπάρκεια, καρδιακή ανεπάρκεια, αναπνευστική ανεπάρκεια, νόσος κολλαγόνου, νεοπλασία), η χρήση κορτικοστεροειδών, η χρήση αντινεοπλασματικών, η παχυσαρκία (>30 kg/m²), η υποθρεψία, ο χρόνος της επέμβασης (επείγουσα ή προγραμματισμένη), η ταξινόμηση της επέμβασης (καθαρή, καθαρή-μολυσμένη, μολυσμένη, ρυπαρή), η διάρκεια της επέμβασης, η φυσική κατάσταση του ασθενούς όπως καθορίζεται από το ASA score, το είδος της αναισθησίας (γενική, ραχιαία, επισκληρίδιος), η χρήση καπνού ή/και αλκοόλ.

Αποτελέσματα: Η λοίμωξη του χειρουργικού πεδίου ήταν η συχνότερη μετεγχειρητική λοίμωξη στη μελέτη. Χρησιμοποιώντας μοντέλο μονοπαραγοντικής λογιστικής παλινδρόμησης οι ακόλουθοι παράγοντες βρέθηκαν στατιστικά σημαντικοί για την πρόκληση λοίμωξης (p<0.10): σακχαρώδης διαβήτης, αναπνευστική ανεπάρκεια, παχυσαρκία, ο χρόνος της επέμβασης, η ταξινόμηση της επέμβασης, το ASA score και το άρρεν φύλο. Χρησιμοποιώντας όμως μοντέλο πολυπαραγοντικής λογιστικής παλινδρόμησης παράγοντες κινδύνου στατιστικά σημαντικοί (p<0.05), ήταν ο σακχαρώδης διαβήτης, ο χρόνος της επέμβασης, ASA score >3, και το άρρεν φύλο.

Συμπεράσματα: Η λοίμωξη του χειρουργικού πεδίου είναι η συχνότερη μετεγχειρητική λοίμωξη. Παράγοντες κινδύνου στατιστικά σημαντικοί για λοίμωξη είναι ο σακχαρώδης διαβήτης, ο χρόνος της επέμβασης, ASA score >3, και το άρρεν φύλο.

Λέξεις κλειδιά: Γενική Χειρουργική, Λοιμώξεις, Παράγοντες Κινδύνου

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