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ORIGINAL PAPER

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Examination of Risk Factors for the Development of Surgical Site Infections

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ABSTRACT

Introduction. Hospital-acquired infections (HAI) and surgical site infections (SSI) are a global public health problem. The aim of the study was to determine the incidence of SSIs at the Surgical Clinics of the University Clinical Centre Banja Luka and to identify risk factors for the development of SSIs. **Methods**. In order to determine the frequency of SSIs through the incidence compared to the patients operated at the Surgical Clinics of the University Clinical Centre Banja Luka, we conducted a prospective cohort study which encompassed 11.216 operated patients, in the period from November 11th,2014 to September 30th, 2015. In order to identify risk factors for the development of SSIs, a nested case-control study of risk factors for SSIs was conducted. The study group consisted of patients who were diagnosed with SSIs in the period of monitoring, while the control group was consisted of patients without SSIs who corresponded with the study group in age and sex. **Results.** The highest values of incidence of SSIs were observed at the Department of Anesthesia and Intensive Care (2.65%), Department of Orthopaedic Surgery (2.48%) and the Department of Vascular Surgery (2.15%), and the lowest ones at the Department of Urology (0.59%). Among the cases of SSIs, deep infections of the surgical site were the most represented (82.7%). Multivariate logistic regression was used to identify the following independent risk factors: length of pore-operative stay in hospital (p=0.000; OR=1.062; 95% CI=1.037-1.087), reintervention (p=0.000; OR=22.409; 95% CI=6.361-79.071) and cotrticosteroids (p=0.023; OR=4.141; 95%CI=1.221-14.047). **Conclusion.** The incidence of SSIs at the Surgical Clinics of the University Clinical Centre Banja Luka is at the level of hospitals in developed countries. There are a number of risk factors for SSIs, which may be prevented.

Keywords: surgical site infections, incidence, risk factors.

1. INTRODUCTION

A hospital-acquired infection (HAI), also known as a nosocomial infection, is an infection which occurs in patients and staff at the hospital or other health care facility. These infections may be manifested in pupils and students in training. Infections will be considered to be acquired at hospital if they become evident 48 hours after the admission or later. Surgical site infections (SSIs) occur within 30 days after the surgical intervention, if an implant was has not been positioned, or up to one year if it has (1).

In addition to urinary tract infections, pneumonia and blood infections, surgical site infections (SSIs) represent one of the most common localizations of hospital-acquired infections. It is estimated that, in the USA, approximately 157000 patients a year acquire the SSIs (2) and that these infections cause additional costs of 3.3 billion dollars (3). According to the results from the study conducted by Haley and associates, one third of a total number of intra-hospital infections may be prevented thanks to the epidemiological surveillance (4, 5).

Based on the findings by Worth and associaties, who conducted a prospective cohort study, which included 183625 procedures in the period from 2002 to 2013, there has been a significance reduction in the incidence rates of SSIs due to the epidemiological surveillance. During that period, 5123 cases of SSIs were registered. It was noted that the annual risk for development surface SSIs was reduced by 11% (RR, 0.89; 95% confidence interval CI, 0.88-0.90), 9% for deep SSIs (RR, 0.91; 95% CI, 0.90-0.93), 5% for organ/space infections (RR, 0.95; 95% CI, 0.93-0.97) (6).

With the purpose of effective prevention of SSIs, it is necessary to know the risk factors associated with surgery.

2. AIM OF THE STUDY

a) to identify the incidence rate of SSIs at the Surgical Clinics of the University Clinical Centre Banja Luka

b) to identify risk factors for the development of SSIs.

3. PATIENTS AND METHODS

In order to determine the frequency of SSIs through the incidence compared to the patients operated at the Surgical Clinics of the University Clinical Centre Banja Luka (except for the Clinic of Pediatric Surgery and Maxillofacial Surgery Clinic), we conducted a prospective cohort study in the period from November 11th, 2014 to September 30th, 2015. The study included 11.216 operated patients. The incidence of SSIs in relation to the operated patients was established.

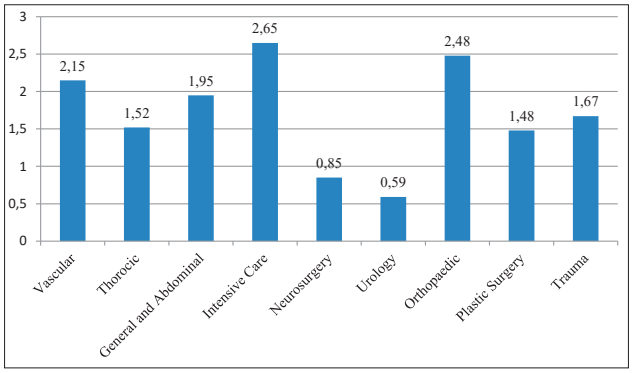
To identify risk factors for SSIs in the prospective cohort study, we conducted the nested case-control study of risk factors for SSIs. The study group consisted of patients who were diagnosed with SSI in the period of monitoring. For each patient with SSI, two controls were identified, that is, two chronologically subsequent patients of the same sex and similar age (±5 years) who had undergone the surveillance, and who did not acquire the SSI.

SSIs were identified by a personal examination of the patient's condition, the existing medical records (medical history, temperature charts, laboratory, microbiological samples taken from the surgical site, etc.), use of definitions and protocol of the European Centre for Disease Prevention and Control (ECDC) (7). The study only included the patients who had signed a written consent to participate in the study.

Statistical analysis of data was conducted with the help of software package SPSS 20.0 for Windows. In this study, we used methods of descriptive and analytical statistics. Out of methods of analytical statistics, the following were used in the study: Student's t test, chi-squared (x2 test) and Fisher's exact test probability. The significance of the independent variables in the univariate and multivariate logistic model was estimated with the probability $p \leq 0.05$.

4. RESULTS

The incidence study included 11.216 operated patients. The highest values of incidence of SSIs were observed at the Department of Anesthesia and Intensive Care (2.65%), Department of Orthopaedic Surgery (2.48%) and the Department of



Graph 1. Incidence Rate of SSIs

Vascular Surgery (2.15%), and the lowest ones at the Department of Urology (0. 59%) (Graph 1).

Among the cases of SSIs, the most represented were deep infections of the surgical site (82.7%) and organ /space infections (15%) which is shown in Table 1. Surface SSIs were represented at 2.3%. There were no differences in age (p=0.929) and gender (p=0,837) between the patients from the study and control group, as shown in Table 1. The respondents did not differ in the presence of comorbidities, such as diabetes, malignant diseases and obesity.

Characteristics	Cases N = 173	Controls N = 344	p
Average age	63.53	63.41	0.929 ♣
‹ 25 years 25 – 44 45 – 64 65 – 79 ≥ 80	2 (1.16) 19 (10.99) 64 (37.00) 67 (38,72) 21 (12.13)	5 (1.45) 32 (9.30) 131 (38.00) 140 (40,70) 36 (10.46)	0.076** 0.545* 0.810* 0,666* 0.566*
Gender m/f	105/68	212/132	0,837 *
Neoplasma	57 (32.9)	103 (29.9)	0.485 *
Diabetes mellitus	24 (13.8)	52 (15.5)	0.706*
Chronic liver disease	0 (0)	5 (1.4)	0.174 **
Chronic pulmonary disease	3 (1.7)	10 (2.9)	0.558 **
Renal Insufficiency	4(2.3)	17 (4.9)	0.236 **
Infection at the admission	58 (33.5)	0 (0)	0.000**
Obesity	0 (0)	2 (0.6)	0.554**
Other intrahoospital infection	11 (6.3)	7 (2.0)	0.011*
Malnutrition	1 (0.5)	0 (0)	0.335**

Table 1. Characteristics of the respondents in the nested case-control study. * X2 test. ** Fisher's test. ♣ t – test

Risk factor	B*	SE	p	OR†	95% CI‡
Length of hospitalization in the department	0.082	0.011	0.000	1.086	1.062-1.109
Preoperative hair removal	0.648	0.250	0.009	1.913	1.172-3.122
Lenght of time from hair removal to operation	0.035	0.017	0.040	1.036	1.002-1.071
Lenght of operation	0.006	0.001	0.000	1.006	1.003-1.009
Number of people in the operating room	0.233	0.100	0.019	1.262	1.038-1.534
Level of contamination	0.417	0.147	0.005	1.517	1.137-2.025
ASA4	1.048	0.474	0.027	2.852	1.125-7.227
Stay in the Intensive Care Unit	1.356	0.339	0.000	3.879	1.996-7.540
Length of stay in the Intensive Care Unit	0.288	0.104	0.006	1.334	1.088-1.636
NNIS 0	-0.466	0.188	0.013	0.628	0.434-0.907
Stoma	1.127	0.403	0.005	3.085	1.399-6.803
Central vascular catheter	1.240	0.525	0.018	3.456	1.235-9.673
Lenght of drainage	0.153	0.027	0.000	1.165	1.105-1.229
Postoperative wound dehiscence	3.688	0.605	0.000	39.961	12.203-130.860
Length of urinary catheterisation	0.120	0.021	0.000	1.127	1.081-1.175

Tabela 2. Risk factors for the development of SSIs identified by unvivariate logistic regression. *-coefficient; †-odds ratio; ‡-confidence interval

Risk factors for the development of SSIS, identified with the use of unvatiate logistic regression, are shown in Table 2. SSIs were more frequent in patients who had their hair removed preoperatively p=0.009; OR=1.913; 95% CI= 1.172-3.122), patients with drainage (p=0.000; OR=1.165; 95%CI=1.105-1.299) and patients with stoma (p=0.005; OR=3.085;95% CI= 1.399-6.803). NNISo was a protective factor for the development of SSIs (OR=0.628; 95%CI= 0.434-0.907). Multivariate logistic regression was used to identify three independent risk factors

associated with SSIs: lenght of stay (p=0.000; OR=1.062; 95% CI=1.037-1.087), re-intervention (p=0.000; OR=22.409; 95% CI=6.361-79.071) and the usage of corticosteroids (p=0.023; OR=4.141; 95%CI=1.221-14.047).

5. DISCUSSION

HAIs represent a global public health problem as they increase morbidity and mortality. Furthermore, they represent a significant economic cost and have a negative effect on patients' quality of life (8).

In our study, the cumulative incidence of SSIs ranged from 0.59% at the Urology Clinic to 2.65% at the Department of Intensive Care Medicine, which corresponds to the SSI rates in developed countries.

In the study conducted by Ridgeway and associates in 102 hospitals in England, a cumulative incidence among patients who had undergone total hip arthroplasty was 2.23%, and in patients with partial arthroplasty, it was 4.97% (9).

Similar values were observed in the three-and-a-half-year study of the operated patients in Virginia and France (10, 11).

In the retrospective cohort study, conducted by Amri and associates, out of total number of 1481 patients who had undergone the surgery of colorectal cancer, 6.1% had SSIs (12).

Relatively few studies talk about the role of gender on the formation of the SSIs. In the study conducted by Kim and associates, who monitored the rates of SSIs in cranioplastic operations, it was proven that females were more susceptible to surgical site infections (OR = 5.98; p = 0.000), hence SSIs were almost six times more often registered in female patients (13).

Male patients in our study group were more frequently represented (105/68), but those differences were not statistically significant (p = 0.837; OR = 1.040; 95% CI = 0.715 to 1.513).

According to some studies, the population ages 70 or above has a significantly higher risk of developing SSIs, as compared to the young and healthy people (14, 15). In our study, age was not statistically significant with respect to the emergence of SSIs (p = 0.928; OR = 1.001; 955c = 0.988 to 1.014).

Most authors agree that patients whose ASA score is greater than 2 have a greater risk of SSIs (16). In our study, SSIs were registered almost three times more frequently in patients with a score ASA4, as compared to other patients (p = 0.027; OR = 2.852, 95% CI = 1.125 to 7.227).

SSIs did not occur with the same frequency in all departments. In our study, the highest percentage was registered at the Department of General and Abdominal Surgery (38.1%), following the Department of Traumatology (12.1%) and the Department of Vascular Surgery (11.6%).

The emergence of the SSIs was accompanied with the stay in the intensive care unit longer than one day (p = 0.000; OR = 3.879; 95% CI = 1.996 to 7.540). The risk was increased with the length of stay in the intensive care unit (p = 0.006; OR = 1.334; 95% CI = 1.088 to 1.636).

In the study conducted by Pereira and associates, it was established that the patients who had pre-operatively stayed in hospital longer than 4 days acquired SSIs three times more frequently (OR=3.3) (17).

Furthermore, there are authors who advocate non-removal of hair from the surgical site since the lowest rates of infection were in patients who did not have their hair removed (18). Our study confirmed that preoperative hair removal carries the risk of SSIs (p = 0.009, OR = 1.913; 95% CI = 1.172 to 3.122), which was also increased with the prolonged time from hair removal to surgery (p = 0.040; OR = 1.036; 95% CI = 1.002 to 1.071).

Length of surgery is directly related to the risk of the occurrence of SSIs. In our study, the length of the operation was statistically significant with respect to the development of SSIs (p = 0.000; OR = 1.006; 95CI = 1.003 to 1.009).

In the study conducted by Han and associates, intraoperative contamination was determined as a risk factor for the development of SSIs (OR=10.549, p = 0.000) as well as the "open" surgery in relation to laparoscopic surgery (OR=2.111, p = 0.001) (19). Analysis of risk factors with the use of univariate logistic regression in our study showed a correlation of SSIs with the degree of contamination (p = 0.005, OR = 1.517; 95% CI = 1.137 to 2.025).

In the prospective cohort study, conducted by Suljagic, it was determined that the risk for the development of SSIs increased with the NNIS index (OR: 1.3; 95% CI: 1.063-1.7). In our study, the results of univariate logistic regression showed that the NNIS index o had a protective role (p = 0.013), while for the rest of the index values, there was no statistically significant difference (20).

Previous studies on the role of drainage in the development of SSIs have yielded contradictory results. Some previous observational and experimental studies have shown that the presence of drainage represents a risk for the occurrence of SSIs, as it acts as a foreign body and reduces the local defense of the tissue (21). In some later studies, the connection between the use of drainage and occurrence of SSIs was not confirmed (22). In their meta-analysis, Diener and associates established that the intra-abdominal abscess occurred less frequently in cases when the drainage had been removed earlier (3-4 days) in relation to the removal in ≥ 5 days upon the insertion. (OR 0.26; 95% CI =0.07-1.00; P = 0.05) (23). However, univariant logistic regression showed that the occurrence of SSIs was associated with the length of the drainage (p = 0.000, OR = 1.165, 95% CI = 1.105 to 1.229), while multivariate regression did not show the independence of this factor.

Pittet and colleagues singled out the corticosteroid therapy as a risk factor for the occurrence of HAIs in hospitals in Switzerland, but the independence of the risk factor for the development of HAI was not confirmed by the multivariate regression analysis (24). In the study conducted by Fukuda, a statistically significant relationship between the use of corticosteroids and the occurrence of SSIs for cholecystectomy (OR 2.83; P = 0.003) and colon surgery was showed (OR 1.27, P = 0.040) (25).

In our study, there was a statistically significant difference in the incidence of corticosteroid therapy in patients with SSIs, compared to those without SSIs (p = 0.010, OR = 4.160, 95% CI = 1.399 to 12.367). In multivariant logistics regression, corticosteroids remained an independent risk factor for the development of SSIs (p = 0.023, OR = 4.141, 95% CI = 1.221 to 14.047).

Postoperative wound opening represents an additional risk for the operated patients. In our study, patients who had undergone the postoperative wound opening were almost 40 times more likely to have acquired SSIs as compared to patients whose wounds were not opened postoperatively (p

= 0.000; OR = 39,961, 95% CI = 12.203 to 130.860). Postoperative wound opening remained an independent risk factor, and patients who had undergone the re-intervention were 22 times more likely to have acquired SSIs than those without the re-intervention (p = 0.000; OR = 22,409, 95% CI = 1.221 to 14.947).

6. CONCLUSION

The incidence of SSIs at the Surgical Clinics of the University Clinical Centre Banja Luka is at the level of hospitals in developed countries.

There are a number of risk factors for SSIs, which may be prevented.

REFERENCE

1. Garner JS, Jarvis WR, Emori TG. CDC definition for nosocomial infections. Am J Infect Control. 1988; 16: 128 -40.
2. Magill SS, Edwards JR, Bamberg W, Beldavs ZG, Dumyati G, Kainer MA, et al. Multistate point-prevalence survey of health care-associated infections. N Engl J Med. 2014; 370: 1198-1208.
3. Zimlichman E, Henderson D, Tamir O, Franz C, Song P, Yamin CK, et al. Health care-associated infections: a meta-analysis of costs and financial impact on the US health care system. JAMA Intern Med. 2013; 173: 2039-46.
4. Haley RW, Culver DH, White JW, Morgan WM, Emori TG, Munn VP, Hooton TM. The efficacy of infection surveillance and control programs in preventing nosocomial infections in US hospitals. American Journal of Epidemiology. 1985; 121: 182-205.
5. Haley RW. The scientific basis for using surveillance and risk factor data to reduce nosocomial infection rates. J Hosp Infect 1995; 30 Suppl: 3-14.
6. Worth LJ, Bull AL, Spelman T, Brett J, Richards MJ. Diminishing surgical site infections in Australia: time trends in infection rates, pathogens and antimicrobial resistance using a comprehensive Victorian surveillance program, 2002-2013. Infect Control Hosp Epidemiol. 2015 Apr; 36(4): 409-16. doi: 10.1017/ice.2014.70.
7. European Centre for Disease Prevention and Control. Surveillance of surgical site infections in European hospitals – HAISSI – protocol version 1.02. Stocholm: ECDC, 2012.
8. Badia JM, Casey AL, Petrosillo N, Hudson PM, Mitchell SA, Crosby C. Impact of surgical site infection on healthcare costs and patient outcomes: a systematic review in six European countries. J Hosp Infect. 2017 Mar 8. pii: S0195-6701(17)30135-4. doi: 10.1016/j.jhin.2017.03.004. [Epub ahead of print].
9. Ridgeway S1, Wilson J, Charlet A, Kafatos G, Pearson A, Coello R. Infection of the surgical site after arthroplasty of the hip. J Bone Joint Surg Br. 2005 Jun; 87(6): 844-50.
10. Sawyer RG, Raymond DP, Pelletier SJ, Crabtree TD, Gleason TG, Pruett TL. Implications of 2457 consecutive surgical infections entering year 2000. Ann Surg. 2001; 233(6): 867-74.
11. Thibon P, Parienti JJ, Borgey F, et al. Use of censored data to monitor surgical-site infections. Infect Control Hosp Epidemiol. 2002; 23: 368-71.
12. Amri R, Dinaux AM, Kunitake H, Bordeianou LG, Berger DL. Risk Stratification for Surgical Site Infections in Colon Cancer. JAMA Surg. 2017 Apr 12. doi: 10.1001/jamasurg.2017.0505. [Epub ahead of print].
13. Kim JS, Park IS, Kim Sk et al. Analysis of the Risk factors Affecting the Surgical Site Infection after Cranioplasty following decompressive Craniectomy. Korean neurotrauma, 2015; 11(29: 100-5.
14. Caulley L, Johnson-Obaseki S, Luo L, Javidnia H. Risk factors for postoperative complications in total thyroidectomy: A retrospective, risk-adjusted analysis from the National Surgical Quality Improvement Program. Medicine (Baltimore). 2017 Feb; 96(5): e5752. doi: 10.1097/MD.0000000000005752.
15. Schuld J, Glanemann M. Surgical treatment of colorectal carcinoma in the elderly. Chirurg. 2017 Feb; 88(2): 123-30. doi: 10.1007/s00104-016-0342-7.
16. Wong ES. Surgical site infections. In: Mayhall CG, editor. Hospital epidemiology and infection control. 3rd ed. Baltimore: Lippinocott Williams & Wilkins; 2004: 287-310.
17. Pereira HO, Rezende EM, Couto BR. Length of preoperative hospital stay: a risk factor for reducing surgical infection in femoral fracture cases. Rev Bras Ortop. 2015 Oct 23; 50(6): 638-46. doi: 10.1016/j.rboe.2015.09.006.
18. Garibaldi RA, Cushing D, Lerer T. Risk factors for postoperative infection. Am J Med. 1991; 91(3B): 158S-163S.
19. Han J, Wang Z, Wei G, Yi B, Ma H, Gao Z, Yang Y, Zhao B, Zhao B, Tao Y. Risk factors associated with incisional surgical site infection in colorectal cancer surgery with primary anastomosis. Zhonghua Wai Ke Za Zhi. 2014 Jun; 52(6): 415-9.
20. Suljagić V, Jevtic M, Djordjevic B, Jovelic A. Surgical site infections in a tertiary health care center: prospective cohort study. Surg Today. 2010 Aug; 40(8): 763-71. doi: 10.1007/s00595-009-4124-4. Epub 2010 Jul 30.
21. Soleto L, Pirard M, Boelaert M, et al. Incidence of surgical –site infections and the valididty of the National nosocomial Infectuons Surveillance System risk index in a general surgical ward in Santa Cruz, Bolivia: Infect Control Hosp Epidemiol. 2003; 24: 26-30.
22. Nora PF, Vanecko RM, Bransfield JJ. Prophylactic abdominal drains. Arch Surg. 1972; 105(2): 173-6.
23. Diener MK, Tadjalli-Mehr K, Wente MN, Kieser M, Büchler MW, Seiler CM. Risk-benefit assessment of closed intra-abdominal drains after pancreatic surgery: a systematic review and meta-analysis assessing the current state of evidence. Langenbecks Arch Surg. 2011 Jan; 396(1): 41-52. doi: 10.1007/s00423-010-0716-0. Epub 2010 Oct 21.
24. Pittet D, Harbarth S, Ruef C, Francioli P, Sudre P, Petignat C, Trampuz A, Widmer A. Prevalence and risk factors for nosocomial infections in four university hospitals in Switzerland. Infect Control Hosp Epidemiol. 1999; 20: 37-42.
25. Fukuda H. Patient-related risk factors for surgical site infection following eight types of gastrointestinal surgery. J Hosp Infect. 2016 Apr 22. pii: S0195-6701(16)30042-1. doi: 10.1016/j.jhin.2016.04.005. [Epub ahead of print].