Marta Wałaszek, Witold Zieńczuk, Zdzisław Wolak, Wiesław Dobroś, Michał Wałaszek

SURGICAL SITE INFECTIONS IN PATIENTS OF ORTHOPEDIC - TRAUMA UNIT IN DISTRICT HOSPITAL IN 2008-2012

The District St. Luke Hospital. in Tarnow

ABSTRACT

THE PURPOSE OF THE STUDY. The purpose of this study was to evaluate the prevalence and structure of surgical site infections in the Department of Orthopaedis – Trauma Unit in Regional Hospital. St. Luke in Tarnow in 2008-2012.

MATERIALS AND METHODS. Data analysis included 7189 patients operated in 2008-2012. The data collection and analysis used standard statistical tools and definitions for nosocomial infections issued by the U.S. Centers for Disease Control and Prevention (CDC).

RESULTS. In the study group it was 91 cases of SSI (surgical site infection), including 35 patients (38%) with post-operative open reduction of long bone fracture (FX), 16 (18%) with reduction of closed fractures (CR), 15 patients (16%) undergoing hip endoprosthesis (HPRO), 13 (14%) with open reduction surgery of small bones (OR-OTHER), 4 (4%) after knee endoprosthesis surgery (KPRO), and 8 (9%), after treatments of other infections (OTHER). The latter have not been taken into account in the further analysis due to the small number and variety of surgical procedures. The incidence of SSI was for: FX from 2.6 (2008) to 4.1 (2011); CR from 1.2 (2012) 4.8 (2008), HPRO from 0.7 (2012) to 1.3 (2009 r.), OR-OTHER from 0 (2009) to 4.5 (2010); KPRO from 0 (2010-2012) to 2.1 (2009). Among the etiological factors isolated from clinical materials derived from patients diagnosed with infections dominated Gram-positive bacteria, especially Staphylococcus-aureus: HPRO-40%, KPRO-75% FX-46%, OR-OTHER-62%, CR-63%, OTHER -38%. Strains resistant to methicillin (MRSA) were not reported.

CONCLUSION. Prevention measures implemented in many areas of the potential impact on risk factors for SSI, has helped to achieve in 2012, the lowest rate of infection for all the analyzed procedures in the last 5 years. Conducting targeted surveillance of surgical site infection keeps morbidity associated with SSI at an acceptably low level and allows for precise planning of the preventive measures in this area.

Key words: *nosocomial infections, surgical site infection, surveillance of the infections, infections associated with orthopedic implant*

INTRODUCTION

Intensive development of medicine observed with improvement of new methods of diagnosis and treatment has created new challenges in the area of prevention of nosocomial infections. Invasive procedure for treating patients save lives, but also increase the risk of displacement of microorganisms to the areas of the body vulnerable to infection. Building of a system for infection control requires a systematic analysis of the epidemiological situation and take preventive measures in respect of detected infections (1,2). Surgical site infections are an important group among diagnosed nosocomial infections. They occur with certain frequencies in all surgical specialties (3) They occupy a special place in the field of orthopedics and traumatology due to invasive medical interventions carried out in the area of bone tissue. These infections are characterized by long-term treatment and an uncertain outcome. They can lead to the patient's disability and long-term incapacity for work. Failure to treat these infections prompt patients to seek redress and compensation under adverse medical events.

MATERIALS AND METHODS

In 2008-2012, the Department of Orthopedics and Traumatology performed 7189 surgical operations. This unit is subject to monitoring of the treatment of infections detected by the Infection Control Team (ZKZ) of this hospital. Surgical treatments were analyzed and classified according to the procedures of International Classification of Diseases (ICD 9), (Table I).

Infection Control Team in the diagnosis of nosocomial infections, applied the definitions given by the CDC-Center for Disease Control and Prevention of Infectious Diseases (4). The registration of detected infections division used the following categories of clinical forms of infection: superficial, deep and organ involvement. Information about the patients was collected by active monitoring through daily analysis of the results of microbiological testing and review of patient records, consultations with doctors and nurses. Each case classified as surgical site infection (SSI) was discussed with the patient's doctor. For each isolated microorganism recognized as an etiologic agent of infection was assessed drug sensitivity, which was examined by the automatic instrument Witek II. The incidence of SSI was calculated as ratio of the number of new cases of SSI per unit of time divided by the number of operations and multiplied by 100. (5).

In this paper, the characteristics of the patient's risk factors were obtained by calculating SSI Risk Index which is based on an integrated analysis of three categories of variables determining: the degree of microbial contamination of the surgical site, duration of surgery and the surgical patient susceptibility of infection according to ASA (American Society of Anesthesiology) score (6,7). The degree of microbial contamination of surgical site defined the operating physician during surgery. Considered a risk factor for above-standard duration of operation for 25% (75th paracentyl) longest ongoing operations. The classification of patients in the ASA score conducted an anesthesiologist before surgery.

Risk factors were grouped according to the scheme: the place operated dirty-1p., above-standard duration of the operation-one point, three or more points on a scale of ASA- 1 point. We also calculated the standardized risk index SIR (Standardized infection ratio) in relation to the incidence observed in the American program of infection control NNIS (National Nosocomial Infection Surveillance) (8).

In patients of Orthopaedics – Trauma Unit perioperative antibiotic prophylaxis was used according to the hospital own rules. Cefazolin was used at a dose of 1 to 2 g, for 30 min. before the incision of tissue following by two kinds of antibiotic prophylaxis: "ultra-short" - (cefazolin to 24 hours after treatment) and "short-term" (cefazolin to 72 hours after surgery).

RESULTS

Within five years 7 189 patients were treated in the Department of Orthopedics and Traumatology with an average length of stay was 7.9 day. The Department carried out an average of 40 microbiological tests per bed for a year. In the observed sample were identified 91 cases of SSI, including 35 patients (38%) after open fracture surgery (FX), 16 (18%) post-operative reposition of closed fractures (CR), 15 (16%) of patients who underwent hip replacement surgery (HPRO), 13 (14%) after open surgery of small bones (OR-OTHER), 8 (9%) after surgery other (OTHER), 4 (4%) after arthroplasty surgery of the knee (KPRO).

The dominant form of SSI were deep infections, which accounted for 71% of all SSI. The incidence of SSI in each year for FX ranged from 2.6 (2008) to 4.1 (2011), for CR from 1.2 (2012) to 4.8 (2008), for HPRO from 0.7 (2012) to 1.3 (2009),for OR-OTHER from 0 (2009) to 4.5 (2010), fpr KPRO from 0 (2010-2012) to 2.1 (2009) (Table II).

SSI Risk Index was calculated for each category of treatment, in which the incidence was dependent on the identified risk factors. For the procedures HPRO of patients with no risk no SSI was found, among patients with a single risk factor, incidence was 1.41, with two or more factors 1.24. In patients with KPRO procedures there were no SSI in patients with no risk factors, with one risk factor incidence was 1.28, with two or more of

Tabela. I. The list of surgical procedures performed in the Orthopedic Trauma Ward and their codes ICD-9.

Code	Operative procedures	ICD-9
HPRO	Hip prosthesis, Arthroplasty of hip	00.70-00.73; 81.51-81.53
KPRO	Knee prosthesis, Arthroplasty of knee	00.80-00.84; 81.54; 81.55
FX	Open reduction of fracture or dislocation of long bones with or without internal or external fixation; does not include placement of joint prosthesis	79.21; 79.22; 79.25; 79.26; 79.31; 79.32; 79.35; 79.36; 79.51; 79.52; 79.55; 79.56
OR- OTHER	Open reduction of fracture or dislocation of small bones with or without internal or external fixation; does not include placement of joint prosthesis – other then FX	77.28; 78.070-78.079; 79.33; 79.34; 79.37; 79.391-79.395; 79.80-79.89
CR	Closed reduction of fracture or dislocation of bones with external fixation;	79.11-79.18; 79.191-79.194
OTHER	Other operative procedures	77.67; 78.627; 81.11; 81.45; 81.56; 81.84; 84.01; 84;07

2.08. Otherwise the incidence ranged for patients with FX procedures amounting to 2.03 patients without risk factors, 2.61 with one risk factor, and 10.32 for two or more.

Tab. II. SSI incidence in a period of 2008-2012 years by codes ICD-9.

Year	HPRO	KPRO	FX	OR-Other	CR
2008	1,1	1,8	2,6	4	4,8
2009	1,3	2,1	3,7	0	2,6
2010	0,3	0,0	3,7	4,5	3,3
2011	1,2	0,0	4,1	3,2	1,3
2012	0,7	0,0	3,7	1,5	1,2

After the procedures "OR OTHER" incidence in patients with no risk factors was 2.35, with one risk factor 1.06 and 3.72 with two or more risk factors. The CR treatments were associated in patients with no risk factors with incidence 1.78, to in one risk factor 1.59 and 6.25 with two or more risk factors (Table III). The results were compared with the U.S. NNIS infection control results. The incidence among patients of U.S. hospitals and the investigated ward shows no difference in the incidence of HPRO and KPRO. The incidence was higher for FX in all groups of patients with SSI risk index calculated in a comparable population of patients within the NNIS. The standardized index for FX risk exceeded 1, which means that there was in this group of patients more infections than expected (Table IV).

Among the etiological factors isolated from raw materials derived from patients with SSI dominated Gram-positive bacteria, especially Staphylococcus-aureus: for HPRO-40%, KPRO-75%, FX-46%, and the OR-OTHER-62%, CR-63%; OTHER-38%. Strains resistant to methicillin (MRSA) were not detected. During this study period, the number of microbiological tests performed in the ward increased from 16 tests per the bed in 2008 to 82 in 2012. Regarding the use of perioperative antibiotic prophylaxis antibiotic "ultra-short" dose was used in 5% of the patients in the group with diagnosed infection, "short" in 56%. In 12% of patients antibiotics were introduced before surgery as a treatment for the underlying disease. 26% of patients were not given antibiotics as prophylaxis.

The resulting rates of incidence were the basis for the development of measures to reduce SSI. In the

Tab. III. SSI incidence in patients with different numbers of risk factors.

	Type of surgery				
	HPRO	KPRO	FX	OR-Other	CR
Number of procedures	n=1611	n=440	n=1044	n=515	n= 732
Average patient is age (years)	68	67	52	33	54
Number of SSI	15	4	35	13	16
Without risk factors					
Number of procedures	515	167	345	170	337
Number of SSI	0	0	7	4	6
SSI incidence	0,00	0,00	2,03	2,35	1,78
With 1 risk factor					
Number of procedures	854	235	574	283	315
Number of SSI	12	3	15	3	5
SSI incidence	1,41	1,28	2,61	1,06	1,59
With 2 or 3 risk factors					
Number of procedures	242	48	126	62	80
Number of SSI	3	1	13	6	5
SSI incidence	1,24	2,08	10,32	3,72	6,25
Total					
Number of procedures	1611	440	1044	515	732
Number of SSI	15	4	35	13	16
SSI incidence	0,93	0,91	3,35	2,52	2,19

Tabela. IV. SSI incidence in patients with risk factors compared to NNIS.

Type of surgery	Index/ risk factors	Number of SSIs	Incidence in this study (%)	NNIS incidence (%)	Expected number of SSIs	SIR* SSI
HPRO n=15	0	0	0	0,78	0,0	
	1	12	1,41	1,55	12,0	1,00
	2i3	3	1,24	2,07	3,0	1,00
KPRO n=4	0	0	0	0,87	1,5	0,00
	1	3	1,28	1,22	2,9	1,05
	2i3	1	2,08	2,03	1,0	0,00
FX n=35	0	7	2,03	0,64	2,2	3,17
	1	15	2,61	1,33	7,6	1,96
	2i3	13	10,32	2,59	3,3	3,98
OR-OTHER n=13	0	4	2,35	bd	bd	bd
	1	3	1,06	bd	bd	bd
	2i3	6	3,72	bd	bd	bd
CR n=8	0	6	1,78	bd	bd	bd
	1	5	1,59	bd	bd	bd
	2i3	5	6,25	bd	bd	bd

* SIR standardized infection ratio

Tab. V. The number of used barrier surgical occupancy, surgical gloves, surgical masks, disinfectants to wash the patient's body before surgery, the tests for the carriage of staphylococcus aureus among patients and staff, environmental studies of the operating room.

liczba year	Number of barrier surgical occupancy (set)	Number of pairs of gloves with high resistance to damage	Number of surgical masks of high filtration	Number of packages of antiseptic to clean the patient's body (box 0.5 liter)	Number of research MSSA carriage		Number of environ- mental studies of the operating room	Number of SSI	SSI incidence
					Operat. team	Patients			
2008	75	0	0	0	7	0	20	18	1,4
2009	64	0	0	16	12	0	20	19	1,3
2010	304	0	0	32	36	0	20	23	1,6
2011	1038	3950	50	63	163	249	60	18	1,2
2012	1560	2150	10 450	68	369	765	120	13	0,9

plan were omitted areas for which was obtained the compliance of internal procedures such as education, duration of stay before surgery, the surgical clipping, hand hygiene, aseptic and antiseptic action, care after surgery. With regard to other risk factors, the following preventive measures were introduced: discontinuation of the use of cotton drapes and replacement them with those which meet the standard DIN EN 13795, surgical masks with high filtration were introduced and surgical gloves more resistant to damage. Rules for preparing a patient for surgery were clarified taking into account the patient's body hygiene. Compulsory monthly testing of the members of surgical teams and patients for the carriage of Staphylococcus aureus in the nose was introduced (Table V).

DISCUSSION

In the word under investigation surveillance of surgical site infections has been conducted by a team for hospital infections since 2001. Systematic surveillance of the infections was conducted up to one year after the operation because of the large number of treatments with use of the implant. In the initial period of monitoring of SSI was pointed to the general incidence rates per 100 operations (3). Since 2008, it was introduced targeted surveillance of selected orthopedic operating procedures. These observations led to better diagnose the cause of infection and enhancing cooperation between the team and medical personnel of the ward.

Our studies have shown no difference between the observed incidence rates for SSI and described in the literature. In our study, SSI occurred with a frequency of 1.3%, and according to data from NHSN (National Healthcare Safety Network), the incidence was 1.9% (9). Babiak et al. (10) described the occurrence of infections in orthopedic trauma wards at the level of 2.4%.

In our department incidence of infections after HPRO during the study period was as an average 0.9%. Wójkowska-Mach et al. (11) in a survey of surgical site infections following total hip replacement surgery performed on a slightly larger material found the incidence of these infections in the range of 2.3% to 7.5%. The multi-center study conducted in the framework of the NNIS obtained comparable incidence rates for procedures HPRO and KPRO taking into account the risk index. In the group of patients who underwent the procedure at the ward under study as compared with the data of NNIS incidence of infections after HPRO was respectively 1.41 and 1.65 for patients with one risk factor, 1.24, and 2.52 for patients with two or more risk factors.

Standardized Risk Index (SIR) for HPRO and KPRO was one or less which means that in our study occured fewer infections for these procedures than expected (Table IV). Infection rates higher than in the comparable NNIS system were obtained in the procedures relating to open repositioning of long bones (FX). Also standardized risk index for these treatments has exceeded a value of 1, which means that more infections occurred in this area than expected in comparison to NNIS (12).

With regard to the results of incidence of infections after FX procedures authors see a need to re-examine infections in this group. Assuming constancy of organizational and personal factors in the ward and repeatability of sanitation procedures used in the operating room, which is fixed and unchanging for all the analyzed procedures, it is necessary to take into account additional risk factors of the patient. There was not analyzed the incidence of open fractures in high impact tissue injury and multiple foci of necrosis, coexisting with large physical contaminations at the injury site that may affect the occurrence of infection. The risk of infection may also depend on the time elapsed since the tissue damage to the first dose of antibiotic.

These factors were not examined in this study. Hryniewicz et al (13) indicate that penetrating injuries with the presence of necrotic tissue, operated more than 4 hours after the event, carry a high risk of infection, up to 40%. As a part of monitoring the infection rates were calculated for other procedures than the open reduction of long bones and fixation of fractures and dislocations (OR-OTHER), and for setting of closed-fractures and repositions (CR), but a comparative material in this area was not found in the available literature.

In our study, Gram-positive organisms were the most common cause of surgical site infections, which was dominated by strains of Staphylococcus aureus, representing 51% of the isolates. Stick and Truszkiewicz in the analysis of the patients civil claims mention MRSA infection as the most common cause of infection in the area of orthopedics and traumatology (14). Bloch-Bogusławska E et al. also indicate that S. aureus was the most common pathogen causing infections in orthopedic and trauma wards in the reviewed lawsuits due to nosocomial infections (15). Our results do not differ from those listed in the literature.

It was also performed an analysis of the results of the use of perioperative antibiotic prophylaxis, according to the recommendations for the diagnosis and treatment of infections in the hospital (16). A review of the literature suggests that the perioperative use of antibiotics reduces the number of infections in orthopedic surgery and trauma wards (17,18). According to the materials developed by Steinberg et al. (18), the incidence of SSI depends on the time of administration of antibiotics. In this study, patients who received antibiotic too early or too late in relation to tissue incision, had higher rates of infection of up to 6%. Our study was not carried out as an in-depth analysis of antibiotic administration time, however, it is possible to further reduce infection rates by applying the general principles recommended antibiotic prophylaxis.

SUMMARY AND CONCLUSIONS

Prevention measures implemented in many areas of the potential impact on risk factors for SSI, has helped to achieve in 2012, the lowest rate of infection for all the analyzed procedures in the last 5 years. In our study the incidence of SSI for procedures HPRO and KPRO was at a level comparable to the results of a multicenter study of NNIS.

Our results allow the following conclusions:

1 The method of SSI surveillance applied in this study has a high sensitivity.

2 Conducting targeted surveillance of surgical site infection can properly control the morbidity associated with SSI and precisely plan the preventive measures in this area.

3 Standard risk index confirms the comparability of the patients treated in the studied ward and those being a subject to the NNIS.

4 The risk factors of the patient may influence the incidence of SSI in FX procedures.

5 In the case of surgical treatment of open fractures of long bones, the use of combined antibiotic therapy should be considered.

6 Among the etiological factors Staphylococcus aureus was most frequently detected. Absebce MRSA strains in the clinical material indicates effective supervision on antibiotic resistany strains and efficient prevention procedures.

REFERENCES

1. Wałaszek M, Wolak Z, Dobroś W. Ocena monitorowania zakażeń szpitalnych w Szpitalu Wojewódzkim im. Św. Łukasza w Tarnowie. Zakażenia, 2011;12(5):96-100.
2. Wałaszek M, Wolak Z, Dobroś W. Zakażenia krwi związane z cewnikowaniem naczyń żylnych–analiza działań prewencyjnych. Przegl Epidemiol 2012;66:417-424.
3. Wałaszek M, Wolak Z, Dobroś W. Zakażenia szpitalne u pacjentów hospitalizowanych w latach 2005-2011. Szpital Wojewódzki im. Św. Łukasza w Tarnowie, Przegl Epidemiol 2012;66:617-621.
4. Staszkiewicz W, Hryniewicz W, Grzesiowski P, i in. Praktyczne zasady kontroli zakażeń szpitalnych. Zbiór rekomendacji i procedur dla polskich szpitali zaakceptowany przez Głównego Inspektora Sanitarnego, 2000:14-19.
5. Centers for Disease Control and Prevention (CDC), National Nosocomial Infections Surveillance (NNIS) System Report, data summary from January 1992 through June 2004, issued 2004, http://www.cdc.gov/nhsn/ PDFs-Stat /NNIS_2004.pdf
6. Culver DH, Horan TC, Gaynes RP Surgical wound infection rates by wound class, operative procedure, and patient risk index. Am J Med 1991; 91(suppl 3B): 152S-7S.
7. Vacant CJ, Van Houten RJ, Hill RJ A statistical analysis of the relationship of physical status to postoperative morality in 63 388 cases. Anesth Analg 1970; 49: 564-566.
8. Halez RW Culver DH White JW, in. Identifzing patients at high risk of surgical wound infection; A simple multivariate index of patient susceptibility and wound contamination . Am J Epidemiol 1985; 121: 206-15.
9. Centers for Disease Control and Prevention (CDC),National Healthcare Safety Network (NHSN) Surgical Site Infection (SSI) Event r. http://www.cdc.gov/nhsn/pdfs/pscmanual/9pscssicurrent.pdf z dn. 15.02.2013
10. Babiak I, Kowalski M, Szczęsny G, i in. Specyfika zakażeń na oddziałach urazowo-ortopedycznych wskazania terapeutyczne. Zakażenia. 2004:3.70-76.
11. Wójkowska-Mach J, Bulanda M, Jaje E, i in. Zakażenia miejsca operowanego po zabiegach endoprotezowania stawu biodrowego-analiza wyników nadzoru w dwóch polskich oddziałach ortopedycznych.: Ortopedia Traumatologia Rehabilitacja 2009:3(6),253-263.
12. Robert P. Gaynes, David H. Culver, Teresa C. Horan, Jonathan R. Edwards, Chesley Richards, James S. Tolson

Surgical Site Infection (SSI) Rates in the United States, 1992–1998: The National Nosocomial Infections Surveillance System Basic SSI Risk Index
13. Hryniewicz.W, Kulig J, Ozorowski T, i in. Stosowanie antybiotyków w profilaktyce okołooperacyjnej.http://www.antybiotyki.edu.pl/szpitalna-polit-rekomendacje-diagno st . php z dnia 11.12.2013 r.
14. Pałka J. Truszkiewicz W.: Zakażenie szpitalne jako przyczyna cywilnych roszczeń pacjentów. Arch. Med. Sąd. 2007:LVII,81-84.
15. Bloch-Bogusławska E. Wolska E. Engelgardt P, i in. Bakteryjne zakażenia szpitalne w latach 2000- 2006 w materiałach własnych Katedry Medycyny Sądowej CM UMK w Bydgoszczy. Arch Med Sąd 2008:LVIII,22-26.
16. Ozorowski T. Rekomendacje do diagnostyki i terapii zakażeń w szpitalu. Materiały warsztatowe, Olsztyn. 2007.
17. Górecki A. Marczyński W. Babiak. I.: Zasady profilaktyki rozpoznawania i leczenia nieswoistych zakażeń kości i stawów. Ortopedia Traumatologia Rehabilitacja. 2008;4(6); Vol.10,396-415.
18. Steinberg J, Braun B, Hellinger W, i in. Timing of Antimicrobial Prophylaxis and the Risk of Surgical Site Infections, Ann Surg 2009; 250: 10-6.

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Address for correspondence:
Marta Wałaszek
Szpital Wojewódzki im.Św.Łukasza w Tarnowie
ul.Lwowska 178 a,33-100 Tarnów
Tel. 14 63 15 321
e-mail: zak@lukasz.med.pl