SURGICAL SITE INFECTIONS: INCIDENCE AND ADDITIONAL COSTS

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Keywords: *surgical site infection, length of hospital stay, hospitalization cost*

Abstract: *Despite the progress made in the modern surgery, the surgical site infections continue to occupy a main place among the complications that occur after the surgery of any kind, resulting in substantial increases of the morbidity and perhaps of the mortality in the operated patients and also of the total cost of the hospitalization. Objectives: The evaluation of the incidence of the surgical site infections and the cost of these complications in terms of mortality, days of hospitalization and financial losses. Material and method: Case-control study; the cases are 45 patients with surgical site infections, who were paired according to the ratio 1:2 with 90 control patients who did not have postoperative infectious complications. The patients are from surgical wards of an emergency county hospital with 1054 beds. Results: The incidence of these postoperative infectious complications was of 1.24%; they have a major impact on the hospital costs: the prolongation of the postoperative hospitalization of the patients with a median of the value of 16 days, the rising cost of the hospitalization of the patients with over 100%. There was not a significantly higher risk of death among the patients with postoperative infection compared with those without infection. Conclusions: The surveillance and control programmes of the postoperative infectious complications can lead to the significant reduction of the postoperative morbidity and of the direct and indirect costs of the surgery.*

Cuvinte cheie: *cheie: infecţie nosocomială postoperatorie, durata de spitalizare, costuri de spitalizare*

Rezumat: *Cu toate progresele făcute în chirurgia modernă, infecţiile nosocomiale postoperatorii continuă să ocupe un loc central între complicaţiile care apar după intervenţiile chirurgicale de orice tip, conducând la creşterea substanţială a morbidităţii şi, probabil, a mortalităţii la pacienţii operaţi, precum şi a costurilor totale de spitalizare. Obiective: Evaluarea incidenţei infecţiilor nosocomiale postoperatorii şi a costurilor acestor complicaţii în termeni de mortalitate, zile de spitalizare şi pierderi financiare. Material şi metodă: Studiu caz-martor; cazurile sunt 45 de pacienţi cu infecţii nosocomiale postoperatorii, care au fost împerecheaţi, respectând raportul 1:2 cu 90 pacienţi–martor care nu au avut complicaţii infecţioase postoperatorii. Pacienţii provin din secţii chirurgicale ale unui spital clinic judeţean de urgenţă cu 1054 de paturi. Rezultate: Incidenţa acestor complicaţii infecţioase postoperatorii a fost de 1,24%; ele au un impact major asupra costurilor de spitalizare: prelungirea duratei de spitalizare postoperatorie a pacienţilor cu o valoare mediană de 16 zile, creşterea costurilor de spitalizare ale pacienţilor cu peste100%. Nu a existat un risc de deces semnificativ mai mare în rândul pacienţilor cu infecţii postoperatorii comparativ cu cei fără infecţii. Concluzii: programele de supraveghere şi control a complicaţiilor infecţioase postoperatorii pot conduce la reducerea importantă a morbidităţii postoperatorii şi la reducerea costurilor directe şi indirecte pentru pacientul operat.*

INTRODUCTION

The surgical site infections (SSI) is a major cause of postoperative morbidity in patients hospitalized at surgical wards, so currently there is a growing interest in the study of the associated risk factors and in the prevention of their action.

Despite of these concerns, the studies assessing the direct and indirect costs of these infections are less frequent, although it is widely accepted that they prolong the hospital stay and increase the costs.

PURPOSE

The determination of the incidence of the surgical site infections (SSI), of the mortality, of the excess hospital days and of the additional costs of the hospitalization in the patients with SSI in the year 2010 in an emergency county hospital.

METHODS

We realized a retrospective case-control during the period 01.01.2010-31.12.2010 in three surgical departments from the largest sanitary unit from the county, The Emergency County Hospital Sibiu: General Surgery, Orthopaedics and ENT; The General Surgery Wards, two in number, have in a total of 106 beds, The Orthopaedics Department has a total of 75 beds and ENT department has 25 beds.

In the study, 45 patients were included who have been already operated, who were diagnosed in this period with SSI, according to the centralized sheets reported in the hospital epidemiology service, from a cohort of 5592 patients hospitalized in the mentioned wards during this period. Of all hospitalized patients, only 3614 had been operated, so of these patients were selected the patients from the study.

Criteria of inclusion in the group of the cases: a patient with SSI was defined as any patient who developed SSI

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Article received on 03.04.2013 and accpted for publication on 27.06.2013
ACTA MEDICA TRANSILVANICA September 2013;2(3):227-230

during the period of the study; the diagnosis of the surgical site infection was made by the surgeon, was recorded and initialled by him on the individual sheet of the case of the nosocomial infection, according to the case definitions for the surgical site infections in OMSF no.916/2006.(1)

For the 45 patients selected in the group of the cases, following variables were noted: age, sex, date of admission, date of surgery, total hospital days, number of days of postoperative hospitalization, number of days of hospitalization in the ICU ward, presence or not of the death, type of surgical procedure (general, orthopaedic or ENT and its encoding) and also the following variables needed to establish the infection risk score for each patient, according to CDC recommendations based on the analysis of the surveillance system NNIS (National Nososcomial Infection Surveillance System):(2) the class of the contamination of the surgery (Altemeier classification from I-IV), the duration of the surgery in minutes, the ASA anaesthetic risk score of the patient; for infectious NNIS risk index calculation we gave one point for:

- Surgical wounds Class III and IV
- ASA score greater than or equal to 3
- The duration of the surgery over the time "T" (typical to the category of the surgery, according to NNIS data. (2)

Thus, we obtained four classes of NNIS risk of infection: 0, 1, 2 and 3.

The surgical interventions from the study and also their coding are summarized in table no.1

Table no. 1. Categories of Surgical Interventions Monitored Both at the Group of the Cases and at the Group of Witnesses and Their Content

No.	Type of surgery and its codification	The content of the procedure
1.	Amputation of a limb Amp	Total or partial amputation or disarticulation of the upper or lower limbs, including fingers.
2.	Appendectomy Ape	Surgery for the removal of the caecal appendix with its meso.
3.	Cholecystectomy (classical or laparoscopic) Chol	Surgical procedures for removal of the gallbladder and of the cystic duct (antero-grade procedure, retrograde or combined version). Caelioscopic procedure for the removal of the gallbladder and of the cystic duct.
4.	Colon surgery Col	Cervical incision, excision or bowel anastomosis, including its procedures with small bowel anastomosis
5.	Open reduction of the fractures Rdf	Open reduction of long bone fractures, with internal or external fixation devices. It excludes prosthetic joints fractured open reduction or intra-articulation fractures of small bones.
6.	Gastric surgery Gas	Incision, excision or anastomosis of the stomach, including partial or total gastrectomy, vagotomy, piloromiotomia, pyloroplasty or gastro-entero-anastomoza.
7.	Surgical cure of hernia Her	Surgery of the suppression of the hernia produced at the level of the umbilical ring, groin, including the interventions of the rehabilitation of the abdominal wall dehiscent (eventrations cure, eviscerations).
8.	Hemiarthrosplasty Hartrpl	Only the replace of the femoral head of the hip joint, including a revision of the hemiathroplastia (but excluding the conversion to the total arthrosplasty hip).
9.	Neck surgery Neck	Oncology surgery for ENT (tumour nose, mouth, larynx, ear), total larynges surgery, partial excision of the cervical lymph nodes), laryngoscope, tracheotomy.
10.	Rectal surgery Rect	Previous resection of the rectum with colorectal anastomosis, amputation of the rectum.
11.	Bowel surgery Enter	Incision, excision or anastomosis of the intestine, excluding anastomosis procedures of it with the bowel
12.	Spleen surgery Spleen	Splenectomise

Also, from the deduction of the costs for the patient displayed by the information system of the hospital, it was noted the total expenditure for each case.

The criteria for the inclusion in the group of witnesses: the control group was selected from the patients hospitalized in the supervised departments from the General Surgery, ENT and Orthopaedics, who suffered one or more surgical interventions, but showed no infectious complications at the level of the surgical wounds (n = 3569). Of these, we chose a total of 90 patients; we have noted the same data set as in the case of the patients with infection and they have been "matched" with the patients - cases, following the proportion of 2 to 1. The criteria of "matching" were *the belonging to the class of NNIS infectious risk index and the type of the surgical performed procedure*.

The collection and definition of the data: the collection of the data was done separately for each patient using the information from the sheet of the case of the nosocomial

infection used in the infection surveillance system from the hospital, the additional data being extracted from the patients' case report forms. The data regarding the costs were noted from the computerized data archiving of the hospital, from the deduction of the expenditure for the patient. *The excess hospitalization days* was calculated as the difference between the duration of the hospitalization of a patient with SSI and the average duration of the hospitalization for the two uninfected matched-patients. *The additional costs attributable* to SSI were calculated as the difference between the total costs for SSI patients and the total costs with the uninfected patients. SSI *incidence* was calculated by reporting the total number of SSI identified in the mentioned period to the total number of the patients operated in the three sections. SSI *mortality* was defined as the difference between the percentage of the patients with SSI who died and the percentage of the uninfected patients who died during the controlled period.

Statistical analysis:

Excel was used to achieve the database, the data being then exported in the MedCalc statistical software.

RESULTS

SSI incidence During the studied period, 45 patients had SSI from a total of 3614 operated patients, which represents an incidence of 1.24%. The highest rates were in the General Surgery wards, followed by Orthopaedics and ENT (table no. 2).

Table no. 2. The SSI incidence rate - analysis on wards

Ward	Total number of surgeries	Total number of SSI	Incidence (%)
General Surgery	2036	34	1,67
Orthopaedics	1067	10	0,93
ENT	511	1	0,19

The main features of the matched case-control pairs of patients are summarized in table no. 3.

Table no. 3. The characteristics of the 135 patients with and without SSI

Variable	Cases (n=45)	Witnesses (n=90)
Age (years): average±1DS (range) *Test T student: P = 0.4279*	61,35±15,38 (20-92)	63,75±17,06 (16-89)
Sex (% males / % females) *Test comparison of proportions: P = 0.7086*	64,44% / 35,55%	58,88% / 41,11%
Risk score NNIS 0 1 2 3	 7 15 22 1	 14 30 44 2
Types of surgeries Amp Hartrpl Rdf Ape Chol Col Enter Gas Her Rect Spleen Neck	 3 1 8 1 6 14 1 4 3 1 2 1	 6 2 16 2 12 28 2 8 6 2 4 2
Total number of hospitalization days: median (range) *Test Mann-Whitney P< 0.0001*	31 (10-114)	15 (3-53)
Number of post operatory hospitalization days: median (range) *Test Mann-Whitney P< 0.0001*	27 (9-104)	10 (3-48)
Total number of hospitalization days in ICU: median (range) *Test Mann-Whitney P= 0.0122*	2 (0-20)	1 (0-5)

Mortality: From the total number of 135 patients from the case-control study a number of 5 have died, two among cases (4.44% of them) and 3 among controls (3.33% of them). SSI mortality was 1.1%. The two patients with SSI who died were part of the infectious NNIS risk class 2, one suffering an orthopaedic surgery (open reduction of the fracture) and the other a digestive surgery (surgery of the small intestine). The three patients who died without SSI were part of the same infectious NNIS risk class 2, like the cases; one underwent a surgery for the amputation of a limb, the other two having a digestive interventions (surgery of the colon). The relative risk of death among the cases with SSI was 1.35 (CI $_{95}$, 0.21 to 8.37).

The excess hospital days: At the cases of SSI, the total duration of the hospitalization was significantly higher than in the witnesses group (Mann-Whitney Test *P <0.0001*). Similarly, the postoperative hospital stay was significantly higher in patients with postoperative surgical wound infection (Mann-Whitney Test *P <0.0001*).

The median number of days of hospitalization was *at cases of 27 days* (range from 10 to 114 days) and *at the witnessing of 10 days* (range from 3 to 48 days). *The excess post operatory hospitalization days because of the presence of the postoperative wound infection* was 16 days (IC$_{95}$, 9.1 to 21.29). The excess hospital days differ depending on the type of the performed surgery (table no. 4):

Table no. 4. Excess hospital days depending on the type of the surgery

Type of surgical intervention	Excess hospital days (median days)
Amp	13
Hartrpl	18,5
Rdf	22,5
Ape	12
Chol	18,25
Col	9,5
Enter	15,5
Gas	23,25
Her	5
Rect	6
Spleen	20
Neck	1

During the hospitalization for the main disease, some patients required hospitalization in the ICU for a variable number of days; the total number of days of hospitalization in ICU was significantly higher at the infected patients comparative with the uninfected ones (*Mann –Whitney Test* P = 0.0122). Considering the risk of the acquiring the nosocomial infection in ICU hospitalizations which excess 48 hours, we found that the relative risk related to the prolonged

hospitalization in ICU is significant in the case of the infected patients (table no. 5).

Table no. 5. The relative risk related to the hospitalization at ICU in the study group

Number of cases hospitalizes at ATI for more than 48 hours	Total number of cases	OR= 2,93 (IC_{95}, 1,38 – 6,19)
22	45	
Number of witnesses hospitalized at ATI for more than 48 hours	Total number of witnesses	
15	90	

Hospital costs: The hospitalization costs at the infected patients were significantly higher than in non-hospitalized ones (*Mann-Whitney Test P <0.0001*). The median of the costs for the patients with SSI was 5914 lei (with limits range from 1463 to 29,533 lei), while the control group's median cost was of 2940 lei (with limits range between 530 and 15,487 lei). In absolute terms, according to the data from the patient's bill, the total cost of the hospitalization at the 45 patients with SSI was of 328,734 lei versus 262,741 lei at the 90 patients without these infectious complications. The difference in costs attributable to the presence of postoperative wound infections in the three studied sections was of 65 993 lei.

DISCUSSIONS

The post operative infections at the patients hospitalized at surgery wards may extend the hospitalization for periods sometimes substantial, depending on the type of the operation and the type of the acquired infection; the superficial wound infections are usually easier to handle than the deep incisional SSI or than of the organ / space SSI. Therefore, the orthopaedic operations, especially those of the prosthesis or the ones of the gastrointestinal tract are very costly when such infectious complications occur.(3) The direct costs include the prolongation of the period of the hospitalization, the need for the prolonged antibiotic therapy, sometimes the need of the patients to be hospitalized for varying periods at ICU services, the need for another surgery or often the need of the patient to be hospitalized again. There are more costs resulting from the additional examinations: radiological, laboratory, other drugs, etc. More difficult to be assessed are the indirect costs of these complications: temporary or permanent inability to work (both the patient and his family), the treatment at home or the cost of the possible forensic actions that the patient can perform against the hospital.

Many studies that have referred to the problem of direct costs took into account the total duration of the hospitalization of the operated and uninfected patients compared with that of the infected patients to have an indicator in terms of SSI costs. A study in the 1990s (4) uses the term "excess of length of stay" as an indicator attributable to the postoperative wound infections, the authors finding that the median of this indicator is 6.5 days of postoperative hospitalization. In another study in 2002 (5), the authors calculated a median of 14 days of excess hospitalization for the patients infected at the orthopaedic surgery wards.

In this study, *the excess hospitalization days because of the presence of the postoperative wound infection* in three surgical wards was of 16 days with different values depending on the type of the performed surgery. The highest values were for the orthopaedic (arthroplasty) and digestive (stomach surgery) surgeries, while the lower values were for the neck surgery. As in other studies, in this one we found that there is a statistically significant cost difference between the infected and uninfected patients, the median of the costs for those with SSI being of 5914 lei, while the median of the costs in the control group was of 2940 lei (P <0.0001). Even if the difference in cost between the infected and uninfected patients is obvious we can notice the significant differences in cost between the same types of patients (either infected or uninfected) of U.S. studies (Kirkland – 8864 $ for those infected, or $ 4,391 for uninfected; Whitehaus - $ 24,344, $ 6,636 respectively) and our study that found the average cost of approx. $ 1,747 for infected patients, respectively approx. $ 870 for those uninfected. This discrepancy raises the question of the correctness of the national average costs for the health services.

In this study we have not identified a risk of mortality significantly different in patients infected compared with uninfected ones, the mortality because of SSI being of 1.1%, compared to other studies that have found a significant risk of death attributable to SSI - 4.3%.(4)

CONCLUSIONS

1. The postoperative surgical wound infections had an incidence of 1.24% in the studied sections, the largest value being in the General Surgery Department.
2. The postoperative surgical wound infections caused the prolongation of the postoperative hospitalization period of the patients infected with a median value of 16 days, this value varies depending on the type of the performed surgery.
3. The postoperative surgical wound infections increased the hospital costs of the patients with about 101%.
4. We have not found that there is a significantly higher risk of death among the patients with SSI comparing with those without postoperative infectious complications.
5. The surveillance and control programs of the postoperative infectious complications are fully justified and may lead to a significant reduction in the postoperative morbidity and reduce the direct and indirect costs for the surgical patient.

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