SURGICAL SITE INFECTIONS SURVEILLANCE IN NEUROSURGERY PATIENTS

Alina Petrica¹, Mihai Ionac², Cristina Brinzeu³, Antoniu Brinzeu³

Abstract

Background: This study aimed to determine the rate of surgical site infection (SSI) after neurosurgical procedures, the main risk factors, and the spectrum of micro-organisms involved as well as to determine the effectiveness of surveillance methods for SSI. Material and methods: Consecutive patients undergoing neurosurgery between 1st of January 2007, and 1st of January 2008, in the Clinical Emergency Hospital from Timisoara, were recruited for the study. As it was a retrospective study, the complete medical records of each case were reviewed, and all SSIs were recorded. Statistical analyses were performed to identify the rate of SSI and the risk factors. Univariate and multivariate analyses were conducted; all dependent variables found in univariate analysis were entered in the multiple regression model. Results: A total of 42 postoperative SSIs were identified among 768 cases included in the study, with a resulting overall infection rate of 5.46%. The risk of SSI was increased by postoperative antibiotic administration, operation type (craniotomies had a higher risk), length of preoperative stay, and physical status of the patient (ASA score). We found that age, Altemeier class, antibiotic prophylaxis, placement of foreign bodies such as aneurysm clips and diabetes mellitus have no relation with postoperative SSIs. The microorganisms met more frequently in patients with SSIs were Staphylococcus aureus and Klebsiella. Conclusions: From the point of view of the surgeon, the present series reports a low incidence of SSIs for elective neurosurgery. Still, SSIs remain an important problem in neurosurgery. The primary problem with passive surveillance by surgeons is failure to capture cases, so an active surveillance program is necessary for accurate identification of SSIs.

Key Words: surgical site infection, antibiotic prophylaxis, neurosurgery, risk factor, surveillance

INTRODUCTION

Surgical site infections (SSIs) are the most common and serious complications among surgically treated patients. They result in extended length of hospital stay, pain, discomfort and sometimes prolonged or permanent disability and finally, increased medical costs.¹,²

The last concern has become increasingly important, as physicians and third party payers strive to gain control of the rising cost of medical care. Despite the number of publications in which risk factors for SSI in patients having undergone neurosurgical operation have been detailed, the nature and magnitude of these risk factors are not clear.³ The average SSI rate without antibiotics ranges between 5% and 11% in cerebrospinal fluid (CSF) shunts, between 1% and 5% in craniotomies and spinal surgery in clean and clean-contaminated patients, and between 11% and 38% in CSF fistulas.⁴,⁷

Because of the potentially devastating consequences of infectious complications, considerable efforts should be made for reduction of the infection rates in neurosurgery.⁸ One of the key components to any surgical infection prevention strategy should be a multi-disciplinary approach and everyone should be committed equally to the process improvement as a team.⁹

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OBJECTIVES

Due to the fact that until now there was no study done in Timisoara concerning surgical site infections, we have tried to find out how big is the problem for our hospital. This paper aims to determine the rate of surgical site infection after neurosurgical procedures, the main risk factors, and the spectrum of microorganisms involved, as well as to determine the effectiveness of surveillance methods for SSI.

MATERIAL AND METHODS

This is a retrospective study of 768 patients that underwent a neurosurgical operation between 1st of January 2007, and 1st of January 2008. Among them, 0.52% were shunt operations, 48.95% spinal operations and 50.52% craniotomies. The complete medical records of each case were reviewed, and several data were recorded. These data were the age, diagnosis, type of operation, presence or absence of antibiotic prophylaxis, the daily aspect of the surgical site, presence or absence of fever, results of the cultures, ASA score and Altemeier wound class and length of postoperative hospital stay. Surgical site infections were classified as superficial, deep, or organ/space infections (intracranial, osteomyelitis, disc space infection, spinal abscess, meningitis, ventriculitis) according to the CDC/NHSN surveillance definition of healthcare associated – infection. The main outcome of the study was calculating the NNIS risk index and analyzing whether a patient developed an SSI or not, together with the relationship between the two variables.

Outcome data are given as the mean ± standard deviation and median. The chi-square test or Fisher exact test were used where appropriate, significance was set at a probability value of 0.05, and 95% CIs were calculated. Univariate and multivariate analyses were conducted with SPSS v.15.0 and Epi Info for Windows. The objective of the univariate analysis was to determine the risk factors linked to SSI, and then to conduct multivariate analysis. Thus, all variables that were found to be linked to SSI at a 20% level of significance were included in the multivariate analysis, and then the odds ratio and the 95% CIs were calculated. Factors that were neither associated in univariate analysis in our study nor in the literature as risk factors have been excluded.

RESULTS

Among the 768 cases included in the study, there were identified 42 postoperative SSIs, with a resulting overall infection rate of 5.46% while for craniotomies the rate of infection was 8.16% and for spinal surgery 2.65%. (Fig. 1) Only 7(16.6%) of the 42 cases were diagnosed by the surgeon as SSI. The other 35 cases were diagnosed as SSI using different criteria: organisms isolated from an aseptically obtained culture of fluid or tissue from the superficial or deep incision, organisms cultured from cerebrospinal fluid (CSF), signs or symptoms of infection: pain or tenderness, localized swelling, redness, or heat, fever > 38°C.

Most of the SSIs were superficial (52.3%), with lower incidence of the deep (33.33%) and organ/space ones (14.28%). (Fig. 2) As for the wound class, 2.24% of the clean neurosurgical operations developed SSI comparing with 20% of the contaminated operations.

We had no data on the duration of operation and we assumed that none of the operations exceeded the T point, so the NNIS index ranged from 0 to 2 (52.08% of patients with NNIS 0, 42.7% with NNIS 1 and 5.2% with NNIS 2). From these groups of patients, 2%, 9.75% and 5% developed SSI. (Fig. 3) Only 1 of the 42 cases of SSI didn’t receive antibiotic prophylaxis. As a general aspect, 77% of the patients received antibiotic prophylaxis with cefazolin and 23% didn’t receive any antibiotic.

Figure 1. SSI incidence by type of surgery.

Figure 2. Infection type by procedure.
For the spinal operation the mean length of hospital stay in days was 11.85±4.8, with a minimum of 3 and a maximum of 34 days. For craniotomies the mean length of stay was 15.72±7.4, with a minimum of 2 days and a maximum of 49 days. (Fig. 5)

Bacteria found in neurosurgical SSIs are mainly gram-positive cocci, particularly *S. aureus* (72.72%). The second most frequent organism in our study was *Klebsiella* (in 4.54% cases only *Klebsiella* was isolated while in 9.09% cases there were both *S. aureus* and *Klebsiella*). Other isolated germs were *E. coli* and *Enterobacter* (each with 4.54%) and *Acinetobacter* (4.57%). (Fig. 4)

The univariate analysis pointed out that the length of preoperative stay, ASA class, NNIS risk index, surgery planning circumstances, placement of foreign bodies such as aneurysm clips and diabetes mellitus were associated with SSI development. On the other hand, Altemeier class and antibiotic prophylaxis were no longer significantly associated with SSI occurrence. (Table 1)

When the relationship was studied in the regression model, statistically significant relation was found among variables including postoperative antibiotic administration, ASA, length of preoperative stay, but not for diabetes mellitus and implants. The final logistic regression model with the significant and nonsignificant risk factors for SSI is presented in Table 2.

### Table 1. Univariate analysis of risk factors.

<table>
<thead>
<tr>
<th>Variable</th>
<th>p Value</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (years)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 37</td>
<td>Reference value</td>
<td></td>
</tr>
<tr>
<td>38 - 51</td>
<td>0.19</td>
<td>1.78 (0.69; 4.77)</td>
</tr>
<tr>
<td>52 - 61</td>
<td>0.99</td>
<td>1 (0.29; 3.38)</td>
</tr>
<tr>
<td>&gt; 61</td>
<td>0.04</td>
<td>2.74 (0.93; 8.27)</td>
</tr>
<tr>
<td><strong>Implant</strong></td>
<td>0.014</td>
<td>5.35 (1.681; 17.045)</td>
</tr>
<tr>
<td><strong>NNIS</strong></td>
<td>&lt; 0.001</td>
<td>4.99 (2.18; 11.85)</td>
</tr>
<tr>
<td><strong>Altemeier</strong></td>
<td>1</td>
<td>0.68 (0.11; 2.98)</td>
</tr>
<tr>
<td><strong>Operation planning (elective/emergency)</strong></td>
<td>0.029</td>
<td>2 (1.062; 3.765)</td>
</tr>
<tr>
<td>ASA</td>
<td>0.007</td>
<td>2.91 (1.10; 7.81)</td>
</tr>
<tr>
<td><strong>Antibioprophylaxis</strong></td>
<td>0.322</td>
<td>1.517 (0.662; 3.478)</td>
</tr>
<tr>
<td><strong>Diabetes mellitus</strong></td>
<td>0.008</td>
<td>5.028 (1.799; 14.214)</td>
</tr>
<tr>
<td><strong>Antibiotic post surgery</strong></td>
<td>0.001</td>
<td>2.703 (1.445; 5.057)</td>
</tr>
<tr>
<td><strong>Length of preoperative stay</strong></td>
<td>&lt; 0.001</td>
<td>4.80 (1.86; 13.08)</td>
</tr>
</tbody>
</table>

The mortality rate attributable to SSIs was 4.76% with 2 of 42 cases with SSIs. From the overall mortality rate of the neurosurgical patients, 25% was due to SSIs.

### DISCUSSION

The range of infection in clean neurosurgical operations in randomized controlled trials is 4.0% to 12% without prophylactic antibiotics and 0.3% to 3.0% with prophylactic antibiotics. Currently, an incidence of infections less than 5% is considered acceptable. The total SSI rate of 5.46% in our study was similar, being slightly higher than the acceptable range.
Mollman and Haines reported that was found no association between operation duration and infection risk. Korinek reported that emergency surgery, clean-contaminated and dirty surgery, an operative time longer than 4 hours are independent predictive risk factors for SSIs. Posterior approach, procedures for tumor resection, dural tear, and morbid obesity were reported as risk factors for SSI after spinal surgery. Other factors such as diabetes mellitus also contribute to the development of SSIs.

Other retrospective studies report that obesity, surgical reexploration, steroid administration, and increased hospital stay for patients with infections have no relation to SSIs.

The use of antibiotic prophylaxis in neurosurgery is controversial as studies evaluating the efficacy of antibiotic prophylaxis in neurosurgical procedures have shown variable results. Barker performed a meta-analysis of 6 prospective randomized trials or trial subgroups (N=843), and although no individual trial demonstrated a statistically significant effect of prophylactic antibiotic therapy, the pooled odds ratio was 0.37 (95% confidence interval, 0.17 to 0.78), favoring antibiotic treatment (p<0.01).

Primarily retrospective analyses of approximately 3000 patients in a number of Level IV studies demonstrated low postoperative infection rates with the use of prophylactic antibiotics. In our study only one of the patients with SSIs didn’t receive antibiotic prior to the operation, but it was proven to have no influence on SSI.

Our data showed that age, operation type (Altemeier class), antibiotic prophylaxis, placement of foreign bodies such as aneurysm clips and diabetes mellitus have no relation with postoperative SSIs.

On the other hand, we have found a significant association between post surgery antibiotic and SSI, p=0.001; OR=2.703, 95%CI (1.445; 5.057). The regresional model explained only 14.2% of the occurrence of SSI. We weren’t able to quantify the other risk factors that contributed to SSI development.

Our study encountered several problems. We could not find any written data concerning the exact duration of operations. This is why we weren’t able to calculate an accurate risk index, nor to correlate it with the incidence rate of SSIs (The NNIS index we put into the univariate analysis was calculated assuming that the duration of operation was standard).

In many cases, the medical records from the neurosurgery department didn’t include any results of cultures, or any proof that a culture was sent to the bacteriology department. So, we studied the bacteriology department’s records and we noted down all the cultures that were specified as cultures from the surgical site, from LCR or bone fragments. Even though we found data consistent with that in randomized controlled trials, we aren’t sure of the accuracy of our data concerning the cultures.

Another pitfall of our study was the length of hospital stay. For both spinal operations and craniotomies the mean length of hospital stay was far less than 30 days. There was no surveillance of these patients beyond the hospitalization period. Even though the patients were followed up by the surgeon or the general practitioner, there is no consensus for recording data concerning the SSIs, apart from the hospital. Also by the time of the study, the general trend in our hospital was not admitting we have SSI. Neurosurgeons have traditionally reported postoperative infection rates substantially lower than the real ones.
CONCLUSIONS

In the light of the data above, do we have a good picture of SSIs for the neurosurgery patients of our hospital? The answer is NO. Our study looked at few of the factors involved in SSI development. Apart of the patients’ and operation’ characteristics there are the perioperative factors as the operation theatre, skin preparation and disinfection that seem to make a difference. We should pay more attention to these factors and try to improve our practice in order to lower the incidence of SSI. So we definitely have to look forward to new research and to an active surveillance program for accurate identification of SSIs.

REFERENCES