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Clinical study

Analysis of hospital infection register indicates that the implementation of WHO surgical safety checklist has an impact on early postoperative neurosurgical infections

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ABSTRACT

WHO surgical safety checklist has been proven to reduce postoperative infections in several studies. The aim of our study was to focus on surgical site infections (SSIs) after neurosurgical operations, and to determine whether the checklist implementation would have an impact on the reported SSIs. We used hospital-acquired infection (HAI) register to evaluate the effects of WHO surgical safety checklist in neurosurgery. The HAI register was searched for superficial and deep SSIs, deep organ SSIs, infections following orthopaedic implantation, and other surgical infections of 4678 neurosurgical patients operated on between 2007 and 2011. The data analysis consisted of 95 and 104 neurosurgical postoperative infections before and after the checklist implementation. Time from operation to infection was shorter before than after checklist implementation ($p = 0.039$), indicating a positive effect of the checklist use in the onset of early HAIs. The overall incidence of SSIs of all neurosurgical patients did not differ (4.1% and 4.5%, respectively) and no differences were noticed in the incidences of the subgroups of superficial SSIs, deep SSIs, and deep organ SSIs. The reduction in early postoperative infection rate along with checklist implementation, but not in the long run indicates the complexity of preventing HAIs in neurosurgical patients and need for a multistep infection control approach.

1. Introduction

In recent studies, the incidence of postoperative neurosurgical site infections (SSIs) has varied between 0.4% and 5.1% [1–6]. Surgical checklists, especially the WHO surgical safety checklist, have been proven to reduce surgical complications including SSIs [7–11], and to enhance communication and collaboration in the operation theatre [11–16].

Most neurosurgical adverse events are predictable if not preventable [17]. In our previous study of neurosurgical patients we discovered the checklist implementation to reduce preventable complication-related reoperations, and particularly infection-related reoperations [18].

In another study the implementation of the checklist was associated with reduced postoperative complications, of which majority were SSIs [11]. In order to observe the impact of the surgical safety checklist in a larger patient population over a wider time range we aimed to benefit the hospital-acquired infections register (HAI register) among neurosurgical patients. The HAI register of Turku University Hospital consists of nosocomial infections reported by the hospital wards. The system was fully computerised in 2005, and the reporting of HAIs has been comprehensive. Therefore, the reliability of the register as a data source was considered sufficient for a database analysis.

2. Materials and methods

The study protocol was approved by the Ethical Committee of Hospital District of Southwest Finland and accepted by the Chief of the Operative Group of Turku University Hospital. Register database was formed following national legislation in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

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The HAI register of the Turku University Hospital was searched for SSIs reported on neurosurgical patients operated on between Jan 1st, 2007 and Dec 31st, 2011. Infection categories were: superficial or deep incisional SSI, organ/space SSI such as intracranial abscess, bacterial or fungal meningitis, ventricular shunt infection, spinal abscess or discitis, infection of an orthopaedic implant of spine, and other surgical infection. Infections were considered as HAIs if they occurred within 30 days after surgery or within one year, when foreign material was involved.

The validity of HAI register was evaluated by an infection control nurse, who compared the reported infections in 2007 – 2011 to positive microbiological cultures, laboratory test results and usage of antibiotics found from electronic patient records of all neurosurgical ward patients, and to the annual infection prevalence results. Yearly 35-74 cases missing from the HAI register were evaluated, and 3-14 additional wound infections (superficial or deep incisional SSI, deep organ SSI) per year was found. All non-reported infections were added to the HAI register and included in this analysis. Thus, the reporting coverage of the neurosurgical ward of all infections was 71–88%.

The search resulted to 239 infections in 217 patients who underwent 236 operations, representing 4.0% of the total amount of neurosurgical operations (N = 5943) during the study period. The electronic patient records were then manually examined by an independent reviewer not directly involved in the treatment of neurosurgical patients (MW) and by an infectious disease consultant (HM). After reviewing the data, the infection category was changed if applicable. Two infections of two patients were excluded, as they appeared not to be surgical infections in closer examination. Lumbar drainage of cerebrospinal fluid and duplicates of infections reported twice with different infection categorisation were excluded. These criteria led to the exclusion of 13 infections. Thus, the number of infections in 2007 – 2011 was 226.

The years of the study period were divided in three tertiles (January through April; May through August; September through December). The WHO Surgical Safety Checklist (Appendix [12]) was introduced and implemented in the beginning of May 2009. The study period was divided into two based on this date. The patients and infections were divided into these two groups according to the operation date. The second tertile in 2009 was considered as a 'grey area' regarding the use of the checklist, and therefore was limited out excluding 10 infections from the study. To equalise the patients before and after the implementation of the checklist the third tertile in 2011 and its 17 infections were limited out resulting in 199 infections. The eventually compared study periods were January 2007 – April 2009 and September 2009 – August 2011 with 95 and 104 infections, respectively. The final data comprised of 187 individual patients. Before the checklist implementation there were 90 individual patients of which six patients had two separate infections. After the implementation the corresponding figures were 103 and two patients, respectively. One patient was represented twice in the group before and once in the group after the implementation. Three patients were represented once in both groups. The total numbers of neurosurgical operations during the two study periods were 2342 before and 2336 after the checklist implementation, respectively.

The adherence of checklist use was recorded in the Operation Room electronic database and reviewed for the 104 patients with SSIs. At least the 'Time-out' phase of the checklist was used in 82% of the patients with a SSI after the checklist implementation.

Concerning other typical factors potentially contributing to HAIs, such as monthly bed occupancy rate, the number and educational status of operating neurosurgeons, daily nursing practices and hygiene procedures on the surgical ward, or operational changes in the OR, no major changes in the practice was identified during the study period. The proportion of on-duty procedures was relatively high during the whole study period (22%).

The demographics are presented in Table 1. As a whole the groups did not differ significantly considering diagnosis or procedure, yet in the number of tumour diagnosis and intracranial haematomas the confidence interval overlapped less.

Data are described as counts and proportions. For proportions, 95% confidence intervals (CIs) were calculated. Baseline characteristics were compared before and after checklist implementation were analysed using Chi-square test, one-way analysis of variance or Kruskal-Wallis test. Time to infection from operation before and after checklist implementation was compared with Wilcoxon test and presented with Kaplan-Meier curve. Fisher's exact tests were performed to study association between infection subgroup and microbe findings, timing and urgency of the operation, and level of experience of the operator and also between infection subgroup and the 'time out' phase of the checklist was performed or not. P-values < 0.05 were considered statistically significant (two-tailed). The statistical analyses were generated using SAS software (version 9.3 for Windows, SAS Institute).

3. Results

Analysis of the HAI register consisted of 199 neurosurgical postoperative surgical site infections (SSIs) in a data of 4678 neurosurgical operations between 2007 and 2011. The percentage of SSIs was 4.1% (N = 95) before and 4.5% (N = 104) after the checklist implementation, in populations of 2342 and 2336 operations, respectively. The difference was not statistically significant.

Fig. 1 presents the time from operation to infection for patients with a registered SSI before and after checklist implementation. The postoperative infections occurred earlier before the checklist implementation than after it (p = 0.039). Fig. 2 presents the time distribution of SSIs before and after implementation of checklist indicating the difference in the occurrence of SSIs within 30 days postoperatively. The distribution of SSIs in tertiles is presented in Fig. 3. During the whole observation period, there was considerable variation of the numbers of infections by tertiles. No association of infection rates to seasonal variation, inpatient occupancy rate, or the number or occupational status of the operating neurosurgeon was noticed.

Table 2 shows the infections before and after the checklist implementation categorised in subgroups. There were no statisti-

Table 1
Demographics of the studied patients with infection, before (N = 95) and after (N = 104) the checklist implementation.

Demographics	Before the checklist (N = 95)	After the checklist (N = 104)	P-value
Age (Mean (SD))	56.2 (15.8)	55.9 (16.0)	0.8867*
Gender, male (N (%))	45 (47.4)	41 (39.4)	0.2584**
Time between operation and infection, days (Median (Q_1; Q_3))	13.0 (8.0; 23.0)	18.5 (10.0; 30.0)	0.0403***

SD = standard deviation; Q_1 = lower quartile; Q_3 = upper quartile.
* One-way analysis of variance.
** Chi-square test.
*** Kruskal-Wallis test.

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