SURGICAL-SITE INFECTIONS FOLLOWING CESAREAN SECTION IN AN ESTONIAN UNIVERSITY HOSPITAL: POSTDISCHARGE SURVEILLANCE AND ANALYSIS OF RISK FACTORS

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OBJECTIVES: To evaluate a multi-method approach to postdischarge surveillance of surgical-site infections (SSIs) and to identify infection rates and risk factors associated with SSI following cesarean section.

DESIGN: Cross-sectional survey.

SETTING: Academic tertiary-care obstetric and gynecology center with 54 beds.

PATIENTS: All women who delivered by cesarean section in Tartu University Women’s Clinic during 2002.

METHODS: Infections were identified during hospital stay or by postdischarge survey using a combination of telephone calls, healthcare worker questionnaire, and outpatient medical records review. SSI was diagnosed according to the criteria of the Centers for Disease Control and Prevention National Nosocomial Infections Surveillance System.

RESULTS: The multi-method approach gave a follow-up rate of 94.8%. Of 305 patients, 19 (6.2%; 95% confidence interval [CI] 3.8–9.6) had SSIs. Forty-two percent of these SSIs were detected during postdischarge surveillance. We found three variables associated with increased risk for developing SSI: internal fetal monitoring (odds ratio [OR], 16.6; CI 95, 2.2–125.8; \( P = .007 \)), chorioamnionitis (OR, 8.8; CI 95, 1.1–69.6; \( P = .04 \)), and surgical wound classes III and IV (OR, 3.8; CI 95, 1.2–11.8; \( P = .02 \)).

CONCLUSIONS: The high response rate validated the effectiveness of this kind of surveillance method and was most suitable in current circumstances. A challenge exists to decrease the frequency of internal fetal monitoring and to treat chorioamnionitis as soon as possible (Infect Control Hosp Epidemiol 2005;26:449-454).

ABSTRACT

The single most important risk factor for postpartum maternal infection is delivery by cesarean section. Maternal morbidity related to infections has been shown to be eightfold higher after cesarean section than after vaginal delivery. Reducing the number of deliveries by cesarean section and identifying risk factors for postcesarean surgical-site infections (SSIs) could contribute to a decrease in maternal morbidity.

The reported incidence of SSI following cesarean section varies widely, ranging from 0.3% in Turkey to 17% in Australia. Among hospitals reporting to the National Nosocomial Infections Surveillance (NNIS) System, the rate of SSI after cesarean section was 2.8% to 6.7% depending on the risk index category. The incidence rate depends on the following: the definition of SSI adopted, the intensity of surveillance, the prevalence of risk factors for SSI in the patient group being audited, and whether the survey contains postdischarge data. SSI may not be detected for several weeks after discharge and may not require admission to the operating hospital. Because the length of postoperative hospitalization continues to decrease, the increasing number of SSIs is not detected through the standard surveillance method; therefore, postdischarge surveillance has become increasingly important to obtain accurate rates of SSI. Several methods for postdischarge surveillance of SSI have been evaluated for efficiency, including direct examination of patients’ wounds during follow-up visits to either surgery clinics or physicians’ offices, review of medical records of surgery clinic patients, and patient and healthcare worker surveys by mail or telephone. Automated data, especially from pharmacy and administrative claims, might substantially improve both inpatient and postdischarge surveillance for SSI while reducing the resources required; however, this method is not available everywhere. Nevertheless, there is no universally accepted strategy for monitoring these infections. When choosing a surveillance method, infection control personnel must consider not only the sensitivity and the sources for data, but also the human and financial resources allotted for SSI surveillance.

Various factors affect infection rates in different settings; those most frequently cited in the literature include...
Infections were identified during hospital stay or within 30 days following cesarean section by readmission to the hospital or by postdischarge survey using the criteria of the Centers for Disease Control and Prevention (CDC) NNIS System. The postdischarge survey was performed according to the modified methodology developed by Stockley et al. The patient received a questionnaire (Figure) to be given to the physician (ie, obstetrician or general practitioner) to complete if problems developed regarding the wound or if endometritis developed after discharge. All study subjects were contacted at home by telephone 30 to 35 days after surgery (including those patients who had been diagnosed as having SSI during admission). The patients were asked about their general health and the state of their surgical wound using a standard format based on the physician’s questionnaire. If a patient’s complaints referred to a possible infection and the questionnaire had not been received, the investigator contacted the physician for verbal confirmation of SSI or the medical chart was reviewed to determine whether the patient had attended the outpatient department for the treatment of SSI or had been admitted to the hospital. If it was not possible to contact the patient, the outpatient medical records of those patients who were known to have returned to Tartu University Women’s Clinic were reviewed. When the completed questionnaire arrived and the CDC criteria were met, no further contact with the physician was established.

All surveillance data were collected by a single investigator. Demographic information, potential risk factors, and surgical indications were recorded. Host-related variables included age, nationality, parity, existing comorbidities (eg, diabetes, preeclampsia, anaemia, or chorioamnionitis), bacterial vaginosis during pregnancy, a preoperative condition assessed by American Society of Anaesthesiologists (ASA) score, number of prenatal care visits, duration of ruptured membranes, duration of labor, preoperative stay, length of hospital stay, use of internal fetal monitoring, and number of vaginal examinations prior to cesarean section at the hospital. Surgery-related variables included emergency nature of the operation, indications for cesarean section, duration of the operation, manual removal of the placenta, volume of blood loss, and antibiotic prophylaxis. The study subjects were postoperatively monitored for temperature, SSI, wound and endocervical culture, and antibiotic treatment.

Data Collection

EXTREMES OF MATERNAL WEIGHT (BEING UNDERWEIGHT OR OBESE), PROLONGED LABOR OR RuptURE OF MEMBRANES, LONG DURATION OF SURGERY, MULTIPLE PROCEDURES, MANUAL REMOVAL OF THE PLACENTA, YOUNG MATERNAL AGE, MATERNAL PREOPERATIVE CONDITION, PROCEDURE-RELATED BLOOD LOSS, AND ABSENCE OF ANTIBiotic PROPHYLAXIS. It is important to identify these factors to target high-risk patients who need specific prevention measures.

Despite recent progress in developing a medical infrastructure, some of its components, such as a national system for nosocomial infections surveillance, have not yet been established in Estonia. In Estonia, only a few studies have been conducted on healthcare-associated infections. The aims of this descriptive study were to evaluate a multi-method approach to postdischarge surveillance of SSI and to identify infection rates and risk factors associated with SSI following cesarean section by comparing patients with and without SSI.

METHODS

Setting

Tartu University Women’s Clinic is a 54-bed (2002 data) academic, tertiary-care obstetric and gynecology center that serves mainly the population of southern Estonia, which accounts for approximately one-third of the Estonian population, and has an average of 2,000 deliveries per year.

Patients

The study population consisted of women who delivered by cesarean section in Tartu University Women’s Clinic during 2002. The purpose of the study was explained to patients, and their verbal consent to participate was obtained.
Definitions
According to the modified wound classification, cesarean section deliveries were classified as follows: class I if there was no rupture of membranes or labor, class II if there was less than 2 hours of membrane rupture without labor or labor of any length with intact membranes, class III for rupture of membranes greater than 2 hours, and class IV for purulent amniotic fluid. 

Statistics
All comparisons were unpaired, and all tests of significance were two-tailed. For all categorical variables, Fisher’s exact test or chi-square was used. For continuous variables, Student’s t test was performed. Odds ratios (ORs) and 95% confidence intervals (CI) were calculated using standard methods. A P-value of .05 or less was considered to indicate statistical significance. Multiple logistic regression analysis was performed to obtain adjusted estimates of OR and to identify independent risk factors. Data were analyzed using Stata statistical software (version 8.0; StataCorp, College Station, TX).

RESULTS
There were 310 cesarean sections performed among 2,092 deliveries (14.8%; CI95, 13.3 to 16.4) during the study period. Three hundred five patients were enrolled in the study (4 patients refused to participate, and 1 patient died during the operation due to a complication of underlying disease, rupture of an aortic aneurysm). Among the study patients, there were 192 (63%) emergency and 113 (37%) elective cesarean sections performed. Indications for cesarean section are provided in Table 1.

During the study period, 19 SSIs were identified: 14 patients developed incisional (2 deep and 12 superficial) infections, 4 developed endometritis, and 1 developed intra-abdominal abscess. The overall infection rate was 6.2% (CI95, 3.8 to 9.6). Of the 19 SSIs identified, 11 (57.9%) were diagnosed before and 8 (42.1%) after discharge. Of the latter, 2 patients were readmitted to the hospital and 6 had SSIs that were detected by multi-method postdischarge surveillance.

During the postdischarge surveillance, 280 patients were contacted by telephone. Fifteen of them described a possible infection but only 6 cases were finally confirmed by the physician (4 with the questionnaire and 2 with personal contact). Information was obtained on chart review for 9 study subjects who could not be contacted by telephone nor from whom a completed questionnaire was received. No SSI was detected. In this study, 16 of the 305 eligible patients were not available for any information during the postdischarge period. A combination of healthcare worker questionnaires, telephone calls, and chart reviews gave a postdischarge follow-up rate of 94.8%.

Two patients were excluded from the study during risk factor analysis because SSI developed more than 30 days after their cesarean sections. The characteristics of the sample are given in Table 2. Variables such as nationality, diabetes, preeclampsia, anemia, bacterial vaginosis during pregnancy, manual removal of the placenta, and volume of blood loss did not show significant association between patients with and without SSI (data not shown). Univariate analysis identified that chorioamnionitis, duration of labor, internal fetal monitoring, and surgical wound classes III and IV were associated with SSI (Table 2). Multiple logistic regression analysis found three variables that were independently associated with increased risk for developing SSI: internal fetal monitoring (OR, 16.6; CI95, 2.2 to 125.8; P = .007), chorioamnionitis (OR, 8.8; CI95, 1.1 to 69.6; P = .04), and surgical wound classes III and IV (OR, 3.8; CI95, 1.2 to 11.8; P = .02).

Analysis of the use of antibiotic prophylaxis revealed that 163 (84.9%) of the emergency cesarean section deliveries and 37 (32.7%) of the elective cesarean section deliveries received prophylaxis. Two hundred twenty-three (73.1%) of the patients had followed the guidelines according to the current policy for hospital antibiotic prophylaxis. Seventy-five patients received antibacterial treatment without any confirmed diagnosis of infection after the operation.

Patients with SSI had a longer mean hospitalization...
time than did noninfected patients (5.8 ± 0.3 vs 7.9 ± 1.5 days; *P* < .03).

**DISCUSSION**

To our knowledge, this is the first extensive SSI surveillance study performed in Estonia. The main goals of our study were to evaluate a multi-method approach to postdischarge surveillance of SSI and to identify infection rates after cesarean section.

The overall SSI rate of 6.2% in our hospital is lower than rates from other studies that have used postdischarge surveillance. Rates have varied from 9.6% in Brazil[^1^] to 17% in Australia.[^4^] The comparison of our SSI rates with NNIS System benchmarks is not meaningful because postdischarge surveillance is not required by the NNIS System, but any comparison of SSI rates must take into account whether case-finding included the detection of SSI after discharge. Twelve percent to 84% of SSIs are detected after patients are discharged from the hospital.[^7^] During postdischarge surveillance in our study, 42.1% of SSIs were detected; however, the numbers were relatively small and may therefore have been affected by a random error. The data suggest the necessity to perform postdischarge surveillance to obtain more accurate SSI rates. Noy and Creedy[^4^] recommended in their study that when the rate is being calculated, the number of responders, rather than the number of the total sample, should be used. As increasingly more infections emerge after discharge and in cases of a low response rate, inclusion of nonresponders may lower the infection rate and produce inaccuracies when compared with other healthcare facilities. Thus, when these comparisons are being made, the denominator has to be taken into consideration. In our study, the response rate was high and the exclusion of nonresponders from the denominator would not have changed the results significantly (6.2% vs 6.6%). However, the best way to conduct postdischarge surveillance is still a matter of dispute according to the literature. The ideal methodology should have a high follow-up rate, be cost-effective, and have high sensitivity and specificity.[^6^][^8^][^10^] The follow-up rate in our study was 94.8%; in a study conducted by Stockley et al.,[^19^] a combination of different postdischarge surveillance methods gave a follow-up rate of 92.7%. In the study performed by Taylor et al.,[^20^] patients were contacted only by telephone. The compliance rate was 93.3%, and it was concluded that this method of contact is feasible and effective. Stockley et al.[^19^] found that the combination of different methods is relatively simple to use and causes minimal inconvenience to patients and healthcare workers. We agree with this because most of the patients were interested in participating in the surveillance and because given that approximately

### TABLE 2

**ANALYSIS OF RISK FACTORS FOR SURGICAL-SITE INFECTIONS FOLLOWING CESAREAN SECTION**

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>SSI (n = 19)</th>
<th>No SSI (n = 284)</th>
<th>OR</th>
<th>CI&lt;sub&gt;95&lt;/sub&gt;</th>
<th><em>P</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>27.7 ± 6.5</td>
<td>28.5 ± 5.9</td>
<td>.59</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gestational age, wk</td>
<td>39.2 ± 2.6</td>
<td>38.6 ± 2.6</td>
<td>.38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prenatal care visits</td>
<td>9.4 ± 2.2</td>
<td>9.6 ± 2.7</td>
<td>.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative stay, d</td>
<td>1.2 ± 1.2</td>
<td>1.1 ± 1.7</td>
<td>.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vaginal examination</td>
<td>2.6 ± 1.7</td>
<td>1.9 ± 1.8</td>
<td>.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration of labor, h</td>
<td>6.0 ± 8.5</td>
<td>2.8 ± 4.7</td>
<td>.008</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration of ruptured membranes, h</td>
<td>10.5 ± 18.2</td>
<td>5.4 ± 21.2</td>
<td>.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASA score</td>
<td>1.3 ± 0.5</td>
<td>1.5 ± 0.8</td>
<td>.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration of surgery, min</td>
<td>40.7 ± 6.8</td>
<td>40.6 ± 15.0</td>
<td>.97</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repeat cesarean section</td>
<td>4 (21)</td>
<td>62 (21)</td>
<td>.95</td>
<td>0.32–2.85</td>
<td>1.00</td>
</tr>
<tr>
<td>Emergency</td>
<td>14 (74)</td>
<td>178 (63)</td>
<td>1.67</td>
<td>0.61–4.57</td>
<td>.46</td>
</tr>
<tr>
<td>Chorioamnionitis</td>
<td>2 (11)</td>
<td>2 (1)</td>
<td>16.58</td>
<td>2.75–100.29</td>
<td>.02</td>
</tr>
<tr>
<td>Nulliparity</td>
<td>11 (58)</td>
<td>133 (47)</td>
<td>1.56</td>
<td>0.63–3.89</td>
<td>.35</td>
</tr>
<tr>
<td>Internal fetal monitoring</td>
<td>2 (11)</td>
<td>3 (1)</td>
<td>11.02</td>
<td>1.72–70.43</td>
<td>.03</td>
</tr>
<tr>
<td>Absence of prophylaxis</td>
<td>7 (37)</td>
<td>96 (34)</td>
<td>1.14</td>
<td>0.44–2.99</td>
<td>.79</td>
</tr>
<tr>
<td>Surgical wound class*</td>
<td>12 (63)</td>
<td>84 (30)</td>
<td>4.08</td>
<td>1.55–10.73</td>
<td>.002</td>
</tr>
</tbody>
</table>

SD = standard deviation; SSI = surgical-site infection; OR = odds ratio; CI<sub>95</sub> = 95% confidence interval; ASA score = American Society of Anesthesiologists preoperative assessment score.

*Contaminated or dirty.*
65% of the population owns a mobile phone, the telephone questionnaire is a suitable method. The method we used is not very time consuming. It is also more acceptable to patients because only those who have a problematic wound area need to go to the hospital for checkups. The data collection was simplified by the fact that most of the women returned to our clinic for postdischarge care. The same applies to the physicians; only physicians whose patients have problems should take part in the study. In the study by Stockley et al., the medical records of patients who could not be contacted by phone were not reviewed. In contrast, we performed chart reviews and received information regarding nine more patients, a method also practiced by Noy and Creedy. The high response rate validates the effectiveness of this kind of surveillance method.

The literature suggests that direct observation of surgical sites by trained professionals (eg, infection control practitioners) is the most accurate method to detect SSI. However, in our study this was not possible because we had to consider human and financial resources allotted for SSI surveillance. It could be one of the reasons why our infection rate is lower than those from other studies. The validity of the information obtained from patients and physicians and whether the diagnosis of SSI can be based on this is a matter of dispute in several research studies. Seaman and Lammer found that patients, despite using verbal or printed instructions, were unable to recognize infections. They reported that patients correctly identified their infections in only 11 cases, whereas medical examiners diagnosed infection in 21 wounds, and called into question the validity of data obtained using patient-retumed questionnaires or telephone surveys. A recent study, however, demonstrated that patients can accurately diagnose the absence of a wound complication but are less accurate in diagnosing the presence of an infection. Patients frequently confuse serous discharge with pus and, therefore, this marker may overestimate infection rates. The results of the current study also support the latter because nine of the patients self-reported the SSIs, which were not confirmed by a physician. Confidence in the results should be improved by gathering information from patient records, microbiologic findings, and discussions with the physician. The current data were collected from several sources, and SSIs were always confirmed by the physician. All of the SSI diagnoses were determined by the investigator to have met the CDC criteria.

Multi-method postdischarge surveillance has been described as cost-effective in several studies. The current study included the costs of labor, postage, and telephone calls. Sands et al. evaluated the use of automated ambulatory diagnosis, testing, and pharmacy code screening combined with discharge diagnosis to identify SSI in non-obstetric patients undergoing surgery. They found that ambulatory code screening was a sensitive method for detecting patients with SSI. Yokoe et al. screened automated ambulatory medical records, hospital and emergency department claims, and pharmacy records and found that this method allows efficient identification of postpartum infections not detected by conventional surveillance. Computerized systems could reduce the time and costs required to perform surveillance, but electronic medical records do not exist yet on a large scale in Estonia.

Studies have indicated that antibiotic exposure is a sensitive indicator of an infection because relatively few serious infections are managed without antibiotics. Poor specificity (too many false-positive results) has been a major problem because antibiotics are so widely used after surgery for extended prophylaxis, empiric therapy of suspected infection, and treatment of infections other than SSI. In our study, 75 patients without any confirmed infection diagnosis received antimicrobial treatment after cesarean section. Therefore, we cannot use therapy as an indicator of SSI. Inappropriate use of antimicrobial agents not only adds to the cost of medical care, but also needlessly exposes the patient to potential toxicity and risks that promote the development and spread of antimicrobial resistance in health-care facilities.

Our postdischarge surveillance system was most suitable in the current circumstances.

The second aim of this study was to identify the risk factors that contribute to SSI following cesarean section. In contrast to the NNIS System results, age, ASA score, duration of labor, and duration of surgery were not significant risk factors in our study sample. The average age of the patients in the infected group was younger than that of the noninfected group, but not significantly younger. However, our rate estimates could have been affected by a random error caused by the small number of infections observed. The multiple logistic regression revealed three variables independently associated with post-cesarean SSI. Other studies have also reported a contaminated or dirty operation as a risk factor. Internal fetal monitoring and chorioamnionitis, although they occurred in only a few cases, appeared to predispose women strongly to SSI. A challenge exists to decrease the frequency of internal fetal monitoring and treat chorioamnionitis as soon as possible.

There were no significant differences regarding infections between elective and non-elective groups or between those receiving and not receiving appropriate antibiotic prophylaxis. A Cochrane Review from 2002 recommends prophylactic antibiotics to all women undergoing cesarean section. According to our current hospital policy, antibiotics should be given to only high-risk groups. Because for 73% of the patients our current hospital antibiotic prophylaxis policy was followed, we cannot conclude whether selective prophylactics is a better alternative than routine prophylactics. The results of this study indicate the need for intervention to improve the rational use of antibiotic prophylaxis in consonance with the hospital guidelines.

It has been proved in several studies that a significant increase in hospital stay occurs when a patient acquires SSI. A significantly longer hospital stay also occurred in the current study once SSI was identified.

Healthcare-associated infection control is a relatively new field in Estonia, and we have to develop a surveillance
system and propose a control strategy for nosocomial infections. The baseline quantification of nosocomial infection rates and their comparisons with external rates enable hospitals to direct infection surveillance and control programs. The next step in our hospital would be to inform physicians about the results and set up further follow-up of SSIs. As greater efforts are made to quantify and describe the characteristics of healthcare-associated infections in Estonia, active surveillance, application of prevention interventions, and judicious antimicrobial use should greatly improve patient outcomes.

REFERENCES