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Infections after caesarean sections

Abstract

Background. All hospitals in Norway are required to participate in NOIS (the Norwegian Surveillance System for Hospital-Acquired Infections). Hospitals can choose to have from one to five given surgical procedures under surveillance, caesarean sections being one of them. This article describes the incidence of surgical site infections after caesarean sections, and identifies risk factors for such infections.

Material and methods. A national protocol was developed in accordance with the European protocol (HELICS). Patients who underwent caesarean section (1 September–30 November in 2005, 2006 or 2007) in hospitals that had caesarean sections under surveillance were included in the study and monitored for 30 days after the operation. Cases were identified in accordance with standardised criteria. Several potential risk factors, as well as demographic and clinical data were recorded.

Results. Data were obtained from 3 900 women who had undergone caesarean sections. After discharge, 3 491 women completed follow-up. 290 (8.3 %) of them experienced infections. 86 % of the infections occurred after hospital discharge. 54 women had deep infections or infections in organs or body cavities; 20 of these women were rehospitalised and 11 were reoperated. Age above 29 years and wound contamination grade 3 were independent risk factors for infection.

Interpretation. One of 12 women who undergo a caesarean section develops a surgical site infection. The incidence of infections in Norway is lower than in other European countries. We recommend hospitals to evaluate the preventive measures implemented at their institution.

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About 9 000 caesarean sections are performed in Norway annually (1); the percentage of children delivered in this way increased from 2 % in 1967 to 16 % in 2006 (2, 3). Complications may occur after any surgical intervention, also after caesarean sections postoperative surgical site infections (SSIs) are an important complication (4). In a study performed at the obstetric department at Hammerfest hospital in the period 1995–1999, it was found that 9.6 % (33/344) of the women developed infections after caesarean section; 17 developed superficial SSI and one developed endometritis (5). Awareness of the complication incidence is important for assessment of pros and cons of caesarean section as a delivery method, and for choice of prophylactic measures.

NOIS (the Norwegian surveillance system for nosocomial infections), which started in 2005, can provide data on the incidence of infections after caesarean section. The purpose of NOIS (a central health registry subject to a specific regulation) is prevention of infection through continuous and systematic collection, analysis, interpretation and reporting of data (on a hospital level) on the occurrence of infections. Studies from other countries have shown that implementation of infection surveillance in itself reduces the frequency of infections (6, 7). Estimations indicate that 30 % of nocosomial infections are preventable (6, 8). Surveillance of nosocomial infections contributes to document the quality of hospital care. The NOIS registry is available to all researchers and may be used for research on extent and etiology of infections, as well as on effects of infection control measures.

In this paper we present data from the three first 3-month NOIS surveillance periods in 2005–7. We measured the incidence of SSIs after caesarean section, risk factors for such infections, and the proportion of SSIs that caused hospital readmission and reoperation.

Material and methods

The NOIS-registry regulation requires Norwegian hospitals to monitor surgical procedures and submit data to the registry. Hospitals that applied for exemption due to lack of data systems were exempted from the first two surveillance periods. All patients who underwent caesarean sections at hospitals included in the surveillance during the three NOIS periods (1 September–30 November 2005 [NOIS-1], 2006 [NOIS-2], or 2007 [NOIS-3]) are included in this study. The surveillance design is based on a European protocol developed by HELICS (Hospitals in Europe Link for Infection Control through Surveillance) (*http://helics.univlyon1.fr/helicshome.htm*).

Endpoints

Endpoints in the surveillance system are postoperative SSIs (superficial infections, deep infections or organ/body cavity infections) associated with the intervention. These events are recorded at discharge and 30 days after the caesarean section. Readmissions and reoperations associated with postoperative SSIs were also recorded. No other complication types are monitored.

Risk factors

The following potential risk factors for infection associated with the patients and interventions were recorded: extent of wound contamination (grade of cleanliness), duration of the operation, patient morbidity according to the ASA (the American Society of Anaesthesiologists) classification, perioperative prophylactic use of antibiotics, and type of operation (elective or emergency caesarean section). See table 1 for further details.

Main message

- Postoperative surgical site infections affect about one of 12 women who have undergone a caesarean section
- Most infections occur after hospital discharge

In the USA, NNIS (the National Nosocomial Infections Surveillance System) (9, 10) has developed a risk index that combines the patient's morbidity (assessed by ASA classification), duration of surgery, and degree of contamination at the site of surgery before operation. An intervention may be assigned 0–3 index points. The index is used to stratify patients by selected factors known to increase the risk of postoperative SSIs. Risk stratification is meant to improve the basis for comparisons between hospitals, by stratifying for factors that may vary from hospital to hospital (e.g. the proportion of patients increased morbidity). However, the index is not validated for use in Norway.

Data collection

One person at each hospital (often a public health nurse) is responsible for checking data and for collecting missing information. Most hospitals use computer programmes that can retrieve data (that are already available) from hospital databases, e.g. patient registries and operation planning programmes. Hospitals that lack electronic tools record the information manually.

Patients are followed up by mail correspondence 30 days after operations. Patients reply to a questionnaire from the hospital about whether the wound has healed normally, and if there are any signs of infection. All deep postoperative SSIs and infections in organs and body cavities, must be diagnosed by a physician according to international criteria (11). During hospitalisation, superficial SSIs were diagnosed by a physician, but after discharge those diagnosed by the patients themselves were also accepted.

Data are sent to the Norwegian Institute of Public Health (after quality control) by encrypted e-mail or regular mail (on a CD-rom). All received data are subjected to logical controls, and there is a constant dialogue with contact persons at the hospitals to quality control the data and correct mistakes.

Analysis

The incidence of infections was calculated for patients with «complete follow-up» and for infections that occurred before discharge. Patients with «complete follow-up» are defined as those who either answered the letter they received from the hospital 25–30 days after the caesarean section, who developed the most serious type of infection (infection in organ/body cavity), or died in the follow-up period. Incidence rates were calculated for the entire patient group, as well as for the subgroups with and without each of the risk factors. The incidence rate was calculated by dividing the number of infections observed by the number of women with complete follow-up after discharge. We also calculated the risk ratio for each of the potential risk factors. In addition, separate analyses were performed to study possible risk factors for the most serious infections (deep infections or organ/body cavity infections). We used multiple Poisson regression to control for possible confounding variables. Excel version 2003 and Stata version 9.0 were used in the analyses. 95 % confidence intervals were calculated for incidence rates and risk ratios.

Results

The surveillance periods differed with respect to the number of hospitals that submitted data and the number of interventions included (tab 2). Altogether, data were collected from 3 900 caesarean sections; 313 postoperative SSIs were identified and 45 (14 %) infections occurred during the hospital stay (incidence 1.2 %, 95 % CI 0.8–1.5).

After discharge, 3 491 (90 %) patients were followed up completely; 290 infections (incidence 8.3 %, 95 % CI 7.4–9.2) were identified among them. The incidence rate varied between the surveillance periods (tab 3). Patients who acquired infections while they were in hospital had a longer postoperative hospital stay than those who did not develop infections (5 vs. 11 days). Of the 54 patients with deep infections or organ/body cavity infections, 20 were rehospitalised, and 11 were reoperated.

The following results are only for the women with complete follow-up. Of the 290 infections, 236 (81 %) were superficial and 54 (19 %) were deep or occurred in organs/body cavities. The incidence of deep infections and organ/body cavity infections was 1.6 % (95 % CI 1.1–2.0).

When data from the three surveillance periods are merged, the incidence rate varied between 0 and 21 % between hospitals. Additional descriptive data from the three com-

Table 2 Surveillance of postoperative SSIs after caesarean section in patients who were followed up completely (n = 3 491) during the surveillance periods: NOIS-1 (2005), NOIS-2 (2006), and NOIS-3 (2007)

	NOIS-1	NOIS-2	NOIS-3	Total	Total number with missing information
No. of hospitals	20	26	35	39[1]	–
No. of interventions (followed up completely (%))	771 (87 %)	1 222 (91 %)	1 498 (90 %)	3 491 (90 %)	409
No. given antibiotic prophylaxis (%)	349 (45 %)	714 (58 %)	788 (57 %)	1 851 (55 %)	104
No. of elective interventions (%)	325 (42 %)	646 (53 %)	779 (52 %)	1 750 (50 %)	–
Median age in years[2]	31 (27–34)	31 (27–34)	31 (27–35)	31 (27–34)	–
Median preoperative stay in days[2]	1.0 (0–1)	1.0 (0–1)	1.0 (0–1)	1.0 (0–1)	–
Median postoperative stay in days[2]	5.0 (4–6)	4.0 4–5)	4.0 (4–5)	4.0 (4–5)	–
Median duration of surgery in minutes[2]	36 (27–51)	34 (27–42)	34 (28–44)	34 (27–45)	18

[1] Of which 15 participated in 3 surveillance periods; 12 in 2 and 12 participated once
[2] Median (interquartile width 25–75 %)

Table 3 Incidence rate and type of infection after caesarean section according to surveillance period in patients with complete follow-up (n= 3 491): NOIS-1 (2005), NOIS-2 (2006), and NOIS-3 (2007)

	NOIS-1	NOIS-2	NOIS-3	Total
No. of operations	771	1 222	1 498	3 491
Incidence rate (95 % CI)	7.8 % (5.9–9.7)	9.4 % (7.8–11.1)	7.7 % (6.3–9.0)	8.3 % (7.4–9.2)
No. of superficial infections (number of these diagnosed by patients)	52 (25)	93 (37)	91 (27)	236 (89)
No. of deep infections	3	13	10	26
No. of organ/body cavity infections	5	9	14	28

pleted surveillance periods are presented in tables 2 and 3.

Antibiotic prophylaxis was given in 1 851 (55 %) interventions (information was missinging for 104 of them). Among patients with emergency caesarean sections, 410 (25 %) did not receive prophylactic antibiotics. Of those who had elective caesarean sections, 602 (35 %) were given antibiotics.

In the multivariate analysis, age (30–39 years: RR 1.5; age ≥ 40 years: RR 1.8) and SSI grade 3 (RR 2.0) were significantly associated with infection (tab 4). The explanatory variable, hospital, had little influence on associations between infection and the other variables. When controlling for other factors, only a few of the 39 hospitals had incidence rates that were significantly different from the average (tab 4). For the most serious infections (deep infections and organ/body cavity infections) no significant risk factors were identified. Of the variables included in the NNIS risk index, none other than SSI grade were significantly associated with infection. More than 99 % of patients had 0 or 1 NNIS risk index category, and none had 3 risk points (tab 5).

Discussion

In the surveillance periods assessed, the incidence of postoperative SSIs after caesarean section in Norway was 8.3 %. Most infections (86 %) were diagnosed after discharge.

Strengths and weaknesses of the study

Loss to follow-up in NOIS is lower than that reported in many other studies (12–15). The high proportion of infections discovered after discharge emphasises the importance of proper follow-up after hospitalisation. Without such follow-up the infection rate will be underestimated, and thereby also the patient-related and economic disadvantages of such infections. In our study, 90 % of the women are completely follow-up and the hospitals made a considerable effort to contact as many patients as possible after discharge.

It has been common to include all operated patients in the denominator not only those who have been followed up after discharge an approach which assumes that hospitals receive information about all patients who develop infections after discharge (probably not the case). An Australian study showed that 32 % additional infections were identified when patients who had

Table 4 Univariate and multiple Poisson- regression for incidence of postoperative SSIs after caesarean section in patients with complete follow-up (n = 3 491): NOIS-1 (2005), NOIS-2 (2006), and NOIS-3 (2007)

		No. of infections/ No. of operations	Unadjusted risk ratio (95 % CI)	Adjusted risk ratio (95 % CI)
Age (years)	10–29	87/1 388	Reference	Reference
	30–39	187/1 957	1.5 (1.2–2.0)	1.5 (1.1–1.9)
	≥ 40	16/146	1.8 (1.1–2.9)	1.8 (1.1–2.9)
Surgical site infection	Grade 1	167/2 129	Reference	Reference
	Grade 2	101/1 209	1.1(0.8–1.4)	1.1 (0.8–1.4)
	Grade 3	16/102	2.0 (1.2–3.2)	2.0 (1.2–3.3)
	Grade 4	1/9	1.4 (0.2–3.0)	1.4 (0.3–6.5)
	Unknown	5/42	1.5 (0.7—3.5)	1.3 (0.5–3.4)
ASA classification	Class 1	130/1 750	Reference	Reference
	Class 2	147/1 586	1.3 (1.0–1.6)	1.1 (0.8–1.4)
	Class 3	9/86	1.4 (0.7–2.7)	1.3 (0.7–2.5)
	Class 4	0/2	–	–
	Class 5	–	–	–
	Unknown	4/67	0.8 (0.3–2.1)	1.0 (0.4–2.9)
Duration of surgery	≤ P75[1] -time	262/3 187	Reference	Reference
	> P75 -time	27/286	1.2 (0.8–1.7)	1.2 (0.8–1.7)
	Unknown	1/18	0.7 (0.1–4.6)	0.8 (0.1–6.4)
Antibiotic prophylaxis	No	117/1 536	Reference	Reference
	Yes	158/1 851	1.1 (0.9–1.4)	1.1 (0.8–1.4)
	Unknown	15/104	1.9 (1.2–3.1)	1.8 (0.9–3.7)
Acuteness	Emergency	151/1 741	Reference	Reference
	Elective	139/1 750	0.9 (0.7–1.1)	1.0 (0.8–1.4)
NOIS-year	2005	60/771	Reference	Reference
	2006	115/1 222	1.2 (0.9–1.6)	1.3 (0.9–1.8)
	2007	115/1 498	1.0 (0.7–1.3)	1.0 (0.7–1.4)
Preoperative hospital stay	0–2 days	262/3 125	Reference	Reference
	3–5 days	21/234	1.1 (0.7–1.6)	1.1 (0.7–1.7)
	> 6 days	7/132	0.6 (0.3–1.3)	0.7 (0.3–1.4)
Hospital	Reference hospital	3/36	Reference	Reference
	Lowest	0/33	–	–
	Highest	14/68	2.5 (0.8–8.0)	2.4 (0.7–8.3)

[1] P75-time is the 75-percentile for duration of surgery. In NOIS, the P75-time for caesarean section is 60 min (calculated from the operations reported in NOIS-1 and adjusted to NNIS/HELCS)

[2] 39 hospitals participated in the study. Risk ratios for the hospitals varied in relation to a reference hospital that had the same incidence rate as the country average. The table only includes the two hospitals with the lowest and highest risk rates relative to the reference hospital.

not answered letters from the hospital were contacted. The researchers concluded that comparison of incidence rates between studies requires a definition of the denominator, i.e. whether it includes patients who were not followed up after discharge or not (16). In this presentation of NOIS data, the analyses only include patients that have been completely followed up.

In the European surveillance protocol it is not required to follow up patients after hospital discharge. In European countries, the incidence of infections after caesarean section (before hospital discharge) varies between 0.1 % and 3.7 % (17), in our study it is 1.2 %. Patients in the European hospitals stayed for an average of 7 days after the operation, in our study they stayed for 5 days. In European hospitals that followed up patients after discharge (30 % to 89 % of patients were followed up), the incidence rates for infection varied between 7.7 % and 17.0 % (15, 16, 18–21); in our study the incidence rate was 8.3 % and 90 % of patients were followed up. Because conditions such as average postoperative hospital stay and methods to detect patients with infections vary between studies, comparisons must be made with caution. However, the findings can still indicate the magnitude of the problem. The incidence rate in Norway seems to lie in the lower segment of reported rates from comparable studies in other European countries.

In studies from other countries, several of the variables that are included in NOIS; such as age, emergency intervention, lack of prophylactic antibiotics and high ASA score, were significantly correlated with infection (7, 15, 19, 20, 22, 23). In our study, age above 29 years and SSI grade 3 were significantly correlated with development of postoperative SSI. It was difficult to use NNIS (the US risk index) to identify caesarean sections with a high risk in NOIS. This may be explained by the low number of caesarean sections studied, incorrect interpretation or coding of risk variables used in the index, or that the nearly 20-year-old US risk index is not applicable in Norway today. In future surveillance periods we will include the variables height and weight (and thereby also body mass index), as well as diabetes, to see if these factors influence the risk of infections and are suitable for inclusion in a risk index classification. This may improve the basis for comparisons between hospitals and ease the identification of risk patients, so that prevention of infections can be targeted better.

The risk of infection varied considerably between hospitals, also when other variables where taken into account, even though few hospitals had statistically significant lower or higher incidence rates than a hospital with an incidence rate equal to the country average (tab 4). However, the study had low power to detect such differences. We can assume that local factors at the hospitals and individual factors among the surgeons contribute to the variation in incidence of infections. Such factors are not included in the national dataset, but can be analysed locally at each hospital.

Table 5 Incidence of postoperative SSIs after caesarean section by NNIS risk index category. All surveillance periods pooled (n = 3 491, of which 118 had incomplete information)

	Risk Index Category	No. of infections/ No. of operations	Unadjusted risk ratio (95 % CI)
Risk Index Category (NNIS[1])	0	231/922	Reference
	1	46/426	1.4 (1.0–2.0)
	2	3/25	1.6 (0.5–5.3)
	3	–	–

[1] NNIS = National Nosocomial Infections Surveillance System

It is also possible that such local factors may confound the correlation between some of the measured variables and infection. For example, a surgical team may have a combination of long duration of surgery and poor technique. In this case it may be the technique, and not the duration, that causes the infection. In the national dataset we can only analyse at a hospital level, not lower levels. Taking hospitals into consideration had marginal effect on the other variables. The validity of determination of diagnoses and understanding of the variables have not been studied. However, we see examples of obvious mistakes, such as an operation with a duration of 3 minutes. It is uncertain whether, and to what degree, misinterpretation of these conditions may have influenced the results. We are working continuously to improve data quality and investigate the sensitivity of infection diagnostics.

Significance of the study

Recovery after caesarean section can be more demanding for women who develop a postoperative SSI. Indeed, some of these infections can be very serious, and lead to severely impaired health – or even death. Therefore, it is important to consider all infection control measures that can help to prevent this type of infections. As a result of the surveillance program, one hospital discovered that they had an unexpected high rate of postoperative SSIs. The rate decreased after they changed their bandaging routines after caesarean section (unpublished data). Although the reason for this decrease has not been determined with certainty, this is an example of how surveillance data can and should be used to review routines and implement changes to increase the quality of care and patient safety.

Most infections (81 %) were superficial. This is in agreement with data from the European surveillance network, although the rate of SSIs varies between countries (17). In many surgical environments, emphasis is placed on the more serious infections (deep infections and infections in organs/body cavities), as these give rise to more patient suffering and higher costs for the health care system. We believe it is important to include the superficial infections in the surveillance as well, because these involve an additional burden for the patients, increased use of antibiotics, and increased costs, e.g. for doctor visits.

A Cochrane overview from 1998 recommended use of prophylactic antibiotics for all caesarean sections, in order to reduce the occurrence of endometritis (24). *Guidance for childbirth assistance 2006* (25) recommends antibiotic prophylaxis in form of a single dose of ampicillin, and first generation cephalosporin for emergency operations or in special circumstances – such as prolonged duration of surgery or excessive bleeding. Clindamycin is an alternative in case of penicillin allergy. Furthermore, this guidance states: «In the literature, antibiotic prophylaxis is recommended for all types of caesarean sections». In the NOIS survey, 55 % of women received antibiotic prophylaxis and only 75 % of patients requiring acute caesarean sections received antiobiotic prophylaxis. In our opinion, every hospital should review their routines in relation to current recommendations.

Unanswered questions and further research

Surveillance can contribute to document the quality of surgical practice. In addition, it has been demonstrated that surveillance in itself can be a preventive measure against infections (6). However, the data must be used actively in each hospital in order to prevent infections. We recommend each hospital to compare their incidence rate to the country average. Hospital employees should review their results critically, and assess whether there are conditions that should be studied more closely, or if new preventive measures should be implemented. The fact that many hospitals perform few caesarean sections must be taken into consideration, since coincidental variations may have played a role, notice the wide confidence intervals. In order to improve the usefulness of the surveillance, continuous surveillance throughout the year, instead of periodic surveillance, is being considered for implementation by 2011.

Data have to be of good quality to be used well. We will work continuously together with hospitals to improve data quality. We also intend to evaluate the usefulness of the NNIS index in future NOIS periods and possibly develop alternative indices that can help clinicians to identify those caesarean sections that are most likely to have a high risk of infection complications.

Women who undergo caesarean sections should be informed about the risk of developing a postoperative infection after discharge, and about the symptoms of such infections.

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