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CLINICAL ARTICLE

The effect of antibiotic prophylaxis guidelines on surgical-site infections associated with cesarean delivery

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ABSTRACT

Objective: To evaluate the effect of Norwegian antibiotic prophylaxis guidelines on rates of superficial and deep surgical-site infections (SSIs) associated with cesarean delivery (CD). *Methods:* A cross-sectional study was conducted that analyzed the physician-diagnosed SSIs by regimen of antibiotic prophylaxis among women who underwent planned or emergency CD at one of 42 hospitals between January 1, 2008, and December 31, 2010. The antibiotic prophylaxis regimen was verified using a hospital survey, whereas guideline compliance was assessed as part of the mandatory Norwegian Surveillance System for Healthcare-Associated Infections. *Results:* Data for 4498 patients were used. Hospitals that practiced antibiotic prophylaxis for all CDs (n = 4) provided antibiotics more often in both emergency and planned CDs than did those that used this approach for emergency CDs only (n = 33) or had no written guidelines or used prophylaxis on indication only (n = 5) ($P < 0.001$). The provision of antibiotic prophylaxis for all cases of CD was associated with markedly lowered rates of superficial SSIs among planned CDs, whereas no differences in rates of deep SSIs were observed between the guidelines in either planned or emergency CDs. *Conclusion:* Hospitals that provided antibiotic prophylaxis to all women undergoing CD reported high compliance and had reduced rates of superficial SSIs among planned CDs.

1. Introduction

The provision of antibiotic prophylaxis to women undergoing cesarean delivery (CD) has substantially reduced the incidence of febrile morbidity, wound infection, postpartum endometritis, and complications owing to severe maternal infections following both planned and emergency surgery [1]. Since the first studies on this approach were reported in the 1970s, many hospitals have introduced antibiotic prophylaxis as standard care to prevent infectious morbidity after CD [2,3]. National clinical guidelines [1,4,5] have provided recommendations about the correct use of antibiotic prophylaxis in terms of indications, regimen, and timing among women who require CD.

In Norway, 17.0% of the 62 000–63 000 deliveries in 2008–2010 were by cesarean, among which 38.0% were planned procedures [6]. Clinical guidelines published in 1999 by the Norwegian Society of Obstetrics and Gynecology in collaboration with the Norwegian Medical Association covered antibiotic prophylaxis for emergency CD only [7]. However, these guidelines were revised in 2008 to include long duration of surgery and severe hemorrhage as indications for antibiotic prophylaxis among women undergoing planned CD [8]. Ampicillin or a first-generation cephalosporin are usually the drugs of choice for antibiotic prophylaxis, although the dose and timing were not stated in the guidelines [8].

Since 2005, all Norwegian hospitals have been required to report annually to the Norwegian Surveillance System for Healthcare-Associated Infections (NOIS) [9] on the rates of surgical-site infections (SSIs) arising from CD and four other non-gynecologic surgical procedures between September 1 and November 30. NOIS is a mandatory audit based on a European adaptation of guidelines that were originally developed by the US Centers for Disease Control and Prevention (CDC) [10,11]. The aims of NOIS are to monitor, describe, and evaluate the incidence of SSIs; to study the effects of interventions that aim to control infections; and to identify outbreaks so that SSIs can be prevented [12]. This surveillance system is one of 14 national health registries regulated by specific laws in Norway.

The aim of the present study was to evaluate the effect of using the Norwegian antibiotic prophylaxis guidelines on the rates of SSIs associated with CD.

2. Materials and methods

A cross-sectional study was conducted at 42 Norwegian hospitals that perform more than 10 CDs in the 3-month annual reporting period

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[13]. It was a quality assurance study done within the NOIS framework, and all patient information was de-identified [12]. According to Norwegian regulations, quality assurance studies are exempt from obtaining written informed consent from the participants [12].

As part of the present study, the 42 Norwegian hospitals were surveyed about their use of written guidelines on antibiotic prophylaxis during CD between November 30, 2009, and April 26, 2010. Non-responders were sent e-mail reminders and telephoned to obtain complete information on guidelines for antibiotic prophylaxis from all maternity departments. Departments were divided into groups on the basis of guideline availability: those in group A had no written guidelines available and provided antibiotic prophylaxis only when indicated; in group B, the intervention was provided for women undergoing emergency CDs only; and in group C, the intervention was provided for all CDs.

NOIS data were used for women who underwent planned or emergency CD at the 42 hospitals between September 1 and November 30 in 2008, 2009, and 2010. In NOIS, data are collected both electronically and manually from medical records by infection control personnel and transferred to a standardized case-report form. Information collected included the level of care (university hospital, regional hospital, or local hospitals), patient characteristics (age and sex), dates of hospital admission and discharge, type of surgery (planned or emergency), duration of surgery, regimen of antibiotic prophylaxis provided, the American Society of Anesthesiologists (ASA) score, contamination class, and type of infection. All infections are diagnosed by a physician and comprise superficial, deep incision, and organ and/or space infections [10]. SSIs were classified as overall, superficial, and deep infections (including organ and/or space infections). Patients had to have been followed up for 30 days after surgery. Hospitals that did not deliver data for antibiotic prophylaxis were excluded. Additionally, patients were excluded if any information about them was missing.

The hospital-specific guideline information from the survey was merged with the NOIS data. This procedure created two levels of information within the dataset: (1) individual data on compliance with the administration of antibiotics to prevent SSIs after CD and (2) hospital data on guidelines for antibiotic prophylaxis.

Statistical analysis of the data was conducted by applying logistic regression and multilevel logistic regression with hospital and level of care (university hospital, regional hospital, or local hospital) as multilevel variables. Univariate analyses with χ^2 tests and logistic regression were performed using SPSS version 19 (IBM, Armonk, NY, USA). Multilevel analyses were performed using lme4 R version 2.15.0 (R Core Team/R Foundation for Statistical Computing, Vienna, Austria). $P < 0.05$ was considered statistically significant.

3. Results

A total of 6602 CDs were reported to NOIS across the three periods. One university hospital did not deliver data on antibiotic prophylaxis for the 1027 patients who underwent CD, whereas another university hospital did not deliver data for 143 patients in 2008. Of the remaining 5432 patients, 585 (10.8%) had incomplete follow-up after surgery. Thus, 4847 patients were potentially eligible for inclusion in the analyses. After exclusion of patients with missing information on age (n = 12; 0.2%), ASA classification (n = 108; 2.2%), wound contamination (n = 29; 0.6%), antibiotic prophylaxis (n = 198; 4.1%), and duration of surgery (n = 2; <0.1%), the final dataset comprised 4498 patients, equivalent to 92.8% of the 4847 patients originally deemed eligible for analysis.

Four local hospitals had no written guidelines on antibiotic prophylaxis, whereas one regional hospital practiced antibiotic prophylaxis on the basis of indication only (group A). Antibiotic prophylaxis was practiced in emergency CD only in 32 hospitals (group B), including all six included university hospitals, six regional hospitals, and 20 local centers. The remaining two regional hospitals and two local hospitals practiced antibiotic prophylaxis in all CDs (group C).

Patients in group A were younger than were those in group B, whereas patients in Group C were older ($P < 0.01$) (Table 1). More emergency surgical procedures were performed at group C hospitals than at group A and B hospitals ($P < 0.01$) (Table 1). Only non-significant between-group differences were detected for ASA score, contamination class and duration of surgery.

Group C hospitals provided antibiotics more often in both emergency and planned CDs than did group A and B hospitals ($P < 0.001$) (Table 1). No difference was detected in the provision of antibiotics between groups A and B in emergency CDs ($P = 0.13$); however, the four group A hospitals with no written guidelines provided antibiotics more often to patients who had undergone planned CDs (131 [63.3%] of 207 patients) than did group B hospitals (331 [23.1%] of 1435; $P < 0.001$).

A total of 264 (5.9%) women in the study population had SSIs (Table 2). The frequency of superficial infections was higher in group A than in the other two groups ($P = 0.02$). Only non-significant differences in frequencies of SSIs were observed across level of care, age, type of surgery, antibiotic prophylaxis provided, and ASA score (Table 2). Compared with contamination classes 1 and 2 combined, both superficial infections and deep infections were more frequent in contamination classes 3 and 4 ($P < 0.05$), and in surgery that lasted for more than 45 minutes compared to procedures of shorter duration ($P < 0.05$).

Differences in maternal morbidity, clinical indications, and circumstances within the operating theater can be predisposing factors for infectious morbidity. Consequently, the present analysis was stratified by emergency CD to investigate the association between antibiotic prophylaxis guidelines and occurrence of SSIs. A logistic regression analysis of planned CD showed that overall and superficial SSIs were more likely in groups A and B than in group C, whereas no difference was seen in the rate of deep SSIs (Table 3). By contrast, no between-group differences were detected in the rates of overall, superficial, and deep SSIs arising from emergency CD (Table 3).

Similar results were observed in multilevel analyses (Table 3). The explanatory variables (age, ASA score, contamination class, and duration of surgery) exerted minimal statistically insignificant confounding effects (data not shown). The effect of antibiotic prophylaxis guidelines on overall SSI was evenly distributed across categories of the other explanatory variables (no interaction; data not shown).

An evaluation of patients who received antibiotic prophylaxis versus those who did not revealed no differences in the rates of overall, superficial, and deep SSIs in either the planned or emergency CD groups (data not shown).

4. Discussion

The present study showed a statistically significant association between lowered risk for superficial SSIs, but not deep SSIs, after planned CD and with guidelines recommending the use of antibiotic prophylaxis for all CDs. However, no differences in likelihood of SSIs between groups were reported for emergency CDs, which could be attributable to the high use of antibiotic prophylaxis for these procedures in all three groups.

Lack of antibiotic prophylaxis might partly explain the higher odds of infection in groups A and B. Nevertheless, there was no significant difference in likelihood of SSIs after a planned CD between groups A and B, despite the fact that use of antibiotic prophylaxis after planned CD in group A was more than twice that of group B. This conflicting finding suggests that there might be additional causes for superficial SSI other than lack of antibiotic prophylaxis in planned CDs.

Compliance with guidelines for both planned and emergency CDs was higher among the group C hospitals than in those in group B. Therefore, compliance with guidelines seems to be high when they cover all patients. This finding suggests that it might be easier to convey a

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