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## Major article

## A multifaceted prevention program to reduce infection after cesarean section: Interventions assessed using an intensive postdischarge surveillance system



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### Key Words:

Surgical site infection  
C-section  
Hair removal  
Antibiotic prophylaxis  
Surgical safety checklist  
Segmented regression analysis

**Background:** We assessed the effects of the components of a multifaceted and evidence-based caesarean-section surgical site infection (SSI) prevention program on the SSI rate after cesarean section using a postdischarge surveillance (PDS) system.

**Methods:** Multiple prevention interventions were serially implemented. SSI case finding was undertaken through active inpatient surveillance and intensive PDS using a standardized form at the 6-week post-discharge visit. SSI diagnosis was made using the Centers for Disease Control and Prevention standardized criteria. All cesarean deliveries between July 2007 and December 2012 were included. Changes in SSI rate were analyzed using segmented regression analysis.

**Results:** Nine thousand four hundred forty-two cesarean sections were assessed during the study period. PDS forms were completed for 7,985 women (85%). SSI was detected in 451 cases (5.6%); 91% were superficial, 9% were deep/organ-space infections. The SSI rate decreased incrementally from 8.2% at baseline to 4.1%; significant decreases were observed after optimizing antibiotic prophylaxis timing, using a surgical safety checklist, and enhancing prenatal education to discourage prehospital self-removal of hair. Nonelective surgeries or those undertaken after >12 hours of rupture of membranes had a significantly higher rate compared with those without either risk factor (6.3% vs 3.2%;  $P < .001$ ).

**Conclusions:** A multifaceted SSI prevention strategy, with periodic feedback of data, led to a significant reduction in SSI rates after cesarean section.

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Surgical site infections (SSIs) are the third most common cause of nosocomial infections in Canada,<sup>1</sup> the United States,<sup>2</sup> and the United Kingdom.<sup>3</sup> Postoperative caesarean section (CS) SSIs are associated with substantial morbidity, cost, extended length of stay, and can negatively affect quality of life of new moms and babies.<sup>2,4,5</sup> Whereas most infections are minor and can be resolved with incision and drainage and/or antimicrobial therapy alone, rare severe complications include sepsis, necrotizing fasciitis, and death can occur.<sup>5</sup> Many of these infections are preventable.<sup>2,4</sup> CS delivery rates in industrialized countries have continued to rise,<sup>6,7</sup>

substantiating the need for effective prevention strategies for patients undergoing CS.

Evidence-based strategies and bundles to reduce the incidence of SSIs have been recommended by a number of groups.<sup>2,4,8</sup> These include appropriate skin antisepsis for surgical preparation, optimal timing of antibiotic prophylaxis, and appropriate hair removal before surgery. When all of these interventions are implemented together, the bundled approach reduces the incidence of SSIs and postoperative complications. However, the incremental effectiveness of several interventions applied in a serial fashion is still unknown.

Published SSI rates following CS, based on studies that used some form of postdischarge surveillance (PDS), vary widely (2%-24%), likely due to differences in surveillance methodology, the patient populations, and concurrent SSI prevention strategies.<sup>9-21</sup>

This study was undertaken to determine the incidence of post-CS SSIs using a PDS system, and to assess the effects of components

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**Table 1**  
Details on cesarean section (CS) surgical site infection prevention interventions, North York General Hospital (NYGH), Toronto, Ontario, Canada

Period	Intervention	Details
Phase 1 Baseline (July 2007- December 2008)	Optimization of hair removal practices in hospital	All razors removed from labor and delivery unit and all operating room areas. Purchasing department ceased purchasing razors for the hospital
Phase 2 (January 2009-September 2009)	Prenatal education on prehospital self-hair removal (first update)	A paragraph was included in the NYGH "Pregnancy and Birth Journal" instructing expectant mothers not to remove the hair from their lower abdomen/pubis area during the final month of pregnancy. All expectant mothers are offered the 140-page prenatal resource at their first prenatal visit
Phase 3 (October 2009-April 2010)	Optimized timing of antibiotic prophylaxis	Changed the timing of administration of antibiotic prophylaxis for CS from after cord clamp to preincision
Phase 4 (May 2010-October 2010)	Surgical Safety Checklist <sup>22</sup>	Implemented for all obstetric deliveries
	Prenatal education on prehospital self-hair removal (second update)	Enhanced the prenatal "Pregnancy and Birth Journal" messaging by incorporating 2 pages of no hair removal education. The messaging instructed patients not to remove "the hair down there," and encouraged lower risk methods (eg, depilatory creams) when hair removal was necessary
Phase 5 (November 2010- December 2012)	Health care provider prenatal education	Health care providers reinforced to obstetrics patients the importance of not self-removing hair before delivery
	Chlorhexidine/alcohol surgical skin preparation	Implemented the use of 2% chlorhexidine gluconate/70% alcohol surgical skin preparation (instead of povidone-iodine) for patients undergoing CS
	No Hair Removal patient education posters	Displayed posters in health care providers' offices, waiting areas, and throughout the labor and delivery floor (eg, assessment/waiting areas and restrooms). The posters instructed obstetrics patients not to self-remove pubic hair and encouraged lower risk methods (eg, depilatory creams) when hair removal was necessary

of a serially introduced, multifaceted/bundled SSI reduction strategy on the SSI rate in a large community hospital.

## METHODS

This study was conducted at North York General Hospital, a 430-bed community teaching hospital in Toronto, Ontario, Canada, that undertakes ~ 6,000 births (~ 1,700 by CS) annually. Results from the post-CS surveillance system were periodically fed back to all health care providers who practice obstetrics.

### Time courses of SSI prevention interventions

A series of SSI prevention interventions were implemented over the 5 phases of the study (Table 1). Each phase of interventions was added to the interventions already in place from earlier phases.

#### Phase 1 – baseline (from July 2007): Inpatient and postdischarge SSI surveillance

All women who underwent CS since July 2007 were included in the prospective post-CS SSI surveillance. SSI case finding was performed via active inpatient surveillance and PDS. Active inpatient surveillance identified any post-CS infections during the patient's index visit, return visits to the emergency department, or readmissions to the hospital. Unit staff reported any suspected post-CS SSIs (eg, swelling, redness, or heat; pain/tenderness; purulent drainage/pus from incision site; fever (>38°C); spontaneous opening of CS incision; or abscess) to the study infection control professional (ICP). The ICP performed further case investigations on all suspect SSI patients, using information from chart reviews, microbiology cultures, and consultations with the infection control epidemiologist and/or the infectious disease physician as required.

In addition to active case-finding efforts in the hospital and the emergency department, completion of a standardized SSI surveillance form was required of the most responsible health care provider on all patients at a standard 6-week follow-up visit. Standardized Centers for Disease Control and Prevention SSI definitions were used, but grouped into 2 categories: superficial or deep/organ-space SSI.<sup>2</sup> The ICP used a standardized case form to collect information on demographic and operation-specific characteristics, and on SSI occurrence.

Razors were removed and made unavailable in the labor and delivery unit and operating rooms in March 2006, before initiating PDS.

#### Phase 2: Education added to prenatal manual on prehospital self-hair removal (first update)

In January 2009, the prenatal manuals (given to all obstetrics patients) were updated to include statements discouraging hair removal by patients before hospital presentation.

#### Phase 3: Timing of antibiotic prophylaxis

In October 2009, the timing of antibiotic prophylaxis administration was changed from after cord clamp to preincision.

#### Phase 4: Surgical Safety Checklist and enhanced prenatal patient education on self-removing pubic hair

In May 2010, the 19-item Surgical Safety Checklist,<sup>22</sup> an intervention shown to reduce the incidence of mortality and surgical complications, was implemented for all obstetrics deliveries. Concurrently, health care providers (19 obstetricians, 23 family physicians, and 11 midwives) enhanced their prenatal education

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