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Major article

Reduction of surgical site infections in low transverse cesarean section at a university hospital

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Background: We implemented evidence-based interventions to reduce risk of surgical site infection (SSI) following low transverse cesarean section (LTCS).

Methods: An observational study was conducted to determine LTCS SSI rates and the impact of infection control interventions at an academic teaching hospital during the period October 2005 to December 2008, including the use of 2% chlorhexidine gluconate (CHG) for surgical skin preparation before LTCS and no-rinse CHG cloths for preoperative skin cleansing. We compared overall and risk strata specific SSI rates and standardized incidence ratios during 4 study periods and estimated cost savings.

Results: Of 1,844 LTCSs performed, 99 patients were identified with SSI. SSI rates per 100 LTCS declined from 6.27 at baseline and 10.84 during the outbreak period to 5.92 in intervention 1 period and 2.29 in intervention 2 period. Overall, a 63.5% reduction in SSI rate from baseline was achieved by ensuring compliance with SSI prevention guidelines and improving skin antisepsis ($P = .003$). In intervention 2 period, the standardized incidence ratio was 0.99 compared with 2.64 at baseline and 4.50 during the outbreak period.

Conclusion: A multidisciplinary approach including evidence-based SSI prevention practices, effective infection prevention products, and staff and patient engagement substantially reduced infection risk and improved patient safety following LTCS.

From 1996 to 2007, the rate of cesarean delivery in the United States increased 53% to 32 per 100 live births, and cesarean delivery rates increased across racial and ethnic, geographic, maternal age, and infant gestational age strata.[1] Apart from increased medical costs for cesarean delivery compared with vaginal delivery, surgical site infection (SSI) remains a substantial cause of postoperative morbidity and increased health care cost because of maternal readmission.[1-5] In addition, the psychologic costs of potential separation of the mother and newborn are considerable.[5] According to recent data from Centers for Disease Control and Prevention (CDC) National Health Safety Network (NHSN), during the period 2006 to 2008, the pooled mean incidence of SSI per 100 cesarean section (C-section) procedures ranged from 1.46 for National Nosocomial Infection Study (NNIS) risk index 0 to 3.82 for risk index 2 and 3 combined.[6]

The sources of post-C-section SSIs included ascension of vaginal bacteria into the uterine cavity and inoculation of bacteria in the surgical incision.[7] The most common pathogens causing post-obstetric/gynecologic surgery SSIs are *Staphylococcus aureus* (28.3%), coagulase-negative staphylococci (12.4%), *Enterococcus* species (10.1%), and *Escherichia coli* (9.6%).[8]

The Institute for Healthcare Improvement 100,000 Lives campaign promotes implementation of bundles in US hospitals with the aim of preventing HAIs and avoidable deaths. Recent studies have demonstrated that many SSIs can be prevented through implementing a group of evidence-based interventions founded on best practice guidelines.[9,10] Implemented together, the

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bundled interventions reduce the incidence of SSI and postoperative complications. Added to the basic presurgery prevention strategies, these preventive steps include the following: appropriate selection and timing of prophylactic antibiotics, eliminating use of razor shaving, postoperative glycemic control, optimizing tissue oxygen delivery, and maintaining perioperative normothermia.[9-12] In addition, traditional surveillance for SSIs has proven to be a powerful tool in reducing SSI incidence.[10,13]

During the second and third quarters of 2006, we noted an apparent increase in the incidence of SSI following low transverse C-section (LTCS) surgeries. This study was undertaken to evaluate the effectiveness of evidence-based prevention and control strategies to reduce rates of SSI following LTCS.

METHODS

Study method

We conducted an observational study to determine rates of SSI associated with LTCS and the impact of interventions at a 520-bed, academic teaching hospital performing an average of 550 LTCS surgical procedures annually. To identify rates of SSI associated with LTCS procedures, we obtained a list of the LTCS patients each month. Thirty days after each procedure, we reviewed all inpatient and outpatient electronic medical records and microbiologic reports for each LTCS patient to identify cases of SSI developing during hospitalization, postdischarge, or among patients requiring readmission. The rate of SSI per 100 LTCS procedures was determined for each NHSN SSI risk stratum.

The time line for this study was divided into 4 periods: baseline period (October 2005-March 2006), outbreak period (April-October 2006), intervention 1 period (November 2006-September 2007), and intervention 2 period (October 2007-December 2008). The interventions made in each period are summarized in Table 1.

Baseline period: After noting an increase in the incidence of post-LTCS SSI in April-October 2006, LTCS cases were reviewed retrospectively for the period of October 2005 to March 2006 to determine the baseline SSI rate. SSI rates were generated for comparison with the outbreak period.

Outbreak period: The obstetrics and gynecology (OBGYN) clinicians noticed an increased number of post-LTCS patients returning to the clinic with SSI in June 2006. After recognizing this issue, we alerted the OBGYN surgical services immediately and focused on identifying critical control points and analyzing hazards by directly observing LTCS procedures; labor and delivery (L&D) operating room (OR) walks; and a self-administered employee survey to assess potential deficiencies in SSI prevention knowledge, attitudes, and practices. Based on these results, recommendations to reduce the risk of SSI were made including limiting personnel traffic during surgery, improving surgical hand scrub, modifying surgical skin preparation, changing the timing of antimicrobial prophylaxis, revising L&D OR policies, performing SSI prevention in-services, and completing employee competency training.

Intervention 1 period: We focused on changing practice and fully implementing all recommendations from the outbreak period and ensuring compliance with CDC SSI prevention guidelines.

Intervention 2 period: Two changes to skin antisepsis were made during this period: Chloroprep, a combination of 2% chlorhexidine gluconate (CHG) and 70% isopropyl alcohol (IPA), replaced povidone-iodine for surgical skin preparation, and we implemented a preoperative CHG skin cleansing program. Patients undergoing scheduled LTCS were instructed to use 2% CHG no-rinse cloths the night before the procedure, applying 6 cloths in a standardized fashion from the chin to the ankles. If the LTCS procedure was unscheduled, nurses cleansed patients with 2% CHG cloths as part of presurgery preparation. Nurses in the OBGYN clinics educated patients about SSI prevention including not to remove body hair at home prior to surgery. Nurses provided patients with SSI prevention patient education reading material created by the Hospital Epidemiology Department including *Presurgery Instructions of Preparing the Skin before Surgery*. We measured compliance with Chloroprep and 2% CHG cloths by auditing electronic OR notes and electronic preoperative patient checklists including both elective and nonelective LTCS cases.

In addition to changes in skin hygiene and surgical skin preparation, in June 2008 we moved into a new hospital facility, and, in September 2008, the timing of antibiotic prophylaxis for LTCS procedures was modified from administration of cefazolin 2 g immediately after the cord was clamped to within 30 minutes before the skin incision (Table 1).[14]

We provided the OBGYN leadership and staff with quarterly written and verbal updates, including SSI rates and compliance with performance measures compared with the baseline period. This study was approved by the UCLA Human Subjects Protection Committee.

Definition

Cases of LTCS SSI were defined using the standard CDC NHSN definitions. Cesarean section SSIs were classified as superficial, deep incision, or organ spaces infections (endometritis), and rates of LTCS SSI were calculated for NNIS risk indices 0, 1, and 2 and 3 combined.[15]

When we performed chart review, we excluded patients with endometritis related to premature membrane rupture and possible endometritis (eg, lower abdominal pain, and fever) present before C-section to eliminate patients with endometritis caused by retrograde infections.

Statistical analysis

Comparisons for SSI rates in each time line period were performed using STATA 11 (Stata Corp, College Station, TX) and included Fisher exact test and χ^2 test. The rates of SSI for each time period were calculated as the ratio of SSI cases to total number of cases with LTCS procedure, and 2-sided P values and 95% confidence intervals (CI) were calculated. We calculated the NNIS risk index for LTCS procedures and assigned 1 point each to patients with the length of surgery $\geq$ 1 hour, for wound class III or IV, and for American Society of Anesthesiologist score $\geq$ 3.[11] Expected cases for each risk index group were calculated from LTCS cases and NHSN C-section SSI rates in the NHSN 2006 to 2008 data summary.[6]

Standardized infection ratios (SIRs) were calculated as the ratio of observed SSI cases to expected cases. SIR is a measure used to compare the observed number of SSIs (O) in a facility with the expected number of SSIs (E) in the NHSN baseline for US hospitals (ie, SIR = O/E).[10,16] The proportion of cases in NNIS risk 2 and 3 categories relative to total LTCS cases for each time period was also calculated.

Estimated SSI cases averted

SSI cases averted were calculated based on the difference of pre- and postintervention SSI rates (Δ SSI rate) and approximate yearly number of procedures performed at the facility.

$$\text{Estimated SSI cases averted} = \Delta \text{ SSI rate} \times \text{number of procedures per year}$$