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Major article

Incidence and factors associated with surgical site infections in a teaching hospital in Ujjain, India

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*Staphylococcus aureus**Pseudomonas aeruginosa*

Rural

Background: Surgical site infections (SSI) are among the most commonly reported health care-associated infections; however, there is a paucity of data on SSI from India. This study aimed to determine the incidence of SSI and explore its associated factors at a teaching hospital in India.

Methods: Direct and indirect surveillance methods, based on Centers for Disease Control and Prevention guidelines, were used to define SSI. Patients were followed up for 30 days postsurgery. Prescribing and resistance data were collected.

Results: The SSI rate among the 720 patients investigated was 5%. Risk factors for SSI identified were as follows: severity of disease ($P = .001$), presence of drains ($P = .020$), history of previous hospitalization ($P = .003$), preoperative stay ($P = .005$), wound classification ($P < .001$), and surgical duration ($P < .001$). Independent risk factors identified included wound classification (odds ratio = 4.525; $P < .001$) and surgical duration (odds ratio = 2.554; $P = .015$). Most patients (99%) were prescribed antibiotics. Metronidazole (24.5%), ciprofloxacin (11%), and amikacin (9%) were the most commonly prescribed antibiotics. Most commonly isolated bacteria were *Staphylococcus aureus* ($n = 14$), of which 34% were methicillin-resistant *Staphylococcus aureus*, and *Pseudomonas aeruginosa* ($n = 6$), which showed resistance to ceftazidime (70%), ciprofloxacin (63%), and gentamicin (57%).

Conclusion: Incidence of SSI at the hospital was lower than reported in many low- and middle-income countries, although higher than reported in most high-income countries. Targeted implementation strategies to decrease incidence of preventable SSI are needed to further improve quality and safety of health care in this hospital and similar hospitals elsewhere.

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Despite major advances in infection control interventions, health care-associated infections (HAI) remain a major public health problem and patient safety threat worldwide.^{1,2} The global estimated prevalence of HAI, at any given time, approximates 1.4 million.³

Surgical site infections (SSI) are among the most commonly reported HAI.⁴ Incidence varies widely across countries and surgical procedures; however, it is estimated to occur in at least 2% of surgeries.⁵ In low- and middle-income countries (LMIC), SSI incidence may be approximately up to 4 times higher than in high-income countries.¹ SSI involve a complex relationship among several factors: microbial, patient, surgical, and environmental.⁶

They are also dependent on the health care facility, procedures performed, and care level.¹ For individual patients, SSI are associated with longer hospitalization; pain; discomfort; delayed wound healing; prolonged or permanent disability; and, in worst cases, death.² Additionally, SSI place significant economic burden on health system and patient finances and resources because of lengthier hospitalizations and increased cost of treatment.⁵

In India, the risk of acquiring SSI is high (range, 4%–30%).⁷ Nonetheless, prevention and control of HAI is not prioritized and antibiotic (AB) resistance is an ever-growing problem.⁸ Moreover, surveillance data are still scanty.^{1,9} By forming evidence-based strategies to diminish rates of preventable SSI and their adverse effects, one can increase patient safety, circumvent additional health care costs, and ameliorate health care quality.⁵ This study sought to determine the incidence of SSI and explore its associated factors at Chandrikaben Rashmikant Gardi Hospital (CRGH), Ujjain, India.

METHODS

Study setting

The study was conducted in 90-bed general surgery wards of CRGH, a 570-bed teaching hospital associated with Ruxmaniben Deepchand Gardi Medical College (RDGMC). The obstetrics and gynecology; ear, nose, and throat; and orthopedic wards were not included.

Study participants

All patients admitted between October 2010 and August 2011 were included prospectively in the survey. All nonsurgical cases and patients not undergoing surgery at CRGH were not included. Ethical permission was obtained from the Ethics Committee of RDGMC (approval number 114/2010).

Study design

The US Centers for Disease Control and Prevention (CDC) surveillance methods for SSI was used.¹⁰ A trained study assistant conducted indirect surveillance by acquiring patient information using a form containing SSI risk factors. The study assistant also inspected all surgical sites at time of dressing change 24 to 48 hours postsurgery (direct surveillance), took swabs of suspected SSI and sent them for analysis, and completed postdischarge surveillance. For postdischarge surveillance, patients were asked to return for follow-up 30 days postdischarge at the hospital's surgical outpatient clinic. If this did not occur, patients were contacted by mobile phone, and, if an SSI was suspected, they were asked to return to CRGH to confirm the diagnosis. CDC's National Health Safety Network criteria were used for diagnosing SSI.¹⁰ Details of patients' AB prescriptions were collected and presented in the form of drug utilization 90% (DU90%).¹¹

Swab sampling and laboratory methods

Swab samples were plated on blood agar and MacConkey agar medium. Standard conventional microbiological methods were used to identify pathogenic bacteria.¹² The Kirby-Bauer disc-diffusion method on Mueller-Hinton agar plates was used for AB susceptibility testing. Disc strengths were as recommended by the Clinical and Laboratory Standards Institute (CLSI). CLSI interpretative criteria for susceptibility and resistance testing were used.¹³ Intermediate susceptible isolates of gram-negative bacteria were considered resistant in calculations. For *Staphylococcus aureus* isolates, screening for methicillin resistance was done using cefoxitin

disc screen test and 6 g/mL oxacillin in Mueller-Hinton agar supplemented with NaCl (4% wt/vol; 0.68 mol/L) according to CLSI guidelines.¹³

Statistical analyses

Data were entered in EpiData Software (version 3.1, EpiData Software Association, Odense, Denmark); SPSS Statistics (version 20.0; SPSS Inc, Chicago, IL), and Stata (version 10.0; Stata Corp, College Station, TX) were used for analyses. Frequencies and percentages were determined for binary and categorical variables. Range, mean, standard error (SE), and standard deviation were calculated for continuous variables. Cumulative incidence rate of SSI was also calculated.

The relationship between risk factors and SSI was explored using Pearson χ^2 test. In bivariate analyses, a *P* value of $< .1$ was considered significant for entry into a backward multivariate logistic regression model, with SSI as outcome variable. Adjusted odds ratios and their respective 95% confidence intervals (CI) were calculated. A *P* value of $< .05$ was considered significant in the final model. No associations were made from variables with cell counts less than 5, which were excluded from the final logistic regression model.

RESULTS

Demographics

Of 1,765 admitted patients, 41% underwent surgery. Three patients did not undergo surgery at CRGH. The final cohort therefore included 720 patients: 76% male and 24% female. Ages ranged from 4 months to 90 years (mean $\pm$ standard deviation: 40.10 ± 21.23). Fifteen patients died during the study duration (15/720; 2%), out of which 3 patients had contracted SSI.

Incidence of SSI

SSI occurred in 5% (95% CI: 3–7) of patients; all 5% ($n = 36$) were confirmed by visual impression, and 3% ($n = 22$) further confirmed by CDC definition through a positive culture from infection site. CDC-confirmed SSI were further classified into superficial incisional primary (1.5%; $n = 11$), superficial incisional secondary (0.8%; $n = 6$), deep incisional primary (0.4%; $n = 3$), or deep incisional secondary (0.1%; $n = 1$).

Risk factors associated with SSI

Few patients suffered from chronic diseases, including cardiac, renal, or hepatic disease; diabetes; or tuberculosis. Almost half were smokers ($n = 298$), of whom 98% were male and 2% female. Few patients (1.7%) were immunosuppressed at time of surgery. Severity of disease, measured using American Society of Anesthesiologists (ASA) score, ranged from healthy (class I) to severe systemic disease, which is a constant threat to life (class IV). The proportion of patients in each class from class I to class IV was 71%, 22%, 6%, and 0.4%, respectively. Full description of patient risk factors associated with SSI is displayed in Table 1.

The mean duration of preoperative stay was 4 days ($SE \pm 0.21$), whereas the mean duration of postoperative stay was 8 days ($SE \pm 0.29$). For SSI patients, the mean preoperative stay was 6.6 days ($SE \pm 1.44$) and 19 days postoperatively ($SE \pm 2.5$). Some patients (6%) had a history of previous hospitalization (hospitalization/s maximum 2 weeks prior admission). Infection prior to surgery was detected in 17% of patients. The majority showered and had hair removed preoperatively, mostly by shaving. Most patients

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