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Major article

A 4-year prospective study to determine the incidence and microbial etiology of surgical site infections at a private tertiary care hospital in Mumbai, India

Sweta Shah MD, Tanu Singhal MD, MSc *, Reshma Naik GNM, MBA

Department of Infection Prevention and Control, Kokilaben Dhirubhai Ambani Hospital and Medical Research Institute, Mumbai, India

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Background: There is limited single-center data on the incidence and microbial etiology of surgical site infections (SSIs) from developing countries.

Methods: This is a prospective observational study over 4-year period (April 2009-March 2013) at a 750-bed private multispecialty hospital in Mumbai, India, among patients undergoing clean and clean-contaminated surgeries. Standard guidelines for preventing, classifying, and diagnosing SSI were followed.

Results: A total of 24,355 patients underwent clean and clean-contaminated surgeries during the study period. The overall SSI rate was 1.6% (389 cases). The SSI rate in clean surgeries was 1.57%, and the SSI rate in clean-contaminated surgeries was 1.64%. Of the SSIs, 66% were caused by gram-negative bacilli (GNB) (*Escherichia coli* [22.9%], *Klebsiella* [18.2%], *Pseudomonas* [12.7%], and *Acinetobacter* [6.0%] were the top 4), 31.7% were caused by gram-positive bacilli (*Staphylococcus*: 70.5%, *Enterococcus*: 23.8%, *Streptococcus*: 1.8%), and 2.1% were caused by *Candida*. A total of 64% of the *E coli* and *Klebsiella* isolates were extended spectrum β-lactamase producing, 6% of the GNB were carbapenem resistant, and only 17.3% of *S aureus* isolates were methicillin resistant.

Conclusion: Although the SSI rate is comparable with established international benchmarks, increasing prevalence of antimicrobial resistance in GNB is a matter of serious concern.

Surgical site infections (SSIs) are one of the most common health care–associated infections and cause significant morbidity, increase in hospital stay, and increase in treatment costs.[1] There are only a handful of studies that have looked at the burden of SSI in India. These studies report the rate of SSI for all surgical procedures to vary between 9% and 23% and report that methicillin-sensitive *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Escherichia coli* are the most common cause of SSI. However, many of these studies are limited by small sample sizes, follow-up of patients only in the predischarge period, and a retrospective nature.[2] A recent report from the International Nosocomial Infection Control Consortium on SSI rates from several hospitals in developing countries is limited by the absence of country-specific data, amalgamation of private and public hospital data, and absence of data on microbial etiology and antimicrobial resistance.[3] This study aims to generate accurate current data on rates, microbial etiology, and antimicrobial susceptibility pattern of SSIs in the private health care sector in India.

METHODS

The study was conducted in a private multispecialty state of the art 750-bed tertiary care hospital in Mumbai, India, commissioned in January 2009. The hospital has 20 operation theatres with high-efficiency particulate air filters, a fully equipped central sterile services department, and rigorous environmental cleaning and disinfectant practices. There has been a gradual increase in the number of surgeries performed since the hospital was commissioned, and at present the number ranges from 40-50 per day. There is a well-defined infection control policy for preventing SSI as per the Centers for Disease Control and Prevention recommendations.[1] The salient features of the policy include 4% chlorhexidine bath at least twice before surgery, hair removal by clipping immediately before surgery, surgical hand

* Address correspondence to Tanu Singhal, MD, MSc, Consultant Infectious Diseases, Kokilaben Dhirubhai Ambani Hospital and Medical Research Institute, Achutrao Patwardhan Marg, Four Bungalows, Andheri West, Mumbai 400056, India.
E-mail address: tanu.singhal@relianceada.com (T. Singhal).

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Table 1
Distribution of surgeries and surgical site infection by specialty from April 2009-March 2013

Specialty	No. of surgeries completed	SSIs, n (%)
General surgery (adult)	1,407	31 (2.20)
Laparoscopic general surgery (adult)	631	2 (0.32)
Vascular surgery	543	10 (1.84)
General surgery (pediatric)	282	2 (0.71)
Laparoscopic general surgery (pediatric)	30	0 (0.00)
Obstetrics and gynecology	2,173	34 (1.56)
Laparoscopic (obstetrics and gynecology) Surgery	483	11 (2.28)
Neurosurgery	1,576	34 (2.16)
Oncology surgery	3,790	123 (3.25)
Urologic surgery	1,758	3 (0.17)
Orthopedic surgery	4,396	38 (0.86)
Joint replacement surgery	1,256	19 (1.51)
Cardiac (adult) surgery	1,342	25 (1.86)
Cardiac (pediatric) surgery	1,590	57 (3.58)
Ophthalmology surgery	1,554	0 (0.00)
Other surgeries	1,544	0 (0.00)
Total	24,355	389 (1.60)

hygiene with 4% weight/volume chlorhexidine soap, skin preparation with 2% weight/volume chlorhexidine 3 times, and strict postoperative blood glucose control. The antibiotic used for surgical prophylaxis was cefuroxime-cefazolin either alone or in combination with metronidazole (for head and neck, gynecologic, and colorectal surgeries) or ciprofloxacin and amikacin (for major surgeries). It was ensured that the antibiotic was given within 60 minutes of the surgical incision and repeated after 4 hours if surgery was prolonged or if there was excessive blood loss.

This is a prospective observational cohort study in which all patients undergoing clean and clean-contaminated surgical procedures from April 2009-March 2013 were included. Patients undergoing contaminated and dirty surgeries were excluded from the study. Recorded details included age, sex, surgical procedure, operating surgeon, presence of any risk factors, results of methicillin-resistant *S aureus* (MRSA) screen (done only for patients undergoing cardiac, joint, and spine surgeries), modality of hair removal, chlorhexidine bath, type of surgery (clean and clean-contaminated), antibiotic's used, dose of antibiotics, time of antibiotic administration in relation to incision, duration of surgery, administration of repeat dose if so indicated, and duration of antibiotic therapy. Compliance to the hospital antibiotic policy was present if the initial choice of antibiotic, timing of administration in relation to skin incision, and administration of repeat dose where indicated was as per hospital policy.

The patients were followed-up daily during hospital stay for SSI. The occurrence of any SSI in the postdischarge period and for 30 days following surgery was tracked by keeping record of all pus samples received by the microbiology laboratory, keeping records of readmissions for wound debridement or antibiotic therapy, and seeking details from individual surgeons. On the last day of each month, each surgeon would be sent a list of all surgeries performed by them in the previous month and were asked about occurrence of SSI in any of these patients. SSIs were defined and classified as superficial incisional, deep incisional, and organ space as per standard Centers for Disease Control and Prevention definitions.[1]

Wound infection was diagnosed if any one of the following criteria were fulfilled along with change in antibiotics by the surgeon: serous, nonpurulent discharge; pus discharge; signs of inflammation, fever, and debridement; resuturing; washing of the joint; and so forth. Stitch abscess was not included as an SSI.

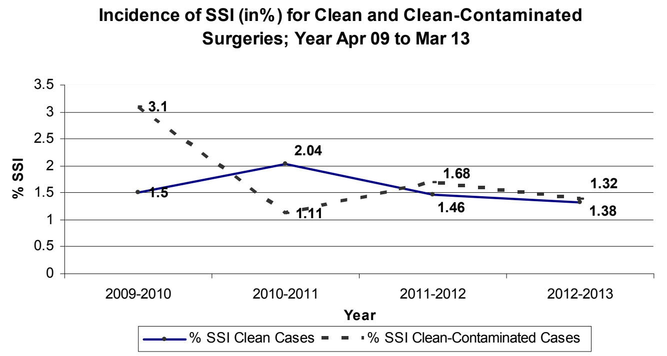

Fig 1. Incidence of SSI for clean and clean-contaminated surgeries. *Apr*, April; *Mar*, March; *SSI*, surgical site infection.

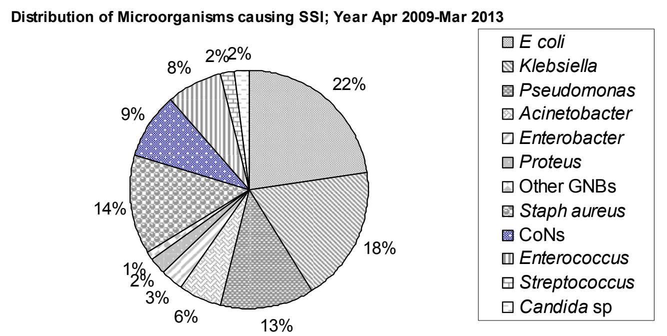

Fig 2. Microbial etiology of SSI (n = 385). *Apr*, April; *CoNS*, coagulase-negative staphylococci; *GNB*, gram-negative bacilli; *Mar*, March; *SSI*, surgical site infection; *Staph*, *Staphylococcus*.

All specimens were processed per standard microbiology techniques. Identification and susceptibility testing were done by VITEK 2 (bioMérieux, SA, France). Details of microbial etiology and susceptibility were recorded and analyzed. Percentage susceptibility to antimicrobials over the years was compared by a χ^2 or Fisher exact test.

Training and surveillance was an integral part of the SSI prevention bundle. Regular surveillance of the operating room complex environment and audit of the processes in the operating room complex were done. Sessions for training of the prevention bundle and periodic feedback on SSI incidence and compliance of the bundle and microbial etiology were conducted at least once in a year for all the surgeons and at least 3 times for nurses and housekeeping.

RESULTS

A total of 24,355 patients underwent clean and clean-contaminated surgeries during the study period. The compliance to hospital antibiotic policy, clipper use for hair removal, and chlorhexidine bath was approximately 90%. The compliance to hospital antibiotic policy increased from 55% in 2009-2010 to >90% in 2010-2013. Of patients undergoing MRSA screen before surgery, 2% were found to be colonized with MRSA. The distribution of the type of surgeries is provided in Table 1.

There were 389 patients who developed SSI. Of these, 199 were women and 190 were men. The median age of patients with SSI was 51 years (range, 2 days-88 years). Of the patients, 12 (3%) were neonates (<1 month), 49 were infants (12.5%), 16% were <12 years, 32% were aged between 12 and 50 years, 30% were aged between