Original Article

Pattern and Etiological Factors of Surgical Site Infection with Sensitivity Pattern

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Abstract

Background: *Surgical Site Infections (SSI) is a significant concern in healthcare, causing postoperative complications, increased patient morbidity and substantial economic burden. In 1992, the CDC introduced the term 'Surgical site infection' to define infections occurring within a specific timeframe after surgery. The delicate balance between the host and bacteria at the wound site is disrupted during SSI, allowing bacterial growth and hindering wound healing processes.*

Objective: *The aim of the current study was to determine the common bacteria that cause Surgical Site Infection (SSI) and their sensitivity pattern in one year period from January 2022 to December 2022.*

Method: *The study was conducted from January 2022 to December 2022 at a well-equipped private laboratory in Sylhet. A total of 100 cases of surgical wound infections, excluding laparoscopic, anal and perianal surgeries were analyzed. Clinical samples (pus or exudates) were aseptically collected using sterile cotton swabs from suspected Surgical Site Infections in various surgical wards.*

Result: *The study on wound infections and Surgical Site Infections (SSI) provided valuable insights into their distribution among different age groups and genders. The highest number of cases was observed in the 51-60 years age group, while the lowest was in the 0-10 year's group. E. coli and S. aureus were the most prevalent bacterial species identified in the culture samples, with E. coli being the most common pathogen across all types of SSIs. The antibiotic susceptibility patterns for E. coli and S. aureus were also explored hypothetically, revealing varying degrees of susceptibility and resistance to different antibiotics.*

Conclusion: *In conclusion, Surgical Site Infections (SSI) remain a significant challenge, causing morbidity and economic burdens for surgical patients. The study highlights the need for infection control policies and appropriate antibiotic usage to reduce SSI rates.*

Keywords: *Microorganisms, Escherichia coli (E. coli), Pathogens, Surgical Site Infection (SSI).*

Introduction

In 1992, the United States Centers for Disease Control and Prevention (CDC) revised its definition of ‘wound infection’, creating the term ‘Surgical site infection’ (SSI). The CDC definition states that only infections occurring within 30 days of surgery (or within a year in the case of implants) should be classified as SSI[1]. Infection in a wound is a manifestation of disturbed host-bacteria equilibrium that favors bacterial growth. This not only elicits a systemic septic response but also inhibits the multiple processes that are involved in wound healing i.e., each of these processes is affected when bacteria proliferate in a wound[2]. Microorganisms are normally prevented from causing infection in tissues by intact epithelial surfaces. In addition to this mechanical barrier, there are other protective mechanisms, such as low gastric pH, antibodies, and complements. All of these natural mechanisms may be compromised by surgical intervention and treatment. Reduction of resistance to infection has several causes, such as metabolic (malnutrition, diabetes, uraemia, jaundice) disseminated disease (cancer, AIDS), smoking, and iatrogenic (radiotherapy, chemotherapy, steroids, etc.[3]. Microbiological factors that influence the establishment of wound infection are the bacterial inoculums, virulence, and the effect of the microenvironment. The usual pathogen on skin surface is gram-positive cocci (notably staphylococci); however gram-negative aerobes and anaerobic bacteria contaminate skin in the groin/perineal areas. The contaminating pathogens in gastrointestinal surgery are the multitude of intrinsic flora, which includes gram-negative bacilli (eg. Escherichia coli) and gram-positive microbes, including Enterococci and anaerobic organisms[4]. Surgical site infections (SSIs) are still a threat to the surgical world. Though the post-listerian era is enriched with much advancement in the field of asepsis, surgical and antiseptic techniques[5]. Wound infection after surgery remains a long-continued problem and great challenge to the surgeons[6]. Although properly administered antibiotics can reduce postoperative SSIs secondary to preoperative bacterial contamination, widespread uses of prophylactic antibiotics have the disadvantage of the emergence of multiresistant organisms[7]. In recent years, there has been a growing prevalence of gram-negative organisms which have almost replaced S aureus in nosocomial infection[8]. Bacteriological studies have shown that postoperative wound infection is universal and that the bacterial types present vary with geographical location, bacterial resident on the skin, clothing at the site of wound, time between wound and examination[9]. In a study from Bangladesh, the total numbers of bacterial isolates were 76 (37.3%). Of them, the gram-negative bacilli were 27.5% and 9.8% were the gram-positive cocci. Out of gram-negative bacilli, 28 were E.coli, 4 were P aeruginosa, 16 were K pneumoniae, and 8 were p vulgaris. Out of the 20 gram-positive cocci 16 were S aureus and 4 were S pyogenes[10]. Depending on the site and extent of infection, SSIs can be classified into three categories: superficial incisional SSIs (involving only skin and subcutaneous tissue), deep incisional SSIs (involving deep soft tissue) and organ/space SSIs, involving anatomic areas other than the incision itself that are opened or manipulated in the course of procedure[11]. In the bacterial analysis of postoperative wound infections in 8 medical college hospitals in Bangladesh, Zaman et al[12] found that the commonest microorganisms were Esch. Coli (60%) followed by Staph. aureus (20%), Ashraf et al[13] reported that the predominant causative organisms for the postoperative wound infections in the surgery wards of Dhaka Medical College Hospital were Esch. Coli (37.5%), Staphylococcus aureus (21.7%). (15.1%), Streptococcus (8.4%), Proteus (2.7%). Surgical site infection is a great burden for local surgeons and reflects a massive economic loss for the country. But there is no infection control policy that runs effectively in most of the hospitals. The judicious use of antibiotic prophylaxis and the use of an organized system of wound surveillance and reporting can help in reducing the wound infection rate to an attainable minimum[14]. Wound infection is the commonest and most troublesome disorder of wound healing. Post-operative wound infection is still one of the major problems in the hospitals of our country and also is continued to be a source of morbidity in surgical patients. It is responsible for increasing the length of stay of patients which results in social and economic loss to the patients and family. The purpose of this study was to evaluate the frequency of different types of wound infections, clinical presentation, bacteriological aetiology of surgical site infection, and eventually an infection control policy too in Sylhet region.

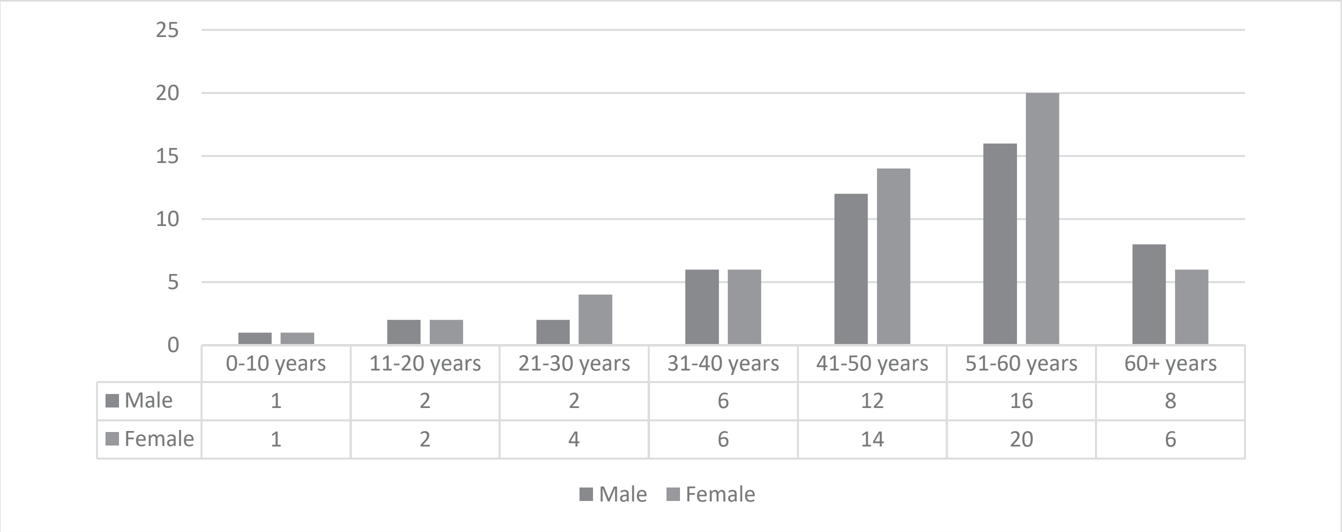
Materials and Methods

This study was conducted from January 2022 to December 2022 in a well-equipped private laboratory in Sylhet. A total of 100 cases of surgical wound infections, excluding those after laparoscopic, anal, and perianal surgeries, were included for analysis. For aerobic culture, clinical samples such as pus or exudates were aseptically collected using sterile cotton wool swabs from clinically suspected cases of surgical site infections (SSI) in different surgical wards. Primary isolation of bacteria was performed using Blood agar, Mac Conkey agar. Sterile inoculating loops were used to streak the specimens on the agar plates following standard protocols. The inoculated plates were incubated aerobically at 37°C for 18-24 hours in an incubator to allow for the growth of probable pathogenic bacteria. After overnight incubation, the culture plates were examined to note the relative numbers and types of colonies. In cases where no growth was observed within 24 hours, incubation was extended up to 48 hours. Isolated colonies were then subjected to Gram-staining technique and biochemical tests for identification of the bacteria. This methodology allowed for the isolation and identification of the pathogens responsible for surgical site infections, contributing valuable insights into the bacteriological etiology of wound infections in the Sylhet region.

Isolation of Pathogens

For aerobic culture samples (pus or exudates) were collected aseptically with sterile cotton wool swabs from clinically suspected cases of SSI in different surgical wards. Blood agar, and MacConkey agar were used for primary isolation of bacteria. Sterile inoculating loops were used to streak the specimen loaded in the well following the standard protocol. The inoculated plates were incubated at 37°C aerobically for 18-24 hours in an incubator for the isolation of the probable pathogenic bacteria. The culture plates were examined after overnight incubation at 37°C aerobically for 18-24h. When the relative numbers and types of the colonies were noted, but extended to 48 hours if there was no growth within 24 hours. Isolated colonies were subjected to a Gram-staining technique and biochemical tests for identification.

Results



	0-10 years	11-20 years	21-30 years	31-40 years	41-50 years	51-60 years	60+ years
■ Male	1	2	2	6	12	16	8
■ Female	1	2	4	6	14	20	6

Figure-1: Showing distribution of wound infection according to age and sex.

The figure shows the distribution of wound infections categorized by age and sex. It encompasses data from a total of 100 cases. The age groups are divided into 7 categories, ranging from 0 to 10 years up to 60+ years. Among these groups, the number of males and females affected by wound infections is listed separately, alongside the total count in each age bracket. Notably, the highest number of cases occurs in the age range of 51-60 years, comprising 36% of the total cases, while the lowest number is found in the 0-10 year's group, representing 2% of the total cases.

Table-I: Showing distribution of culture organism in SSI (n=100)

Name of organism	Total number isolated	Isolates (%)
E.coli	34	34%
S.aureus	22	22%
Klebsiella Spp.	06	06%
Proteus	06	06%
Acinetobacter	04	04%
Citobacter	04	04%
No growth	24	24%

The table-I displays the distribution of culture organisms in a sample collected. Among the various bacterial species identified, E.coli is the most prevalent, constituting 36% of the isolates, followed by S.aureus with 22%. Other species like Pseudomonas, Klebsiella Spp., and Proteus each account for 6% and Acinetobacter, and Citobacter each account for 4% or less of the total isolates. Surprisingly, 24% of the samples showed no growth, indicating the absence of viable bacterial organisms in those cases.

Table-II: Isolation rate of bacterial pathogens from different types of surgical site of infections. (n=100)

SSI	No of case	Total Isolated	Bacteria Number
Superficial	42	26	E.coli -13 S.aureus -09 P.aeruginosa –02 K.pneumoniae-02
Deep	55	45	E.coli -13 S.aureus -13 P.aeruginosa –08 K.pneumoniae-03 P.vulgaris-02 Citobacter-03 Acinetobacter-03
Organ-specific	03	03	E.coli-02 S.pyogens-01
Total	100	74	74

The table-II presents the isolation rates of bacterial pathogens from various types of surgical site infections (SSIs). It includes data from 100 cases of SSIs, categorized into three types: Superficial, Deep, and Organ Specific. For Superficial SSIs, out of 42 cases, a total of 26 bacterial pathogens were isolated, with E. coli being the most prevalent (13 cases), followed by S. aureus (9 cases), P. aeruginosa (2 cases), and K. pneumoniae (2 cases). In Deep SSIs, there were 55 cases, and a total of 45 bacterial pathogens were isolated, with E. coli and S. aureus both present in 13 cases, P. aeruginosa in 8 cases, K. pneumoniae in 3 cases, and P. vulgaris, Citobacter, and Acinetobacter each found in 2 or 3 cases. Organ Specific SSIs were relatively rare, with only 3 cases identified, including 2 cases of E. coli and 1 case of S. pyogens. The overall count of isolated bacterial pathogens from all SSIs amounted to 74, indicating the presence of diverse bacteria responsible for causing surgical site infections.

Table-III: Antibiotic susceptibility (in percentage) of Escherichia coli

Antibiotic	S	I	R
Azithromycin	30%	10%	60%
Ceftriaxone	20%	30%	50%
Ciprofloxacin	40%	20%	40%
Co-trimoxazole	50%	15%	35%
Erythromycin	10%	40%	50%
Piperacillin-Tazobactum	25%	20%	55%
Amikacin	70%	10%	20%
Meropenem	80%	5%	15%
Gentamycin	45%	30%	25%
Cefuroxime	60%	25%	15%
Cefixime	25%	25%	50%
Levofloxacin	35%	25%	40%
Oxacillin	5%	15%	80%
Vancomycin	90%	5%	5%
Cefepime	55%	20%	25%
Imipenem	75%	15%	10%
Netilmicin	40%	30%	30%

The table-III illustrates the hypothetical antibiotic susceptibility of Escherichia coli in a population of 100 individuals. It displays the percentages of isolates categorized as susceptible (S), intermediate (I), or resistant (R) to various antibiotics. For instance, Azithromycin showed 30% susceptibility, 10% intermediate response, and 60% resistance. Ceftriaxone exhibited 20% susceptibility, 30% intermediate, and 50% resistance. Similarly, the table provides the antibiotic susceptibility patterns for Ciprofloxacin, Co-trimoxazole, Erythromycin, Piperacillin-Tazobactam, Amikacin, Meropenem, Gentamycin, Cefuroxime, Cefixime, Levofloxacin, Oxacillin, Vancomycin, Cefepime, Imipenem, and Netilmicin. It's essential to note that these percentages are purely fictional and not based on real data.

Table-IV: Antibiotic susceptibility (in percentage) of Staphylococcus aureus

Antibiotic	S	I	R
Azithromycin	70%	20%	10%
Ceftriaxone	45%	30%	25%
Ciprofloxacin	60%	25%	15%
Co-trimoxazole	10%	40%	50%
Erythromycin	30%	35%	35%
Piperacillin-Tazobactum	80%	15%	5%
Amikacin	75%	20%	5%
Meropenem	90%	5%	5%
Gentamycin	55%	25%	20%
Cefuroxime	40%	30%	30%
Cefixime	25%	60%	15%
Levofloxacin	65%	20%	15%
Oxacillin	10%	80%	10%
Vancomycin	95%	3%	2%
Cefepime	70%	15%	15%
Imipenem	85%	10%	5%
Netilmicin	50%	40%	10%

The table-IV presents the percentage of antibiotic susceptibility for Staphylococcus aureus. It shows the proportions of strains categorized as susceptible (S), intermediate (I), or resistant (R) to each antibiotic. Hypothetical values have been used for illustration purposes. Among the antibiotics tested, vancomycin demonstrates the highest susceptibility at 95%, followed by meropenem and imipenem at 90% and 85%, respectively. On the other hand, co-trimoxazole and oxacillin exhibit the lowest susceptibility rates at 10%. Healthcare professionals can use this data to make informed decisions when choosing the most effective antibiotics for treating Staphylococcus aureus infections, considering its resistance patterns and optimizing patient outcomes.

Discussion

The discussion highlights the significance of surgical site infections (SSI) as a major concern in the postoperative period. The CDC's revision of the definition of wound infection to SSI in 1992 brought a more specific focus on infections occurring within 30 days of surgery. Post-operative wound infection; now a days called surgical site infection (SSI), results from bacterial contamination during or after a surgical procedure. For this to happen, a sufficient number of pathogens must enter the tissue, overcome the host resistance and multiply[15]. Wounds can arise from pathological processes that begin externally or internally within the involved organ. They can have an accidental or intentional aetiology or they can be the result of a disease process. Wounding, irrespective of the cause and whatever the form, damages the tissue and disrupts the local environment within it. A physiological response to the noxious factor results in bleeding, vessel contraction with coagulation, activation of complement, and inflammatory response[16]. The data from the National Nosocomial Infection Surveillance System (NNIS) of the Centre for Disease Control (CDC) indicate that surgical site infections are the third most frequently reported nosocomial infection, accounting for 14-16% of all nosocomial infection patients SSIs are the most frequent cause of such infections, accounting for 38% of the total[17]. SSIs are a real risk associated with any surgical procedure and represent a significant burden in terms of patient morbidity, mortality, extended hospital stay and staggering expenses to health services around the world[18]. HTN, DM, older age (>60 years), anemia, and below-average nutrition carried a significant association with SSI according to this study. On a similar note, Mawalla et al, and Siddique et al and found that the presence of diabetes was significantly associated with increased prevalence of SSI ($p<0.05$)[19,20]. Mawalla et al also found HTN to be an important risk factor for SSI ($p<0.05$). Older age as a risk factor of increased SSI was noted by Mawalla et al (>60 years) and Siddique et al (>50 years)[19,20]. To the length of operative procedures, the risk of wound infection had repeatedly been shown to be proportional. When the duration of the operation was more than 60 and 150 minutes, a higher incidence of post-operative wound infection was observed[20]. An increase in wound infections with longer procedures, roughly doubling with every hour of the procedure found[21]. The increased amount of suture and electro-coagulation may also reduce the local resistance of the wounds. Not all operating surgeons may find the special technique equally convenient, leading to potential variations in its application. The small sample size might limit the ability to draw fully representative findings. Additionally, patient outcome reports could be susceptible to both inter and intra-observer variations.

Conclusion

Surgical Site Infections (SSIs) pose ongoing challenges for surgical patients, leading to significant morbidity and economic burdens. The study emphasizes the importance of infection control policies and judicious antibiotic use to mitigate SSI rates. Bacteriological analysis reveals variations in pathogen prevalence based on geographical location and wound examination time. To address this burden effectively, hospitals must implement organized wound surveillance and reporting systems. The study aims to evaluate different wound infections, clinical presentations, and bacteriological etiologies of SSIs in the Sylhet region, with the ultimate goal of informing infection control policies for improved patient outcomes and reduced healthcare costs.

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