Evaluation of Surveillance for Surgical Site Infections and Drug Susceptibility Patterns, Taif, Saudi Arabia

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Abstract

Surgical wound infections are those infections which are confined to the incisions and involving structures adjacent to the wounds that were exposed during operation.

Aim: To determine microbial profile of surgical site infections and drug susceptibility patterns, Taif, Saudi Arabia.

Method: 217 patients were included in the study. Two skin cultures were obtained, the pre-preparation, and post-preparation culture, from the surgical site by the nurse, and processing under standard method.

Result: The study revealed that bacterial infection at surgical site at least once reached 100% at post-preparation.

The most commonly isolated organisms are, *Staphylococcus aureus* 16.1%, MRSA 3.2%, *E. coli* 12.9%, *Acinetobacter baumannii* 9.6%, were the most frequently isolated organisms, followed by *Streptococcus pyogenes* (Group A streptococcal), *Citrobacter koseri*, and *Pseudomonas aeruginosa* with the same rate of 3.2%. The susceptibility pattern of 112 bacteria isolated against 23 antimicrobial agents. All strains were susceptible to all antibiotic, resistance was observed in some strains.

Conclusion: Meticulous surgical technique, proper sterilization, judicious use of antibiotics, improvement of operation theatre and ward environments, control of malnutrition and obesity, treatment of infective foci and diseases like diabetes, helps to control the morbidity of surgical wound infections.

Keyword: Infection, Microbial contamination, Patients, Prevalence, SSIs, Surgical, Taif, Wound

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Introduction

Surgical site infection (SSI) are defined as infections occurring within 30 days after a surgical operation (or within one year if an implant is left in place after the procedure) and affecting either the incision or deep tissue at the operation site, contributes substantially to surgical morbidity and mortality each year [1].SSI accounts for 15% of all nosocomial infections and, among surgical patients, represents the most common nosocomial infection.

Post-surgical infection leads to increased length of postoperative hospital stay, drastically escalated expense, higher rates of hospital readmission, and jeopardized health outcomes [2]. With an estimated 27 million surgical procedures each year in USA,

and a 2–5% rate of SSIs, approximately 300,000-500,000 SSIs can be predicted to occur annually [3]. They are believed to increase the risk of dying 2-11 folds, with 77% of these deaths attributed directly to the surgical site infection. The duration of the hospital stay increases 20-fold, and the cost increases 5-fold, which results in a net loss of reimbursement to the hospital [4].

Incisional SSIs are further divided into superficial incisional SSIs-involving only skin and subcutaneous tissue and deep incisional SSIs-those involving deeper soft tissues of the incision. Organ/space SSIs involves any part of the anatomy (i.e. organ or space) other than incised body wall layers that was opened or manipulated during an operation [5]. Sutures are a contributory factor in infection; in fact, 66% of SSIs are related to the incision.

Microbial adherence to the surface of suture material has been reported in the surgical literature for many years [6].

Most of these infections are caused by organisms that are part of normal skin flora, such as *Staphylococcus* species, *Propionibacterium acnes*, and gram-negative bacilli. Further, an increasing number of infections are caused by organisms that are resistant to multiple antibiotics [7]. The association between staphylococci and surgical site infections continues developing intense, although continuous advances in aseptic principles of surgery and the ongoing improvement of sterile surgical technique [8]. In fact, in the presence of sutures, only 100 colony-forming units (CFU)/mg are necessary to produce infection [9].

Various bacteria may contaminate not only the tissue in the surgical wound, but the actual suture material. Once suture material becomes contaminated, local mechanisms of wound decontamination become ineffective [10]. The risk of acquiring hospital infection on hospitalized patients in relation to surgery is high, since about 77% of death of patients with nosocomial infections was reported to be related with post-operative infections [11]. The number of surgical patients in developing countries is also increasing but surgical care given to the patients is poor. Surgical cases are responsible for approximately 6-12% of all paediatric admissions. But due to poor surgical care, there is a significant number of death and disability associated to post-operative complications. Microorganisms can get access into a wound either by direct contact of air borne dispersal or by contamination [12]. According to the National Nosocomial Infections Surveillance System, the most frequently isolated pathogens from SSI are *Staphylococcus aureus* (20%) and coagulase-negative staphylococci [13].

These organisms are acquired from the exogenous environment or the patients' own skin flora and hence are introduced easily into wounds [14]. Infection that occurs at the operative site is known as surgical site infection (SSI). SSIs have various adverse effects on patients who undergo surgery, such as unfavourable postoperative complications, need for additional treatment of SSI, prolonged hospital stay, and even mortality. Substantial research has been conducted to prevent SSI, and, as a result, recommendations have been published as guidelines for SSI [15].

In these guidelines, sterilization of surgical instruments is recommended as one of the fundamental and classical measures against SSI. If instruments were microbially contaminated, it would lead to increased SSI incidence. Therefore, instruments are decontaminated and sterilized between surgical procedures to prevent cross transmission [16]. However, in spite of sterilization, surgical instruments remain one of the most important sources of SSI. They can be contaminated during surgical procedures through contact with resident skin flora, which recover several hours after preoperative skin preparation, or through contact with microbes in the digestive tract such as stomach, duodenum, and colon. Surgical instruments might act to spread microbes over the surgical field. Previous studies have examined the microbial contamination of surgical instruments in central sterile supply departments, showing a relatively high incidence of contamination with high microbial counts [17].

The risk of developing a surgical wound infection is largely determined by three factors: the load, type of microbial contamination of the wound and host susceptibility. Certain transient organisms such as *S. aureus*, hospital acquired methicillin resistant *S. aureus* (MRSA) and coliform occur on the skin with other commensals could easily contaminate the surgical wounds from poor hygiene [18]. To reduce the risk of surgical site infections, effective and persistent skin antisepsis, meticulous operative technique, appropriate antimicrobial prophylaxis, and identification of strategies for decreasing wound contamination must be used; patient-related factors such as age, gender, body mass index, underlying disease, co-morbidities, prior operative procedures, and life-style factors such as smoking and alcohol drinking habits must be highlighted. Hair in the surgical incision area should be left unless removal is necessary for the procedure. If removed, caregivers should do so with clippers immediately prior to surgery. Intraoperative skin preparation is of critical importance, not only that the antibacterial solution used has broad spectrum properties, but also that the product be properly applied [19].

Additional strategies used to reduce bacterial migration into the surgical incision include the use of antiseptic impregnated adhesive drapes and/or novel cyanoacrylate-based skin sealants that are applied over the skin prep to immobilize residual skin flora, including those imbedded in hair follicles [20]. SSIs impose a substantial clinical burden. Patients with SSIs are more likely to require readmission to hospital or intensive care unit (ICU) treatment, and are at higher risk of death, than those without such infections, the median duration of hospital station in infected patients was 11 days, compared with 6 days in uninfected patients, and the median extra duration attributable to SSIs was 6.5 days (95% CI: 5 8) [21]. Strategies for the prevention of SSIs are based both on reducing the risk of bacterial contamination and on improving the patient's defences against infection. This requires a 'bundle' approach, with attention to multiple patient-related and procedure-related risk factors [22]. Several studies in a variety of clinical settings have shown that such approaches can produce significant reductions in SSI rates during follow-up periods of up to two years. Evidence-based guidelines for the prevention of SSIs have been published by the CDC [23]. Gloves, facemasks, caps, gowns and sterile drapes should be used to minimise transmission of potential pathogens to the wound. Surgical instruments should be adequately sterilised according to published guidelines; flash sterilization should be reserved only for instruments intended for immediate use (for example, an instrument that has been inadvertently dropped during the operation). It should be noted that despite precautions such as these, some contamination of the surgical site is inevitable because some endogenous bacteria remain even after excellent preoperative preparation of the site [24,25].

Short courses of antimicrobial prophylaxis are widely used to reduce SSI risk. Antimicrobial prophylaxis is primarily indicated in elective procedures in which skin incisions are closed in the operating theatre. The choice of agent should be based on the pathogens most commonly associated with the procedure being performed, and hand hygiene is regarded as one of the key components in any infection prevention strategy [26]. The aim

of the present study was to study the microbial profile of surgical site infections and drug susceptibility patterns, Taif, Saudi Arabia.

Methods

Study population

This study included 217 patients who were admitted in to the surgical wards in Al-Hada Military Hospital Taif, Saudi Arabia, during the 6 months period from April 2015 to September 2015, suffering various forms of SSIs. The demographic data of the patients and the diagnostic criteria were collected by the treating surgical team. Other data including associated risks factors (i.e. diabetes, obesity, steroid therapy), use of prophylactic antimicrobial agents, the type and duration of surgery, clinical evaluation of wound (considered infected if there was pus discharge or redness and swelling with fever), and laboratory data (including gram stain, culture results, identification of the bacterial isolates as well as antimicrobial susceptibility) were recorded on a data sheet. Official approval from directors of the hospital has been obtained, after clarification of the aim of the study and assuring the confidentiality to them.

Sample collection

Two skin cultures were obtained in the operating room ~1 cm from the surgical site by the research nurse. The first sample (the pre-preparation culture) was taken after hair removal, if any, and before the application of any antiseptic agent. The second sample (post-preparation culture) was collected after the application of antiseptic agents and immediately before the surgeon draped the area for the incision. A sterile cotton swab was moistened with sterile buffered transport medium (composed of 0.075 M phosphate buffer, pH 7.9, 0.1% polysorbate 80, 0.1% sodium thiosulfate, and 0.3% lecithin), and a quarter sized area was swabbed in a circular motion, with approximately the pressure applied when a pencil eraser is used. Each swab was placed in a vial containing 2.0 mL of the transport medium, were transported to the Microbiology department and plated within 2 h. Samples were diluted 10-fold in the transport medium, up to 10^3, and were spread plated onto 5% sheep blood agar, and selective media for isolation of Gram-positive cocci (colistin nalidixic acid agar), Gram-negative rods (Mac-Conkey agar, (Saudi Prepared Media Laboratory, Saudi Arabia, Riyadh (SPML).

Sample processing

Direct examination of specimens

The first swab was used to prepare two direct smears. One was examined after adding 10% KOH solution for fungal identification. The other was stained by Gram stain for bacterial examination and detection of PMNL which is an important feature in case of bacterial infection rather than in bacterial colonization. Plates were incubated at 37°C for 48 h. Bacteria were identified by means of standard laboratory identification methods. Oxacillin resistance testing was performed for *Staphylococcus aureus* isolates by use of oxacillin screen agar (Saudi Prepared Media Laboratory, Saudi Arabia, Riyadh (SPML). For each sample, total bacterial counts were enumerated, and the 3 most prevalent organisms were recorded, in order of density.

Species identification

Bacterial growths and fungal yields were identified according to standard conventional procedures

- The species identification was based on Gram-stain, catalase test, oxidase test, indole test, lactophenol cotton blue for microscopy and staining molds, strep latex test kit (BBL Streptocard), staphyloslide test kit (BBL Staphyloslide), germ tube test, sugar assimilation test, sugar fermentation test, and KOH test for fungi identification.
- Identified isolates were stored on nutrient agar slant at room temperature for subsequent susceptibility testing.
- Commercial identification kits were used to identify the isolates up to species level Different type of API kits (Analytab product, Plainview, N.Y), and Vitek system, different card for identification of Gram-positive bacteria, Gram-negative bacteria, yeast (bioMérieux, Inc. Durham NC, USA).

Afterwards, the sensitivity to the antibiotics was accomplished by disk diffusion test performed for all the isolates by the method recommended by clinical and laboratory standard institute (CLST). A suspension of each isolate was made so that the turbidity was equal to 0.5 McFarland turbidity standard and then plated onto Muller-Hinton agar (Saudi Prepared Media Laboratory, Saudi Arabia, Riyadh (SPML). Antibiotic disks (Oxoid) were applied to each plate. After incubation at 37°C for 24 h, inhibition zone size was measured. The patients received the proper antibiotic thereafter [27]. Twenty three types of antibiotics were used in both Gram-negative rod and Gram-positive cocci; Amoxicillin/Clavulinicacid (20/10 µg), Cephalotin (30 µg), Oxacillin (1 µg), Gentamicin (10 µg), Sulfamethoxazole/Trimethoprim (1.25/23.75 µg), Ciprofloxacin (5 µg), Clindamycin (2 µg), Vancomycin (30 µ), Cefoxitin (30 µg), Cefoxithin (30 µg), Ceftazidime (30 µg), Cefotaxime (30 µg), Amikacin (30 µg), Ceftriaxone (30 µg), Ceftazidime (30 µg), Ampicillin/Sulbactam (10/10), Cefotaxim (30 µg), Ticarcillin/Clavulanic acid (75/10 µg), Imipenem (50 µg), Cefepime (10 µg), Ampicillin/Sulbactam (10/10 µg), Aztreonam (30 µg), Piperacillin/Tazobactam (100/10 µg) (Oxoid).

Quality control

To maintain the quality of data every sample was processed in triplicates and every result was cross checked by the principal investigator. *Enterococcus faecalis* (ATCC 29212), *Staphylococcus aureus* (ATCC 24923), *Streptococcus pyogenes* (ATCC 19615), *E. coli* (ATCC 25922), *Pseudomonas aeruginosa* (ATCC 27853) were used as quality control throughout the study for culture, Gram stain. All the strains were obtained from the (ATCC, The essential of live science research, USA)

Data analysis

For each sample, total cfu count was converted to a log10 count to normalize the data. Counts were divided into high and low categories. For pre-preparation data, the top 30% of bacterial counts was considered to be high. As a result, a log count 15 was considered high, and counts of ›5 logs were considered low. For post-preparation data, low counts equalled zero culturable bacteria, and high counts were any values greater than zero. Prevalence of an organism was defined as the percentage of patients from whom that organism was isolated [28]. Statistical analyses were performed using the statistical package for the

social science (SPSS), Version 16 for Windows. Continuous variables were summarized using descriptive statistics in terms of means, ± standard deviations, T. test; 95% confidence intervals (95% CI), *P* value <0.05 were considered significant.

Results

This study included 217 patients, male 100 (46%), female 117 (53.9%),their ages ranged from 10 years to 55 years. 112 samples were positive for culture (51.3%), and 105 (48.3%) was negative growth.

The socio-demographic characteristics (sex, gender) of 217 patients admitted in surgical ward at Al-Hada military Hospital, Taif. The total number of female patient was 117 (53.9%), while male flowed by 100 (46%), was presented in **Table 1**.

During the study period 6 months from April 2015 to September 2015, all patients admitted in surgical wound were included in the study regarding sex, gender, age. The main group of the surgical wound infection in patient was at age of 30-33year 27 (12.4%), flowed 50-55 year 26 (11.9%), while the age of 15-19 year, and 45-49 gave the same rate of 25 (11.5%). In contrast 20-24, and 40-44 year presented in the same percentage of 24 (11%), 25-29, and 34-39 year gave low rate of 23 (10.5%), and 10-14 year gave very low rate of 20 (9.2%) **(Table 2)**.

The predominant causes of SSIs in this study was tibia and fracture with high rate of 100 (46%), followed by gall bladder, and plastic surgery, leg, synovial fluid, knee replacement with carriage 35 (16.1%). In contrast SSIs due to back site, abdomen presented in low rate of 16 (11.9%), while Gall bladder gave rate of 20 (9.2%), appendicitis, and finger ulcer/DM foot found in low rate of 18(8.2%), was presented in **Table 3**.

A total of 217 SSIs patients admitting surgical ward, were the positive culture including Gram-positive cocci, Gram-negative rod, was presented in **Table 4**.

Gall bladder

E. coli was the predominant organisms with rate of 10(8.9%, followed by, *Acinetobacter baumannii* 9 (8%), and *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Citrobacter koseri*, were found in low same range of 2 (1.7%).

Plastic surgery, leg, synovial fluid, knee replacement

E. coli was the predominant organisms with rate of 5 (4.4%), followed by *Staphylococcus aureus*, *Streptococcus pyogenes* Group A streptococcal presented in same rate of 3(2.6%), while, *Citrobacter koseri* covered in low rate of 1 (0.8%).

Table 1 Socio-demographic characteristics (sex, gender) of patient at surgical ward, Taif, *N*=217.

Socio-demographic Characteristics Sex/Gender	Frequency N=217	%
Male	100	46
Female	117	53.9
Total	217	100

Appendicitis

E. coli was the predominant organisms with rate of 5 (4.4%), followed by *Staphylococcus aureus*, Pseudomonas aeruginosa presented in same rate of 2 (1.7%), while *Acinetobacter baumannii*, *Citrobacter koseri* found in the same low rate of 1 (0.8%)

Fracture (include arm, femur, tibia, fibula, thigh, maxilla)

Staphylococcus aureus was the predominant organisms with high rate of 20 (17.8), followed by MRSA 4 (3.5%), While, *Streptococcus pyogenes* Group A streptococcal, *E. coli*, *Pseudomonas aeruginosa* covered in same rate of 3 (2.6%), while *Citrobacter koseri*, *Acinetobacter baumannii* found in low rate of 2 (1.7%), 1 (0.8%) respectively.

Back site, Abdomen

Staphylococcus aureus was the predominant organisms with rate of 6 (5.3%), while *E. coli* 3 (2.6%). In contrast MRSA, and *Acinetobacter baumannii* found in the same rate of 2 (1.7%), and *Streptococcus pyogenes* Group A streptococcal, *Citrobacter koseri* covered in same rate of 1 (0.8%).

Finger ulcer/ DM foot

Only isolated *Staphylococcus aureus*, *E. coli* with low rate of 2 (1.7%). In the present study showed that, some strain of microorganisms colonizing and infecting some surgical sites, but not isolated in another site **(Table 4)**.

Antibiotic sensitivity

Disk diffusion method was performed to all bacterial isolates causing infection. Among these isolates, many were found to be resistant to more than one antibiotic. The susceptibility pattern of bacteria isolated from SSIs patient against 23 antimicrobial agents **Tables 5-7**.

Gram-positive cocci

Staphylococcus aureus found to be resistant in 35 out of 217 cases

Table 2 Socio-demographic characteristics (age in years) of patient at surgical ward, Taif, *N*=217.

Socio-demographic Characteristics	Frequency N=217	Percent (%)
1- Age in years		
10-14	20	9.2
15-19	25	11.5
20-24	24	11
25-29	23	10.5
30-34	27	12.4
35-39	23	10.5
40-44	24	11
45-49	25	11.5
50-55	26	11.9
Total	217	100
Mean 5/24 Std ± 2.7/2.02		

Table 3 Different sits of surgical wound infection and percentage.

Sites of infection	Frequency N= 217	Percent (%)
Gall bladder	20	9.2
Plastic surgery, leg, synovial fluid, knee replacement	35	16.1
Appendicitis	18	8.2
Fracture	100	46
Back site, Abdomen	26	11.9
Finger ulcer/DM foot)	18	8.2
total	217	100

Fracture; Arm, femur, tibia and fibula, thigh, maxilla

representing 16.1%. However, Streptococcus pyogenes (Group A streptococcal) were out of 217 yields representing 7 (3.2%). The result of this study revealed that, resistant of *Staphylococcus aureus*, and *Streptococcus pyogenes* to 23 antibiotic, and fully susceptible to oxacillin, vancomycin, and apmecillin/sulbactam. All strains were susceptible to some antibiotic used in study, and resistance was observed in some strains of Gram-positive cocci, show the different isolates' resistance to various antibiotics in percent study **Table 5**.

The antimicrobial susceptibility pattern of MRSA isolates against antimicrobial agents are summarized in Table 6. More than 7(100%) of MRSA isolates were resistant to, oxacillin, co-trimoxazole, gentamicin, amikacin, ciprofloxacin, ceftriaxone, ceftazidime, ampicillin/ sulbactam. All stains showed sensitive to vancomycin, clindamycin and erythromycin.

Gram-negative rod

E. coli found to be resistant in 28 out of 220 cases representing 12.9%, while *Acinetobacter baumannii* 21 (9.6%). In contrast *Pseudomonas aeruginosa* and *Citrobacter koseri* found to be resistant in 7 representing (3.2%) in **Table 7**. *E. coli* was fully sensitive to ceftriaxone, imipenem, and cefepime, while *Pseudomonas aeruginosa* was sensitive to cefoxithin, amikacin, ciprofloxacin, ceftriaxone, ampicillin/sulbactam, ticarcillin/ clavulanic acid, *Acinetobacter baumannii*, and *Citrobacter koseri*, were sensitive to both antibiotics imipenem and cefepim.

Discussion

Successful management of patients with bacterial infection depends on the identification of bacterial pathogens and on the selection of an antibiotic effective against the organism in question. Antibiotics are one of the pillars of modern medical care and play a major role both as the prophylaxis and treatment of infectious diseases. The issue of their availability, selection and proper use are of critical importance to the global community [29].

The incidence of SSI in the present study was 51.3%, which is higher than reported worldwide incidence of 2.6% to 41.9% [30]. Second, our study differs from the literature in that SSI was more common in younger patients, whereas studies reported SSI to be high in patients of over 55 years of age. This could be because the majority of our patients were operated on due to trauma, and it has been reported that preoperative soft- tissue damage is a

major risk factor for developing SSI [31]. The result of this study showed that, *S. aureus*, *E. coli*, and *Acinetobacter baumannii* were highly associated with surgical wound infections, while MRSA, *Streptococcus pyogenes* (Group A streptococcal), *Pseudomonas aeruginosa* presented in low rate.

However, *S. aureus* was a major pathogen from patients in surgical wards and most commonly isolated bacteria from patients who undergone emergency type of surgery which may be due to surface contamination by this bacterium on the skin and environment causing nosocomial infections. According to CDC, *S. aureus*, and *E. coli* was the most prevalent organism associated with surgical wound infections [31,32], and *E. coli* was most commonly isolated from patients who undergone elective type of surgery which can be due to contamination of wounds with patient's endogenous flora since *E. coli* and Coliforms is normal flora of gastro-intestinal tract [33].

The current findings showed 56.2% and 43.7% of Gram negative and Gram positive bacteria, respectively which is comparable with a study done by Kollef [34] on surgical nosocomial infections which reported 50.3% Gram-negative bacteria followed by Gram-positive bacteria 31.1%.The fact that most Gram-positive bacteria, such as MRSA contaminate the inanimate environment has been well established in colonized or infected patients, personnel in the hospitals and the major mechanism is done via the unwashed hands of health care workers [35].

Presence of bacteria was different from ward to ward based on activities. For example *S. aureus* was the predominant isolate in operating rooms; whereas *P. aeruginosa* was the main isolate from surgical ward. Most of isolates were from operating rooms, and many studies suggested that excellent surgical technique is widely believed to reduce the risk of surgical site infections [36]. There are limited data available to review with regard to SSI in Saudi Arabian patients. Abdel-Fattah [37] reported after a 12-month study of nosocomial infection from a military hospital, the incidence of SSI was 12.9%, whereas Khairy et al. reported an incidence of 6.8% after a prospective study. In both studies, the incidence appears lower than in our study. The present study, rate of SSI was higher in females than in males 107(49.3%), while incidence in male 90(41.4%). This result was in agreement with the finding reported by Khairy et al., who found that, rate of SSI was higher in females than in males (12.5%) [38].

The present study, the most commonly isolated bacteria were *Staphylococcus aureus* 35(16.1), were *E. coli* 28(12.9%), and *Acinetobacter baumannii* 21(9/6%) *P* 0.003. In a similar study, Khairy et al. found that most commonly isolated bacteria were *E. coli* 8(23%), *Pseudomonas aureginosa* 6(23%) and *Staphylococcus aureus* 4(23%) [38]. This result was in agreement with the finding reported in a study from India, the most predominant isolate was *Staphylococcus aureus* (37%) of which 21.7% were MRSA compared to the low isolation rate of *Staphylococcus aureus* in our study 16.1% where 3.2% were MRSA [39]. In the Indian study, the commonest isolate (37%) was *P. aureginosa*, and one third of these were multidrug resistant [40]. Fahad et al. (2014), found that most common infective organism was Staphylococcus species including MRSA in 23 patients (29.11%), Acinetobacter species in 17 (21.5%), Pseudomonas species in 15 (18.9%), and Enterococcus species in 14 (17.7%) [41].

Table 4 lists the most common microorganisms colonizing and infecting surgical sites wounds, Taif.

Bacterial isolates /site	Gall bladder	Plastic surgery, leg, synovial fluid, knee replacement	Appendicitis	Fracture	Back site, Abdomen	Finger ulcer/ DM foot)	Total /%
Staphylococcus aureus	2(1.7%)	3(2.6%)	2(1.7%)	20(17.8)	6(5.3%)	2(1.7%)	35(31.2%)
MRSA	NA*	NA*	1(0.8%)	4(3.5%)	2(1.7%)	NA*	7(6.2%)
Streptococcus pyogenes Group A streptococcal	NA*	3(2.6%)	NA*	3(2.6%)	1(0.8%)	NA*	7(6.2%)
E. coli	10(8.9%	5(4.4%)	5(4.4%)	3(2.6%)	3(2.6%)	2(1.7%)	28(25%)
Pseudomonas aeruginosa	2(1.7%)	NA*	2(1.7%)	3(2.6%)	NA*	NA*	7(6.2%)
Acinetobacter baumannii	9(8%)	8(7.1%)	1(0.8%)	1(0.8%)	2(1.7%)	NA*	21(18.7%)
Citrobacter koseri	2(1.7%)	1(0.8%)	1(0.8%)	2(1.7%)	1(0.8%)	NA*	7(6.2%)
Total Positive culture	112	51.3					112/100
Total	217	100					

NA*: Not Isolated

Table 5 Antibiotic susceptibility pattern (%) of resistant Gram positive isolates in surgical patients.

Antibiotics	Resistant *Staphylococcus aureus* N=35(16.1%)	Resistant *Streptococcus pyogenes* (Group A streptococcal) *N*=7(3.2%)
Amoxicillin/ Clavulanic acid (20/10 µg)	9(25.7%)	1(14.2%)
Cephalothin (30 µg)	8 (22.8%)	2 (28.5%)
Oxacillin (1 µg)	*S	S
Gentamicin (10 µg)	8 (22.8%)	2 (28.5%)
Amikacin (30 µg)	5 (14.2%)	1(14.2%)
Ciprofloxacin (1 µg)	9 (25.7%)	2 (28.5%)
Ceftriaxone (30 µg)	3(8.5%)	2 (28.5%)
Co-trimoxazole (1.2/23.8 µg)	5 (14.2%)	2 (28.5%)
Ceftazidime (30 µg)	3(8.5%)	1(14.2%)
Ampicillin/Sulbactam (10/10)	8(22.8%)	1(14.2%)
Cefotaxim (30 µg)	5 (14.2%)	1(14.2%)
Ticarcillin/clavulanic acid (75/10 µg)	2(5.7%)	2 (28.5%)
Piperacillin/tazobactam (100/10 µg)	2(5.7%)	1(14.2%)
Imipenem (50 µg))	1(2.8%)	S
Cefepime (10 µg)	1(2.8%)	1(14.2%)
Clindamycin (2 µg)	1(2.8%)	1(14.2%)
Vancomycin (30 µg)	S	S
Ampicillin/Sulbactam (10/10 µg)	S	S

*S sensitive

All isolates of *S. aureus* were sensitive to vancomycin which seems to be the only antimicrobial agent which shows 100% sensitivity but 88.5% were sensitive to clindamycin. Vancomycin remains the first choice of treatment for MRSA and to preserve its value, vancomycin use should be limited to those cases where there are clearly needed. The susceptibility testing of the Gram-negative organisms; *E. coli*, *P. aeruginosa* showed that higher resistant to cefotaxime, cephalothin, gentamicin, Co-trimoxazole, in Northwest Ethiopia. Similarly, a study [42] in Europe reported the high resistance of *E. coli* and *P. aeruginosa* isolated from surgical wounds.

The high rate of bacterial resistance against chloramphenicol and TMP-SMX is likely due to indiscriminate use of antibiotics both within hospital and outside as it was described two decade ago in the study area [43]. Increased antibiotic use in hospitals is often associated with increased frequency of resistance [44].

The rise in antibiotic resistance emphasizes the importance of sound hospital infection control, rational prescribing policies, and the need for new antimicrobial drugs and vaccines. The choice of antimicrobial drugs is central to the management of infection. Selection of a suitable antibiotic is fairly straight forward when the microorganism responsible is known. However, when this is not the case, a choice based on current epidemiologic data has to be made and empirical antibiotic treatment is prescribed. This should be followed by conventional culture techniques, whereby the specific antibiotic-sensitivity patterns of the causative organisms are established and the antimicrobial therapy can subsequently be modified if necessary for those patients who have positive cultures [45]. However, prevention must be underpinned by a knowledge and understanding of the microbial pathogenesis, and the importance of surveillance. The Guideline for Prevention of Surgical Site Infection, 1999, provides recommendations concerning reduction of surgical site infection risk. Each recommendation is categorized

Table 6 Antibiotic resistance pattern of MRSA, *N*=7(3.2%).

Antibiotics	Resistant MRSA *N*=7 (3.2%)
Amoxicillin/ Clavulanic acid (20/10 µg)	7(100%)
Cephalothin (30 µg)	6(85.7)
Oxacillin (1 µg)	7(100%)
Gentamicin (10 µg)	7(100%)
Amikacin (30 µg)	7(100%)
Ciprofloxacin (1 µg)	7(100%)
Ceftriaxone (30 µg)	7(100%)
Co-trimoxazole (1.2/23.8 µg)	7(100%)
Ceftazidime (30 µg)	7(100%)
Ampicillin/Sulbactam (10/10)	7(100%)
Clindamycin (2 µg)	S
Vancomycin (30 µg)	S
Erythromycin	S
*S: sensitive	

on the basis of existing scientific data, theoretical rationale, and applicability. However, the previous CDC system for categorizing recommendations has been modified slightly [46-48].

Conclusion

Although SSIs after surgery is declining and the mortality is low, several risk factors have been identified which contribute to the infection rate. The administration of prophylactic antibiotics, weight reduction regimes, shortening of the operating time, identifying promptly treating high-risk groups, will help in further reducing the incidence of SSIs, and aggressive treatment is recommended. There is a need to reinforce rational antimicrobial use to limit emergence and spread of resistant and or continuing surveillance of bacterial antimicrobial sensitivity tests at local level to guide empirical drug choice. The practice of aseptic technique during and after surgery rather than overreliance on antibiotics is necessary to reduce emergence and spread of resistant pathogens.

Table 7 Antibiotic susceptibility pattern (%) of resistant Gram-negative isolates in surgical patients.

Antibiotics	Resistant *E. coli* N=28 (12.9%)	Resistant *Pseudomonas aeruginosa* N=7 (3.2%)	Resistant *Acinetobacter baumannii* N=21 (9.6%)	Resistant *Citrobacter Koseri* N=7 (3.2%)
Aztreonam (30 µg)	1(3.3%)	1(14.2%)	2(9.5%)	1(14.2%)
Cephalothin (30 µg)	3(10.7%)	2 (28.5%)	3(14.2%)	3(42.8%)
Cefoxithin (30 µg)	1(3.3%)	S	3(14.2%)	2 (28.5%)
Gentamicin (10 µg)	2(7.1%)	3(42.8%)	4(19%)	1(14.2%)
Amikacin (30 µg)	1(3.3%)	S	1(4%)	3(42.8%)
Ciprofloxacin (5 µg)	1(3.3%)	S	2(9.9%)	1(14.2%)
Ceftriaxone (30 µg)	*S	S	3(14.2%)	2 (28.5%)
Co-trimoxazole (1.2/23.8 µg)	4(14.2%)	2 (28.5%)	5(23.8%)	5(71.4%)
Ceftazidime (30 µg)	2(7.1%)	1(14.2%)	1(4.7%)	2 (28.5%)
Ampicillin/Sulbactam (10/10 µg)	1(3.3%)	S	1(4.7%)	1(14.2%)
Cefotaxim (30 µg)	5(17.8%)	1(14.2%)	2(9.5%)	1(14.2%)
Ticarcillin/clavulanic acid (75/10 µg)	2(7.1%)	S	2(9.5%)	2 (28.5%)
Piperacillin/tazobactam (100/10 µg)	1(3.3%)	1(14.2%)	4(19%)	1(14.2%)
Imipenem (10 µg)	S	S	S	S
Cefepime (10 µg)	S	S	S	S
*S sensitive				

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