ORIGINAL ARTICLE

POSTOPERATIVE NOSOCOMIAL INFECTIONS AND ANTIMICROBIAL RESISTANCE PATTERN OF BACTERIA ISOLATES AMONG PATIENTS ADMITTED AT FELEGE HIWOT REFERRAL HOSPITAL, BAHIRDAR, ETHIOPIA

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ABSTRACT

BACKGROUND: ***Nosocomial infection constitutes a major public health problem worldwide. Increasing antibiotic resistance of pathogens associated with nosocomial infections also becomes a major therapeutic challenge for physicians. Thus, the aim of this study was to identify post operative bacterial infections and determine their current antimicrobial resistance to commonly prescribed drugs.***

METHODS: ***A cross sectional study was conducted on patients under gone operation from October 2010 to January 2011 and followed for development of clinical signs and symptoms of surgical site and blood stream infection until the time of discharge. Structured questionnaire was used to collect socio demographic characteristics. Wound swab and venous blood samples were collected and processed for bacterial isolation and antimicrobial susceptibility testing following standard bacteriological techniques.***

RESULTS: ***Out of 294 patients who had clean and clean-contaminated operation, 10.9% were confirmed of bacterial nosocomial infections. The rate of nosocomial infections among clean and clean-contaminated operations was 3.3% and 12.8% respectively. Nosocomial surgical site and blood stream infection rate was 10.2% and 2.4% correspondingly. A total of 42 bacterial pathogens were identified of which S. aureus was the leading isolates accounting 26.2% followed by E. coli and Coagulase negative Staphylococcus species each 21.4%. Nearly 100% of Gram positive and 95.5% of Gram negative bacterial isolates showed resistance against two or more antimicrobial drugs.***

CONCLUSIONS*: Multiple drug resistance of isolates to antimicrobials was alarmingly high so that any empirical prophylaxis and treatment needs careful selection of effective drugs. To minimize such infections, adherence of strict aseptic surgical procedures and proper management of wounds is required.*

KEYWORDS: ***Postoperative infection, clean-contaminated operation, Bahirdar, Ethiopia.***

INTRODUCTION

A Nosocomial infection can be defined as: an infection acquired in hospital by a patient who was admitted for a reason other than that infection. An infection occurring in a patient in a hospital or other healthcare facility in whom the infection was not present or incubating at the time of admission and this include infections that are acquired in the hospital but appear after discharge (1). Hospital acquired infections (HAIs) constitute a major public health problem worldwide. They result major causes of morbidity and mortality, functional disability, emotional suffering and economic burden among the hospitalized patients (2, 3). The most common types of nosocomial infections that could occur in a hospital set up are surgical wound and other soft tissue infections, urinary tract, respiratory and blood stream infections (4).

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Postoperative wound infection can occur from first day onwards to many years after an operation but commonly occurs between the fifth and tenth days after surgery (5). It may originate during the operation i.e. as a primary wound infection or may occur after the operation from sources in the ward or as a result of some complications i.e. secondary wound infection (6) and can be characterized by various combinations of the signs of infection (e.g. pain, tenderness, warmth, erythema, swelling, drainage) (5). Most post-operative wound infections are hospital acquired and vary from one hospital to the other and even within a given hospitals and they are associated with increased morbidity and mortality (7). The site of infection may be limited to the suture line or may become extensive in the operative site and the infecting microorganisms are variable, depending on the type and location of surgery, and antimicrobials received by the patient (1).

Surgical site infections (SSIs) which account 17% of all health care-associated infections are the second most common HAIs next to urinary tract infections. They occur after approximately 3% of all operations and result in greater lengths of stay and additional costs (8).

On the other hand, nosocomial bloodstream infections (BSIs) which represent 14 % of total nosocomial infections can be classified as primary or secondary. Primary nosocomial bacteremia occurs without any infection in/on other sites where as secondary bacteremia is the presence of infection in sites such as urinary tract, surgical wound or lower respiratory tract which can lead to a blood stream infection with the same organism (9).

According to data from the national nosocomial infection surveillance system, the distribution of pathogens isolated from SSIs has not changed markedly during the last decade where *Staphylococcus aureus, Coagulase-negative Staphylococci (CoNS), Enterococcus* spp. and *Escherichia coli* remain the most frequently isolated pathogens (10). Furthermore, nosocomial blood stream infections are usually caused by Gram-positive organisms including Coagulase negative Staphylococcus, *S. aureus*, Enterococci (9, 11) and these microorganisms nearly always represent true bacteremia such as *E. coli* and other members of the Enterobacteriaceae*, Pseudomonas aeruginosa,* and *Streptococcus pyogenes* (11).

The emergence of poly antimicrobial resistant strains of hospital pathogens has also presented a challenge in the provision of good quality in-patient care (2). The battle between bacteria and their susceptibility to drugs is yet problematic among public, researchers, clinicians and drug companies who are looking for effective drugs (12). In addition to this, postoperative wound infection by resistant bacteria worsens the condition (13) and it has become serious problem in developing countries owing to poor infection prevention program, crowding hospital environment and irrational prescription of antimicrobial agents. Therefore, the aim of this study was to isolate bacterial pathogens from hospital acquired surgical site and blood stream infection and determine their current antimicrobial resistant patterns among patients who had clean and clean-contaminated operations at Felege Hiwot Referral Hospital.

PATIENTS AND METHODS

A hospital based postoperative study was conducted from October 2010 to January 2011 at Felege Hiwot Referral Hospital (FHRH) in Bahirdar, North West Ethiopia. The hospital has 273 beds offering different specialized services in four major departments: the Pediatrics, Surgery, Gynaecology and Obstetrics and Internal Medicine. More than 8000 patients get admitted in surgical and gynaecology wards per year and on average ten major operations would performed per day. In addition, the hospital accepts referred patients from different parts of the region and provides local emergency services (14).

A predesigned and structured questionnaire was developed and used for collection of data on socio-demographic characteristics.The clinical diagnoses of the patients were made by surgeons and gynaecologists. During the study period a total of 294 patients had clean and clean-contaminated operations and get admitted in Surgical and Gynaecology wards of the hospital as a result of the operation. A bacteriological culture confirmation was made for all patients who had been developed any clinical signs and symptoms of surgical site and/or bloodstream infection during the second day of admission until the time of discharge. All the patients who undergone re-operation, those who have had contaminated and dirty operations, neonates and enrolled patients who have shown signs and symptoms of infection within the first 48 hours of admission were excluded from the study.

For investigation of SSIs, two wound specimens were collected aseptically using sterile cotton swabs by experienced laboratory personnel and the swabs were immediately dipped into a sterile tube containing two drops of sterile normal saline and delivered to Bahirdar Regional Laboratory within five minutes of collection. Then, one of the wound swabs was inoculated on to Blood agar, MacConkey agar, and Manitol Salt Agar plate (all Oxoid, Ltd, England) (15). The inoculated agar plates were incubated aerobically at 37 ^{0}C overnight. The other wound swab was used for Gram staining smears to make presumptive diagnosis (16) and to select significant organism based on the quantitative measurements made on microscopy i.e. finding of bacteria on a given microscopic smear were taken as presence of 10^6 or more bacteria per swab which is reliably predicts a microbial load of $>10^5$ CFU/g of tissue (17). In addition, 10ml of venous blood from adults and 2ml from children were collected from peripheral vein of these operated patients that developed fever higher than 38^{0}C on more than one occasion in 24 hours. And this was done using a sterile, disposable needles and syringes after cleaning the skin with 70% alcohol and 2% tincture of iodine (16). Then, blood samples were dispensed through the rubber liner cape of culture bottles which contain 90 ml and 18 ml of Brain Heart Infusion Broth (Oxoid, Ltd, England) respectively at bed side of the patients. Finally, the bottles were taken to the Regional Laboratory within five minutes of collection and incubated at 35 –37^{0}C for 24 hours. Bottles that showed any sign of growth were sub cultured on to 5% Sheep Blood agar, MacConkey agar and Manitol Salt Agar. Blind sub cultures were made for bottles that did not show sign of growth on to these media keeping the culture broths in incubator for 10 days before being discarded as negative (16). Identification of cultured isolates was done according to the standard bacteriological techniques (15, 16).

Antimicrobial susceptibility testing was performed using Kirby Bauer agar disc diffusion technique for the isolated pathogen (18). A loop full of bacteria was taken from a pure culture colony and was transferred to a tube containing 5ml of phosphate buffer saline and mixed gently until it formed a homogenous suspension and the turbidity of the suspension was adjusted to the turbidity of McFarland 0.5 standard in a tube. The standardized inoculums of each isolate were inoculated on to Mueller-Hinton antibiotic sensitivity medium (Oxoid, Ltd, England). Finally, all the isolates were tested for these under listed Oxoid drug discs: Ampicillin (AP,10μg), Penicillin G (P,10IU), Amoxicillin (AML, 20μg), Chloramphenicol (C, 30μg), Gentamycin (CN,10μg), Tetracycline (T, 30μg), Trimethoprim-sulphamethoxazole (Ts, 25μg), Ceftriaxone (CRO, 30μg), Doxycycline (D, 30μg), Norfloxacin (NOR,10μg), Ciprofloxacin (CIP, 5μg), Nalidixic acid (NA,30μg), Erythromycin (E,15μg), Kanamycin (K,30μg) and Nitrofurantoin (F, 300μg). These antimicrobial drug discs were selected based on Clinical and Laboratory Standards Institute (CLSI), the availability and prescription frequency of these drugs in the study area.

The plates were incubated aerobically at 37 ^{0}C for 18-24 hours and the interpretation of the results of the antimicrobial susceptibility was made based on the CLSI criteria as sensitive, intermediate and resistant by measuring diameter of inhibition the zone (19). All intermediate readings were taken as resistant during data entry. The standard reference strains, *Staphylococcus aureus* (ATCC25923), *Escherichia coli* (ATCC25922 and *P. aeruginosa* (ATCC 27853) were used to assure testing performance of the potency of drug discs as well as quality of culture media.

The quantitative data was checked for completeness, coded and fed into SPSS version16 and P-value <0.05 was considered statistically significant for association between variables. This study was approved by Ethical Review Board of Jimma University.

The following operational definitions and terms were used:

Clean Operations: a type of wound in which no inflammation is encountered and the respiratory, alimentary or genitourinary tracts are not entered and there is no break in aseptic operating procedure

Clean-contaminated operations: a type of wound in which the respiratory, alimentary or genitourinary tracts are entered but without significant spillage (without visible contamination).
Contaminated operations: a type of wound where acute inflammation (without pus) is encountered, or where there is visible contamination of the wound. Examples include gross spillage from a hollow viscous during the operation or compound/open injuries operated within four hrs.
Dirty Operations: a wound in the presence of pus, where there is a previously perforated hollow viscous or compound/open injury more than four hours old.
Postoperative nosocomial infection: a surgical site or blood stream infection occurring after 48 hours of operation until the time of discharge from hospital with clinical signs and symptoms and laboratory confirmation.

RESULTS

A total of 294 patients were undergone major operations and admitted in Surgical (n=146) and Gynaecology (n=148) wards of which 60(20.4%) had clean and 234 (79.6%) clean contaminated operations during the study period. The sex profile of these patients showed that 96 (32.7%) were males and 198(67.3%) were females making male to female ratio of 1:2.1. The mean age of patients was 32.2 years and 280 (95.2%) of them were older than 15 years. The overall culture confirmed nosocomial infection rate on these patients was 10.9%. The infection rate was higher in females (11.6%) than males (9.4%) but the difference was not statistically significant (P=0.564). The infection rate was relatively high (27.3%) in the age group of ≥51 years old followed by 21-30 years of age group (12.6%). However, statistically significant association was observed only in the age group greater than or equal to 51 years old (P=0.033) by considering 11-20 years age group as a reference category during bivariate analysis (Table 1).

Table 1: Postoperative nosocomial infection in relation to sex and age groups of operated patients at FHRH, Bahirdar, October -January, 2010/2011.

Demographic Characters	**Infection status**		
	Infected No. (%)	**Not infected No. (%)**	**Total No. (%)**
Sex			
Male	9(9.4)	87(90.6)	96(32.7)
Female	23(11.6)	175(88.4)	198(67.3)
Total	**32(10.9)**	**262(89.1)**	**294(100)**
Age in years			
0-10	1(11.1)	8(88.9)	9(3.1)
11-20	2(5.6)	34(94.4)	36(12.2)
21-30	18(12.6)	125(85)	143(48.6)
31-40	2(5.1)	37(94.9)	39(13.3)
41-50	3(6.7)	42(93.3)	45(15.3)
≥51	6(27.3)	16(72.7)	22(7.5)
Total	**32(10.9)**	**262(89.1)**	**294(100)**

The rates of surgical site infection (SSI) and blood stream infection (BSI) among patients have undergone major operations were 10.2% and 2.4% respectively. on the other hand, the frequency of nosocomial infection was 3.3% in these patients who had clean operations and 12.8% in these who had clean contaminated operations, and the observed difference was statistically significant (P=0.04). Similarly, the rates of SSI and BSI among clean - contaminated operations were 12%

and 2.6%, respectively. The rate of BSI, without SSI, among those who had clean-contaminated operations was 0.9% (Table 2).

Table 2: Nosocomial surgical site and blood stream infections in clean and clean- contaminated operations at FHRH, Bahirdar, October -January, 2010/2011.

Type of nosocomial infection	**Clean operation (n=60)**	**Clean-contaminated operation (n=234) (N=234)**	**Total (N=294)**
	No. (%)	No. (%)	No. (%)
SSI	1(1.7)	24(10.3)	25(8.5)
BSI	0(0)	2(0.9)	2(0.7)
Both SSI and BSI	1(1.7)	4(1.7)	5(1.7)
Total	**2(3.3%)**	**30(12.8%)**	**32(10.9%)**

SSI: Surgical site infection; BSI: Blood stream infection

A total of 42 bacterial isolates were identified of which 83.3% were from surgical sites and 16.7% were from blood stream infections. Of these isolates, S. *aureus* was the most frequently detected bacterium (26.2%) followed by *E. coli and* coagulase negative *Staphylococcus* (CoNS) species (each 21.4 %) (Fig 1).

The antimicrobial drug resistance profile of bacterial isolates showed that *S. aureus* was 100% resistant for Ampicillin and 91% for Chloramphenicol. Relatively, *S. aureus* showed little resistance (9.1%) to Erythromycin. Similarly, CoNS also showed 100% resistance to Ampicillin but least resistance to Erythromycin (11.1%) and Doxycycline (33%) (Table 3).

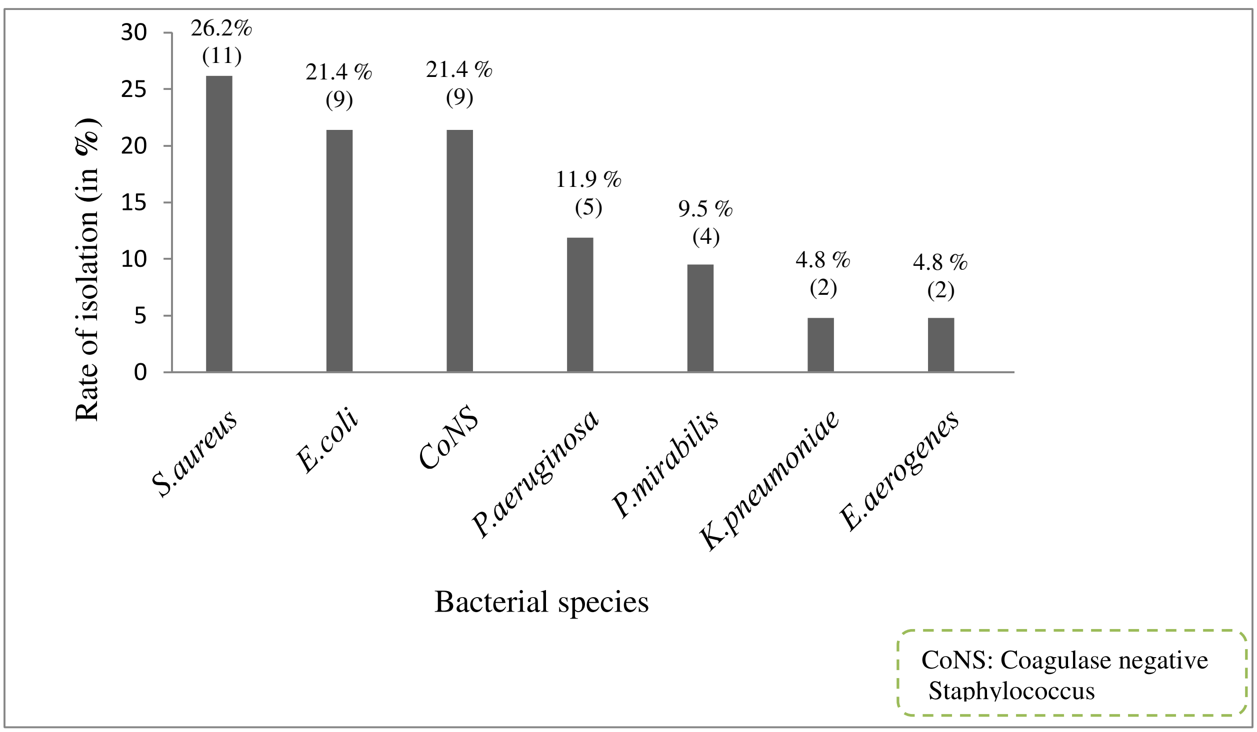

Figure 1: Frequency of nosocomial pathogenic bacteria isolates from operated patients at FHRH, Bahirdar, October -January, 2010/2011.

Table 3: Drug resistance pattern of Gram positive bacteria isolated from nosocomial surgical site and blood stream infections among operated patients, at FHRH, Bahirdar, October - January, 2010/ 2011.

Organism (No)	Drugs tested No (%) of resistance											
	CRO	P	AP	AML	E	Ts	CN	NOR	C	CIP	T	D
***S.aureus* (n=11)**	7 (63.6)	6 (54.5)	11 (100)	8 (73)	1 (9.1)	7 (63.6)	6 54.5)	8 (73)	10 (91)	5 (45.5)	6 (54.5)	4 (36.4)
CoNS (n=9)	4 (44.4)	6 (76)	9 (100)	5 (55)	1 (11.1)	6 (76)	4 (44.4)	4 (44.4)	5 (55)	4 (44.4)	5 (55)	3 (33)
Total (n=20)	**11 (55)**	**12 (60)**	**20 (100)**	**13 (65)**	**2 (10)**	**13 (65)**	**10 (50)**	**12 (60)**	**15 (75)**	**9 (45)**	**11 (55)**	**7 (35)**

CoNS: Coagulase negative Staphylococcus; CRO: Ceftriaxone; P: Penicillin G; AP: Ampicillin; AML: Amoxicillin; E: Erythromycin Ts: Trimethoprim-sulphamethoxazole; CN: Gentamycin; NOR: Norfloxacin; C: Chloramphenicol; CIP: Ciprofloxacin; T: Tetracycline; D: Doxycycline.

Most importantly, Gram negative bacterial isolates were variably resistant for the drugs tested. As indicated in Table 4, 90% of *E. coli* showed resistance for Amoxacillin but not for Chloramphenicol. *P. aeruginosa* showed 100% resistance for Ceftriaxone, Amoxicillin, Ampicillin and Nitrofurantoin. However, Tetracycline and Norfloxacin were drugs which relatively showed low resistance rate (20%) each for *P. aeruginosa.* Similarly, *P. mirabilis*, *Enterobacter aerogenes* and *K. pneumoniae* showed 100% resistance to Ceftriaxone and Ampicillin. In addition, *Enterobacter aerogenes* showed 100% resistance to Chloramphenicol, Gentamycin, Nitrofurantoin and Doxycycline, but it was 100% sensitive for ciprofloxacin and Kanamycin. Moreover, *K. pneumoniae,* which accounted 4.8% of the total isolate, showed 100 % resistance against Amoxacillin, Trimethoprim-sulphamethazole, Ciprofloxacin and Gentamycin but not to Tetracycline. On the other hand, Doxycycline was relatively the most effective drug for *Proteus mirabilis,* with no resistance to this drug (Table 4).

All (100%) of the Gram positive bacterial isolates showed multi drug resistance (MDR) against at least to two to ten more drugs. Antibiogram of Gram positive bacterial isolates showed that 20% and 25% of them were resistant to seven and ten tested drugs respectively. About 27.3% of *S. aureus* and 22.2% of CoNS were also resistant to all ten drugs tested. Similarly, 95.5% of Gram negative bacterial isolates showed MDR against two to twelve drugs. On the other hand, antibiogram of Gram negative isolates revealed that 22.7% of them were resistant to each seven and eight drugs tested. Likewise, 40% of *P. aeruginosa* was resistant to seven, 50% of *E. aerogenes* to eleven and 50% *K. pneumoniae* to all the twelve drugs tested (Table 5).

Table 4: Drug resistance pattern of Gram negative bacteria isolated from nosocomial surgical site and blood stream infection among operated patients at FHRH, Bahirdar, October-January, 2010/2011.

Organism (No)	**Drugs tested No(%) resistance**												
	CRO	AML	AP	Ts	CIP	C	NOR	CN	T	K	NA	F	D
***E.coli* (n=9)**	5 (55.6)	8 (90)	7 (78)	6 (67)	4 (44.4)	0 (0)	4 (44.4)	4 (44.4)	6 (66.7)	4 (44.4)	6 (66.7)	2 (22.2)	6 (66.7)
P.aeruginosa (n=5)	5 (100)	5 (100)	5 (100)	3 (60)	2 (40)	4 (80)	1 (20)	2 (40)	1 (20)	3 (60)	3 (60)	5 (100)	4 (80)
***P.mirabilis* (n=4)**	4 (100)	3 (75)	4 (100)	2 (50)	1 (25)	3 (75)	2 (50)	2 (50)	2 (50)	2 (50)	3 (75)	3 (75)	0 (0)
***E.aerogenes* (n=2)**	2 (100)	1 (50)	2 (100)	1 (50)	0 (0)	2 (100)	1 (50)	2 (100)	1 (50)	0 (0)	1 (50)	2 (100)	2 (100)
***K.pneumoniae* (n=2)**	2 (100)	2 (100)	2 (100)	2 (100)	2 (100)	2 (100)	1 (50)	2 (100)	0 (0)	1 (50)	1 (50)	1 (50)	1 (50)
Total (n=22)	**18 (82)**	**19 (86.4)**	**20 (91)**	**14 (63.6)**	**9 (41)**	**11 (50)**	**9 (41)**	**12 (54.5)**	**10 (45.5)**	**10 (45.5)**	**14 (63.6)**	**12 (54.5)**	**13 (59.1)**

CRO: Ceftriaxone; AML: Amoxacillin, AP: Ampicillin; Ts: Trimethoprim-sulphamethoxazole; CIP: Ciprofloxacin; C: Chloramphenicol; NOR: Norfloxacin; CN: Gentamycin; T: Tetracycline; K: Kanamycin; NA: Nalidixic Acid; F: Nitrofurantoin; D: Doxycycline.

Table 5: Antibiogram of bacteria isolated from nosocomial surgical site and blood stream infections at FHRH, Bahirdar, October - January, 2010/ 2011.

Organism (No)	**Antibiogram No (%) of resistance**											
	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	Total
Gram +ve												
S. aureus (n=11)	1 (9.1)	-	-	2 (18.2)	-	2 (18.2)	2 (18.2)	1 (9.1)	3 (27.3)	Nt	Nt	11 (100)
CoNS (n=9)	2 (22.2)	-	1 (11.1)	-	1 (11.1)	2 (22.2)	1 (11.1)	-	2 (22.2)	Nt	Nt	9 (100)
Total (n=20)	**3 (15)**	**-**	**1 (5)**	**2 (10)**	**1 (5)**	**4 (20)**	**3 (15)**	**1 (5)**	**5 (25)**	**Nt**	**Nt**	**20 (100)**
Gram -ve												
E.coli (n=9)	-	1 (11.1)	1 (11.1)	-	-	2 (22.2)	3 (33.3)	1 (11.1)	-	-	-	8 (88.9)
P.aeruginosa (n=5)	-	-	-	-	-	1 (20)	2 (40)	1 (20)	-	-	1 (20)	5 (100)
P.mirabilis (n=4)	-	-	-	-	1 (25)	1 (25)	-	1 (25)	1 (25)	-	-	4 (100)
E.aerogenes (n=2)	-	-	-	-	1 (50)	-	-	-	-	1 (50)	-	2 (100)
K.pneumoniae (n=2)	-	-	-	-	-	1 (50)	-	-	-	-	1 (50)	2 (100)
Total (n=22)	**-**	**1 (4.5)**	**1 (4.5)**	**-**	**2 (9.1)**	**5 (22.7)**	**5 (22.7)**	**3 (13.6)**	**1 (4.5)**	**1 (4.5)**	**2 (9.1)**	**21 (95.5)**

R2-R12 = number of drugs in which a given isolate is resistant for 2- 12 drugs tested
CoNS = Coagulase negative Staphylococcus, Percentage is calculated for row,
Nt= not tested (Gram positives were tested only for 10 drugs)

DISCUSSION

Nosocomial infections, including surgical site infection, still form a large health problem and contribute substantially to patient morbidity, mortality, prolonged hospital stay, expensive hospitalization and prolonged therapy (20, 21). Emergence of poly antimicrobial resistant strains of hospital pathogens has also presented a major challenge in the provision of good quality in-patient care (2). The 10.9% culture confirmed nosocomial infection rate obtained in this study was comparable with findings of similar local studies conducted by Gedebou *et al* (22), Habte-Gabre *et al* (23), Tesfahunegn *et al* (24) and Taye (25) where the rate of infection reported were 9%, 9.7%, 12.2% and 14.8%, respectively. Our findings were also comparable with different studies carried out elsewhere in other developing countries such as Pakistan (26, 21), India (27) and Mali (28) where infection rate of 11-13%, 9-12% and 10.2% were reported respectively. However, failure to attempt in identification of potential anaerobic bacteria and fungi in this study might under estimate the exact hospital acquired postoperative infection rate in the study area.

In the present study, blood stream infection (BSI) was observed in 2.4% of the study participants. This finding is a little bit higher when compared with findings of Endalafer *et al* (3), Habte-Gabre *et al* (23) and Harbarth *et al* (29) where 1.8%, 1.6% and 1.8% rate were reported respectively. But, it is much higher than reports of Mesele G *et al* (13) where 0.4% and 0.1% nosocomial BSI identified in two tertiary hospitals in Addis Ababa. Moreover, the 2.4% BSI in our finding is also higher than 0.1% reported in India (30). The increased BSI rate observed in this study might reflect the inefficient infection control practices at FHRH.

In our study surgical site infection was significantly associated with class of wounds, being the highest (12%) for clean contaminated operations (P=0.04) and 3.3% for clean operations. This high rate of infection among former wound type would be probably because of profound influence of endogenous contamination during the time of operation. The overall clean wound infection rate of 3.3% in the present study was also comparable with studies done in India (27, 30), and Pakistan (21) where 3%, 5.5%, and 5.3% were reported, respectively. However, the rate 3.3% was much higher than 0.5% found in Yemen (31) due to the fact that the study in Yemen was conducted among patients who had been on effective preoperative antibiotic prophylaxis which might reduce the postoperative infection rates. On the other hand, the 3.3% in our finding is much lower than similar studies conducted by Ahmed *et al* in Pakistan (26) where 8% was reported. The possible reason for the observed difference is that unlike the present study, Ahmed *et al* (26) followed the patients for up to 30 days (even after being discharged) that perhaps minimize the chance of missing such patients in their study. The 3.3% infection rate of clean operations was also much lower than 7.2 % reported in Ethiopia (32). This could be due to difference in total number of clean wound operated patients who participated in those studies. On the other hand, the 12.8% infection rate of clean - contaminated operations in this study was comparable with previous studies done in Ethiopia (32), Pakistan (21) and India (30) where the rates were 14.8%, 12.4%, and 10.8% respectively. However, it was much lower than some of the studies done in Pakistan (26) and Lilani *et al* in India (27) where 19.4% and 22.5% were reported, respectively. The observed difference might be attributed to differences in length of patient follow up and methodology where unlike the present study; Lilani *et al* (27) for instance, included anaerobic culture to isolate potential anaerobic bacteria that cause SSI.

The predominance (26.7%) of *S. aureus* infection seen in this study is most likely associated with endogenous source as the organism is a member of the skin and nasal flora of the patients as it was explained by Isbori *et al* (7) and Angu and Olila (33). Infection with this organism may also be associated with contamination from the environment, surgical instruments or contaminated hands of the health professionals (7, 33). Moreover, in our study *E.coli* (20%) was the second most common isolated bacteria from SSI. This could be because of the profound influence of endogenous contamination from the bowel and hollow muscular organs of patients.

The present study has also indicated that most of *S. aureus* were resistant to nearly all the drugs tested (Table 3) with resistance rate that ranges from 54.5% to 100%. This finding agrees with previous studies done locally by Messele G *et al* (13), Gedebou *et al* (20), Tesfahunegn *et al* (24) and Mulu *et al* (34), where average resistance of 70.6%, 75%, 75% and 52% were obtained for the commonly used antibiotics, respectively. Biadglegne *et al* (12) also reported an average resistance of 62.3% for Tetracycline, Chloramphenicol, Penicillin and Ampicillin. The overall resistance rate of Gram positive bacteria to the commonly used antibiotics in the present study ranges from 55-75%; even up to 100% to Ampicillin. This finding also goes with studies carried out in Uganda (33) where 97% of the isolates were resistant to Ampicillin, in India (2) where 70% of the isolates were resistant to Amoxacillin, Tetracycline, Chloramphenicol and Norfloxacin. In contrary to the results of previous studies, *S. aureus* showed least resistance to Erythromycin (9.1%) and relatively high resistance to Gentamycin (54.5%) in our study. These might be due to the low prescription trends of Erythromycin and high usage of Gentamycin for prophylaxis and treatment in the study area. Most of the Gram negative bacterial isolates also showed resistance to commonly used drugs with average resistance that ranges from 54.5% to 91%. This result goes in line with previous studies conducted by Gedebou *et al* (20, 22), where the majority of Gram negative bacteria were found out to be resistant to the commonly used antibacterial drugs, and Habte-Gabre *et al* (23) where most of the Enterobacteriaceae were also identified as resistant to the commonly prescribed drugs.

The invitro drug resistance pattern of other Gram negative bacteria showed high rate of drug resistance to Amoxicillin, Ampicillin and Chloramphenicol (Table 4). This might be due to these antibiotics having been in use for much longer time or over used and/or their oral route of administration might affected their rate of absorption into blood stream as explained by Anguzu and Olila (33). Moreover, the frequent empirical prescription of these antibiotics as a treatment and prophylaxis in the study area might contribute for observed high rate of resistance (personal observation). These results agree with the previous studies carried out in Ethiopia (13, 24) and other African countries (36, 33). Additionally, *P. aeruginosa*, *P. mirabilis*, *Enterobacter aerogenes* and *K. pneumoniae* also showed 100% resistance to Ceftriaxone. The increased rate of resistance to Ceftriaxone in this study contrasts with previous studies in Ethiopia (3) and Nigeria (37) for which further investigation should be conducted. On the other hand, Ciprofloxacin and Norfloxacin are relatively effective drugs for the treatment of majority of the infections caused by Gram negative bacterial isolates. This could be these antibiotics might not commonly used before and/or newly introduced and are limited in practice because of their higher prices in the study area. In general, the average multiple drug resistance rate of Gram positive and Gram negative bacteria in our study were 100% and 95.5%, respectively. This finding also goes with previous retrospective study done by Biadglegne *et al* (12), where average resistance rates of 98.6% and 100% were reported, in that order.

In conclusion, the rate of nosocomial infection obtained in this study was comparable to other similar studies carried out in developing countries including Ethiopia. However, the bacterial isolates detected from our patients were terribly resistant for commonly available and prescribed antimicrobial drugs. Therefore, antibiotics such as Ampicillin, Amoxicillin, Penicillin, Trimethoprim-sulphamethoxazole, Chloramphenicol and Ceftriaxone are not the drug of choice for treating patients with nosocomial infections in the study area. Felege Hiwot Referral Hospital also needs to make a concerted effort to minimize hospital acquired infections by following strict aseptic operation procedures, effective methods of sterilization and patient management.

REFERENCES

1. WHO. Prevention of hospital acquired infections: A practical guide. Malta: Department of Communicable Disease, Surveillance and response; 2002. Available at http://www.who.int/csr/resources/publications/whocdscsreph 200212.pdf. Accessed on: July 20, 2010.
2. Kamat US, Ferreira AM, Savio R, *et al.* Antimicrobial resistance among nosocomial isolate in a teaching hospital in Goa. *Indian J comm. medicine*. 2008; 33: 89-92.

3. Endalafer N, Gebre-Selassie S, Kotisso B. Nosocomial bacterial infections in a tertiary hospital in Ethiopia. *J Infect Prev*. 2011; 12: 38-43.
4. Graves N. The cost of hospital acquired infections. Unit costs of health and social care. 2000; 25-27.
5. Medical Disability Guidelines. Wound infection, postoperative. 2010. Available at: http://www.mdguidelines.com/wound-infection-postoperative. Accessed on: June 24, 2010.
6. Pradhan G, Agrawal J. Comparative study of post operative wound infection following emergency lower segment caesarean section with and without the topical use of fusidic acid. *Nepal Med Coll J*. 2009; 11: 189-191.
7. Isibor OJ, Oseni A, Eyaufe A. Incidence of aerobic bacteria and *Candida albicans* in post operative wound infections. *Afr.J. microbiol. Res*. 2008; 2: 288-291.
8. Napolitano MN. Perspectives in surgical infections: What does the Future hold? 2010. *Surg Infect*. 2010; 11:111-23.
9. Samuel SO, Kayode OO, Musa O *et al*. Nosocomial infections and the challenges of control in developing countries. *Afr. J. Cln. Exper. Microbiol*. 2010; 11: 102-110.
10. Mangram JA, Horan CT, Pearson LM *et al.* Guideline for prevention of surgical site infection. *Infect Control Hosp Epidemiol*.1999; 20: 247-278.
11. Chinnial TR. Blood culture techniques: increasing yield and reducing contamination. *SLJCC*. 2009; 1: 15-24.
12. Biadglegne F, Abera B, Alem A, *et al*. Bacterial isolates from wound infection and their antimicrobial susceptibility pattern in Felege Hiwot Referral Hospital, North West Ethiopia. *Ethiop J health Sci*. 2009; 19:173-177.
13. Messele G, Woldemedhin Y, Demissie M, *et al.* Common causes of nosocomial infections and their susceptibility patterns in two hospitals in Addis Ababa. *Ethiop. J. Health Biomed Sci*.2009; 2:3-8.
14. FGAE. Factors affecting accessibility and acceptability of VCT services in Bahirdar. family guidance association of Ethiopia, North Western branch. 2001; 1-54.
15. WHO. Basic laboratory procedures in clinical bacteriology. Geneva. 1991. Available at: http://whqlibdoc.who.int/publications/2003/9241545453.pdf. Accessed on: July12, 2010.
16. Cheesbrough M. District laboratory practice in tropical countries 2nd ed. Cambridge, Cambridge University press, 2006; 62-143.
17. Levine NS, Lindberg RB, Mason AD Jr, Pruitt BA Jr. The quantitative swab culture and smear: A quick, simple method for determining the number of viable aerobic bacteria on open wounds. *J Trauma.*1976; 16:89-94.
18. Bauer AW, Kirby WM, Sherris JC, *et al*. Antibiotic susceptibility testing by a standardized single disk method. *Am J Clin Pathol.*1966; 45: 493-6.
19. Cockerill FR, Wikler MA, Bush K, *et al*. Performance standard for antimicrobial susceptibility testing. Twentieth information supplement. *CLSI*. 2010; 30:1-153.
20. Gedebou M, Kronvall G, Habte-Gabr E *et al.* The bacteriology of nosocomial infections at Tikur Anbessa Teaching Hospital, Addis Ababa. *Acta Pathol Microbiol Immunol Scand* (B).1987; 95:331-336.
21. Sangrasi KA, Leghari A, Memon A. Surgical site infection rate and associated risk factors in elective general surgery at a public sector medical university in Pakistan. *Int WJ*. 2008; 5: 74–78.
22. Gedebou M, Habte-Gabr E, Kronvall G *et al.* Hospital-acquired infections among obstetric and gynecological patients at Tikur Anbessa Hospital, Addis Ababa. *J Hosp Infect*.1988; 11: 50-9.
23. Habte-Gabr E, Gedebou M, Kronvall G. Hospital-acquired infections among surgical patients in Tikur Anbessa Hospital, Addis Ababa, Ethiopia. *AMJ Infect control*. 1988; 16: 7- 13.
24. Tesfahunegn Z, Asrat D, Woldeamanuel Y, Estifanos K. Bacteriology of surgical site and catheter related urinary tract infections among patients admitted in Mekelle Hospital. *Ethiop.Med. J*. 2009; 47: 117-27.
25. Taye M. Wound infection in Tikur Anbessa Hospital, surgical department. *Ethiop Med J*. 2005; 43:167-74.
26. Ahmed M, Alam NS, Manzar SO. Post-operative wound infection: a surgeon's dilemma. *Pakistan J Surg*. 2007; 23: 41-47.

27. Lilani PS, Janagale N, Chowdhar A *et al.* Surgical site infection in clean & clean-contaminated cases. *Indian J Micro Biol.* 2005; 23: 249-52.
28. Togo A, Traore A, Kante L, *et al*. Fighting nosocomial infection rates in the general surgery department of the teaching hospital Gabriel Toure in Bamako, Mali. *The Op Biol J.* 2010; 3: 87- 91.
29. Harbarth ST, Rvefch FP, Widmer A *et al*. Nosocomial infections in Swiss university hospitals: a multicenter survey and review of the published experience. *Scheeiz Med Wochenschr*.1999; 129: 325-338.
30. Shah FH, Gandhi MD, Mehta VP *et al*. Nosocomial infections in surgical wards. *The Internet J Surg*. 2010; 24.
31. Rajaa AY, Salam RA, Salih AY. Rate and risk factors of surgical site infections with antibiotic prophylaxis. *Saudi Med J.* 2002; 23: 672-674.
32. Taye M. Wound infection in Tikur Anbessa Hospital, surgical department. *Ethiop Med J*. 2005; 43:167-74.
33. Anguzu JR, Olila, D. Drug sensitivity patterns of bacterial isolates from septic post operative wounds in a regional referral hospital in Uganda. *Afr Health Sci.* 2007; 7: 148-154.
34. Mulu A, Moges F, Tessema B *et al.* Pattern and multiple drug resistance of bacteria Pathogens isolated from wound infection at University of Gondar teaching Hospital, Northwest Ethiopia. *Ethiop Med J*. 2006; 44:125-31.
35. Joyce S, Lakshmidevi N. Surgical site infections: Assessing risk factors, outcomes and antimicrobial sensitivity patterns. *Afr. J. Microbiol. Res.* 2009; 3:175-179.
36. Nwachukwu NC, Orji FA, Okike UM. Antibiotic susceptibility patterns of bacterial isolates from surgical wounds in Abia State University Teaching Hospital (ABSUTH), Abia, Nigeria. *Res J Medicine & Med. Sci, 2009;* 4: 575-579.
37. Taiwo SS, Okesina AB, Onile BA. In vitro antimicrobial susceptibility pattern of bacterial isolates from wound infections in University of Ilorin teaching hospital. *AJCEM*. 2001; 3:6-10.