Postoperative Surgical Site Bacterial Infections and Drug Susceptibility Patterns at Gondar University Teaching Hospital, Northwest Ethiopia

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Abstract

The study aimed to determine the prevalence, etiological agents and drug susceptibility pattern of bacterial pathogens isolated from postoperative surgical wounds and hospital environment in Gondar University Teaching Hospital. Specimens were taken from patients with post operative surgical site infections seen at wards and from hospital environment. Specimens were processed for bacteriological analysis and antibiotic susceptibility test according standard procedures. Antimicrobial susceptibility test for isolated organisms was done using disk diffusion method. Of 111 pathogenic bacteria, Escherichia coli 27 (24.3%), Staphylococcus aureus 26 (23.4%), Coagulase negative Staphylococci 22 (19.8%) and Enterobacter spp. 11 (9.9%) were dominant isolates. The prevalence of methicillin resistant S. aureus was 9 (34.6%). Seventeen (77.3%) and 1 (4.5%) of coagulase negative Staphylococcus were methicillin and vancomycin resistant, respectively. Coagulase negative Staphylococci 41 (41.8%), S. aureus 19 (19.4%) and P. aeruginosa 16 (16.3%) were the major isolates from 75 sites of the hospital environment with an isolation rate of 41 (54.7%). The prevalence of methicillin resistant S.aureus from the environment was 2 (2.0%). High level of multi-drug resistance was observed in bacteria isolates from patients compared to the bacteria isolated from the hospital environments. This study demonstrated high level of multi-drug resistance. Thus, antibiotic sensitivity testing should be carried out for all bacterial isolates of surgical wounds before chemotherapy administered to detect drug resistant strains.

Keywords: Post-operative surgical site infections; Bacteria; Antibiotic susceptibility patterns; Gondar; Ethiopia

Introduction

Surgical wound infections are those infections which are confined to the incisions and involving structures adjacent to the wounds that were exposed during operation [1]. Hospital acquired surgical site infection (SSI) is one of the major health problems throughout the world and is a serious complication affecting hospitalized patients [1-4]. Among hospital acquired infections, SSI accounts for 14-16% of the in-patient infections [2]. SSI is dangerous condition with a heavy burden on the patient has been associated with an increased morbidity, mortality and health care cost that have huge economic impact [3].

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 [3,4]. 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 [4].

Microorganisms can get access into a wound either by direct contact of air borne dispersal or by contamination [5]. Although there is no definitive evidence, direct contact and poor hand washing techniques of health care practitioners during pre and post operative phases of patient care are considered to be major factors [6]. 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 [7]. Certain transient organisms such as S. aureus, hospital acquired methicillin resistant S. aureus (MRSA) and coiform occur on the skin with other commensals [8] could easily contaminate the surgical wounds from poor hygiene.

Antimicrobial resistance has been a problem in the field of surgery, as advances in control of infections have not completely eradicated this problem [9,10]. The widespread uses of antibiotics, together with the length of time over which they have been available have led to major problems of resistant pathogens contributing to morbidity and mortality. The antibiotics resistant pathogens are acquired either from hospital environment or from the skins of infected patients [11]. Hospital acquired infections are further complicated by an increasing prevalence of multidrug resistant organisms like MRSA, methicillin resistant coagulase negative Staphylococci (MRCoNS) and vancomycin resistant Enterococci (VRE) spp [12].

In most developing countries like Ethiopia, it is a common practice that antibiotics can be purchased without prescription. This leads to misuse of antibiotics by the public thus contributing to the emergence and spread of antimicrobial resistance [13-15]. However, studies assessing the etiological agents of surgical site infections in Ethiopia are very scarce. Thus, it is necessary to identify bacterial agents and determine their antibiotic susceptibility pattern from wounds for empirical treat
ment in reference to the inadequate culture and sensitively service in Ethiopia [15]. Therefore, this study was aimed to determine the distribution of bacterial pathogens isolated from post-operative wounds and their antimicrobial susceptibility patterns.

Materials and Methods

Study area and study population

A cross-sectional study was carried out between January 2010 and June 2010 at University of Gondar Teaching Hospital, Northwest Ethiopia by involving consecutive patients in post operative surgical site infections seen at surgery, and gynaecology and obstetrics wards. The hospital is a tertiary level teaching and referral hospital catering more than 450 beds for inpatients and rendering referral health services for over 5 million inhabitants in the North-west Ethiopia.

Sample selection criteria

During patient selection, a standard definition for post operative surgical site infection was used [16].

Bacteriological procedures

A standardized pretested questionnaire was used to obtain data from the patients. Pus swabs were aseptically obtained using sterile cotton wool swabs from surgical sites before the wound was cleaned by antiseptic solution. Environmental sampling was also conducted in two different wards and operating rooms. Furthermore, we evaluated bacterial contamination of personnel nasal swabs and some medical equipment too. All surface samples were taken after decontamination. The swab specimens were transported to the Microbiology Laboratory of Gondar Teaching Hospital, within 1-2 hours of collection.

Sample/rinse method was used for sampling in the present study. Cotton tipped sterile swabs that were moistened in sterile brain-heart infusion broth (BHI) (Merck, Germany) were used to take samples from different surfaces. In each sampling, approximately 25 cm² was covered by moistened swab. The samples were categorized to clinical (patients area) and non-clinical surfaces (common area). The main target of sampling was hand contact surfaces [17].

Culture of specimens

The specimens were inoculated on nutrient agar, MacConkey agar, mannitol salt agar, blood agar and chocolate agar (Oxoid, Basingstoke, Hampshire, UK, England). Plates were thereafter incubated at 37°C for 24-48 hours. Primary cultures were sub cultured following the standard procedures [18].

Identification of bacterial pathogens

Pure cultures on secondary plates were characterized using physical appearances on selective and differential media. Biochemical tests such as catalase, coagulase, oxidase, Voges-Prauskauer, hydrogen sulphide test, urease, methyl red, indole, citrate and sugar utilization tests were done for each pathogen following the standard procedures [18].

Antibiotics used and concentrations

A total of fifteen antibiotics which represent the most commonly prescribed antibiotics in the study area were used in this study: amoxicillin (30µg), ampicillin (10µg), ceftriaxone (30µg), chloramphenicol (30µg), erythromycin (15µg), gentamicin (10µg), methicillin (5µg), trimethoprim sulphamethoxazole (TMP-SMX) (25µg), vancomycin (30µg), doxycycline (30µg), amikacin (30µg), clindamycin (2µg), ciprofloxacin (5µg), kanamycin (30µg), tetracycline (30µg). The criteria used to select the antimicrobial agents tested were based on their availability and frequent prescriptions for the management of wound infections.

Antibiotic susceptibility testing

Susceptibility testing was performed by Kirby-Bauer technique [19] according to the criteria of the National Committee for Clinical Laboratory Standards by disc diffusion method [20]. From a pure culture 3–5 pure colonies of bacteria were taken and transferred into to a tube containing 5 ml sterile nutrient broth (Oxoid) and mixed gently until the turbidity of the suspension become adjusted to a McFarland 0.5 standard. Using sterile cotton swab, the bacteria were seeded evenly over the entire surface of Mueller-Hinton agar (pH 7.2–7.4) (Oxoid). The plates were left at room temperature to dry for 3–5 minutes and a set of 15 antibiotic discs (Oxoid) with the recommended concentrations were placed on the surface of a Muller-Hinton plate. Finally, the plates were incubated at 37°C for 24 hours. Diameters of growth inhibition around the discs were measured and interpreted as sensitive, intermediate or resistant as per the standard protocol [21]. Reference strains E. coli ATCC 25922 and S. aureus ATCC 25923 were tested as controls according to the National Committee for Clinical Laboratory Standards (NCCLS) [20].

Data analysis

The data were entered and analyzed using SPSS soft ware version 16 package. Simple descriptive statistics were used to present the findings.

Ethical consideration

Patients were enrolled after obtaining informed consent. The consents of children were obtained through their parents and guardians. Ethical clearance was obtained from the Research and Publication Office of the University of Gondar. Patients with positive isolate were managed following the routine patients’ management system of the hospital.

Results

A total of 1627 surgical procedures were undertaken from surgery and gynaecology and obstetrics wards during the study period and among this a total of 57 (3.5%) patients developed post operative surgical wound infections. Among these 57 patients, 36 (63.2%) were females and 21 (36.8%) were males. The ages of the study groups ranged from 7 to 75 years. Forty-three (38.7%) of bacterial pathogens were identified from study participants below the age of 21 years old. Emergency type of surgery represented 83 (74.8%) of the bacterial pathogens. Most (64.9%) of the bacterial pathogens were recovered within 10 days after operation. One hundred and one (91%) of the bacterial pathogens were isolated from patients who had already a prophylaxis before surgery was undertaken (Table 1).

One hundred eleven bacteria were isolated and among these 70 (63.1%) and 41 (36.9%) were from surgical and gynecology & obstetrics wards, respectively. Gram negative and Gram positive bacteria represented 62 (55.9%) and 49 (44.1%), respectively. The most common isolates was Escherichia coli (27/111, 24.3%) followed by S. aureus (26/111, 23.4%), coagulase negative Staphylococci (CoNS) (22/111, 19.8%) and Enterobacter spp. (11/111, 9.9%) (Table 2).

Overall bacterial isolates were seen at the surgical ward 70(63.1%) were higher than gynaecology and obstetrics wards 41(36.9%) (X² = 15.2, P<0.001). The same was true for Enterobacter spp. 10 (90.9%) (P=0.05) but S. aureus 15(57.7%) was significantly higher in gynaecology and obstetrics wards (X²= 6.28, P< 0.012) (Table 2). Although higher distribution of S. aureus 21 (80.8%), CoNS 14(63.6%), E. coli 17(63.0), and Enterobacter spp. 10 (90.9%) were isolated from patients who underwent emergency type of surgery, the difference was statistically non-
The susceptibility patterns of bacteria isolated from surgical site infections at Gondar University Teaching Hospital, 2010.

From all 111 pathogenic bacteria isolated; 44 (39.6%) were detected from patients operated by residents in the Department of surgery and 70 (63.1%) were from patients operated by general practitioners in the Department of Gynecology and Obstetrics (Table 4).

The susceptibility patterns of bacteria isolated from surgical site infection against 15 antimicrobial agents are presented in Table 5. Clindamycin, doxycycline, erythromycin, methicillin and vancomycin were tested only for Gram positive bacteria. High level of resistance was observed against amoxicillin (95.5%), ampicillin (89.2%), TMP-SMX (80.2%) and chloramphenicol (74.8%) (Table 5).

Out of 27 isolates of E. coli, (100%), (96.3%), (92.6%), (88.9%), (77.8%), (70.4%), (70.4%), (59.2%), (55.6%), and (29.6%) were resistant to amoxicillin, ampicillin, chloramphenicol, TMP-SMX, tetracycline, kanamycin, amikacin, gentamicin, ceftriaxone, and ciprofloxacin, respectively. Among 11 isolates of Enterobacter spp., 11 (100%), 9 (90.9%) and 9 (81.8%) were resistant to amoxicillin, ampicillin and TMP-SMX, respectively but 26 (100%) and 23 (88.5%) of them were sensitive to doxycycline and chloramphenicol, while 1 (4.5%) of them were resistant to vancomycin (Table 5).

From 26 isolates of S. aureus, 9 (34.6%) were methicillin-resistant but 26 (100%) and 23 (88.5%) of them were sensitive to vancomycin and clindamycin, respectively. Among the 22 isolate of CoNS, 17 (77.3%) were methicillin-resistant and 20 (90.9%) were resistant for doxycycline and chloramphenicol, while 1 (4.5%) of them were resistant to vancomycin (Table 5).

Distribution and frequency of bacterial isolates from hospital environment are presented in table 6. Bacterial pathogens were assessed from 75 environmental sites showing an isolation rate of 41 (54.7%). Coagulase negative Staphylococcus 41 (41.8%), S. aureus 19 (19.4%), Pseudomonas aeruginosa 16 (16.3%) and E.coli 10 (10.2%) were the major isolates. Majority of bacteria (60 (61.2%) were isolated from operating theatre.
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 [22].

The result of this study showed that E. coli, S. aureus, CoNS and Enterobacter spp. were highly associated with surgical wound infections. Over all, more bacterial pathogens were more commonly isolated from surgery ward. However, S. aureus was a major pathogen from patients in Gynecology and Obstetrics wards and most commonly isolated bacteria from patients who undergone emergency type of surgery which was the main isolate in surgical ward and gynecology and obstetrics wards. 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 [30-33].

The prevalence of bacterial contamination among all wards that was done in line to isolation of pathogens from patients has not been determined accurately yet and the current study was the first one in our hospital. The fact that most Gram-positive bacteria, such as MRSA, S. aureus and CoNS were the predominant isolate in operating rooms, whereas P. aeruginosa was the main isolate in surgical ward and gynecology and obstetrics wards. 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 [30-33].

The susceptibility testing of S. aureus showed 9(34.6%) were resistant to ampicillin which is slightly lower than (38.56%) from Delhi [33] and higher than (21.7%) from Chennai [34]. 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

Table 5: Resistance Patterns (in percentages) of bacteria isolated from surgical site wounds at Gondar University Teaching Hospital, 2010.

| Organism             | Antimicrobial agents, N (%) |
|----------------------|-----------------------------|
|                      | AMP | AML | A | E | MET | DO | DA | VA | CIP | CRO | CN | K | TTT | TMP-SMX | C |
| E. coli              | 96.3 | 100 | 70.4 | ND | ND | ND | ND | ND | 29.6 | 55.6 | 59.2 | 70.4 | 77.8 | 88.9 | 92.6 |
| S. aureus            | 80.8 | 96.2 | 50.0 | 50 | 34.6 | 53.8 | 11.5 | nil | 42.3 | 50 | 61.5 | 61.5 | 34.6 | 65.4 | 61.5 |
| CoNs*                | 86.3 | 81.8 | 83.6 | 54.5 | 77.3 | 90.9 | 13.6 | 4.5 | 40.9 | 88.2 | 59.1 | 54.5 | 83.2 | 51.8 | 90.9 |
| Enterobacter spp.    | 90.9 | 100.0 | 83.6 | ND* | ND | ND | ND | ND | nil | 54.6 | 54.6 | 45.5 | 27.3 | 81.8 | 45.5 |
| K. pneumonia         | 100.0 | 100.0 | 86.7 | ND | ND | ND | ND | ND | 33.3 | 83.3 | 33.3 | 50 | 50.0 | 83.3 | 66.7 |
| M. morganii          | 100.0 | 100.0 | 16.7 | ND | ND | ND | ND | ND | 16.7 | 16.7 | 33.3 | 33.4 | 66.7 | 83.3 | 33.3 |
| P. mirabilis         | 75.0 | 100.0 | 50 | ND | ND | ND | ND | ND | nil | 75.0 | 25.0 | 100 | 75.0 | nil | 100.0 |
| S. arizonae          | 75.0 | 100.0 | 100 | ND | ND | ND | ND | ND | nil | 50 | 50.0 | 25.0 | 50.0 | 50.0 | 50.0 |
| P.aeruginosa         | 100.0 | 100.0 | 66.7 | ND | ND | ND | ND | ND | 33.3 | 100 | 66.7 | 100.0 | 100.0 | 100.0 | 100.0 |
| Edwardsiella spp.    | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | nil | nil | 100 | 100.0 | 100.0 | 100.0 | nil | 100.0 | 100.0 |
| Other gram-positive aerobes | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | nil | nil | 100 | 100.0 | 100.0 | 100.0 | nil | 100.0 | 100.0 |
| Total                | 89.2 | 95.5 | 61.3 | 53.0 | 55.0 | 69.4 | 12.0 | 2.0 | 29.7 | 57.7 | 55.9 | 60.4 | 57.7 | 80.2 | 74.8 |

* CoNs: Coagulase Negative Staphylococci; ND = not done; AMP: Ampicillin; AML: Amoxicillin; A: Amoxicillin; E: Erythromycin; MET: Metillin; DO: Doxycline; DA: Dicloxacillin; VA: Vancomycin; CIP: Ciprofloxacin; CRO: Ceftiraxone; CN: Gentamicin; K: Kanamycin; TTC: Tetracycline; TMP-SMX: Trimethoprim-sulphamethoxazole; C: Chloramphenicol; nil: all are sensitive.

Table 6: Frequency and type of bacterial isolates from hospital environment at Gondar University Teaching Hospital.

| Bacterial isolate | Surgical ward No. (%) | Operating room No. (%) | Gyn and Obs No. (%) | Total No. (%) |
|-------------------|------------------------|------------------------|---------------------|--------------|
| E. coli           | -                      | -                      | 8(80.0)             | 10(100.0)    |
| Klebsiella spp.   | -                      | 3(60.0)                | 2(20.0)             | 5(100.0)     |
| Citrobacter spp.  | -                      | 1(100.0)               | -                   | 1(100.0)     |
| P.aeruginosa      | 12(75.0)               | 1(6.3)                 | 3(18.8)             | 16(100.0)    |
| Serratia spp.     | 1(50.0)                | -                      | 1(50.0)             | 2(100.0)     |
| S. aureus         | 5(26.3)                | 14(73.7)               | -                   | 19(100.0)    |
| CoNS              | 10(24.4)               | 30(75.2)               | 1(2.4)              | 41(100.0)    |
| Proteus spp.      | 1(25.0)                | 3(75.0)                | -                   | 4(100.0)     |
| Total             | 29(29.6)               | 60(61.2)               | 9(9.2)              | 98(100.0)    |
and to preserve its value, vancomycin use should be limited to those cases where there are clearly needed. Methicillin resistant CoNS have become the predominant pathogen and increasing dramatically in hospitalized patients [35,36]. According to the current study, methicillin resistant CoNS were 77.3% which is in line with the study that reported 72.5% resistant strains [37]. The present study also showed a single isolate of CoNS resistant to vancomycin which is less from the isolates found India [37]. The emergence of vancomycin resistance in CoNS in our teaching hospital may pose therapeutic problems, and therefore the empirical antibiotic treatment of suspected infections caused by CoNS should be prescribed according to antimicrobial susceptibility testing.

The susceptibility testing of the gram-negative organisms; E. coli, P. aeruginosa and P. mirabilis showed that higher resistant to amoxycillin, ampicillin and ceftriaxone (β-lactam antibiotics). This high resistance of organisms to β-lactam is not surprising, as these antibiotics are the most commonly used antibiotics and resistant pattern were reported from many studies [14,22,28,36,38] in Northwest Ethiopia. Similarly, a study [39] in Europe reported the high resistance of E. coli and P. aeruginosa isolated from surgical wounds.

Majority of gram negative bacteria showed very high resistant to chloramphenicol, tetracycline and TMP-SMX. 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 [40].

P. aeruginosa were resistant to kanamycin (100%) and gentamycin (100%), while 33.3% were resistant to amikacin. This result is consistent with the data obtained by Clark in USA [37]. The isolation of aminoglycosides resistant P. aeruginosa might be plasmid mediated type of resistance leading to membrane impermeability. Regarding to E. coli isolate, more than 70.4% were resistant to kanamycin and amikacin while 59.2% were resistant to gentamycin. As many of the isolates were susceptible to gentamycin, the continued use of the drug in surgical conditions is thus indicated.

From the quinolones, ciprofloxacin was highly active against all gram-negative organisms examined. From this investigation, ciprofloxacin stands out to be the most effective antibiotic against pathogens associated with surgical wound infections. However, the level of resistance to ciprofloxacin is increasing from zero in the year 2000 [41] and 16.0% in the year of 2004 [28] to 27% in the present study (2010). Thus the frequency of single as well as multiple drug resistance was alarmingly high. This might be a reflection of inappropriate use of antimicrobials, lack of diagnostic laboratory services or unavailability of guideline regarding the selection of drugs that enforce to empirical treatment options.

The higher counts of bacteria obtained from the patients in the wards and from the hospital environment and are of great concern, highlighting the quality of wards and operating rooms, and the need for the attention of the hospital authorities to take necessary preventive measures to maintain a sound and healthy atmosphere for the patients, as well as the hospital personnel. 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. Future studies should be extended to include cultures under anaerobic conditions to establish presence of other organisms that require such environment to establish. It is also recommended that gentamicin, ciprofloxacin, vancomycin and clindamycin be preferred in preference to ampicillin and amoxycillin for treatment of post operative surgical site infections. In this study, anaerobic bacterial, fungal and viral agents were not investigated due to limited laboratory facilities and expertise.

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