Antimicrobial Susceptibility Pattern of Bacterial isolates from Pus samples at Kenyatta National Hospital, Kenya.

By

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DECLARATION

I declare that this dissertation is my original work and that it has not been presented and will not be presented to any other university for a similar or any other degree award.

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DEDICATION

This dissertation is dedicated to all clinicians and researchers. I hope this information will be useful.

ACKNOWLEDGMENT

To Almighty God, for his grace, love and faithfulness.

To my supervisors, for their overwhelming support.

To my parents, siblings and sister in law for their love, support and encouragement.

To all the staff at KNH medical microbiology department for their assistance and kindness.

To my biostatistician Francis, for his dedication to transform the data into valuable information.

To my friends, who have been with me through the journey.

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LIST OF ACRONYMS

KNH Kenyatta National Hospital

WHO World Health Organisation

CoNS Coagulase negative *Staphylococci*

ESBL Extended Spectrum Beta Lactamase

SPSS Statistical Package for Social Sciences

AMPI Ampicillin

GNB Gram negative bacteria

PBPs Penicillin binding proteins

U.o.N University of Nairobi

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ABSTRACT

Background

Antimicrobial resistance is not only increasing the healthcare costs but also the severity and death rates from certain infections that could have been avoided by prudent and rational use of the existing and newer antimicrobial agents. Emerging multidrug resistant strains and changing antimicrobial resistance pose challenge in treating pyogenic infections. This study will guide the clinician in choosing appropriate antimicrobials which not only contribute to better treatment but their judicious use will also help in preventing emergence of resistance to the drugs which are still sensitive.

Objective

This study aims to identify bacteria isolates from pus samples along with their antimicrobial susceptibility patterns at Kenyatta National Hospital.

Methodology

This was a retrospective study conducted at Kenyatta National Hospital medical microbiology laboratory involving review of patient's medical laboratory records of bacterial isolates from pus samples tested for antimicrobial susceptibility during the period January 2013 to December 2013. Information regarding the patient's age, sex, bacterial organisms isolated, department where the pus sample was obtained and antimicrobial susceptibility reports was extracted. This was collected in a data collection form which was used as a study instrument. Data analysis was done using SPSS version 21. (Statistical Package for Social Sciences).

Results

Out of four hundred and six pus samples, five hundred and eighteen organisms were isolated. *S.aureus* was the most frequent isolate (29.9%), followed by *Pseudomonas* spp (13.7%), *E.coli* (12%), *Proteus* spp (9.7%), *Klebsiella* spp (7.5%), *Acinetobacter* spp (7.1%), *Citrobacter* (6%), *Enterococcus* (4.6%), *Enterobacter* (4.4%), CONS (3.9%), *S.pyogenes* (0.8%), *S.agalactiae* (0.2%) and *S.viridans* (0.2%). Gram positive isolates were most

susceptible to vancomycin, levofloxacin, linezolid and teicoplanin. Majority of gram negative isolates were most sensitive to imipenem, meropenem, amikacin and levofloxacin. Most resistance of gram negative isolates was shown to ampicillin, augmentin, cotrimoxazole, doxycycline and cephalosporins.

Conclusion and Recommendations.

S.aureus was the predominant isolate. There was high resistance to the commonly used antimicrobials. 60.2% of the isolates were multi-drug resistant. There should be continuous surveillance to monitor aetiology and antimicrobial susceptibility patterns to guide the empirical use of antimicrobials.

CHAPTER 1

INTRODUCTION

1.1 **Background**

Antimicrobial resistance has increased drastically in recent years in both developed and developing countries and it has rapidly become a leading public health concern (Vila *et al.,* 2010). The global problem of antimicrobial resistance is particularly pressing in developing countries, where the infectious disease burden is high and cost constraints prevent the widespread application of newer more expensive agents (Okeke *et al.,* 2005).

Infections caused by resistant microorganisms often fail to respond to the standard treatment resulting in prolonged illness, higher health care expenditures and a greater risk of death. Antimicrobial resistance in addition hampers the control of infectious diseases by reducing the effectiveness of treatment thus patients remain infectious for a long time increasing the risk of spreading resistant microorganisms to others (WHO fact sheet 2014).

The antimicrobial agents are of great value for devising curative measures against bacterial infections. The use of antimicrobial agents for prevention or treatment of infections in any dose and over any time period, causes a "selective pressure" on microbial populations. According to some estimates as much as 50% of antimicrobials use is inappropriate because the uses do not benefit the patients. These uses do increase selection pressure for the emergence and spread of antimicrobial resistant bacteria. Indiscriminate prescription coupled with improper use of antimicrobials, the development of resistance inducing mutations and horizontal transfer of genes coding for antimicrobial resistance among bacteria has remained a major cause for development of resistance among microorganisms to previously sensitive antimicrobial agents.

The widespread use of antimicrobials, together with the length of time over which they have been available have led to major problems of resistant organisms, contributing to morbidity and mortality (Nwachukwu *et al.*, 2009).

In most developing countries like Kenya, patients are able to obtain antimicrobials across the pharmaceutical counters with or without a prescription from the medical practitioners. In addition, poor prescribing practices leading to irrational and unnecessary use of

antimicrobials together with proliferation of counterfeit drugs have led to gross resistance among bacterial organisms.

Pus infection patients are subjected to several factors that may be associated with multidrug resistant microorganism carriage such as inappropriate antibiotic treatment, chronic course of the wound and frequent hospital admission (Kandemir *et al.*, 2007).

The emergence of bacterial antimicrobial resistance has made the choice of empirical therapy more difficult and expensive (Andhoga *et al.*, 2002). Hence there is a requirement for regular screening of organisms causing various infections and to characterize their antimicrobial susceptibility pattern to commonly used antibiotics at the hospital, regional, national and global levels to guide the clinicians to select a relevant antimicrobial for empirical treatment of infections.

This study aims to identify bacteria isolates from pus samples along with their antimicrobial susceptibility patterns at Kenyatta National Hospital. The information obtained from this study will guide the clinician in choosing appropriate antimicrobials which not only contribute to better treatment but the judicious use will also help in preventing emergence of resistance to the drugs which are still sensitive. It will also be used to determine trends in antimicrobial susceptibilities and guide in formulation of local antibiotic policy.

1.2 **Literature review**

Suppuration, the formation of pus, is a common sequel of acute inflammation. Pus consists of living, dead and disintegrated neutrophils, living and dead microorganisms and the debris of tissue cells, all suspended in the inflammatory exudates. An abscess is a localized or discrete focus of pus. However, pus may occur diffusely in loose tissues or body cavities.

Bacterial infection is the usual cause of suppuration and such bacteria are said to be pyogenic (pus forming) and include *Staphylococcus aureus, Streptococcus pyogenes, Pseudomonas aeruginosa, Proteus* species, *Escherichia coli*, *Klebsiella* species, *Clostridium perfringes, Bacteroides* among others. Pyogenic infections are either polymicrobial or monomicrobial and they maybe endogenous or exogenous. Pyogenic infections occur in abscesses, chronic wounds from diabetic patients, decubitus ulcer or bed sores, burns wound infections, post-operative wound infections, cellulitis, bites, suppurative lymphadenitis, exudates from body cavities and pyomyositis.

Various studies across the globe have been consistent enough to show a predictable bacterial profile in pyogenic wound infections. This makes an important observation for a clinician who intends to start empirical treatment to his patients, while laboratory cultures reports are awaited.

A study on aerobic bacterial profile and antimicrobial susceptibility pattern of pus isolates in a South Indian tertiary care hospital revealed *Staphylococcus aureus* (24.29%) was the most common isolates, followed by *Pseudomonas aeruginosa* (21.49%), *Escherichia coli* (14.02%), *Klebsiella pneumonia* (12.15%), *Streptococcus pyogenes* (11.23%), *Staphylococcus epidermidis* (9.35%) and *Proteus* species (7.47%) (Rao *et al.,* 2014). Another study on isolation of different types of bacteria from pus revealed also *Staphylococcus aureus* to be the predominant microorganism (40%) followed by *Klebsiella* species (33%), *Pseudomonas* species (18%), *Escherichia coli* (16%), and *Proteus* species (7%) (Verma 2012).

A study done in a University teaching hospital in Nigeria, revealed *Staphylococcus aureus* (42.3%), *Pseudomonas aeruginosa* (32.9%), *Escherichia coli* (12.8%) and *Proteus mirabilis* (12.8%) are associated with surgical wound infections (Nwachukwu *et al.,* 2009). These findings agree with those reported in Kenya on surgical site infections, that *Staphylococcus aureus* was the most prevalent bacterial isolate (Dinda *et al.,* 2013). These findings also agree with a study done in Uganda that identified *Staphylococcus aureus* as the commonest causative agent of septic post-operative wounds (Anguzu *et al.,* 2007).

A study done on the bacteriology of surgical site infections in Karachi , revealed the most common pathogen isolate was *Staphylococcus aureus* (50.32%), followed by *Pseudomonas aeruginosa* (16.33%), *Escherichia coli* (14.37%), *Klebsiella pneumonia* (11.76%), *Streptococcus pyogenes* (1.30%), and miscellaneous gram negative rods (5.88%) including *Acinetobacter baumannii*, *Proteus mirabilis* and *Citrobacter diversus* (Mahmood 2010). A cross-sectional study designed to determine the distribution of the bacterial pathogens and their antimicrobial susceptibility from suspected cases of post-operative wound infections, also revealed *Staphylococcus aureus* (63%) was the most frequently isolated pathogenic bacteria, followed by *Escherichia coli* (12%), *Pseudomonas* species (9.5%), *Klebsiella* species (5%), *Proteus* species (3.5%) and coagulase negative *Staphylococcus* species (3.5%) (Shriyan *et al.,* 2010).

A study on microbiological profile of diabetic foot ulcers and its antibiotic susceptibility pattern in a teaching hospital in Gujarat, revealed that *Pseudomonas aeruginosa* (27%) was the most common isolate causing diabetic foot infections followed by *Klebsiella* species (22%), *Escherichia coli* (19%), *Staphylococcus aureus* (17%), *Proteus* species (7%), *Enterococci* (3%), *Acinetobacter* (2%), CoNS (2%) and *Providencia* (1%) (Mehta *et al.,* 2014). The predominance of gram negative bacilli in diabetic pus has also been reported in another study (Sivakumari *et al.,* 2009). However, *Staphylococcal* species was the primary pathogen in most of wound infections of diabetic patients (Daniel *et al.,* 2013).

A study done in a tertiary hospital, Pakistan on burn wounds, revealed *Staphylococcus aureus* (57.98%) to be the most causative organism in burn wound infections followed by *Pseudomonas aeruginosa* (19.33%), *Klebsiella pneumonia* (8.4%), *Proteus* species (4.2%), *Staphylococcus epidermidis* (3.36%), *Escherichia coli* and *Enterobacter* (2.52%) each, *Citrobacter* and *Serratia* (0.84%) each (Ahmed *et al.,* 2013). Though a study done in Ibadan, Nigeria on burn wound infections revealed *Klebsiella* species to be the most commonly isolated pathogen, constituting 34.4%, closely followed by *Pseudomonas aeruginosa* (29.0%) and *Staphylococcus aureus* (26.8%) (Kehinde *et al.,* 2004).

In a two year period study done on bacterial profile of burn wounds infections at a burn unit Nishtar hospital Multan , the frequency of gram negative organisms was found to be high with *Pseudomonas aeruginosa* (54.4%) being the most common isolate, followed by *Staphylococcus aureus* (22%), *Klebsiella* species (8.88%), *Staphylococcus epidermidis* (5.79%), *Acinetobacter* species (4.63%), *Proteus* species (2.70%) and *Escherichia coli* (1.54%) (Shahzad *et al.,* 2012).

A three year review of bacteriological profile and antibiogram on burn wounds isolates in Van,Turkey revealed the most frequent bacterial isolate was *Acinetobacter baumannii* (23.6%), followed by coagulase negative *Staphylococci* (13.6%), *Pseudomonas aeruginosa* (12%), *Staphylococcus aureus* (11.2%), *Escherichia coli* (10%), *Enterococcus* species (8.8%) and *Klebsiella pneumonia* (7.2%) (Bayram *et al.,* 2013).

Even though gram negative bacteria are being increased significantly but still *Staphylococcus aureus* is being continued as a major etiological agent of pyogenic infections.

1.3 **Antimicrobial resistance**

The prevalence of antimicrobial resistance varies greatly between and within countries and different pathogens. Also antimicrobial resistance patterns of bacteria isolates keep changing and evolving with time and place.

Data from the past several years show an increasing resistance to ampicillin, penicillin and amoxicillin which were considered first line drugs for treatment of pyogenic infections (Anguzu *et al.,* 2007, Shriyan *et al.,* 2010, Bindu *et al*., 2014).

A study on prevalence and antimicrobial susceptibility of bacteria isolated from skin and wound infections revealed gram positive cocci were highly sensitive to vancomycin, teicoplanin, linezolid and chloramphenicol and gram negative bacilli showed high degree of sensitivity to imipenem, piperacillin/tazobactam and aminoglycosides. The least sensitivity was exhibited for penicillin, ampicillin, tetracycline, cotrimoxazole and cephalosporins (Kaup *et al.,* 2014).

Gram positive isolates in pus were most susceptible to vancomycin, levofloxacin, oxacillicin and clindamycin whereas among the gram negative isolates in pus, the most susceptible drugs were piperacillin/tazobactam, levofloxacin, imipenem, aztreonam and amikacin (Rao *et al.,* 2014).

Rao *et al*., 2013, reported that out of 144 aerobic isolates from pus samples in post-operative wound infections 94.4% were sensitive to imipenem, 75.5% to amikacin, 27% to ciprofloxacin, 22.2% to gentamicin, 21.5% to cotrimoxazole, 12.5% to cefotaxime, 9.7% to ceftazidime and 6.25% to amoxicillin/clavulanic acid. All isolates were resistant to ampicillin. 33% of *Staphylococcus aureus* were sensitive to methicillin and among the CoNS, 58.3% were sensitive methicillin. All gram positive cocci isolated were sensitive to vancomycin and all gram negative isolates were sensitive to imipenem (Rao *et al*., 2013).

S.aureus isolates showed the highest resistance to penicillin (100%), ampicillin (95.5%), ceftriaxone (81.8%), vancomycin (65.2%) while the least resistance was exhibited to amoxicillin/clavulanic acid (30.3%). *Klebsiella* spp were resistant to gentamicin (100%), chloramphenicol(87.5%), ceftriaxone (87.5%) and ciprofloxacin (62.5%). *E.coli* spp were resistant to ampicillin (100%), gentamicin (46.7%), chloramphenicol(40%), ceftriaxone (40%) and ciprofloxacin (40%). *Proteus* spp were resistant to ampicillin(100%), chloramphenicol(66.7%), gentamicin (33.3%) and ceftriaxone (33.3%). *Pseudomonas* spp

were resistant to gentamicin (50%), chloramphenicol (100%), amoxicillin/clavulanic acid (100%), ampicillin (100%) and ceftriaxone (100%). All *proteus* and *pseudomonas* isolates were susceptible to ciprofloxacin. Isolates of CoNS showed 100% resistance to vancomycin, ceftriaxone, ampicillin and penicillin but sensitive to chloramphenicol. Single and multiple antimicrobial resistances were observed in 6.8% and 93.2% of the isolates, respectively. No bacterial isolates was found to be sensitive to all antibiotics tested (Dessalegn *et al*., 2014).

Aminoglycosides and quinolones were found to be the most susceptible drugs in aerobic bacterial isolates from wound infections (Al-azawi, 2013, Anguzu *et al.,* 2007).

Sensitivity of *S.aureus* isolates from burn wound infections at a hospital in Ethiopia were 93.9% vancomycin, 90.9% clindamycin, 86.4% kanamycin and 86.4% erythromycin. Resistance of *S.aureus* isolates above 50% rates was observed in penicillin, methicillin, polymyxin B and chloramphenicol 95.5%, 77.3%, 68.2% and 51.5% respectively (Tigist *et al*., 2012).

Acinetobacter isolates showed almost complete resistance to cephalosporins (cephalexin 98.7%, cefuroxime 98.2%, cefotaxime 93.2%, ceftriaxone 93.3%, ceftazidime 87.5%, cefaclor 97.4%), piperacillin (94.7%), gentamicin (81.3%), while lower rates of resistance were shown in amikacin 68.3% and ciprofloxacin 69.7%. The most effective antimicrobial drug was doxycycline with the lowest resistance rate of 22.1% (Elmanama 2006).

Azithromycin , gatifloxacin, amikacin, ampi/subbuctam and ciprofloxacin were found to be highly susceptible to gram negative organisms in pus while amikacin, azithromycin, ciprofloxacin, clindamycin, cloxacillin, chloramphenicol, moxifloxacin, linezolid and gatifloxacin were highly sensitive for gram positive organisms in pus (Verma *et al.,* 2012, Verma 2012).

However, most of gram negative isolates in diabetic foot ulcers were resistant to amikacin, piperacillin/tazobactam, gentamicin, ampicillin-sulbactam and gatifloxacin. The gram negative bacilli were highly sensitive to imipenem and polymyxin. 69.4% of GNB were ESBL producer. Gram positive isolates were found to be susceptible to vancomycin, linezolid, ampicillin/sulbactam, tetracycline and neomycin. 60% of *Staphylococcus aureus* were methicillin resistant and were sensitive to vancomycin and linezolid (Mehta *et al.,* 2014).

Gram negative organisms were highly resistant to ampicillin and ceftriaxone (β lactam antibiotics). Ciprofloxacin was highly active against all gram negative organisms and also gram positive cocci (Nwachukwu *et al.*, 2009).

100% vancomycin resistance *Staphylococcus aureus* was isolated from wounds of diabetic patients (Daniel *et al.*, 2013). In that study *Staphylococcus aureus* only showed sensitivity to gentamycin and tetracycline.

1.4 **Justification**

Antimicrobials provide the main basis for the therapy of microbial infections.

The inevitable consequence of the widespread use of antimicrobial agents has been the emergence of antimicrobial resistant pathogens.

Pus infection patients are subjected to several factors that may be associated with multidrug resistant microorganism carriage such as inappropriate antibiotic treatment, chronic course of the wound and frequent hospital admission (Kandemir *et al*, 2007).

In Kenya there has been limited data regarding the magnitude of pyogenic infections due to antimicrobial resistant pathogens as well as resistance to commonly prescribed antibiotics used in treatment of these infections. This gap makes the choice of empirical therapy more difficult to the clinician.

Rational use of antibiotics is known to improve treatment outcome, shortens duration of hospital stay and reduces the cost of treatment. This requires continuous surveillance of antimicrobial susceptibility pattern.

CHAPTER 2

2.1 **Research question**

What are the bacterial isolates from pus samples and their antimicrobial susceptibility pattern at KNH?

2.2 **General objective**

To identify the bacterial isolates from pus samples and their antimicrobial susceptibility pattern during the period January 2013 to December 2013 at the KNH.

2.3 **Specific objectives**

1. To identify the bacterial isolates from pus samples at KNH.
2. To determine the antimicrobial susceptibility pattern of the bacterial isolates from pus samples at KNH.

CHAPTER 3: METHODOLOGY

3.1 **Study area**

This study was conducted at the Kenyatta National Hospital medical microbiology laboratory. KNH is a National referral hospital located at Hospital road Upper Hill, Nairobi and as such receives large numbers of patients from different parts of the country. It also serves as a primary health care facility for a significant proportion of the population in Nairobi in the middle and lower socio economic classes. It has a bed capacity of 2000, 55 wards and 24 theatres.

3.2 **Study design**

This was a retrospective study involving review of patient's medical laboratory records for pus samples during the period January 2013 to December 2013.

3.3 **Study population**

Data from KNH medical microbiology laboratory records of bacterial isolates from pus samples tested for antimicrobial susceptibility during the period January 2013 to December 2013 was studied.

Pus samples from outpatient and inpatients wards of KNH received at KNH medical microbiology laboratory in which isolation and identification of organisms along with their antimicrobial susceptibility was done was included. Pus samples from eye, ear, nose and throat was excluded.

3.4 **Inclusion criteria**

Laboratory records of patients with bacterial isolates from pus samples tested for antimicrobial susceptibility during the period January 2013 to December 2013.

3.5 **Exclusion criteria**

Laboratory records of pus samples from eye, ear, nose and throat.

Laboratory records with incomplete data.

Laboratory records of pus samples with no bacterial growth.

Laboratory records of pus samples that grew fungi.

Laboratory records of bacterial isolates from pus samples not tested for antimicrobial susceptibility.

3.6 **Sample size**

The sample size was estimated using Fisher's formula (Fisher 1991).

The formula for sample size calculation used is; $N = Z^2PQ/d^2$,

Where: N = Minimum sample size

Z = Constant, standard normal deviation (1.96 for 95% confidence interval)

P = The prevalence of pyogenic infections in Kenya is unknown. Therefore 50% prevalence was assumed.

Q = 1-P

d = Acceptable margin of error

Z = 1.96

P =0.5

Q =0.5

d=0.5

$N = (1.96)^2 \text{ x}0.5\ (1\text{-}0.5)/\ (0.05)^2$

N = 384 was the minimal sample size.

3.7 **Sampling method**

The sampling frame was laboratory records of bacterial isolates from pus samples tested for antimicrobial susceptibility during the period January 2013 to December 2013 at KNH medical microbiology laboratory, and which met the inclusion criteria. Stratified random sampling was used to select the records. The records were first divided into relevant strata

(subgroups) depending on the various KNH departments where the pus sample was received from (outpatient, medical wards, surgical wards, burns unit, pediatric wards and obstetrics and gynaecological wards). A random sample was then selected from each stratum. Cases were selected in a way that ensured the same proportion from each stratum in the sample as exists in the population.

3.8 **Data collection**

Antimicrobial susceptibility reports of bacterial isolates from pus samples were reviewed from the patient's medical laboratory records. Information regarding the patient's age, sex, bacterial organisms isolated, department where the pus sample was obtained and antimicrobial susceptibility reports was extracted. This was collected in a data collection form which was used as a study instrument.

3.9 **Data management and analysis**

All the filled data collection forms were reviewed by the principle investigator to ensure they were completed appropriately. Data collected was then entered into an excel spreadsheet, later in a coded form into statistical package for social sciences (SPSS) version 21 for analysis in a password protected computer. Back up copies were stored in an external hard drive and compact disc which were in sole custody of principle investigator. The filled forms were in safe custody of the principle investigator who filed and stored them in a lockable cabinet for verification during analysis.

Data was summarized using descriptive statistics. Continuous variables such as age were summarized using measures of central tendency and dispersion (mean and median). Nominal variables such as number of organisms isolated were summarized using frequencies and percentages. The organisms isolated were compared with the antibiotics using pivot tables. This enabled us to determine sensitivity of each organism to each antibiotic.

3.10 **Ethical considerations**

Ethical clearance was sought from the Kenyatta National Hospital/ University of Nairobi ethics and research committee. Permission to extract data from the hospital registers and laboratory records was obtained from the Kenyatta National Hospital head of laboratory medicine. The study was a minimal risk study since there was no direct patient involvement but a retrospective review of the records. For confidentiality, the patient's laboratory records

were only used within the confines of the KNH microbiology laboratory and only the investigator had access to laboratory records for the purposes of this study. The patient's identifying information such as the name and hospital number were not included in the data collection forms. Raw data in filled forms, data stored in password protected computer and even the back up copies in hard drives and compact disc were destroyed at the end of the study.

3.11 **Study limitations**

Incomplete data. This was minimized by cross checking with the hospital registers and logbooks.

Lack of anaerobic bacteria profile done on pus samples.

CHAPTER 4

RESULTS

Laboratory records of pus samples from 406 patients were studied and analyzed. 196 (48.3%) were males and 210 (51.7%) were females. The highest contributor of pus samples was from the surgical wards (32.8%), followed by medical wards (25.1%), burns unit (16.3%), obsgynae wards (8.9%), out-patient dept. (8.4%), paediatric wards (6.4%) and ICU (2.2%).

Figure 1: Gender of the study population

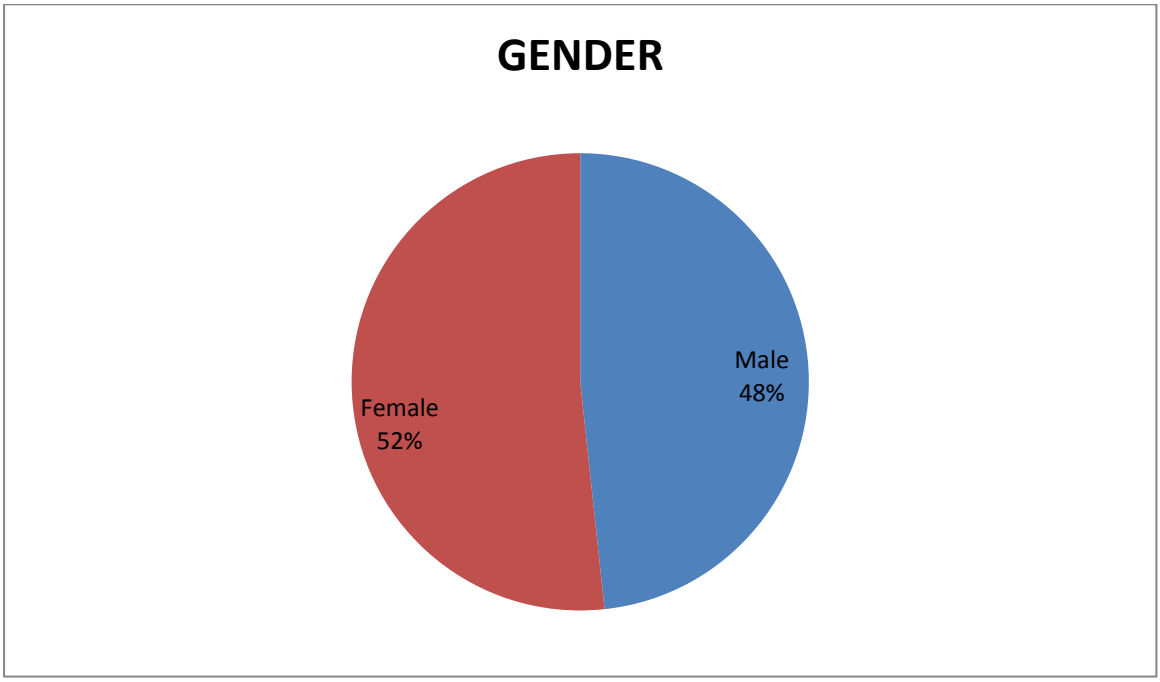


Table 1: Department distribution of pus samples.

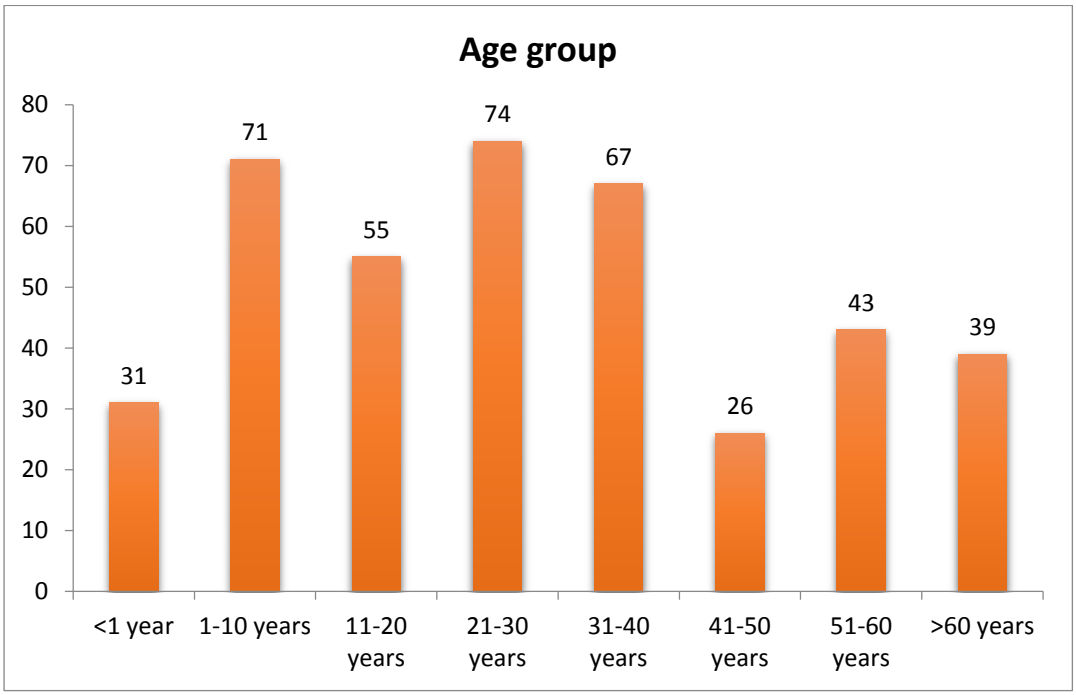
Department	**N= 406**	**%**
Burns unit	66	16.3%
ICU	9	2.2%
Medical wards	102	25.1%
Obsgynae wards	36	8.9%
Out-patient dept.	34	8.4%
Paediatric wards	26	6.4%
Surgical wards	133	32.8%

The ages of the study groups ranged from 3days-120 years with a mean of 29.14years and median of 26 years. Majority of the patients (18.2%) were in the age range group of 21-30years. Those aged <1 year of age were 7.6%, 17.5% were in the age range group of 1-10 years, 13.5% were in the age range group of 11-20 years, 16.5% were in the age range group of 31-40 years, 6.4% were in the age range group of 41-50 years, 10.6% were in the age range group of 51-60 years and 9.6% were in the age range group of >60 years.

Table 2: Age distribution of the study population.

Age group	N=406	%
<1 year	31	7.6%
1-10 years	71	17.5%
11-20 years	55	13.5%
21-30 years	74	18.2%
31-40 years	67	16.5%
41-50 years	26	6.4%
51-60 years	43	10.6%
>60 years	39	9.6%

Figure 2: Age distribution of the study population.



Five hundred and eighteen bacterial isolates were isolated from 406 pus samples. 304 (74.9%) samples yielded pure bacterial isolates while 102 (25.1%) yielded mixed bacterial isolates. 304 samples yielded only one organism, 92 samples yielded two organism and 10 samples yielded three organisms. Out of the 518 bacterial isolates, 313 were gram negative isolates and 205 were gram positive isolates.

Among the 518 bacterial isolates, *S.aureus* 155 (29.9%) was the most common isolated organism, followed by *Pseudomonas* spp 71(13.7%), *E.coli* 62 (12%), *Proteus* spp 50 (9.7%), *Klebsiella* spp 39 (7.5%), *Acinetobacter* spp 37 (7.1%), *Citrobacter* 31 (6%), *Enterococcus* 24 (4.6%), *Enterobacter* 23 (4.4%), CoNS 20 (3.9%), *S.pyogenes* 4(0.8%), *S.agalactiae* 1(0.2%) and *S.viridans* 1 (0.2%).

Table 3: Distribution of bacterial isolates from pus samples.

Organism	**N**	**%**
Staphylococcus aureus	155	29.9%
Pseudomonas spp	71	13.7%
E.coli	62	12%
Proteus spp	50	9.7%
Klebsiella	39	7.5%
Acinetobacter	37	7.1%
Citrobacter	31	6%
Enterococcus	24	4.6%
Enterobacter	23	4.4%
CoNS	20	3.9%
Streptococcus pyogenes	4	0.8%
Streptococcus agalactiae	1	0.2%
Streptococcus viridans	1	0.2%
Total	518	100%

Antimicrobial susceptibility patterns of different bacterial isolates.

S.aureus showed high sensitivity to most of the drugs tested(linezolid(100%), chloramphenicol (100%), piperacillin/tazobactam(100%), vancomycin(93.9%), teicoplanin(96.2%), amikacin (83.3%), cefepime(83.3%) levofloxacin(80%), augmentin(72.4%), doxycycline(75%), gentamycin(73.5%), cefuroxime(72.5%), cefotaxime(72.7%), imipenem(73.9%) and meropenem(71.4%). It was 100% resistant to benzylpenicillin. **Table 4: Antimicrobial susceptibility of *S.aureus.***

S.aureus	**Sensitivity n (%)**	**Resistant n (%)**
Ampicillin	19(41.3%)	27(58.7%)
Augmentin	84(72.4%)	32(27.6%)
Benzylpenicillin	0(0%)	16(100%)
Doxycycline	48(75%)	16(25%)
Gentamycin	61(73.5%)	22(26.5%)
Chloramphenicol	5(100%)	0(0%)
Cefuroxime	50(72.5%)	19(27.5%)
Piperacillin/tazobactam	2(100%)	0(0%)
Vancomycin	62(93.9%)	4(6.1%)
Ceftriaxone	45(68.2%)	21(31.8%)
Cefotaxime	8(72.7%)	3(27.3%)
Ceftazidime	11(40.7%)	16(59.3%)
Cefepime	5(83.3%)	1(16.7%)
Imipenem	17(73.9%)	6(26.1%)
Meropenem	15(71.4%)	6(28.6%)
Amikacin	5(83.3%)	1(16.7%)
Cotrimoxazole	16(48.5%)	17(51.5%)
Erythromycin	16(55.2%)	13(44.8%)
Ciprofloxacin	10(62.5%)	6(37.5%)
Levofloxacin	56(80%)	14(20%)
Linezolid	17(100%)	0(0%)
Clindamycin	4(66.7%)	2(33.3%)
Teicoplanin	125(96.2%)	5(3.8%)

Pseudomonas spp showed high sensitivity to amikacin (86.7%), ciprofloxacin (83.3%), meropenem (81.1%), piperacillin (80%), cefepime (76.3%), levofloxacin (77.4%) and imipenem(68.3%). High resistance was showed to ampicillin (100%), augmentin (100%), doxycycline (100%), cotrimoxazole (100%), cefuroxime (100%) ceftriaxone (81.4%) and cefotaxime (83.3%).

Table 5: Antimicrobial susceptibility of *Pseudomonas* spp.

Pseudomonas	**Sensitivity n (%)**	**Resistant n (%)**
Gentamycin	21(55.3%)	17(44.7%)
Piperacillin	4(80%)	1(20%)
Piperacillin/tazobactam	15(60%)	10(40%)
Ceftriaxone	8(18.6%)	35(81.4%)
Cefotaxime	4(16.7%)	20(83.3%)
Ceftazidime	23(54.8%)	19(45.2%)
Cefepime	29(76.3%)	9(23.7%)
Imipenem	28(68.3%)	13(31.7%)
Meropenem	43(81.1%)	10(18.9%)
Amikacin	39(86.7%)	6(13.3%)
Ciprofloxacin	20(83.3%)	4(16.7%)
Levofloxacin	24(77.4%)	7(22.6%)
Ticarcillin/clavulanic	1(50%)	1(50%)
Tazobactam	1(100%)	0(0%)
Ampicillin	0(0%)	3(100%)
Augmentin	0(0%)	3(100%)
Doxycycline	0(0%)	1(100%)
Cefuroxime	0(0%)	5(100%)
Cotrimoxazole	0(0%)	3(100%)

E.coli showed high sensitivity to piperacillin/tazobactam (100%), meropenem (100%), imipenem (90%), amikacin (81.5%), gentamicin (75%), chloramphenicol(100%) cefepime(66.7) and levofloxacin(60%). High resistance was showed to ampicillin (100%), cotrimoxazole (100%), augmentin (70.9%) and doxycycline (63.6%).

Table 6: Antimicrobial susceptibility of *E.coli.*

E.coli	**Sensitivity n (%)**	**Resistant n (%)**
Ampicillin	0(0%)	33(100%)
Augmentin	16(29.1%)	39(70.9%)
Doxycycline	8(36.4%)	14(63.6%)
Gentamycin	21(75%)	7(25%)
Cefuroxime	17(50%)	17(50%)
Piperacillin/tazobactam	9(100%)	0(0%)
Ceftriaxone	20(50%)	20(50%)
Cefotaxime	11(50%)	11(50%)
Chloramphenicol	3(100%)	0(0%)
Ceftazidime	14(46.7%)	16(53.3%)
Cefepime	10(66.7%)	5(33.3%)
Imipenem	18(90%)	2(10%)
Meropenem	33(100%)	0(0%)
Amikacin	22(81.5%)	5(18.5%)
Cotrimoxazole	0(0%)	7(100%)
Ciprofloxacin	5(45.5%)	6(54.5%)
Levofloxacin	18(60%)	12(40%)

Proteus spp showed high sensitivity to meropenem(100%), piperacillin/tazobactam(83.3%), imipenem(83.3%), amikacin(83.3%), levofloxacin(78.6%), chloramphenicol(71.4%) ciprofloxacin(70%), cefotaxime(66.7%) and ceftazidime(64.7%). The least sensitivity was showed to ampicillin(23.8%), doxycycline(25%) and cotrimoxazole(33.3%).

Table 7: Antimicrobial susceptibility of *Proteus* spp.

Proteus	**Sensitivity n (%)**	**Resistant n (%)**
Ampicillin	5(23.8%)	16(76.2%)
Augmentin	16(42.1%)	22(57.9%)
Gentamycin	11(52.4%)	10(47.6%)
Chloramphenicol	5(71.4%)	2(28.6%)
Cefuroxime	17(48.6%)	18(51.4%)
Piperacillin/tazobactam	5(83.3%)	1(16.7%)
Doxycycline	3(25%)	9(75%)
Ceftriaxone	22(61.1%)	14(38.9%)
Cefotaxime	14(66.7%)	7(33.3%)
Ceftazidime	11(64.7%)	6(35.3%)
Cefepime	8(57.1%)	6(42.9%)
Imipenem	15(83.3%)	3(16.7%)
Meropenem	23(100%)	0(0%)
Amikacin	15(83.3%)	3(16.7%)
Cotrimoxazole	3(33.3%)	6(66.7%)
Ciprofloxacin	7(70%)	3(30%)
Levofloxacin	22(78.6%)	6(21.4%)

Klebsiella spp showed high resistance to ampicillin (95.5%), augmentin (80.6%), cefuroxime (79.2%), piperacillin/tazobactam (100%), ceftriaxone (75.9%), cefotaxime (92.3%) and cotrimoxazole (100%). More than 50% sensitivity was shown to meropenem(90.5%), imipenem(88%), amikacin(76.9%) and levofloxacin(54.5%).

Table 8: Antimicrobial susceptibility of *Klebsiella* spp.

Klebsiella	**Sensitivity n (%)**	**Resistant n (%)**
Ampicillin	1(4.5%)	21(95.5%)
Augmentin	7(19.4%)	29(80.6%)
Doxycycline	7(43.8%)	9(56.2%)
Gentamycin	8(47.1%)	9(52.9%)
Cefuroxime	5(20.8%)	19(79.2%)
Piperacillin/tazobactam	0(0%)	5(100%)
Ceftriaxone	7(24.1%)	22(75.9%)
Cefotaxime	1(7.7%)	12(92.3%)
Ceftazidime	8(47.1%)	9(52.9%)
Cefepime	3(37.5%)	5(62.5%)
Imipenem	22(88%)	3(12%)
Meropenem	19(90.5%)	2(9.5%)
Amikacin	10(76.9%)	3(23.1%)
Cotrimoxazole	0(0%)	3(100%)
Ciprofloxacin	6(46.2%)	7(53.8%)
Levofloxacin	6(54.5%)	5(45.5%)

Acinetobacter spp showed resistance to most of the antibiotics tested in this study. High resistance was showed to ampicillin 100%, augmentin 96.7%, piperacillin/tazobactam 87.5%, cefuroxime 100%, ceftriaxone 92%, cefotaxime 91.7%, ceftazidime 88.9% and cotrimoxazole 100%, chloramphenicol 66.7%, cefepime 66.7%, ciprofloxacin 66.7%). It showed more than 50% sensitivity to gentamycin(50%), meropenem(58.8%) and amikacin(60%).

Table 9: Antimicrobial susceptibility of *Acinetobacter* spp.

Acinetobacter	**Sensitivity n (%)**	**Resistant n (%)**
Ampicillin	0(0%)	18(100%)
Augmentin	1(3.3%)	29(96.7%)
Doxycycline	4(40%)	6(60%)
Gentamycin	11(50%)	11(50%)
Chloramphenicol	1(33.3%)	2(66.7%)
Cefuroxime	0(0%)	24(100%)
Piperacillin/tazobactam	1(12.5%)	7(87.5%)
Ceftriaxone	2(8%)	23(92%)
Cefotaxime	1(8.3%)	11(91.7%)
Ceftazidime	2(11.1%)	16(88.9%)
Cefepime	4(33.3%)	8(66.7%)
Imipenem	7(43.8%)	9(56.2%)
Meropenem	10(58.8%)	7(41.2%)
Amikacin	6(60%)	4(40%)
Cotrimoxazole	0(0%)	2(100%)
Ciprofloxacin	3(33.3%)	6(66.7%)
Levofloxacin	5(35.7%)	9(64.3%)

Citrobacter showed sensitivity to amikacin(85.7%), piperacillin/tazobactam(80%), meropenem(76.5%), imipenem(75%), levofloxacin(69.2%), ciprofloxacin(66.7%), cefepime(54.5%) and doxycycline(50%). High resistance was showed to ampicillin (100%), augmentin (86.2%), cefuroxime (84.6%), cefotaxime (80%) and cotrimoxazole (100%).

Table 10: Antimicrobial susceptibility of *Citrobacter* spp.

Citrobacter	**Sensitivity n (%)**	**Resistant n (%)**
Ampicillin	0(0%)	14(100%)
Augmentin	4(13.8%)	25(86.2%)
Doxycycline	5(50%)	5(50%)
Gentamycin	8(42.1%)	11(57.9%)
Cefuroxime	2(15.4%)	11(84.6%)
Piperacillin/tazobactam	4(80%)	1(20%)
Ceftriaxone	7(35%)	13(65%)
Cefotaxime	1(20%)	4(80%)
Ceftazidime	8(40%)	12(60%)
Cefepime	6(54.5%)	5(45.5%)
Imipenem	9(75%)	3(25%)
Meropenem	13(76.5%)	4(23.5%)
Amikacin	6(85.7%)	1(14.3%)
Cotrimoxazole	0(0%)	1(100%)
Ciprofloxacin	2(66.7%)	1(33.3%)
Levofloxacin	9(69.2%)	4(30.8%)

Enterococcus showed sensitivity to most of the drugs tested. High sensitivity was showed to augmentin(100%), chloramphenicol(100%), ceftriaxone(100%), cefuroxime(100%), cefotaxime(100%), imipenem(100%), levofloxacin(100%), linezolid(100%), teicoplanin(91.3%), vancomycin(80%) and ampicillin(71.4%). The least sensitivity was showed to erythromycin(25%) and ciprofloxacin(42.9%). No isolate tested for cotrimoxazole was found to be sensitive.

Table 11: Antimicrobial susceptibility of *Enterococcus* spp.

Enterococcus	**Sensitive n (%)**	**Resistant n (%)**
Ampicillin	10(71.4%)	4(28.6%)
Augmentin	4(100%)	0(0%)
Doxycycline	5(55.6%)	4(44.4%)
Gentamycin	6(54.5%)	5(45.5%)
Chloramphenicol	6(100%)	0(0%)
Cefuroxime	1(100%)	0(0%)
Vancomycin	8(80%)	2(20%)
Ceftriaxone	1(100%)	0(0%)
Cefotaxime	1(100%)	0(0%)
Imipenem	1(100%)	0(0%)
Cotrimoxazole	0(0%)	2(100%)
Erythromycin	1(25%)	3(75%)
Ciprofloxacin	3(42.9%)	4(57.1%)
Levofloxacin	13(100%)	0(0%)
Linezolid	2(100%)	0(0%)
Teicoplanin	21(91.3%)	2(8.7%)

Enterobacter showed sensitivity to doxycycline(70%), chloramphenicol(50%), imipenem(77.8%), meropenem(86.7%), amikacin(55.6%), cotrimoxazole(100%), ciprofloxacin(50%) and levofloxacin(55.6%). High resistance was showed to cephalosporins, ampicillin and augmentin.

Table 12: Antimicrobial susceptibility of *Enterobacter* spp.

Enterobacter	**Sensitive n (%)**	**Resistant n (%)**
Ampicillin	0(0%)	7(100%)
Augmentin	1(4.5%)	21(95.5%)
Doxycycline	7(70%)	3(30%)
Gentamycin	5(38.5%)	8(61.5%)
Chloramphenicol	1(50%)	1(50%)
Cefuroxime	2(20%)	8(80%)
Piperacillin/tazobactam	2(40%)	3(60%)
Ceftriaxone	1(6.7%)	14(93.3%)
Cefotaxime	1(16.7%)	5(83.3%)
Ceftazidime	2(15.4%)	11(84.6%)
Cefepime	3(37.5%)	5(62.5%)
Imipenem	7(77.8%)	2(22.2%)
Meropenem	13(86.7%)	2(13.3%)
Amikacin	5(55.6%)	4(44.4%)
Cotrimoxazole	3(100%)	0(0%)
Ciprofloxacin	4(50%)	4(50%)
Levofloxacin	5(55.6%)	4(44.4%)

Coagulase negative *Staphylococci* showed high sensitivity to augmentin(75%), gentamycin(66.7%), cefuroxime(75%), chloramphenicol(100%), vancomycin(100%), imipenem(75%), erythromycin(66.7%), levofloxacin(63.6%), linezolid(100%) and teicoplanin(92.9%). The least sensitivity was showed to cotrimoxazole(33.3%) and ceftazidime(33.3%).

Table 13: Antimicrobial susceptibility of CoNS.

CoNS	**Sensitivity n (%)**	**Resistant n (%)**
Ampicillin	5(50%)	5(50%)
Augmentin	12(75%)	4(25%)
Doxycycline	2(40%)	3(60%)
Gentamycin	4(66.7%)	2(33.3%)
Chloramphenicol	1(100%)	0(0%)
Cefuroxime	9(75%)	3(25%)
Vancomycin	7(100%)	0(0%)
Ceftriaxone	5(41.7%)	7(58.3%)
Cefotaxime	2(40%)	3(60%)
Ceftazidime	1(33.3%)	2(66.7%)
Imipenem	3(75%)	1(25%)
Meropenem	1(50%)	1(50%)
Amikacin	1(50%)	1(50%)
Cotrimoxazole	1(33.3%)	2(66.7%)
Erythromycin	2(66.7%)	1(33.3%)
Levofloxacin	7(63.6%)	4(36.4%)
Linezolid	2(100%)	0(0%)
Teicoplanin	13(92.9%)	1(7.1)

Streptococcus pyogenes showed 100% sensitivity to all the drugs tested in this study.(ampicillin, augmentin, benzylpenicillin, doxycycline, cefuroxime, vancomycin, ceftriaxone, ceftazidime, erythromycin, levofloxacin and teicoplanin).

Streptococcus agalactiae showed 100% sensitivity to ampicillin, benzylpenicillin, vancomycin, cotrimoxazole, levofloxacin, linezolid and teicoplanin. It was only resistant to clindamycin(100%).

Streptococcus viridans showed 100% sensitivity to all drugs tested.(ampicillin, doxycycline, gentamycin, levofloxacin and teicoplanin).

Table 14: Multiple drug resistance patterns of bacterial isolates from pus samples.

Multiple drug resistance patterns of isolates n (%)

Organism	**R0**	**R1**	**R2**	**R3**	**R4**	**>R5**
S.aureus	60(38.7%)	35(22.6%)	12(7.7%)	17(11%)	15(9.7%)	16(10.3%)
Pseudomonas	11(15.5%)	15(21.1%)	17(23.9%)	9(12.7%)	11(15.5%)	8(11.2%)
E.coli	5(8.1%)	9(14.5%)	11(17.7%)	10(16.1%)	11(17.7%)	16(25.8%)
Proteus	10(20%)	11(22%)	9(18%)	1(2%)	5(10%)	14(28%)
Klebsiella	4(10.3%)	4(10.3%)	2(5.1%)	4(10.3%)	4(10.3%)	21(53.8%)
Acinetobacter	2(5.4%)	0	0	2(5.4%)	9(24.3%)	24(64.8%)
Citrobacter	1(3.2%)	4(12.9%)	6(19.4%)	4(12.9%)	3(9.7%)	13(42%)
Enterococcus	11(45.8%)	7(29.2%)	2(8.3%)	1(4.2%)	3(12.5%)	
Enterobacter	1(4.3%)	1(4.3%)	0	3(13%)	6(26.1%)	12(52.1%)
CONS	5(25%)	4(20%)	2(10%)	4(20%)	3(15%)	2(10%)
S.pyogenes	4(100%)					
S.agalactiae		1(100%)				
S.viridans	1(100%)					
Total	115(22.2%)	91(17.6%)	61(11.8%)	55(10.6%)	70(13.5%)	126(24.4%)

R0-sensitive to all antibiotics tested; R1, R2, R3, R4, >R5- resistant to one, two, three, four, more than five antibiotics respectively.

Among the total isolates, 312(60.2%) of them were resistant to two or more antibiotics (Multi-drug resistant). 115(22.2%) of the isolates were sensitive to all drugs tested. 91(17.6%) were resistant to only one drug tested.

CHAPTER 5

5.1 **DISCUSSION**

Five hundred and eighteen bacterial isolates were isolated from 406 pus samples. 304 (74.9%) samples yielded pure bacterial isolates while 102 (25.1%) yielded mixed bacterial isolates. Anguzu *et al.*,2007 also reported 27.3% of cultured samples had mixed growth while 72.7% had pure bacterial growth(Anguzu *et al.*,2007). Poly microbial isolates has been reported in other studies (Rao *et al.*, 2013, Al-azawi 2013, Dessalegn *et al.*, 2014).

The result of this study shows that *Staphylococcal aureus, Pseudomonas, Escherichia coli, Klebsiella, Proteus, Acinetobacter, Citrobacter, Enterobacter, Enterococcus,* coagulase negative *Staphylococci, Streptococcus agalactiae, Streptococcus pyogenes* and *Streptococcus viridans* are found in pus.

S.aureus was the predominant isolate (29.9%), followed by *Pseudomonas* (13.7%) in our study. This is in agreement with a study by Rao *et al.*, 2014 where *S.aureus* (24.29%) was the most common isolate followed by *Pseudomonas* (21.49%) (Rao *et al.*, 2014). However Verma 2012 reported *S.aureus* was the predominant microorganism (40%) followed by *Klebsiella* spp (33%) (Verma 2012).

In this study, gram positive isolates were most susceptible to vancomycin, levofloxacin, linezolid and teicoplanin. This findings are similar to those reported by Kaup *et al.,* 2014 that gram positive isolates were highly sensitive to vancomycin, teicoplanin, linezolid and chloramphenicol (Kaup *et al.*,2014).

S.aureus in this study is most sensitive to linezolid (100%) piperacillin/tazobactam (100%) chloramphenicol (100%), vancomycin (93.9%) and teicoplanin (96.2%). Similar studies have reported the same findings. Kaup *et al.*,2014 reported that *S.aureus* was sensitive to vancomycin (100%), teicoplanin (100%), chloramphenicol(90.48%) and linezolid(100%) (Kaup *et al.*,2014). Shriyan *et al.*, 2010 also reported *S.aureus* to be sensitive to vancomycin (100%), teicoplanin (100%) and linezolid (100%) (Shriyan *et al.*, 2010). However Daniel *et al.,* 2013 reported 100% vancomycin resistant *S.aureus* (Daniel *et al.,* 2013).

The least sensitivity to *S.aureus* was showed by ampicillin and ceftazidime. 100% resistant was observed to benzylpenicillin. Resistance of *S.aureus* to ampicillin and benzylpenicillin may be because of presence of plasmid mediated β lactamase producers and selection

pressure since this drugs are widely used. Concurrent administration of a β lactamase inhibitor like clavulanic acid markedly expands the spectrum of activity of acid resistant penicillins like ampicillin and amoxycillins. The β lactamases inhibitor are potent inhibitor of bacterial β lactamases.

In this study also, *S.aureus* showed high sensitivity to older drugs like chloramphenicol and doxycycline which means exposure of bacteria only to newly developed antibiotics eliminated resistance against older out of use antibiotics and present bacterial strains have grown sensitive to these outdated agents. Seven isolates of *S.aureus* in this study tested for susceptibility to methicillin were all resistant and were found to be sensitive to vancomycin. Altered target PBP are the basis of methicillin resistance. The organisms produce PBP that have low affinity for binding β lactam antibiotics.

In this study the majority of gram negative isolates were most sensitive to imipenem, meropenem, amikacin and levofloxacin. This is in agreement with the study Rao *et al.,* 2014 that gram negative isolates were most susceptible to levofloxacin, imipenem, amikacin and also piperacillin/tazobactam (Rao *et al.,* 2014). Gram negative isolates in this study showed better sensitivity to amikacin than gentamycin.

Gram negative isolates in this study showed a high antimicrobial resistance. Most resistance of gram negative isolates in this study was shown to ampicillin, augmentin, cotrimoxazole, doxycycline and cephalosporins. This could be because they are being indiscriminately used on empirical basis for prolonged duration of time. Resistance to penicillins by gram negative bacteria is because of impaired penetration to target PBP because of impermeable outer cell wall membrane. Also efflux which consists of cytoplasmic and periplasmic protein component that efficiently transport some β lactam antibiotics from the periplasmic back across the outer membrane.

Resistance of gram negative bacteria to cephalosporins may be due to production of extended spectrum β lactamases that hydrolyzes the compounds, though in our study we did not test for ESBL producer isolates. Resistance to doxycycline may be due to Tet (AE) efflux pump and ribosomal protection protein expressing gram negative bacteria.

Pseudomonas spp was highly sensitive to meropenem (81.1%) amikacin (86.7%), piperacillin (80%) ciprofloxacin (83.3%) and levofloxacin (77.4%). This findings were similar from studies that showed *Pseudomonas* spp were most sensitive to carbapenems,

aminoglycosides, and the quinolones (Kaup *et al.,* 2014, Bayram *et al.*,2013, Mahmood 2000).

E.coli showed high sensitivity to chloramphenicol (100%), piperacillin/tazobactam (100%), imipenem (90%) meropenem (100%) and amikacin (81.5%). This findings are also similar from a study by Kaup *et al.*,2014 that showed *E.coli* was most sensitive to piperacillin/tazobactam (100%), imipenem (100%), amikacin (90.48%) and chloramphenicol (85.71%) (Kaup *et al.*,2014). Mahmood 2000 also reported *E.coli* was most sensitive to piperacillin/tazobactam (100%), imipenem (100%) meropenem (100%) and amikacin (95.45%) (Mahmood 2000).

Proteus showed most sensitivity to amikacin (83.3%), piperacillin/tazobactam (83.3%), imipenem (83.3%), meropenem (100%) and levofloxacin (78.6%). The results are also similar to those by Rao *et al.*,2014 that showed *Proteus* to be sensitive to piperacillin/tazobactam (75%), imipenem (100%), levofloxacin (87%) and amikacin (75%) (Rao *et al.*,2014).

Klebsiella showed more than 50% sensitivity only to imipenem, meropenem, amikacin and levofloxacin. This is similar to those by Rao *et al*., 2014 that showed *Klebsiella* to be most sensitive to imipenem(76.92%), levofloxacin(76.92%) and amikacin(76.92%)..

Acinetobacter spp in this study was resistant to most of the antibiotics tested. Sensitivity was shown to gentamycin, meropenem and amikacin. *Acinetobacter* strains are often resistant to antimicrobial agents and therapy of infection can be difficult. Contrary to our findings Bayram *et al.*,2013 reported that *Acinetobacter* strains were highly resistant to ceftazidime, piperacillin/tazobactam, imipenem, meropenem, gentamicin, cefepime, ciprofloxacin and amikacin. In that study, *Acinetobacter* strains were sensitive to tigecycline and colistin (Bayram *et al.*,2013). *Acinetobacter* strains can be treated with carbapenems, lactamase inhibitors such as sulbactam, tigecycline, aminoglycosides such as tobramycin and amikacin, and also polymyxin B.

In this study , among the total isolates, 312(60.2%) of them were resistant to two or more antibiotics (Multi-drug resistant). 115(22.2%) of the isolates were sensitive to all drugs tested. 91(17.6%) were resistant to only one drug tested. Multiple drug resistant isolates has been also reported in other studies (Dessalegn *et al.*, 2014, Muluye *et al.*, 2014, Raza *et al.*,

2013). Multi- drug resistant isolates may be due to empirical usage of broad spectrum antibiotics and non adherence to a hospital antibiotic policy.

The limitations of this study was that limited number of antimicrobials were used to test some isolates. Since it being a retrospective study some of the data registered were incomplete and therefore not included. We also failed to include more variables because of unavailability.

5.2 **CONCLUSION**

Staphylococcal aureus was the most common isolate from pus. There was high resistance to the commonly used antimicrobials. 60.2% of the isolates were multidrug resistant.

5.3 **RECOMMENDATIONS**

I. Antimicrobial susceptibility testing be carried out on isolates of pus before chemotherapy to avoid selection of drug resistant strains.

II. Continuous surveillance to monitor aetiology and antimicrobial susceptibility patterns both in the community and hospital settings to guide the empirical use of antimicrobials.

III. National surveillance of antibiotic resistant organisms and increasing awareness among the population to the hazards of inappropriate antimicrobial use through public health education campaigns.

IV. Chloramphenicol should replace the penicillins in the empirical choice of antimicrobials.

V. Appropriate antimicrobials should be used to test the isolates.

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APPENDIX

Appendix 1: Data collection form

Antimicrobial susceptibility pattern of bacterial isolates from pus samples at Kenyatta National Hospital, Kenya.

Study number ……

A. Socio demographic characteristics

Age of patient…….years

Sex

Male ☐

Female ☐

B. Area from which the specimen was obtained

Outpatient ☐ Paediatric wards ☐

Medical wards ☐ Obstetrics and Gynaecological ward ☐

Surgical wards ☐ Others (Specify) ☐

Burns unit ☐

C. Organism isolated

Staphylococcus aureus ☐

Pseudomonas aeruginosa ☐

Escherichia coli ☐

Klebsiella pneumonia ☐

Proteus species ☐

Streptococcus pyogenes ☐

CoNS ☐

Acinetobacter ☐

Enterococcus ☐

Citrobacter ☐

Enterobacter ☐

Others ☐ Specify…….

D. Antimicrobial susceptibility pattern

Antimicrobial	**Sensitive (S)**	**Resistant (R)**
Amoxicillin	☐	☐
Ampicillin	☐	☐
Amoxy/clav (Augmentin)	☐	☐
Penicillin G	☐	☐
Doxycycline	☐	☐
Gentamycin	☐	☐
Chloramphenicol	☐	☐
Cefuroxime	☐	☐
Piperacillin	☐	☐
Piperacillin/tazobactam	☐	☐
Tazobactam	☐	☐
Methicillin	☐	☐
Vancomycin	☐	☐
Ceftriaxone	☐	☐
Cefotaxime	☐	☐

Antimicrobial	Sensitive (S)	Resistant (R)
Ceftazidime	☐	☐
Cefepime	☐	☐
Imipenem	☐	☐
Meropenem	☐	☐
Amikacin	☐	☐
Cotrimoxazole	☐	☐
Erythromycin	☐	☐
Ciprofloxacin	☐	☐
Levofloxacin	☐	☐
Linezolid	☐	☐
Clindamycin	☐	☐
Teicoplanin	☐	☐
Ticarcillin/clavulanic	☐	☐