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# Antibiotic Susceptibility Patterns of Bacteria Associated with Sepsis among Hospitalized Patients in the Yaoundé University Teaching Hospital—Cameroon

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## Abstract

**Background and Objective:** In developing countries, the steep increase in septicaemia cases is a major health problem that creates the biggest challenge for clinicians in the selection of appropriate antimicrobial agents. This is further complicated by the development of resistance in organisms to antimicrobial agents, which is the mainstay of treatment. The aim of this study was to determine the antimicrobial resistance patterns of bacterial isolates associated with sepsis among hospitalized patients including the detection of Methicillin Resistance *Staphylococcus aureus* (MRSA) and Extended Spectrum Beta lactamases (ESBLs). **Methods:** A cross-sectional study was carried out for 5 months at the Yaounde University Teaching Hospital. Bacterial species were isolated from 150 blood samples collected from hospitalized patients. Antimicrobial susceptibility testing was carried out using the Kirby-Bauer disc diffusion method. The isolates were tested for methicillin resistance and ESBLs. **Results:** The prevalence of septicaemia was 16% (24/150) among hospitalized patients. In our study, 75% (18/24) of infections were caused by Gram-negative and 25% (6/24) by Gram-positive bacteria. *Klebsiella spp., Escherichia coli,* and *Staphylococcus aureus* were the most common isolates. The antibiotic susceptibility patterns of the isolates showed that Gram-negative bacteria were highly resistant to Amoxicillin clavulanic acid and ceftriaxone while the Gram-positive bacteria were highly resistant to minocycline. Fifty percent (3/6) of the isolated *S. aureus* were methicillin-resistant and 27.8% (5/18) of the isolated Enterobacteriaceae were ESBLs producers. In multivariable logistic regression analysis, temperature above 37.9˚C (AOR = 4.455; 95% Cl = 1.458 -

15.693; p = 0.033) and being under respiratory assistance (AOR = 4.311; 95% Cl = 1.458 - 12.749; p = 0.008) were significantly associated with septicaemia. **Conclusion:** The Occurrence of multidrug-resistant strains in this study emphasizes the need for continuous surveillance in hospitals to detect resistant strains. Strict guidelines for antibiotic therapy and the implementation of infection control measures to reduce the increasing burden of antibiotic resistance are advocated.

### Keywords

Septicaemia, ESBLs, MRSA, Antimicrobial Resistance, Yaoundé

## 1. Introduction

Sepsis (septicaemia) is a life-threatening condition having a high prevalence in middle and low-income countries [1]. For its management, a timely and effective application of antibiotics is crucial to preside over the morbidity and mortality of the infection [2] [3]. Antibiotics are useful for infection control, but their misuse and overuse have induced antibiotic resistance in various pathogens putting the world at risk [4]. This growing threat prompted the World Health Organization to issue a global action plan for antimicrobial resistance [4]. The Centre for Disease Control and Prevention (CDC) has classified Methicillin-Resistant *Staphylococcus aureus* (MRSA) and Extended-spectrum beta-lactamase-producing Enterobacteriaceae together with other Multidrug-Resistant (MDR) bacteria as serious threats [4]. Several studies have demonstrated the high mortality attributable to bloodstream infections due to these MDR organisms [5] [6] [7] [8]. The emergence and global spread of multidrug resistant bacteria, in hospital and community settings, limits the use of therapeutic options, especially for people with co-morbidity conditions such as cancers and Human Immunodeficiency Virus (HIV) [9].

In Cameroon, previous studies reported a high prevalence rate of septicaemia [10] [11], yet there is limited information on the aetiology of MDR bacteria causing septicaemia. This study was therefore carried out to determine the antimicrobial resistance patterns of bacterial isolates associated with sepsis among hospitalized patients including the detection of MRSA and Extended Spectrum Beta lactamases (ESBLs) at the Yaoundé University Teaching Hospital. This research will contribute to the knowledge of drug-resistant bacteria causing septicaemia and the factors predisposing the infection in our hospital setting. It will also contribute to ensuring appropriate treatment of patients and prevent further development of drug resistance.

## 2. Material and Methods

### 2.1. Study Design and Setting

This cross-sectional study was conducted from November 2021 to March 2022 at the Yaoundé University Teaching Hospital, in the central region of Cameroon.

The study population consisted of hospitalized patients presenting attending the different ward of the selected facility and presenting sign and symptoms of septicaemia (which included fever or hyperthermia, tachycardia, and tachypnea with suspected or defined sites of infection, was considered eligible for the study). Exclusion criteria were 1) Patients or Carers who have not given consent and 2) Patients that could not provide a blood sample. The sample size was determined using single population proportion formula with a prevalence value (p = 9.8%) taken from a previous study [12] and a 95% confidence interval (CI). Consecutive sampling technique was used to recruit our participants.

## 2.2. Ethical Statement

The study was conducted following the Declaration of Helsinki, and the protocol was approved by the Faculty of Health Science Institutional Review Board (Ref. 2022/1608-02/UB/IRB/FHS) and the Yaoundé University Teaching Hospital (No 4593/AR/CHUY/DG/DGA/CAPRC). Participation was voluntary and each subject involved in the study gave a written consent

## 2.3. Blood Culture and Identification of Isolates

Aseptically, approximately 2 - 5 ml of blood from children and 8 - 10 ml of blood from the adult, was obtained after cleaning the venous site with 70% alcohol and subsequently with a 10% povidone-iodine solution. The collected venous blood was immediately inoculated into blood culture bottles containing Tryptone Soy Broth (TSB) (Oxoid, Hampshire, UK). The culture bottles were immediately transported from the sites of collection (the different wards) to the laboratory, where they were incubated at 37˚C and inspected daily for the presence of visible microbial growth for 7 days. The appearances of discrete colonies, turbidity of the broth, gas production, hemolysis and/or coagulation of broth were the different characteristics inspected daily. Depending on the initial Gram reaction, microbial growth was subculture on blood, chocolate and MacConkey agar plates and was incubated at 37˚C for 18 - 24 h for bacterial isolation. The blood and MacConkey agar plates were incubated aerobically while chocolate agar + polyvitex was incubated in a microaerophilic atmosphere (5% - 10% $CO_2$) in an anaerobic jar. In case of no microbial growth, systematic subculture was done the 3rd and 7th day on blood agar and chocolate + polyvitex agar aimed at recovering fastidious bacteria. Identification of culture isolates was done according to standard bacteriological techniques and their characteristic appearance on their respective media, Gram smear technique, haemolytic activities on blood agar, catalase, coagulase, mannitol fermentation and Dnase for Gram-positive bacteria were used. Whereas for Gram-negative bacteria, API20E (Biomerieux, France) and oxidase were used as described by the manufacturer's instructions.

## 2.4. Antibiotic Susceptibility Test

The antibiogram was performed by the diffusion method using antibiotic discs on Mueller Hinton agar according to the Kirby Bauer technique. The isolates were tested against Amoxicillin + clavulanic acid (20 µg), Ticarcilline (75 µg) Cefoxitin (30 µg), Ceftazidime (30 µg), Imipenem (10 µg), Aztreonam (30 µg), Levofloxacin (5 µg), Ciprofloxacin (5 µg), Amikacin (30 µg), Gentamicin (10 µg), Nitrofurantoin (100 µg), Netilmicine (10 µg), Minocycline (30 µg), Tetracycline (30 µg), Norfloxacine (10 µg), Vancomycin (30 µg), Clindamycin (2 µg) and Erythromycin (15 µg). The inoculums were prepared from an 18 - 24-hour pure colony culture in sterile physiological water (0.85% NaCl). The bacterial suspension was adjusted to 0.5 MacFarland standards and was inoculated onto Mueller Hinton agar. The results were interpreted following the CASFM-EUCAST (Comite d'Antibiogramme de la Societe Francaise de Microbiology/The European Committee on Antimicrobial Susceptibility Testing) 2021 criteria [13].

### 2.5. Phenotypic Characterization of the Identified Strains

Detection of Extended Spectrum Beta-lactamases (ESBLs) in Enterobacteriaceae; The screening test for the production of ESBL was performed using both ceftazidime (30 µg) and Ceftriaxone (30 µg) disks. If the zone of inhibition was less than or equal to 22 mm for ceftazidime and/or less than or equal to 25 mm for Ceftriaxone, the Enterobacteriaceae isolate was considered a potential ESBL-producer as recommended by the CASFM-EUCAST 2021 [13]. Double Disk Synergy Test was used to confirm the production of ESBL. It was done by placing discs containing cefotaxime (30 µg), ceftazidime (30 µg) and aztreonam (30 µg) 15 mm to the disc with clavulanic acid (amoxicillin-clavulanic acid). A positive result was indicated when the inhibition zones around any of the cephalosporin discs increased in the direction of the disk containing clavulanic acid.

Detection of Methicillin-Resistant *Staphylococcus aureus*; Strain with Cefoxitin (30 ug disk) zone diameter < 22 mm was reported as methicillin-resistant, following the CASFM-EUCAST recommendation [13].

### 2.6. Data Analysis

The Data was entered into Statistical Package for Social Sciences (SPSS), Chicago, IL, the USA for Windows, version 25. Data were analyzed using descriptive statistics; this included the use of tables and percentages to explain the results. Bivariate and multivariate logistic regression analyses were performed to evaluate the association between variables and septicaemia. Variables with a p-value < 0.25 in the bivariable logistic regression model were subsequently analyzed in the multivariable logistic regression to control the confounding factors and a p-value < 0.05 from multivariable logistic regression was considered statistically significant.

## 3. Results

### 3.1. Sociodemographic Characteristics

A total of 150 symptomatic patients were included in this study, the mean age was 50.03 ± 18.655 years. The youngest was 10 years and the oldest was 92 years. The majority of the participants were aged above 60 years old. Of the 150 included participants, the dominant gender [78 (52.0%)] was male, while 72 (48.0%) were female. All participants had some level of education and 50.7% (76/150) of the participants came from the emergency department. Other socio-demographic characteristics are illustrated in Table 1.

### 3.2. Prevalence of Septicaemia

Out of the 150 blood samples processed for culture, 24 (16.0%) cultures showed

Table 1. Sociodermographic characteristics.

| Characteristics | Total (n = 150) | |
|---|---|---|
| | Participants (n) | Percentage (%) |
| **Age-group/years** | Mean ± SD (50.03 ± 18.655) | |
| ≤20 | 13 | 8.7 |
| 21 - 30 | 13 | 8.7 |
| 31 - 40 | 18 | 12.0 |
| 41 - 50 | 25 | 16.7 |
| 51 - 60 | 35 | 23.3 |
| >60 | 46 | 30.7 |
| **Gender** | | |
| Male | 78 | 52.0 |
| Female | 72 | 48.0 |
| **Level of Education** | | |
| Primary | 46 | 30.7 |
| Secondary | 57 | 38.0 |
| Tertiary | 47 | 31.3 |
| **Occupation** | | |
| Student | 19 | 12.7 |
| Self-employed | 41 | 27.3 |
| Employed | 26 | 17.3 |
| Unemployed | 64 | 42.7 |
| **Department (service)** | | |
| Emergency | 76 | 50.7 |
| Pediatric | 9 | 6.0 |
| Internal medicine | 34 | 22.7 |
| Reanimation | 23 | 15.3 |
| Surgical ward | 8 | 5.3 |

bacterial growth and thus bacteriologically confirmed septicaemia. No growth was observed in 126/150 (84.0%) blood culture sets. A high number of the positive case was seen in patients aged above 60 years old [9/24 (37.5%)] and male patients [17/24 (70.8%) of the positive cases].

### 3.3. Bacteria Isolates of Blood Culture among Study Participants

A total of 24 (16%) bacterial pathogens were isolated from 150 blood culture sets. The majority [18/24 (75%)] of the isolates responsible for septicaemia were Gram-negative (Enterobacteriaceae) whereas Gram-positive (cocci) bacteria accounted for [6/25 (25.0%)]. In the case of Gram-negative bacteria, *Klebsiella spp* [8/22 (33.3%)] was the most frequently isolated organism, followed by *E. coli* [6/24 (25.0%)], *Acinetobacter spp* [2/24 (8.3%)], *Enterobacter cloacae* [1/24 (4.2%)] and *Serratia marcescens* [1/24 (4.2%)]. While *S. aureus* was the only isolated Gram-positive bacteria, accounting for 25.0% (6/24) (Figure 1). It is to be noted that only monobacterial infection was observed in all cases.

### 3.4. Antimicrobial Resistance Patterns of Blood Culture Isolates

The blood culture isolates were tested against specific antibiotics and their susceptibility to these drugs was recorded in Table 2 and Table 3. The antimicrobial susceptibility patterns of Enterobacteriaceae showed a high level of resistance of *Klebsiella* species to amoxicillin-clavulanic acid [7/8 (87.5%)], ticarcillin [6/8 (75%)], ceftazidime [6/8 (75%)] and ceftriaxone [6/8 (75%)]. *E. coli* showed a 100% resistance to Amoxicillin-clavulanic acid and Ticarcillin. Also, the *Acinetobacter species* showed a high level of resistance to ceftazidime and ceftrixone at 100%. *Enterobacter cloacae* isolate was highly resistant to the majority of the antibiotics except for ciprofloxacin and gentamicin. *Serratia mercescens* was resistant to amoxicillin-clavulanic acid only (Table 2). *S. aureus* showed a high level of resistance to minocycline [4/6 (66.7%)]. However, the isolates showed a low

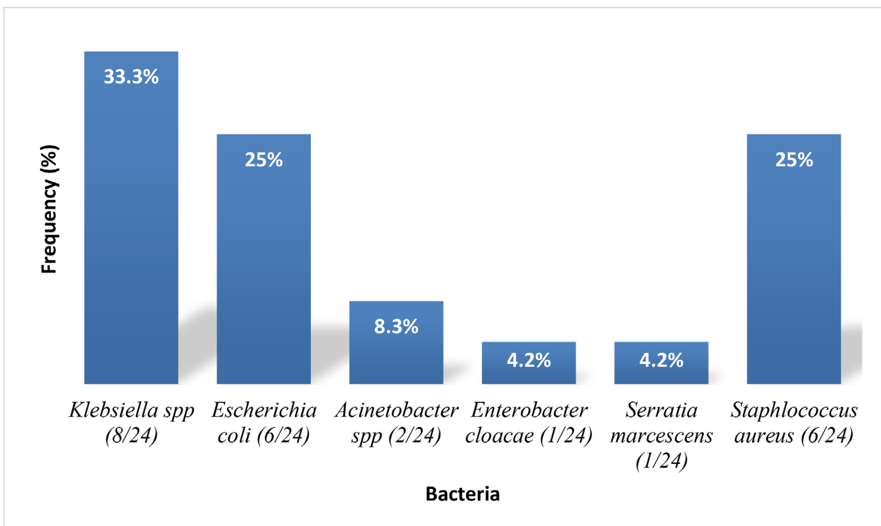


Figure 1. Frequency of bacteria isolated.

Table 2. Antimicrobial resistance patterns of Gram-negative bacteria.

| Bacteria species | Antimicrobial Agent tested | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AMC | TIC | FOX | CAZ | CRO | IMP | ATM | LEV | CIP | AN | GM | NIT |
| *Klebsiella spp* (n = 8) | 87.5 (7) | 75 (6) | 25 (2) | 75 (6) | 75 (6) | 12.5 (1) | 62.5 (5) | 25 (2) | 50 (4) | 25 (2) | 62.5 (5) | 37.5 (3) |
| *E. coli* (n = 6) | 100 (6) | 100 (6) | 0 | 83.3 (5) | 83.3 (5) | 16.7 (1) | 66.7 (4) | 50 (3) | 66.7 (4) | 16.7 (1) | 16.7 (1) | 16.7 (1) |
| *Acinetobacter spp* (n = 2) | 50 (1) | 50 (1) | 50 (1) | 100 (2) | 100 (2) | 50 (1) | 50 (1) | 50 (1) | 0 | 50 (1) | 0 | 50 (1) |
| *Entrobacter clocacae* (n = 1) | 100 (1) | 100 (1) | 100 (1) | 100 (1) | 100 (1) | 100 (1) | 100 (1) | 100 (1) | 0 | 100 (1) | 0 | 100 (1) |
| *Serracia mercesceus* (n = 1) | 100 (1) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | 88.9 (16) | 77.8 (14) | 22.2 (4) | 77.8 (14) | 83.3 (15) | 22.2 (4) | 61.1 (11) | 38.9 (7) | 44.4 (8) | 27.8 (5) | 33.3 (6) | 33.3 (6) |

AMC = Amoxiciline clavulanic acide; TIC = Ticarcilline; FOX = cefoxitin, CAZ = Ceftazidime, IMP = Imipenem; ATM = Aztreonam; LEV = Levofloxacin; CIP = Ciprofloxacine; AN = Amikacine; GM = Gentamicin; NIT = Nitrofurantoin.

Table 3. Antimicrobial resistance pattern of Gram-positive bacteria.

| Bacteria species | Antimicrobial agent tested | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FOX | CN | NET | MIN | TET | CIP | NOR | VA | CM | E |
| *S. aureus* (6) | 50.0 (3) | 16.7 (1) | 33.3 (2) | 66.7 (4) | 50.0 (3) | 50.0 (3) | 33.3 (2) | 16.7 (1) | 33.3 (2) | 50.0 (3) |

FOX = Cefoxitin; CN = Gentamicin; NET = Netilmicine; MIN = Minocycline; TET = Tetracycline; CIP = Ciprofloxacin; NOR = Norfloxacin; VA = Vancomycin; CM = Clindamycine; E = Erythromycin.

level of resistivity (sensitive) to Vancomycin [1/6 (16.7%)], Gentamicin [1/6 (16.7%)], Ciprofloxacin [2/6 (33.3%)], Clindamycin [2/6 (33.3%)] and Netilmicine [2/6 (33.3%)] (Table 3).

### 3.5. Multidrug Resistance (MDR)

Out of the 25 bacterial isolates, MDR was found in 19 (76%). Among these MDR isolates, 14 isolates (77.8%) were Gram-negative bacteria and five (83.3%) were Gram-positive bacteria. The MDR patterns of Gram-positive bacteria consist of 5/6 (83.3%) of S. aureus. MDR patterns of Gram-negative bacteria comprise 2/2 (100%) *Acinetobacter spp*, 1/1 (100%) of *Enterobacter clocacae*, 6/8 (80%) of *Klebsiella spp* and 5/6 (83.3%) of *E. coli* (Table 4).

### 3.6. Phenotypic Resistance

Among the isolated Enterobacteriaceae (Gram-negative bacteria), Extended Spectrum Beta-lactamase (ESBLS) was expressed by 5 of the 18 isolates, giving a prevalence of 27.8%. ESBLS was expressed only by the *Klebsiella spp* and *E. coli* with both accounting for 60% (3/5) and 40% (2/5) of the positive case respectively.

**Table 4.** Occurrence of Multi-drug resistance bacteria.

| Bactria species | Resistance to one class of drug | Resistance to two classes of drugs | MDR (≥3 class) | ESBLS production | MRSA |
|---|---|---|---|---|---|
| *Klebsiella spp* (n = 8) | - | 2 (20%) | 6 (80%) | 3 (37.5%) | - |
| *E. coli* (n = 6) | - | 1 (16.7%) | 5 (83.3%) | 2 (33.3%) | - |
| *Acinetobacter spp* (n = 2) | - | - | 2 (100%) | - | - |
| *Enterobacter clocacae* (n = 1) | - | - | 1 (100%) | - | - |
| *Serratia mercesceus* (n = 1) | - | 1 (100%) | - | - | - |
| Gram-negative bacteria (n = 18) | - | 4 (22.2%) | 14 (77.8) | 5 (27.8%) | - |
| *S. aureus* (n = 6) | 1 (16.7%) | - | 5 (83.3%) | - | 3 (50%) |
| Gram-positive bacteria (n = 6) | 1(16.7%) | - | 5 (83.3%) | - | 3 (50%) |

Among the Gram-positive bacteria, 50% (3/6) of the *S. aureus* were methicillin resistant. This is illustrated on Table 4.

### 3.7. Factors Associated with Septicaemia

In bivariable logistic regression analysis, septicaemia was statistically significant in male patients (COR = 2.588; 95% Cl = 1.004 - 6.671; p = 0.049), in those with a body temperature above 37.9˚C (COR = 4.455; 95% Cl = 1.261 - 15.73; p = 0.02) and those under respiratory assistance (COR = 4.286; 95% Cl = 1.653 - 11.111; p = 0.003). However, in multivariable logistic regression analysis, only having a body temperature above 37.9˚C (AOR = 4.455; 95% Cl = 1.458 - 15.693; p = 0.033) and in those under respiratory assistance (AOR = 4.311; 95% Cl = 1.458 - 12.749; p = 0.008) were statistically significant (Table 5).

## 4. Discussion

This study aimed at determining the antimicrobial resistance pattern of bacteria associated with sepsis among hospitalized patients at the Yaoundé University Teaching Hospital. We included patients of all age groups. Results showed that septicaemia was present in 16.0% of hospitalized patients. In comparison to other studies in Cameroon, this prevalence was lower than the 28.3% and 25.5% reported by Kamga *et al.* [10] and Zefack *et al.* [11] in Yaoundé, Cameroon respectively. Also, this finding was found lower than that reported in Ethiopia (24.2%) by Ali *et al.* [14], and in India (41.4%) by Kumar *et al.* [15]. Our result was quite similar to that of Dagnew *et al.* [15] in Northwest Ethiopia (18.2%) and that of Shitaye *et al.* [16] in Nigeria (18.2%), but was however higher than that of Marshall *et al.* [17] in Iran (4.1%). These varying proportions may be due to the different methodologies used and the area of study.

The range of microorganisms that invade the bloodstream has been systematically studied by several researchers. In our study, 75% of infections were caused by Gram-negative and 25% by Gram-positive bacteria. Studies in different countries; Nigeria (69.3% and 30.7%) and Tanzania (69.7% and 30.3%) reported

Table 5. Bivariable and multivariable logistic regression analyses of factors associated with septicaemia among hospitalized patients.

| Factor | Number positive (%) | Number negative (%) | COR (95% Cl) | *P-value* | *AOR* (95% Cl) | *P-value* |
|---|---|---|---|---|---|---|
| **Age group/years** | | | | | | |
| ≤20 | 1 (7.7) | 12 (92.3) | 1 | | | |
| 21 - 30 | 1 (7.7) | 12 (92.3) | 1 (0.056 - 17.903) | >0.999 | | |
| 31 - 40 | 2 (11.1) | 16 (88.9) | 1.5 (0.121 - 18.54) | 0.752 | | |
| 41 - 50 | 3 (12.0) | 22 (88.0) | 1.636 (0.153 - 17.504) | 0.684 | | |
| 51 - 60 | 8 (22.9) | 27 (77.1) | 3.556 (0.399 - 31.682) | 0.256 | | |
| >60 | 9 (19.6) | 37 (80.4) | 2.919 (0.335 - 25.467) | 0.332 | | |
| **Sex** | | | | | | |
| Female | 7 (9.7) | 65 (90.3) | 1 | | 1 | |
| Male | 17 (21.8) | 61 (78.2) | 2.588 (1.004- 6.671) | 0.049 | 2.229 (0.802 - 6.194) | 0.124 |
| **Level of Education** | | | | | | |
| Primary | 8 (17.4) | 38 (82.6) | 1 | | | |
| Secondary | 9 (15.8) | 48 (84.2) | 0.891 (0.314 - 2.528) | 0.828 | | |
| Tertiary | 7 (14.9) | 40 (85.1) | 0.831 (0.275 - 2.515) | 0.744 | | |
| **Occupation** | | | | | | |
| Student | 2 (10.5) | 17 (85.5) | 1 | | | |
| Self Employed | 6 (14.6) | 35 (85.4) | 1.457 (0.266 - 7.992) | 0.665 | | |
| Employed | 5 (19.5) | 21 (80.8) | 2.024 (0.348 - 11.764) | 0.432 | | |
| Unemployed | 11 (17.2) | 53 (82.8) | 1.764 (0.355 - 8.761) | 0.488 | | |
| **Department** | | | | | | |
| Emergency | 13 (17.1) | 63 (82.9) | 1 | | | |
| Paediatric | 1 (11.1) | 8 (88.9) | 0.606 (0.07 - 5.268) | 0.650 | | |
| Internal Medicine | 5 (14.7) | 29 (85.3) | 0.727 (0.188 - 2.811) | 0.644 | | |
| Reanimation | 3 (13.0) | 20 (87.0) | 0.336 (0.272 - 2.564) | 0.753 | | |
| Surgical Ward | 2 (25.0) | 6(75.0) | 1.615 (0.293 - 8.914) | 0.582 | | |
| **Temperature** | | | | | | |
| ≤37.9˚C | 3 (5.8) | 49 (94.2) | 1 | | 1 | |
| >37.9˚C | 21 (21.4) | 77 (78.6) | 4.455 (1.261 - 15.73) | 0.020 | 4.193 (1.121 - 15.693) | 0.033 |
| **Under Antibiotics** | | | | | | |
| No | 17 (13.6) | 108 (86.4) | 1 | | 1 | |
| Yes | 7 (28.0) | 18 (72.0) | 2.471 (0.898 - 6.795) | 0.080 | 2.384 (0.771 - 7.373) | 0.131 |
| **Past Hospitalisation** | | | | | | |
| No | 17 (14.4) | 101 (85.6) | 1 | | | |

Continued

| | | | | | | |
|---|---|---|---|---|---|---|
| Yes | 7 (21.9) | 25 (78.1) | 1.664 (0.622 - 4.446) | 0.310 | | |
| **Diagnose of an infection** | | | | | | |
| No | 19 (18.1) | 86 (81.9) | 1 | | | |
| Yes | 5 (11.1) | 40 (88.9) | 0.566 (0.197 - 1.624) | 0.290 | | |
| **Under respiratory assistance** | | | | | | |
| No | 12 (11.3) | 94 (88.7) | 1 | | 1 | |
| Yes | 12 (27.3) | 18 (72.7) | 4.286 (1.653 - 11.111) | 0.003 | 4.311 (1.458 - 12.749) | 0.008 |
| **Underlying Diseases** | | | | | | |
| No | 17 (14.2) | 103 (85.8) | 1 | | 1 | |
| Yes | 7 (23.3) | 23 (76.7) | 1.844 (0.686 - 4.96) | 0.225 | 1.138 (0.356 - 3.642) | 0.828 |
| **Past operation** | | | | | | |
| No | 21 (17.4) | 100 (82.6) | 1 | | | |
| Yes | 3 (10.6) | 26 (89.7) | 0.549 (0.152 - 1.985) | 0.361 | | |

COR; Crude Odd Ratio, AOR; Adjusted Odd Ratio, Cl; Confidence interval.

similar higher proposition of Gram-negative bacteria than Gram-positive bacteria respectively [19] [20]. Conversely, Gram-positive bacteria have been reported as the commonest cause of bacteraemia in hospitalized patients than Gram-negative in studies carried out by Kamga *et al.* (56.2% and 43.8%) and Zefack *et al.* (62.2% and 30.8%) in Yaoundé Cameroon [10] [11]. The same findings have been reported in other developing countries [14] [16] [18]. The possible explanation for the difference could be the difference in the study design, nature of the patient population and seasonal variation.

In the case of Gram-negative bacteria, *Klebsiella species* (33.3%) was the predominant bacteria followed by *E. coli* (25%). This finding is comparable to other studies done in Yaoundé Cameroon [11] and Gondar Ethiopia [16] where the isolation rates of *Klebsiella spp and E. coli* were (12.3% and 10.8%) and (12.7% and 7.0%) respectively. However, our finding was contrary to what was obtained in Cameroon [10], Addis Ababa Ethiopia [19], and India [15] where E. coli was the predominant bacteria isolated among Gram-negative bacteria. Again, *S. aureus* (25%) was the only bacteria isolated. This finding is in contradiction with other studies in Cameroon [10] [11], Ethiopia [14] [16], India [15], and Nigeria [20]. However, quite similar to that of Habyarimana *et al.* in Kigali Rwanda [21] who found *S. aureus* as the predominant Gram-positive bacteria.

This study revealed that all cases of septicaemia in our study were caused by a single microorganism. This observation is in agreement with earlier studies [11] [17]. On the contrary, septicaemia of polymicrobial aetiology has been found in other studies [22] [23].

The antimicrobial susceptibility profile of the etiological agents of septicaemia has revealed that 66.7% of the *S. aureus* isolated were resistant to minocycline.

Also, among Gram-negative bacteria, *Klebsiella spp*. showed highest resistance to amoxicillin clavulanic acid (87.5%) and *E. coli* showed a 100% resistance to amoxicillin clavulanic acid and tetracycline. In general, our Antimicrobial susceptibility pattern indicates that Gram-negative bacteria exhibited a greater level of antimicrobial resistance ranging between (22.2% - 88.9%) than Gram-positive bacteria (16.7% - 66.7%) to various antibacterial agents employed during the study period. This was similar to other studies done in Nigeria for which Gram-negative bacteria (19.8% - 92.3%) and Gram-positive (10% - 87%) [24] and in Gondar Ethiopia which had Gram-negative bacteria (20% - 100%) and Gram-positive (23.5% - 58.8%) [16] antimicrobial resistance. This situation raises serious concern and suggests a very high resistance gene pool perhaps due to gross misuse and inappropriate usage of the antibacterial agents [24].

Imipenem and Cefoxitin were found to be the most effective drug against Gram-negative bacteria. This finding is different from that reported in Kamga *et al.* [10] and Zefack *et al.* [11] in Cameroon where gentamicin was found to be the most effective drug, but similar to that of Kummar *et al.* [14] in India. Whereas, among Gram-positive bacteria, Gentamycin and Vancomycin were the most sensitive antibiotics. These findings are similar to that reported in Cameroon and Ethiopia [10] [11] [14] [16].

*E. coli* and *Klebsiella spp*. were the sole producers of ESBLs among the isolated Enterobacteriaceae. ESBL-producing *E. coli* accounted for 2 isolates (33.3% of the total *E. coli* isolated or 8.3% of the total blood isolates) and ESBL-producing *Klebsiella spp*. accounted for 3 isolates (37.5% of *Klebsiella spp*. isolated or 12.5% of blood isolates). This is contrary to that report in Malaysia [25] where ESBL-producing *E. coli* accounted for 9 isolates (5.2% of the total *E. coli* isolated or 0.5% of the total bloodstream isolates) and ESBL-producing *Klebsiella spp*. accounted for 23 isolates (15.5% of *Klebsiella spp*. isolated or 1.3% of bloodstream isolates). Furthermore, the proportion of Methicillin Resistant *S. aureus* (MRSA) among all *S. aureus* blood isolates and among all bacteria isolates was 50.0% and 8.3%, respectively. Karunakaran *et al.* [25] in Kuala lumper, Malaysia report different propositions of MRSA of 26.0% and 2.3% among all *S. aureus* blood isolates and all bacteria isolates respectively. The difference in rates could also have been due to different patient populations in the respective hospitals.

In our study, MDR was observed in the case of 76% of isolates, which is higher than reported by Wasihun *et al.* [26] and Birru *et al.* [12] in Ethiopia. Among the MDR, 73.7% were Gram-negative and 26.3% were Gram-positive. This finding is in contradiction to what was reported by Birru *et al.* [12] where instead 60% were Gram-positive and the rest were Gram-negative in Ethiopia.

Several risk factors of septicaemia were assessed during this study, and among the various risk factors assessed related to septicaemia, high body temperature was found to be significantly associated and it was seen that patients with a body temperature above 37.9˚C were 4.2 times more prone to infections. This finding is similar to that reported by Zefack *et al.* [11]. Again, patients on respiratory assistance were found to be significantly associated with septicaemia, where they had a 4.3 risk to have infection.

Male gender was significantly associated with septicaemia; however, these were not identified as independent risk factors in the multivariate analysis. Similarly, other socio-demographic characteristics and clinical factors of patients such as the presence of underlying disease, past operation, past hospitalization and antibiotic therapy were not identified as predisposing factors. The lack of association between septicaemia and the aforementioned factors has also been described in studies conducted in Cameroon [11], Ethiopia [12] and Egypt [27].

## 5. Conclusion

Our study reveals the prevalence of septicaemia at the University Teaching Hospital Yaoundé is high and also *Klebsiella spp, E. coli and S. aureus* were the leading cause of septicaemia among symptomatic hospitalized patients who attended the hospital during this period. Patients older than 50 years registered the highest number of septicaemia cases in this study. In general, Gram-negative bacilli were highly sensitive to imipenem and showed a high level of resistance to amoxicillin-clavulanic acid. *S. aureus* was highly sensitive to Gentamycin and Vancomycin and showed a high level of resistance to minocycline. Again, none of the antibiotics used singly showed high sensitivity to all the Gram-negative bacteria. So, a combination of two or more drugs (such as gentamicin, cefoxitin and ciprofloxacin) is needed to cover the broad range of Gram-negative bacilli. MDR bacteria were also observed during this study expressed by the presence of ESBLs and MRSA among the isolated bacteria. Further, high body temperature (>37.9˚C) and being on respiratory assistance were significantly associated with septicaemia.

### 5.1. What is Already Known on This Topic?

There is a high incidence of septicaemia in hospital settings. The majority of blood culture isolates are multidrug-resistant.

### 5.2. What this Study Adds

Point 1. High occurrence of MRSA and ESBLs-producing-Enterobacteriaceae;
Point 2. High body temperature (>37.9˚C) and being on respiratory assistance are predisposing factors to septicaemia in hospitalised patients.

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## Authors' Contributions

LCNY, BDTP, AWB, WD conceived the study and designed it. LCNY carried out the sample collection, lab work and data analysis. AWB, ACB and HKG supervised the lab work and sample collection. The general supervision was carried out by BDTP and WD. AWB, LCNY and WD drafted the article. All the authors reviewed the article. All the authors read and agreed to the final manuscript.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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