**Reviewer’s Comments**

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**RESISTANCE PROFILE OF BACTERIA ISOLATED AT THE SANGMELIMA REFERENCE HOSPITAL, SOUTH CAMEROON REGION : A RETROPROSPECTIVE STUDY**

**Abstract**

**Background and objective** : Bacterial resistance to antibiotics is now one of the most serious threats to global health. Knowledge of the main bacterial species responsible for bacteremia and their antibiotic resistance profile makes possible to provide an objective basis for effective antibiotic therapy. However, in the South Cameroon region, microbiological documentation is not always present. The objective of our study was to determine the resistance profile of bacteria isolated at the Sangmélima Reference Hospital.

 **Methods**: It was a retroprospective study that examined biological samples collected from interned and ambulatory patients who had been seen at the Sangmélima Reference Hospital during the period from January 2021 to October 2021. The samples were grown on specific media and the strain susceptibility was carried out on agar media using the Kirby-Bauer technique and the interpretation was done according to the guidelines of the CASFM 2020.

**Results**: For the retrospective part, GNB were most represented (15/26 ; 57.7%,) with the *E. coli* (n=12/15) and only *Staphylococcus spp* for GPB (n=11/26). Staphylococcus resistance was particularly relevant with 81.81% to erythromycin, 63.63% to cefoxitin and 72.72% to Cotrimoxazole. *E. coli* showed a resistance of 66.66% for augmentin and 83.33% for cefuroxime. In the prospective part, GPB wereonly represented by *Staphylococcus epidermidis* (7/7 ; 50%), and GNB included *E. coli*(3/7 ; 21.42%), *K. pneumoniae*(2/7 ; 14.29%) and *A baumannii*(2/7 ; 14.29%). For all isolated bacteria strains, a high resistance to the majority of betalactams and penicillin was observed. However, bacteria with greater antibiotic resistance were Staphylococcus strains, highly resistant to beta-lactams, while *A. baumannii* strains showed higher resistance, and *E. coli* especially to penicillins and fluoroquinolones.

**Conclusion**: *E. coli* and *Staphylococcus spp* were more identified and their resistance to frequently used antibiotics such as penicillins and beta-lactams was very high.

**Keys words**: *A. baumannii*, Antibacterial resistance, Cameroon Southern region, *E. coli, Staphylococcus spp*

**INTRODUCTION**

Bacterial infections are serious conditions, responsible for significant morbidity and mortality worldwide, and are among the most common care-associated infections. In developing countries, these bacteria are currently a major public health problem because their spread is associated with an increase in mortality and morbidity (1). Several studies conducted in Cameroon demonstrate the frequent involvement of *Staphylococcus aureus* in infections associated with a mortality of 15%-60%, a full resistance of *Escherichia coli* to amoxicillin and amoxicillin + clavulanic acid. Some lactose-fermenting coccobacilli such as *Acinetobacter baumannii* and *Pseudomonas aeruginosa* show a recent increase in resistance to imipenem and piperacillin-tarzobactam (2, 3). In 2021, Napa *et al* demonstrated that *P. aeruginosa* strains circulating in the Center region have several enzymatic mechanisms of resistance to antibiotics associated with a high production of biofilm (4). In the South Cameroon region, microbiological documentation is not always present. We therefore proposed to determine the frequency of bacteria isolated within the Sangmélima Reference Hospital (HRS) and to evaluate their resistance to antibiotics in order to provide a database for future comparative studies, by analyzing hospital statistics over 6 months, in addition to a four-month bench job.

**METHODS**

***Study design:* It was a ten months period retro-prospective study carried out in the Microbiology Laboratory of the Sangmélima Reference Hospital (HRS), Sangmélima being a forest town located in the Southern Region of Cameroon. The retrospective part (January to June 2021) was carried out from the registers and antibiograms of the archives of the HRS Microbiology Laboratory. The prospective part was a 4-month bench work (July to October 2021) performed on clinical samples. All isolates came from diagnostic samples of patients hospitalized in the various HRS departments, ambulatory patients and samples from other health facilities in the region. Ethical clearance was obtained from The Yaoundé 1 University Institutional Ethics Committee, authorization to collect samples from HRS, and informed consent from all the study participants. Specimens were collected from both in and out patients as described by Rémic (5).**

***Retrospective part data collection* : It consisted in extracting the results of the tests and antibiograms carried out from January to June 2021, from the bench registers of the Laboratory. The variables collected were: (a) Frequency of examinations requested, (b) Distribution by service, (c) Sex, (d) Sample type, (e) Isolated germs, (f) Iolates Antibiotic susceptibility.**

**Prospective part samples : Some samples were taken from the laboratory, others from the various departments of the hospital, and some sent from other health facilities in the southern region. These included urine and blood samples, pus and vaginal swabs, puncture fluids and semen.**

**Isolation and identification *:***Depending on the type of sample, a macroscopic examination was first carried out, then a stocking done by exhaustion on Chapman agar medium, chocolate +VCN and fresh blood agar, on EMB, CLED agar, Sabouraud agar, Columbia blood agar, Cooked blood agar + VCN. Each culture was followed by incubation from 18 to 24 hours incubation at 37°C. Colonies from positive primary cultures were stained with Gram´s method of staining. From the result obtained (Gram-negative bacteria -GNB and Gram-positive bacteria –GPB), biochemical tests were performed using Oxidase test, Catalase test, Coagulase test and DNase test. Identification on gallery API 20 NE (BioMérieux, France) was done, following the manufacturer’s instructions.

**Antibiotic sensitivity test *:*** The susceptibility test was performed using the Kirby Bauer disk diffusion method according to the Clinical and Laboratory Standards Institute (CLSI) guidelines. The bacterial inoculum was obtained by using isolated colonies on nutrient agar and homogenized in 5ml of sterile distilled water. This suspension was then adjusted in comparison to the McFarland 0.5 standard. The test was carried out in series of three copies according to the CLSI protocol M2-A9 (7). The antibacterial susceptibility of GPB and NGB was determined using the antibiotic discs listed below. Inhibition diameters measurementand interpretation (sensitive, intermediate, resistant) were made according to CASFM V1.2 2020 (6). BGPs were tested for Amoxicillin, Oxacillin, Cefoxitin, Cefotaxime, Chloramphenicol, Gentamicin, Erythromycin, Clindamycin, Norfloxacin, Fusidic acid, Cotrimoxazole, Rifampicin, Ciprofloxacin, Levofloxacin, Vancomycin, Kanamycin, Tobramycin, Netilmicin, Tetracycline, Minocycline, Tigecycline, Fosfomycin, Novobiocin.NGBs were tested for Amoxicillin, Augmentin, Piperacilline, Ticarcilline+Clavulanic sterile acidevillon, Cefoxitine, Cefotaxime, Cefuroxime, Ceftazidime, Cefepime, Cefixime, Imipenem, Amikacine, Gentamicin, Aztreonam, Nalidic acid, Levofloxacin, Ciprofloxacin, Fosfomycin, Cotrimoxazole, Colistine, Tobramycin, Tetracycline, Netilmycin, Ertapenema.

**Detection of extended-spectrum beta lactamases** : Extended-spectrum beta lactamases (ESBLs) are enzymes found in certain bacteria and are responsible for their resistance to antibiotics such as penicillins and cephalosporins. The double disc synergy was used to screen all the isolates for ESBLs production as recommended by CASFM (6). Amoxicillin + clavulanic acid disc (30 µg/10 µg) was placed in the centre, equidistant from the ceftazidime disc (30 µg,) cefamin (30 µg) and cefotaxime (30 µg). A strain was ESBL positive if the production of inhibition zones in the form of champagne cork was observed between the amoxicillin + clavulanic acid discs and the ceftazidime, cefadepima, cefotaxime discs. Otherwise, the strain was negative ESBL.

**Statistical analysis *:*** Data was entered on Microsoft Excel 2016. Data analysis was performed with IBM SPSS Statistics Version 22.0. The descriptive data are presented in terms of numbers and percentages. Statistical significance difference was considered at value of p < 0.05.

**Ethical considerations*:*** The study was performed after receiving an ethical clearance from the Joint Institutional Board for Animals & Human Bioethics (JIRB) of the University of Yaoundé 1 (Ref N° BTC-JIRB2022-019) and an approval from the Ethics Committee the approval of the Reference Hospital of Sangmelima (N°01/021/ARM/MINSANTE/SG/HRS/CM *du 21 Juillet 2021*).Anonymity of participants and confidentiality of results were scrupulously respected.

**RESULTS**

***Retrospective epidemiological profile of samples*** : From the bench records of the laboratory the epidemiological profile of samples with identified bacteria could be established (Table 1). We recorded many samples, including urine (n=13 ; 50%), vaginal swabs (n=7 ; 26.92%), stool (n=3 ; 11.54%) and urethral secretions (n=2 ; 7.69%) were the most represented. Samples from outpatients were the least represented (n=7 ; 26.92%) compared to 73.08% of inpatients (n=19) shared majoritary between medical and emergency departments (15.38% and 23.07% respectively). We recorded 15 samples (57.7%) from women and 11 samples (42.30%) from men. The sample most represented in both males(n=7) and females (n=5) was urine, followed by stool. Gram-negative bacilli were most represented (n=15 ; 57.7%,) with the *E. coli*(n=12) and only *Staphylococcus spp* for Gram-positive bacilli (n=11).*E. coli* was the most isolated germ in the samples and was mainly present in urine and vaginal secretions. *Staphylococcus spp* strains were mostly isolated from urine and urethral secretions.Staphylococcus resistance was particularly relevant with 81.81% to erythromycin, 63.63% to cefoxitin and 72.72% to Cotrimoxazole. *E. coli* showed a resistance of 66.66% for augmentin and 83.33% for cefuroxime.

***Prospective epidemiological profile of samples*** : In four months, fourteen participants were recruited for this study part, 12 men for 2 women, according to inclusion criteria. The average age of the sample donors was 29 years, ranging from 6 days to 78 years. Various samples were collected, the majority of which were urethral secretions and urine (n=4 ; 28.57% each) and at lower frequencies blood (n=1 ;7.14%). The samples were from both hospital outpatients (50%, n=7) and inpatients (50%, n=7). For interned patients, the pediatrics department was in the lead with (n=4 ; 57.14%) of samples provided followed by the surgery department (n=2 ; 28.57%) (Table 2).

Four bacterial species were isolated and identified. Half belonged to the Gram-positive coccis group represented by *Staphylococcus epidermidis* (n=7 ; 50%), the other half belonged to the Gram-negative bacilli group and included *Escherichia coli* species isolated at a frequency of (n=3 ; 21.42%), closely followed by *Klebsiella pneumoniae* (n=2 ; 14.29%) and *Acinetobacter baumannii*(n=2 ; 14.29%), as shown in Figure 1.Men were the most infected, mostly by *S. epidermidis* (58.33%, n=7/12). In women, however, *E. coli* was the most isolated species, at the same frequency as *A. baumannii*.*S. epidermidis* was the bacterial species most isolated from urethral secretions (100%), pus (100%). E. coli was isolated more frequently in vaginal secretions and urine at frequencies of 100% (n=2), 50% (n=2) respectively.

***Antibiotic sensitivity test***:*E. coli* strains resistance to penicillins remains very high, 100% for amoxicillin and augmentin.The same is true for fluoroquinolones, particularly levofloxacin and ciprofloxacin, were innefficacious with 100% resistance each (Figure 2).All isolated strains of *A. baumanii* were resistant to all ß-lactam (100%) except ertapenem (Figure 3). Isolated Klebsiella pneumoniae strains were resistant to penicillins (100%) and fosfomycin (100%) (Figure 4). For *S. epidermidis*, many resistances were observed against all antibiotics classes and higher for ß-lactam (with a resistance of 71.42% to cefoxitin), and tigecyclin (100%) (Figure 5).

**DISCUSSION**

For the retrospective part, GNB were most represented (57.7%) with *E. coli* having the highest isolation frequency, followed by *Salmonella spp.*and *Klebsiella spp.*, and with GPB, only *Staphylococcus spp*. were isolated. These results corroborate those of Raed *et al*. in 2022 whose work in Jordan reported isolation frequencies of 29%, 14%, 7%, and 3.5% respectively for *E.coli, Klebsiella pneumoniae, Salmonella enterica,* and *Staph.epidermidis* (8). The frequency difference observed is due to the nature of the sample. Indeed, germs such as *E. coli* are usually isolated at lower frequencies in wounds than in urine or genital secretions as in our study.Staphylococcus resistance was particularly relevant with 81.81% to erythromycin, 63.63% to cefoxitin and 72.72% to cotrimoxazole. *E. coli* showed a resistance of 66.66% for augmentin and 83.33% for cefuroxime. These results are in agreement with the reports from Cameroon (2) and other african countries, as was the case in Ethiopia in 2017 where Mulu *et al.*revealed GPB and GNB resistance to cotrimoxazole and penicillin (9). Indeed, these antibiotic families are widely prescribed in the first intension and HRS being a reference structure in the Southern Region, patients often come from other health structures where probabilistic treatments based on the use of these molecules have sometimes already been initiated.

On the bench in the prospective part, with our own manipulations, we were able to isolate and identify the *Staphylococcus epidermidis* (50%), as well as *Escherichia coli* (21.42%), closely followed by *Klebsiella pneumoniae* and *Acinetobacter baumannii*. These trends are similar to previous works elsewhere in Cameroon by Ateudjeu *et al* for who *E. coli* had a sample high prevalence while it was in stool, Kousseri city (Far North region) (3), Mbamyah*et al*who revealed *Klebsiella pneumoniae* as the most prevalent species isolated from *Klebsiella* isolates identifiedin Yaoundé (Central Region) (10), and Okalla *et al*.who showed low rates of *A. baumannii*(3.8%) from clinical specimens in the city of Douala (Littoral region) (11).This can be a proof that these strains are circulating in Cameroon.

For all isolated bacteria strains, a high resistance to the majority of betalactams and penicillin was observed. However, bacteria with greater antibiotic resistance were Staphylococcus strains, highly resistant to beta-lactams, while *A. baumannii*strains showed higher resistance, and *E. coli* especially to penicillins and fluoroquinolones. This overall high rate of resistance of the isolates to the penicillins could be explained by the over use of these drugs in the treatment of common infections and ease of drug acquisition without prescription and even from road side vendors (10). A High resistance to colistin was noted in our study, which complicates treatment because colistin is recommended for the treatment of *A baumannii* infections (12)

***Study limitations***: The sample size was small and isolates were collected from only one hospital, although it is a regional referral hospital. The study needs to be extended to other hospitals in the southern region for a longer period.

**CONCLUSION**

The purpose of our study was, on the one hand, to describe the epidemiological profile of the bacteria identified within the Sangmélima Reference Hospital. It emerged that the bacteria frequently involved were the GNB mainly represented by *E. coli* and the GPBonly represented by the Staphylococci, and that some tests such as urine cultures were the most precribed. Resistance to frequently used antibiotics such as penicillins was very high, as well as a high level of resistance to beta-lactams were observed. Therefore, treatment of common bacterial infections in the study area needs to be guided by antibiotic susceptibility testings.

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**CONFLICT OF INTEREST**

The authors have declared that there is no conflict of interest associated with this work.

**AUTHOR'S CONTRIBUTION**

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**Manuscript writing and review** : all the authors.

**REFERENCES**

1. Agyepong N, Govinden U, Owusu-Ofori A, Essack SY. Multidrug-resistant gram-negative bacterial infections in a teaching hospital in Ghana. *Antimicrobial Resistant Infections Control* 2018; 7:37
2. Kengne M, Fotsing O, Ndomgue T, Nwobegahay MJ. Antibiotic susceptibility patterns of *Staphylococcus aureus* strains isolated at the Yaounde Central Hospital, Cameroon: a retro prospective study. *Pan African Medical Journal* 2019; 32:103.
3. Ateudjieu J, Beyala BL, Guenou E, Chebe NA, Chukuwchindun AB, Koukoum GAP, Bisseck ZAC. Profile and antibiotic susceptibility pattern of bacterial pathogens associated with diarrheas in patients presenting at the Kousseri Regional Hospital Annex, Far North, Cameroon. *Pan African Medical Journal* 2018; 29:170.
4. Napa Tchuedji YLG, Gonsu Kamga H, Lyonga Mbamyah E, Chafa Betbeui A, Assana IR, Fonyuy Bongnyang G, Guenou E and Etoa FX. Study of Resistance Mechanisms and Evaluation of Biofilm Detection Tests in Clinical Isolates of Pseudomonas aeruginosa Circulating in Yaounde, Cameroon. *Acta Scientific Microbiology*2021; 4(12): 104-110.
5. Fnac. Rémic. Référentiel en microbiologie médicale. 4eme édition. 2010.
6. CA-SFM : Comité de l’Antibiogramme de la Société Française de Microbiologie. 2020.  <http://www.sfm.asso.fr> (accessed 17 April 2022).
7. CLSI (Clinical Laboratory Standards Institute). Performance Standards for Antimicrobial Disc Susceptibility Tests. (11th edn.), Approved standard M02-A11– Publication of Clinical and Laboratory Standards Institute [CLSI), 2012, USA, 32.
8. Ennab R, Al-Momani W, Al-Titi R, Elayan A. Antibiotic Profile of Pathogenic Bacteria Isolated from Postsurgical Site Infections in Public Hospitals in Northern Jordan. *Infect Drug Resist*. 2022;15:359-366. <https://doi.org/10.2147/IDR.S350406>
9. Mulu W, Abera B, Yimer M, [Hailu](https://bmcresnotes.biomedcentral.com/articles/10.1186/s13104-017-2584-y#auth-Tadesse-Hailu) T, Ayele H & Abate D. Bacterial agents and antibiotic resistance profiles of infections from different sites that occurred among patients at Debre Markos Referral Hospital, Ethiopia: a cross-sectional study. *BMC Research Notes* 2017; 10, 254. <https://doi.org/10.1186/s13104-017-2584-y>
10. Mbamyah E, Enyeji F, Torimiro J, Mangum P, Djuissi M, Teukam A, Mesembe M, Ikomey G, Betbeui A, Sedena D, Baiye W, Eyoh A and Gonsu H. High Prevalence of Multidrug Resistant *Klebsiella* Species Isolated from the Yaounde University Teaching Hospital, Cameroon. *Open Journal of Medical Microbiology* 2021; 11, 91-99. doi: [10.4236/ojmm.2021.112008](https://doi.org/10.4236/ojmm.2021.112008)
11. Okalla Ebongue C, Mengue RE, Nda Mefo’o JP, Dongmo Tsiazok M, N’guessan Kouassi R,Ngo Bum E. Antimicrobial Multi-Resistance of Acinetobacter baumanii Isolated from Clinical Specimens in Douala (Cameroon).*Journal of Diseases and Medicinal Plants*2015; 1:2, pp. 31-36. doi: 10.11648/j.jdmp.20150102.12[accessed Jul 01 2022].
12. Katip W, Meechoui M, Thawornwittayakom P, Chinwong D, Oberdorfer P. Efficacy and Safety of High Loading Dose of Colistin in Multidrug-Resistant *Acinetobacter baumannii*: A Prospective Cohort Study. *Journal of Intensive Care Medicine*. 2019;34(11-12):996-1002. doi: 10.1177/0885066617725694.

**TABLES AND FIGURES**

**Table 1**:Retrospective Characterization of samples

|  |  |
| --- | --- |
| **Parameters** | **n (%)** |
| ***Type of specimen*** |
| Cervical spinal fluid | n=1 (3.85) |
| Stool  | n=3(11.54) |
| Urethral secretions  | n=2 (7.69) |
| Urine  | n=13 (50) |
| Vaginal swab | n=7 (26.92) |
| ***Sample origin*** |
| Outpatients | n=7 (26.92) |
| Inpatients  | n=19 (73.08) |
| ***Sex***  |
| Female | n=15 (57.7) |
| Male  | n=11 (42.30) |
| ***Bacterial diversity in isolates*** |
| GNB | n=15 (57.7) |
| GPB | n=11 (42.30) |
| Total | 26 (100) |

GNB= Gram-negative bacteria

GPB= Gram-positive bacteria

**Table 2**: Prospective Characterization of samples

|  |  |
| --- | --- |
| **Parameters** | **n (%)** |
| ***Type of specimen*** |
| Blood | n=1 (7.14) |
| Urethral secretions  | n=4 (28.57) |
| Urine  | n=4 (28.57) |
| Vaginal swab | n=2 (14.29) |
| Pus | n=3 (21.43) |
| ***Sample origin*** |
| Outpatients | n=7 (50) |
| Inpatients  | n=7 (50) |
| ***Sex***  |
| Female | n=2 (14.29) |
| Male  | n=12 (85.71) |
| Total | 14 (100) |

Table: Frequency and percentage of type of microorganisms in the study

|  |  |
| --- | --- |
| **Microorganismes** | **n (%)** |
|  |
| *Staphylococcus epidermidis* |  |
| *Escherichia coli* |  |
| *Klebsiella pneumoniae* |  |
| *Acinetobacter baumannii* |  |
| Total |  |

Figure 1 :**General frequency of isolated and identified bacteria**

Staph.epi.=*Staphylococcus epidermidis*, E.coli=*Escherichia coli*, Kleb.pneu.=*Klebsiella pneumoniae*, Acineto.bau=*Acinetobacter baumannii*

Figure 2 : ***Escherichia coli* antibiotic resistance profile**

Figure 3 : ***Acinetobacter baumannii* antibiotic resistance profile**

Figure 4 : ***Klebsiella pneumoniae* antibiotic resistance profile**

Figure 5 : ***Staphylococcus epidermidis* antibiotic resistance profile**