



## Research Article

## Distribution of Bacterial and Fungal Etiologies of Bloodstream Infections in Children Treated for Cancer in Cameroon

*Distribution des Etiologies Bactériennes et Fongiques des Infections Sanguines chez les Enfants Traités pour un Cancer au Cameroun*

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### ABSTRACT

**Introduction.** In Cameroon, the lack of data on local microbial ecology favours the use of empirical antibiotic therapies extrapolated from foreign studies. The aim of this study was to identify bacterial and fungal causes of bloodstream infections and to report their antimicrobial sensitivities in paediatric cancer patients in Cameroon. **Methods.** We performed a prospective study from January to September 2021 on in paediatric cancer patients at the Chantal Biya Foundation Mother-Child Centre (CME-FBC) in Cameroon. Blood samples were taken from each febrile patient and analysed using standard laboratory procedures for culture, identification and antibiotic susceptibility testing. **Results.** We observed 61 patients for which 238 blood cultures were drawn. Mean participant age was 6.62 years and the children less than 5 years were the most represented (41%). The blood culture positivity rate was 28.1%, with Gram-negative bacilli being the most commonly isolated organisms (50.9% of isolates). The susceptibility of Gram-negative bacilli to first-line treatment (ceftriaxone and gentamicin) was less than 50%, while susceptibility to 4th-generation cephalosporins, carbapenems and quinolones remained acceptable, with values between 60% and 80%. Antibiotic resistance was present, with 38% of gram-negative bacilli multi-resistant and 100% of methicillin-resistant *S. aureus*. **Conclusion.** Gram-negative bacilli are the main aetiological agent of bacteraemia in febrile MCC-CBF cancer patients, with a significant proportion of isolated pathogens showing high levels of antimicrobial resistance. It is important to rely on local epidemiological data for the development of empirical antibiotic therapies.

### RESUME

**Introduction.** Au Cameroun, le manque de données sur l'écologie microbienne locale favorise l'utilisation d'antibiothérapies empiriques extrapolées à partir d'études étrangères. Le but de cette étude était d'identifier les causes bactériennes et fongiques des infections sanguines et de rapporter leurs sensibilités antimicrobiennes chez les patients pédiatriques atteints de cancer au Cameroun. **Méthodologie.** Nous avons réalisé une étude prospective de janvier à septembre 2021 sur des patients atteints de cancer pédiatrique au Centre Mère-Enfant de la Fondation Chantal Biya (CME-FBC) au Cameroun. Des échantillons de sang ont été prélevés sur chaque patient fébrile et analysés en utilisant des procédures de laboratoire standard pour la culture, l'identification et l'antibiogramme. **Résultats.** Nous avons observé 61 patients pour lesquels 238 hémocultures ont été prélevées. L'âge moyen des participants était de 6,62 ans et les enfants de moins de 5 ans étaient les plus représentés (41%). Le taux de positivité des hémocultures était de 28,1 %, les bacilles à Gram négatif étant les organismes les plus fréquemment isolés (50,9 % des isolats). La sensibilité des bacilles à Gram négatif au traitement de première intention (ceftriaxone et gentamicine) était inférieure à 50 %, tandis que la sensibilité aux céphalosporines de quatrième génération, aux carbapénèmes et aux quinolones restait acceptable, avec des valeurs comprises entre 60 et 80 %. La résistance aux antibiotiques était présente, avec 38 % de bacilles gram-négatifs multirésistants et 100 % de *S. aureus* résistants à la méthicilline. **Conclusion.** Les bacilles à Gram négatif sont le principal agent étiologique des bactériémies chez les patients fébriles atteints de cancer MCC-CBF, avec une proportion significative d'agents pathogènes isolés présentant des niveaux élevés de résistance aux antimicrobiens. Il est important de s'appuyer sur les données épidémiologiques locales pour développer des antibiothérapies empiriques.

## HIGHLIGHTS

### What is known of the subject

In Cameroon, the lack of data on local microbial ecology favours the use of empirical antibiotic therapies extrapolated from foreign studies.

### The aim of our study

Identification of bacterial and fungal causes of bloodstream infections and report of their antimicrobial sensitivities in paediatric cancer patients in Cameroon.

### Key Results

1. Mean participant age was 6.62 years (range 4.8 months to 15.8 years) and the children less than 5 years were the most represented (41%).
2. Out of 238 blood cultures, the positivity rate was 28.1% (n=57), with Gram-negative bacilli being the most commonly isolated organisms (50.9% of isolates, n=29/57). Subjects with positive blood cultures were younger (mean age 5.2 years vs. 7.3 years;  $p = 0.003$ ) and often had a clinical focus on physical examination ( $p = 0.008$ ).
3. The susceptibility of Gram-negative bacilli to first-line treatment (ceftriaxone and gentamicin) was less than 50%, while susceptibility to 4th-generation cephalosporins, carbapenems and quinolones remained acceptable, with values between 60% and 80%. Antibiotic resistance was found, with 38% of gram-negative bacilli multi-resistant and 100% of methicillin-resistant *S. aureus*.

### Implications for future practices and policies

There is a need to rely on local epidemiological data for the development of empirical antibiotic therapies.

## INTRODUCTION

The management of children with cancer is fraught with complications, the most feared of which are infections(1–3). They are directly associated to prolonged hospitalization, increased healthcare costs, finally increased risk of mortality varying from 8 to 41%(4–6). Due to the multifactorial immune deficiency in these patients, fever is often the only symptom present even with severe infections(7,8). So that, any fever in patients on cancer chemotherapy is presumed to be infectious until proven otherwise. In Cameroon, there is a paucity of studies on local flora in oncologic patients. A few empirical treatment regimens are used in case of suspicion of infections, but they are almost always the result of an implicit consensus from studies of microbial flora carried out in other countries(7–9). This may give rise to some reservations as to their suitability for our context. In fact, the limits of the technical platform (exceptional use of central routes, absence of implantable chambers, not enough infrastructure for the isolation of immunocompromised patients, intra-hospital hygiene of limited implementation) modify the nature of the infectious risk. And with a limited control over access to antibiotics in pharmacies and over the counter, antibiotic pressure is much greater. Lack of knowledge of the local microbial ecology and the systematic use of foreign

protocols expose patients to a risk of delayed diagnosis and treatment of infections, a risk of antibiotic overconsumption and therefore a subsequent risk of antibiotic resistance. In order to adapt policies and encourage a more selective management strategy of cancer patients in Cameroon, we underwent this study whose primary purpose was to determine the spectrum of bloodstream isolates and report on the antimicrobial susceptibilities of causative pathogens in paediatric cancer patients with fever in the oncology service of the Mother and Child Center of the Chantal Biya Foundation (MCC-CBF), Yaounde.

## PATIENTS AND METHODS

### Study design

Between January and September 2021, we performed a prospective study in which febrile episodes of cancer inpatients at the MCC-CBF were investigated for bacteremia and fungemia. The MCC-CBF is a multidisciplinary hospital affiliated with the faculty of medicine and biomedical sciences of Yaounde I, Cameroon. The oncologic service with 26 in-patients' beds is one of the referral centers of child cancer management and provides services for children coming from any part of Cameroon. Cancer patients less than 18 years old and who presented with fever (temperature above 38°C) were included. Patients could be included more than once if they had another febrile episode after being afebrile for 5 days. During the study period, in the unit, ceftriaxone and gentamicin constitute the empiric antibiotic regimen for suspected infections, regardless to the number of neutrophils. In the event of persistent fever after 48 hours, the treatment was switched to ceftazidime and amikacin. Amphotericin B was used in case of isolation of a fungus susceptible to it at blood culture or in case of persistence of fever after 5 days despite the antibiotherapy. Patients in the MCC-CBF oncology unit are typically administered co-trimoxazole as antibiotic prophylaxis against pulmonary pneumocystosis until either the durable remission of the cancer or the onset of severe adverse effects associated with the drug. The presence of an absolute neutrophil count (ANC) of <1500 cells/ml was regarded as neutropenia, and classified mild if between 1000 and 1500, moderate between 500 and 1000 and severe if low 500 cells/ml(7).

### Laboratory procedures

For each febrile episode and before any antibiotic treatment (other than the co-trimoxazole), two blood samples of 2 ml of blood were collected and transferred in BACT/ALERT® aerobic bottles (BioMérieux). Samples were processed at the Centre Pasteur du Cameroun Microbiology laboratory. The blood culture bottles were placed into the BACT/ALERT® blood culture system (BioMérieux) for continuous monitoring according to manufacturer's instructions. Samples from bottles that flagged positive were withdrawn for Gram stain and subcultured onto chocolate agar, blood agar and CLED plates. The plates were incubated for 18–24h at 35–37 °C (CLED) or 37°C +5% of CO<sub>2</sub> (Chocolate agar or blood agar). Resulting colonies were subjected to API

20E test system for definitive identification. If organisms could not be identified using the conventional methods, the Vitek 2 Compact® (BioMérieux) was used, according to the manufacturer's instruction. Antimicrobial susceptibility tests were done using a modified Kirby-Bauer disk diffusion technique following CLSI 2021 guidelines. The presence of blood stream infections (BSI) was defined by at least one set of positive blood culture for usual pathogenic bacteria or fungi in patients. Coagulase negative *Staphylococcus spp* (*CoNS*), *Bacillus spp*, and *Corynebacterium spp* were considered pathogens if they grew in the two collected blood culture bottles or if they grew in one bottle in a patient with clinical evidence of a bloodstream infection; otherwise, they were considered contaminants. In regard to antimicrobial susceptibility, the laboratory's findings were taken as the basis for classification. Those identified as susceptible to an antibiotic or antifungal were considered susceptible, while those designated as intermediate or resistant were regarded as resistant. Multidrug resistant (MDR) phenotype was defined as in vitro resistance to at least 1 agent in at least 3 antimicrobial categories: penicillins, cephalosporins, beta-lactamase inhibitor combinations, fluoroquinolones, aminoglycosides, chloramphenicol, folate pathway inhibitors, tetracyclines, macrolides and glycopeptides.

### Statistical analyses

Categorical data were described as proportions. Analyses were carried out to compare the significance of difference in distribution by using Chi square test or Fisher's exact test where appropriate. P-values of  $\leq 0.05$  were considered statistically significant. Data were entered using Excel office and analyzed with SPSS version 2.0.

### Ethics approval and consent to participate

Ethical clearance was obtained from the ethical committee of the faculty of medicine and biomedical sciences of Yaoundé. Written informed consent from parents and children were obtained.

## RESULTS

### General characteristics

We observed 61 patients which presented 119 independent febrile episodes for which 238 blood cultures were drawn. Mean participant age was 6.62 years (range 4.8 months to 15.8 years) and the children less than 5 years were the most represented. Thirty-eight participants (62.3%) were male; the Burkitt lymphoma was the most frequent malignancy. Of 61 participants, 26 (42.3%) had a single febrile episode, 19 (31.1%) had two febrile episodes, 11 (18%) had three febrile episodes, and 5 (8.6%) had four febrile episodes (Table 1). Of the 238 blood cultures obtained during the different febrile episodes, 67 (28%) were positive. The main suspected focus of infection was digestive (n=21). During 72 febrile episodes, no clinical infectious focus was found. Neutropenia was found in 62 out of 118 febrile episodes. It was severe in 45% of cases (n=53).

### Blood culture isolates

A positivity rate of 28.1% was observed in 67 of the 238 blood cultures, with 57 distinct bacterial species isolated.

Gram-negative bacilli (GNB) constituted 50.9% of the total, or 29 bacteria, with *Klebsiella pneumoniae* being the most frequently reported Gram-negative bacilli (n=12, 41.4%), followed by *Acinetobacter baumannii* (n=4;13.8%) and *Pantoea spp* (13.8%, n=4).

**Table 1. Characteristics of study participants N=61**

Variables	N	%
<b>Gender</b>		
Male	38	62,3
Female	23	37,3
<b>Age (years)</b>		
< 5	25	41
5-10	22	36,1
10-18	14	22,9
<b>Type of Cancer</b>		
<b>Solid tumour</b>		
Burkitt Lymphoma	14	73,8
Nephroblastoma	7	
Neuroblastoma	7	
Rhabdomyosarcoma	6	
Retinoblastoma	5	
Osteosarcoma	3	
Others	3	
<b>Hematological neoplasm</b>		
Lymphoblastic acute leukemia	8	26,2
Myeloblastic acute leukemia	5	
Lymphoblastic lymphoma	3	
<b>Clinical site of infection (N=119)</b>		
At least one site	57	39
Digestive	21	
Cutaneous	11	
Pulmonary	9	
Ear Nose and Throat	8	
Urinary	3	
Osteoarticular	2	
Neurological	1	
<b>Neutropenia (N=119)</b>		
Unidentified	72	61
Severe	53	45
Moderate	9	7,6
Mild or Normal	57	47,4

**Table 2. Distribution of blood cultures isolates**

<b>Gram negative bacilli</b>	29
<b>Enterobacterales</b>	
<i>Klebsiella pneumoniae</i>	12
<i>Pantoea spp</i>	4
<i>E. coli</i>	2
<i>Kluyvera cryocrescens</i>	1
<b>Non-Enterobacterales</b>	
<i>Acinetobacter baumannii</i>	4
<i>Pseudomonas aeruginosa</i>	2
<i>Sphingobacterium multivorum</i>	1
<i>Stenotrophomonas maltophilia</i>	1
<i>Sphingomonas paucimobilis</i>	1
<i>Burkholderia cepacia</i>	1
<b>Gram positive cocci (N=20)</b>	
<i>Staphylococcus aureus</i>	3
Coagulase Negative Staphylococci	14
<i>Streptococcus spp</i>	2
<i>Enterococcus faecalis</i>	1
<b>Fungi (N=8)</b>	
<i>Candida spp</i>	7
<i>Kodamaea ohmeri</i>	1

Twenty of the bacteria identified (35.1%, n= 20) were Gram-positive cocci (GPC), with CoNS (n=14; 70%) and *Staphylococcus aureus* (n=3; 15%) being the most frequently observed. Fungal elements were identified in 14% of cases, n=8, with *Candida* species representing the most prevalent (n=7; 87.5%). Subjects with positive blood cultures were observed to be younger (mean age

5.2 years vs. 7.3 years;  $p = 0.003$ ) and frequently presented with a clinical picture on physical examination ( $p = 0.008$ ) (Table 2). The species of fungi found were *Candida pelliculosa* (n=2), *Candida parapsilosis* (n=1), *Candida famata* (n=1), *Candida tropicalis* (n=1), *Candida rugosa* (n=1) and *Candida spp* (n =1). *Kodamaea ohmeri* was also found in a sample.

**Table 3. Antimicrobial susceptibility of Gram negative bacilli**

Antibiotics tested	Antibiogram results N(%)	
	Proportion of resistant isolates	Proportion of susceptible isolates
Amoxicillin	16/17 (94)	1/17 (6)
Amoxicillin/clavulanate	12/15 (80)	3/15 (20)
Third generation cephalosporins (except Ceftazidim)	8/11 (72)	3/11 (28)
Ceftazidim	14/27 (52)	13/27 (48)
Cefepim	6/28 (21)	22/28 (79)
Imipenem	8/21 (38)	13/21(62)
Gentamycin	14/27 (52)	13/27 (48)
Amikacin	10/29 (34)	19/29 (66)
Ciprofloxacin	24/29 (83)	5/29 (17)
Levofloxacin	4/14 (29)	10/14 (71)
Sulfamethoxazole trimethoprim	15/19 (79)	4/19 (11)
Colistin	3/12 (25)	9/12 (75)

**Table 4. Antimicrobial susceptibility of Gram-positive cocci**

Antibiotics tested	Antibiogram results N(%)	
	Proportion of resistant isolates	Proportion of susceptible isolates
Oxacillin	3/3 (100)	0 (0)
Gentamycin	1/3 (33)	2/3 (67)
Amikacin	0 (0)	4/4 (100)
Ciprofloxacin	1/2 (50)	1/2 (50)
Levofloxacin	1/4 (25)	3/4 (75)
Colistin	1/3 (33)	2/3 (67)
Erythromycin	4/4 (100)	0 (0)
Vancomycin	0 (0)	5/5 (100)

**Table 5. Antimicrobial susceptibility of Isolated fungi**

Antifungals tested	Antifongigram results N(%)	
	Proportion of resistant isolates/tested isolates	Proportion of susceptible isolates/tested isolates
Miconazole	0 (0)	5/5 (100)
Ketoconazole	0 (0)	5/5 (100)
Amphotericine B	0 (0)	5/5 (100)
Econazole	1/5 (20)	4/5 (80)
Voriconazole	0 (0)	3/3 (100)
Fluconazole	0 (0)	3/3 (100)
Nystatine	0 (0)	3/3 (100)
Clotrimazol	1/3 (33)	3/3 (100)

### Antimicrobial susceptibility

The resistance rate of Gram-negative bacilli to antibiotics was ranging from 21% (cefepime) to 94% (amoxicillin). For the antibiotics used as first-line treatment in the unit, the resistance rate of Gram-negative bacilli was 72% for third-generation cephalosporins other than ceftazidime (so ceftriaxone was available) and 52% for gentamicin. It was 52% for ceftazidime, 34% for amikacin and 38% for

imipenem (Table 3). The antibiograms for GNB are shown in the table 3. The proportion of gram-positive cocci resistant to gentamicin was 33%. Vancomycin and amikacine remained 100% effective in vitro on the isolates tested (Table 4). The antibiograms for GPC are shown in the table 4. The fungi remained for the most part sensitive to the usual antifungals (Table 5).  
**Multidrug resistance**

A germ was considered as multidrug resistant if it was resistant to at least 1 agent in at least 3 antimicrobial categories in vitro. We found out that 38% of GNBs

were multi-resistant germs (*Klebsiella pneumoniae* (n=8), *Acinetobacter baumannii* (n=1), *Burkholderia cepacia* (n=1) and *Sphingobacterium multivorum* (n=1)).

**Table 6. Multi resistance pattern of isolates according to WHO classification**

WHO category	Resistance criteria	Number of germs concerned	Resistance frequency
Critical Priority	Carbapenem-resistant <i>Acinetobacter baumannii</i>	4	1 (25)
	Carbapenem-resistant Enterobacterales	19	5 (26,3)
	Carbapenem-resistant <i>Pseudomonas aeruginosa</i>	2	0 (0)
High priority	Vancomycin-resistant enterococci	1	0 (0)
	Methicillin-resistant <i>Staphylococcus aureus</i>	3	3 (100)

All the staphylococci tested were methicillin resistant but remained susceptible to vancomycin. According to classification of multiresistant germs made by the WHO, we found critical and high priority germs (Table 6).

## DISCUSSION

Although cancer management has seen great improvements over the past 50 years, infections remain an important cause of morbidity and mortality in pediatric oncology. The general objective of our study was to determine the spectrum of bloodstream isolates and report on the antimicrobial susceptibilities of causative pathogens in paediatric cancer patients with fever in the oncology service of the Mother and Child Center of the Chantal Biya Foundation (MCC-CBF), Yaounde. The proportion of positive blood cultures was 28.1%, which is much higher than what is described in most african series dealing with bacteremia in pediatric oncology. Indeed, in the pediatric population, Obeng et al had found a proportion of positive blood cultures of 21.5% in 2015 in Ghana(8) and Lubwama et al in 2019 a proportion of 10.1% of positive blood cultures in Uganda(9). This high rate could be explained by difficult care conditions (inconstant water supply for hand washing, understaffed health workers) likely to increase the risk of infection in our patients in our context. At the end of our analysis, Gram-negative bacteria were the most common germs, accounting for 50.8% (n=29), with a predominance of Enterobacterales (n=19). These results are quite similar to some Indian or sub-Saharan studies(8–10). Alterations to the digestive mucosa caused by chemotherapy, which are fairly frequent in patients undergoing chemotherapy, favour bacterial translocation and therefore more Enterobacterales sepsis such as *Klebsiella pneumoniae* or *E coli*. These differences can be attributed to variations in selection pressure depending on antibiotic therapy habits. In addition, broad-spectrum antibiotics also favour the selection of potentially multi-resistant pathogens through the elimination, to varying degrees, of the normal microbiota. The virtual absence of the use of biomaterials such as port-a-cath type implantable chambers greatly reduces the risk of gram-positive cocci bacteremia, commensal germs of the skin, such as coagulase-negative staphylococci (11). We also found a significant proportion of fungi, especially *Candida spp*. The use of broad-spectrum antibiotic and prolonged neutropenia have been described as risk factors for the

development of candidemia(12,13). Antimicrobial resistance is one of the most important health problems worldwide. In our study, we found a very high rate of resistance to penicillins (amoxicillin resistance of 94.4% for GNB and 50% for GPC, oxacillin resistance of 100% for GPC), It was similar to numerous studies Mvalo et al had also found resistance rates to ampicillin and oxacillin of between 84 and 88%(11) and Obeng et al in 2015 found resistance rates of 7.1 to 100% for ampicillin depending on the species and 80 to 100% for the combination of amoxicillin and clavulanic acid(8). It suggests that their use should not be recommended even for minor infections. This level of resistance may be encouraged by the wide accessibility of these products and their inappropriate and widespread use in the community. The first- and second-line antibiotic treatments used in the study site, consisting of a combination of third-generation cephalosporins and an aminoglycoside, are also already subject to significant resistance. In fact, the rate of germ resistance is 69.2% for ceftriaxone and 44% for ceftazidime. The rate of resistance to amikacin varies between 0 and 25% (for GPC and GNB respectively). These results are in line with those of Mvalo et al, who found resistance rates of 50% for ceftriaxone and 25% for amikacin(11), and also with those of Obeng et al, who found 60.9% of GNB to be resistant to cefotaxime and 34.5% to amikacin(8). The WHO has defined a classification of priority pathogens according to their degree of resistance to antibiotics and the need to create new antibiotic molecules. The so-called critical priority germs are mainly identified by their ability to resist imipenem or vancomycin which were the backbone of third-line treatment in our study site and in many resources limited countries. We thus found a quarter of the GNB were resistant to carbapenemases and all the *Staphylococcus aureus* isolates tested were MRSA. These results are similar from those collected by Lubwama et al who had much more alarming proportions of GNB resistant to imipenem between 36.4 and 50%(9). Antibiotic MDR have been linked to high mortality in cancer patients(14). Vancomycin, fortunately remains active against the MRSA, although it poses at its level, in the same way as imipenem, a problem of financial accessibility. This can promote risky situations (such as incomplete treatments, an administration rate conditioned by fluctuating availability) and therefore precipitate the acquisition of resistance. The fluoroquinolones which is sometimes

used as the 4th line of antibiotics available in our context remain quite effective for the management of GNB infections with sensitivity rates ranging from 70 to 80%. Which is quite close to the results obtained by Mvalo et al and Obeng et al who found sensitivity rates of 75 to 80% for the first and 61.2 to 76.5% for the second (8,11). However, its better financial accessibility compared to the third line and the absence of real control over its daily use for other indications (such as supposed typhoid fevers, bacillary dysentery) also expose it to a risk of resistance at long term. The fungi in our study remain multi-susceptible pathogens, with resistance rates ranging from 0 to 33.3% for the antifungals tested. Mvalo et al found *Candida* spp to be susceptible to amphotericin B (100%) and fluconazole (68.7%)(11). Intravenous amphotericin B is preferred because of its broad spectrum, especially in neutropenic patients. However, it is not readily available, which makes it difficult to use correctly with sufficient treatment times and therefore increases the risk of future resistance.

## CONCLUSION

Gram-negative bacilli are the most common bacteria responsible for bacteraemia in paediatric oncology patients at the MCC-CBF, Yaounde. with a predominance of Enterobacterales. Antibiotic resistance is present, with decreasing susceptibility to first-line antibiotics and a significant proportion of multi-resistant bacteria of critical and high priority according to the WHO. Optimising the use of antibiotics is a necessity in a context of limited resources.

## Limitations

Although our study is one of the few studies in Central Africa on sepsis in pediatric oncology, we recognize some shortcomings. Our limited financial resources did not allow us to collect a sufficient number of blood cultures per febrile episode (i.e. two pairs) as recommended by the guidelines, nor even to repeat blood cultures in patients with persistent fever. All this probably restricted our ability to identify and describe exhaustively all the germs responsible for bacteremia and fungemia. The study was cross-sectional and done in one center so its results could not be generalized. Also we did not evaluate outcomes such as mortality associated with bacteremia and antimicrobial resistance including chemotherapy received, duration of neutropenia and antibiotic prophylaxis.

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The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript

## Authors' contributions

- Conceived and designed the experiments: Minka Obama, Taguebue, Pondy.
- Specimen collection Minka Obama, Pondy.
- Laboratory procedures: Minka Obama, Ngome
- Supervision in the oncology unit: Pondy, Chelo,
- Supervision at the Lab: Ngome

- Data analysis: Minka Obama, Obama, Taguebue, Pondy.
- Wrote the manuscript: Minka Obama, Taguebue.
- All authors read and approved the final manuscript.

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## Abbreviations

CLSI: Clinical & Laboratory Standards Institute; GNB gram negative bacilli GPC gram positive cocci MDR multi drug resistant MRSA: Methicillin resistant *Staphylococcus aureus* WHO world health organization Ethics approval and consent to participate

The study received ethical and scientific approval from the Institutional Review Board of the Faculty of medicine and Biomedical Sciences, Yaounde I. The MCC-CBF approved participation of authors based at their institution (Chelo, Taguebue Pondy.).

A written parental informed consent was obtained from all parents.

## Consent for publication

Not applicable.

## Competing interests

The authors declare that they have no competing interests.

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