ISSN: 2573-9611

Research Article

Journal of Pediatrics & Neonatal Biology

Epidemiology and Sensitivity Profile of Blood Culture Isolates at The Pediatric University Hospital of Bangui

Bogning Mejiozem Brice Olivier[1], Victoire NGatimo[1], Gody Jean Chrysostome[1,2].

Centre Hospitalier universitaire pédiatrique de Bangui, (Central African Republic)

Faculté des Sciences de la Santé, Université de Bangui, Bangui, Central African Republic.

***Corresponding author**
Bogning Mejiozem Brice Olivier, Centre Hospitalier universitaire pédiatrique de Bangui, Central African Republic.

Submitted: 01 Aug 2022; **Accepted:** 07 Aug 2022; **Published:** 13 Aug 2022

Citations: *Brice Olivier B M, Gatimo V N, Chrysostome G J (2022). Epidemiology and Sensitivity Profile of Blood Culture Isolates At The Pediatric University Hospital of Bangui. J Pediatr Neonatal Biol 7(2): 87-96.*

Abstract

Background: *Bacteremia are serious and dreaded diseases, due to their high associated mortality, for which blood culture is the key examination for establishing the diagnosis. Little is known about the epidemiology of sepsis in the Central African Republic (CAR).*

Objective: *To determine the epidemiology and antibiotic susceptibility profile of bacteria isolated from blood cultures in the CHUPB, in order to optimize the probabilistic antibiotic therapy used in first line.*

Methodology: *This was a cross-sectional study conducted at the University Hospital of Bangui (CHUPB) over a period of 12 months (January 1 to December 31, 2021), covering all bacteria isolated from blood cultures taken from children hospitalized in intensive care and neonatal intensive care units. The data were analyzed with the STATA version 14 software. The Chisquare test and ANOVA test were used to compare proportions at the $p<0.05$ threshold.*

Results: *Out of four hundred and fifty-five blood cultures performed during the 12 months, the positivity rate was 13.17% (n=56/425). The neonatal intensive care unit had a positivity rate of 75% (n=42) versus 25% (n=14) for the intensive care unit. The mean age of the blood culture positive children was 19 days (3 days to 15 years) and the sex ratio was 1.94. Among the 56 isolates, a high prevalence of gram-negative bacilli 98.21% (n=55) was noted. The most frequently isolated species were Klebsiella pneumoniae 75% (n=42) and Escherichia coli 19.64% (n=11). Staphylococcus aureus 1.78%(n=1) was the only Gram-positive cocci isolated. Enterobacteriaceae were multi-resistant to empirical antibiotics at CHUPB. Only Tigecycline and Amikacin were still more than 90% sensitive to Klebsiella pneumoniae. Escherichia coli had a sensitivity greater than 80% for Ertapenem, Imipenem and chloramphenicol.*

Conclusion: *This study, which was the first at the CHUPB, underlined the importance of regular monitoring of blood culture isolates, while determining antibiotic sensitivities in order to better guide the probabilistic antibiotic therapy of bacteremia.*
Key words : Blood cultures - epidemiology - isolates - CHUPB.

Introduction

Bacteremia are serious conditions responsible for a very high morbidity worldwide. [1,2]. The mortality rate attributable to bacteremia remains very high, especially in cases of polymicrobial bacteremia, but their clinical importance is often underestimated in sub-Saharan Africa where the majority of fevers are associated with malaria [3,4]. This bacteremia constitutes a diagnostic and therapeutic emergency. They are generally evoked on clinical grounds, but their diagnosis is essentially based on the isolation of germs in blood cultures [5,6]. Indeed, blood culture represents the most reliable means of recognizing the germ responsible for a bacteremia, but it requires a delay that is often incompatible with the urgency of the situation. Bacteria responsible for bacteremia are very varied, and it is sometimes necessary to show ingenuity to isolate and identify them [5]. The results of this examination require, depending on the case, from 24 hours to several days [7]. However, probabilistic antibiotic therapy remains necessary while waiting for the results of the blood culture, and must be as effective

as possible [6]. For this, it is necessary in health facilities to know the bacterial ecology that may be responsible for bacteremia and their antibiotic sensitivity profile, in order to provide an objective basis for the probabilistic antibiotic therapy of these infections. It is with this in mind that we conducted this study to determine the epidemiological profile and the sensitivity of bacteria isolated from blood cultures of children hospitalized at the CHUPB. The final objective was to optimize probabilistic antibiotic therapy to improve the management of bacteremia in the intensive care unit and in the neonatology department of the hospital.

Material and methods

Type and period of the study

This was a cross-sectional and descriptive study conducted over a period of 12 months (January 1 to December 31, 2021) at the CHUPB. This is the only pediatric facility in the country where all sepsis and septic shock cases from Bangui and its surroundings are referred for better management. The study focused on all blood culture isolates validated by the Bangui Pasteur Institute and communicated to clinicians in the intensive care unit and the neonatal resuscitation unit of the CHUPB.

Criteria for selecting children for blood cultures
Blood cultures are taken from any child presenting
- Suspicion of sepsis not responding to the empirical antibiotics used at CHUPB.
- An unexplained prolonged fever
- In children with catheters and those with urinary catheters who present an unexplained worsening of their clinical condition 72 hours after admission to the neonatology or intensive care unit.

Course of The Study

At the IPB, the bacteriology department has carried out the identification of bacteria based on cultural, morphological and biochemical characteristics (API gallery, bio Mérieux SA, Marcyl'Étoile/France). Antibiotic susceptibility testing is performed using the Mueller-Hinton agar diffusion technique (with 5% toned soft blood for demanding germs) with an interpretative reading according to the recommendations of the French Society of Microbiology (CA-SFM) antibiogram committee [8]. Antibiotic resistance of different bacteria was detected by the antibiogram method associated with other complementary tests necessary in certain situations.

The same applies to the detection of meticillin resistance using a cefoxitin disc (30 micrograms); for strains with a diameter between 25 and 27 mm, the PLP2a protein is tested by latex particle agglutination technique (Slidex MRSA Detection bioMérieux Marcyl'Étoile/France) from colonies collected on the edge of the inhibition zone of a cefoxitin disk on Mueller-Hinton agar, after 24 hours of incubation. In establishing the percentages of resistance of the different bacterial species, the IPB had included the "intermediate" category in the "resistant" category.

Once the blood culture isolates were validated by the IPB, the results were shared with the CHUPB clinicians. Data regarding the frequency of blood cultures by month and department, age and sex of children, germs isolated, and their antibiotic susceptibility were recorded by Access 2019 software and kept secret to ensure confidentiality.

Data Processing and Analysis

The data were analyzed with the STATA version 14 software. Chi-square test and ANOVA test had been used to compare the proportions at the $p < 0.05$ threshold.

Results

Frequency of blood culture requests at CHUPB

During the study period, 425 blood cultures were collected and sent to the bacteriology department of the IPB. The highest number of requests was in June (106) and July (101). Blood cultures were less requested in January (8) and November (6).

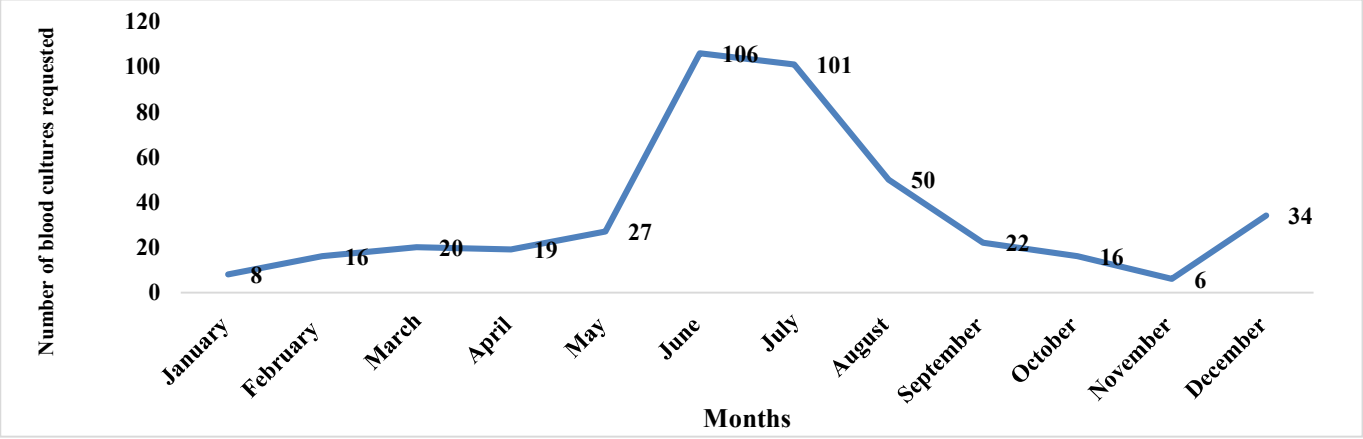

Figure 1: Monthly distribution of positive blood cultures and number of requests

Frequency of positive blood cultures and positivity rate

Of the 425 blood cultures taken during the study period, 56 were positive, i.e. a positivity rate of 13.17%. The samples were positive throughout the year with a peak in September 50% (n=11/22) and November 50% (n=3/6). The lowest positivity rate was noted in May 3.7% (n=1/27). The distribution of the positivity rate by month is shown in figure 2.

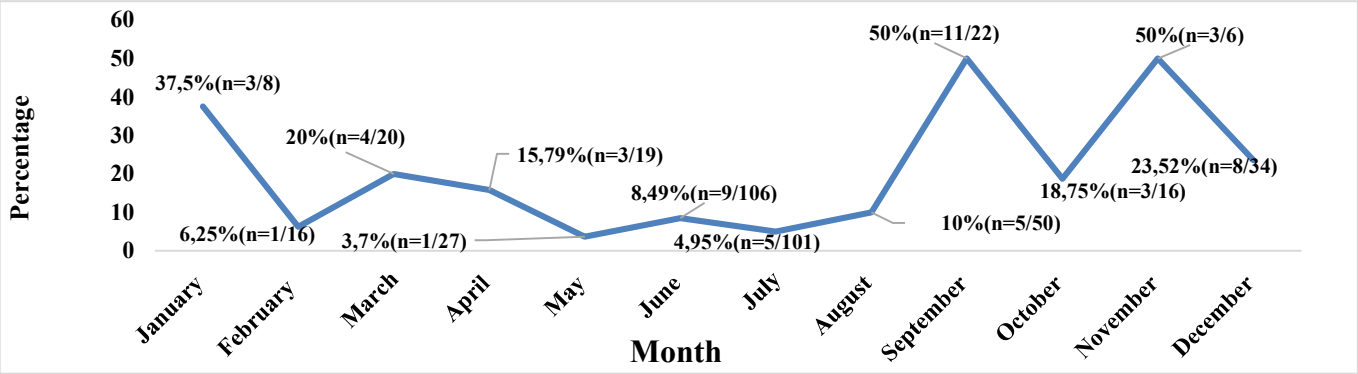

Figure 2: Distribution of blood culture positivity rate by month.

General Characteristics of Positive Blood Cultures

The sex ratio was 1.94. The mean age of the children was 19 days with extremes of 3 days to 15 years. Isolates were more common in children less than 28 days of age (75%, n=42) than in children older than 28 days (25%, n=14). The majority of positive blood cultures were from neonates hospitalized in the neonatal unit 75% (n=42) versus 25.01% (n=14) for intensive care.

See table I

Table I: Distribution of Positive Blood Cultures According To General Characteristics.

Characteristics of positive blood cultures (N= 56)	Number	Percentage
Sex		
Male	37	66,07
Female	19	33,93
Age range in days		
[0 - 3[	4	7,14
[3 -7[	13	23,21
[7 -14[	16	28,57
[14 -28[	9	16,07
> 29	14	25,01
Unit of origin of blood cultures		
Neonatology	42	75,00
Intensive care	14	25,00

Distribution of bacteria isolated from positive blood cultures

During the study period, gram-negative bacilli accounted for 98.21% (n=55) of isolates versus 1.78% (n=1) of gram-positive cocci. The 55 gram-negative bacilli were subdivided into two major groups. These were Enterobacteriaceae which represented 98.18% (n=54/55) of cases, with a predominance of Klebsiella pneumoniae in 77.77% (n=42/54) of cases, *Escherichia coli* in 20.37% (11/54) of cases and Enterobacter cloacae in 1.85% (n=1/54) of cases. Concerning the non-closing Gram-negative bacteria, we isolated only one strain, *Acinetobacter Baumanii* (1.81%). Finally, the only gram-positive cocci isolated was Streptococcus spp. 1.78 (n=1/56).

See table II.

Table II: Distribution of Bacteria Isolated In Positive Blood Cultures

Categories	Groups	Species	Number	Percentage
Gram-negative bacillus	Enterobacteria	*Klebsiella Pneumoniae*	42	75,0
		Escherichia coli	11	19,64
		Enterobacter cloacae	1	1,78
	Non-closing bacteria	*Acinetobacter Baumanii*	1	1,78
Gram-positive bacillus	Cocci	*Streptocoque spp*	1	1,78

Distribution of isolated bacteria according to services
The distribution of bacteria by service is shown in Figure 3.

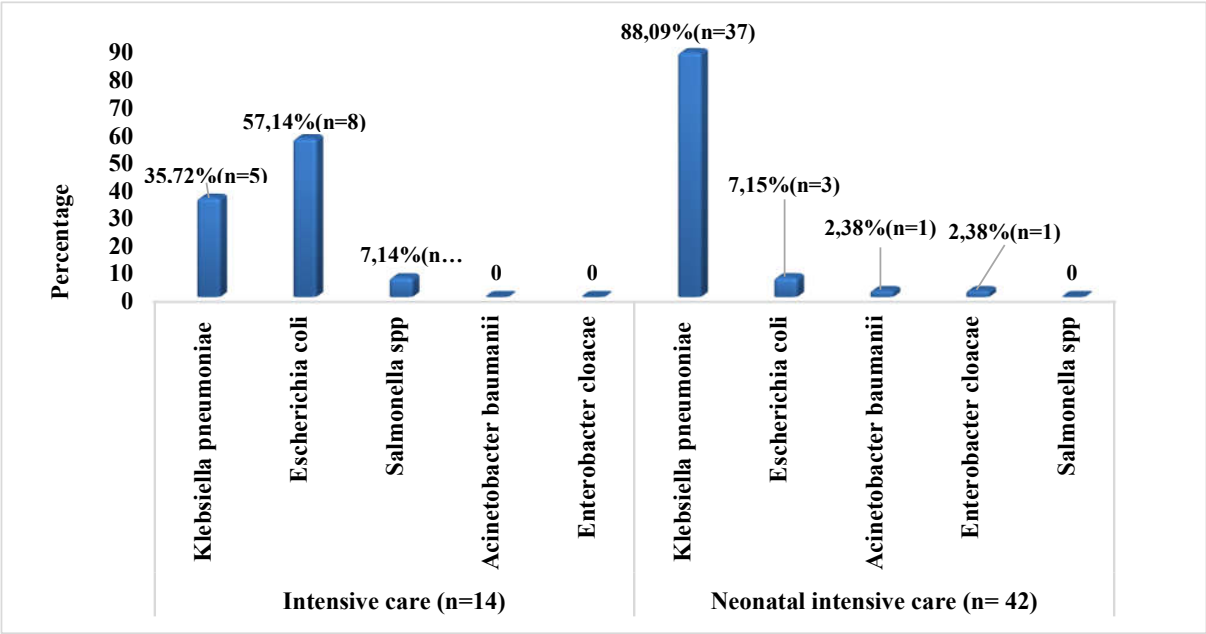

Figure 3: Distribution of bacteria isolated by department.

Study of the sensitivity of *Klebsiella pneumoniae* to antibiotics (N=42)
Klebsiella pneumoniae was susceptible to Tigecycline 92.85%(n=39);Amikacin 92.85%(n=39); Cefoxitin 64.28%(n=27); Netilmicin 57.14%(n=24); Chloramphenicol 23.81%(n=10) Amoxicillin + Clavulanic Acid 14.28%(n=6); Gentamicin 11.90%(n=5); Tobramicin 9.52%(n=4); Nalidixic Acid 9.52%(n=4); Ciprofloxacin 7.14%(n=3) and Ceftriaxone 2.38%(n=1).

The antibiotic resistance rate for *Klebsiella pneumoniae* was about 100%(n=42) for Ampicillin; Ticarcillin; Cefalexin; Cefepime; Imipenem; Ertapenem; and Methicillinam. This resistance was 97.61%(n=41); for Ceftriaxone; 88.09%(n=37) for Gentamicin; 88.09%(n=37) for Tobramicin; 85.71%(n=36) for Amoxicillin + Clavulanic acid; 85.71%(n=36) for Ciprofloxacin; 83.33%(n=35) for Nalidixic acid; 76.19%(n=32) for Chloramphenicol; 40.47%(n=17) for Netilmicin; 35.71%(n=15) for Cefoxitin; 7.14%(n=3) for Tigecycline and
2.38%(n=1) for Amikacin.

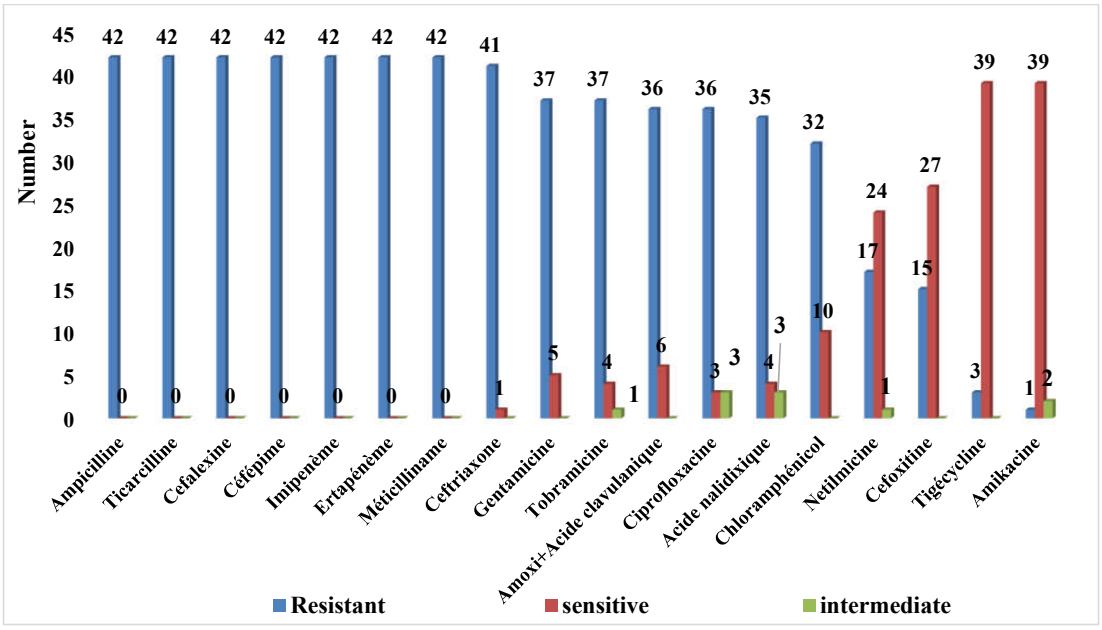

Figure 4: Distribution of blood cultures by antibiotic sensitivity of klebsiella pneumoniae

Study of the sensitivity of Escherichia Coli to antibiotics (N=11)

The sensitivity of *Escherichia Coli* was 90.91% (n=10) for Ertapenem and Imipenem. It was 81.81% (n=9) for chloramphenicol, 63.63% (n=7) for Amikacin; 27.27% for (Amoxi + Clavulanic acid, Nalidixic acid and Netilmicin); 18.18% for (Cefoxitin and Cefepime); 9.09% for (Ampicillin, Ticarcillin, Cefalexin; Ceftriaxone; Gentamicin; Tobramicin and Ciprofloxacin).

The rate of resistance of Escherichia Coli to antibiotics was 100% for (Meticillinam and Tigecycline); 90.91% for (Ampicillin, Ticarcillin, Cefalexin, Ceftriaxone, Gentamicin, Tobramicin and Ciprofloxacin); 81.81% for (Cefoxitin and Cefepime); 72.72% for (Amoxi+Clavulanic acid and Nalidixic acid); 54.54% (n=6) for Netilmicin; 18.18% for (Amikacin and Chloramphenicol); 9.09% (n=1) for Ertapenem.

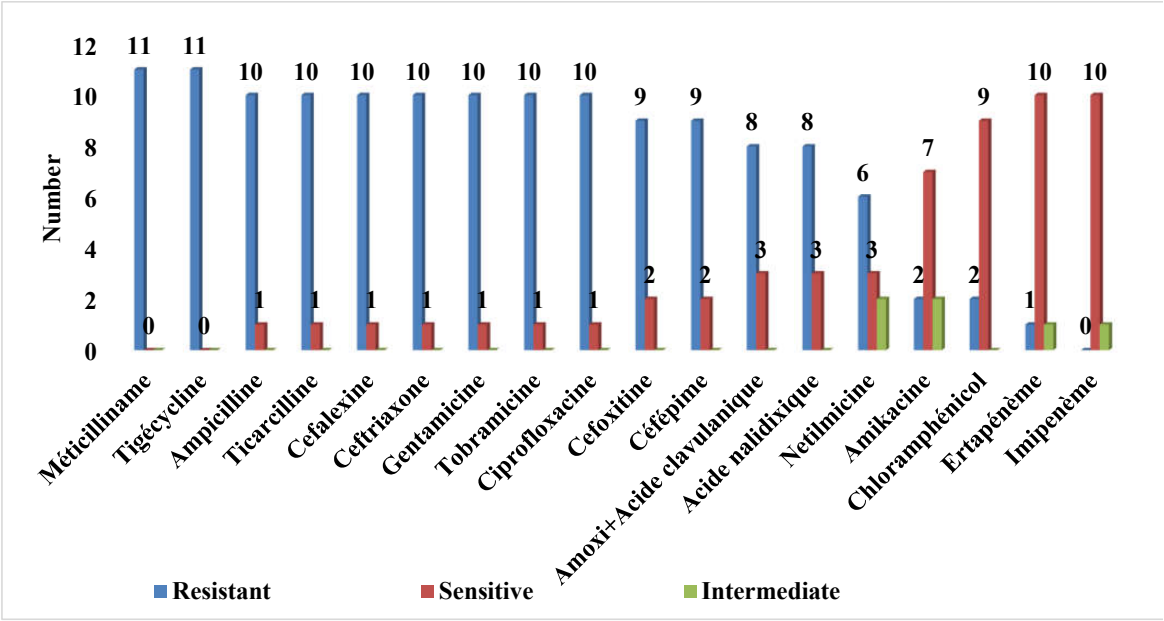

figure 5: distribution of blood cultures according to sensitivity of escherichia coli to antibiotics.

Study of the sensitivity of other bacteria to antibiotics

The sensitivities and antibiotic residues of Salmonella spp, Acinetobacter baumanii and Enterobacter cloacae are shown in Table III.

Table III: Distribution of bacteria isolated in positive blood cultures.

Bacteria	*Salmonella spp (N=1)*			*Acinetobacter baumanii (N=1)*			*Enterobacter cloacae (N=1)*		
Antibiotics	R	S	I	R	S	I	R	S	I
Ampicilline	1	0	0	1	0	0	1	0	0
Amoxi+Acide clavulanique	1	0	0	1	0	0	1	0	0
Ticarcilline	1	0	0	1	0	0	1	0	0
Cefalexine	1	0	0	1	0	0	1	0	0
Cefoxitine	0	1	0	1	0	0	1	0	0
Ceftriaxone	1	0	0	1	0	0	1	0	0
Céfépime	1	0	0	1	0	0	1	0	0
Imipenème	0	1	0	0	1	0	0	1	0
Ertapénème	0	1	0	0	1	0	0	1	0
Méticilliname	1	0	0	1	0	0	1	0	0
Gentamicine	1	0	0	1	0	0	1	0	0
Amikacine	0	1	0	0	1	0	0	1	0
Netilmicine	0	1	0	1	0	0	1	0	0
Tobramicine	1	0	0	1	0	0	1	0	0
Acide nalidixique	1	0	0	0	1	0	1	0	0
Ciprofloxacine	1	0	0	0	1	0	1	0	0
Tigécycline	0	1	0	0	1	0	0	1	0
Chloramphénicol	1	0	0	0	1	0	1	0	0

Discussion

Epidemiology

Bacteremia are serious diseases, responsible for significant morbidity and mortality worldwide [1]. For any clinician, knowledge of the most frequently encountered bacterial species in a disease and their susceptibility to the main antibiotics is essential to initiate an effective treatment [1]. This is particularly true for bacteremia, which is often observed in 25%-31% of sepsis, and in almost 70% of septic shock [9]. Sometimes in 15-30% of cases, no portal of entry is identified and about one third of patients with septic shock have no bacteriological documentation [10]. In this case, probabilistic antibiotic therapy must be adapted from the outset because it conditions the prognosis of the disease [11]. The blood culture is the key examination that allows the detection and identification of the pathogen in question and the characterization of its sensitivity profile to anti-infectives. This last point is essential since the mortality in case of sepsis is multiplied by three when the antibiotic treatment is not adapted [10]. Continuously updated knowledge of bacterial epidemiology and antibiotic susceptibility of blood culture isolates is essential for the implementation of this adapted presumptive antibiotic therapy [12]. In fact, in current practice at the CHUBP, the initial antibiotic therapy often remains empirical during the first 72 hours, while waiting for the therapeutic response before considering a probable blood culture in order to readjust the initial antibiotic therapy according to the results of the antibiogram. However, the importance of blood culture for the detection of bacteremia on admission before any antibiotic therapy is well known and many studies have been devoted to it [13]. During the study period, the blood culture positivity rate was 13.17%. This rate was superposable to those of several African and Asian authors who reported rates varying from 14.24% to 15.9% as mentioned in Table IV.

Table IV: Corroborating Blood Culture Positivity Rates at our In Different Developing Countries.

Authors	Country	Year	Positivity rate
Banik et al [14]	India	2018	14,24%
Eshetu et al [15]	Ethiopia	2018	15,2%
Bhandari et al [16]	Nepal	2015	15,4%
Maïga et al [17]	Mali	2004	15,5%
Bahwere et al [18]	Democratic Republic of Congo	2001	15,9%
Our study	CAR	2019	13,17%

When the indications for blood cultures are well defined and samples are taken during fever peaks in patients who have not yet taken antibiotics, the positivity rate increases, as shown by other studies conducted in African, Asian and American countries, with positivity rates higher than our own, ranging from 16.5% to 45.5%.

Table V: Blood Culture Positivity Rates Above our In Different.

Authors	Country	Year	Positivity rate
Gupta et al [19]	India	2016	16,5%
Archibald et al [20]	Tanzania	2006	18,3%
Soraa et al [21]	Morocco	2011	19,7%
Ki-Zerbo et al [22]	Dakar	1996	19,8%
Mylotte et al [23]	USA	2000	19,8%
Mahmoud et al [6]	Morocco	2010	20%
Akoua-Koffi et al [24]	Ivory Coast	2015	22,5%
Elouennass et al [25]	Morocco	2008	45,5%
Our study	CAR	2022	13,17%

Finally, positivity rates lower than ours have also been reported by several African authors ranging from 4.1% in Senegal to 12.8% in Cameroon, see Table VI.

Table VI: Positivity rates of blood cultures lower than ours in different studies on a continental scale.

Authors	Country	Year	Positivity rate
Lakhe et al [26]	Senegal	2018	4,1%
Mnif Chaabene et al [27]	Tunisia	2017	10%
Benjemaa et al [28]	Tunisia	2004	10,5%
Okalla Ebongue et al [5]	Cameroon	2014	12,8%
Our study	CAR	2019	13,17%

The disparities in the literature concerning the rates of bacteremia in relation to the number of blood cultures performed can be explained by several factors. On the one hand, this positivity rate may be due to the heterogeneity of the different services in which the samples are taken and the indications for blood cultures, as shown by the data of the French national observatory of the epidemiology of bacterial resistance to antibiotics (ONERBA), which reports that the positivity rate varies from 6.5 to 13.3% depending on the hospitals in France [11]. On the other hand, the time of sampling is crucial for the search for bacteria in the blood: thermal peaks and shivering are the most favourable (except for bacterial endocarditis, where the time is of little importance). The positivity rate can thus be high in studies performed in hospitals insisting on these recommendations. This was done by Bahwere et al., who found that the rate of positivity in febrile patients increased from 15.9% for all specimens to 24.4% [18]. Finally, the clinical context is a major element in the prediction of bacteremia. Indeed, the source of the infection allows to stratify patients into low, medium and high risk of bacteremia. For example, cellulitis is at low risk (2%) compared to pyelonephritis (19%-25%), acute bacterial meningitis (53%) or septic shock (69%) [29].

Bacteriological profile of isolates

During the study period, the bacteriological profile of the isolates in our series was marked by the predominance of gram-negative bacilli, which represented 98.21% (n=55) of cases. Several authors have reported the predominance of gram-negative bacteria in different proportions. [5,6,19,23,28,30]. In contrast to our series, several authors from developed countries have reported a predominance of gram-positive bacteremia in the isolates [11,22,31,32]. [11,22,31,32]. Some African countries, such as Banik et al, have found higher rates of grampositive bacteria than gram-negative bacteria [14]. The same is true of the Moroccan study [25] and the Tanzanian study [20]. Finally, another study carried out in Burkina Faso by Lankoande noted a predominance of gram-negative bacteremia [33]. The authors explain this change in the epidemiology of Gram-negative bacteria, compared to Gram-positive bacteria, by the increasingly frequent use of biomaterials and by the improvement of antibiotic regimens directed towards Gram-negative bacteria, particularly in oncology and intensive care patients, as well as by the increase in the overall number of blood cultures performed [34]. In our study, the nosocomial or community character of bacteremia was not explored. Of course, the nature of the germs isolated in our series and their multidrug-resistant profiles pointed more towards a nosocomial origin. Thus, the predominance of Klebsiella Pneumoniae (75.0%) and Escherichia coli (19.64%) as the two main Gram-negative bacilli reported in our study and their multidrug resistance to most of the empirical antibiotics used in the department testifies to the nosocomial origin of bacteremia at the CHUPB. This resistance of Klebsiella Pneumoniae to antibiotics was 100% to (ampicillin; Ticarcillin; Cefalexin; Cefepime; Imipenem; Ertapenem; and to Meticillinam). The same findings were made by two authors [12,28].

In our study, Enterobacteriaceae represented 98.18% of all bacteria isolated and thus correspond to the 1st cause of infections in the neonatal intensive care unit of CHUPB. They were represented essentially by Klebsiella pneumoniae (75.0%) and Escherichia coli (19.64%). Several authors have reported a predominance of Enterobacteriaceae but in different proportions to ours as shown in Table VII.

Table VII: Rate of Gram-negative bacteria in relation to the total bacteria identified and according to different studies

Série	Pays	Entérobactéries	Klebsiella Pneumoniae	Escherichia coli
Our study	CAR	98,18%	75,0%	19,64%
Okalla Ebongue et al [5]	Cameroon	68,60%	40,5 %	36,00%
Gupta et al [19]	India	58,34%	19,70%	22,40%
Lakhe et al [26]	Senegal	58,10%	5,8%	8,10%
Banik et al [14]	India	37,54%	9,96%	4,21%
Marty et al [35]	France	----------	3.6%	30,00%

The high frequency of *Klebsiella Pneumoniae* and Escherichia coli in our series, contrary to other studies, could be explained by the nosocomial character of bacteremia in our series, which suggests a problem of control of the hospital environment in Bangui. Indeed, *Klebsiella Pneumoniae* and Escherichia coli are nosocomial bacteria par excellence, essentially found in the hospital environment, having a capacity to acquire and easily accumulate several antibiotic resistance mechanisms.

In our study, the Gram-positive cocci isolates were essentially *Streptococcus spp*., whose proportion was 1.78% of all isolates. This proportion is the lowest compared to the literature data as mentioned in Table VIII.

Table VII : Rate of Gram-positive bacteria in relation to the total bacteria identified according to different studies.

Authors	Country	Gram-positive cocci (+)	Streptococcus spp
Gupta et al [19]	India	41,65%	18,30%
Lakhe et al [26]	Senegal	41,8%	10,5%
Banik et al [14]	India	62,37%	42,14%
Our study	CAR	1,78%	100%

Antibiotic Resistance Profile

The proper use of antibiotics is the therapeutic act that leads to the cure of the patient by limiting the emergence of resistant bacterial strains and its consequences. Poor quality prescriptions affect the patient's prognosis, entail a risk of therapeutic failure and expose the patient to the risk of emergence of bacterial resistance [36-38]. Analysis of the resistance profiles of isolated strains showed that enterobacteria were multi-resistant to most of the empirical and second-line antibiotics in the neology department and intensive care unit of the CHUPB (ampicillin; Ceftriaxone, Gentamicin; Amoxicillin + Clavulanic acid; Ciprofloxacin; Chloramphenicol). This very alarming multiresistance suggested by our study had no correspondent in the literature and testifies to the nosocomial origin of our infections. Indeed, during this period, we were confronted with an epidemic of Klebsiella pneumoniae in the neonatology department. An alternative was noted for Klebsiella pneumoniae which kept a sensitivity higher than 50% for two antibiotics absent from the Central African mache (Tigecycline, Netilmicin) and to two other antibiotics present in Bangui but very expensive (Amikacin; Cefoxitine). The alternative for Escherichia Coli was Ertapenem and Imipenem which had a sensitivity of 90.91% but were very expensive in CAR. The other alternative was Chloramphenicol whose sensitivity was 81.81% but contraindicated in neonatal period. Finally, Amikacin is also an alternative with a sensitivity of 63%. The high frequency of nosocomial bacteremia related to multidrug-resistant bacteria justifies the recommendation of first-line treatment with imipenem associated with amikacin in intensive care units. The search for the entry point must be a key step in orienting this anti-infectious treatment while waiting for the positivity of the blood culture, the treatment must then be adapted to the microbiological results and evaluated according to the clinical evolution.

Conclusion

Bacteremia are a daily concern for the clinician, especially in a country with limited resources such as the CAR. The initiation of an adequate antibiotic treatment as soon as possible conditions the evolution of the disease. Thus, this study reported the predominance of Gramnegative bacteria of nosocomial origin with very high rates of resistance, in particular to empirically used antibiotics, within the CHUPB. The data from this study will allow us to adapt the probabilistic antibiotic therapy of bacteremia in the intensive care unit and in the neonatal intensive care unit of this hospital. Another approach will be to develop a strategy to control the development of multi-resistant bacteria in Bangui by increasing hospital hygiene measures and strict aseptic conditions during medical care. It therefore seems timely and urgent to set up a program to control nosocomial infections and multi-resistant bacteria in order to control the spread of these epidemic strains and avoid the evolution towards therapeutic impasse in Bangui. However, more specific studies taking into account factors related to bacterial resistance are essential to complete the more general data presented.

Limitations of the study

The present study had some pitfalls related to the very long delays in obtaining blood culture results (the first results being delivered after 48 hours and the final results after 10 days, sometimes after

the death of the patients) and to the high cost of only one blood culture per child. However, this study has the advantage of being conducted in the only referral hospital for the management of severely ill children in the CAR. This provides sufficient coverage of the child population of Bangui. In addition, the methodological rigor and sample size increased the reliability of the statistical analysis.

Référence

1. Karlowsky, J. A., Jones, M. E., Draghi, D. C., Thornsberry, C., Sahm, D. F., & Volturo, G. A. (2004). Prevalence and antimicrobial susceptibilities of bacteria isolated from blood cultures of hospitalized patients in the United States in 2002. Annals of clinical microbiology and antimicrobials, 3(1), 1-8.
2. Søgaard, M., Nørgaard, M., Pedersen, L., Sørensen, H. T., & Schønheyder, H. C. (2011). Blood culture status and mortality among patients with suspected community-acquired bacteremia: a population-based cohort study. BMC infectious diseases, 11(1), 1-9.
3. Obaro, S., Lawson, L., Essen, U., Ibrahim, K., Brooks, K., Otuneye, A., ... & Adegbola, R. (2011). Community acquired bacteremia in young children from central Nigeria-a pilot study. BMC infectious diseases, 11(1), 1-10.
4. Croizé, J., Cadoux, B., Leclerc, P., François, P., Brion, J. P., & Le Noc, P. (1989). Comparaison de deux systèmes d'hémoculture: Signal et Bactec. In Annales de biologie clinique (Paris) (Vol. 47, No. 6, pp. 311-316).
5. Okalla Ebongue C, NdaMefo'o JP, Ngouadjeu Dongho E, Eboumbou Moukoko EC, et al. Profil bactériologique et sensibilité aux antibiotiques des isolats d'hémoculture (2006-2011) à Douala, Cameroun. Revue Malienne d'Infectiologie et de Microbiologie. 2014;2:27-39
6. Mahmoud, M., Yahyaoui, G., & Benseddik, N. (2010). HEMOCULTURES: PROFIL BACTÉRIOLOGIQUE ET SENSIBILITÉ AUX ANTIBIOTIQUES. Maroc Médical, 32(2).
7. Elouennass, M., Sahnoun, I., Zrara, A., Bajjou, T., & Elhamzaoui, S. (2008). Épidémiologie et profil de sensibilité des isolats d'hémoculture dans un service de réanimation (2002–2005). Médecine et maladies infectieuses, 38(1), 18-24.
8. Comité de l'Antibiogramme de la Société française de microbiologie (CASFM) 2008 ; In : http : //www.sfm.ass.
9. Rangel-Frausto, M. S., Pittet, D., Costigan, M., Hwang, T., Davis, C. S., & Wenzel, R. P. (1995). The natural history of the systemic inflammatory response syndrome (SIRS): a prospective study. Jama, 273(2), 117-123.
10. Boles JM, Bollaert PE, Iaeger A, Saulnier F, Wolff M, Zéni F. Réanimation médicale de Collège national des enseignants de réanimation (France). Elsevier Masson. 2e édition . 2009:p1968. ISBN : 978-2-294-08855-1.
11. Bertrand, X., Costa, Y., & Pina, P. (2005). Surveillance de la résistance bactérienne aux antibiotiques dans les bactériémies: données de l'observatoire national de l'épidémiologie de la résistance bactérienne aux antibiotiques (ONERBA) 1998–2003. Médecine et maladies infectieuses, 35(6), 329-334.
12. Ben Haj Khalifa, A., & Khedher, M. (2010). Fréquence et profil de sensibilité aux antibiotiques des bactéries isolées des hémocultures au CHU de Mahdia. Revue Tunisienne d'Infectiologie, 92-95.
13. Skogberg, K., Lyytikäinen, O., Ruutu, P., Ollgren, J., & Nuorti, J. P. (2008). Increase in bloodstream infections in Finland, 1995–2002. Epidemiology & Infection, 136(1), 108-114.
14. Banik, A., Bhat, S. H., Kumar, A., Palit, A., & Snehaa, K. (2018). Bloodstream infections and trends of antimicrobial sensitivity patterns at Port Blair. Journal of laboratory physicians, 10(03), 332-337.
15. Bitew, A. (2018). Multi-drug resistance profile of bacteria isolated from blood stream infection at Tikur anbessa specialized hospital, Addis Ababa, Ethiopia. EC Microbiol, 14, 119-26.
16. Bhandari, P., Manandhar, S., Shrestha, B., & Dulal, N. (2016). Etiology of bloodstream infection and antibiotic susceptibility pattern of the isolates. Asian journal of medical sciences, 7(2), 71-75.
17. Maïga, I. I., Sidibé, M., Maïga, A., & Rochereau, A. (2004). Les bactéries isolées par hémoculture à l'hôpital du point G. Mali Médical, 19(1), 18.
18. Bahwere, P., Levy, J., Hennart, P., Donnen, P., Dramaix-Wilmet, M., Hemelof, W., ... & De Mol, P. (2001). Community-acquired bacteremia among hospitalized children in rural central Africa. International Journal of Infectious Diseases, 5(4), 180-188.
19. Gupta, S., & Kashyap, B. (2016). Bacteriological profile and antibiogram of blood culture isolates from a tertiary care hospital of North India. Tropical Journal of Medical Research, 19(2), 94-94.
20. Archibald, L. K., Pallangyo, K., Kazembe, P., & Reller, L. B. (2006). Blood culture contamination in Tanzania, Malawi, and the United States: a microbiological tale of three cities. Journal of clinical microbiology, 44(12), 4425-4429.
21. Soraa, N., Zougaghi, L., Zahlane, K., Admou, B., Haouach, K., Kachach, M., & Chabaa, L. (2011). EPIDEMIOLOGY AND SUSCEPTIBILITY PROFILE OF BLOOD CULTURE ISOLATES IN A MOROCCAN UNIVERSITY HOSPITAL CENTER. Revue Tunisienne d'Infectiologie. April, 5(2), 78-81.
22. Ki-Zerbo, GA, Thioub, B., Diop, BM, Badiane, S., Coll-Seck, AM, & Samb, A. (1996). Study of positive blood cultures at the University Hospital of Fann Dakar: assessment of three years of the bacteriology laboratory. Black African Medicine , 43 (6).
23. Mylotte, J. M., & Tayara, A. (2000). Blood cultures: clinical aspects and controversies. European journal of clinical microbiology and infectious diseases, 19(3), 157-163.
24. Akoua-Koffi C, Tia H, Plo JK, Monemo P, Cissé A, Yao C et al. Épidémiologie des infections de la circulation sanguine d'origine communautaire à Bouaké, dans le centre de la Côte d'Ivoire. Nouveaux microbes et nouvelles infections.2015;7:100-4.
25. Elouennass, M., Sahnoun, I., Zrara, A., Bajjou, T., & Elhamzaoui, S. (2008). Épidémiologie et profil de sensibilité des isolats d'hémoculture dans un service de réanimation (2002–2005). Médecine et maladies infectieuses, 38(1), 18-24.

26. Lakhe, N. A., Sylla, K., Mbaye, K. D., Ndiaye, R., & Diallo, V. M. P. C. (2018). Bacteremia: Profile and Antibiotic Resistance at the Infectious and Tropical Diseases Clinic in Fann Hospital, Dakar, Senegal. J Infect Dis Ther, 6(348), 2332-0877.
27. Mnif Chaabene, B. (2017). Hémocultures positives: résultats de l'étude multicentrique prospective. L'antibiorésistance en Tunisie (LART). 27ème congrès STPI, 25.
28. Mahjoubi, F., H'mida, Y. B. H., Hammami, N., Ayed, M. B., & Hammami, A. (2004). Profil bactériologique des bactériémies et sensibilité aux antibiotiques des bactéries en cause dans la région de Sfax (1993–1998). Pathologie Biologie, 52(2), 82-88.
29. Sciotto, L., Abbas, M., & Serratrice, J. (2017). Détection d'une bactériémie par des hémocultures: qui en bénéficie?. Revue médicale suisse, 13(579), 1774-1778.
30. Hurley, J. C. (2010). Does gram-negative bacteraemia occur without endotoxaemia? A meta-analysis using hierarchical summary ROC curves. European journal of clinical microbiology & infectious diseases, 29(2), 207-215.
31. Bourneton, O., Mutel, T., Heranney, D., Hernandez, C., Lavigne, T., Waller, J., ... & Foegle, J. (2010). Incidence des bactériémies et fongémies aux hôpitaux universitaires de Strasbourg de 2005 à 2007. Pathologie Biologie, 58(1), 29-34.
32. Berche, P. (2012). Denis F., Ploy MC., Martin C., Bingen É. et Quentin R.—Bactériologie médicale, techniques usuelles, Elsevier Masson, Paris, 2011, 631 pages. Bulletin de l'Académie Nationale de Médecine, 196(2), 542-544.
33. Baudat, V., Chuard, C., & Regamey, C. (2005). Review of positive blood cultures over two years at the Cantonal Hospital of Fribourg. Swiss Medical Journal , 36 , 2338.
34. MARTY, L., & JARLIER, V. (2000). Surveillance des bactéries nosocomiales à partir du laboratoire dans les hôpitaux de l'interrégion Paris-Nord en 1994 et 1996. Bulletin épidémiologique hebdomadaire, (18), 75-77.
35. Leibovici, L., Shraga, I., Drucker, M., Konigsberger, H., Samra, Z., & Pitlik, S. D. (1998). The benefit of appropriate empirical antibiotic treatment in patients with bloodstream infection. Journal of internal medicine, 244(5), 379-386.
36. Kollef, M. H., Sherman, G., Ward, S., & Fraser, V. J. (1999). Inadequate antimicrobial treatment of infections: a risk factor for hospital mortality among critically ill patients. Chest, 115(2), 462-474.
37. Ibrahim, E. H., Sherman, G., Ward, S., Fraser, V. J., & Kollef, M. H. (2000). The influence of inadequate antimicrobial treatment of bloodstream infections on patient outcomes in the ICU setting. Chest, 118(1), 146-155.