Original Article

Effects of Gender and Seasonal Variation on the Prevalence of Bacterial Septicaemia Among Young Children in Benin City, Nigeria

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ABSTRACT

Aim: To determine the effects of gender and seasonal variations on the prevalence of bacterial septicaemia among children 5 years and younger, and to identify the bacterial agents responsible for septicaemia and their antibiotic susceptibility profiles. **Methods:** Blood was collected from 1,724 children (967 males and 757 females) aged 1 day to 5 years with clinical signs and symptoms of septicaemia. This study was carried out from 1 January to 31 December 2007 at the University of Benin Teaching Hospital, Benin City, Nigeria. The blood samples were processed to diagnose bacterial septicaemia. Bacterial isolates were identified and susceptibility test was performed using standard techniques. **Results:** An overall prevalence of 22.10% of confirmed bacterial septicaemia was observed in this study. Generally, gender and seasonal variations did not significantly affect the prevalence of bacterial septicaemia, though females (50.57%) during the dry season had significantly (p < 0.001) higher prevalence than their male counterparts (19.91%). *Staphylococcus aureus* was the predominant bacterial isolate causing septicaemia in both seasons, while *Citrobacter freundii* was the least frequent. *Pseudomonas aeruginosa* was not recovered during the dry season. Most isolates were susceptible to gentamicin and cefuroxime, but only 1.44% of *Staphylococcus aureus* strains were susceptible to ceftriaxone. **Conclusion:** Bacterial septicaemia was observed in 22.1% of children 5 years and younger with clinical signs and symptoms of septicaemia. Seasonal variation did not affect the prevalence. Effect of gender was only noticed in the dry season, where females had a higher prevalence than males. Gentamicin and cefuroxime were the most active antibacterial agents. Rational use of antibiotics is advocated.

INTRODUCTION

Septicaemia is a systemic disease caused by the spread of microorganisms and their toxins in the blood [1]. It has also been described as any systemic bacterial infection documented by a positive blood culture [2]. Septicaemia is a common cause of paediatric morbidity and mortality [3], and the World Health Organization (WHO) estimates that 85% of newborn deaths are due to infections, including sepsis, pneumonia and tetanus [4]. Forty percent of the infants identified with sepsis die, and the biggest toll is in developing countries [4]. In Nigeria, septicaemia in a major cause of death in neonates and children [5,6]. Prompt diagnosis and effective treatment is necessary to prevent death and complications from septicaemia [3].

Physical signs and symptoms are useful in identifying infants and children with septicaemia and other non-localised infections but they have limited specificity [7,8]. Bacteriological culture to isolate the offending pathogen remains the mainstay of definitive diagnosis of septicaemia [3]. Organisms isolated from the bloodstream of patients with sepsis vary from area to area [9]. The results of bacteriological cultures and antibiotic susceptibility tests take about a week, necessitating initial empirical treatment of suspected septicaemia. Therefore, knowledge of the epidemiological and antimicrobial susceptibility patterns of common pathogens in a given area helps to inform the choice of antibiotics.

Seasonal variations and gender are known to affect the prevalence of a number of infections [10-12]. This study aimed to determine the effects of gender and seasonal variations on bacterial septicaemia among children aged five years or younger in Benin City Nigeria.

MATERIALS AND METHODS
Patients and Processing of Specimens
This study was carried out from 1 January to 31 December 2007 at the University of Benin Teaching Hospital, Benin City, Nigeria. Verbal informed consent was obtained from parents of children recruited in this study. The Ethics Committee of the University of Benin Teaching Hospital approved the protocol for this study.

A total of 1724 children aged 1 day to 5 years with clinical signs and symptoms of septicaemia were included in this study. They consisted of 967 males and 757 females. Blood samples were collected from each patient and dispensed into blood culture bottles (glucose broth and thioglycolate broth) and incubated for a maximum of seven days. Bottles with signs of growth, such as turbidity, haemolysis, clot formation, gas production and/ or cotton ball effect were subcultured on chocolate, blood and MacConkey agar plates. The chocolate agar plates were incubated in candle jars and the blood and MacConkey agar plates were incubated aerobically. Significant bacteria isolates were identified by standard techniques [13]. Disc susceptibility test was performed using the British standard for Antimicrobial Chemotherapy (BSAC) method [14].

The rainy season was defined as the period between the months of April and September and the dry season between October and March. The data were analysed using Chi (X^2) square test.

RESULTS
A total of 381 children with signs and symptoms of septicaemia were confirmed as having bacterial septicaemia, corresponding to 22.1% of the sample. There was no significant difference between males and females in the prevalence of septicaemia (males 21.10% and females 23. 38%, P > 0.05; Table 1).

Seasonal variation (dry *versus* rainy season) did not affect the overall prevalence of septicaemia (P > 0.05), though it was 28.38% in the dry season and 22.52% in the wet season. But in the dry season the prevalence of septicaemia was significantly higher (P < 0.001) in females (50.57%) than in males (19.91%) (Table 2).

Table1: Prevalence of bacterial septicaemia

Gender	No tested	No infected (%)
Male	967	204 (21.10)
Female	757	177 (23.38)
Total	1724	381 (22.10)

Male versus female X^2 test P > 0.05

Staphylococcus aureus was the predominant isolate causing bacterial septicaemia (36.48%) while *Citrobacter freundii* was the least frequent cause (0.26%) (Table 3). *Pseudomonas aerueginosa* was not recovered in the dry season whereas *Citrobacter freundii* and *Enterobacter* species were not isolated during the rainy season. The frequency of isolates recovered in the rainy and dry seasons was 54.33% and 45.67%, respectively (Table 3). *P. aeruginosa* was most susceptible to gentamicin and ceftazidime but all other isolates were most susceptible to gentamicin and cefuroxime (Table 4).

Table 2: Effect of gender and seasonal variation on the prevalence of bacterial septicaemia

Season	Gender					
	Male		Female		Total	
	No tested	Infected n (%)	No tested	Infected n (%)	No tested	Infected n (%)
Dry	437	87 (19.19)	176	89 (50.57)*	613	174 (28.38)
Rainy	530	117 (22.08)	389	88 (22.62)	919	207 (22.52)

*Male *versus* female in dry season, P < 0.01

Table 3: Seasonal variations of bacterial isolates

Isolate	Season		
	Dry n (%)	Rainy n (%)	Total n (%)
Staphylococcus aureus	70 (40.22)	69 (33.33)	139 (36.48)
Escherichia coli	2 (1.14)	8 (3.86)	10 (2.62)
Klebsiella species	40 (22.98)	39 (18.84)	79 (20.73)
Citrobacter freundii	1 (0.57)	0 (0)	1 (0.26)
Enterobacter species	5 (2.87)	0 (0)	5 (1.31)
Proteus species	12 (6.89)	35 (16.90)	47 (12.34)
Previdencia species	3 (1.72)	4 (1.93)	7 (1.84)
Pseudomonas aeruginosa	0 (0)	10 (4.83)	10 (2.62)
Alkaligenes species	35 (20.11)	35 (16.90)	70 (18.37)
Acinetobacter species	6 (3.44)	7 (3.38)	13 (3.41)
Total	174 (45.67)	207 (54.33)	381 (100)

DISCUSSION AND CONCLUSION

Septicaemia is a major cause of death in neonates and children in Nigeria [5,6]. Prompt diagnosis and effective treatment is necessary to prevent death and complications from septicaemia [3]. This study aimed at determining the effects of gender and seasonal variations on the prevalence of bacterial septicaemia among children of five years and younger, as well as to identify the bacterial agents and their susceptibility patterns.

The prevalence of bacterial septicaemia in females (23.38%) was not significantly different from that in males (21.01%) (P > 0.05). This finding does not agree with that of Mugalo *et al.* [9], who reported significantly higher prevalence in the females. The reason for this difference is unclear, but may be due to geographical locations. However, our finding agrees with another report in Nigeria [15], although the age of patients in that study ranged from 0 – 61 years.

The prevalence of 22.1% of confirmed bacterial septicaemia recorded in this study is the lowest reported in Nigeria and some African countries [3,9,15]. The prevalence of bacterial septicaemia was higher in the dry season (28.4%) than the rainy season (22.5%). It follows that change in season may not likely influence the prevalence of bacterial septicaemia, as has been observed for other infections such as otitis media [10]. However, the prevalence of bacterial septicaemia was higher among females during the dry season (P < 0.01), whereas during the rainy season it was identical in males and females (22.7% and 22.6% respectively). No reason could be adduced for this.

S. aureus was the most predominant aetiologic agent of bacterial septicaemia in this study (36.48%), which agrees with earlier findings [3,9] and it was the most predominant isolate in both seasons. No *P. aeruginosa* isolate was recovered during the dry season.

The susceptibility testing indicated that most isolates were susceptible to gentamicin and cefuroxime. *P. aeruginosa* was susceptible mostly to gentamicin and ceflazidime. Ceftriaxone was the least active antibacterial agent as it was active only against *S. aureus*, with only 1.44% of it being susceptible. We expected that ceftriaxone, a third generation cephalosporin, would be more effective than cefuroxime, but this was not so. Due to our drug rotation policy, cefuroxime had not been not in use for some time. By contrast, ceftriaxone continued to be used without laboratory guidance, especially as antibiotic coverage during surgery and in emergencies as blind therapy, which has resulted in bacterial resistance to this drug. Rational use of antibiotics is needed to stem the tide of rising bacterial resistance of blood stream infectious agents.

Generally, gender and seasonal variations did not affect the prevalence of bacterial septicaemia among children five years and younger. However, females in the dry season had a higher prevalence than their male counterparts. The high prevalence of resistance observed in this study points to the need for rational use of antibiotics.

Table 4: Susceptibility profiles of bacterial isolates

Isolate	Antibacterial agent							
	CIP	CN	C	CXM	AMX	AUG	CAZ	CRO
Staphylococcus aureus (n = 139)	37 (26.6)	75 (54.0)	8 (5.8)	99 (71.2)	38 (27.3)	67 (96.2)	62 (44.6)	2 (1.4)
Escherichia coli (n = 10)	1 (10.0)	6 (60.0)	0 (0.0)	6(60.0)	0 (00.0)	2(20.0)	1 (10.0)	0 (0.0)
Klebsiella species (n = 79)	23(29.1)	27 (34.2)	9 (11.4)	29 (36.7)	0 (0.0)	39 (49.4)	21 (26.6)	0 (0.0)
Citrobacter freundii (n = 1)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Enterobacter species (n = 5)	0 (0.0)	3 (60.0)	0 (0.0)	3 (60.0)	1 (20.0)	0 (0.0)	2(40.0)	0 (0.0)
Proteus species (n = 47)	22 (46.8)	28 (59.6)	5 (10.6)	25 (53.2)	0 (0.0)	23 (48.9)	20 (42.6)	0 (0.0)
Previdencia species (n = 7)	3 (42.9)	3 (42.9)	0 (0.0)	6 (85.7)	0 (0.0)	1(14.3)	3 (42.9)	0 (0.0)
Pseudomonas aeruginosa (n = 10)	1 (10.0)	7 (70.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	7 (70.0)	0 (0.0)
Alkaligenes species(n = 70)	15 (21.4)	50 (71.4)	22 (31.4)	39 (55.7)	18 (25.7)	30(42.6)	24 (34.2)	0 (0.0)
Acinetobacter species (n = 13)	1 (7.7)	5 (38.5)	1 (7.7)	9 (69.2)	0 (0.0)	7 (53.9)	5 (38.5)	0 (0.0)

CIP = ciprofloxacin, CN = Gentamicin, C = Chloramphenicol, CXM = Cefuroxime, AMX = Amoxicillin, AUG = Amoxicillin – clavunate, CAZ = Ceftazidime, CRO = Ceftriaxone, n = number tested, figures in parenthesis are percentages.

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