Incidence, bacteriological profile and antibiotic sensitivity pattern of neonatal sepsis in a tertiary health facility in Abuja, North-central Nigeria.

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Research article

Keywords: neonatal sepsis, mortality, cross-sectional study, antibiotic sensitivity

Abstract

Background: Neonatal sepsis is commonly caused by bacteria in the first 28 days of life. If prompt management is not instituted, it could lead to death within hours of onset. Due to diagnostic limitation in developing settings, prompt laboratory identification of causative organism is usually a challenge. To prevent mortality, clear knowledge of bacteria and their antibiotics sensitivity pattern is important for prompt empirical treatment.

Methods: This prospective and cross-sectional study enrolled 339 newborns and were admitted for probable sepsis to the special care unit of the university of Abuja Teaching Hospital. Socio-demographic profile and Blood culture was done from every enrolled newborn using BACTEC 9050. The pattern of the clinical features, incidence, bacteriological profile and antibiotic sensitivity pattern of newborns with confirmed neonatal sepsis were documented.

Results: A total of 645 newborn were admitted for probable sepsis during the study period based on clinical features and initial laboratory work-up. Forty-six of the 645 newborns (46/645) had laboratory confirmed sepsis based on blood culture resulting in a neonatal sepsis incidence rate of 71.3 (95%CI 50.7-91.9) *per 1000 admitted newborn*. Seventeen of the 46 confirmed sepsis cases were among the 1322 newborns delivered within the study facility during the study period giving an in-hospital neonatal sepsis incidence rate of 12.9 (95% CI 6.7-19.0) per 1000 live birth. Amongst the 46 babies with positive blood culture, 27/46 (58.7%) had normal white cell count while the remaining 19/46 (41.3%) had abnormal results. In all, 52 counts of bacteria categorized into 11 bacteria species were isolated from the 46 positive blood cultures. *Enterococcus spp* and *streptococcus species* were the commonest gram-positive while *Escherichia coli* and *Chryseomonas luteola* were the commonest gram-negative bacteria isolates. Imipenem (all bacterial isolates except *Vibrio fluvialis*), Augmentin (*Streptococcus spp, Staphylococcus spp, Escherichia spp, Enterococcus spp, Klebsiella spp, Moraxella catarrhalis, Acinetobacter baumannii*), Vancomycin (*Streptococcus spp, Staphylococcus spp, Escherichia spp, Enterococcus spp*), and Ofloxacin (all except *Vibrio fluvialis and Citrobacter freundii*) had the widest coverage of bacteria isolated from newborn with sepsis.

Conclusion: Sepsis in newborn is still prevalent in our environment and compared to previous documented isolates and sensitivity pattern, the bacteria causes, and their antibiotic sensitivity patterns appears to be changing.

Background

Neonatal sepsis is a life threatening emergency and any delay in treatment may result to septic shock and death.[1] According to a 2006 report of the World Health Organization, it is estimated that 1.6 million deaths occur globally every year due to neonatal sepsis and it is responsible for 30 to 40% of all neonatal deaths occurring in developing countries.[2–4] Nigeria ranks number one in annual newborns death in Africa and second highest in the world.[5] The neonatal mortality in Nigeria stands at 33/1000 live births.[6] In developing countries, bacterial pathogens are the most common cause of neonatal sepsis,[7] causing a wide variety of infections including meningitis, pneumonia, urinary tract infection and sepsis.[3,5] These infections can run a rapid course with death occurring in less than 24 hours, if prompt effective empirical treatment is not instituted.[3, 8] The development of effective empirical antibiotic protocols depend on the knowledge of the prevailing bacterial pathogens in that locality. In the neonatal period, it has been documented that the commonest blood-culture isolates in many low income countries were Staphylococcus aureus, Streptococcus pyogenes, and Escherichia coli.[7, 9] Tinuade et al in Sagamu and Olateju et al in Gwagwalada, described Klebsiella specie and coagulase-negative Staphylococci featuring prominently in Nigeria.[10,11] The spectrum of organisms that cause neonatal sepsis changes over time and varies from region to region, even in the same center from time to time.[3,10] These organisms have also developed increasing multi-drug resistance over the last two decades.[3] Therefore, current knowledge of center specific pattern of bacterial isolates and their antimicrobial susceptibility pattern is useful for prompt management of patients. The present study was undertaken to highlight the local pattern of bacterial isolates in neonates and their antimicrobial sensitivity in a tertiary care hospital in Abuja.

Methods

Study design and area

This prospective and cross-sectional study was conducted over an 8-month period in 2014 at the Special Care Baby Unit (SCBU) of the University of Abuja Teaching Hospital (UATH). The UATH is a 350-bed tertiary hospital that runs primary and secondary in addition to tertiary health care services. The hospital is in Gwagwalada Area Council of the Federal Capital Territory (FCT), Abuja; North Central region of Nigeria.[12] It is the main referral centre for neonatal care in north-central region. UATH has annual deliveries of 2,500 babies and an average annual SCBU admission of 968 babies using the year 2012 records. The SCBU is 30-bedded unit with separate inborn and outborns sections manned by a neonatologist, four senior and junior residents each, six house officers and twenty nurses with further training in neonatology. One thousand, three hundred and twenty-two (1322) newborns were delivered in the center during the study period.

Management overview of neonatal sepsis in UATH

On presentation to the SCBU, historical assessment and detailed physical examination are done. After collection of the relevant samples, the subjects are commenced on empiric antibiotics of amoxicillin/clavulanic acid at 15 mg/kg body weight and gentamicin at 2.5 mg /kg body weight per dose every 12 hours. Necessary changes are made based on clinical response and/or result of blood culture and sensitive test. Sometimes, third generation cephalosporin mostly cefotaxime and ceftazidime are used for severe infections and in babies who presented with relevant clinical features and/or clinical examination suggestive of meningitis. Other supportive measures where necessary are also initiated.

Sample size determination and sampling technique

The sample size was calculated using the Cochrane formula,[13] based on a prevalence of neonatal sepsis from a previous,[11] a confidence level of 95% and a level of precision estimated to be ± 5% of the assumed prevalence in addition to a non-response rate of 10%. This resulted to a minimum sample size of 331.Consecutive neonates who met the inclusion criteria were enrolled into the study. The inclusion criteria included neonates admitted to the SCBU with features suggestive of sepsis (such as fever, jaundice, lethargy, poor suck etc) and those whose parents/guardians gave consent for enrolment of their newborn in the study. Excluded from this study were newborns with major congenital malformations (this was to avoid mortality not directly linked to sepsis) and neonates who have had administration of antibiotics for more than 24 hours, prior to presentation to the hospital.

Blood and data collection method

All the neonates that were enrolled into the study had their blood specimens drawn for culture before treatment was initiated or latest within 12 hours of admission. The skin over the site of blood collection was cleaned thoroughly with 70% alcohol, allowed to dry and cleaned with Povidone iodine for two minutes before blood sample was collected. Two millilitres of blood were drawn by trained assistants from a peripheral vein. One millilitre was for blood culture, and the other for complete blood count (CBC). A structured questionnaire was used to collect relevant information for each newborn. The questionnaire was pre-tested at Federal Staff Hospital, Jabi in Abuja. It was then analysed for completeness and ease of completing the questionnaire. The neonatal information collected included age, sex, weight on admission, place of delivery, and specific clinical features such as fever, jaundice, hypothermia, hyperthermia, poor skin colour, respiratory distress, feed intolerance, bleeding diathesis, and abdominal distension etc.

Measures and definition of term

i. Weight was measured using a standardized Bassinet scale, Salter [TM] Model 180, made in England, with a sensitivity of 0.05kg and calibrated in 0.1kg. Before placing the baby in the weighing scale, the scale was readjusted to zero each time for a new reading. All clothing was removed including the diaper, in order not to affect the weighing scale reading.
ii. Length of each baby enrolled in to the study, was measured using inelastic tape measure, by placing the baby on a hard surface, lying supine and the lower limbs fully stretched.
iii. Occipito-frontal circumference (OFC) was measured using inelastic tape measure. The frontal and occipital bony prominences were identified before measurements were taken using an inelastic tape measure.
iv. Gestational age of each baby was determined using modified Ballard score.[14]
v. The newborns family's Socio-economic status was determined using Olusanya's social economic classification.[15]
vi. Neonatal sepsis for the sake of this study was defined as blood stream infection with positive blood culture result.

Laboratory methods

Blood specimen bottles collected from newborns admitted to the SCBU for probable sepsis were put within one hour of collection into BACTEC 9050 (Becton-Dickinson™ New Jersey, USA) automated system, by a trained dedicated microbiologist to the BACTEC laboratory. It was then monitored for growth by the microbiologist, as flagged by the machine, every 24 hours, for maximum of 5 days, when the bottles were expelled by the automated machine. The BACTEC 9050 system, which accommodates 50 test vials, features an extremely small footprint (only 4 1/4 square feet of tabletop needed, and no external computer required).[16]

For gram staining procedure, a single colony was picked and emulsified in a drop of normal saline on a clean glass slide and allowed to dry. The slide was then fixed with heat, stained with crystal violet for one minute, followed by procedure mordant with Lugo's iodine solution for 30 seconds. The slide was then washed with water. The process of decolourisation was carried out with acetone for one to two seconds before washing with water. Counter-staining was with safranin, added for two minute and later washed with water and allowed to air dry. The slide was then examined microscopically. Gram positive bacteria (GPB) were presumed if the identified pathogen appeared dark purple, while a red colour suggested Gram negative bacteria (GNB).

Antimicrobial susceptibility testing was done using modified Kirby-Bauer disc diffusion method,[17] using multidisc antibiotics (Oxoid Ltd, Hampshire, UK), as described by the Clinical Laboratory Standards. The degree of inhibition of bacterial growth around the antibiotics in the impregnated discs was noted and the result was reported as sensitive or resistant. For determining sensitivity, the following anti-microbial discs were used; Ampicillin 10 µg, Ceftazidime 30 µg, Augmentin (Amoxicillin 20 µg; Clavulanic acid 10 µg), 30 µg, Vancomycin 30 µg, Cefotaxime 30 µg, Ceftriaxone 30 µg, Gentamicin10µg, ofloxacin 5 µg and Imepenam10µgm.

A complete blood count (CBC) with white blood cell differential count was done for each subject. The complete blood count was processed in the general laboratory of University of Abuja Teaching Hospital. The CBC sample bottle was placed in the BC- 3200 autolizer machine Mindray.™ The machine extracts the required volume of blood for auto analysis and then displayed the result on the monitor. Other investigation done included serum bilirubin estimation for babies with visible jaundice, while serum electrolytes, urea, creatinine and glucose were also evaluated in babies with perinatal asphyxia and neonatal seizures. For the sake of this study, normal white cell count on CBC was defined as cell count between 9–30,000/mm^3 (or 9–30 × 10^9/L). Values above or below this range were considered abnormal.

Data analysis

The raw data were inputted into the Excel spread sheet and analysed using the Statistical Package for Social Sciences (SPSS) version 20 Microsoft USA. Frequency tables were generated for simple proportions and descriptive analysis.

Results

Characteristics of newborns enrolled for study

Figure 1 shows a summary of the recruitment process. A total of 645 newborns were admitted to the SCBU during the study period. About two-thirds (474) of the 645 admitted were born within the study center while the remainder (177) were referred to it (Fig. 1). After initial review, 339 of the 645 admitted newborns were enrolled with a presumptive diagnosis of neonatal sepsis. Table 1 shows the socio-demographic characteristics and anthropometric indices of newborns enrolled. About one-third, 110 (32%) of the enrolled newborns were ≤ 1 day, 58 (17%) were 2–7 days old while 171(51%) were more than 7 days old. The mean age of babies enrolled was 4.2 ± 1.6 days. There were more male enrollees 196 (58%) compared to female 143 (42%). Majority (81%) of the admitted newborn were discharged from the SCBU alive after full recovery, 15 (4%) left against medical advice following request by parent/caregiver while 49 (15%) of the 339 newborns died while on admission. Eight of the 49 recorded mortality had sepsis confirmed on blood culture. Other characteristics of enrolled newborns are shown in Table 1.

Table 1
Characteristics of newborns admitted to the SCBU of the UATH between September 2013 to April 2014

Newborn variables	Frequency n (%)	Newborn variables	Frequency n (%)
Age at Presentation	n = 339	Gestational at delivery	n = 338
≤ 1 day	110 (32)	Pre-term (< 37 weeks)	109 (33)
2–7 days	58 (17)	Term (37–40 weeks)	211 (62)
> 7 days	171 (51)	Post-term (> 40 weeks)	18 (5)
Sex	n = 339	Head circumference	n = 295
Male	196 (58)	< 33 cm	99 (34)
Female	143 (42)	33-37cm	169 (57)
		> 37 cm	27 (9)
Place of delivery	n = 339		
Inborn	168 (49)	Length at birth	n = 268
Outborn	171 (51)	< 45 cm	118 (44)
		≥ 45 cm	150 (56)
Mode of delivery	n = 339		
Spontaneous Vertex ± assisted	214 (63)	Birth weight	n = 337
Operational (Caesarean section)	125 (37)	< 2.5 kg	148 (44)
		2.5-4.0 kg	179 (53)
Maternal education	n = 339	> 4.0	10 (3)
≤ 6 years	67 (22)		
7–12 years	118 (40)	Feeding history	n = 339
> 12 years	114 (38)	Breastmilk only	235 (69)
		Infant formula ± breastmilk	104 (31)
Maternal socio-economic class	n = 339		
Low	171 (51)	Outcome	n = 339
Middle	58 (17)	Survived	275 (81)
High	110 (32)	Died	49 (15)
		Left against medical advice	15 (4)

Incidence rate and clinico-laboratory presentation of neonates with sepsis

Forty-six of the 339 enrolled had bacterial isolates on blood culture. Since 645 newborns were admitted during this period, this resulted to a neonatal sepsis incidence rate of 71.3 (95% CI 50.7–91.9) per 1000 admitted newborn. Seventeen of the 46 confirmed sepsis cases were among the 1322 newborns delivered within the study center during the period of study giving an in-hospital neonatal sepsis incidence rate of 12.9 (95% CI 6.7–19.0) per 1000 live birth. Twenty-

seven of the 46 newborns with confirmed sepsis (58.7%) had white cell count within normal range while the remaining 19 (41.3%) had abnormal white cell count. Other abnormalities encountered on CBC included anaemia (22.0%) and polycythaemia (3.0%).

Bacterial profile and antibiotic sensitivity pattern in newborns admitted for sepsis

In all, 52 counts of organism categorized into 11 bacteria species were isolated among the 46 newborns with blood culture confirmed sepsis. Of these, 28 (53.9%) were gram positive bacteria while the remainder, 24 (46.1%) were gram-negative organisms. Table 2 shows the species of bacteria isolates on blood culture. Enterococcus 16/52 (30.8%) and streptococcus species 9/52 (17.35) were the commonest organisms isolated from the newborns. Other encountered organisms included Escherichia coli 6/52 (11.5%), Chryseomonas luteola 5/52 (9.6%), Klebsiella species 4/52 (7.7%) Acinetobacter baumanii 3/52 (5.8%) and staphylococcus species 3/52 (5.8%). Less commonly cultured bacteria included Pseudomonas species 1/52 (1.9%), Citrobacter freundii 1/52 (1.9%) and Vibro fluvialis 1/52 (1.9%). The different bacterial isolates stratified by selected newborn parameters are summarized in Table 2. For gram-positive organisms, Enterococcus septicemia were seen more in males, late onset sepsis (≥ 72 hours) and neonates born outside the study facility while streptococcus septicemia was more in females, early onset sepsis and outborns. Staphylococcus septicemia was seen more in males, newborns with early onset sepsis, those with birth weight ≥ 2.5 kg and those delivered within the study facility. Correspondingly, for gram-negative organisms, Escherichia coli was isolated more in males, newborns that developed sepsis within 72 hours of life, < 2.5 kg and outborns while Klebsiella spp (female, ≥ 2.5 kg and inborn) and Pseudomonas spp (male, < 25 kg, EOS and outborns) showed almost reverse infectivity patterns with newborn parameters. Other isolated organisms were almost evenly distributed among the categories of newborns. There were no significant differences in newborns socio-demographic characteristics and bacteria isolates pattern seen (Table 3).

Table 2
Blood culture bacterial isolates stratified by some selected clinical and demographic parameters of newborns admitted for sepsis to the SCBU of the UATH between September 2013 to April 2014

Bacterial isolates	Newborn parameters											
	Gender			Time of onset after birth			Birth weight			Place of birth		
	Male	Female	Total	< 72 hrs.	≥ 72 hrs.	Total	< 2.5 kg	≥ 2.5 kg	Total	Inborn	Outborn	Total
Gram positive organisms												
Enterococcus faecalis	8	6	14	5	9	14	7	7	14	5	9	14
Streptococcus species	4	5	9	6	3	9	4	5	9	3	6	9
Staphylococcus aureus	2	1	3	3	0	3	0	3	3	2	1	3
Enterococcus cloaca	1	0	1	1	0	1	1	0	1	1	0	1
Enterococcus sakazakii	1	0	1	1	0	1	0	1	1	0	1	1
Gram negative organisms												
Escherichia coli	4	2	6	4	2	6	4	2	6	2	4	6
Chryseomonas luteola	4	1	5	3	2	5	2	3	5	2	3	5
Klebsiella species	1	3	4	2	2	4	1	3	4	3	1	4
Acinetobacter baumanii	1	2	3	2	1	3	0	3	3	0	3	3
Pseudomonas species	2	0	2	0	2	2	2	0	2	0	2	2
Citrobacter freundii	0	2	2	1	1	2	1	1	2	1	1	2
Vibro fluvialis	1	0	1	0	1	1	1	0	1	0	1	1
Moraxella catarrhalis	1	0	1	1	0	1	0	1	1	1	0	1
Total	30	22	52	29	23	52	23	30	52	21	32	52

Table 3

Bacteria isolates and patterns of antibiotic responses among newborns presenting with sepsis to the SCBU of the UATH between September 2013 to A[...]

Bacteria isolate in Blood	BACTERIAL ANTIBIOGRAM (%)																
	AM	AU	CH	CL	CL$_2$	CO	CE	CE$_2$	CE$_3$	CE$_4$	CI	ER	GE	IM	LE	ME	OF
Streptococcus spp	10.0	80.0	20.0	0.0	60.0	0.0	80.0	90.0	20.0	0.0	0.0	30.0	0.0	60.0	0.0	0.0	40.0
Staphylococcus spp	0.0	40.0	60.0	20.0	60.0	0.0	0.0	0.0	0.0	20.0	0.0	40.0	20.0	60.0	0.0	0.0	20.0
Escherichia spp	14.0	50.0	65.0	0.0	14.0	7.0	21.5	21.5	14.0	0.0	7.0	14.0	21.5	50.0	7.0	7.0	14.0
Pseudomonas spp	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100	0.0	100	0.0	0.0	100	0.0	0.0	100
Enterococcus spp	5.0	15.5	18.5	0.0	5.0	0.0	2.5	2.5	0.0	0.0	2.5	5.0	5.0	15.5	5.0	5.0	2.5
Klebsiella spp	0.0	25.0	50.0	0.0	0.0	0.0	75.0	75.0	25.0	0.0	0.0	0.0	25.0	100	0.0	0.0	50.0
Moraxella catarrhalis	100	100	100	0.0	0.0	0.0	100	0.0	100	0.0	100	0.0	100	100	0.0	0.0	100
Vibrio fluvialis	0.0	0.0	100	0.0	0.0	100	0.0	100	0.0	0.0	0.0	0.0	100	0.0	0.0	0.0	0.0
Acinetobacter baumannii	0.0	33.3	0.0	0.0	0.0	0.0	0.0	0.0	66.7	0.0	100	0.0	66.7	66.7	33.3	33.3	33.3
Citrobacter freundii	0.0	0.0	100	0.0	0.0	0.0	100	100	100	0.0	0.0	0.0	0.0	100	0.0	0.0	0.0
Chryseomonas luteola	0.0	0.0	0.0	0.0	0.0	40.0	0.0	0.0	40.0	0.0	80.0	0.0	40.0	100	0.0	0.0	100

AM-ampicillin; AU-augumentin; CH- chloramphenicol; CL-cloxacillin; CL$_2$-clindamycin; CO-clotrimazole; CE-ceftriaxone; CE$_2$- cefuroxime; CE$_3$- ceftazidime; CE$_4$- ciprofloxacin; ER- erythromycin; GE- gentamycin; IM- imipenem; LE- levofloxacin; ME- meropenem; OF- ofloxacin; TE- tetracycline; VA- vancomycin

Antibiotics sensitivity pattern of the isolated organisms are shown in Table 3. The Streptococcus spp had a high sensitivity to ceftriaxone (80%,) cefuroxime (90%) and augumentin (80%); moderate sensitivity to clindamycin (60%), imipenem (60%), ofloxacin (40%) and low sensitivity to ampicillin (10%), chloramphenicol (20%), ceftazidime (20%), erythromycin (30%) and vancomycin (10%). Likewise, the staphylococcus spp had no high sensitivity to any antibiotics. They had moderate sensitivity to augumentin (40%), clindamycin (60%), erythromycin (40%), imipenem (60%) and low sensitivity of 20% to cloxacillin, cefixime, gentamycin, ofloxacin and tetracycline. Escherichia spp were poorly responsive to virtually all antibiotic considered with moderate susceptibility to only augumentin (50%), chloramphenicol (65%) and imipenem (50%). Pseudomonas spp had zero sensitivity to all except ceftazidime (100%), ciprofloxacin (100%), ofloxacin (100%) and imipenem (100%) while contrary to pseudomonas, Moraxella catarrhalis was 100% sensitive to all antibiotics except for cloxacillin, clindamycin, clotrimazole, cefuroxime, cefixime, levofloxacin, meropenem and vancomycin. Finally, Klebsiella spp had mixed sensitivity patterns with a 75% sensitivity to ceftriaxone and cefuroxime, 50% sensitivity to chloramphenicol and ofloxacin and a 25% sensitivity to augumentin, gentamycin and ofloxacin. Sensitivity pattern of other less common organisms isolated on blood culture are shown in Table 3.

Table 4 shows in summary the antibiotics coverage pattern of bacteria isolates based on their gram stain property. Imipenem had the strongest coverage with 92% against gram positive bacteria (GPB), 100% against gram negative bacteria (GNB) and an average coverage of 96%. Ofloxacin performed relatively poorer with a 64% coverage of gram positive, 46% coverage for gram negative and 55% on average. Others included Augumentin, 62% (GPB), 50% (GNB) and average of 56%; Vancomycin (60% for GPB. 75% for GNB and average of 67.5%); Ceftriaxone (40 for GPB. 60% for GNB and average of 50%); Cefotaxime (40% for GPB, 60% for GNB and average of 50%); Ceftazidime (7% for GPB, 61% for GNB and average of 34%); Cefuroxime (40% GPB. 53% for GNB and average of 46.5%); and Gentamicin (20% for GPB, 42% for GNB and average of 31%). Ampicillin was the weakest antibiotics with a 33% coverage for GPB, 0% coverage for GNB and an average coverage of 16.5%.

Table 4
Antimicrobial sensitivity pattern of blood culture isolates
against commonly available antibiotics in newborn
admitted to SCBU of the UATH between September 2013 to
April 2014

Antibiotics	Sensitivity		
	Gram positive	Gram negative	Average Sensitivity
Imipenem	92	100	96.0
Ofloxacin	64	46	55.0
Augmentin	62	50	56.0
Vancomycin	60	75	67.5
Ceftriaxone	40	60	50.0
Cefotaxime	40	60	50.0
Ceftazidime	7	61	34.0
Cefuroxime	40	53	46.5
Gentamicin	20	42	31.0
Ampicillin	33	0	16.5

Discussion

Bacterial isolation rate of 13.6% was observed in this study, this is lower than what was reported in studies within and outside the country. In Ilorin, a bacteria isolation rate of 30%,[18] was reported and 34% in India.[19] However, both the Ilorin and Indian studies excluded subjects with any prior exposure to antibiotics unlike this current study which included newborns with 24 hours or less antibiotic exposure. This could be responsible for the high isolation in the two referenced studies. There may be need for BACTEC use in more studies at various centres to validate its applicability in the tropics where antibiotics is readily available over the counter.[9]

Our study found that more than half (53.9%,) of the bacteria isolates were Gram positive organisms, while Gram negative organisms made up 46.1%. This pattern was found in Qatar[20] where a predominance of Gram-positive bacteria was noted (66%) and 16.2% for Gram negative bacteria, in Karachi (54.1%)[21] for Gram positive bacteria and 45.9% for GNB. In Gwagwalada, a report of 58% for GPB and 42% for GNB.[11] Some other studies also revealed preponderance of GPB over GNB.[22, 23] Unlike our study, other studies found a preponderance of GNB over GPB. Khetam et al[21] reported 54.5% for GNB and 45.4% for GPB, while another study in Pakistan[24] showed GNB of 54.6% and GPB of 45.4%. However, Iregbu et al[25] in Abuja, found equal occurrence of both Gram positive and negative organisms. These variations are possibly due to organisms acquired from the birth canal for the early onset sepsis and from the community for the late onset sepsis.

Enterococcus faecalis was the most common gram-positive organism isolated in this current study, while Escherichia coli were the commonest gram-negative organisms. This is a departure from findings from a similar study that was carried out in the unit 10 years earlier, where Staphylococcus aureus was found to be the commonest organism and Klebsiella was the leading Gram negative organism.[11] This further corroborates the fact that, the organisms responsible for neonatal sepsis vary from time to time, even in the same unit, and possible changing pattern of neonatal sepsis. The Enterococcus faecalis isolated did not demonstrate multi-resistant pattern, whuch favours the possibility of a non-nosocomial source of the isolates, even though it is usually associated with nosocomial infection.

Staphylococcus aureus was the third commonest Gram-positive bacteria after Enterococcus specie and Streptococcus specie in the current study. Iregbu et al[25] in Abuja, found Enterococcus faecalis as a major cause of neonatal sepsis second only to Staphylococcus aureus among the Gram-positive bacteria. It was also found to be the commonest Gram-positive bacteria causing neonatal sepsis in Accra,[26] accounting for 14.4% of the organisms isolated. The Abuja study was a retrospective study, so some of the data may be incomplete. It could also be a pointer, to the emergence of Enterococcus, as an important cause of neonatal sepsis in Abuja. Similarly, Escherichia coli were the commonest GNB identified as causes of neonatal sepsis in studies within Nigeria and outside.[24, 27–29, 30, 31] It was also a leading cause of Gram-negative neonatal sepsis in some other studies, like the ones from Portharcourt[24] and Ife.[22]

Klebsiella specie and Staphylococcus aureus were the third commonest Gram-negative bacteria and Gram-positive bacteria respectively in this study. This was a sharp departure from many studies both locally and internationally, where these organisms were identified as the leading causes of neonatal sepsis.[11, 21, 24, 28, 32–36] The reason for this may not be immediately deduced, but it could be due to the method of isolation, as there is no reported study in the Northern part of the country where BACTEC machine was used for bacteria isolation yet. This could also be an emerging pattern of neonatal sepsis in the country, particularly in the North central region. Citrobacter spp accounted for 1.8% of neonatal sepsis in our study, which was comparable to the 3.1% reported in a study done by Ramesh et al.[36] This organism was however not reported in other similar studies.[11, 18]

Ella et al in Kaduna,[37] reported similar antimicrobial sensitivity pattern of gram-positive organisms as reported in our study. Studies in India,[23, 38] reported 80% sensitivity to vancomycin, whereas Bode Thomas et al[24] in Jos reported 67% sensitive of GPB to gentamicin. Iruegbu al[25] showed an 89% sensitivity of GPB to Augmentin. Studies in Calabar, Uganda and India,[30, 36, 39] observed a high sensitivity to gentamicin. Studies in South West Nigeria,[22, 40] reported a high sensitivity to ofloxacin which is comparable with the finding of this study. The reason for low sensitivity of GPB to gentamicin in this study could be as a result of extensive use of gentamicin as empiric antibiotics in our neonatal unit. Possibly the bacteria are developing resistance to it. Also, the varied sensitivity pattern of Gram-positive organism across the country supports the theory that organisms associated with neonatal sepsis and their sensitivity varies from place to place and region to region.[1, 8] Use of empiric antibiotics as earlier stated, could be another reason why the sensitivity of these organisms to the antibiotics differs.

Gram-negative bacteria sensitivity pattern seen in this study is similar to the findings in Abuja[25] and Baghdad,[27] where 100% sensitivity of Gram-negative bacteria to imipenem and meropenem was reported. A good sensitivity of Gram-negative bacteria to cephalosporins, cefotaxime 86.7%, ceftazidime 81.3% was reported in Sagamu.[35] Mugalu et al in Uganda,[39] reported a 94.1% sensitivity of Escherichia coli to ceftriaxone while Iregbu[25] in Abuja observed 94% sensitivity to cefotaxime. Though much higher than what was found in this study, it shows that cephalosporins are very active against Gram negative bacteria. Therefore, caution must be applied in the use of these cephalosporins as empirical antibiotics, so resistance is not developed these important class of antibiotics as was reported for gentamycin in this study.

Limitation

One major limitation we had during this study was inability of some babies who presented over the weekend to be immediately screened for sepsis because the BACTEC laboratory was closed on weekends. This may have affected culture of organisms since their blood after collection had to be stored over the weekends.

Conclusion

Neonatal sepsis is prevalent in our setting. Enterococcus and streptococcus species were the commonest gram-positive organisms while Escherichia coli and Chryseomonas luteola were the commonest gram-negative organism. Imipenem had the widest coverage for both gram-positive and gram-negative organism. Due to poor sensitivity of gentamicin observed in this study, the current empiric antibiotic combination of Amoxicillin/Clavulanic acid and Gentamicin should be changed to Amoxicillin/Clavulanic acid and a third-generation cephalosporin such as Ceftriaxone and Cefotaxime. Lastly, even though, Imipenem had the widest coverage for bacteria isolated in study participants, its use should be reserved for serious infections to prevent resistance and minimize cost.

List Of Abbreviations

EOS	Early onset sepsis
ESR	Erythrocyte sedimentation rate
GBS	Group B Streptococcus
GNB	Gram negative bacteria
GPB	Gram positive bacteria
LOS	Late onset sepsis
OFC	Occipito-frontal circumference
SCBU	Special care baby unit
UATH	University of Abuja Teaching Hospital
WBC	White blood cells

Declarations

Ethics approval and consent to participate

Ethical clearance was obtained from the Medical Ethics Committee of the University of Abuja Teaching Hospital, Gwagwalada for review and approval was obtained before the commencement of the research (reference number FCT/UATH/HREC/PR/304). Written informed consent was obtained from a parent and/or guardian for all participants. Additionally, verbal consent was obtained for older children who were able to give approval to be enrolled in the study. Participation in the study was entirely voluntary, and no financial inducement whatsoever was involved. Participants were informed that voluntary withdrawal at any stage of interaction was guaranteed for them without any adverse effect to them. All information was handled with strict confidentiality.

Consent for publication

Not applicable

Availability of data and material

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests

Funding

Funding for this study was from equal contributions from all authors. No External funding was received for this study.

Authors' contributions

OO conceptualized the study and together with KIA and KEO developed the study methodology. ODIC analysed the study data. Result and discussion were written by ODIC KKI and OI. Supervision of data collection and laboratory sample analysis was done by OK and NI. KIA and KEO supervised the entire work. All authors read and approved the final manuscript.

Acknowledgements

We are also grateful to the highly dedicated staff nurses SCBU for their tireless efforts in some study related documentations and heroic efforts in salvaging sick babies.

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Figures
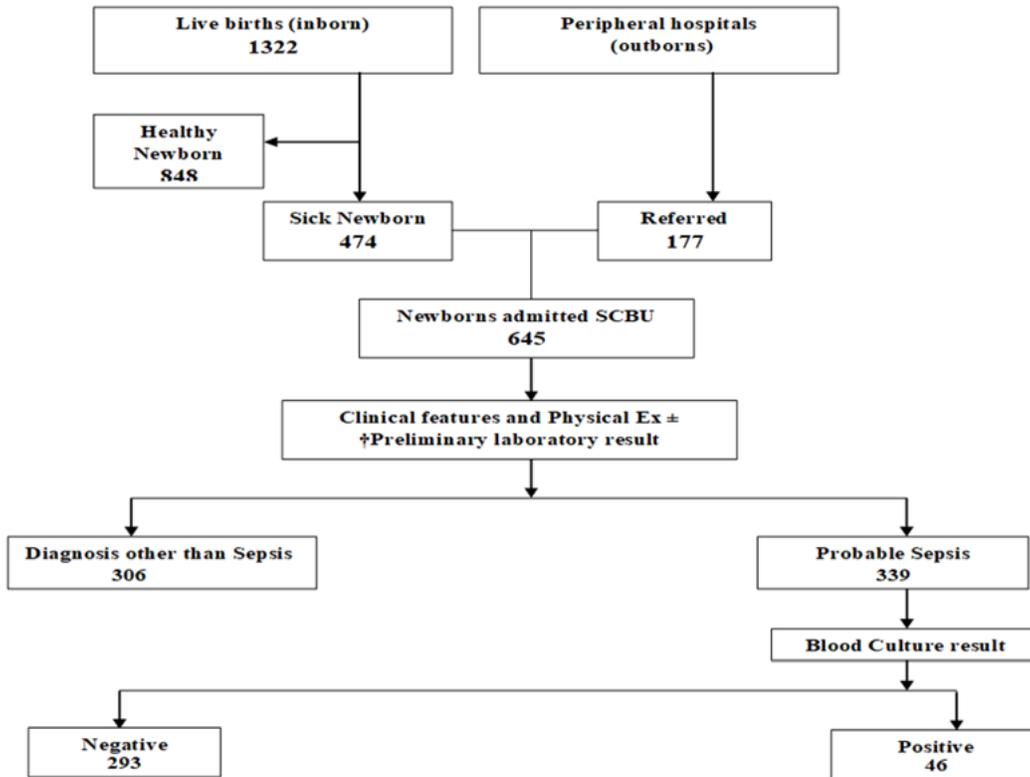
Figure 1

Overview of recruitment processes of surveyed newborns in the SCBU between September 2013 to April 2014 (†Complete blood count, urinalysis and gram stain)