JIDC | THE JOURNAL OF INFECTION IN DEVELOPING COUNTRIES

Original Article

Etiology of early onset septicemia among neonates at the University College Hospital, Ibadan, Nigeria

Abimbola Ellen Akindolire[1], Olukemi Tongo[1], Hannah Dada-Adegbola[2], Olusegun Akinyinka[1]

[1] Department of Paediatrics, University College Hospital, Ibadan, Nigeria
[2] Department of Medical Microbiology and Parasitology, University College Hospital, Ibadan, Nigeria

Abstract

Introduction: Neonatal septicemia remains a major cause of newborn deaths in developing countries. Its burden is further compounded by the emergence of multidrug-resistant pathogens, which is related to a lack of antibiotic protocols resulting in unrestricted use of antibiotics. The absence of reliable antibiotic sensitivity testing makes the formulation of antibiotic guidelines and judicious use of antibiotics difficult. This study sought to identify the current bacterial agents associated with early onset septicemia (EOS; age <72 hours) and their antibiotic susceptibility patterns among neonates at the University College Hospital, Ibadan, Nigeria.

Methodology: A total of 202 inborn and outborn neonates with risk factors for or clinical features of septicemia in the first 72 hours of life had samples for blood cultures and antibiotic sensitivity patterns taken prior to treatment.

Results: Of the subjects, 95 (47.0%) were inborn and 107 (53.0%) outborn, with a M:F ratio of 1.3:1; 12.5% were culture positive, and the prevalence of EOS was 8.8/1,000 live births. The isolates were *Staphylococcus aureus* (52%), 30.7% of which were methicillin-resistant *Staphylococcus aureus* (MRSA), *Klebsiella pneumoniae* (12%), *Enterobacter aerogenes* (8%), *Enterococcus* spp. (8%), *Eschericia coli* (4%), and other Gram-negatives (12%). All the isolates except *Staphylococcus aureus* were susceptible to ampicillin, ampicillin/sulbactam, amikacin, gentamicin, and third-generation cephalosporins. All MRSA were sensitive to amikacin, ciprofloxacin, and chloramphenicol, while all methicillin-sensitive *Staphylococcus aureus* were sensitive to ampicillin/sulbactam.

Conclusions: *Staphylococcus aureus* was the commonest cause of EOS in our setting, with 30.7% of the *Staphylococcus aureus* isolates being MRSA. Only MRSA demonstrated multidrug resistance.

Key words: early onset; septicemia; neonates; bacteria.

J Infect Dev Ctries 2016; 10(12):1338-1344. doi:10.3855/jidc.7830

(Received 20 October 2015 – Accepted 13 April 2016)

Introduction

Neonatal septicemia (NNS) is a major contributor to neonatal morbidity and mortality worldwide. An estimated three million newborn deaths occur annually, and 36% of these are attributable to NNS. Newborn death rates are more than four times higher in Africa than in Europe and account for 44% of all deaths of children under five years of age [1-4]. Neonatal septicemia can be classified as early onset (EOS) if septicemia manifests within three days of life or late onset (LOS) if it manifests after three days of life [5]. Organisms causing EOS are usually maternally acquired before or during delivery, whereas organisms causing LOS are acquired from the environment, which could be the community or nosocomial in hospitalized patients [6]. Over the years, there have been increasing reports from developing countries, of changing patterns of the etiology of NNS [7-9]; however, these studies hardly diffentiated between EOS and LOS. The trend in etiology of EOS remains the same in developed countries.

The increasing prevalence of multidrug-resistant organisms being reported in developing countries gives cause for concern, and in the face of the high infection rates and associated mortality in such settings, there is a need to take urgent steps to address this trend. These steps include rational use of antibiotics based on well-derived guidelines, especially in cases of EOS. Some of the problems militating against this include the challenges with reliable laboratory antibiotic sensitivity testing. Some do not have the luxury of taking blood samples for culture before commencement of treatment, especially in settings where point-of-care fees are charged for medical services. Samples taken subsequently, especially following antibiotic therapy, may not be the true representation of the primary organisms responsible for EOS.

This study was conducted to determine the current bacterial etiology of EOS and their antibiotic susceptibility pattern in our setting, a tertiary hospital in a developing country.

Methodology

The study was conducted in the newborn unit of the University College Hospital (UCH), Ibadan, Nigeria, between November 2013 and February 2014. Outborn neonates < 48 hours of age and inborn neonates requiring admission are usually admitted into the special-care baby unit, while outborn neonates > 48 hours are admitted into a separate neonatal ward. Full-term babies with maternal risk factors for septicemia are screened but nursed by their mothers' bedsides on the post-natal wards, except when they develop signs of illness. This was a cross-sectional study of 202 consecutive neonates < 72 hours of age and admitted to or delivered in the hospital with risk factors for or clinical features of septicemia. The risk factors included maternal peripartum fever (temperature ≥ 38°C occurring three days before or after delivery), maternal abnormal vaginal discharge, offensive amniotic fluid, prolonged rupture of membranes, meconium-stained amniotic fluid, maternal dysuria, abdominal tenderness, raised maternal white blood cell count, positive endocervical or high vaginal swab culture, positive maternal urine culture, antepartum hemorrhage, and prolonged labor. The clinical features in the newborn included fever or hypothermia, respiratory distress, tachypnea, reduced activity, and feed intolerance.

Maternal demographic data, details of pregnancy, delivery, and perinatal history, including antibiotic use, were obtained from mother and labor ward records (for inborn babies), and the presenting symptoms and clinical findings of the neonates at admission were entered into a proforma.

Each neonate had 1.0–1.5 mL of blood taken from a venous line. The blood samples were then transferred to the BactecPeds Plus blood culture bottles (Becton Dickinson Diagnostic Instrument Systems, Baltimore, USA). These were sent to the microbiology laboratory immediately and incubated in the Bactec 9050 machine (Becton Dickinson Diagnostic Instrument Systems, Baltimore, USA) at 37°C for four days. All samples were taken immediately before commencement of antibiotic therapy.

Positive vials were Gram stained and subcultured on Chromagar (CHROMagar, (Paris, France) orientation, group B streptococcus, and MRSA, all with supplements). Gram-negative organisms were further identified by the Microbact 24E GNB bacterial identification system (Oxoid, Hampshire, UK). *In vitro* antibiotic susceptibility testing was done on Mueller-Hinton agar (Merck, Lancashire, UK) using the disk diffusion method and was interpreted with standard charts.

Data was checked and analyzed using SPSS version 17.0 (IBM, Armonk, USA). Descriptive statistics are presented using tables, charts, graphs and means (± SD) as appropriate.

Results

There were 908 deliveries in the hospital during the study period. A total of 202 neonates were screened for septicemia, of which 94 (46.5%) were inborn and 108 (53.5%) outborn; there were 115 males and 87 females. The characteristics of the neonates are shown in Table 1.

Table 1. Neonatal characteristics.

Characteristics	Inborn n (%)	Outborn n (%)	All babies n (%)
Birth weight (kg)			
< 1.5	11 (11.7)	11 (10.2)	22 (10.9)
1.5 – < 2.5	31 (33.0)	11 (10.2)	42 (20.8)
> 2.5	49 (52.1)	28 (25.9)	77 (38.1)
Not known	3 (3.2)	58 (53.7)	61 (30.2)
Total	**94 (100.0)**	**108 (100.0)**	**202 (100.0)**
Gestational age			
< 28 weeks	2 (2.1)	4 (3.7)	6 (3.0)
28–32 weeks	16 (17.0)	22 (20.4)	38 (18.8)
33–36 weeks	27 (28.7)	22 (20.4)	49 (24.3)
37–42 weeks	48 (51.1)	54 (50.0)	102 (50.5)
> 42 weeks	1 (1.1)	6 (5.6)	7 (3.5)
Total	**94 (100.0)**	**108 (100.0)**	**202 (100.0)**

Table 2. Presenting clinical features.

Clinical features	Inborn (N = 94) n (%)	Outborn (N = 108) n (%)	Total (N = 202) n (%)
None	30 (14.9)	7 (3.5)	37 (18.4)
Fever	19 (9.4)	39 (19.3)	58 (28.7)
Lethargy/reduced activity	16 (7.9)	42 (20.8)	58 (28.7)
Respiratory distress	48 (23.8)	80 (39.6)	128 (63.4)
Seizures	2 (1.0)	24 (11.9)	26 (12.9)
Coma	0 (0.0)	7 (3.5)	7 (3.5)
Apnoea	5 (2.5)	15 (7.4)	20 (9.9)
Temperature < 36°C	27 (13.4)	33 (16.3)	60 (29.7)
Pallor	1 (0.5)	5 (2.5)	6 (3.0)
Jaundice	12 (5.9)	11 (5.4)	23 (11.4)
Cyanosis	6 (3.0)	12 (5.9)	18 (8.9)
Tachypnea	24 (11.9)	27 (13.4)	51 (25.2)
Bleeding diathesis	4 (2.0)	16 (7.9)	20 (9.9)
Poor feeding	7 (3.5)	13 (6.4)	20 (9.9)
Abdominal distension	12 (5.9)	11 (5.4)	23 (11.4)
Regurgitation/vomiting	6 (3.0)	4 (2.0)	10 (5.0)
Significant pregavage aspirate	2 (1.0)	0 (0.0)	2 (1.0)
Periumbilical redness	2 (1.0)	2 (1.0)	4 (2.0)
Sclerema	0 (0.0)	8 (4.0)	4 (2.0)
Mottled skin	3 (1.5)	8 (4.0)	11 (5.4)
Prolonged capillary refill	0 (0.0)	1 (0.5)	1 (0.5)
Hepatomegaly	3 (1.5)	17 (8.4)	20 (9.9)

Table 3. Characteristics of neonates based on blood culture positivity.

Characteristics	Blood culture positive n (%)	Blood culture negative n (%)	X
Birth weight			**0.728**
< 1.5	3 (1.5)	19 (9.5)	
1.5 – < 2.5	3 (1.5)	39 (19.4)	
≥ 2.5	10 (5.0)	67 (33.2)	
Not known	9 (4.5)	52 (25.9)	
Gestational age			**0.538**
< 28 weeks	1 (0.5)	5 (2.5)	
28–32 weeks	4 (2.0)	34 (16.9)	
33–36 weeks	3 (1.5)	46 (22.9)	
37–42 weeks	16 (8.0)	85 (42.3)	
> 42 weeks	1 (0.5)	3 (1.5)	
Place of ANC			**0.010**
UCH	2 (1.0)	36 (17.8)	
Outside UCH	23 (11.4)	141 (69.8)	
Place of delivery			**0.277**
UCH	8 (4.0)	86 (42.6)	
Outside UCH	17 (17)	91 (45.0)	

ANC: antenatal care; UCH: University College Hospital.

Clinical features

Overall, 36 (17.8%) had risk factors only, while 166 (82.8%) presented with clinical features. Of those with clinical features, respiratory distress was the most common presenting feature (63.4%); fever (28.7%), temperature < 36°C (29.7%), and lethargy (28.7%) were the other common features (Table 2).

Prevalence of culture-proven EOS

The blood culture was positive in 25 (12.4%) neonates, 8 of whom were inborns, giving a prevalence of EOS of 8.8/1,000 live births. Of the 8 inborn neonates with positive cultures, 6 (75%) were from mothers who had antenatal care at peripheral centers but were only referred for delivery due to obstetric complications. Of the 108 outborn neonates screened, 17 (15.9%) had positive blood cultures, as shown in Table 3.

One neonate who had no clinical features but was screened because of a history of maternal peripartum fever had a positive blood culture. All other neonates with positive cultures had at least one clinical feature.

The organisms found are shown in Table 4. *Staphylococcus aureus* was the most common pathogen in both inborn and outborn infants (52% of EOS). There was both a higher prevalence of positive cultures and a wider spectrum of organisms associated with EOS among the outborn compared with inborn neonates. Group B streptococcus (GBS) was not isolated in any neonate.

Table 4. Bacterial isolates in early onset septicemia among inborn and outborn neonates.

Organism	Inborn N = 94 n (%)	Outborn N = 108 n (%)	Total N = 202 n (%)
Staphylococcus aureus MRSA, MSSA	7 (28.0)	6 (24.0)	13 (52.0)
Klebsiella pneumoniae		3 (12.0)	3 (12.0)
Escherichia coli	1 (4.0)		1 (4.0)
Enterococcus spp.		2 (8.0)	2 (8.0)
Enterobacter aerogenes		2 (8.0)	2 (8.0)
Streptococcus pneumoniae		1 (4.0)	1 (4.0)
Other Gram negatives		3 (12.0)	3 (12)
Total	**8 (32.0)**	**17 (68.0)**	**25 (100)**

MRSA: methicillin-resistant *Staphylococcus auereus*; MSSA: methicillin-sensitive *Staphylococcus auereus.*

Table 5. Percentage of organisms susceptible to antibiotics.

Antibiotics	Organisms							
	Staphylococcus aureus		*Kleb.*	*E. Coli*	*Enterococcus* spp.	*S. pneu*	*Enterobacter* spp.	Other Gram negatives
	MSSA	MRSA						
AMP	100	33.3	100	100	0	100	100	0
AMS	100	33.3	-	-	0	-	-	100
AUG	0	0	-	0	100	100	-	-
P	-	-	0	-	-	100	-	-
OX	40	0		0	0	-	-	--
AMC	33.3	33.3	25	0	0	-	50	0
AML	66.7	0	0		0	-	0	0
AK	80	100	100		0	100	100	100
GN	66.7	25	100	100	50	0	-	100
VA	100	66.7	0	-	100	-	-	-
OFX	100	0	-	0	-	100	100	-
CIP	50	100	100	100	0	100	100	100
CFX	80	-	-	-	-	100	-	100
CAZ	0	0	-	100	0	-	100	100
CTX	25	0	-	100	0	-	100	-
CXM	75	0	100	-	-	-	100	0
MRP	66.7	0	100	-	-	0	-	100
C	-	100	-	0	0	-	-	0
E	100	100	-	-	100	-	-	-

MSSA: methicillin-sensitive *Staphylococcus auereus*; MRSA: methicillin-resistant *Staphylococcus auereus*; AMP: ampicillin; AMS: ampicillin/sulbactam; AUG: amoxicillin-clavulanic acid; P: penicillin; AMC: amoxicillin; AML: ampiclox; AK: amikacin; GN: gentamicin; VA: vancomycin; OFX: ofloxacin; CIP: ciprofloxacin; CFX: cefixime; CAZ: ceftazidime; CTX: cefotaxime; CXM: cefuroxime; MRP: meropenem; C: chloramphenicol; E: erythromycin.

The other Gram-negative organisms isolated among outborns were *Acinetobacter iwoffii*, *Acinetobacter baumanii*, and *Serratia marcescens*. Of the *Staphylococcus aureus* isolates, 9 (69.3%) were methicillin sensitive (MSSA) while 4 (30.7%) were methicillin resistant (MRSA), and this represents 16% of the entire isolates. All 4 MRSA were from inborn babies, but maternal risk factors for sepsis were present before presentation for delivery.

Antibiotic susceptibility pattern of EOS organisms

The susceptibility of all organisms except *Staphylococcus aureus* was 100% to ampicillin, ampicillin/sulbactam, amikacin, gentamicin, third-generation cephalosporins, and quinolones. MSSA demonstrated 100% susceptibility to ampicillin/sulbactam, 80% to amikacin, and 66.7% to gentamicin. MRSA demonstrated 33.3%, 100%, 66.7%, and 25% susceptibility to ampicillin/sulbactam, amikacin, vancomycin, and gentamicin, respectively, as shown in Table 5.

Discussion

The prevalence of EOS among inborns in this study of 8.8/1,000 live births is higher than that reported from developed countries, where the prevalence is 0.9–3.3/1,000 live births [10], implying that much is needed to be done to reduce the scourge of neonatal infections in Nigeria and other developing countries to improve newborn health. This high prevalence was largely accounted for by neonates whose mothers received antenatal care outside of the UCH but were referred for delivery; these infants accounted for 75% of culture-proven EOS among the inborn neonates. This, coupled with the finding of a wider spectrum of organisms among the outborns, suggests that infection rates are higher at those peripheral hospitals, which may indicate that the level of hygienic and aseptic techniques are probably suboptimal in the peripheral centers. It is therefore important to emphasize infection control at such levels of healthcare if neonatal infection, which is one of the commonest causes of newborn mortality, is to be reduced in Nigeria.

In developing countries, there is a wide variation in the incidence of NNS, ranging from 5.6/1,000 live births in a hospital-based study in Pakistan [11], 15.5 in a hospital in India [12], to 54.9/1,000 live births in Nigeria [13], which has been attributed to factors such as socioeconomic structure, perinatal practices, as well as a lack of infection control practices and good antibiotic protocols. The persistently low NNS rates from developed countries are mainly due to good infection control practices, including rational use of antibiotics [10].

Staphylococcus aureus was the commonest organism isolated from both inborn and outborn neonates. Similar reports have been made from other centers in Nigeria [13-15]. *Staphylococcus aureus* was the third commonest organism isolated among inborns in a study from India, next to coagulase-negative *Staphylococcus aureus* and *Klebsiella pneumoniae* [12]. It has been shown that horizontal transmission from mothers is probably the major source of *Staphylococcus aureus* to neonates [16]. This observation may therefore suggest poor hygiene as a major contributing factor to the high incidence of NNS in Nigeria and other developing countries. It is also possible that the nasal and/or vaginal carriage rate of *Staphylococcus aureus* is high in our environment, though there are no studies available to show this. It is worthy of note that 16.1% of isolates in EOS were MRSA. Though MRSA colonization has been reported in recent times in babies in the neonatal intensive care unit right from admission, it is more commonly associated with LOS and outbreaks [17]. These MRSA isolates were found only among the inborns of both referred and registered mothers; this may suggest that some of the mothers or babies may have acquired MRSA from the healthcare staff in the labor ward. However, there were no facilities to type the strains and identify the possible source.

Escherichia coli was the only Gram-negative organism responsible for EOS among inborn neonates, hence the need to take this into consideration in the choice of first-line empirical antibiotics. This is not unexpected, as *Escherichia coli* is a genital tract organism, which would likely be transmitted perinatally. *Escherichia coli* has not been as commonly reported as *Klebsiella* in Nigerian studies in recent times [9,13,18], but this may be because most studies did not differentiate between EOS and LOS. That no GBS was found in this study further buttresses the fact that it is not as common in this environment [10] as in developed countries, where it is the major cause of EOS [19,20]. The reason for this is not clear, but the fact that several mothers had been exposed to prior antibiotics may be a contributory factor. Studies of maternal GBS carriage would be necessary to establish if the organism is indeed not common in this environment or if there are factors protecting the babies. Finding *Staphylococcus aureus* and *Escherichia coli* as the commonest organisms in this study just as it had been more than 30 years ago in Ibadan [21] and more than 10 years ago in Uganda [22] suggests that not much has changed with

respect to the etiology of EOS and probably infection control practices.

Many other recent studies from developing countries did not differentiate between EOS, LOS, or even nosocomial infections [10], and treatment guidelines based on such reports will likely negate the principles of rational antibiotic use in newborns and will, in the long run, promote multidrug resistance. In most studies from developing countries, including Nigeria that differentiated between EOS and LOS, multidrug-resistant Gram-negative organisms such as *Klebsiella*, *Escherichia coli*, *Pseudomonas*, and *Salmonella* were commonly reported in EOS [10,23,24]. Studies from Europe and the United States show a predominance of Gram-positive organisms, especially GBS, despite the use of prophylactic intrapartum antibiotics [20,25]. Other organisms causing EOS include, in order of reducing frequency, *Eschericha coli*, *Streptococcus viridans*, and *Staphylococcus aureus* [10].

The initial empirical treatment of EOS goes a long way in determining the likelihood of development of secondary infection with multidrug-resistant Gram-negative bacteria. Several studies from developing countries have recommended second- and third-generation cephalosporins as first-line antibiotics, but this can only compound the already bad situation [26]. In this study, most of the organisms showed good susceptibility to ampicillin, amikacin, and gentamicin, except MRSA, which expectedly demonstrated limited susceptibility to these drugs and even to vancomycin (only 66.7% of isolates were susceptible). This high resistance of MRSA to vancomycin is consistent with what has been previously reported [27,28], and this has grave implications in a low-resource setting like Nigeria, where there are limited choices of antibiotics.

Also worthy of note is the fact that the Gram-negative organisms were all sensitive to meropenem, while only 66.7% of the MSSA and none of the MRSA and *Streptococcus pneumoniae* were susceptible.

With the findings from this study, organisms causing EOS demonstrated susceptibility to drugs recommended by the World Health Organization (WHO) as first-line antibiotics; however, reports of substandard/adulterated ampicillin and gentamicin in Nigeria have limited its use in our unit [29,30]. Though the study was conducted in a tertiary hospital setting, most of the culture-proven septicemia were in babies from the various facilities at the peripheral level, and these probably represent the babies who were the most ill. It may therefore be inferred that it is unnecessary to institute more complex antibiotics, particularly the higher-generation cephalosporins, as first-line antibiotics, as recommended in some previous studies from Nigeria [31]. This will go a long way in the control of the emergence of multidrug-resistant strains of organisms, which is the current problem in newborn units across many developing countries. It does not appear that new, safe, and affordable classes of antibiotics will be developed soon.

If gains are to be made in reducing the prevalence of NNS, there is a need to standardize obstetric practices in healthcare centers that serve the community and to promote training of healthcare workers, especially in the areas of hand hygiene and aseptic procedures.

Conclusions

The prevalence of EOS in our setting is still high, *Staphylococcus aureus*, and *Eschericha coli* remain the commonest etiologic agents. A substantial number of the *Staphylococcus aureus* isolates were methicillin resistant strains. All organisms demonstrated good susceptibility to the WHO recommended first line empirical antibiotics except for MRSA which showed high resistance even to vancomycin.

Considering the fact that the most common organism responsible for EOS was *Staphylococcus aureus* the first choice of empiric antibiotics in this setting should include an anti-staphylococcal agent.

The fact that most part of the positive cultures were isolated from neonates of mothers who were referred from the peripheral centres, made clear that further studies are needed in those areas as well as improvement in practices aimed at promoting hygienic perinatal practices and reducing neonatal infections and neonatal mortality. In addition, community based studies on bacterial etiology and antimicrobial susceptibility pattern may be required in our environment in order formulate antibiotic guidelines for the peripheral level to promote rational use of antibiotics in the community and discourage the emergence of multi drug resistant strains of bacteria.

Acknowledgements

We acknowledge the parents of subjects for their cooperation and consent. We also acknowledge the nursing staff of the neonatal unit of the University College Hospital, Ibadan, for their cooperation during the conduct of the study.

We acknowledge the contribution of Prof. S. Allen in reviewing the manuscript.

References

1. Liu L, Oza S, Hogan D, Perin J, Rudan I, Lawn JE, Cousens S, Mathers C, Black RE (2015) Global, regional, and national causes of child mortality in 2000–13, with projections to inform post-2015 priorities: an updated systematic analysis. Lancet 385: 430-440.
2. Lawn JE, Blencowe H, Oza S, You D, Lee AC, Waiswa P, Lalli M, Bhutta Z, Barros AJ, Christian P, Mathers C (2014) Every newborn: progress, priorities, and potential beyond survival. Lancet 384: 189-205.
3. Wright S, Mathieson K, Brearley L, Jacobs S, Holly L, Wickremasinghe R (2014) A crisis and an opportunity. Ending newborn deaths: ensuring every baby survives. Fairfield: Save the Children. 1-6.
4. Darmstadt GL, Kinney MV, Chopra M Cousens S, Kak L, Paul VK, Martines J, Bhutta ZA, Lawn JE, Lancet Every Newborn Study Group (2014) Every newborn: who has been caring for the baby? Lancet 384: 174-188.
5. Schelonka RL (2005) Bacterial and Fungal infections. In: MacDonald MG, Seshia MMK, Mullett M, editors. Avery's Neonatology, 6th edition Philadelphia: Lippincott Williams & Wilkins. 1235-1273.
6. Stoll BJ (2007) Infections of the Neonatal Infant. In: Kliegman RM, Behrman RE, Jenson HB, Stanton BF, editors. Nelson Textbook of Pediatrics, 18th edition. Philadelphia: Saunders. 794-811.
7. Bode-Thomas F, Ikeh EI, Pam SD, Ejeliogu EU (2004) Current aetiology of neonatal sepsis in Jos University Teaching Hospital. Niger J Med 13: 130-135.
8. Egri-Okwaji MTC, Iroha EO, Kesah CN, Odugbemi T (1998) Changing pattern of causative organisms causing neonatal septicaemia at the Lagos University Teaching Hospital. Nig J Paediatr 25: 1-5.
9. Ogunlesi TA, Ogunfowora OB, Osinupebi O, Olanrewaju DM (2011) Changing trends in newborn septicaemia in Sagamu, Nigeria: Bacterial aetiology, risk factors and antibiotic susceptibility. J Paediatr Child Health. 47: 5-11.
10. Vergnano S, Sharland M, Kazembe P, Mwansambo C, Heath PT (2005) Neonatal sepsis: an international perspective. Arch Dis Child Fetal Neonatal Ed 90: F220-FF224.
11. Bhutta ZA, Yusuf K (1997) Neonatal sepsis in Karachi: factors determining outcome and mortality. J Trop Pediatr 43: 65-70.
12. Mondal GP, Raghavan M, Bhat BV, Srinivasan S (1991) Neonatal septicaemia among inborn and outborn babies in a referral hospital. Indian J Pediatr 58: 529-533.
13. Anah MU, Udo JJ, Ochigbo SO, Abia-Bassey LN (2008) Neonatal septicaemia in Calabar, Nigeria. Trop Doct 38: 126-128.
14. Kenneth C Iregbu, Olufumilayo Y Elegba, Babaniyi IB (2006) Bacteriological profile of neonatal septicaemia in a tertiary hospital in Nigeria. Afr Health Sci 6: 151-154.
15. Fadero FF, Aboderin AO, Onigbinde MO, Ako-Nai AK (2007) Bacterial pathogens and antibiotic sensitivity in neonatal septicaemia at the Ladoke Akintola University Teaching Hospital, (LTH), Osogbo, Southwestern Nigeria. Int J Trop Med 2: 21-24.
16. Leshem E, Maayan-Metzger A, Rahav G, Dolitzki M, Kuint J, Roytman Y, Goral A, Novikov I, Fluss R, Keller N, Regev-Yochay G (2012) Transmission of *Staphylococcus aureus* from mothers to newborns. Pediatr Infect Dis J 31: 360-363.
17. Fainareti NZ, Ioannis M. Zacharioudakis, Panayiotis D. Ziakas, Mylonakis E (2014) MRSA colonization and risk of infection in the neonatal and pediatric ICU: A meta-analysis. Pediatrics 133: 1015-1023.
18. Mokuolu AO, Jiya N, Adesiyun OO (2002) Neonatal septicaemia in Ilorin: bacterial pathogens and antibiotic sensitivity pattern. Afr J Med Med Sci 31: 127-130.
19. Vergnano S, Menson E, Kennea N, Embleton N, Russell AB, Watts T, Robinson MJ, Collinson A, Heath PT (2010) Neonatal infections in England: the NeonIN surveillance network. Arch Dis Child Fetal Neonatal Ed 96: F9-F14.
20. Schuchat A, Zywicki SS, Dinsmoor MJ, Mercer B, Romaguera J, O'Sullivan MJ, Patel D, Peters MT, Stoll B, Levine OS (2000) Risk factors and opportunities for prevention of early-onset neonatal sepsis: a multicenter case-control study. Pediatrics 105: 21-26.
21. Dawodu AH, Alausa OK (1980) Neonatal septicaemia in the tropics. Afr J Med Sci 2: 1-6.
22. Mugalu J, Nakakeeto MK, Kiguli S, Kaddu-Mulindwa DH (2006) Aetiology, risk factors and immediate outcome of bacteriologically confirmed neonatal septicaemia in Mulago hospital, Uganda. Afr Health Sci 6: 120-126.
23. Zaidi AKM, Thaver D, Ali SA, Khan TA (2009) Pathogens associated with sepsis in newborns and young infants in developing countries. Pediatr Infect Dis J 28 Suppl 1: 10-18.
24. Nwankwo EOK (2011) Risk factors and bacterial profile of suspected neonatal septicaemia at a teaching hospital in Kano, Northwestern Nigeria. Sierra Leone J Biomed Res 3: 104-109.
25. Baltimore RS, Huie SM, Meek JI, Schuchat A, O'Brien KL (2001) Early-onset neonatal sepsis in the era of group B Streptococcal prevention. Pediatrics 108: 1094-1098.
26. de Man P, Verhoeven BAN, Verbrugh HA, Vos MC, van den Anker JN (2000) An antibiotic policy to prevent emergence of resistant bacilli. Lancet 355: 973-978.
27. Shitaye D, Asrat D, Woldeamanuel Y, Worku B (2010) Risk factors and etiology of neonatal sepsis in Tikur Anbessa University Hospital, Ethiopia. Ethiop Med J 48: 11-21.
28. Hiramatsu K (1998) Vancomycin-resistant Staphylococcus aureus: a new model of antibiotic resistance. Lancet Infect Dis 1: 147-155.
29. Nkang A, Okonko I, Lennox J, Babalola E, Adewale O, Motayo B, Mejeha OK, Adekolurejo OA (2010) Survey of the efficacy and quality of some brands of the antibiotics sold in Calabar Metropolis, South-south region of Nigeria. Sci Res Essays 5: 395-406.
30. Onanuga A, Eboh DD (2012) Biological activities of ciprofloxacin tablets and gentamicin injections commonly used in Nigeria. J Pharm Biomed Sci 14: 1-6.
31. Ojukwu JU, Abonyi LE, Ugwu J, Orji IK (2006) Neonatal septicemia in high risk babies in South-Eastern Nigeria. J Perinat Med 34: 166-172.

Corresponding author

Dr. Abimbola Akindolire
Paediatrics Department
University College Hospital
Queen Elizabeth Road,
200284
Ibadan, Nigeria
Phone: 08037878389
Email: abimbola_12@yahoo.com

Conflict of interests: No conflict of interests is declared.