ORIGINAL ARTICLE

Clinical and Bacteriologic Profile of Neonatal Sepsis in a Tertiary Care Hospital: A 5-Year Review

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ABSTRACT

Background: Neonatal sepsis, a clinical syndrome characterized by non-specific signs and symptoms, is the most common cause of neonatal mortality and morbidity. It is classified into early or late-onset depending on the onset of symptoms, if within the first 72 hours or later. Early onset sepsis (EOS) occurs due to ascending infection following rupture of membranes or during passage through an infected birth canal. Late onset sepsis (LOS) can be nosocomial or community-acquired. A high index of suspicion and timely and judicious use of antibiotics are needed to achieve good outcomes.

Objective: This study looked into the clinical and bacteriologic profile of neonatal sepsis in a tertiary care hospital from January 2013 to December 2017.

Methodology: This was a retrospective observational study. Data on maternal risk factors, mode of delivery, gestational age, birth weight, birth setting, clinical manifestations, and blood culture and sensitivity were gathered. Descriptive statistics was used to analyze the data.

Results: Majority of cases were late onset sepsis with an equal distribution in those born via normal spontaneous delivery (NSD) and cesarean section (CS). There were more culture- positives in low birth weight (LBW) infants and those not delivered within a hospital. The most common maternal risk factor was UTI. Majority of culture-positive newborns presented with respiratory distress, poor feeding, fever, and irritability with respiratory distress being the most common manifestation for both EOS and LOS. Predominant isolates were CONS, *E. coli* and *Klebsiella sp.* Both *E. coli* and *Klebsiella* were resistant to both first-line empiric antibiotics - ampicillin and gentamicin but highly sensitive to piperacillin-tazobactam and imipenem.

Conclusion: Clinical signs and symptoms of neonatal sepsis are non-specific. The presence of respiratory distress, fever, poor feeding, and irritability together with other risk factors should raise suspicion for sepsis and prompt investigation and treatment. Predominant isolates seen were CONS, *E. coli* and *Klebsiella sp.* with resistance to first-line empiric antibiotics.

KEYWORDS: *neonatal sepsis, early-onset, late-onset, risk factors, clinical signs and symptoms, antibiotic sensitivity*

INTRODUCTION

Sepsis is the most common cause of neonatal morbidity and mortality. Neonatal sepsis is a generalized bacterial infection documented by a positive blood culture in the first four weeks of life, along with a clinical syndrome characterized by systemic signs of infection.[1] Although remarkable developments have been made in recent years to reduce the number of deaths globally, too many newborns continue to die. In 1990, both the United Nations (UN) and World Health Organization (WHO), prioritized the Millennium Development Goals (MDG), that targeted a 2/3 reduction in child mortality rate by 2015.[2] In 2013 however, 44% of deaths in children under five occurred during the neonatal period (up from 37% in 1990). It was found that the three major causes of neonatal deaths worldwide were infection from neonatal sepsis/pneumonia (36%), pre-term birth (28%), and birth asphyxia (23%).[2,5] Despite major advances and increasing research in neonatal care in developed countries, 40% of neonates with sepsis die or experience a major disability such as neurodevelopmental impairment.[3] In 2015, MDG data showed that neonatal deaths as a share of under-five deaths declined far more slowly than other under-five deaths during the same period (1990 to 2015).[2] In 2017, newborn deaths further increased and accounted for 45% of under-five deaths globally.[4] In the Philippines, report from the UNICEF showed that neonatal sepsis accounts for 13% of neonatal deaths and 10-12% of all causes of deaths in the country.[5]

Neonatal sepsis can be categorized into early or late-onset depending on the timing of occurrence of symptoms – whether within the first 72 hours of life or later. Early onset sepsis usually occurs due to ascending infection or passage through an infected maternal genital tract. Late onset sepsis on the other hand, is either nosocomial or community-acquired.[1] Each newborn should be evaluated for the presence of the following maternal and neonatal factors that are associated with an increased risk for sepsis: premature rupture of membranes (PROM) $\geq$ 18 hours, maternal fever or active maternal infection within days of delivery (such as urinary tract infection, septicemia, pneumonia/respiratory tract infection, chorioamnionitis), prematurity, fetal distress, low birth weight, meconium-staining and low APGAR score.[6,7,8] Common clinical signs and symptoms are non-specific and may involve different organ systems at one time. These include temperature instability (fever/ hypothermia), jaundice, respiratory distress (grunting, tachypnea, presence of retractions), apnea, hepatomegaly, poor feeding, vomiting, lethargy/poor activity, cyanosis, abdominal distension, irritability and diarrhea.[9]

Common laboratory tests such as complete blood count, C-reactive protein, and erythrocyte sedimentation rate are used to aid in diagnosis, even if they have limited diagnostic accuracy for neonatal sepsis.[10,11] The gold standard for diagnosing neonatal sepsis is still blood culture despite its low sensitivity - majority of sepsis cases are diagnosed in the presence of concerning clinical signs with negative culture results.[12,13] When culture for blood and/or other sterile sites are negative but the neonate continues to show signs consistent with infection, this is classified as clinical sepsis.[14] The limitations of ancillary tests and the low sensitivity of blood culture combined with non-specific clinical signs constrain pediatricians to treat patients based on a high level of suspicion. This necessitates initiation of empiric antibiotic therapy until sepsis is ruled out. Group B streptococcus (GBS) and *Escherichia coli* (*E. coli*) are the most common pathogens of EOS. Trends in the epidemiology of early-onset sepsis show a decreasing incidence of GBS disease. This is attributed to the implementation of prenatal screening and treatment for GBS.[15,16] For LOS, the most common organisms are coagulase-negative *Staphylococcus* (CONS), *Staphylococcus aureus (S. aureus) and Klebsiella*.[17]

In 2011, An international review was done by Waters, D et. al. to determine the most common etiology of community-acquired neonatal sepsis in low- and middle-income countries. The study, where the Philippines was included, showed that the most prevalent pathogens overall were *S. aureus* (14.9%), *E. coli* (12.2%), and *Klebsiella sp.* (11.6%). However, variations were observed between global regions and age-of-onset categories. *Klebsiella* was highly prevalent in Southeast Asia and showed the highest antimicrobial resistance.[18] Locally, a multi-center retrospective study done by Lazarte, C et. al. in 2006, showed that majority of admitted neonates had EOS. They also found that gram-negative organisms comprised the majority of neonatal infections, with *Pseudomonas* and *Burkholderia*

being the most prevalent.[19] Another retrospective study done by Baltazar et. al in 2014 in the NICU of a tertiary government hospital showed that the most common isolates were *Klebsiella* followed by CONS and *Enterobacter cloacae.* Most isolates were resistant to first-line antibiotics - ampicillin, penicillin and cefuroxime.[20] The diversity of organisms causing neonatal sepsis varies from one hospital to another and can change over time in the same location. Although most isolates remain sensitive to newer antibiotics, emergence of resistant strains is a potential problem due to changing patterns of antibiotic use.

The subtle and non-specific symptomatology of sepsis causes difficulty in early detection and timely treatment. The pathogens causing sepsis in the newborn and the antibiotic susceptibility varies from one hospital to another. Prompt treatment based on a rational protocol according to antibiotic susceptibility will greatly help in reducing morbidity and mortality from neonatal sepsis.

METHODOLOGY

A. Study Design and Setting

This is a retrospective observational study of neonatal sepsis cases admitted under the Department of Pediatrics, Hospital of the Infant Jesus Medical Center from January 2013 to December 2017.

B. Inclusion and Exclusion Criteria

All neonates admitted during the study period who fulfilled the sepsis case definition set by the Philippine Society of Newborn Medicine (Standards of Newborn Care 4th ed) and who had blood culture and sensitivity done before antibiotics were started were included. Patients who received antibiotics prior to hospital admission were excluded.

C. Data Collection

In-patient records of neonates who were admitted and who fulfilled the sepsis case definition were reviewed and analyzed. Details in the history including maternal risk factors, mode of delivery, gestational age, birth weight, birth setting, and clinical manifestations were recorded. Data on blood culture and sensitivity (done by conventional method) were also obtained. Descriptive statistics was used in the data analysis.

RESULTS

A total of 251 neonates, born within and outside of the hospital, and admitted because of suspected sepsis were included in the study. In both suspected and culture-positive cases, majority of neonates were males with a male to female ratio of 1.5:1. Culture positive cases were higher in females than in males (35%).

Table 1. Gender Distribution

Distribution	Suspected Case (%)	Culture Positive (%)	Culture Negative (%)
Total Number	251	78 (31.1)	173 (68.9)
Males	151 (60.2)	43 (28.5)	108 (71.5)
Females	100 (39.8)	35 (35)	65 (65)

The incidence of suspected sepsis was slightly higher in babies delivered by cesarean section (CS). However, there was an equal number of CS and normal spontaneous vaginal delivery (NSD) cases in those who were culture-positive.

Table 2. Distribution According To Mode of Delivery

Type of Delivery	Suspected Case (%)	Culture Positive (%)	Culture Negative (%)
Total number	251	78 (31.1)	173 (68.9%)
Normal Spontaneous Vaginal Delivery	119 (47.4)	39 (32.8)	80 (67.2)
Cesarean Section	132 (52.6)	39 (29.5)	93 (70.5)

Majority of suspected sepsis were delivered within a hospital (in-hospital or other hospitals). There were 455 deliveries in our hospital (in-hospital birth), and 63 were admitted due to suspected sepsis. Of these, 48 (76.2 %) were suspected EOS and 12 (25%) were culture-positive. Most of the cases born in other hospitals (n=145) were suspected LOS (86.2%) and 35 (28%) were culture-positive. It was observed that those born in a lying-in and at home had positive culture results (50% for both EOS and LOS), but this group comprised a significant minority in relation to the study population.

Table 3. Distribution According to Birth Setting and Age of Onset

Birth Setting	EOS			LOS		
	Suspected case (%)	Culture-Positive (%)	Culture Negative (%)	Suspected Case (%)	Culture Positive (%)	Culture Negative (%)
Total number (n = 251)	76 (30.3)	21 (27.6)	55 (72.4)	175 (69.7)	57 (32.6)	118 (67.4)
In-Hospital (n = 63)	48 (76.2)	12 (25)	36 (75)	15 (23.8)	4 (26.7)	11 (73.3)
Other Hospitals (n = 145)	20 (13.8)	5 (25)	15 (75)	125 (86.2)	35 (28)	90 (72)
Lying-in (n = 42)	8 (19)	4 (50)	4 (50)	34 (81)	17 (50)	17 (50)
Home (n = 1)	-	-	-	1 (100)	1 (100)	-

Based on gestational age, majority of neonates were born term and preterms comprised only 13.9% of cases. There was no significant difference in the number of culture positive cases among term and preterm neonates.

Table 4. Distribution According to Gestational Age

Gestational Age (in weeks)	Suspected Case (%)	Culture Positive (%)	Culture Negative (%)
Total number	251	78 (31.1)	173 (68.9)
≥ 37 weeks (term)	216 (86.1)	69 (31.9)	147 (68.1)
< 37 weeks (preterm)	35 (13.9)	9 (25.7)	26 (74.3)

Majority of subjects had a normal birthweight. We had 41 suspected sepsis cases with low birthweights (LBW) and 41.5% of these had positive cultures.

Table 5: Distribution of Neonates According to Birth Weight

Birth weight (in grams)	Suspected Case (%)	Culture Positive (%)	Culture Negative (%)
Total number	251	78 (31.1)	173 (68.9)
≥ 2 500 grams	210 (83.7)	61 (29.1)	149 (70.9)
< 2 500 grams (LBW)	41 (16.3)	17 (41.5)	24 (58.5)

Of the 251 suspected cases, 101 neonates (40.2%) had maternal risk factors. Of these, 23.8% were culture-positive. Urinary tract infection was the leading maternal risk factor noted.

Table 6. Distribution According to Maternal Risk Factors

Risk Factor	Suspected Case	Culture Positive (%)	Culture Negative (%)
PROM ≥ 18 hrs	16	3 (18.8)	13 (81.2)
Maternal fever	5	-	5 (100)
Urinary Tract Infection (UTI)	55	16 (29.1)	39 (70.1)
Upper Respiratory Tract Infection (URTI)	16	4 (25)	12 (75)
Bacterial vaginosis/vaginitis	7	1 (14.3)	6 (85.7)
Septicemia	2	-	2 (100)
Total	101 (40.2)	24 (23.8)	77 (76.2)

In the cases evaluated, the neonates presented with fever, poor suck/feeding, poor activity/lethargy, irritability, respiratory distress, cyanosis, seizures, jaundice, abdominal distention, vomiting, diarrhea, apnea and hypoglycemia. Most common manifestations were respiratory distress, poor feeding, fever, jaundice, and irritability with respiratory distress being the most common presentation for both EOS and LOS. Culture positive cases were highest in newborns who presented with irritability, followed by fever, respiratory distress, and poor suck (Tables 7, 8).

Table 7: Distribution Based On Presenting Clinical Signs

Clinical feature	Suspected Case	Culture Positive (%)	Culture Negative (%)
Respiratory distress	153	50 (32.7)	103 (67.3)
Poor feeding	95	26 (27.4)	69 (72.6)
Fever	65	27 (41.5)	38 (58.5)
Jaundice	50	12 (24)	38 (76)
Irritability	29	14 (48.3)	15 (51.7)
Poor activity/Lethargy	20	4 (20)	16 (80)
Vomiting	31	8 (25.8)	23 (74.2)
Diarrhea	28	7 (25)	21 (75)
Cyanosis	17	4 (23.5)	13 (76.5)
Seizures	4	1 (25)	3 (75)
Abdominal distension	4	1 (25)	3 (75)
Apnea	3	-	3 (100)
Hypoglycemia	2	-	2 (100)

Table 8: Comparison of Demographic and Clinical Features of EOS and LOS

	Early Onset Sepsis	Late Onset Sepsis
Male:Female	47:29 (1.6:1)	104:71 (1.5:1)
Term:Preterm	61:15 (4:1)	144:20 (7.2:1)
Normal:LBW	57:19 (3:1)	153:22 (6.9:1)
NSD:CS	27:49 (0.6:1)	93:82 (1.1:1)
Respiratory distress	36	117
Fever	14	51
Poor feeding	22	73
Irritability	2	27
Jaundice	25	25
Vomiting	10	21
Poor activity/Lethargy	9	11
Diarrhea	3	25
Cyanosis	7	10
Abdominal distension	3	1
Apnea	2	1
Seizures	2	2
Hypoglycemia	2	-

Of the 251 cases reviewed, 78 (31.1%) were culture-positive and 21 (27%) were among EOS and 57 (32%) among LOS. In both EOS and LOS, the predominant isolates were Coagulase Negative Staphylococcus, *E. coli* and *Klebsiella sp.* (Table 9).

Table 9: Frequency of Bacterial Isolates in EOS and LOS

Bacteria	EOS	LOS	Total
Gram-positive			
CONS	9 (42.8)	25 (44)	34 (43.6)
Staphylococcus aureus	2 (9.5)	1 (1.7)	3 (3.8)
Group B streptococci	-	3 (5.3)	3 (3.8)
Gram-negative			
Klebsiella	3 (14.3)	9 (15.8)	12 (15.4)
Pseudomonas	1 (4.8)	1 (1.7)	2 (2.6)
Escherichia coli	5 (23.8)	10 (17.5)	15 (19.2)
Acinetobacter baumanii	-	1 (1.7)	1 (1.3)
Enterobacter cloacae	1 (4.8)	7 (12.3)	8 (10.3)
Total	21 (27)	57 (73)	78 (100)_

Both gram-positive and gram-negative bacterial isolates showed low sensitivity to first-line empiric antibiotics (ampicillin and gentamicin). *Staphylococcus aureus* isolates showed intermediate sensitivity to vancomycin and clindamycin. Among gram-negative isolates, *Klebsiella sp.*, *E. coli* and *Enterobacter cloacae* were noted to have low sensitivity to most first and second-line empiric antibiotics. *Klebsiella sp.* isolates were sensitive to piperacillin-tazobactam, imipenem, and amikacin. *E. coli* was sensitive to piperacillin-tazobactam, cefotaxime, ceftriaxone, and imipenem. *Enterobacter cloacae* was sensitive to piperacillin-tazobactam, and ampicillin but was intermediate to gentamicin. The single isolate of *Acinetobacter baumanii* was sensitive to all tested antibiotics. *Pseudomonas sp.* was sensitive to piperacillin-tazobactam. In general, both gram-positive and gram-negative bacterial isolates were sensitive to both piperacillin-tazobactam and imipenem in vitro. It is important to note that methods to screen for extended-spectrum β –lactamase (ESBL) producing strains were not performed in this study.

Table 10: Antibiotic Sensitivity Pattern of Gram-Positive Organisms

Antibiotics	Organisms (%)		
	CONS n = 34	***S. aureus*** n = 3	***GBS*** n = 3
Oxacillin	8 (23)	2 (67)	2 (67)
Clindamycin	22 (65)	2 (67)	1 (33)
Vancomycin	32 (94)	2 (67)	3 (100)

Table 11: Antibiotic Sensitivity Pattern of Gram-Negative Organisms

Antibiotics	Organisms (%)				
	Klebsiella sp. n = 12	***Escherichia coli*** n = 15	***Pseudomonas sp.*** n = 2	***Acinetobacter baumanii*** n = 1	***Enterobacter cloacae*** n = 8
Ampicillin	3 (25)	6 (40)	-	1 (100)	8 (100)
Cefuroxime	3 (25)	10 (67)	-	1 (100)	3 (38)
Cefotaxime	3 (25)	15 (100)	-	1 (100)	3 (38)
Ceftriaxone	3 (25)	15 (100)	-	1 (100)	4 (50)
Piperacillin-Tazobactam	12 (100)	15 (100)	2 (100)	1 (100)	8 (100)
Imipenem	12 (100)	14 (93)	2 (100)	1 (100)	7 (88)
Ciprofloxacin	12 (100)	2 (13)	2 (100)	1 (100)	8 (100)
Gentamicin	6 (50)	2 (13)	-	1 (100)	5 (62)
Amikacin	12 (100)	8 (53)	2 (100)	1 (100)	2 (25)

Of the 251 suspected sepsis cases, 242 (96%) were discharged improved. Among 78 culture-positive neonates, 76 (97%) were sent home, while 2 were discharged against medical advice (DAMA). There were 7 deaths, and all were EOS cases. The most common risk factors in those who died were prematurity, maternal UTI and PROM. All deaths presented with respiratory distress on admission. None of those who died had a positive blood culture.

Table 12: Outcome of Patients

	EOS (n=76)		**LOS** (n=175)	
Total (n=251)	**Culture Positive (%)** 21 (27.6)	**Culture Negative (%)** 55 (72.4)	**Culture Positive (%)** 57 (32.6)	**Culture Negative (%)** 118 (67.4)
Died (n=7)	-	7 (100)	-	-
Improved (n=242)	19 (7.9)	48 (19.7)	57 (23.6)	118 (48.8)
DAMA (n=2)	2 (9.5)	-	-	-

DISCUSSION

Neonatal sepsis is one of the major health concerns in developing countries, including the Philippines. In this retrospective study, the incidence of suspected or clinical sepsis was higher among males compared to females. Similar male preponderance has been reported in several studies [5,6,9] but our study showed a higher rate of culture confirmed sepsis in the female population. Most studies present a higher incidence of sepsis among preterm and low birth weight babies as they are more susceptible to infection due to their inherent weak immune system.[21,22] However, our study showed a higher percentage of sepsis among term than preterm neonates. This probably reflects differences in population characteristics and the occurrence of other predisposing factors among the study participants. Although we have more subjects that have normal birth weights, the percentage of culture positives among suspected cases was higher in low birth weight infants.

As to mode of delivery, there was no significant difference in the number of culture-positive patients who were born via normal spontaneous vaginal delivery and cesarean section. The distribution of subjects according to birth setting showed that there was a higher percentage of culture-positive neonates who were delivered at home and in lying-in centers. The rate of sepsis among all deliveries in the hospital during the study period was 13.8% (63/455). Of these, the percentage of culture-positive cases was significantly

lower and almost the same as those who were born but admitted in other hospitals. According to Zaidi and Huskins contributory factors to a high nosocomial infection rate in low and middle-income countries are lack of aseptic delivery techniques and hand hygiene compliance, lack of proper sterilization facilities, lack of knowledge and training regarding adequate sterilization, and overcrowding and understaffed health facilities.[23] These however were not reflected in our study.

Based on presenting clinical manifestations of patients with suspected sepsis, poor feeding, fever, respiratory distress, jaundice, and irritability were the most common findings. Respiratory distress was the most common presenting sign among culture-positive cases. A study done by Bonadio and colleagues found that change in respiratory status (distress), change in affect, and poor peripheral perfusion are indicators that best identified infants with serious bacterial infection. Poor feeding and alterations in level of alertness or activity were also included, although noted to be less sensitive indicators.[24].

Among the cases reviewed, LOS was more common than EOS, which is consistent with reports from other Asian countries. [1,8,22]

The percentage of positive blood cultures in our study was only 31.1%. Reasons for negative blood cultures include presence of other pathogens such as anaerobic organisms, viruses, and fungi. No workup however was done for these pathogens. This finding is comparable with rates reported in other developing Asian and African countries. Both gram-positive and gram-negative bacteria were isolated in our study. The incidence of gram-positive bacteria was higher compared to gram-negative bacteria. Coagulase Negative Staphylococcus (CONS) was the most common pathogen found in our study followed by *E. coli* and *Klebsiella sp.* for both EOS and LOS. Our results are similar to the results of Lazarte et. al and Baltazar, et.al which showed a high incidence of CONS and *Klebsiella* isolates from blood culture. It also parallels the results of the study done by Ballot and colleagues, which found that there is a high rate of CONS infections reported in Southeast Asia, as well as in the Middle East and Latin America. [24] In contrast, a review done by Zaidi and colleagues in 2009 revealed a higher ratio of gram-negative to gram-positive organisms (1.6:1) as etiologic agents for neonatal sepsis across Asia and the Pacific regions.[26] The same review cited *Klebsiella sp*. and *E. coli* as predominant pathogens in the majority of cases. CONS was the most common etiologic agent in our study and was considered a true pathogen upon careful assessment.

Ampicillin and gentamicin remain to be the fIrst line empiric antibiotics for neonatal sepsis in our hospital. However, in our study, most organisms showed poor sensitivity to both antibiotics. Both CONS and *S. aureus* were sensitive to vancomycin. For gram-negative organisms, susceptibility to piperacillin-tazobactam and imipenem were observed. Only *E. coli* remained susceptible to cephalosporins. The rest of the gram-negative isolates showed intermediate sensitivity to cephalosporins. The results of our study is comparable to the findings of Baltazar et. al in 2014, which showed increasing resistance of *Klebsiella* to ampicillin. Our findings also concur with the review done by Zaidi and colleagues showing high resistance (70%) of neonatal isolates from hospitals in developing countries to ampicillin and gentamicin.[23] Sensitivity to Ciprofloxacin was shown in this study particularly for *Pseudomonas, E.coli, Acinetobacter and Enterobacter.* Although fluoroquinolones (ciprofloxacin) are not recommended for use in infants and young children, they may be used in cases when bacteria show multiple resistance to standard and alternative antibiotics.[27]

We attempted to compare the 2018 Antimicrobial Resistance Surveillance Program (ARSP) data in our country with our results. In the ARSP data, *E. coli* rates of resistance against the fluoroquinolones and third generation cephalosporins (Ceftriaxone) are at 41% and 39% respectively. Resistance to carbapenems continue to rise with resistance rates to imipenem at 5%.[28] The *E.coli* isolates in our results have high resistance to ciprofloxacin (86.7%) but have low resistance (6.7%) to imipenem and 0% resistance to ceftriaxone. For *Klebsiella sp*, ARSP data reported a resistance rate of 11% for imipenem while in our results, *Klebsiella* had 0% resistance to imipenem. [28] ARSP report for *Pseudomonas aeruginosa* showed that carbapanem resistance was at 19% for imipenem.[28] *Acinetobacter baumanii* was reported to have more than 50% resistance to many antibiotics: piperacillin-tazobactam at 58%, imipenem at 56% and ciprofloxacin at 55%.[28] In our study, however, *Pseudomonas sp. and Acinetobacter* showed 0% resistance to piperacillin-tazobactam,

imipenem, amikacin, and ciprofloxacin. It should be noted that we only had 2 isolates for *Pseudomonas sp.* and 1 for *Acinetobacter baumanii*.

CONCLUSIONS AND RECOMMENDATIONS

The clinical and bacteriologic profile of neonatal sepsis is ever-changing and the most common risk factors for sepsis are low birth weight, maternal UTI, and PROM. Respiratory distress, fever, poor feeding, and irritability are the most common presenting manifestations and should prompt investigation and treatment. Predominant isolates seen were CONS, *E. coli* and *Klebsiella sp.* with resistance to first-line empiric antibiotics.

We recommend continuing studies on neonatal sepsis incidence, etiology and the changing patterns of antibiotic resistance. Periodic antibiotic susceptibility reviews in all health care facilities will greatly help in management and in decreasing rates of antibiotic resistance.

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