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Original Article

Paediatrics Section

Neonatal Sepsis in a Tertiary Care Hospital: Bacteriological Profile, Antibiotic Sensitivity Pattern and Outcome

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ABSTRACT

Introduction: Neonatal septicaemia refers to generalised bacterial infection confirmed by positive blood culture in the first 28 days of life and it is a leading cause of morbidity and mortality in the Neonatal Intensive Care Units (NICU) of India.

Aim: To isolate and identify the bacterial agents responsible for neonatal sepsis and to determine the antibiotic sensitivity patterns of isolates in a tertiary care hospital in Uttar Pradesh.

Materials and Methods: A total of 132 neonates (0 to 28 days) admitted to NICU with a diagnosis of probable sepsis were included. Informed consent obtained from their parents. Detailed history, general physical examination, demographics data, neonatal risk factors, and lab data including sepsis screen bacterial growth and antibiotic sensitivities patterns were studied and analysed. Results were analysed using MS Excel and group comparisons were done by applying chi-square test.

Results: Blood culture reports were positive in 57 (43.2%) neonates. In culture proven sepsis, 34 (59.6%) neonates had Early Onset Neonatal Sepsis (EONS) and 23 (40.4%) had Late Onset Neonatal Sepsis (LONS). Common clinical presentation of neonatal sepsis was breathing difficulty and refusal to feed. Most common maternal risk factor was prolonged rupture of membrane (>24 hours). Low birth weight and prematurity were important neonatal risk factors for sepsis. The most frequently isolated organisms in blood were gram negative bacteria (*Acinetobacter baumanii*- 21.1% and *Klebsiella pneumoniae*- 17.5%). Most of isolates showed high resistance to commonly used antibiotics such as penicillin/ampicillin, cefotaxime and amikacin.

Conclusion: Gram negative organisms were the most common cause of neonatal sepsis and majority of isolates were resistant to commonly prescribed antibiotics, which present a great threat to newborn survival, and thereby require rational antibiotic policy for NICU.

Keywords: Antimicrobial resistance, Bacteremia, Newborn, Septicaemia

INTRODUCTION

Neonatal septicaemia is a blood stream infection characterised by signs and symptoms of bacteremia, in the first 28 days of life and it is one of the leading cause of deaths in newborn, accounting for more than two lakh deaths globally every year [1]. Neonatal sepsis is grouped into two subtypes depending on onset of infection onset before 72 hours of life (EONS) or after 72 hours (LONS) [2]. The risk factors associated with neonatal sepsis are Low Birth Weight (LBW), preterm birth/prematurity, Prolonged Rupture of Membranes (PROM), foul smelling amniotic fluid, frequent per vaginal examination, maternal fever, superficial skin infection (pyoderma, umbilical discharge) and top milk feeding [3]. The causative organisms of neonatal sepsis in Low and Middle-Income Countries (LMICs) and High Income Countries (HICs) were different [4]. *Klebsiella pneumoniae* was reported most common pathogen pursued by *Staphylococcus aureus* and *Pseudomonas species*, in India (NNPD) [5]; while group B streptococci (GBS) was the commonest causes of EONS as well as LONS in developed countries [6]. The emergence of antibiotic resistance to commonly used antibiotics (ampicillin, amoxicillin/clavulanate, cefotaxime and aminoglycosides) lead to difficulty in the treatment of neonatal sepsis. Knowledge regarding most common organism causing neonatal sepsis and their Antimicrobial Resistance (AMR) pattern is mandatory to choose most appropriate first line antibiotic, So that early diagnosis and treatment will lead to decrease morbidity and mortality due to neonatal sepsis.

The varying microbiological profile of neonatal septicaemia in India indicates the need of annual review of bacteriological profile, antibiotics sensitivity patterns in all the neonatal intensive care units of India. Thus, the present study was done with the aim to know the changing trend of bacteriological profile and antibiotic sensitivity patterns of organism causing septicaemia in neonatal intensive care unit of tertiary care hospital Uttar Pradesh, India.

MATERIALS AND METHODS

This prospective study was conducted in the NICU under Department of Pediatrics, in a Tertiary Care Hospital, Moradabad (UP) between February 2018 to September 2019 year after obtaining approval from Ethics Review Committee (Ref.No-TMMC&RC/IEC/17-18/012). Neonates with at least one of the clinical features of sepsis (Refusal to feed, lethargy, respiratory rate >60/min, apnea, grunting, chest retraction, temperature instability such as hyperthermia or hypothermia, vomiting, abdominal distension, abnormal gastric residual, convulsion, hypotonia, irritability, pus draining umbilicus and bleeding diathesis) and/or newborn with at least two of the following risk factors such as maternal fever, foul smelling liquor, PROM, frequent (>3) clean vaginal examinations, single unclean vaginal examinations, very preterm (<34 wk), low birth weight (<2.5 kg) were enrolled in this study [2]. Minimum sample size was calculated using the formula $N=4PQ/d^2$. Enrolment of neonates was done after obtaining written informed consent from parents.

Demographic details were recorded in a pre-formed proforma along with detailed history and general physical examination followed by appropriate investigations (CBC, C-Reactive Protein (CRP), Blood culture). About 2 mL of blood was drawn by a venous puncture following strict aseptic precautions (3 swab technique) and aseptically inoculated into blood culture bottles. BACTEC system was used for blood culture and bacterial growth, Antibiotic sensitivity patterns were reported by the microbiologist. The isolated organisms were identified and tested for antimicrobial susceptibility patterns using Kirby-Bauer disc diffusion susceptibility method and clinical laboratory standards institute guidelines [2].

STATISTICAL ANALYSIS

Research data were entered sequentially in Microsoft excel spreadsheet and analysed in Statistical Package for Social Sciences (SPSS) Statistics V20.0. Group comparisons were done by applying χ^2 (chi-square test). Frequency and percentage were calculated. A p-value <0.05 was taken as significant.

RESULTS

During the study period, 132 neonates with probable sepsis were admitted in the NICU. Of the 132 neonates, 94 were inborn and 38 were outborn newborn. Age of newborns was reported to be 0-7 days among 72.7%, 8-14 days among 17.4%, 15-21 days among 7.6% and 22-28 days among 2.3% subjects. There were 68.2% males and 31.8% females. Caesarean delivery was done for 40.9% and normal delivery for 59.1% subjects. Home delivery was reported among 12.1% and hospital delivery among 87.9% subjects. Pre-term delivery was found among 73 (55.3%) and term delivery among 59 (44.7%) subjects [Table/Fig-1].

Characteristics		Categories	Frequency (%)
Age of newborns (Days)	0-7	96	72.7
	8-14	23	17.4
	15-21	10	7.6
	22-28	03	2.3
Gender	Male	90	68.2
	Female	42	31.8
Type of cases	Inborn	94	71.2
	Outborn	38	28.8
Type of delivery	NVD	78	59.1
	LSCS	54	40.9
Gestational age (wks)	<37 (PT)	73	55.3
	>37 (FT)	59	44.7
Low Birth weigh (<2.5 kg)	Yes	84	63.6
	No	48	36.4

[Table/Fig-1]: Demographic characteristics of neonates with probable sepsis (n=132).
*FT: Full term; PT: Preterm; NVD: Normal vaginal delivery; LSCS: Lower segment CS

Among, total enrolled neonates, difficulty in breathing were seen in 101 (76.5%) neonates as the main symptoms followed by, refusal to feed in 94 (71.2%), hypothermia in 62 (46.9%), lethargy in 56 (42.4%), jaundice (i.e., yellowish discoloration of eyes or skin) in 20 (15.2%), seizure and jaundice in 20 (15.2%), Vomiting in 14 (10.6%), fever in 12 (9.1%), cyanosis in 10 (7.5%), and GI bleeding in 7(5.3%) [Table/Fig-2].

PROM was the most common risk factor of neonatal sepsis with 65.9% babies followed by PPROM 73 (55.3%), frequent (>3) clean vaginal examination in 18 (13.6%), birth asphyxia in 12 (9.1%), maternal fever in 12 (9.1%) and maternal sepsis in 8 (6.1%), and foul smelling liquor in 4 (3.1%) [Table/Fig-3].

CRP was positive in 71(53.7%) neonates of the total of 132, of which 54 were culture positive, and 17 were negative. In 61 babies with negative CRP, 3 were culture positive and 58 were culture negative. C-reactive protein estimation was found to be a most useful screening test with 94.7% sensitivity, 77% specificity, 95% negative predictive value and 76% positive predictive value [Table/Fig-4].

Chief complaint	Onset of sepsis		Total frequency	Percentage
	EONS group	LONS group		
Difficulty in breathing	78	23	101	76.5
Refusal to feed	29	65	94	71.2
Lethargy	24	32	56	42.4
Vomiting	8	6	14	10.6
Jaundice	0	20	20	15.1
Cyanosis	8	2	10	7.5
Fever	0	12	12	9.1
Hypothermia	19	43	62	46.9
Seizures	0	20	20	15.1
GI bleeding	0	07	07	5.3

[Table/Fig-2]: Distribution of clinical presentation among the neonates with clinical sepsis (n=132).
GI: Gastrointestinal; EONS: Early onset neonatal sepsis; LONS: Late onset neonatal sepsis

Perinatal risk factors	No	Frequency (%)
Maternal fever	12	9.1
PPROM	73	55.3
PROM (>24 hour)	87	65.9
Birth asphyxia (Apgar score <3 at 5 minute)	12	9.1
Maternal sepsis	8	6.1
Foul smelling of liquor	4	3.1
Frequent (>3) clean vaginal examinations	18	13.6
Single unclean vaginal examination	0	0

[Table/Fig-3]: Distribution of perinatal risk factors among the neonates with clinical sepsis (n=132).
PPROM: Preterm premature rupture of membranes; PROM: Prolonged rupture of membranes

CRP	Blood culture	
	Positive	Negative
Positive	54 (94.7)	17 (12.9)
Negative	3 (5.27)	58 (87.1)
Total	57	75

[Table/Fig-4]: Correlation of CRP-positivity with Culture-positivity rate.
Chi-square value=6.709, p-value=0.001*; CRP: C-reactive protein

The mean hemoglobin level was 15.70±3.23, Total Leucocyte Count (TLC) was 12000±1342, Packed Cell Volume (PCV) was 47.34±11.91, Total Red Blood Cell Count (TRBC) was 5.92±9.01, Mean Corpuscular Volume (MCV) was 105.17±11.95, Mean Corpuscular Haemoglobin (MCH) was 34.05±3.39, Mean Corpuscular Haemoglobin Concentration (MCHC) was 31.91±3.40, Red blood cell Distribution Width (RDW) was 18.46±5.63 and Band cells was 8.20±5.14. White Blood Cells (WBCs) count was found to be normal among 73 (55.4%), high (>24000/mm^3) among 43 (32.5%) and low (<5000/mm^3) among 16 (12.1%) subjects.

Out of 132 neonates, 85(64.3%) presented with EONS and 47(35.7%) neonates presented with LONS. Only 57 (43.2%) had culture proven sepsis. In culture proven sepsis, 34(59.6%) neonates had EONS and 23 (40.4%) had LONS. Gram positive isolates and gram negative isolates accounted for (63.2%) and (38.8%) respectively. Of the 57 (43.2%) blood cultures positive sepsis, *Acinetobacter baumanii K. pneumoniae, Staphylococcus aureus, E Coli, Pseudomonas, MRSA, Enterococcus*, and *S. Pyogenous* were the predominant isolates as shown in [Table/Fig-5]. *MSSA* was relatively more common in LONS while *Acinetobacter baumanii* was more frequent in EONS. As not all isolates were tested for all antibiotics, number of samples tested for a particular antibiotic has mentioned in the [Table/Fig-6] along with percentage of resistance. All gram positive isolates were sensitive to vancomycin and linezolid. Most of gram negative isolates showed resistance to ampicillin, cefotaxime, and aminoglycosides. [Table/Fig-6] showed the details of the bacterial isolates and their antibiotics sensitivity patterns. Mortality was observed in 7 (5%) of the cases. Among the seven expired neonates, five (71%) had growth of Multidrug Resistance Organism (MDRO) [Table/Fig-7].

Organisms	Type of sepsis		Frequency of Isolation	Percent
	EONS	LONS		
Acinetobacter Baumanni	10	2	12	21.1
Klebsiella Pneumonae	8	2	10	17.5
Staph Aureus(MSSA)	2	5	07	12.2
Pseudomonas Species	4	3	07	12.2
E. Coli	7	3	10	17.5
MRSA	1	3	04	7.0
Coagulase negative staphylococci	1	3	04	7.0
Streptococcus Pyogenes	0	2	02	3.5
Enterococcus faecalis	1	0	01	1.7
Total	34	23	57	100

[Table/Fig-5]: Distribution of isolates in culture proven sepsis with their relative frequency (n=57).
*MSSA: Methicillin-sensitive *staphylococcus aureus*; MRSA: Methicillin-resistant *staphylococcus aureus; EOS:* Early onset neonatal sepsis; LOS: Late onset neonatal sepsis

CRP estimation was found to have a sensitivity of 94.7%, specificity of 77%, positive predictive value of 76% and negative predictive value of 95% in neonatal sepsis.

DISCUSSION

Septicaemia is a significant cause of morbidity and mortality in the newborns. It is estimated that three million newborns suffer from sepsis globally every year [7]. Despite advancement in hygiene, newer antimicrobial agents, and technology for rapid identification and treatment, neonatal sepsis remains one of the major causes of deaths in the newborns in LMICs [8].

Antibiotic	*Acinetobacter* (n=12)		*Klebsiella* (n=10)		*Staph aureus* (n=11)		*Pseudomonas* (n=7)		*E. Coli* (n=10)	
	R/R+S	R%	R/R+S	R%	R/R+S	R%	R/R+S	R%	R/R+S	R%
Cefotaxime	10/12	84	9/10	90	NT	-	6/7	85	8/10	80
Cefoxitin	NT		NT		5/11	45	NT		NT	
Ampicillin	12/12	100	10/10	100	10/11	91	7/7	100	6/10	60
Amikacin	12/12	100	7/10	70	3/11	27	5/7	71	9/10	90
Gentamycin	11/12	92	6/10	60	2/11	18	4/7	57	9/10	90
Pip-taz	8/12	67	3/10	30	NT	-	2/7	28	6/10	60
Oxacillin	NT	-	NT	-	5/11	45	NT	-	NT	-
Ciprofloxacin	4/12	33	3/10	30	4/11	36	3/7	42	5/10	50
Meropenem	2/12	17	0/10	0	NT	-	1/7	15	1/10	10
Vancomycin	NT	-	NT	-	0/11	0	NT	-	NT	-
Linezolid	NT	-	NT	-	0/11	0	NT	-	NT	-
Colistin	1/12	8	0/10	0	NT	-	0/7	0	0/10	0

[Table/Fig-6]: Antibiotics resistance patterns among the major isolates.
*Pip-Taz Piperacillin-Tazobactam, R Number of resistant isolates, R% Percentage of resistant isolates, S Number of susceptible isolates, NT Not tested
#Staph aureus include Both MSSA and MRSA

Outcome	Frequency (%)	Culture positive sepsis cases	Culture negative sepsis cases
Death	7 (5.3%)	7 (5.3%)	0
Recovered	125 (94.6%)	48 (36.4%)	73 (55.3)
LAMA	2 (1.5%)	02 (1.5%)	0
Total	132 (100%)	57 (43.2%)	75 (56.8)

[Table/Fig-7]: Clinical outcome of sepsis.
LAMA: Left against medical advice

The knowledge of current bacteriological profile of sepsis and patterns of antibiotic sensitivity in a geographic area is the basis of deciding empirical treatment of neonatal sepsis [9]. Blood culture positivity rate in NICU vary from center to center and time to time. It varies from 5% to 24% in the United States, 7% to 11% in Europe but in India, culture positivity rate ranged from 7.8% to 55.43% [10,11]. In this study, blood culture positivity rate among the neonates with probable sepsis was 43.2%, and almost similar results were also reported by various studies from India [7,12-15]. However, positivity rate in this study is high as compared to the results reported by Bhat YR et al., (17.8%), Jyothi P et al., (19.2%), Srinivasa S and Arunkumar D, (19.2%) Mehar V et al., (22.1%), Pavan Kumar DV et al., (26.2%) [16-20]. Difference in blood culture techniques and other factors like intrapartum antibiotic use, collection of blood sample after administration of antibiotic therapy, low grade bacteremia and infection with anaerobes decide culture positivity rate. Blood culture positive sepsis was mostly seen in neonates with birth weight less than 2.5 kg. The percentage of probable sepsis in LBW was 63.6%. Ghosh S and Basu G, and Thakur S et al., were also reported similar results [11,13]. The present study results are congruent with the available literature. In present study, respiratory distress was the commonest presentation followed by refusal to feed. Similar findings were also reported by Thakur S et al., Goyal M et al., [13,21]. Study by Galhotra S et al., showed hypothermia being the commonest symptom followed by respiratory distress [10]. Sethi AB et al., reported refusal to feed as leading symptom followed by respiratory distress [22].

The occurrence of EONS in India ranged from 10.4% to 75.0% [10]. The study found that EONS (59.6%) was more common than LONS (40.4%). Similar results were also reported by various studies from India [10-12,17,19,22-24]. On contrary, LONS was more common in studies done by Goyal M et al., [21]. Neonatal sepsis is an emergency of life-threatening nature. If treatment is delayed it may lead to significant morbidity and mortality. So that the knowledge of the prevailing micro-organisms as well as the antibiogram essential for initiating empirical antibiotic therapy while waiting for the blood-culture reports [25]. In South Asia region, gram negative bacteria (*Klebsiella* spp, *Escherichia coli*, and *Acinetobacter*) were the most frequently isolated organism causing sepsis in newborns [26,27]. In this study, the most common organism causing sepsis in newborns were gram negative bacteria. Similar results were also reported by different studies from India [11,12,14-19,21-24,26-35]. In contrast to present study, gram positive bacteria was the predominant pathogens in the few studies from India [10,13,20]. *Acinetobacter baumanii* (21.1%) followed by *Klebsiella pneumonia* (17.5%) were predominant gram negative bacteria isolated in this study. In contrast to this study, Nayak S et al., reported *Klebsiella* species followed by *Acinetobacter baumannii* were commonest gram negative pathogens isolated in blood culture [12]. Similar results were also reported by Delhi Neonatal Infection Study (DeNIS) where 75% of isolates were gram negative bacilli [26].

AMR is today a global problem and it is surging rapidly in India. Most of gram negative bacteria causing neonatal sepsis are now multidrug resistant [27]. There are certain risk factors for emergence of AMR such as irrational use of broad spectrum antibiotics, poor infection control practice, lack of antibiotics stewardship policy, lack of nurse patient ratio and overcrowding. Hence, in any NICU, it is very essential to have annual review to define the current bacteriological profile and their sensitivity pattern.

The antibiotic sensitivity pattern has been found to be different in various studies in different parts of the same region. In this study, antibiogram found that majority of gram negative bacilli and cocci were highly resistant to first line antibiotics such as ampicillin, amoxyclav, 3rd generation cephalosporins and aminoglycosides. That was similar to various studies from India, where the gram negative organisms showed a high degree of resistance to commonly used antibiotics [9,10-23,26,28-35]. In this study, colistin (100%) and meropenem (96.8%) were found to be most sensitive antibiotics for gram negative sepsis, while for gram positive sepsis, linezolid (100%) and vancomycin (100%) were found to be most sensitive antibiotics. Almost similar antibiotics sensitivity patterns were also reported by various studies from India [10,12-14,17-22,26,28]. A comparison of antibiotic sensitivity patterns of most common organism is presented in [Table/Fig-8].

In a similar study, reported by Galhotra S et al., were found all the gram positive isolates were sensitive to vancomycin and linezolid and all the gram negative isolates showed resistance to ciprofloxacin, cephalosporins, cotrimoxazole and aminoglycosides [10]. In another study, *Klebsiella pneumonia* were resistant to ampicillin (100%) ceftazidime (87%), ceftriaxone (87%), and cefepime, while 93% of the *Staphylococcus aureus* were sensitive to ciprofloxacin and 40%, 47%, and 73% were sensitive to erythromycin, clindamycin, and gentamycin, respectively [12]. Another study reported by Thakur S et al., were found high degree of resistance against penicillin (98%), amoxyclav (76%) and third generation cephalosporins in both gram positive and gram negative isolates [13]. Zakariya BP et al., were reported *Klebsiella pneumoniae* was resistant to most of the antibiotics tested except amikacin and meropenem [14]. Of the total 33 *Klebsiella pneumoniae* isolates, 16 (32.0%) were ESBL producers. Jyothi P et al., also observed the similar analysis of drug resistance pattern among gram negative isolates, 97% were resistant to ampicillin and lowest to imipenem (7%), among

S. No	Author	Place	Year	Most common Organism	Antibiotic sensitivity Patterns
1	Galhotra S et al., [10]	Ludhiana, Punjab	2015	*Staphylococcus aureus*	Vancomycin (100%) Linezolid (100%)
2.	Nayak S et al., [12]	Mengalore, Karnataka	2014	*Klebsiella pneumoniae*	Imipenem (52%) Piperacillin+Tazo (39%)
3.	Thakur S et al., [13]	Tanda, Himachal Pradesh	2016	*Staphylococcus aureus*	Vancomycin (100%) Amoxyclav (34%)
4	Zakariya BP et al., [14]	JIPMER, Puducherry	2011	*Klebsiella pneumoniae*	Amikacin (100%) Meropanem (100%)
5.	Jyothi P et al., [17]	RIMS, Karnataka	2013	*Klebsiella pneumoniae*	Imipenem (93%) Amikacin (52%)
6.	Srinivasa S and Arunkumar D, [18]	North India	2014	*Staphylococcus aureus*	Vancomycin (100%) Linezolid (100%)
7.	Mehar V et al., [19]	Indore, Madhya Pradesh	2013	*Staphylococcus aureus*	Vancomycin (100%) Linezolid (100%)
8.	Pavan Kumar DV et al., [20]	Tamilnadu, South India	2017	*Staphylococcus aureus*	Meropanem (100%) Amikacin (100%)
9.	Goyal M et al., [21]	Jaipur, Rajasthan	2018	*CoNS*	Vancomycin (96.7%) Polymyxin B (100%)
10.	Sethi AB et al., [22]	Hyderabad, Telagana	2018	*Klebsiella Pneumoniae*	Meropenem (88.5%) Amikacin (73.5%)
11.	Delhi Neonatal Infection Study (DeNIS) [26]	New Delhi	2016	*Acinetobacter baumanii*	Carbepenems (22%) Cephalosporins (62%)
12.	Roy MP et al., [28]	VMMC, New Delhi	2017	*CoNS*	Vancomycin (84.8%)
13.	Present study	Moradabad, Uttar Pradesh	2019	*Acinetobacter baumanii*	Meropenem (83.4%) Colistin (92.7%)

[Table/Fig-8]: Comparison of antibiotic sensitivity patterns of organisms among Indian studies [10, 12-14,17-22, 26 28].
*CONS: Coagulase-negative *staph aureus*

gram positive isolates, high resistance was seen to penicillin (90%), cloxacillin (84%), and amoxiclav (76%) [17]. Srinivasa S and Arunkumar D, studied that gram positive bacteria showed good sensitivity to higher antibiotics such as vancomycin, linezolid and poor sensitivity to ampicillin, while gram negative bacteria showed good sensitivity to amikacin, gentamycin [18]. Goyal M et al., reported majority of gram negative bacteria were sensitive to polymycin B (100%), colistin (96.27%), meropenem (88.88%) and imipenam (81.48%) [21]. Recently a large cohort was reported by DeNIS collaboration high degree of AMR, not only to commonly used antibiotics but also to reserve antibiotics such as extended-spectrum cephalosporins and carbapenems [26].

Now-a-days, this situation is alarming because these are reserve antibiotics. If rational antibiotics policy are not followed and continue using these last line antibiotics (meropenem, colistin, linezolid, vancomycin), multi drug resistance organisms will naturally develop against these antibiotics. For prevention of neonatal infection, strict infection control practices and rational antibiotics policy of NICU should be followed. Out of 132 neonates with clinical/probable sepsis, 48 (36.4%) neonates discharged, 2 (1.5%) Left Against Medical Advice (LAMA) and 7 (5.3%) newborns expired due to blood culture positive sepsis.

Limitation(s)

The limitations of this study were small sample size and study has enrolled neonates which were only admitted to tertiary care hospital, Moradabad. Future research should covered suspected neonates from different institute of Uttar Pradesh to determine overall antibiotic sensitivity patterns.

CONCLUSION(S)

The study found most of gram negative bacilli and gram positive cocci showed high degree of AMR to commonly used empirical antibiotics. Based on the findings, a combination of ciprofloxacin and gentamycin was suggested as a first line empirical antibiotics, and a combination of Meropenem and Vancomycin (if *MRSA* suspect) as a 2nd line would be most appropriate antibiotics for EONS. Rational antibiotic therapy, strict infection control practice, timely escalation/de-escalation of ongoing antibiotics, and early identification of at high risk infants is essential to reduce the neonatal mortality rate due to sepsis.

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