PEDIATRICS

Identification of potential risk factors for the poor prognosis of neonatal sepsis

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Abstract

Background and aim. Risk factor-based approach is one of the best approaches employed by middle income countries which are not well facility driven for any disease management. Thus, through this approach, we aim to identify the potential risk factors responsible for the poor outcome in neonatal sepsis.

Methods. A case control was conducted retrospectively with neonates admitted to Neonatal Intensive Care Unit during January 2012 to December 2016. Cases were identified using ICD-10 Code from inpatient medical records and demographic, maternal and neonatal details were collected from the medical files. Logistic regression was performed to identify the risk factors associated with mortality in neonatal sepsis.

Results. A total of 613 neonates were found to have culture positive sepsis from the 4690 neonates admitted in the Neonatal Intensive Care Unit (NICU). There was a total of 831 episodes in the 613 neonates. The mortality rate in neonates with sepsis was found to be 25.4%. Extremely low birth weight (OR 6.171, CI 3.475-10.957), extreme preterm (OR 5.761, CI 2.612-12.708), very preterm (OR 2.548, CI 1.607-4.042), preeclampsia (OR 1.671, CI 1.091-2.562), acute renal failure (OR 4.939, CI-2.588-9.426), coagulopathy (OR 2.211, CI-1.486-3.289), septic shock (OR 173.522, CI-23.642-1273.59), thrombocytopenia (OR 5.231, CI-3.310-8.268), leukopenia (OR 2.422, CI- 1.473-3.984), CRP > 24 (OR 2.099, CI-1.263-3.487) and abnormal absolute neutrophil count (OR 2.108, CI-1.451-3.062) were some of the significant predictors, identified through risk-based approach, in assessing mortality in neonatal sepsis.

Conclusion. Risk-based approach applied was successful in determining plausible important predictors such like extreme low birth weight, extreme preterm, resistance against gram negative infections, preeclampsia, septic shock, hypotension, leukopenia, neutropenia, thrombocytopenia in predicting mortality in neonatal sepsis. These potential risk factors, identified through risk- based approach, can play a pivotal role in assisting clinician to make appropriate and judicious decision.

Keywords: neonatal sepsis, risk based approach, mortality, logistic regression

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Background and aim

Worldwide, neonatal sepsis is one of the predominant reasons for mortality and morbidity in children [1]. About 40% of the childhood mortality is conferred by neonatal sepsis alone [2]. The Million Death Study of India has also reported that, 78% of neonatal deaths are due to low birth weight and prematurity and neonatal infections which includes sepsis and birth asphyxia accounting for 0.27 million or 27% of all death [3]. One of the major impediments in the poor prognosis of neonatal sepsis is its unspecific sign and symptoms, which eventually affects the management of the disease leading to poor outcome [4]. This is clearly reflected in slow decrease rate of Neonatal Mortality Rate (NMR) of India, which has impeded in accomplishing the Millennium Development Goal -4 (MDG-4) by 2015 [5]. Even though real time- polymerase chain reaction (RT-PCR) based method is now growing as a novel procedure for quick detection of sepsis, still blood culture reports remain the only option left for the confirmation of the disease in many clinical settings, which basically takes 48 hours for generating the results [6]. Moreover, such results are also at a risk of showing false positive or false negative report after exposure of antenatal antibiotic [7]. Culture report-based approach appears to be little difficult in developing country like India, where most district hospitals are not well facility driven [8]. Thus, there is a need to glance at the various other approaches to combat the poor outcome in neonatal sepsis.

Risk factor-based approach is one of such approaches which can be applied to combat the situation [9]. It is a type of method which aims at recognizing the critical risk in a study setting and fixing them in first concern to avoid potential effect [10]. This method is applied in many clinical settings and is also considered as one of the best measures in high income countries for reducing mortality in early onset sepsis [11]. Early and fast identification of the risk factors through this approach in neonatal sepsis, will help in reducing the mortality and morbidity of the neonates, thus making the management of disease less burdensome [12]. Evidence generated by this approach can aid in developing integrated prevention strategies and management guidelines for the disease [7,13]. There were no to very few studies from Indiaavailable pertaining to this approach and most of which had not accounted for potential risk factors [14,15]. Moreover, those available studies had not taken nosocomial sepsis into consideration [16,17].

Based on the above reason, we aim to conduct our study for identification of prominent risk factors associated with mortality in neonatal sepsis and thus, generate local data pertaining to the demography and prognosis of early-onset, late-onset and nosocomial sepsis. Additionally, results produced by our study through this approach will allow the health care professionals and policy makers to frame and design corrective and preventive measures for better management of disease, especially in developing countries like India.

Methods

Study population and design

Case control study was designed which included neonates admitted from January 2012 to December 2016 at the level 3 Neonatal Intensive Care Unit (NICU) of a tertiary care university-affiliated hospital in Karnataka, India. Data were retrospectively captured after receiving institutional ethics committee approval for the study protocol. Sepsis was confirmed by microbial isolation in blood sample and neonates with age less than 30 days at first confirmed culture were included in the study. Patients who died because of neonatal sepsis were considered as cases while those who did not die due to neonatal sepsis were considered as controls. Furthermore, neonates with positive culture sepsis were screened and categorized into either early onset/ late onset/nosocomial infected.

Data collection

Basic demographic details of both neonate and mother, clinical variables, neonatal interventions used, laboratory investigations, neonatal complications, antenatal risk factors and patient outcome were collected from the files. Furthermore, date of discharge or death was also collected for each neonate. Variables captured from the files were then categorized into neonatal, maternal and others.

Neonatal variables included: demographic details like birth weight, gestational age, gender, mode of delivery (vaginal delivery/ Caesarean section), place of birth (inborn/out-born). Furthermore, neonatal complication like respiratory distress syndrome (RDS), Fetal distress, Meconium aspiration syndrome (MAS), seizures, birth asphyxia, were also comprehended under neonatal variable category. Apart from this, complications such as increased respiratory efforts which include strider grunting and nasal flaring, coagulopathy resulting in impaired clot formation due to derangement of homeostasis resulting in excessive bleeding or clotting with International Normalized Ratio (INR) of ≥0.5, Prothrombin time (PT) ≥ 17seconds and Activated Partial Prothrombin Time (APTT) ≥60 seconds, acute renal failure, pulmonary and intracranial haemorrhage, septic shock were also embodied as risk factors. Furthermore, type of infection (early/late/ nosocomial) was also considered to analyze the magnitude of each infection in neonates, with early onset infection being the reference category. Meanwhile, length of stay, age at admission and Apgar score at 1 min and 5 min were also noted.

Birth weight was divided into four categories i.e., extremely low-birth weight (<1000 g), very low-birth weight (1001-1500 g), low birthweight (1501-2500 g) and normal (>2500 g), with normal birth weight being the reference category for analysis.

Similarly, gestational age was also further classified into extremely preterm (<28 weeks), very-preterm (28-31 weeks), moderately pre-term (32-34 weeks), late-preterm (35-36 weeks) and full term (37 and above weeks), with

full term being the reference category for analysis.

Cases were categorized as early onset, late onset, and nosocomial based on the following definition:

- **Early onset:** sepsis occurring within 72 hours of birth [1,4]
- **Late onset:** sepsis occurring after 72 hours of birth which may or may not be preceded by one sterile sample [1,4]
- **Nosocomial:** Positive culture sample being compulsorily preceded by at least one sterile sample culture after 72 hours of birth. It is also known as health care acquired sepsis [1,4,18].

Maternal variables includes: Antenatal risk factors like Prolonged premature rupture of membranes (PPROM), Premature vaginal Leaking/ Bleeding, Pregnancy Induced Hypertension (PIH), Gestational Diabetes (GDM), abnormal amniotic fluid, maternal infection like Urinary tract infection (UTI) and respiratory-tract infection (RTI). In contrast to all the maternal variables, breast feeding was also considered as one of the variables, which was anticipated to show protective effect on the outcome measure.

Other variables includes: Neonatal interventions like Mechanical Ventilation (MV), Continuous positive airway pressure (CPAP), central line catheter, surfactant use, surgical procedure and transfusion whereas laboratory investigations such as thrombocytopenia (Platelet count <30,000), leukopenia (White blood cell- WBC count <5000), C - reactive protein (CRP >15 mg/dL), abnormal Absolute neutrophil count (ANC) (Normal- 4000-14000 neutrophils/ μL) were also included as risk factors for mortality in neonatal sepsis.

Outcome measures

Mortality due to sepsis was the primary outcome measure of the study.

Data analysis

Continuous variables were expressed as mean±SD and categorical variables as frequency and percentage. Binomial logistic regression was used to calculate Odds Ratio (OR) thus, identifying the factors associated with mortality in neonatal sepsis patients. For the three categorical variables i.e., type of infection, birth weight category and gestational age category, early onset infection, normal birth weight (>2500 g) and full-term infants (gestational age 37 weeks and above) were taken as reference categories respectively. Statistical significance of Apgar score between neonates who survived and died was calculated using Mann-Whitney test. A p value of <0.05 was considered as statistically significant and the data analysis was performed using Statistical Package for the Social Sciences (SPSS) version 20.0 (IBM Corp. IBM SPSS Statistics for Windows, Armonk, NY).

Ethical consideration

The ethical approval for the study was obtained from Institutional Ethics Committee, (IEC Project number: 54/2017) before commencing of the data collection procedure.

Results

General demographic features

A total of 613 neonates were found to have positive culture sepsis from the 4690 neonates admitted in the NICU, with 133 early onset, 294 late onset and 186 nosocomial infected categories respectively. A total of 831 episodes was found in whole 613 neonates, indicating towards more than one episode in some of the neonates. The rate of sepsis was found to be 9.57/100 neonates for inborn and 15.98/ 100 neonates for out born. The total rate of sepsis in the NICU was 13.07/ 100 neonates with mortality rate of 25.4%.

The mean age of neonates at admission was found to be 3.95 ± 6.6 days. 42% (258 neonates) of infection were diagnosed in the first week of birth with the rest being diagnosed after 7 days. The entire study population totalled to 14,308 follow-up days. The length of stay for the infected neonates in the NICU was found to be 23.34 ± 18.98, with a range varied from 0-192 days while the mean maternal age was 27.22 ± 4.31 with a range of 18-44.

The Apgar score at 5 minutes between neonates who died and those who survived was 7.86 ± 1.66 and 8.33 ± 1.35 respectively was found to be statistically significant with p = 0.033. The length of stay in hospital also differ significantly (p <0.001) between neonates who died and those who survived i.e., 40.96 ± 6.62 and 44.04 ± 5.2 respectively.

The general demographic features of the study population with number of neonates having sepsis is shown in table I.

Neonatal variables contributing to mortality in neonatal sepsis

Binomial logistic regression was performed to identify the neonatal factors associated with mortality in neonatal sepsis. It is contemplated that four demographic neonatal variables i.e., extreme low birth weight (OR 6.171, CI-3.475-10.957, p<0.001), extreme preterm (OR 5.761, CI-2.612-12.708, p<0.001) and very preterm (OR 2.548, CI- 1.607-4.042, p<0.001), inborn (OR 1.962, CI- 1.349-2.853 had shown statistically significant association with mortality while gender, mode of delivery had not much significant association. Similarly, nosocomial infection (OR 2.72, CI- 1.687-4.385, p<0.001) had also shown significant association with mortality when compared with late onset while keeping early onset as the reference category.

Neonatal complications such as increased respiratory effort (OR 2.416, CI-1.635-3.572, p<0.001), hypotension (OR 31.435, CI-17.984-54.947, p<0.001), intracranial hemorrhage (OR 2.534, CI-1.219-5.271, p=0.010), pulmonary hemorrhage (OR 23.703, CI-8.146-68.975, p<0.001), had shown higher odds of mortality in neonatal sepsis when compared to those lacking it. Additionally, acute renal failure (OR 4.939, CI-2.588-9.426, p<0.001), coagulopathy (OR 2.211, CI-1.486-3.289, p<0.001), septic shock (OR 173.522, CI-23.642-1273.59, p<0.001) had also shown similar kinds of results.

Table I. Demographical data of the neonates having sepsis (early/late/nosocomial infected).

Parameters	Early onset[a,b]	Late onset[a,b]	Nosocomial[a,b]	Total
Number of episodes	144 (17.3)	392 (47.2)	295 (35.5)	831
Number of infants	133 (21.69)	294 (47.96)	186 (30.34)	613
Place of birth				
• Inborn	36 (26.9)	71 (24.3) 223 (75.7)	95 (51.5)	202 (32.95)
• Out born	97 (73.1)		91 (48.5)	411 (67.05)
Gender		185 (63)		
• Male	80 (60.2)	109 (37)	111 (60.2)	376 (61.33)
• Female	53(39.8)		75(39.8)	237 (38.66)
Birth weight				
• ELBW	10 (7.51)	23 (7.82)	24(12.90)	57 (9.29)
• VLBW	18 (13.53)	53 (18.02)	52 (27.95)	123 (20.06)
• LBW	52 (39.07)	93 (31.63)	85 (45.69)	230 (37.52)
• Normal	53 (39.84)	125 (42.51)	25 (13.44)	203(33.11)
Gestation age				
• EP	6(4.5)	9 (3.06)	17 (9.13)	32 (5.22)
• VP	19 (14.28)	54 (18.36)	67 (36.02)	140 (22.82)
• MP	21 (15.78)	36 (12.24)	24 (8.16)	81 (13.21)
• LP	12 (9.02)	18 (6.12)	13 (6.98)	43 (7.01)
• Term	75 (56.39)	186 (63.26)	65 (34.94)	326 (53.18)
Mode of delivery				
• NVD	60 (45.11)	97 (32.99)	74 (39.78)	231 (37.68)
• LSCS	73 (54.88)	197 (67.00)	112 (60.21)	382 (62.31)
Outcome				
• Alive	108 (81.20)	237(80.62)	113 (60.76)	458 (74.71)
• Death	25 (18.79)	57 (19.38)	73 (39.24)	155 (25.28)

a= total number, b= percentage in bracket ()

ELBW- Extremely low birth weight, EP- Extreme Preterm, LBW- Low Birth Weight, LP- Late Preterm, LSCS- Lower Segment Caesarean Section, MP- Moderate Preterm, NVD- Normal Vaginal Delivery, VLBW- Very Low Birth Weight, VP- Very Preterm.

Table II. Binomial logistic regression analysis of neonatal risk factors affecting mortality in neonatal sepsis.

Factors	P value	Odds ratio (OR)	95% CI
Birth weight#			
ELBW	0.0001*	6.171	3.475-10.957
VLBW	0.104	1.544	0.915-2.604
LBW	0.428	0.819	0.500-1.342
Gestational age€			
EP	0.0001*	5.761	2.612-12.708
VP	0.0001*	2.548	1.607-4.042
MP	0.880	1.047	0.573-1.915
LP	0.272	0.654	0.306-1.395
Gender			
Male	0.711	0.932	0.643- 1.352
Mode of delivery			
NVD	0.101	0.728	0.498- 1.064
Place of delivery			
Inborn	<0.001*	1.962	1.349- 2.853
RDS	0.094	2.971	1.435- 5.912
MAS	0.298	0.542	0.601-1.743
Birth asphyxia	0.539	0.831	2.894-5.936
Fetal distress	0.342	1.321	0.564-3.991
Increased respiratory efforts	<0.001*	2.416	1.635-3.572
Hypotension	<0.001*	31.435	17.984- 54.947
Intracranial hemorrhage	0.010*	2.534	1.219- 5.271
Pulmonary hemorrhage	<0.001*	23.703	8.146- 68.975
ARF	<0.001*	4.939	2.588- 9.426
NEC	<0.001*	22.550	9.284-54.770
Coagulopathy	<0.001*	2.211	1.486-3.289
Septic shock	<0.001*	173.522	23.642-1273.59

*= significance, # compared to normal, € compared to full term, ν compared to early onset infection

CI- Confidence Interval, ARF- Acute Renal Failure, EP- Extreme Preterm, ELBW- Extremely low birth weight, LBW- Low Birth Weight, LP- Late Preterm, MAS- Meconium aspiration syndrome, MP- Moderate Preterm, NEC- Necrotizing Enterocolitis, NVD- Normal Vaginal Delivery, RDS- Respiratory Distress Syndrome, VLBW- Very Low Birth Weight, VP- Very Preterm, T-Term.

Table III. Binomial logistic regression analysis of maternal risk factors affecting mortality in neonatal sepsis.

Factors	P value	Odds ratio (OR)	95% CI
PPROM	0.730	0.901	0.498- 1.631
PV Leaking/ bleeding	0.729	0.920	0.575- 1.474
Abnormal amniotic fluid	0.827	1.060	0.627- 1.793
PIH	0.018*	1.671	1.091- 2.562
GDM	0.086	0.297	0.068- 1.291
Breast feeding	0.001*	0.3	0.182- 0.494
Maternal infection	0.638	1.211	0.545- 2.688

*= significance

CI- Confidence Interval, GDM- Gestational Diabetes Mellitus, PIH- Pregnancy induced hypertension, PPROM- Prolonged Premature Rupture of Membrane, PV- Premature Vaginal.

However, neonatal complications such as RDS, birth asphyxia, fetal distress, MAS had failed to show any significant association with neonatal sepsis mortality. All these neonatal risk factors are shown in table II.

Maternal variables contributing to mortality in neonatal sepsis

Two out of seven maternal risk factors had shown eloquent results in terms of mortality in neonatal sepsis. Pregnancy induced hypertension maternal risk factor have 1.671 times increased chances of getting mortality when compared to those mothers who did not have it (OR 1.671, CI-1.091- 2.562, p=0.018). Similar kind of results was shown by maternal infection which includes urinary tract infection and respiratory tract infection as risk factor (OR 1.211, CI- 0.545- 2.688), but with no significance i.e., p=0.638. However, breast milk as anticipated had shown protective effect against mortality in neonatal sepsis (OR 0.3, CI-0.182-0.494, p<0.001) (Table III).

Other variables contributing to mortality in neonatal sepsis

Identification of potent other risk factors which includes both neonatal intervention and laboratory parameters/ sepsis biomarkers was also performed by binomial logistic regression to find out their association with mortality and was observed that almost all the variables categorized under neonatal interventions i.e., mechanical ventilation, Continuous Positive Airway Pressure (CPAP), central line catheter, surfactant, transfusion had shown significant results in terms of association with mortality. Meanwhile variable surgery had shown no association with mortality in neonatal sepsis. Similarly, laboratory parameters/ sepsis biomarkers suchlike as thrombocytopenia (platelet count <30,000) (OR 5.231, CI-3.310-8.268, p<0.001), leukopenia (WBC < 5000) (OR 2.422, CI-1.473-3.984, p<0.001), CRP > 24 (OR 2.099, CI-1.263-3.487, p=0.04) and abnormal absolute neutrophil count (OR 2.108, CI-1.451-3.062, p<0.001) had also showed similar results as that of neonatal interventions. Among all the sepsis biomarkers, thrombocytopenia has the strongest association with mortality in neonatal sepsis with OR of 5.231 (Table IV).

Table IV. Binomial logistic regression of neonatal interventions and laboratory parameters/sepsis biomarker affecting mortality in neonatal sepsis.

Factors	P value	Odds ratio (OR)	95% CI
Mechanical ventilation	<0.001*	12.239	7.632-19.627
CPAP	<0.001*	2.017	1.385-2.937
Peripheral line catheter	<0.001*	3.182	1.926-5.255
Surfactant	<0.001*	2.925	1.865-4.586
Surgical procedures	0.817	1.058	0.657-1.702
Transfusions	<0.001*	5.824	3.934-8.623
Platelet count <30,000	<0.001*	5.231	3.310-8.268
Leukopenia (<5000)	<0.001*	2.422	1.473-3.984
CRP > 24	0.004*	2.099	1.263-3.487
ANC abnormal	<0.001*	2.108	1.451-3.062

ANC- Absolute Neutrophil Count, CI- Confidence interval, CPAP- Continuous Positive Airway Pressure, CRP- C Reactive Protein.

Microorganisms contributing to mortality in neonatal sepsis

56% of the cases in our study is encountered due to gram negative organisms while the rest were by gram positive organisms. Based on the observation, it was concluded that gram positive infection was more common during the early onset infections accounting for 70% together, whereas late and nosocomial infections were majorly encountered by gram negative organism, together reckoning for 80% of the infections.

Discussion

Rapid diagnosis and relevant treatment are the key to decrease mortality in neonatal sepsis. India, being a developing country, lacks a lot of highly sophisticated facility driven health care system when compared to that of other well-developed countries, thus opting for the novel "risk-based approach" for reducing mortality in neonatal sepsis. Thus, identifying prominent risk factors associated with mortality in neonatal sepsis, through this approach, becomes very crucial in this venture. Therefore, our study

was conducted to determine varied neonatal, maternal, and other risk factors contributing towards neonatal sepsis mortality which in turn will contribute to tackle the burden of disease and its complications. Many studies conducted earlier had clearly distinguished between early and late onset sepsis, however, have not reported nosocomial sepsis in their analysis, perhaps including hospital-borne infections as a part of late onset infections itself [19-22]. However, we have focused on clearly delineating these very different kinds of infections.

Thus, the current research article illustration was based on the foundation of three divisions i.e., neonatal, and maternal predictors assessed compared with other studies, secondary findings, and implication of the study in research.

Neonatal and maternal predictors assessed compared with other studies

Studied results disport that inborn neonate was found to be at greater risk of mortality than that of out born. As neonatal survival is of utmost priority in child health, governments have incentivized institutional deliveries especially for high-risk births [20,23]. Our hospital being the only level 3 NICU in the region, many high-risk neonates were admitted or are born thus, contributing to the higher mortality rate.

The lack of protective maternal antibody, underdeveloped innate immunity, and easily damaged skin, makes the preterm neonates prone to higher risk of infection [24] which can be confirmed in our analysis.

Study conducted by Coggins et al showed that neonates having late onset sepsis with renal complications had higher odds of mortality when compared to those without it. Moreover, renal complication severity increased within 7 days of sepsis evaluation and had showed increased 30 days of mortality [25]. Similar kind of trend was also observed in our research.

Predictive monitoring of physiological changes is required for early detection of necrotizing enterocolitis for neonates suffering from sepsis thus, preventing their progression into septic shock. Fourfold increase in the mortality rate is seen in patients (specially in low birth weight) with complications like septic shock [26]. Result found in our study had also rendered similar findings, where greater odds of mortality were found in sepsis patients with necrotizing enterocolitis and septic shock as complications.

Likewise, pregnancy induced hypertension (PIH) in the mother was also found to be associated with neonatal sepsis and mortality [27-29]. Babies born to mothers with PIH before 37 weeks of gestation have a statistically significant lower birth weight than their counterparts from normotensive mothers [29]. Analogous kind of results were found in our research where, PIH was one of the prominent maternal risk factors for mortality in neonatal sepsis patients.

Distressingly, breast feeding showed a statistically significant protective effect for survival in neonates with sepsis which is in accordance with the results obtained from recent meta-analysis study. Exclusively breast feed neonates during their first few days of life had shown significantly lower risk of having sepsis and thus minimal risk of undergoing mortality [30].

Thus, the identified key neonatal and maternal risk predictors can be utilized to frame a considerate preventive strategy for controlling mortality in neonatal sepsis patients.

Secondary findings

Neonatal intervention suchlike blood transfusion, central catheter line, mechanical ventilation was known to increase central line blood stream infection (CLABSI) thus resulting in elevated morbidity and mortality in neonates [31,32] which was like our research findings. Laboratory parameters like leukopenia, neutropenia was associated with higher odds of early onset neonatal sepsis and mortality in preterm birth [33]. Similarly, thrombocytopenia in neonatal sepsis increased the mortality rate by 4 folds, with an additional six folds increase in case of gram-negative sepsis [34]. Outcome obtained from our study was in concordance to the fact given.

Compared to early and late onset sepsis, nosocomial infections showed a statistically significant higher risk of death which is comparable to the data reported from the developing countries i.e., hospital acquired neonatal infection rates are 3-20 times higher in developing than data reported from developed countries [35,36]. Disparity in surveillance, lack of infrastructure, lack of trained personnel can be considered as the major factors contributing towards nosocomial infections. However, development of infection control departments, antibiotic stewardship programmer can be considered for tailoring this issue in developing and low-income countries [37,38].

Resistant gram-negative organisms are often the primary cause of nosocomial infections in preterm neonates, resulting in higher mortality. The distribution of microorganisms in our study was found to be similar to data obtained from other developing countries [34], with notable differences being lower *Staphylococcus aureus*, *Pseudomonas* and *E.coli* infections [22]. The rate of *Cougulase Negative Staphylococcus (CoNS)* infections in our setting was also high as compared to developing countries. This high preponderance is usually seen in developed countries or where NICU's have adopted sophisticated care especially for very low birth weight neonates and thus, can be considered as contaminants in our study [22].

Thus, findings from our study clearly indicate that, apart from keeping an eye on CLABSI, nosocomial infection should be taken into consideration for reducing the burden of the disease.

Implication of the study in research

Results obtained from our study will help in identifying and providing correct weightage to the foremost

important predictors responsible for poor prognosis in neonatal sepsis and thus, can assist clinician in providing legitimate and judicious treatment to the patients for proper management of the disease. Risk score generation and stratification of the patients is another aspect of implication of the study which can play a significant part in the formation of management strategies and guidelines for the disease. Moreover, the current research finding will generate various novel multifarious pathways for the young researchers and investigators to explore in the field of neonatal sepsis domain.

Thus, findings obtained from our research confirm that, risk-based approach can be considered as a novel and effective approach in managing the burden of neonatal sepsis especially in developing countries like India. However, further extensive research is still required for identifying various other potential risk factors related to neonatal sepsis mortality in the years to come, with putting more emphasis on nosocomial infections, thus greatly supporting in formation of management guidelines and strategies across the globe.

Limitation of study

Effect of certain demographic factors such as educational status of mother, socio-economic factors such like income level, source of income, environmental factors such as availability of water and sanitation and housing conditions and maternal nutritional status are some of the key determinants in analyzing the poor outcome in neonatal sepsis. Failing to consider, these determinants can be a shortcoming of the study.

Conclusion

Risk- based approach applied was successful in determining plausible important predictors for assessing poor outcome in neonatal sepsis. Extreme low birth weight, extreme preterm, pregnancy induced hypertension, necrotizing enterocolitis, septic shock, hypotension, leukopenia, neutropenia, thrombocytopenia, central venous catheter line, blood transfusion was some of the major potential risk factors contributing towards mortality in neonatal sepsis. However, breast feeding practices had shown protective effect against it. These potential risk factors, identified through risk- based approach, can play a pivotal role in assisting appropriate and judicious decision making for clinicians. Aggressive and costlier treatment can be provided to the patients who are at a higher risk of getting mortality, thus moving towards better outcome. However, comprehensive amount of research is still required to acknowledge, risk-based approach as only exclusive method for disease management.

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