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Original Research Article

Clinicoetiological Study of Shock in Neonates Admitted in NICU and their Immediate Outcome

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Abstract

Shock represents a complex condition characterized by the acute failure of the circulatory system, leading to compromised tissue and organ perfusion. This results in an imbalance between the demand and supply of oxygen and nutrients. The incidence of neonatal shock in India is 16 per 1000 live births, and globally it is 10 per 1000 live births. Mortality in neonatal intensive care units is frequently attributed to shock-related complications and multiorgan dysfunction syndrome (MODS). A prospective observational study was carried out from October 2018 to September 2020 in the NICU Department of Pediatrics, conducted in ASRAM hospital, Eluru, Andhra Pradesh. Results showed that majority (86%) of the neonates with shock was of below 7 days age. The type of shock in 34 cases out of 50 (68%) was distributive shock. 14 cases had hypovolemic shock and 2 had obstructive shock. Ventilator support was needed in 36% of cases and continuous positive airway pressure was given to 28% cases.

Introduction

Shock represents a complex condition characterized by the acute failure of the circulatory system, leading to compromised tissue and organ perfusion. This results in an imbalance between the demand and supply of oxygen and nutrients. The widespread reduction in effective tissue perfusion causes inadequate delivery of oxygen and nutrients, ultimately leading to altered cellular and subcellular functions. This, in turn, triggers anaerobic metabolism, lactic acid accumulation, cellular damage, multi-organ dysfunction syndrome, and, ultimately, cardiovascular failure and organismal death.[1,2] Adequate tissue perfusion relies on three key factors: cardiac output, maintenance of vasomotor tone in local vascular beds, and the blood's ability to deliver oxygen and remove metabolic wastes. Oxygen delivery to cells depends on the oxygen content in the blood, primarily bound to hemoglobin. The respiratory system regulates hemoglobin's oxygen-binding capacity, while the cardiac output, mean arterial pressure, peripheral vascular resistance, and oxygen extraction/consumption rate at the cellular/tissue level collectively determine oxygen transport in the blood. Arterial oxygen content is determined by oxygen combined with hemoglobin in red blood cells (RBCs).[3,4] The oxygen carried by RBCs plays a crucial role in the oxygen delivery equation. Hypoxia, characterized by low oxygen levels in tissues, can result from insufficient oxygen supply, uneven distribution, or an inability to consume oxygen. Hypoxemia or respiratory failure, causing low oxygen levels in the body, is distinct from shock, which involves the exchange of gases in target organs and tissues.[5,6] The relationship between shock and hypoxia is intricate, with overlapping etiology and treatment strategies. In neonatal care, shock poses a significant clinical challenge, often arising from various causes, with sepsis being a primary contributor.7,8 The incidence of neonatal shock in India is 16 per 1000 live births, and globally it is 10 per 1000 live births. Mortality in neonatal intensive care units is frequently attributed to shock-related complications and multiorgan dysfunction syndrome (MODS). Despite numerous studies on shock in pediatric and adult populations, research on neonatal shock remains relatively limited. Many neonates who do not survive do so not solely due to the acute hypotensive phase of shock but rather due to associated complications and MODS.[9]

Aims and Objectives

1. To evaluate the type and etiology of shock in neonates.
2. To study clinical profile of shock in neonates.
3. To study the immediate outcome of shock in neonates

Materials and Methods

A prospective observational study was carried out from October 2018 to September 2020 in the NICU Department of Pediatrics, conducted in ASRAM hospital, Eluru, Andhra Pradesh. Neonates aged between 0-28 days meeting the inclusion criteria were taken as study population

Inclusion Criteria

- All neonates admitted in NICU with shock including preterm and term babies irrespective of their birth weight.
- Neonates whose parents gave consent

Exclusion Criteria

Following patients were excluded:

- Neonates with major congenital anomalies.
- Neonates with cardiogenic shock.

Sample Size: Time bound convenient sampling was used to get the sample. The NICU admissions to the department of Pediatrics, ASRAM hospital, Eluru during the time frame of October 2018 to September 2020 for a period of 2 years constituted the sample size Sample size (n) = 50.

Case Definition

Any of the following more than two criteria taken as a shock [10]

- Prolonged CFT >3sec.
- Cool/warm peripheries.
- Heart rate changes (tachy/bradycardia).
- Decreased urine output.
- Blood pressure variation based on zubrow's chart.

Method of Data Collection: The study was conducted after obtaining clearance from Institutional ethical committee from ASRAM hospital, Eluru district of Andhra Pradesh. All new-borns with shock were enrolled in this study after taking informed written consent from mother/father or guardian. Essential clinical information that included demographic details, detailed present and past history; clinical examination and events during the hospital course, were noted in pre-defined case record proforma followed by all necessary investigations. The neonates were followed up and the outcomes were recorded.

Statistical Analysis: Data was collected and entered in MS Excel. Data was analyzed using SPSS version 21.0.

Result

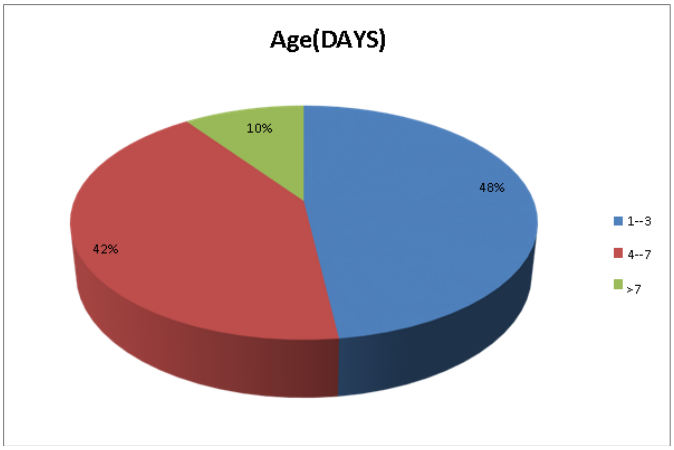

Figure 1: Age distribution of neonates with shock

Majority (86%) of the neonates was of below 7 days age and 14% were of ≥ 7 days

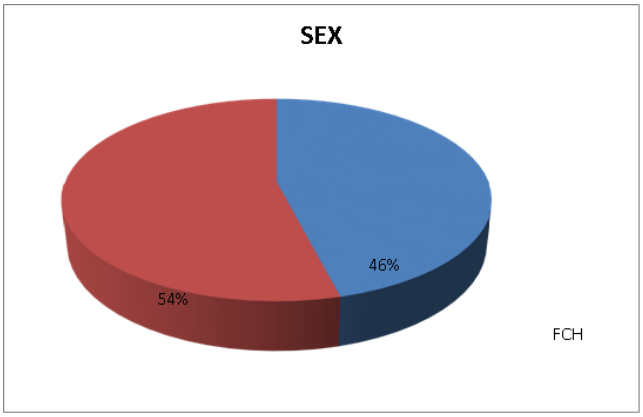

Figure 2: Sex distribution of neonates

54 % of the neonates were males and 46% were females

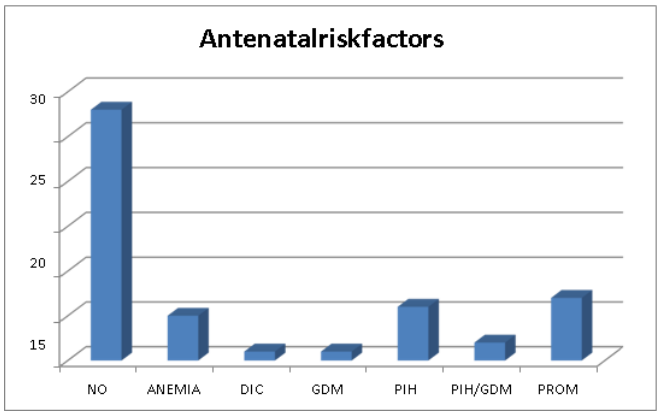

Figure 3: Distribution of Antenatal risk factors

Out of 50 cases, 28 (56%) of the mothers were without any antenatal risk factors. Out of 50 cases, 28(56%) of the mothers were without any antenatal risk factors. 7(14%) were with prolonged rupture of membrane, 6 (12%) were with only pregnancy induced hypertension, 5 (10%) were with anemia, 2 cases were with both pregnancies induced hypertension and gestational diabetes mellitus, one each with DIC and GDM.

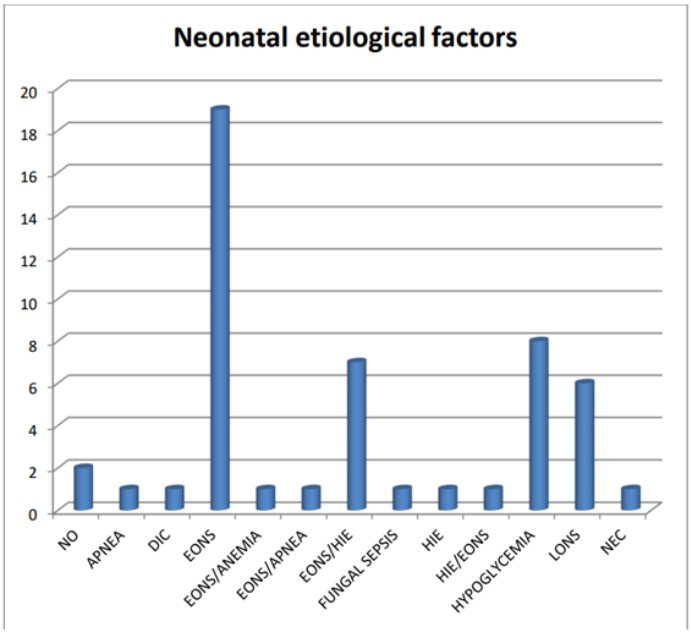

Figure 4: Distribution of Neonatal etiological factors

96% of cases were associated one or other neonatal etiological factors. Among which, 29 (58%) showed early onset of neonatal sepsis; 8 cases were with hypoglycemia; 6 showed late onset of neonatalsepsis; 9 cases were with hypoxic ischemic encephalopathy.

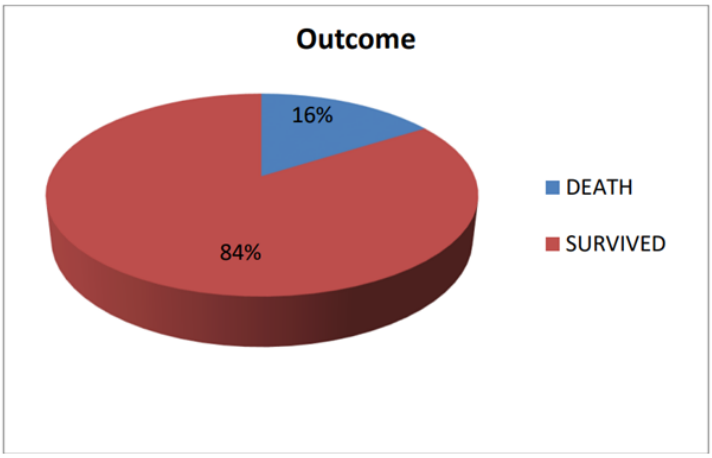

Figure 5: Distribution of neonatal outcome

Neonatal death occurred in 8 (16%) of cases.

Table 1: Antenatal risk factors * Outcome

Antenatal Risk Factors	Outcome		Total
	Death	Survived	
NO	4	24	28
	14.3%	85.7%	100.0%
ANEMIA	0	5	5
	0.0%	100.0%	100.0%
DIC	0	1	1
	0.0%	100.0%	100.0%
GDM	0	1	1
	0.0%	100.0%	100.0%
PIH	2	4	6
	33.3%	66.7%	100.0%
PIH&GDM	1	1	2
	50.0%	50.0%	100.0%
PROM	1	6	7
	14.3%	85.7%	100.0%
Total	8	42	50
	16.0%	84.0%	100.0%

Chisquaretest.p=0.613

Neonatal deaths occurred in more percentages in cases of mother shaving PIH and GDM; PIH; PROM. But there was no significant difference among mothers with different risk factors with respect to neonatal outcome.

Table 2: Neonatal etiological factors* Outcome

Neonatal etiological Factors	Outcome		Total
	Death	Survived	
NO	1	1	2
	50.0%	50.0%	100.0%
APNEA	0	1	1
	0.0%	100.0%	100.0%
DIC	0	1	1
	0.0%	100.0%	100.0%
EONS	3	16	19
	15.8%	84.2%	100.0%
EONS/ANEMIA	0	1	1

	0.0%	100.0%	100.0%
EONS/APNEA	1	0	1
	100.0%	0.0%	100.0%
EONS/HIE	0	7	7
	0.0%	100.0%	100.0%
FUNGALSEPSIS	0	1	1
	0.0%	100.0%	100.0%
HIE	1	0	1
	100.0%	0.0%	100.0%
HIE/EONS	1	0	1
	100.0%	0.0%	100.0%
HYPOGLYCEMIA	1	7	8
	12.5%	87.5%	100.0%
LONS	0	6	6
	0.0%	100.0%	100.0%
NEC	0	1	1
	0.0%	100.0%	100.0%
Total	8	42	50
	16.0%	84.0%	100.0%

Chisquaretest.p=0.05

Death occurred in 100% of cases having neonatal etiological factors of EONS and Apnea; HIE; HIE and EONS respectively. This difference was significant.

Table 3: Ventilator*Outcome

Ventilator	**Outcome**		**Total**
	Death	**Survived**	
NO	1	17	18
	5.6%	94.4%	100.0%
CPAP	0	14	14
	0.0%	100.0%	100.0%
Ventilator	7	11	18
	38.9%	61.1%	100.0%
Total	8	42	50
	16.0%	84.0%	100.0%

Chi square test p=0.004

Death occurred in 38.9% of neonates on ventilator support. This association was highly significant.

Discussion

In this investigation, the majority (86%) of neonates experiencing shock were below 7 days old, while 14% were aged ≥7 days (range: 1 to 24 days). Sujana CS et al [11] reported that the age of presentation with septic shock varied from 1 to 20 days. Similar observations were made by Fekadu G et al [12], with 75.50% falling below 1 week of age. Another study by Ismail et al [13] indicated that 64% of neonates with sepsis were aged <3 days, while 36% were older than 3 days, with a mean age of 5.85±4.81 days.

In the current investigation, 54% of the newborns were male, while 46% were female. This observation closely aligns with the findings of Sujana CS et al [11], where the proportions of males and females were 53.6% and 46.3%, respectively. Notably, all eight instances of neonatal mortality in our study involved female infants, accounting for 34.8% of the total deaths. The gender of the newborns exhibited a highly significant association with neonatal outcomes. In a study conducted by Jimba et al [14], 57.3% were male and 42.7% were female among clinical sepsis cases. Similarly, Kermorvant-Duchemin et al [15] reported that 52% were male, and 48% were female. Rabie Shehab El-Din et al [16] found that 56.7% were male, and 43.3% were female among sepsis cases. Among 50 cases, 28 mothers (56%) exhibited no antenatal risk factors. Prolonged rupture of membranes (PROM) was present in 7 cases (14%), pregnancy-induced hypertension in 6 cases (12%), anemia in 5 cases (10%), and two cases showed a combination of pregnancy-induced hypertension and gestational diabetes mellitus (GDM). Additionally, one case each presented with disseminated intravascular coagulation (DIC) and GDM. Neonatal deaths were more frequent in cases where mothers had pregnancy-induced hypertension and GDM, pregnancy-

induced hypertension alone, and PROM. However, there was no statistically significant difference in neonatal outcomes among mothers with various risk factors. Ismail et al [13] identified PROM lasting more than 18 hours as a maternal risk factor in 9% of neonatal sepsis cases. In a study by Rajkumar et al [17], maternal risk factors included anemia (73.85%), preeclampsia/eclampsia (22.86%), hypertension (13.19%), antepartum hemorrhage (1.76%), intrapartum fever (1.76%), gestational diabetes (1.1%), and diabetes (0.66%). Hypertension, preeclampsia/eclampsia, and antepartum hemorrhage were significantly more prevalent in non-survivors compared to survivors. Jimba et al [14] reported cases of PROM lasting ≥18 hours as 27.1%, while Kermorvant-Duchemin et al [15] found PROM lasting >18 hours in 36% of cases.

In the present investigation, LSCS was the mode of delivery in 62% of cases, while normal vaginal delivery accounted for 38%. Neonatal deaths were more prevalent in LSCS cases; however, there was no significant difference in neonatal outcomes across various delivery modes. In contrast, Sujana CS et al [11] reported different findings, with 55.7% of cases being NVD, 43.1% LSCS, and 1.2% instrumental deliveries. Fekadu G et al [18] study revealed that vaginal deliveries constituted 66.66%, Caesarian sections accounted for 25.4%, and instrumental deliveries made up 7.84%.

In this research, out of a total of 50 infants, 30 (60%) exhibited vigor, while 20 (40%) were classified as nonvigorous. The mean gestational age at delivery was 33.62 ± 3.251 weeks. Survival rates were 86.7% for vigorous neonates and 80% for nonvigorous neonates, with no statistically significant difference observed. Among the 50 infants, 39 (78%) were born preterm, and 11 (22%) were term infants, with no significant disparity in neonatal outcomes between term and preterm deliveries. In a study conducted by Sujana CS et al [11], the mean gestational age was 35.78 ± 3.00. Of the neonates presenting with septic shock, 56.8% were preterm, 38.9% were term, and 4.25% were post-term babies. Kermorvant Duchemin et al [15] reported that 42% of septic shock cases had a gestational age of ≤28 weeks, 35% were ≥ 32 weeks, and 23% were between 28-32 weeks. Non-survivors were significantly more prevalent in preterm deliveries.

In this research, ninety percent of the cases were linked to various neonatal etiological factors. Among these, 29 (58%) exhibited early-onset neonatal sepsis, 8 cases were associated with hypoglycemia, 6 manifested late-onset neonatal sepsis, and 9 cases were connected to hypoxic ischemic encephalopathy. Notably, all cases with neonatal etiological factors of early-onset neonatal sepsis (EONS) and apnea, as well as hypoxic ischemic encephalopathy (HIE), experienced a 100% mortality rate, and this discrepancy was statistically significant.

In the breakdown, 75.5% and 44.4% were diagnosed with early-onset neonatal sepsis, while 24.5% and 55.6% were diagnosed with late-onset neonatal sepsis, as reported by Fekadu G et al [18] and Rajkumar et al [17], respectively. According to the latter study, the incidence of clinical neonatal sepsis was 43.83%. In Jimba et al's study, 74.1% of cases were attributed to early-onset neonatal sepsis (EOS), and 25.9% to late-onset neonatal sepsis (LOS). Rabie Shehab El-Din et al [19] documented 44.19% of cases with EOS and 55.81% with LOS.

In present study, Majority (86%) of the neonates were normotensive. 14 % of neonates were hypotensive. There was no significant difference between hypotensive and non-hypotensive neonates with respect to neonatal outcome. Majority (84%) of the neonates were with normal heart rate. In majority of the neonates (92%) the capillary refill time was <3 sec. In 92% of the neonates, urinary output was ≥ 1ml/kg/hr. In 8% of cases, oliguria was found. There was no significant association between heart rate and neonatal outcome with respect to neonatal outcome. All the neonates with capillary refill time of <3 secs survived and death occurred in 17.4% of the neonates with capillary refill time of >=3 sec. But this difference was not significant. All the neonates with urine output of <1 ml/kg/hr survived and death occurred in 17.4% of the neonates with urine output of >=1ml/kg/hr. But this difference was not significant.

In the current investigation, blood culture yielded negative results in 9 cases (18%). Among the cases where the organism was identified, Klebsiella pneumonia was predominant in 4 cases (28%), E. coli and Coagulase-negative staphylococci each accounted for 20% (10 cases). No significant differences in neonatal outcomes were observed among various blood culture groups. In a study by Sujana CS et al [11], focusing on neonates with septic refractory shock, blood culture positivity was 44.2%. Ismail et al [13]. reported a 17% culture-positive rate in neonates with sepsis, while Rajkumar et al [17]. found a 5.93% culture-positive rate in confirmed sepsis cases, with E. coli being the most common organism (66.67%). Of the 50 cases examined in this study, distributive shock was identified in 34 cases (68%), hypovolemic shock in 14 cases, and obstructive shock in 2 cases, with no significant differences in neonatal outcomes observed among different types of shock. Treatment response varied, with 66% responding to Dopa+Dobutamine, 16% to dopamine, and 18% to fluids. About 44% responded to treatment within 24-48 hours. Survival rates were 88.9%, 87.5%, and 81.8% with fluid-responsive, dopamine, and Dopa+dobutamine treatments, respectively, but these differences were not significant. The mean duration of treatment was 32.38 ± 23.025 hours,

contrasting with Sujana CS et al [11] finding of a mean duration of 49.63±43.39 hours for septic shock.

The mean duration of hospital stay was 7.76±4.90 days in this study, showing a highly significant difference between survivors and non-survivors. Fekadu G et al [18]. reported a hospital stay duration of 3-5 days in 61% of cases. In terms of transfusions, 23 cases did not require any, 14 received platelet transfusions, and 13 received both fresh frozen plasma and platelet transfusions. However, no significant differences were observed in neonatal outcomes among various transfusion types. Ventilator support was not needed in the majority, but 36% required ventilator support, and 28% received continuous positive airway pressure. This aligns with Jimba et al.'s [14] findings where 83.5% of clinical sepsis cases did not require mechanical ventilation. In this study, death occurred in 38.9% of neonates on ventilator support, demonstrating a highly significant association.

In this study, neonatal death occurred in 8 (16%) of cases. In a study by Sujana CS et al [11], 64% of the septic shock cases died. Contrastingly, in another study by Fekadu G et al [18], 19% of neonatal sepsis cases recovered; deaths and disability occurred in 3.92% cases each. Mortality rate in neonatal sepsis among out borns was 38.24% as reported by Rajkumar et al [17]. In the present study, mean birth weight was 2.14±0.572 kgs which was similar to the findings by Sujana CS et al, where the mean birth weight was 1.95±0.65. In present study, 86.7%, 80%, 100% of normal, low, very low birth weight babies respectively survived. There was no significant difference among different birth weight categories with respect to neonatal outcome. In a study by Fekadu G et al, 92.5% of sepsis cases had the weight of 2.5 kg-4 kg. 7.5% were of low birth weight (2.5kgs (normal) and 36% were of<2.5kgs (low birth weight) according to Ismail et al [13].

Conclusion

The most common type of shock was distributive shock followed by hypovolemic shock followed by obstructive shock. Sex, neonatal etiological factors and ventilator support of the neonates were significantly associated with neonatal outcome.

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