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Original Research Article

A STUDY ON RISK FACTORS AND CLINICAL PROFILE OF NECROTIZING ENTEROCOLITIS IN PRETERM NEONATES WEIGHING >1 KG ADMITTED IN NICU AT TERTIARY CARE HOSPITAL

A Satyavani[1], K. Satya Kumari[2], P. Bindhu Madhavi[3], Keerthi Supraja[4], BS Chakravarthy[5]

[1]*Associate Professor, Department of Paediatrics, Andhra Medical College, Visakhapatnam, Andhra Pradesh, India.*
[2]*Associate Professor, Department of Paediatrics, Andhra Medical College, Visakhapatnam, Andhra Pradesh, India.*
[3]*Assistant Professor, Department of Paediatrics, Government Medical College, Rajahmundry, Andhra Pradesh, India.*
[4]*Post Graduate, Department of Paediatrics, Andhra Medical College, Visakhapatnam, Andhra Pradesh, India.*
[5]*Professor &HOD, Department of Paediatrics, Andhra Medical College, Visakhapatnam, Andhra Pradesh, India.*

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Corresponding Author:
Dr. A Satyavani,
Associate Professor, Department of Paediatrics, Andhra Medical College, Visakhapatnam, Andhra Pradesh, India.
Email: vanimurty99@yahoo.com

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ABSTRACT

Background: Necrotizing Enterocolitis (NEC) contributes significantly to a high neonatal death rate in India and other developing countries. A number of elements related to its development are modifiable and can be addressed. The aim is to study risk factors, clinical course and outcome of necrotizing enterocolitis in preterm babies.

Materials and Methods: It was a observational prospective study. All preterm babies with gestational age between 28-34 weeks admitted in NICU who meet the inclusion criteria during the study period will be enrolled in the study. Preterm babies of gestational age 28-34 weeks admitted to NICU, KGH, Visakhapatnam between November 2022 to May 2024.

Results: Our result supports the notion that NEC is a common pathophysiological pathway of multifactorial etiology, rather than a uniform disease entity. The most important antenatal risk factors found in this study were PIH, PPROM, GDM while the natal and postnatal risk factors being RDS, Sepsis, Mechanical ventilation, Birth asphyxia, O2 support, blood transfusion, prolonged antibiotics, UVC. In current study, out of 48 babies with NEC, 75% of mothers had preeclampsia indicating it as independent antenatal risk factor. Out of 31 cases on probiotics, all survived indicating the role of probiotics in reducing mortality in NEC. NEC was seen in 89.5% cases with initiation of enteral feeds after 24 hrs indicating that the delayed initiation of enteral feeds increases the risk of NEC.

Conclusion: Necrotizing enterocolitis has a high prevalence and mortality in preemies. Sepsis, formula feeding and a low birth weight adversely affect outcome. Early diagnosis and timely intervention can improve survival.

Keywords: Necrotizing enterocolitis, PIH, PPROM, GDM, Sepsis, preterm babies.

INTRODUCTION

Necrotizing enterocolitis (NEC) is a potentially fatal infection that almost exclusively affects new borns. NEC has a mortality rate of up to 50%. The pathophysiology of NEC is an inflammation of the intestines, that results in the bacterial invasion, cellular damage, and death, resulting in necrosis of the colon and intestine. NEC can progress to intestinal perforation, resulting in peritonitis, sepsis, and death. Because the signs and symptoms of NEC, such as poor feeding, vomiting, lethargy, and abdominal tenderness, are nonspecific, clinicians should be suspicious when theyare observed in the neonatal population.[1,2]

Necrotizing enterocolitis is an infection of the intestinal wall caused by bacteria. This results in inflammation and cellular degeneration of the intestine wall. If left untreated, an intestinal

perforation may occur, allowing intestinal contents to spill into the peritoneum and causing peritonitis. In premature neonates, it was said that gastrointestinal tract immaturity leads to the pathogenesis of necrotizing enterocolitis. Necrotizing enterocolitis presents with a wide variety of clinical features which are nonspecific and subtle. Parental reports frequently indicate decreased activityand fatigue. Additionally, they may report gastrointestinal symptoms such as decreased appetite, nausea, diarrhea, and an increase in abdominal circumference. Additionally, patients may experience blood in their stool. The patient may have systemic signs of respiratory failure and circulatory collapse as the disease progresses, such as cyanosis and unresponsiveness.[3]

Abdominal distention, abdominal tenderness to palpation, visible intestinal loops, decreased bowel sounds, palpable abdominal mass, and abdominal wall erythema are all possible physical examination findings. Respiratory failure, circulatory collapse, and decreased peripheral perfusion are all possible systemic findings.

Prolonged hospitalization and treatment may result in complications. Patients may require continuous total parenteral nutrition for an extended period of time, which may result in liver failure. Adhesions and scarring following surgery may result in stricture and obstruction. Additionally, complications such as short bowel syndrome, intestinal failure, nutritional deficiencies, and associated growth and developmental defects may occur.[4]

Need for the study

Necrotizing enterocolitis (NEC) is the most frequently occurring severe gastrointestinal disease in preterm infants. Etiology of NEC is thought to be multifactorial. The most common identified risk factors of NEC were prematurity and Low birth weight(LBW). The risk is directly proportional to birth weight and gestational age. Additional risk factors include the formula feeds, IUGR, low Apgar scores, SGA, patent ductus arteriosus (PDA), receiving erythrocyte transfusions, and contracting nosocomial infections.

The identification of clinical risk factors for the development of NEC enables the identification of neonates at risk for the disease and the development of strategies for its prevention and early treatment.

Aim and objectives of the study

Aims and objectives:

1. To study the risk factors of necrotizing enterocolitis in preterm babies.
2. To study clinical course and outcome of necrotizing enterocolitis in preterm babies.
3. To compare presence of risk factors in cases vs controls.

MATERIALS AND METHODS

Study Design: Hospital based observational study

Study Setting: NICU, Andhra Medical College, King George Hospital, Visakhapatnam.

Study Population: Preterm babies of gestational age 28-34 weeks admitted to NICU, KGH, Visakhapatnam.

Inclusion criteria:

- Preterm babies of gestational age 28-34 weeks admitted to NICU, KGH, Visakhapatnam between November 2022 to May 2024.

Exclusion criteria:

- Preterm babies with life threatening congenital malformations
- Preterm babies with surgical gastrointestinal disease (other than NEC)
- Birth weight <1500 gms
- Those who expire within 48 hrs of admission
- Those newborns whose parents didn't give consent will be excluded from the study

Study Period: The study period was one and half year i.e, from 1st November 2022 to 31st May 2024.

Methods: All preterm babies with gestational age between 28-34 weeks admitted in NICU who meet the inclusion criteria during the study period will be enrolled in the study. The data will be entered in predesigned proforma. Among the preterms enrolled in the study, those who develop NEC will be taken as cases and those who do not develop NEC will be taken as controls. For all the preterms enrolled in the study, maternal details like antenatal steroids, mode of delivery and any antenatal complications like PIH, maternal infections etc will be noted .Baby details like birth weight, gestational age, cause of preterm delivery will be noted. They will be followed through out their NICU stay, any complications like PDA, Sepsis, Shock etc will be noted and will be treated. Details of feeding like type of feed, day of initiation, time to reach full enteral feeds will be noted. Any feed intolerance or abdominal distension other symptoms of NEC will be noted. Investigations like Blood Glucose, Complete blood picture, Sepsis screening will be done for all. Other Investigations like ECG, 2D ECHO, X-Ray Chest & Abdomen, ABG etc will be done whenever required.

Statistical analysis: Clinical and biochemical data will be tabulated. Qualitative data will be presented as frequency and percentage while quantitative data will be presented as mean ± standard deviation according to their distribution. Chi square or Fisher test will be used to compare qualitative data while quantitative data will be compared with student test or its non-parametric equivalent. Data will be analyzed with the IBM SPSS version 26.0.

RESULTS

Based on birth weight in case group, out of 48 cases :17 (35.4%) belonged to <1500g, 25 (52%) belonged to 1500-2000 g and 6 (12.5%) belonged to 2000-2500g. In the control group, out of 212 controls: 48 (22.6%) belonged to <1500 g, 82 (38.6%) in 1500-2000 g and 82 (38.6%) in 2000-2500 g.

Table 1: Birth weight wise distribution of cases and control

	Cases		Controls		Total	
	N	%	N	%	N	%
<1500	17	35.4%	48	22.8%	65	25%
1500 – 2000	25	52.1%	82	38.6%	107	41%
2000 - 2500	6	12.5%	82	38.6%	88	34%
Total	48	100.0%	212	100.0%	260	100%

Table 2: Gestational age wise distribution of cases and controls

	Cases		Controls		Total	
	N	%	N	%	N	%
28 – 30 Weeks	16	33.3%	20	9.4%	36	13.8%
30 – 32 weeks	23	47.9%	67	31.6%	90	34.6%
32 – 34 weeks	9	18.8%	125	60%	134	51.5%
Total	48	100%	212	100%	260	100%

In the cases group based on gestational age at birth, out of 48 cases :16 (33.3%) belonged to 28-30 wks, 23(47.9%) belonged to 30-32 wks,9(18.8%) belonged to32-34 wks.

In the control group based on gestational age at birth, out of 212 controls:20(9.4%) belonged to 28-30 weeks, 67(31.6%) belonged to 30-32 weeks, 125(60%) belonged to 32-34 weeks.

Table 3: Parity wise distribution

	Cases		Controls		Total	
	N	%	N	%	N	%
Primipara	21	43.7%	103	48.5%	124	47.6%
Multipara	27	56.3%	109	51.5%	136	52.3%
Total	48	100%	212	100%	260	100%

Based on parity, 124 (47.6%) were primi and 136 (52.3%) were multi In cases group, primi 21(43.7%), Multi 27 (56.2%) In control group, Primi 103 (48.5%) and multi 109 (51.4%).

Table 4: Antenatal risk factors in cases and controls

	Cases		Controls		P value OR (95% CI)
	N	%	N	%	
Gestational diabetes	14	29.1%	43	20.2%	<0.0001* OR 1.61 (0.79-3.28)
Pregnancy induced HTN	36	75.0%	94	44.3%	<0.0001* OR 3.76 (1.85-7.63)
PPROM	27	56.2%	72	33.9%	<0.0001* OR 2.5 (1.32-4.72)
Abruptio placenta	6	12.5%	14	6.6%	<0.0001* OR 2.02 (0.73-5.56)
IUGR	21	43.7%	65	30.6%	<0.0001* OR 1.75 (0.92-3.33)

In cases group, out of 48 cases based on antenatal risk factors GDM are 14/48(29.1%), Pregnancy induced hypertension constitute 36/48 (75%), PPROM are 27/48 (56.2%), Abruptio placenta - 6/48(12.5%) and IUGR-21/48 (43.7%).In the control group, out of 212 controls GDM-43/212 (20.2%), Pregnancy induced hypertension-94/212 (44.3%), PPROM - 72/212(33.9%), Abruptio placenta-14/212 (6.6%) and IUGR 65/212(30.6%).

There was a statistically significant difference observed with relation to risk factors between cases and controls as the p value calculated to be <0.05.

Table 5: Mode of delivery in cases and contols

	Cases		Controls		Total	
	N	%	N	%	N	%
NVD	37	77%	174	82.1%	211	81.1%
LSCS	11	23%	38	17.9%	49	18.8%
Total	48	100%	212	100%	260	100%

Based on mode of delivery, out of total 48 cases, 37/48(77%) in case group underwent normal vaginal delivery and 11/48 (22.9%) underwent LSCS.

In control group, out of total 212 controls 174/212 (82%) underwent Normal vaginal delivery and 38/212(17.9%) underwent LSCS.

Table 6: Natal and Post natal risk factors in cases and controls

	Cases		Controls		p value	OR (95% CI)
	N	%	N	%		
Sepsis	40	83.3%	74	34.9%	0.001*	9.32(4.14-20.9)
Respiratory distress syndrome	43	89.5%	135	63.6%	0.001*	4.9(1.86-12.9)
Polycythaemia	11	22.9%	71	33.4%	0.001*	0.59(0.28-1.22)
Anaemia	26	54.1%	46	21.6%	0.001*	4.26(2.21-8.21)
Any blood transfusion	24	50%	37	17.4%	0.001*	4.72(2.42-9.22)
Apneas	41	85.4%	137	64.6%	0.001*	3.2(1.37-7.49)
Requirement of O2 support	43	89.5%	135	63.6%	0.001*	4.9(1.86-12.9)
Requirement of MV	30	62.5%	54	25.4%	0.001*	4.87(2.51-9.44)
Birth Asphyxia	30	62.5%	81	38.2%	0.001*	2.69(1.41-5.14)
Patent ductus arteriosus	33	68.7%	60	28.3%	0.001*	5.57(2.82-10.9)
Intraventricular haemorrhage	18	37.5%	59	27.8%	0.001*	1.55(0.8-3)
Umbilical catheterisation	37	77.1%	78	36.7%	0.001*	5.77(2.78-11.9)
Prolonged Antibiotics requirement (>5 days)	42	87.5%	168	79.2%	0.001*	1.88(0.73-4.58)
Antenatal corticosteroids	27	56.2%	93	43.8%	0.001*	1.6(0.87-3.09)
Surfactant therapy	36	75%	98	46.2%	0.001*	3.48(1.72-7.07)

Based on natal post natal risk factors, sepsis cases vs control (83.3% vs 34.9%), RDS (89.5%vs 63.6%), Polycythaemia (22.9% vs 33.4%), Anaemia (54.1% vs 21.6%), Any blood transfusion (5o% vs 17.4%), Apnea (85.4% vs 64.6%), Requirement of o2 support (89.5% vs 63.6%), Requirement of MV (62.5 vs 25.4%), Birth asphyxia(62.5% vs 38.2%), PDA (68.7% vs 28.3%), IVH (37.5 vs27.8%),Umbilicalcatheterisation (77.1% vs 36.7%), Prolonged antibiotic requirement (87.5% vs79.2%),Antenatal corticosteroids (56.2% vs 43.8%), Surfactant therapy (75% vs46.2%).

Table 7: NEC Cases with sepsis

	NEC Cases	
	N	%
CRP Positive sepsis	40	83.3%
Culture positive sepsis	37	77.1%
Early onset sepsis	15	31.2%
Late onset	25	52.1%

In cases group,out of 48 cases: 40 (83.3%) had CRP positive sepsis, 37 (77.1%) had culture positive sepsis, Early onset sepsis in 15 (31.2%) and Late onset sepsis in 25 (52.1%).

Table 8: Day of life of onset of NEC

	1 – 10 days		11 – 20 days		20 – 28 days		Total	
	N	%	N	%	N	%	N	%
<1499 g	13	38.2%	2	16.7%	2	100%	17	33.3%
1500 – 1999g	17	50.1%	8	66.6%	0	0%	25	47.2%
2000 – 2500g	4	11.7%	2	16.7%	0	0%	6	19.4%
Chi square test = 3.15, p=0.53, Not Statistically significant								

In the present study, there was no statistically significant association observed with relation to day of life of onset of NEC among cases as p value calculated to be >0.05

Table 9: Incidence with type of Milk

	Cases	
	N	%
Mother own milk	12	25%
Donor breast milk	6	12.5%
Formula feed	30	62.5%
Total	48	100%

Out of 48 preterm babies with NEC 12/48 (25%) had mother own milk, 6/48(12.5%) had donor breast milk and 30/48 (62.5%) had formula feeds.

Table 10: Age of Enteral feeding after birth

	Cases		Controls		Total	
	N	%	N	%	N	%
<24 hours	5	10.4%	78	36.8%	83	31.9%
24 – 48 hours	29	60.4%	111	52%	140	53.8%
48 – 72 hours	14	29.2%	23	10.2%	37	14.2%
>72 hours	0	0.0%	0	0.0%	0	0.0%
Total	48	100%	212	100%	260	100%
Chi square test = 18.229, p=0.0001*, Statistically significant						

In cases group, enteral feeding initiation was done <24 hrs in 10.4%, 24-48 hrs in 60.4%, 48- 72 hrs in 29.2%. In controls group, <24 hrs in 36.8%, 24-48 hrs in 52%,48-72 hrs in 10.2% Distribution based on age of enteral feeding after birth was significantly associated between the case and control group as p value calculated to be <0.05

Table 11: Duration of NICU Stay

	Cases		Controls		Total	
	N	%	N	%	N	%
1 -2 days	0	0.0%	0	0.0%	0	0.0%
3 – 4 days	3	9.7%	11	4.7%	14	6.1%
5 – 7 days	6	8.4%	6	2.9%	12	4.5%
>7 days	39	81.9%	195	92.4%	234	89.3%
Total	48	100%	212	100%	260	100%
Chi square test = 8.51, p=<0.014*, Statistically significant						

Distribution based on duration of NICU Stay between cases and controls is significantly different as p value calculated to be <0.05

Table 12: NEC Staging based on modified bells criteria

	1000 – 1499		1500 – 1999		2000 – 2500	
	N	%	N	%	N	%
Stage IA	2	11.7%	4	16%	5	83.3%
Stage IB	5	29.4%	16	64%	1	16.6%
Stage II A	8	47.2%	3	12%	0	0.0%
Stage II B	0	0.0%	0	0.0%	0	0.0%
Stage III A	0	0.0%	1	4%	0	0.0%
Stage III B	2	11.7%	1	4%	0	0.0%
Chi square test = 18.84, p=0.015*, Statistically significant						

In the present study, a statistically significant difference observed with relation to NEC staging based on modified bells criteria and birth weight among case group as p value calculated to be <0.05.

Table 13: Probiotic supplementation

	Cases		Controls		Total	
	N	%	N	%	N	%
Yes	31	14.3%	185	85.6%	216	83%
No	17	38.6%	27	61.3%	44	16.9%
Total	48		212		260	100%

In the present study, 216/260 (83%) had probiotic supplementation. In the case group, 31out of 48 cases (64.5%) had probiotic supplementation and 185 out of 212 (87.3%) in control group had probiotic supplementation.

Table 14: Outcome among cases birth weight wise distribution

	Survived		Expired	
	N	%	N	%
1000 – 1499	13	34.2%	4	40%
1500 – 1999	20	52.6%	5	50%
2000 – 2500	5	13.2%	1	10%
Total	38	100%	10	100%
Chi square test = 0.148, p=0.92, Not Statistically significant				

Table 15: Outcome among controls birth weight wise distribution

	Survived		Expired	
	N	%	N	%
1000 – 1499	42	21.9%	6	28.5%
1500 – 1999	72	37.7%	10	47.6%
2000 – 2500	77	40.4%	5	23.9%
Total	191	100%	21	100%
Chi square test = 2.17, p=0.33, Not Statistically significant				

Table 16: Outcome among cases according to gestational age

	Survived		Expired	
	N	%	N	%
28 – 30 weeks	9	23.6%	7	70%
30 -32 weeks	21	55.2%	2	20%
32 – 34 weeks	8	21.2%	1	10%
34 – 36 weeks	0	0%	0	0%
Total	38	100%	10	100%
Chi square test = 22.33, p=0.0001*, Statistically significant				

In the cases group, 70% of those who didn't survive belong to 28-30 weeks gestation.

This observation was statistically significant

Table 17: Outcome among controls according to gestational age

	Survived		Expired	
	N	%	N	%
28 – 30 weeks	16	8.4%	4	19%
30 -32 weeks	63	32.9%	4	19%
32 – 34 weeks	112	58.7%	13	62%
34 – 36 weeks	0	0%	0	0%
Total	191	100%	21	100%
Chi square test = 3.48, p=0.17, Not Statistically significant				

Gestational age and outcome are not significantly associated in the control group.

Table 18: Outcome among cases on probiotic supplementation

	Survived		Expired	
	N	%	N	%
Yes	31	81.5%	0	0%
No	7	18.5%	10	100%
Total	38	100%	10	100%
Chi square test = 19.78, p=0.0001*, Statistically significant				

In the cases group, out of 31 on probiotics, all survived. This observation was Statistically significant

Table 19: Outcome among controls on probiotic supplementation

	Survived		Expired	
	N	%	N	%
Yes	183	95.8%	2	9.5%
No	8	4.2%	19	90.5%
Total	191	100%	21	100%
Chi square test = 126.7, p=0.0001*, Statistically significant				

In the control group, out of 185 on probiotics, 2 didn't survive. This observation was statistically significant

Table 20: outcome of Surfactant therapy in cases

	Survived		Expired	
	N	%	N	%
Yes	35	94.5%	1	9.1%
No	2	5%	10	90.9%
Total	37	100%	11	100%
Chi square test = 33.06, p=0.0001*, Statistically significant				

Out of 36 cases on surfactant therapy, 1 didn't survive This observation was statistically significant

Table 21: Outcome of Surfactant therapy in controls

	Survived		Expired	
	N	%	N	%
Yes	87	45.4%	11	55%
No	105	54.6%	9	45%
Total	192	100%	20	100%
Chi square test = o.683 p=0.408, Not statistically significant				

Out of 98 controls on surfactant therapy, 11 didn't survive This observation was not statistically significant

Table 22: Comorbidities contributing to mortality other than NEC in cases and control

	Cases		Controls	
	N=10	%	N=21	%
RDS	7	70%	20	95.2%
Recurrent apnea	9	90%	20	95.2%
PDA	2	20%	12	57.1%
Pulmonary haemorrhage	6	60%	6	28.5%
Refractory shock	9	90%	7	33.3%
Sepsis	6	60%	10	47.6%
Culture +ve	3	30%	0	0%

Out of 48 cases, 10 expired for which the contributing comorbidities are as follows: RDS in70% cases (7/10), Recuurent apnea in 90% (9/10), PDA in 20% cases (2/10), Pulmonary hemorrhage in 60% (6/10), Refractory shock in 90% (9/10), Sepsis in 60% (6), Culture positive sepsis in 30% (3/10).

DISCUSSION

NEC is one among the most serious complications of preterm birth, occurring in approximately 5%–10% of VLBW infants. While more (extremely) preterm infants are surviving,the deaths attributed to NEC continues to rise. Death rates have been reported to

range between 15% and 30%. Surgical intervention is frequently required, and survivors face an increased risk of impaired long-term growth and neurodevelopment. Despite preventive measures such as prenatal glucocorticoid administration, breastfeeding, donor milk use, and probiotic supplementation, NEC continues to be a relatively common complication in the majority of neonatal intensive care units (NICUs),[5,6] In our study, incidence of NEC in VLBW neonates was 16.1%. ELBW neonates were not included in our study. This was higher compared to Kelvin et al,[7] in which the incidence of NEC was 12.5% amongst ELBW infants and 4.9% amongst VLBW infants.

Another study done by Moro et al,[8] reported incidence of 10.9% and 4.7% amongst ELBW and VLBW preterm infants respectively. Bahubali et al,[9] reported incidence of 9.8% among VLBW babies.

In this study, we found that incidence of NEC among neonates was more in children weighing 1500-2000 gms, which is in contrast with the findings of Guthrie et al,[8] who found that neonates who developed NEC had a VLBW. In their study, 45 percent of the neonates with NEC weighed <1000 g. This may be due to lowbirth weight infants' increased susceptibility to various medical conditions and infections.

In this study, we found that incidence of NEC among the preterms was more than in the full-term neonates. This is consistent with Mohammed et al findings that the most of the neonates who developed NEC were premature (87.5%), with only 12.5 percent being full-term.

Sitotaw et al,[11] showed that the odds of having NEC among neonates aged <28 weeks GA and 28-32 weeks GA were 3.94 times and 3.65 times higher than neonates aged 34-36 weeks GA respectively. Based on parity, 47.7% were primi and 52.3% were multi. In cases group, primi (43.7%), Multi (56.3%). In control group, Primi (48.5%) and multi (51.5%).

No statistically significant difference was observed with relation to parity between cases and controls. In cases group, GDM (29.1%), Pregnancy induced hypertension (75%), PPROM (56.2%), Abruptio placenta (12.5%) and IUGR (43.7%) were the common antenatal risk factors.

This is in consonance with a study conducted by Bashiri et al,[12] (2003) found that maternal hypertensive disorders were an independent risk factor in LBW infants (OR 5.21; 95% CI 1.64–16.58).

Sitotaw et al,[11] across sectional study conducted in 2021 on 350 preterm neonates found that the likelihood of having a NEC among neonates who were born from mothers who were with maternal chronic disease particularly hypertension was 3.2 times (AOR =3.2,1.7-5.9) higher than their contraries.

Yansu et al 13, ameta analysis done in 2022, which included 52 studies, reported that gestational diabetes (OR =3.62) and Premature rupture of membranes (OR=3.81) were risk factors for NEC in neonates.

Sitotaw et al,[11] found that Neonates who were born from mothers withchorioamnionitis were 4.8 times more likely to have NEC compared to their contraries.

In this study, the incidence of NEC was more in neonates delivered by cesarean section (CS) (22.4%) than in those deliveredby NVD (17.5%). This is in agreement with Lee et al,[14] who showed that 73.1% of infants who developed NEC were delivered by CS; Ahle et al,[15] who found that delivery by CS was associated with a greater incidence of NEC, except in gestational age more than 31 Weeks and Maayan-Metzger et al83., who showed that delivery by CS was associated with a greater incidence of NEC.

Sepsis cases vs control (83.3% vs 34.9%), RDS(89.5% vs 63.6%), Polycythaemia (22.9% vs 33.4%), Anaemia (54.1% vs 21.6%), Anyblood transfusion (50% vs17.4%), Apnea (85.4% vs 64.6%), Requirement of o2 support (89.5% vs 63.6%),Requirement of MV (62.5% vs 25.4%), Birth asphyxia (62.5 vs 38.2%), PDA(68.7% vs 28.3%), IVH (37.5% vs 27.8%), Umbilicalcatheterization (77.1% vs 36.7%), Prolonged antibiotic requirement (87.5% vs 79.2%), Antenatal corticosteroids (56.2% vs 43.8%), Surfactant therapy (75% vs 46.2%) were the major contributing natal and postnatal risk factors. In the present study, out of 48 NEC cases, 62.5% had birth asphyxia as the risk factor. This was statistically significant.

This is in agreement with the study done by Bahubali et al 9, which showed that out of 100 NEC cases, 41 % had birth asphyxia as the risk factor.

In our study, antenatal steroids were given to 120 mothers out of which 22.5% of their babies developed NEC while 77.5% did not develop NEC. This was statistically significant. This concurs with the study done by Kelvin et al,[7] in which antenatal steroids were given to 163 mothers of which only 4.2% oftheir babies developed NEC while 95.8% of preterms didn't develop NEC which was significant. This is also in agreement with other studies done by Bahubali et al,[9] Yansu et al,[13] which showed a significant beneficial effect of antenatal steroids on NEC.

In cases group, 83.3% had CRP positive sepsis, 77.1% had culture positive sepsis, Early onset sepsis in 31.2% and Late onset sepsis in 52.1%. In the present study, setting for sepsis was seen in cases of NEC which is comparable to the study done by Kelvin et al 7 66.7%, Bahubali et al 9 57%, Xeurong et al,[16] 23.5%. In the present study, RDS is a risk factor in 89.5% of cases.

The deterioration of respiratory system (increase in required respiratory support, decreased po2 and o2 saturation) was an early sign of NEC. Kelvin et al,[7] a retrospective cohort study also showed an increase in the incidence of NEC with increasing duration on mechanical ventilation. This finding is supported by prior studies by Gane et al. and Guthrie et al,[8] Bahubali et al.[9]

In present study, 77.1 % of preterm cases with NEC had umbilical vein catheterisation. This in agreement

with Livaditis et al,[17] who reported that NEC is a potential complication after umbilical catheterisation particularly in predisposed infants and disorders may occur regardless of type of vessels used or indications for procedures. Bahubali et al also showed a significant association between NEC and UVC exposure.

It was observed that NEC was more in cases with sepsis, RDS, perinatal asphyxia and the finding was in consonance with findings made by Mohammed et al.[17] In present study, we found that there was a significant association between development of NEC and prolonged course of antibiotics more than 5 days, where 87.5% of NEC cases received prolonged course of antibiotics more than 5 days. This is in agreement with Cotten et al 18, who found that 53% of neonates in their study who received prolonged empirical antibiotic therapy had increased risk of NEC. In current study out of 48 cases, 24 (50%) cases received blood transfusion which was significant. Yansu et al,[13] showed that blood transfusion was a risk factor for NEC.

This was in agreement with Xeurong et al,[16] in which 17.65% of cases had blood transfusion compared to 5.65% in controls. Infusion of concentrated red blood cells may result in blood redistribution within the body, impacting the blood supply to the mesentery. The introduction of histocompatibility antigens through infusion can stimulate an immune response leading to potential damage.

Day of onset of NEC: In the present study, no statistically significant association was observed with relation to day of life of onset of NEC among cases. In present study it was observed that in most of the preterm babies day of onset of NEC is in initial first weeks of life that is approximately around 1 to 10 days. Bahubali et al in their study showed that the mean age of diagnosis of NEC was1.82+/- 1.02 d in stage I, 2.62+/- 1.15 days in stage II, 5.29 +/-2.74 days in stage III.

In current study 25% had mother own milk, 12.5% had donor breast milk and 62.5% were given formula feeds. Mohammed et al 17, also found that 4.7% of infants who were diagnosed as having NEC received exclusively breastfeeding, 76.7% of infants received exclusively formula feeding, and 18.6% of infants received both breast and formula feeding.

Mohammed et al,[17] also found that 4.7% of infants who were diagnosed as having NEC received exclusively breastfeeding, 76.7% of infants received exclusively formula feeding, and 18.6% of infants received both breast and formula feeding.

Distribution based on age of enteral feeding after birth was significantly associated between the case and control group as 100% (48/48) cases with NEC had received enteral feeding in the present study.

NEC was seen in 43 out of 48 cases (89.5%) with initiation of enteral feeds after 24 hrs when compared to 10% with enteral feeds <24 hrs.

Rate of advancement of enteral feedings has been viewed as one of the risk factors for NEC. Clinicians have considered advancing enteral feeding less than 20 ml/kg/day as safe24. In the present study,enteral feeding advancement rate was <20ml/kg/day in 86.1% of NEC cases while in the remaining 13.9% cases, advancement rate was>20ml/kg/day. This is in agreement with Mohammed et al,[17] who reportedthat enteral feeds were advanced by increments of less than 20 ml/kg/day in 84.6% of patients. However, in 14.4%, daily feeding volume increased by more than 20 ml/kg/day. Our results may be explained by that infants fed more slowly might have higher risk of acquiring a severe infection owing toprolonged hospital stay than infants fed more quickly.

Duration of NICU stay: Distribution based on duration of NICU Stay between cases and controls is significantly different. Most of preterm babies in current study had an average stay of around more than 7 days

NEC staging and birth weight: In our study, a statistically significant difference was observed with relation to NEC staging based on modified bells criteria and birth weight among case group.

In present study 47.2% (8/17) of preterms with birth weight of 1000-1499 g developed NEC stage IIA while 83.3% (5/6) of preterms with birth weight 2000-2500 g developed NEC stage IA suggesting that there is an increased severity of NEC in VLBW babies compared to LBW babies.

In current study 10 out of 48 cases expired. 100% mortality was found in stage III i.e all the 4 cases belonging to stage III expired. All the cases (11/11) of stage IA survived.

Probiotic supplementation: In the present study, 85.8% had probiotic supplementation. In the case group, 64.5% had probiotic supplementation and 87.3% in control group had probiotic supplementation. Outcome of cases on probiotic supplementation Probiotic organisms generally consist of strains of Lactobacillus, Lin et al. They reported a lower incidence of NEC in probiotic group (1.1% Vs 5.3%; p=0.04).

Bin-Nun et al. found a significantly lower incidence of all cases of NEC in probioticgroup (4% Vs 16.6%; p=0.031). Dani et al. found a lower incidence of NEC (1.4 Vs 2.7%) in the probiotic group, but his study not reach statistical significance. Costalos et al. reported a non significant trend lowered less NEC of any severity in the probiotic group (9.8% Vs 16%; p=0.5).

In the present study, Out of 31 cases on probiotics, all survived. 17 out of 48 NEC cases were not on probiotics out of which 10 cases didn't survive. In present study it indicates that NEC associated mortality more in non probiotic group than on probiotic group.

Surfactant therapy: Out of 36 cases on surfactant therapy, 94.5% (35) survived. This observation was statistically significant. Out of 98 controls on surfactant therapy, 45.4% (87) survived. This observation was not statistically significant. Out of total 48 cases, 36 cases were given surfactant therapy due to RDS out of which 1 preterm baby did not

survive and 12 babies not given surfactant out of which 10 babies expired.

Gestational age and outcome: In the cases group, 55.2% of those who didn't survive belong to 30-32 weeks gestation. This observation was statistically significant. Gestational age and out come are not significantly associated in the control group.

Mortality: Mortality and condition related shows, RDS (70% vs 95.2%), Recurrent apnea (90%vs 95.2%), PDA (20% vs 57.1%), Pulmonaryhemorrhage (60% vs 28.5%),Refractory shock (90% vs 33.3%), sepsis (60% vs 47.6%) and culture positive(30% vs 0%).

In the present study, we found that there was an association between RDS and NEC, where 70% of the NEC cases who expired were diagnosed as having RDS. This is in agreement with Ahle et al 15, who found that 43% of infants with NEC had RDS. Moreover, Mohammed et al,[17] reported that there was a significant association between HMD and NEC, where 14% of the NEC cases were diagnosed as having hyaline membrane disease. Prematurity was the major risk factor being responsible for majority of cases (eg: low APGAR score, hyaline membrane disease, low. Birth weight and low gestational age) when exposed to bacterial infection, may experience intestinal ischemia leading to NEC. Additional factor for increased rate if infections is intubation / mechanical ventilation.

In the present study, hyaline membrane disease has an association with NEC and this is comparable to the study done by Beeby PJ,[19] where it was 52.4%. But inanother study done by Boo N88, 2.4% of cases with NEC are having hyaline membrane disease which was higher compared to the present study.

Limitation of Study

As the mortality of ELBW babies is higher, in our study we couldn't include ELBW babies.

CONCLUSION

Authors found that PIH is associated with an increased risk for NEC independent of birth weight. Among various postnatal risk factors, prematurity is found to be the most common risk factor. Sepsis and PDA found to be strongly associated with the incidence of NEC. Future studies with larger sample size and rigorous design are needed to further elucidate the potential risk factors of NEC in infants to provide reliable evidences to the clinical prevention and treatment of NEC. Perinatal health care should be strengthened to reduce incidence of neonatal complications so as to prevent occurrence of NEC in neonates.

REFERENCES

1. Cuna A, George L, Sampath V. Genetic predisposition to necrotizing enterocolitis in premature infants: Current knowledge, challenges, and future directions. Semin Fetal Neonatal Med. 2018 Dec;23(6):387-393.
2. Afzal B, Elberson V, McLaughlin C, Kumar VH. Early onset necrotizing enterocolitis (NEC) in premature twins. J Neonatal Perinatal Med. 2017;10(1):109-112.
3. Gephart SM, Hanson C, Wetzel CM, Fleiner M, Umberger E, Martin L, Rao S, Agrawal A, Marin T, Kirmani K, Quinn M. NEC-zero recommendations from scoping review of evidence to prevent and foster timely recognition of necrotizingenterocolitis. Maternal health, neonatology and perinatology. 2017 Dec;3(1):1- 4.
4. Ginglen JG, Butki N. Necrotizing Enterocolitis. In: StatPearls [Internet].Treasure Island (FL): StatPearls Publishing; 2021 [cited 2021 Nov 13]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK513357/
5. Neu J, Walker WA. Necrotizing enterocolitis. N Engl J Med. 2011;364(3):25564.
6. Thompson AM, Bizzarro MJ. Necrotizing enterocolitis in newborns: pathogenesis, prevention and management. Drugs. 2008;68(9):1227–38.
7. Gitau K, Ochieng R, Limbe M, Kathomi C, Orwa J. The incidence and modifiable risk factors for necrotizing enterocolitis in preterm infants: a retrospective cohort study. The Journal of Maternal-Fetal & Neonatal Medicine. 2023 Dec 15;36(2):2253351.
8. Moro M, Perez-Rodriguez J, Figueras-Aloy J, Fernandez C, Domenech E, Jimenez R, Perez-Sheriff V, Quero J, Roques V. Predischarge morbidities in extremely and very low-birth-weight infants in Spanish neonatal units. American journal of perinatology. 2009 May;26(05):335-43.
9. Gane B, Bhat BV, Adhisivam B, Joy R, Prasadkumar P, Femitha P, Shruti B. Risk factors and outcome in neonatal necrotising enterocolitis. The Indian Journal of Pediatrics. 2014 May;81:425-8.
10. Mohammed LH, Khairy M, Mohammed NR, El-Hussieny N. Retrospective study of necrotizing enterocolitis in neonatal intensive care unit of Cairo University Pediatric Hospital Med J Cairo Univ 2012; 80:31–40Ostlie DJ, Splide TL, St Peter SD, Sexton N, Miller KA, Sharp RJ, et al. Necrotizing enterocolitis infullterm infants. J Pediatr Surg 2003; 38:1039–1042.
11. Mekonnen SM, Bekele DM, Fenta FA, Wake AD. The prevalence of necrotizing enterocolitis and associated factors among enteral fed preterm and low birth weight neonates admitted in selected public hospitals in Addis Ababa, Ethiopia: a cross-sectional study. Global pediatric health. 2021May;8:2333794X211019695.
12. Bashiri A, Zmora E, Sheiner E, Hershkovitz R, Shoham-Vardi I, Mazor M. Maternal hypertensive disorders are an independent risk factor for the development of necrotizing enterocolitis in very low birth weight infants. Fetaldiagnosis and therapy. 2003 Oct 23;18(6):404-7.
13. Su Y, Xu RH, Guo LY, Chen XQ, Han WX, Ma JJ, Liang JJ, Hao L, Ren CJ. Risk factors for necrotizing enterocolitis in neonates: a meta-analysis. Frontiers in pediatrics. 2023 Jan 6;10:1079894.
14. Lee JY, Park KH, Kim A, Yang HR, Jung EY, Cho SH. Maternal and placental risk factors for developing necrotizing enterocolitis in very preterm infants. PediatrNeonatol 2016; 58:57–62.
15. Ahle M, Drott P, Andersson RE. Epidemiology and trends of necrotizing enterocolitis in Sweden: 1987–2009. Pediatrics. 2013 Aug 1;132(2):e443-51.
16. Tan X, Zhou Y, Xu L, Zhang L, Wang J, Yang W. The predictors of necrotizing enterocolitis in newborns with low birth weight: A retrospective analysis. Medicine. 2022 Feb 18;101(7):e28789.
17. Mohammed LH, Khairy M, Mohammed NR, El-Hussieny N. Retrospective study of necrotizing enterocolitis in neonatal intensive care unit of Cairo University Pediatric Hospital Med J Cairo Univ 2012; 80:31–40Ostlie DJ, Splide TL, St Peter SD, Sexton N, Miller KA, Sharp RJ, et al. Necrotizing enterocolitis infullterm infants. J Pediatr Surg 2003; 38:1039–1042.
18. Cotten CM, Taylor S, Stoll B, Goldberg RN, Hansen NI, Sánchez PJ, Ambalavanan N, Benjamin DK, NICHD Neonatal Research Network. Prolonged duration of initial empirical antibiotic treatment is associated with increased rates of necrotizing enterocolitis and death for extremely low birth weightinfants. Pediatrics. 2009 Jan 1;123(1):58-66.
19. Beeby PJ, Jeffery H. Risk factors for necrotising enterocolitis: the influence of gestational age. Archives of disease in childhood. 1992 Apr 1;67(4 Spec No):432-5.