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Research Article

A TO STUDY TO ASSESS THE INCIDENCE OF NEUROLOGICAL ABNORMALITY IN HIGH-RISK NEONATES IN OUR NEONATAL INTENSIVE CARE UNIT

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ABSTRACT

Aim: The present study is an attempt to study incidence of neurological abnormality in high-risk neonates in our neonatal intensive care unit and to find out association with antenatal, perinatal and neonatal factors for predicting risk for deviant development.
Methods: The study was conducted at Department of Paediatrics, NIMS Medical College and Hospital, Jaipur from October 2022 to September 2024. 75 subjects were included in the study.
Results: The study population included 64(85.3%) preterm and 11(14.7%) term neonates. Out of 75 newborns, 63 were born by LSCS, 3 required vacuum assistance, while rest 9 were born by normal vaginal delivery. In the study group 57 were AGA, 12 were SGA and 6 were LGA. Head circumference was normal in 63 newborns, 1 had definite abnormality. 9 of the infants although did not have microcephaly for their GA, their head size was small for their weight/ length. Anterior fontanel was normal in all while 10 had definite cranial suture abnormality. Neurosensory abnormality was seen in 13 newborns (17.3%). In them, 7 had moderate abnormality while 6 had definitive abnormality. At 40 weeks the moderately abnormal & definite abnormal neurological assessment were highest in 35-36+6wk gestation age group i.e. 10(52.6%) & 3(15.8%) respectively.
Conclusion: High risk newborns have increased Incidence (10.6%) of neurological abnormality in comparison to overall newborn population (4-5%). Those newborns who were neurologically normal and those who were definitively abnormal, remained so even at follow up. Moderate abnormal newborns are likely to improve and unlikely to deteriorate. Fetal distress was one of the common and major risk factors for neurological disabilities in the newborn both at 40 wks of gestational age(p=0.021) and also at 3months of age (p=0.018). Prematurity and IVF conception by themselves did not appear to be a risk factor for abnormal neurological outcome in the newborn. Use of antenatal steroids appear to decrease incidence of neurological abnormality in the newborn(P<0.001).

Keywords: *neurological abnormality, neonatal intensive care unit, antenatal, perinatal.*

INTRODUCTION

A gradual improvement in neonatal survival among sick and low birth weight babies has been noted in India during the last two decades, a trend similar to that seen in developed countries. This improvement is attributed to advances in antenatal and neonatal intensive care, and the development of Level II and III nurseries in both private and government sectors, which have enhanced care during delivery and improved basic neonatal care at all levels. Evidence from developed countries has shown that improved survival is not necessarily associated with a decrease in disabilities; rather, more infants survive with an increased risk of disabilities that require special follow-up.[1]

For neonates with complicated pregnancies, births, or neonatal courses, parental concern about whether their child will develop normally is intense. Early anticipation of future neurodevelopmental problems during the neonatal period and infancy can help predict neurological abnormalities, allowing for timely intervention. However, due to limited resources, a high birth rate, and a high incidence of low birth weight and birth asphyxia in our country, it remains challenging to identify which babies require early intervention and follow-up for neurodevelopmental assessment. This challenge is compounded by the fact that approximately one quarter of children with cerebral palsy have no identifiable risk factors.[2]

Modern child healthcare should aim not only to identify and rehabilitate children with major disabilities but also those with subtle weaknesses in specific developmental domains such as language, visual-perceptual, or motor function. Cranial ultrasound (US) and other neuroimaging modalities have gained immense importance in recent years for detecting abnormalities such as porencephalic cysts, intracranial hemorrhage, and ventricular dilatation. However, ultrasound primarily detects structural damage, and moderate hypoxic-ischemic injury may remain undetected. Neurological evaluation of the newborn is, therefore, an essential parameter for assessing obstetric and neonatal strategies, as perinatal events have been shown to be associated with neonatal morbidity.[3]

Follow-up studies with well-designed methodologies can provide valuable information on the proportion of children who develop impairments,[4] the timing at which these impairments can be most accurately observed,[5] and possible causal relationships between perinatal factors and developmental outcomes. Such data are crucial for physicians caring for high-risk infants, as they help reduce the "wait and see" approach and enable better communication with families regarding diagnosis and prognosis.[6] Neonatal neurological examination has emerged as a valuable and cost-effective tool for selecting infants who require follow-up. Although many neurologically abnormal infants later recover, some continue to have persistent problems and remain at risk for future handicaps. An abnormal neonatal neurological examination has been shown to correlate with abnormal developmental outcomes in both full-term infants (with or without asphyxia) and preterm infants.[7,8]

A normal neonatal neurological examination, even in the presence of defined risk factors, generally assures normal development, and such neonates do not require follow-up if cranial ultrasound findings are also normal. Most signs of neurological dysfunction, except seizures and coma, are often not systematically documented in medical charts; however, studies have demonstrated that abnormal neonatal neurological signs may be associated with later mental handicaps.[9]

The present study is an attempt to study incidence of neurological abnormality in high-risk neonates in our neonatal intensive care unit and to find out association with antenatal, perinatal and neonatal factors for predicting risk for deviant development.

MATERIALS AND METHODS

The study was conducted at Department of Paediatrics, NIMS Medical College and Hospital, Jaipur from October 2022 to September 2024. 75 subjects were included in the study.

Inclusion criteria

All Preterm and Term high risk neonates admitted to the hospital NICU during study period.
All high-risk neonates described as per NNF 2010.

Exclusion criteria

(i) presence of congenital anomalies
(ii) Newborns whose mothers were on antiepileptic or anti-psychotic drugs
(iii) Newborns who were discharged against medical advice or were not available for follow up.

METHODOLOGY

• 75 high risk neonates fulfilling the inclusion criteria admitted at nicu were recruited after taking informed consent from mothers /fathers.
• Details of all high risk neonates admitting in NICU were recorded in predesigned proforma.
• Detailed antenatal & natal history were elicited with special reference to high risk maternal & obstetric factor.
• Gestational age was assessed by BALLARD scoring
• SARNAT & SARNAT staging was done for asphyxiated newborns.
• All the newborns were managed according to Standard neonatal protocols.
• The infants were examined 24 hours after birth. Their weight, length, head circumference were recorded. Clinical examination was done to rule out any obvious congenital anomaly.
• Cry, suck, activity and primitive reflexes were noted in order to rule out any neurologic damage.
• Every effort was made to get a good follow up.

Neurological assessment was done at 40wk and 3months ±7 days. Amiel-Tison Neurological assessment at 2002 (ATNAT)(62) was used. The complete procedure takes approximately 5 minutes. A simple 0, 1, and 2 scoring system is

proposed. Because this coding system is not quantitative, any computation of quotient or total score is inappropriate. The central nervous system function may be judged optimal when every individual item is coded 0. When a score of 1 is assigned on some or most of the items, an impairment of minor to moderate degree is considered. When some or most of the items are coded with 2, severe impairment should be considered. All the morbidities and maternal risk factors were recorded in a pre-designed study Performa.

STATISTICAL ANALYSIS

Statistical testing was conducted with the statistical package for the social science system version SPSS 17.0(Chicago, IL, USA). Results are expressed as mean ± SD, median (min-max) or numbers and percentages. Outcomes at 40 weeks and at 3 months were compared using Chi-squared test or Fisher's exact test as appropriate. $P<0.05$ was considered statistically significant.

RESULTS

Table 1: Baseline characteristics

Gestational Age	**Frequency**	**%**
below 30 wk	11	14.7%
30 to 31 + 6 wk	10	13.3%
32 to 34 + 6 wk	24	32.0%
35 to 36 + 6 wk	19	25.3%
≥ 37wk	11	14.7%
Total	75	100%
MOD		
SVD	9	12.0%
LSCS	63	84.0%
Vacum	3	4.0%
Total	75	100%
AGA/SGA/LGA		
AGA	57	76.0%
SGA	12	16.0%
LGA	6	8.0%
Total	75	100%

The study population included 64(85.3%) preterm and 11(14.7%) term neonates. Out of 75 newborns, 63 were born by LSCS, 3 required vacuum assistance, while rest 9 were born by normal vaginal delivery. In the study group 57 were AGA, 12 were SGA and 6 were LGA.

Table 2: At 40 weeks of Gestational age

At 40 weeks		**Frequency**	**%**
HC	**Normal**	63	84.0%
	Moderate abnormal	0	0
	Definate abnormal	1	1.3%
AF	**Normal**	75	100.0%
	Moderate abnormal	0	0.0%
	Definate abnormal	0	0.0%
Suture	**Normal**	65	86.7%
	Moderate abnormal	0	0%
	Definate abnormal	10	13.3%
Neurosensory Assessment	**Normal**	62	82.7%
	Moderate abnormal	7	9.3%
	Definate abnormal	6	8.0%
Recoil of Arm	**Normal**	47	62.7%
	Moderate abnormal	27	36.0%
	Definate abnormal	1	1.3%
Scarf Sign	**Normal**	46	61.3%
	Moderate abnormal	24	32.0%
	Definate abnormal	1	1.3%

Popliteal Angle	**Normal**	52	69.3%
	Moderate abnormal	18	24.0%
	Definate abnormal	1	1.3%
Adductor Angle	**Normal**	52	69.3%
	Moderate abnormal	16	21.3%
	Definate abnormal	3	4.0%
Dorsiflexion Angle	**Normal**	50	66.7%
	Moderate abnormal	20	26.7%
	Definate abnormal	1	1.3%
Rigtening reaction	**Normal**	51	68.0%
	Moderate abnormal	11	14.7%
	Definate abnormal	9	12.0%
Raise to sit	**Normal**	48	64.0%
	Moderate abnormal	14	18.7%
	Definate abnormal	9	12.0%
Reverse Manuever	**Normal**	46	61.3%
	Moderate abnormal	16	21.3%
	Definate abnormal	9	12.0%
Primitive Reflex	**Normal**	60	80.0%
	Moderate abnormal	14	18.7%
	Definate abnormal	1	1.3%
Palate and Tongue	**Normal**	68	90.7%
	Moderate abnormal	0	0.0%
	Definate abnormal	3	4.0%

Head circumference was normal in 63 newborns, 1 had definite abnormality. 9 of the infants although did not have microcephaly for their GA, their head size was small for their weight/ length. Anterior fontanel was normal in all while 10 had definite cranial suture abnormality. Neurosensory abnormality was seen in 13 newborns (17.3%). In them, 7 had moderate abnormality while 6 had definitive abnormality. Abnormality was most observed in Arm recoil -28(37.3%), scarf sign 25(33.3%), and reverse maneuver (33.3%) signs. Among other signs Popliteal angle was abnormal in 19 (25.3%), Adductor angle was abnormal in 19 newborns (25.3%), dorsiflexion was abnormal in 21(28%), Rightening reaction was abnormal in 20 (26.7%) and abnormality in Raise to sit seen in 23 newborns (30.7%). Primitive reflexes were abnormal in 15 newborns (20%).

Table 3: Gestational age wise outcome at 40 weeks

Gestational Age	**Outcome at 40 Weeks**			**P Value**
	Normal	**Moderate abnormal**	**Definate abnormal**	
	Frequency/%	**Frequency/%**	**Frequency/%**	
below 30 wk	10 (90.9%)	1 (9.1%)	0 (0.0%)	0.001
30 to 31 + 6 wk	10 (100%)	0 (0.0%)	0 (0.0%)	
32 to 34 + 6 wk	18 (75.0%)	6 (25.0%)	0 (0.0%)	
35 to 36 + 6 wk	6 (31.6%)	10 (52.6%)	3 (15.8%)	
≥37wk	10 (90.9%)	0 (0.0%)	1 (9.1%)	
Total	54 (72.0%)	17 (22.7%)	4 (5.3%)	

At 40 weeks the moderately abnormal & definite abnormal neurological assessment were highest in 35-36+6wk gestation age group i.e. 10(52.6%) & 3(15.8%) respectively. It was also noticed that neurological abnormality was minimum in preterm group that is below 30-31+6 week's age group. It appears that prematurity in itself is not the risk factor for neurological abnormality.

Table 4: At 3 months on follow up

At 3 months		**Frequency**	**%**
HC	**Normal**	71	94.7%
	Moderate abnormal	0	0
	Definate abnormal	1	1.3%
AF	**Normal**	75	100.0%
	Moderate abnormal	0	0.0%

	Definate abnormal	0	0.0%
Suture	**Normal**	74	98.7%
	Moderate abnormal	0	0.0%
	Definate abnormal	1	1.3%
Fix & track	**Normal**	71	94.7%
	Moderate abnormal	3	4.0%
	Definate abnormal	1	1.3%
Response to voice	**Normal**	73	97.3%
	Moderate abnormal	1	1.3%
	Definate abnormal	1	1.3%
Crying	**Normal**	73	97.3%
	Moderate abnormal	1	1.3%
	Definate abnormal	1	1.3%
Arm Recoil	**Normal**	68	90.7%
	Moderate abnormal	4	5.3%
	Definate abnormal	3	4.0%
Scarf Sign	**Normal**	68	90.7%
	Moderate abnormal	4	5.3%
	Definate abnormal	3	4.0%
Popliteal Angle	**Normal**	68	90.7%
	Moderate abnormal	4	5.3%
	Definate abnormal	3	4.0%
Adductor Angle	**Normal**	68	90.7%
	Moderate abnormal	4	5.3%
	Definate abnormal	3	4.0%
Dorsiflexion	**Normal**	61	81.3%
	Moderate abnormal	11	14.7%
	Definate abnormal	3	4.0%
Righting reaction	**Normal**	68	90.7%
	Moderate abnormal	4	5.3%
	Definate abnormal	3	4.0%
Reverse Maneuevers	**Normal**	68	90.7%
	Moderate abnormal	3	4.0%
	Definate abnormal	4	5.3%
Premitive Reflex	**Normal**	68	90.7%
	Moderate abnormal	3	4.0%
	Definate abnormal	4	5.3%
Palate & Tongue	**Normal**	74	98.7%
	Moderate abnormal	0	0.0%
	Definate abnormal	1	1.3%

Head circumference was normal in 71 newborns. While 1 had moderate abnormality, none had definite abnormal head circumference. 3 others had small head for their weight/length. Anterior fontanel was normal in all and only one of the newborn had cranial sutural abnormality. Incidence of Sensory abnormalities were low at 3 months. Fix & track was moderately abnormal in 3 & definitely abnormal in 1 (total 5.3% abnormality). Response to voice and crying was abnormal in 2 newborns each (2.6%). Arm recoil, scarf sign, popliteal angle, Rightening reaction & adductor angle were moderately abnormal in 4 and definitely abnormal in 3 newborns (9.3% abnormal in each group). Incidence of Dorsiflexion abnormality was very high-14(18.7%). 11 had moderately abnormality and 3 had definitely abnormalities. Reverse manuever & primitive reflex was normal in 68, moderately abnormal in 3 and definitely abnormal in 4 newborns Palate & tongue was normal in 74, none had moderately abnormality and definitely abnormality in 1 newborn.

Table 5: Gestational age wise outcome at 3 months

Gestational Age	**Outcome at 3 months**			**P Value**
	Normal	**Moderate abnormal**	**Definate abnormal**	
	Frequency/%	**Frequency/%**	**Frequency/%**	
below 30 wk	10 (90.9%)	1 (9.1%)	0 (0.0%)	0.361
30 to 31 + 6 wk	10 (100%)	0 (0.0%)	0 (0.0%)	

32 to 34 + 6 wk	22 (91.7%)	2 (8.3%)	0 (0.0%)
35 to 36 + 6 wk	15 (78.9%)	1 (5.3%)	3 (15.8%)
≥ 37wk	10 (90.9%)	0 (0.0%)	1 (9.1%)
Total	67 (89.3%)	4 (5.3%)	4 (5.3%)

At 3 months the moderately abnormal & definite abnormal neurological assessment were highest in 35-36+6 wk gestation age group i.e. 1(5.3%) & 3(15.8%) respectively. 10 newborns who are moderately abnormal in 35-36+6 wk age group at 40 wks when followed at 3 months of age only 1 found to be moderately abnormal rest 9 have normal neurological assessment while 3 newborns who are definitely abnormal at 40 wks of gestation in same group are found to be definitely abnormal when followed at 3 months of age. In newborns who were born at 32-34+6 of gestation when assessed at 40 weeks of gestation only 6 were moderately abnormal while none were definite abnormal . Among 6 newborn who were moderately abnormal when followed up at 3 months of age only 2 were moderately abnormal rest 4 were normal

.

Table 6: Effect of maternal risk factor on neurological outcome of newborn

Mother Information		**Outcome at 40 Weeks**			**Outcome at 3 months**			**p value**	
		Normal	**Moderate abnormal**	**Definate abnormal**	**Normal**	**Moderate abnormal**	**Definate abnormal**	**40 wks**	**3 months**
IVF Conceived	10	10 (100%)	0 (0.0%)	0 (0.0%)	10 (100%)	0 (0.0%)	0 (0.0%)	0.106	0.502
Fetal Distress	35	23 (65.7%)	12 (34.3%)	0 (0.0%)	31 (88.6%)	4 (11.4%)	0 (0.0%)	0.021	0.018
Preterm Labour	15	13 (86.7%)	2 (13.3%)	0 (0.0%)	15 (100%)	0 (0.0%)	0 (0.0%)	0.320	0.326
Diabeties	5	5 (100%)	0 (0.0%)	0 (0.0%)	5 (100%)	0 (0.0%)	0 (0.0%)	0.353	0.726
PIH	12	8 (66.7%)	4 (33.3%)	0 (0.0%)	10 (83.2%)	2 (16.7%)	0 (0.0%)	0.464	0.119
HTN	0	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	–	–
Hypothyroidism	9	7 (77.8%)	2 (22.2%)	0 (0.0%)	7 (77.8%)	2 (22.2%)	0 (0.0%)	0.743	0.0446
Others	0	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	–	–
Placenta Previa	0	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	–	–
Abruptio Previa	0	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	–	–
PROM	4	2 (50.0%)	2 (50.0%)	0 (0.0%)	4 (100%)	0 (0.0%)	0 (0.0%)	0.386	0.777
Oligo – Hydramnios	6	4 (66.7%)	2 (33.3%)	0 (0.0%)	6 (100%)	0 (0.0%)	0 (0.0%)	0.704	0.677
Liquor									
Clear	74	53 (71.6%)	17(22.9%)	4(5.4%)	66 (89.2 %)	4(5.4%)	4(5.4%)	0.876	0.985
MSL	1	1 (100%)	0 (0.0%)	0 (0.0%)	1 (100%)	0 (0.0%)	0 (0.0%)		
Steroid Administration	49	43 (87.8%)	6 (12.2%)	0 (0.0%)	47 (95.9%)	2 (4.1%)	0 (0.0%)	<0.001	0.013

Among all the maternal factors, fetal distress was one of the common and major risk factor for neurological disabilities in the newborn both at 40 wks of gestational age(p=0.021) and also at 3months of age (p=0.018) although only moderate abnormalities seen in these children. Among the 75 enrolled subjects, 35 had history of fetal distress. In those who had fetal distress, newborns of 12 of them had moderate neurological abnormality at 40wks of gestational age. On follow up at 3 months 8 of them were normal on examination and 4 remained moderately abnormal. None of the infants born to the 10 IVF conceived mothers had any abnormal neurological outcome. Although some of the newborns who had mothers with preterm labour, diabetes in pregnancy, pregnancy induced hypertension, hypothyroidism in pregnancy, premature rupture of membrane, oligohydrominos were having moderate abnormality on neurological examination, they did not to have any statistical significance in my study as risk factors for abnormal neurological outcome in newborn(P>0.05). Some of the newborns who were born to mothers with history of pregnancy induced hypertension and hypothyroidism also had moderate neurological abnormalities at 40wk of gestational age and at 3months. But they were not statistically significant to call for any association (P>0.05). 4 of the newborns had history of premature rupture of membrane and 6 of the newborns had oligohydrominos. Among them 2 in each group had transient moderate neurological abnormality at 40wks of gestational age. On follow up at 3month they have become neurological normal. 49 neonates (65%) had mothers, who have taken full course of steroids antenatally. None of them had definitive abnormality either at 40 wks of GA or at 3 months on follow up. Only 6 (12.2%) of them had moderate neurological abnormality at 40 wks of GA, even in those 4 have become normal at 3 months follow up. So, the group who were given antenatal steroids (4% neurologically abnormal) have significantly lower neurological abnormality in comparison to overall cohort (10.6% neurologically abnormal). This phenomenon of decreased incidence of abnormal neurological outcome observed both at 40 wks of GA (P<0.001) and 3 months follow up (P=0.013).

Table 7: Affect of neonatal risk factor on their neurological outcome

Neonatal Information		Outcome at 40 Weeks			Outcome at 3 months			p value	
		Normal	Moderate abnormal	Definate abnormal	Normal	Moderate abnormal	Definate abnormal	40 wks	3 months
Female	24	15 (62.5%)	8 (33.3%)	1 (4.2%)	21 (87.5%)	2 (8.3%)	1 (4.2%)	0.316	0.705
Male	51	39 (76.5%)	9 (17.6%)	3 (5.9%)	46 (90.2%)	2 (3.9%)	3 (5.9%)		
Re-Admission	2	0 (0.0%)	2 (100.0%)	0 (0.0%)	0 (0.0%)	2 (100%)	0 (0.0%)	0.030	<0.001
Resuscitation	20	12 (60.0%)	6 (30.0%)	2 (10.0%)	16 (80.0%)	2 (10.0%)	2 (10.0%)	0.316	0.287
Excessive Weight loss	0	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	–	–
Respiratory Distress	70	50 (0.0%)	16 (0.0%)	4 (0.0%)	62 (88.6%)	4 (5.7%)	4 (5.7%)	0.839	0.726
Feed intolerance	2	2 (100.0%)	0 (0.0%)	0 (0.0%)	2 (100%)	0 (0.0%)	0 (0.0%)	0.671	0.885
NEC	0	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	–	–
Culture Positive Sepsis	17	13 (76.5%)	3 (17.6%)	1 (5.9%)	13 (76.5%)	3 (17.6%)	1 (5.9%)	0.853	0.036
Probable Sepsis	36	19 (52.8%)	14 (38.9%)	3 (8.3%)	32 (88.9%)	1 (2.8%)	3 (8.3%)	0.002	0.365
Shock	16	10 (62.5%)	5 (31.3%)	1 (6.3%)	12 (75.0%)	3 (18.8%)	1 (6.3%)	0.622	0.025
Birth Asphyxia	6	2 (33.3%)	2 (33.3%)	2 (33.3%)	2 (33.3%)	2 (33.3%)	2 (33.3%)	0.004	0.000
ICH	3	2 (66.7%)	0 (0.0%)	1 (33.3%)	2 (66.7%)	0 (0.0%)	1 (33.3%)	0.070	0.085
Seizures	13	6 (46.7%)	3 (23.1%)	4 (30.8%)	7 (53.8%)	2 (15.4%)	4 (30.8%)	<0.001	<0.001
CHF	0	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	–	–
Anemia	7	4 (57.1%)	3 (42.9%)	0 (0.0%)	4 (57.1%)	3 (42.9%)	0 (0.0%)	0.361	<0.001
Thrombo-cytopenia	6	6 (100%)	0 (0.0%)	0 (0.0%)	6 (100%)	0 (0.0%)	0 (0.0%)	0.281	0.677
Hyperbilirubi-nemia	48	35 (72.9%)	13 (27.1%)	0 (0.0%)	44 (91.7%)	4 (8.3%)	0 (0.0%)	0.016	0.009
Poly-cythemia	1	1 (100%)	0 (0.0%)	0 (0.0%)	1 (100%)	0 (0.0%)	0 (0.0%)	0.821	0.941
Hypo-thermia	0	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	–	–
Hypo-calcemia	4	4 (100%)	0 (0.0%)	0 (0.0%)	4 (100%)	0 (0.0%)	0 (0.0%)	0.440	0.777
Hyper-calcemia	1	1 (100%)	0 (0.0%)	0 (0.0%)	1 (100%)	0 (0.0%)	0 (0.0%)	0.821	0.941
Hypo-glycemia	4	4 (100%)	0 (0.0%)	0 (0.0%)	4 (100%)	0 (0.0%)	0 (0.0%)	0.440	0.777
Hyper-glycemia	0	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	–	–
Hyper-kalemia	0	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	–	–
Hypo-kalemia	4	4 (100%)	0 (0.0%)	0 (0.0%)	4 (100%)	0 (0.0%)	0 (0.0%)	0.44	0.777
Hyper-natremia	2	0 (0.0%)	2 (100%)	0 (0.0%)	2 (100%)	0 (0.0%)	0 (0.0%)	0.030	0.885
Hypo-natremia	4	1 (25.0%)	3 (75.0%)	0 (0.0%)	3 (75.0%)	1 (2.5%)	0 (0.0%)	0.036	0.184
Hypo-magnesemia	0	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	–	–
Apnea	3	2 (66.7%)	1 (33.3%)	0 (0.0%)	3 (100%)	0 (0.0%)	0 (0.0%)	0.845	0.830
HIE stage									
0	57	48 (84.2%)	9 (15.8%)	0 (0.0%)	55 (96.5%)	2 (3.5%)	0 (0.0%)	<0.001	<0.001
1	13	6 (46.2%)	7 (53.8%)	0 (0.0%)	11 (84.6%)	2 (15.4%)	0 (0.0%)		
2	4	0 (0.0%)	1 (25.0%)	3 (75.0%)	1 (2.5%)	0 (0.0%)	3 (75.0%)		
3	1	0 (0.0%)	0 (0.0%)	1 (100%)	0 (0.0%)	0 (0.0%)	1 (100%)		
Ventilation	47	29 (61.7%)	15 (31.9%)	3 (6.4%)	40 (85.1%)	4 (8.5%)	3 (6.4%)	0.032	0.235

70 of 75 enrolled subjects had respiratory distress, out of them 16(22.8%) had moderate neurological abnormality (tone abnormality) at 40 wks of gestational age. 12 of them became normal at 3 months and 4(5.7%) remained moderately abnormal. All the 4 neonates who had definite abnormality had respiratory distress and remained so at follow up. But results were not statistically significant to prove any association between respiratory distress and abnormal neurological outcome (P>0.05). 6 of the newborns had birth asphyxia, of whom 2 had moderate neuronal abnormality and another 2 had definite neuronal abnormality at 40 wks of GA. On follow up at 3months also the neurological status of them remained same. Birth asphyxia appears to be a risk factor for neurological abnormality in newborn (p=0.004). All the 4 newborns who have got definite neurological abnormalities had history of seizures. In the study total 13 newborns had seizures. Beside the 4 definite abnormal newborns, 6 were normal and 3 were moderately abnormal neurologically at 40 wks of gestational age. 1 of the moderately abnormal child had become normal at follow up. So occurrence of seizure at neonatal period on itself appears to be a risk factor for neurological abnormality(P<0.001). 53 neonates had either culture positive sepsis (17) or probable sepsis (36). Out of them 17 (32%) had moderate neurological abnormalities and 4(7.5%) had definite abnormalities. On follow up at 3 months, 13 of the moderate abnormal have become normal, while all 4 definite abnormal newborns continued to be abnormal. Sepsis also appeared to be associated with neurological abnormality in the newborn (P=0.002). 48 of the neonates had hyperbilirubinemia. At 40wks of gestational age, 13 (27.3%)of these children had moderate neurological abnormalities but only 4 remained moderately abnormal at the end of 3 months follow up. Hyperbilirubinemia had significant association with moderate neurological abnormality of the newborn both at 40 wks of gestation(p=0.016) age and at 3 months of age (p=0.009). 7 of the infants had anemia, out of which 3 had moderate neurological abnormality at 40 wks of gestational age as well as 3 months age on follow up. It appears to have a significant association (p<0.001) with moderate neurological abnormality in the newborns. 3 had ICH, 1 had polycethemia, 3 had apnea. The incidence of these factors is too low in the study group to look for any association of them with neuro abnormality in newborns. Electrolyte abnormalities were seen in few of the subjects. 4 had hypocalcemia ,1 had hypercalcemia, 4 had hypokalemia, 2 had hypernaterimia, 4 had hyponaterimia. Beside these 4 had hypoglycaemia. Among all the children who had electrolyte abnormality, only those with sodium abnormality had either transient or lasting neurological abnormality. Both the children who had hypernaterimia note to have moderate neuronal abnormality (p=0.03) at 40 wks of gestational age who have become normal at 3 months follow up. Out of the 4 chldren who had hyponatremia, 3 had moderate abnormality at 40 wks of GA but on follow up at 3months only 1 remained moderately abnormal. So among all the electrolyte abnormality hypernatremia/hyponatremia appears to be associated with at least transient moderate neurological abnormality. 47(62.6%) of the children needed ventilation. At 40 wks of GA 15 (31.9%) had moderate abnormality and 3(6.4%) had definite abnormality. On follow up at 3 months, 4 of moderate abnormal remained moderately abnormal, all 3 of the definite abnormal remained definite abnormal. Ventilation appears to have an association with transient neuronal abnormality in newborn (p=0.032). Out of 75 children, 18 children had HIE. In the 13 children who had HIE stage 1, 7 had moderate abnormality (53.8%) at 40 wks of GA. Only 2 of them (15.4%) remained moderately abnormal at 3months of age, rest have become normal. 4 of the children had HIE stage 2, of whom 1 had moderate abnormality(25%), 3 had definite abnormality(75%) at 40 weeks of GA. On follow up at 3 months, moderate abnormal child has become normal and 3 definite abnormal children remained definitive abnormal. Child who had HIE stage 3, was definitively abnormal at 40wks of GA, as well as at 3months. It indicates that those diagnosed with HIE stage 2 and 3 have poor neurological outcome (P<0.001).

DISCUSSION

Advance in medical management have greatly improved the survival of newborns but mere survival doesn't completely satisfy holistic approach of health. If the child remains dependent for life on the family, it will be huge burden not only on family but also on the society as well. So, there is need to understand the incidence and severity of these neurological problems and their risk factor for their causation. Neurological assessment of neonate may provide objective assessment of nervous system function. So that we can intervene early and help the child achieve his/her maximum neurological development.

In our study 75 high risk newborns 64(85.3%) preterm and 11(14.7%) term neonates) followed at 40 weeks of completed Gestational age, 54(72%) were neurologically normal, 17 (22.7%) were moderately abnormal, 4 (5.3%) were definitive abnormal. On follow up at 3 months the normal and definitive abnormal infants remained neurologically same. Among the 17 moderate abnormal infants 13 (76.5%) have become normal and only 4(23.5%) remained moderately abnormal on neurological examination at 3 months on follow up. In our study also as there were multiple risk factors in a child. In the mothers who had children with moderate/definitive neurological abnormality, fetal distress was seen in 12, preterm labour occurred in 2, PIH was noted in 4, PROM in 2, oligohydramnios seen in 2 and Hypothyroidism in 2. As there were multiple factors in many of these children establishing an association with neurological abnormality was very difficult and it needs focused studies on each factor to prove or disapprove any association.

In the purulia study[10] in India, of the 134 developmentally delayed children 62 were preterm, 80 were LBW, 52 had sepsis, 14 had convulsions, 39 had birth asphyxia, 14 had jaundice. But they were not able to prove any direct association to these factors as many children had more than one illness or factor. In our study some of maternal risk factors and neonatal factors seem to be associated with neurological abnormality in the newborn. But only some had statistically significant association.

Brandes et al[11] done a cohort study to assess the physical and mental development of infants born after in vitro fertilization (IVF) , born between February 1985 and March 1989 in their institute with 116 non-IVF matched controls. They examined these children (ranged 12-45 months) by Bayley and Stanford-Binet scales and found no difference in the developmental indices between the matched controls and the study group.

In our study fetal distress appeared to be a significant risk factor for neurological disability [P- 0.021(40 weeks), P-0.018 at 3 months]. Among the 35 children who had fetal distress, 12 had moderate neurological abnormality at 40 weeks of GA and out of 12, 4 remained moderate abnormal at 3 months follow up. But none had definitive abnormality. I failed to find any previous studies in literature about association of fetal distress with neuronal damage in newborn, even after extensive search in pubmed and Embase. In our study, prematurity on itself did not appear to be a risk factor for neurological abnormality in the infants. Out of 21 newborns with GA<32 weeks, 20 (95.2%) were neurologically normal, 1(4.8%) was moderately abnormal at 40 weeks and 3 months. In 43 newborns who were of GA between 32-37 weeks, 16(37.2%) were moderately abnormal neurologically, 3 (7%) were definitive abnormal at 40 wks of GA, of them 3(7%) definitive abnormal remained same but out of 16, 3(7%) remained moderately abnormal and rest became normal at 3 months. Only one (9%) of the total 11 term newborns had definitive neurological abnormality, with rest of them being normal both at 40 wks of GA and 3 months. With decreasing gestational age there is no increase in neuro abnormality at either 40 weeks of GA or at 3 months on follow up

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In a Prospective national cohort study in England by Tamanna Moore et al[12] , Of the 576 babies evaluated after birth in 2006, 13.4% (n=77) were found to have severe impairment and 11.8% (n=68) moderate impairment. They also found that prevalence of neurodevelopmental impairment was significantly associated with length of gestation, with greater impairment as gestational age decreased. Júlia L et al[13], in their study in brazil on preterms also found that they have increased incidence of behavioral and cognitive disorders at preschool age and also low IQ. Dr. Manikum Moodley[14], in his recent study in USA, including 100 newborns of diabetic mothers, noted hypotonia in these children (P=0.03). He further noted that this was even more common in those born to Type-I DM mothers. Beside many congenital malformations and metabolic complications, infants of diabetic mothers are also suspected to have increased neurological abnormalities. In a study done by E Stenninger et al[15], they found that children born to mothers with diabetes mellitus during pregnancy, who subsequently developed neonatal hypoglycaemia, experienced long term neurological dysfunction related to minimal brain dysfunction/deficits in attention, motor control, and perception.

In our study we found some of the neonatal factors along with maternal factors mentioned above having association with neurological abnormality. Mwaniki MK et al16 reported that most common neurological sequelae after antenatal or perinatal insult were learning difficulties, cognition, or developmental delay (n=4032; 59%); cerebral palsy (n=1472; 21%); hearing impairment (n=1340; 20%); and visual impairment (n=1228; 18%). The overall median risk of at least one sequela in any domain was 39·4%. Nandita Chattopadhyay et al[17] in their purulia study in India some of the high risk factors having more strong association than others, mainly neonatal factors. They found LBW, prematurity and neonatal illnesses as major contributors to Neurodevelopmental disorders among high risk newborns.

Kesiak M et al[18] after review of many studies, opined that antenatal steroid therapy reduced the incidence of intraventricular haemorrhage in preterm infants, Use of betamethasone reduced the incidence of periventricular leukomalacia in extremely low weight infants. In our study 49 neonates (65%) had mothers, who have taken full course of steroids antenatally. None of them had definitive abnormality either at 40 wks of GA or at 3 months. Only 6 (12.2%) of them had moderate neurological abnormality at 40 wks of GA, even in those 4 have become normal at 3 months follow up. So the group who were given antenatal steroids (4% neurologically abnormal) have significantly lower neurological abnormality in comparison to overall cohort (10.6% neurologically abnormal). This phenomenon of decreased incidence of abnormal neurological outcome observed both at 40 wks of GA (P<0.001) and 3 months follow up (P=0.013). So use of antenatal steroids might have neuro protective role for the newborn.

CONCLUSION

High risk newborns have increased Incidence (10.6%) of neurological abnormality in comparison to overall newborn population (4-5%). Those newborns who were neurologically normal and those who were definitively abnormal, remained so even at follow up. Moderate abnormal newborns are likely to improve and unlikely to deteriorate. Fetal distress was one of the common and major risk factors for neurological disabilities in the newborn both at 40 wks of gestational age(p=0.021) and also at 3months of age (p=0.018). Prematurity and IVF conception by themselves did not appear to be a risk factor for abnormal neurological outcome in the newborn. Use of antenatal steroids appear to decrease incidence of neurological abnormality in the newborn(P<0.001). Those diagnosed with HIE stage 2 and 3 have poor neurological outcome (P<0.001). Birth asphyxia appeared to be a risk factor for neurological abnormality in newborn (p=0.004). Neonatal seizures appeared to be a risk factor for poor neurological outcome (P<0.001). Sepsis also appeared to be associated with neurological abnormality in the newborn (P=0.002). Hyperbilirubinemia had significant association with moderate neurological abnormality of the newborn both at 40 wks of gestation(p=0.016) age and at 3 months of age(p=0.009).

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