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Neurodevelopmental outcome of "At Risk" Newborns at 18 month of Age (Using CDC-KIMS Model)

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Abstract
Objectives: Present study was done with following objectives: Follow up of 'At risk' NICU graduates for Growth and Neurodevelopmental outcome at 12 to 18 months of age using CDC-KIMS model, to study the risk stratification profile of these graduates and its impact on Neurodevelopmental impairment and to develop "risk score" from the risk stratification profile.
Material and Methods: This is a prospective observational cohort study in neonates with risk factor for developing Neurodevelopmental impairment were followed up for a period of one and a half year to observe their neurodevelopmental outcome. The study was conducted at the High Risk Newborn follow up Clinic of the Department of Pediatrics, SSG hospital, Vadodara. Ninety patients completed 12 to 18 months follow up, who were analyzed in the final results. High Risk grading and stratification was done according to the CDC-KIMS model. All the perinatal details and their course in the NICU were noted in the predesigned Proforma.
Results: The Male: Female ration observed in the total hospital admissions during our period of study was 1.3:1. There was a significant difference seen when the different risk groups were compared for their stay in NICU and total hospital stay. The mean length values did not show any significant difference ($P > 0.05$) between the risk groups at birth and on follow up at 3, 6, 9 and 12 months with 95% confidence limit. There is a significant chance ($P < 0.05$) of abnormal DASII and mild delay in the group having complex course / hypoxia, apnea, hypotension.
Conclusion: CDC-KIMS model for neuron developmental follow up is user friendly. At the time of discharge "At risk" new born should stratified into mild, moderate and high risk group should have detailed initial assessment.

Keywords: High risk group, hypoxia, NICU, neurodevelopmental impairment

Introduction

There has been tremendous improvement in neonatal care in the last two decades. The sustained global initiatives, efforts of local government, technological advances in neonatology, the close obstetric-neonatal collaboration and better understanding of neonatal patho-physiology have steadily improved the survival of the low birth weight, preterm, birth asphyxiated and other high risk thought to be fatal [1, 2, 3]. As a result, a whole new generation of NICU graduates is emerging.

Babies cared for in NICU are at high risk of developing major and minor Neurodevelopmental abnormalities in the long term. The most pertinent issues in care of sick newborns are chances of survival and intact long term neurodevelopment. It is the question of quality of life in terms of the neurodevelopment competence that has been a major concern to quite a few research workers [4, 5, 6].

Numerous studies have shown that despite substantial improvements in the neonatal mortality, the incidence of chronic morbidities and adverse outcomes among survivors have not declined much [7].

There have been methodological problems in follow-up studies producing conflicting data about the sequel of being *'at risk'* [8]. As the total number of survivors at potential risk for neurodevelopmental morbidity increases, many clinical research questions with major ramifications on medical care have evolved. These questions can be answered only by performing long-term follow-up studies.

However, a detailed and rigorous follow-up of all the neonates discharged from a particular health facility would be neither practical nor feasible because of the cost and subject dropout. Therefore, it is important to select a cohort of neonates who are at a higher risk of developing

these adverse outcomes – *'at-risk' infants.* Surprisingly, there are no standardized guidelines for follow up of high risk infants even in tertiary care centers [9, 10].

A part from the initial biologic risk, perinatal interventions designed to address these risks may substantially affect later development. So extended follow-up is critical to identify possible negative effects that a medical intervention or the standard of care might have on the child's brain and that are not obvious in the first year of life [11, 12]. There has been an increase in high-prevalence, low-severity dysfunctions, particularly in small, premature infants. These abnormalities include learning disabilities, borderline to low-average intelligence quotients (IQs), attention-deficit/hyperactivity disorder (ADHD), specific neuropsychological deficits (e.g. visual motor integration, executive function), and behavior problems [13-16].

There are a substantial number of neonatal discharges from our NICU, who are followed up in our High Risk Clinic. For our study, this CDC-KIMS model was used to identify the at risk neonates and stratify them for growth and neurodevelopmental follow up.

Present study was done with following objectives

a. Follow up of 'At risk' NICU graduates for Growth and Neurodevelopmental outcome at 12 to 18 months of age using CDC-KIMS model
b. To study the risk stratification profile of these graduates and its impact on Neurodevelopmental impairment.
c. To develop "risk score" from the risk stratification profile.

Materials and Methods

This is a prospective observational cohort study. Neonates with risk factor for developing Neurodevelopmental impairement were followed up for a period of one and a half year to observe their neurodevelopmental outcome. The study was conducted at the High Risk Newborn follow up Clinic of the Department of Pediatrics, SSG hospital, Vadodara.

The cohort consisted of Neonates discharged from the Neonatal Intensive Care Unit from Jan to Dec 2007.

Inclusion criteria: NICU graduates admitted and discharged between Jan 2007 and Dec 2007 and satisfying the CSC-KIMS model for risk stratification were selected for the study. (CDC-KIMS model) Informed consent was taken from ther parents for getting enrolled in the study.

Exclusion criteria: neonates who had following conditions were excluded from the study

- Major congenital
- Genetic disease or syndrome
- Congenital heart disease

143 High risk newborn satisfying the inclusion criteria were enrolled for the study. Out of this, 53 patients did not complete more than 6 months follow up and hence were excluded from the final analysis. 90 patients completed 12 to 18 months follow up, who were analyzed in the final results. High Risk grading and stratification was done according to the CDC-KIMS model. The enrolled NICU graduates were classified into Mild, Moderate or High risk group for Neurodevelopmental Impairment according to the highest category of the risk factor which the patients had. NNF definitions were used for defining all the morbidities in the neonatal period The Intrauterine weight chart (AIIMS) was used for assigning the intrauterine growth status.

All the perinatal details and their course in the NICU were noted in the predesigned Proforma. Discharge was planned when the baby was out of morbidity and mother was confident enough to look after the feeding and routing care of the baby at home. During discharge, babies with abnormal neurological examination were enrolled for regular physiotherapy. At each follow up, apart from the routine advice on feeding, immunization, and counseling on child rearing and the felt needs of the parents, a detailed anthropometry was recorded. Weight, height, head circumference were plotted on a growth chart. Developmental screening test (TDSC) was regularly done. Detailed Central Nervous System examination was done. A detailed developmental assessment was done in the patients after the age of 9 to 12 month.

Detailed visual and hearing assessments were done as and when required. Head sonogram was done in all patients; EEG and CT / MRI were done whenever feasible. Full scale DASII was performed by Clinical Psychologist at 9 to 12 months. The Neurodevelopmental Outcome was assigned taking into consideration the clinical findings, the motor and mental developmental scores and quotients. The D.S.M. IV (Diagnostic and statistical Manual-IV) criteria were used to classify the outcome of DASII into normal, mild, moderate or severe delay on motor mental scale. At the end of 12 to 18 months, final clinical diagnosis was assigned *viz*. normal, cerebral palsy, microcephaly, seizures, psychosocial retardations etc.

Statistical analysis

The data were analyzed using SPSS version 15 (SPSS Inc., Chicago, Illinois, USA). For all tests, confidence level and level of significance were set at 95% and 5% respectively.

Result and Discussion

At the end of the study, 90 patients completed 12 to 18 months follow up for growth and neurodevelopment by screening test and 64 infants had full scale developmental assessment done by DASII at 12 months. The detailed composition of this cohort of 90 patients has been described in the subsequent table.

Table1: Sex distribution

Sex	No. of patients
Male	62 (69%)
Female	28 (31%)
Total	90

62 male and 28 females were enrolled in the study. Male: Female ration was observed to be 2:2:1.

As our cohort had equal number of intramural and out born babies and probably because of the gender bias and socio-cultural due to which males are given more priority than females, we observed a high M: F ratio. On the country, McGregor SG S *et al*. [17] observed a ration 1.27:1 in their study.

Table 2: Mode of delivery

Delivery	No. of patients
Normal vaginal	70 (77.7%)
Caesarian section	18 (20.0%)
Instrumental	2 (2.2%)

77.7% were delivered by normal vaginal route; 20% by caesarian section.

Table 3: Gestational age

Gestational age (weeks)	No. of patients
> 2.5	13 (14.4%)
2 – 2.49	13 (21.1%)
1.5 – 1.99	41 (45.5%)
< 1.0	01 (1.1%)

85% were < 2.5 kg and out of that, 45% were between 1.5-2 kg, 17.7% babies were VLBW. The mean gestational age was 36.64 weeks, which was near term.

Table 4: Birth weight

Birth weight (Kg)	No. of patients
> 2.5	13 (14.4%)
2 – 2.49	19 (21.1%)
1.5 – 1.99	41 (45.5%)
1 – 1.49	16 (17.7%)
< 1.0	01 (1.1%)

85% were < 2.5 kg and out of that, 45% were between 1.5 – 2 kg 17.7% babies were VLBW. The average birth weight was 1.88 kg (range – 0.99 to 3.58).

Table 5: Intrauterine growth statues

	Preterm	Full term	Total
AFD	20 (22.2%)	32 (35.5%)	52
SFD	10 (11.1%)	25 (31.1%)	38
Total	30	60	90

42.2% had intrauterine growth retardation (SFD) and 57.7% were appropriate for gestational age (AFD).

Considering their gestational age, 20 (22.2%) were preterm ADF and 32 (35.5%) were full term AFD whereas 10 (11.1%) were preterm SFD and 28 (31.1%) were term SFD. Full term SFD babies formed a large group (31.1%). There were no LFD babies among those enrolled. Comparing with few studies, Kaur A *et al*. observed an equal distribution of SFD and AFS (1.02:1), while Kumar P *et al*. noted a SFD population of 19.3% in their studies.

8.8% of the babies were classified as having mild risk, 47.7% as moderate risk and 43.3% as high risk. We had less number in the mild risk group because such babies are commonly followed up in the well-baby clinic and only few babies satisfied High Risk Clinic follow up criteria.

Table 6: Distribution of variables among the risk groups

Variables	Distributions among the risk group			
	Mild (n=8)	Moderate (n=43)	High (n=39)	Total (n=90)
Gestational age				
>37	6	30	24	60
36 – 34	2	10	11	23
33 – 30	0	3	4	7
Birth Wt				
> 2.5	0	5	8	13
2 – 2.49	2	9	8	19
1.5 – 1.99	6	21	14	41
1 – 1.49	0	8	8	16
< 1	0	0	1	1
Intrauterine Growth status				
AFD	8	24	20	52
SFD	0	19	19	38
Residence				
Vadodara city	8	24	20	52
Vadodara district	0	11	5	16
Out of Vadodara district	0	6	10	16
Maternal Literacy				
Nil	0	7	12	19
Primary	1	18	14	33
Secondary	6	9	4	19
Higher secondary	1	4	6	11
> Higher secondary	0	5	3	8
Mode of Delivery				
Normal	7	37	26	70
LSCS	1	6	11	18
Instrumental	0	0	2	2
Type of Delivery				
Intramural	4	24	16	44
Extramural	4	19	23	46

At birth, all the 3 groups were comparable in their mean birth weight. On following their growth curve in first year, no significant difference (P > 0.05) was noted in the mean weight at 3, 6, 9 and 12 month between the three risk groups. Catch growth occurred in all the 3 groups between 2 to 6 months of age but they fail to cross the WHO 3rd

centile. This was similar to the observations made by Yudkin PL *et al*. [18] in the study of "Growth outcome of high risk baby in 1st year of life" in which Z scores of weight improved significantly from 3 months to 9 months (P=0.013). The mean length values did not show any significant difference (P > 0.05) between the risk groups at birth and on follow up at 3, 6, 9 and 12 months with 95% confidence limit.

Table 7: Comparison of the mean of dasii quotients between. the risk groups

	Mild n=7(8)	Moderate n=32 (43)	High n=25(39)	Total N=64(90)	Significant difference between groups
Motor Quotient	77.57+7.39 (66 – 90)	84.46+13.91 (56 – 111)	67.28+28.05 (21 – 129)	77+21.59 (21 – 129)	II-III (*P*< 0.01)
Mental Quotient	78.85+7.71 (66 – 92)	77.59+12.83 (55- 105)	70.24+29.07 (4 – 114)	74.85+20.56(4 – 114)	None

The motor quotient of the high risk groups is lower than the mild moderate risk group which was also significant statistically (*P*< 0.01). While the difference of mental quotient between the moderate and high risk group was not statistically significant

Table 8: Final Clinical Diagnosis

Final diagnosis / outcome	Mild 8	Moderate 43	High 39	Total 90
Normal child	7 (12%)	30 (51.7%)	21 (36.2%)	58
Mild developmental Day	4 (4.7%)	12 (57.1%)	8 (38%)	21
Quadriplegic CP	0	0	6 (100%)	6
Diplegic CP	0	0	3 (100%)	3
Dystonic CP	0	0	0	0
Hemiplegic CP	0	0	0	0
Hypotonic CP	0	0	0	0
Total CP cases	0	0	9 (100%)	9
Psychosocial / mental delay	0	0	9 (100%)	9
Global delay	0	0	9 (100%)	9
Deafness	0	2 (33.3%)	4 (66.6%)	6
Visual problem	0	0	0	0
Epilepsy	0	0	5 (100%)	5
Head circumference < 3rd centile	3 (6.3%)	18 (38.2%)	26 (55.3%)	47

In our study, out of the total 90 patients, 58 (64.4%) were normal, 21 (23.3%) had mild developmental delay 9 (10%) had Cerebral palsy (6 had Quadriplegia, 3 had Diplegia, while no baby developed Dystonic, Hemiplegic or Hypotonic (CP), All the 9 patients of CP were globally delayed 6 (6.6%) had Deafness 5 (5.5%) had Epilepsy and 47 (52.2%) had head circumference below WHO 3rd centile at the age of 1 year. Visual abnormalities were not present in any baby. One comparing the prevalence of disabilities in our study to the general population, it is noted that NICU graduates are at higher risk of these disabilities than the general population and so should be closely followed up to detect them and start intervention early [20-23].

On comparing the abnormal DASII outcome between AFD and SFD, there was a statistically significant increase for mild delay (*P*< 0.05) in the SFD group, while no significant increase was found for mod/ severe delay in the SFD group (*P*> 0.05). Thorpe K *et al*. [22] in 'neurodevelopmental outcome in LBW: one year follow up', inferred that SFD babies in bigger gestational age group i.e. > 34 week perform worse than those born below 34 weeks, when compared to AGA babies. Goetghebuer *et al*. [23] in their extensive study of preterm babies found that PTSFD babies performed poorly as compared to PTAFD babies

Table 9: Dasii outcome and type of nicu care required

	DASII Abnormal	Mild delay	Mod / Severe Delay
Simple NICU admission n=54	21 (38.8%)	15 (27.7%)	6 (11.1%)
Complex course/hypoxia, apnea, hypotension n=12	7 (58.3%)	5 (41.6%)	2 (16.6%)

There is a significant c hance (*P*< 0.05) of abnormal DASII and mild delay in the group having complex course / hypoxia, apnea, hypotension. Kumar P *et al*. also noticed in his study that babies who had received ventilation (a complex medical course) are at a much higher risk of having NDD. Abnormal DASII and mod / severe delay were seen more significantly (*P*< 0.001) in patient having abnormal neurological examination.

Conclusion

CDC-KIMS model for neurodevelopmental follow up is user friendly. At the time of discharge "At risk" new born should stratified into mild, moderate and high risk group should have detailed initial assessment. Important pointers for neurodevelopmental impairment are poor head growth, abnormal neurological examination, persistent tone abnormalities and high total risk scores.

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