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Original Articles

Neurodevelopmental Assessment in Preterm Neonates at Early Ages: Screening of at-risk Infants for Long Term Sequlae

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Abstract

Background: *Preterm infants are at risk for long term neurodevelopmental impairements. Neurodevelopmental assessment at early months of infancy has been proposed as a valuable tool for prediction of neurodevelopmental outcomes in this population.*

Objective*: The present study attempted to find the neurodevelopmental impairments in preterm infants and thus to identify the at risk infants for follow up and subsequent therapeutic intervention.*

Methodology*: This prospective cross-sectional observational study was conducted in Dhaka Shishu (Children) Hospital from October 2011 to March, 2012. A total 103 preterm neonates who met the inclusion criteria underwent rapid neurodevelopmental assessment (RNDA) at neonatal period and again at their 3 months of age to find the at risk infants for long term neurodevelopmental impairments.*

Results*: Among the enrolled 103 preterm infants during RNDA at neonatal period, abnormal domains found in primitive reflexes 41(39.7%), gross motor 42(40.7%), fine motor 32(31%), vision 40(38.7%), hearing 32 (31%), speech 40(38.7%), cognition 3(2.8%), behavior 3 (2.8%) and 3(2.8%) had seizure. Again in RNDA at 3 months of age, the no. of preterm infants having abnormal developmental domains are: gross motor 49(47.5%), fine motor 19(18.3), vision 9(8.6%), hearing 16(15.4%), speech 15 (14.5%), cognition 6(5.7%), speech 15 (14.5%), cognition 6(5.7%), behavior 11(10.6%) and 3 (2.9%) had seizure.*

Conclusion*: The identification of neurodevelopmental impairments in early months of preterm infants should offer a valuable complement to tools for identification of at risk infants for long term sequlae (in neurodevelopmental impairment).*

Key words*: Preterm, Neonates, Neurodevelopmental assessment.*

Introduction:

Preterm birth is associated with variable degrees of brain injury and adverse neurodevelopmental outcomes.[1] The survival of preterm infants has increased due to improved care in the delivery room and neonatal intensive care unit.[2] However, it has become clear that there is an increased rate of neurodevelopmental abnormalities[3] in preterm infants, even in the absence of ultrasonographic abnormalities of brain. Follow up studies have revealed high rates of neurodevelopmental disability among very preterm infants who survive, with 5 to 15 percent having cognitive, behavioral and social difficulties that impede progress in school and require special educational support.[4]

An estimated 20% of infants are born prematurely in Bangladesh, and 30% have low birth weight (i.e, <2500gm).[5] With a total population of >146 million people, including >20 million children <5 years of age[6], large unrecognized populations may be at risk for neurodevelopmental morbidity, particularly considering that 85% of deliveries occur at home, often with no skilled care, only 7% of births are ever registered; and primary health care services do not

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include screening for the developmentally delayed child.[6] In an epidemiologic survey of disabilities among 2 to 9 year old children in Bangladesh, an estimated 68 of 1000 had some form of disability related to motor, vision, hearing, cognitive disabilities and seizure disorders[7]. A more recent survey suggests that, although the prevalence of disabilities may not have changed in the past decade, there is a shift from serious and obvious disabilities to milder problems related to cognitive disability, behavioral problems, hearing impairments and speech and language delay.[9]

Methodologic issues remain as to how to identify younger children with impairments and disabilities, yet there is a growing awareness among parents of the presence of developmental problems early in the child's life. With fast declining infant and child mortality rates, smaller family sizes, and increasing emphasis on enrollment into primary school, the issue of "quality of survival" is gaining ground.[10]

Quality of survival is of particular concern among preterm infants. A recent review of neurocognitive outcomes of very preterm infants concluded that early identification of disabilities and impairment is vital, because a significant proportion are expected to have problems that need follow-up into the preschool and school years.[11]

The ability to predict outcome improves parental counseling and selection of infants for early therapeutic strategies aiming at preventing or ameliorating cerebral injuries[12]. Recent reviews of early intervention studies in high risk populations have demonstrated the potential to improve long-term cognitive and psychosocial development in children across low and high income countries.[13] A detailed neurologic examination of infants is a valuable predictive tool in terms of later moderate to severe neurodevelopmental impairments.[12]

Rapid neurodevelopmental assessment (RNDA)[14], a reliable and valid neurodevelopmental assessment tool is being used with children <2 years which is particularly useful for early identification of children at high risk for neurodevelopmental impairments. The rapid neurodevelopmental assessment was developed for use in children aged 0 to 24 months in which the following domains are being assessed: primitive reflexes (0to<1 month), gross motor, fine motor, vision, hearing, speech, cognition, behavior and seizures. A summary sheet at the end of the assessment is used to describe the impairment in different domains aids in identification of at risk infants who will be screened for future follow up and subsequent therapeutic intervention.

The purpose of this study was to do neuro-developmental assessment (NDA) of preterm neonates during their neonatal period and again at their 3 months of age to identify neurodevelopmental impairment and thus to screen at risk infants for early therapeutic intervention and subsequent follow up. Thus, this study is of a valuable aid in preventing and ameliorating developmental impairment in preterm infants.

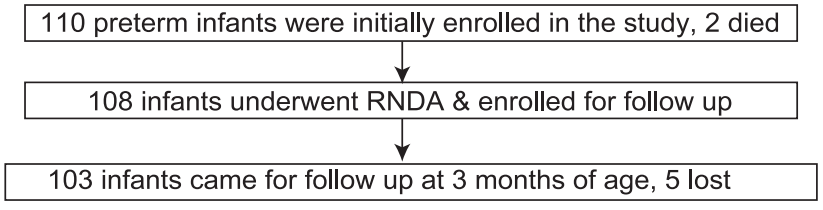
Materials and methods

This was a prospective cross-sectional study carried out in Dhaka Shishu (Children) Hospital (DSH) from October, 2011 to March, 2012. Preterm neonates (<37 weeks of gestational age) without perinatal asphyxia, congenital anomalies, respiratory distress syndrome', sepsis, birth trauma and other neonatal conditions admitted in the neonatal unit of DSH were enrolled for the study. Infants when clinically stable underwent neurodevelopmental assessment (NDA) by RNDA during their stay in the hospital in the neonatal period and again at 3 months of age during follow up. A structured questionnaire was used for recording all the informations including antenatal, perinatal condition and NDA findings.

Results

In this study, 110 preterm neonates who were admitted in the neonatal unit of Dhaka Shishu (Children) Hospital were selected according to inclusion criteria during the study period from October, 2011 to March, 2012.

Algorithm stated below shows the flow chart of the infants:



Observation and results of the study are given below:

Table-I

Distribution of age, gestational age & weight among the study population (n=103)

Age in days (Mean ± SD)	7.23 ± 5.75
Gestational age in weeks mean ± SD	31.85 ± 1.91
Weight in kg (mean ± SD)	1.81 ± 0.17

The mean age (in days) of infants of preterm neonates was 7.23, mean gestational age (in week) was 31.85 and weight (in kg) was 1.81.

Table- II

Rapid neurodevelopment assessment (RNDA) findings of the preterm neonates (n=103) during neonatal period

Domain		Disability grade	No. of Preterm neonates
Primitive reflexes	Normal		62 (60.1%)
		Mild	7 (6.7%)
	Abnormal	Moderate	14 (13.5%)
		Severe	20 (19.4%)
Gross motor	Normal		61 (59.12%)
		Mild	6 (5.7%)
	Abnormal	Moderate	16 (15.3%)
		Severe	20 (19.7%)
Fine motor	Normal		71 (68.9%)
		Mild	3 (2.8%)
	Abnormal	Moderate	10 (9.7%)
		Severe	19 (18.4%)
Vision	Normal		63 (61.1%)
		Mild	5 (4.8%)
	Abnormal	Moderate	15 (14.8%)
		Severe	20 (19.4%)
Hearing	Normal		71 (68.9%)
		Mild	3 (2.8%)
	Abnormal	Moderate	10 (9.7%)
		Severe	19 (18.4%)
Speech	Normal		63 (61.1%)
		Mild	6 (5.7%)
	Abnormal	Moderate	13 (12.6%)
		Severe	21 (20.3%)
Cognition	Normal		100 (97.7%)
	Abnormal		3 (2.8%)
Behavior	Normal		100 (97%)
	Abnormal		3 (2.8%)
Seizure	Absent		100 (97%)
	Present		3 (2.8%)

One hundred and three preterm neonates underwent RNDA during neonatal period. Among these abnormal domains found in no of neonates are as- follow: Primitive refex41 (39.7%), gross motor 42 (40.7%), fine motor 32(31%), vision-40 (38.7%), hearing-32 (31%), speech-40 (38.7%), and cognition- 3 (2.8%), behavior- 3 (2.8%), seizure 3 (2.8%).

Table-III

No. of Preterm infants (n=103) having one or more domain abnormality in RNDA at discharge (n=103)

Single domain affected	No. of Preterm infants	Percentage of preterm infants
Primitive	2	1.94
Gross motor	3	2.9
Fine motor	2	1.94
Vision	1	0.97
Hearing	1	0.97
Speech	1	0.97
Cognition	Nil	Nil
Behavior	Nil	Nil
Seizure	Nil	Nil
More than one domain affected	41	39.8

Out of 103 preterm infants, single domain affected in RNDA is as follows: primitive reflex 2 (1.94%), infant, gross motor 3(2.9%), fine motor 2 (1.94%), vision 1 (0.97%), hearing 1 (0.97%), speech 1 (0.97%).

Table- IV

Rapid neurodevelopment assessment (RNDA) findings of the preterm infants (n=103) at 3 months of age

Domain		Disability grade	No. of Preterm neonates
Gross motor	Normal		54 (52.4%)
	Abnormal	Mild	10 (9.6%)
		Moderate	19 (18.4%)
		Severe	20 (19.7%)
Fine motor	Normal		84 (81.4%)
	Abnormal	Mild	6 (5.7%)
		Moderate	5 (4.8%)
		Severe	8 (7,7%)
Vision	Normal		94 (91.2%)
	Abnormal	Mild	3 (2.8%)
		Moderate	3 (2.9%)
		Severe	3 (3.9%)
Hearing	Normal		87 (84.4%)
	Abnormal	Mild	4 (3.8%)
		Moderate	5 (4.8%)
		Severe	7 (6.7%)
Speech	Normal		58 (85.4%)
	Abnormal	Mild	4 (3.8%)
		Moderate	4 (3.8%)
		Severe	7 (6.75%)
Cognition	Normal		97 (94.1%)
	Abnormal	Mild	6 (5.7%)
		Moderate	3 (2.9%)
		Severe	2 (1.9%)
Behavior	Normal		92 (89.3%)
	Abnormal	Mild	6 (5.7%)
		Moderate	3 (2.9%)
		Severe	2 (1.9%)
Seizure	Normal		100)97%)
	Abnormal		3 (2.9%)

One hundred and three enrolled preterm infants came for follow up at their 3 months of age and underwent RNDA. The no. of infants with abnormal domain are gross motor-49 (47.5%), fine motor-19 (18.3%), vision-9 (8.6%), hearing-16(15.4%), speech-5 (14.5%), cognition-6(5.7%), behavior- 11(10.6%) and seizure in 3 (2.3%) infants.

Out of 103 infants who came for follow up at 3 months age underwent RNDA.Single domain affected in neurodevelopmental outcome in no. of infants are as follow: gross motor 6(5.8%), fine motor 3(2.9%), vision 1(0.97%), hearing 2(1.9%), speech 2(1.9%). No. of infants having more than one domain affected is 36 (34.9%).

Table-V

No. of preterm infants n=103) at 3 months of age having are one or more abnormal domain in RNDA (n=103)

Single domain affected	No. of infants	Percentage of infants
Gross motor	6	5.8
Fine motor	3	2.9
Vision	1	0.97
Hearing	2	1.9
Speech	2	1.9
Cognition	Nil	-
Behavior	Nil	-
Seizure	Nil	-
More than one domain affected	36	34.9

Table-VI

Comparison between rapid neurodevelopmental assessment (RNDA) during neonatal period and at 3 months of age (n=103)

Domain		Disability grade	No. of Preterm neonates		P-value
			At discharge	At 3 months age	
Primitive reflexes	Normal		62 (60.1%)	-	-
		Mild	7 (6.7%)	-	
	Abnormal	Moderate	14 (13.5%)	-	-
		Severe	20 (19.4%)	-	-
Gross motor	Normal		61 (59.2%)	54 (52.4%)	0.24
	Abnormal	Mild	6 (5.8%)	10 ((9.7%)	
		Moderate	16 (15.8%)	19 (18.4%)	0.44
		Severe	20 (19.4%)	20 (19.4%)	0.73
Fine motor	Normal		71 (69.9%)	54 (52.4%)	0.46
		Mild	3 (2.9%)	10 ((9.7%)	
	Abnormal	Moderate	10 (9.7%)	19 (18.4%)	0.122
		Severe	19 (18.4%)	20 (19.4%)	0.02
Vision	Normal		63 (61.1%)	94 (91.2%)	0.02
		Mild	5 (4.8%)	3 ((2.9%)	
	Abnormal	Moderate	15 (14.5%)	3 (2.9%)	0.000
		Severe	20 (19.4%)	3 (2.9%)	0.000
Hearing	Normal		71 (68.9%)	87 (84.4%)	0.91
		Mild	3 (2.9%)	4 (3.8%)	
	Abnormal	Moderate	10 (9.7%)	5 (4.8%)	0.10
		Severe	19 (18.4%)	7 (6.7%0	0.01
Speech	Normal		63 (61.1%)	88 (85.4%)	0.25
		Mild	6 (5.3%)	4 (3.8%)	
	Abnormal	Moderate	13 (12.6%)	4 (3.8%)	0.01
		Severe	21 (20.3%)	7 (6.7%)	0.001
Cognition	Normal		100 (97%)	97 (94.1%)	0,30
		Mild	3 (2.9%)	6 (5.8%)	
	Abnormal	Moderate	-	-	-
		Severe	-	-	-
Behavior	Normal		100 (97%)	92 (89.3%)	0.27
		Mild	3(2.9%)	6 (5.8%)	
	Abnormal	Moderate	-	3 (2.9%)	0.11
		Severe	-	2 (1.9%)	0.23
Seizure	Absent		100 (97%)	100 (97%)	0.60
		Mild	3 (2.9%)	3 92.9%)	
	Present	Moderate	-	-	-
		Severe	-	-	-

Statistically significant difference is found in the following domains of RNDA at discharge (neonatal period) and at 3 months of age: fine motor (severe: $p<0.05$), vision (moderate and severe: $p<0.05$), hearing (severe $p<0.01$) & speech (moderate and severe: $p<0.05$).

Discussion

Children born prematurely are at risk for major and minor neurodevelopmental disabilities. Prediction of outcome is of significance in the neonatal period-when new therapeutic interventions are introduced. Knowledge of the severity and spectrum of impairments is necessary for counseling parents, tailoring follow-up services and allocating early intervention program. A detailed neurologic examination in infancy is a valuable tool for predicting outcome.[12] Keeping these facts in mind and working under low resource set up, the study was done to find the neurodevelopmental impairments in preterm neonates by RNDA during early infancy which may aid in identifying the at-risk infants of long term neurodevelopmental impairment.

In this study, the mean age (in days) of the preterm infants was 7.23, mean gestational age (in weeks) was 31.85 and mean weight (in kg) was 1.81. We found more male (62.1%) than female (37.9%) in the study population. In one study,[15] gestational age (in weeks) was 29±0.9 which is lower than that of this study. The explanation may be that prompt referral to larger hospital with better management of preterm neonates in comparison to our health facilities may lead to survival of large number of very preterm neonates with lower birth weight.

Among the 103 preterm neonates who underwent RNDA during neonatal period, number of infants having abnormal domains are as follows: primitive reflexes 41 (39.8%), gross motor 42(40.7%), fine motor 32(31.05%), vision 40(38.85), hearing 32(31.06%), speech 40(38.8%), cognition 3(2.9%), behavior 3(2.9%) and 5(4.85) had seizure. No of preterm infants having single domain affected during neonatal period are as follow: primitive reflex 2(1.94%), gross motor 3(2.9%), fine motor 2(1.94%), and vision 1 (0.97%) hearing 1(0.0%), speech 1 (0.9%). The number infants having more than one domain affected were 41(39.8%). This study demonstrated that a high proportion of infants had identifiable problems in more than one domains during neonatal period which indicates the necessity to do follow up RNDA.

Follow up neurodevelopmental assessment of the 103 infants was done at 3 months of age. Among them, number of infants having abnormal developmental domains are gross motor 49(47.5%), fine motor 19(18.4%), vision 9(8.7%), hearing 16(15.5%), speech 15 (14.5%), cognition 6(5.5%), behavior 11(10%) and 3(2.9%) had seizure.

Number of infants having single domain affected are as follow: gross motor 6(5.8%), fine motor 3(2.9%), vision 1(0.97%), hearing 2(1.9%), speech 2(1.9%). More than one domain affected in 36(34.9%) infants. The single largest category of neurodevelopmental impairment (NDI) was gross motor abnormality which is greater at 3 months of age than previously in the neonatal period. In contrast, other abnormal domains have come down to lower level. Some studies[16,17,18] showed that motor performance of children born prematurely is affected in 20-40% which is comparable to this study.

In an old study, NDA at 20 months of age disclosed significantly lower Bayley Motor development scores in preterm infants.

Although these comparisons are not directly relevant to this study, but can support to some extent in to do neurodevelopmental assessment during early infancy to predict long term impairment which may help in screening at risk preterm infants. Hopefully, future studies in NDA in early months of preterm infants could be of comparable to this study and may strongly support to do support the routine neurodevelopmental assessment (NDA) by RNDA in preterm infants for at risk preterm infant identification.

Conclusion

This study concluded that preterm neonates are at substantial risk for neurodevelopmental impairments. Routine neurodevelopmental assessment (NDA) by RNDA during neonatal period and frequent follow up NDA at early months of infancy may strongly aid in identifying at-risk infants for future long neurodevelopmental disability.

Limitation of the study

The limitations of the study included single centre and short period of follow up.

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