EARLY PREDICTORS OF NEURODEVELOPMENTAL OUTCOME IN HIGH RISK INFANTS

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Objective: *To find out a few simple and easily elicitable items at three and six months of age that can predict neurodevelopmental outcome at one year in high risk babies. Design: One year longitudinal follow up study.* ***Setting:*** *Hospital based study including inborn and outborn infants discharged from the Neonatal Intensive Care Unit (NICU) of a referral hospital, followed up in a High Risk Clinic.* ***Methods:*** *Sixty high risk babies were followed up longitudinally for a period of one year. A detailed neurodevelopmental examination was done with special attention to the following items - axillary suspension, head support, social smile, disappearance of primitive reflexes and neurobehavior at three months age while pull to sit, rolling over, sitting momentarily without support, transfer of objects and voluntary reach were evaluated at six months age. Bayley Scales of Infant Development (Baroda Norms) was used for assessing the outcome at one year.* ***Results:*** *Babies with absence of social smile, abnormal neurobehavior at three months and absent pulling to sit position, absent voluntary reach, and absent transfer of objects, remained delayed at one year. The specificity of each of these items was 100%. These items had a positive predictive value of 100%.* ***Conclusions:*** *Inability to achieve social smile and abnormal neurobehavior at three months age and absence of pulling to sit position, transfer of objects and voluntary reach at six months age, warrant early intervention. These items are easy to elicit, do not require any special kit or elaborate training. Hence these items can be tested even by those working at the primary level or in office practice.*

Key words: *Early Predictors, High risk infants, Neurodevelopmental Outcome.*

SURVIVAL of the "high risk" newborns(l) has been improving over the past few years. But what lies beyond survival for the Neonatal Intensive Care Unit (NICU) graduates? Neonatal special care is -available in the referral hospitals in cities that cater to a large population scattered hundreds of kilometers around it. Once the high risk baby is discharged from the NICU, it is taken back to the remote village or town, where facilities for sophisticated psychomotor assessment or even care by a Pediatrician *per se,* may not be available. In the urban situation, a detailed neurodevelopmental assessment is not feasible in a busy pediatric practice. Experience has shown that physicians relying solely upon the child's developmental history and clinical examination, tend to overlook developmental aberrations, particularly the milder varieties(2). Hence an attempt was made to find out a few simple predictors of neurodevelopmental outcome in high risk infants from two standard tests for assess-

merit of development, namely, Bayley Scales of Infant Development (BSID) and Amiel Tison's method(3,4). These items do not need a kit or any special training for elicitation and hence can be easily used for evaluating the development of high risk infants.

Subjects and Method

The study was done in the High Risk Follow Up Clinic of K.E.M. Hospital, Pune. The study subjects consisted of NICU graduates with the following risk factors: *(i)* prematurity (gestational age <37 weeks); *(ii)* birth asphyxia; *(iii)* intraventricular hemorrhage; *(iv)* apnea; *(v)* septicemia/ meningitis; *(vi)* hyperbilirubinemia; *(vii)* seizures; and *(viii)* birth weight < 1500 gm (VLBW). Neonates with congenital abnormalities, chromosomal or neuromuscular disorders were excluded. After discharge from the NICU, the infants were followed up at the High Risk Clinic. Detailed neurodevelopmental examination was done at three and six months age with special attention to the following items. Testing was not done if the baby was sick, sleepy or irritable.

At three months: Six simple items were considered at three months. Head support was tested for motor assessment while social smile was tested to see mental development. Axillary suspension was included to give a general idea of tone. Passive tone was judged by doing the Scarf sign in the upper limbs and measuring the adductor angle in the lower limbs (normal angle-40-80°). Persistence of primitive reflexes such as Moro and asymmetrical tonic neck reflex (ATNR) were noted. Neurobehavior of the infant included the state of the child (alert/ irritable/lethargic), feeding difficulties and sleep pattern. The posture, adductor thumb and abnormal movements were also recorded.

At six months: An object was offered to the infant to see if the baby voluntarily reached out for it and to look for transfer from one hand to another. Motor milestones like rolling over and sitting momentarily without support were observed. Passive tone was assessed by checking scarf sign (elbow reaching the midline) and adductor angle (normla angle 70-110°). The active tone was assessed by the pulling to sit position. In the supine position, the infant was encouraged to grasp the examiner's thumbs. Normally the infant will attempt to pull himself to the sitting position, keeping the head in the plane of the trunk without any assistance from the examiner. Corrected age was used for preterm infants(5,6).

These infants were assessed using Baroda Norms(7) at one year ± fifteen days. This was done by a trained psychologist in a specially designed soundproof room with a one way vision mirror. The psychologist was blinded to the earlier neruodevelopmental assessment of these babies and decoding was done only after BSID assessment was completed.

These selected milestones, at three and six months ages, were analyzed statistically to find out their predictive value for neurodevelopmental outcome at one year as assessed by BSID. A mental and motor quotient each >85 was considered as normal. A test was considered positive when a particular item was absent or abnormal (*e.g.,* absence of social smile or a wider adductor angle for that age).

Results

Sixty neonates discharged from the NICU were identified for follow up using eight predetermined criteria. They were followed up prospectively from three months onwards in a High Risk Clinic. Six infants were excluded from the study as two infants missed the testing at six months

while four infants did not come for the scheduled one year assessment on BSID. Hence the final sample consisted of fifty-four infants.

This sample included 25 preterm (PT) infants and 29 full term (FT) infants. One infant was of 28 weeks by gestation and the mean gestational age was 35.20 ± 2.20 weeks. One baby had extremely low birth weight (<1000 g) and the mean birth weight was 1904.76 ± 679.05 g. Nineteen infants (35.7%) were VLBW while nine babies (16.7%) had birth weight above 2500 grams. Prematurity was the commonest inclusion criterion (47.6%), followed by VLBW (35.7%), septicemia (28.5%) and hyperbilirubinemia (26.1%). Birth asphyxia was present in 21.4% of the infants. Apnea and intraventricular hemorrhage were seen in 9.5% while neonatal seizures were documented in 4.7%.

Of these fifty-four infants, thirty infants had more than one risk factor. The median of the number of risk factors in the infants that were delayed was 2 (range, 1-6). The median of the number of risk factors in the infants who were normal was 1 (range, 1-3).

All these infants were assessed clinically at three and six months age with special attention to the selected items. They were tested on BSID (the gold standard) at the age of one year by a trained psychologist.

Nine infants who had not developed social smile and had abnormal neurobehavior at three months turned out to be delayed at one year. All these nine infants had absence of pull to sit maneuver, absence of reach and transfer at six months. Two additional infants were found to have absence of pull to sit and transfer at six months. All these eleven infants remained delayed at one year as judged by BSID. Three infants had cerebral palsy (CP) with mental retardation, of which one was a hypotonic CP and the other two had spastic quadriplegia. Of the fifty-four infants, thirty one were grouped as delayed by BSID. Twenty three infants had both motor and mental quotients of 85 and above and hence were called normal by BSID.

At three months, absence of social smile and abnormal neurobehaviour had a high specificity of 100% although the sensitivity was around 40%. At six months, absence of pulling to sit position, absence of transfer of objects from one hand to another the absence of voluntary reaching out for an object each had a high specificity of 100%. The positive and negative predictive values of each item were calculated based on the BSID quotients. All the above mentioned items had a positive predictive value of 100% but the predictive value of a negative test was around 55% *(Tables I & II).*

Discussion

The amazing advances in the neonatal care in the past decade have improved survival of high risk babies. But just survival is not enough, it is the quality of life that is important! Gross neurodevelopmental ab-

TABLE **I**-*Children Positive for Items Tested at Three Months.*

Items	Positive	BSID at one year	
		Normal	Abnormal
Neurobehavioral-abnormalities	9	0	9
Absent social smile	9	0	9
Absent head support	22	8	14
Persistant neonatal reflexes	15	4	11
Abnormal adductor angle, scarf sign	17	4	13
Abnormal axillary suspension	18	5	13

TABLE II- *Children Positive for Items Tested at Six Months.*

Items	Positive	BSID at one year	
		Normal	Abnormal
Absent pull to sit	11	0	11
Absent transfer of objects	11	0	11
Absent reaching for objects	9	0	9
Abnormal adductor angle, scarf sign	21	5	16
Absent rolling over	14	5	9
Absent sitting with support	32	13	19

normalities are obvious but it is the less severe disability that may not be diagnosed until it is too late(8).

A good regular follow up is a necessity for any NICU graduate. But for pediatricians and general practitioners working in remote places, this is not always possible. Parents of these babies are not really aware that close monitoring is mandatory even though their babies have no apparent illness like fever or diarrhea. Furthermore, problems such as poverty, illiteracy and poor transport facilities result in a poor follow up. Even if the physician knows that the baby is at risk, he or she does not always have, the time to do a detailed neurodevelopmental examination. Assessment using BSID requires a trained psychologist and a special kit. Hence these babies who are so intensively cared for in the NICU are left on their own to accept the consequences of their perinatal illness. Early detection and timely intervention are stressed times and again(9), but the referral age for intervention is far from ideal. Many a times children are referred at an age when not prevention but rehabilitation is the only choice left. Not much can be done for a baby who has already developed contractures but a spastic baby detected early would certainly benefit from early intervention and therapy. Hence the purpose of this study was to find out early and easy indicators that would suggest delayed development.

Neurodevelopmental assessment as early as at three to four months has been reported to be useful(10,ll). Failure to achieve age appropriate milestones may be the first clue to the diagnosis, unless screened periodically(12,13). Six milestones, mental and motor, were selected for testing at three and six months age. The items tested included mental and motor milestones which were easily seen during the routine examination like social smile, reaching for an object. Tests for assessing the general tone like axillary suspension and those for assessing passive tone like scarf sign and adductor angle were also included. Many a times, parents themselves volunteered information like abnormal posture or movements or abnormal behavior of the child (lethargic/irritable). Absence of social smile and abnormal neurobehavior at three months and absence of voluntary reach, transfer of objects and pull to sit at six months predicted delayed development at one year as tested by BSID. The predictive value of a positive test, *i.e.,* absence of a milestone or deviation from normal, was found to be high in the range of 80-100%, though the negative predictive value was not conclusive. The present sample included high risk babies . who obviously had a higher prevalence of disability. As the prevalence of disease increases, the negative predictive value decreases, as seen in this sample.

In a three year study, Ross *et al*.(14) showed that items from nine to twelve months neurodevelopmental examination

correctly classified about 80% of children as to composite outcome at three years. Generally some obvious neurodeficit is evident by nine to twelve months and it may be too late to intervene at this age. Many of ; the abnormalities are transient(8) and may disappear in the second year. But it is difficult to predict in which children they may persist. Hence these simple predictors will alert the physician that close monitoring and early intervention may be required. These simple and easy predictors need to be tested on a bigger sample in a field trial to know whether they can be used for detection of delayed development by primary care personnel such as Aanganwadi workers.

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