INTERNATIONAL JOURNAL OF CURRENT MEDICAL AND PHARMACEUTICAL RESEARCH
ISSN: 2395-6429, Impact Factor: 4.656
Available Online at www.journalcmpr.com
Volume 7; Issue 08(A); August 2021; Page No.5878-5882
DOI: http://dx.doi.org/10.24327/23956429.ijcmpr20211035

Research Article

A STUDY OF PROGNOSTIC SIGNIFICANCE OF APGAR SCORE REGARDING NEURODEVELOPMENT AMONG NEONATES WITH LOW APGAR SCORE IN A TERTIARY CARE CENTER IN SOUTHERN INDIA

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ARTICLE INFO

Article History:
Received 12th May, 2021
Received in revised form 23rd June, 2021
Accepted 7th July, 2021
Published online 28th August, 2021

Key words:
Apgar Score, Neurodevelopment, Psychomotor Development Assessment Tools, Denver Developmental Screening Test (Ddst),

ABSTRACT

Introduction: Neurodevelopmental outcome of babies born with low Apgar score is a matter of growing concern among Paediatricians and neonatologists. We present here a single institution experience with this simple and financially viable way of testing babies using the Denver Developmental Screening Test to detect early aberrations in the neurodevelopment of neonates.

Material and methods: This was a prospective study to assess the neuro- development, using the Denver Developmental screening test (DDST) on 46 children who were born with a low Apgar score in a tertiary care centre. The children were followed up for three years and assessed in the domains of gross motor, fine motor, social and language milestone.

Results: The Neurodevelopment was normal in 36 (78%) babies with low APGAR (score below 7). Four (8%) babies developed delay in various neuro- developmental parameters. In the remaining six (14%) the results were inconclusive.

Conclusion and clinical significance: There was no statistical significance between the degree of asphyxia and DDST findings in our study. Low Apgar Score, *per se,* is not indicative of neuro developmental outcome in the new-borns; low Apgar just reflects the severity of birth asphyxia and urgent need for meticulous and aggressive neonatal resuscitation according to Neonatal Resuscitation Protocol (NRP) guidelines. If administered promptly, the neurodevelopmental outcome of babies with low Apgar score is comparable to those born with a normal Apgar score.

INTRODUCTION

In 1952 Dr Virginia Apgar devised a scoring system that is a rapid method of assessing the clinical status of a new-born infant immediately after birth.[1] The Apgar score was devised with the aim to standardise assessment of new-borns, to determine the need for resuscitation, and to evaluate the effectiveness of resuscitation and its estimation has been a time-honoured routine followed in all delivery rooms. The score was never intended for prediction beyond the immediate postnatal period as it score does not predict neonatal mortality or morbidity. It just reflects the need for prompt resuscitation and ensure smooth transition from intrauterine to extra uterine environment. Dr Apgar selected five signs that could be determined easily without interfering with the care of the infant. The five signs of the score are heart rate, respiratory effort, muscle tone, reflex irritability, and colour. The score is initially measured at 1-min after birth. A second measurement is done at 5mins, thereafter every 5-mins (for upto 25mins postpartum) to assess the effectiveness of continuing resuscitation.[2]

Multiple studies have examined the relation between low Apgar scores and subsequent death and neurologic disabilities, including cerebral palsy, epilepsy, and cognitive impairment. The relative risk estimates were 4-7 for epilepsy, > 20 for cerebral palsy and 1.33 for cognitive impairment. However, the absolute risk was low (<5% for most neurologic conditions) and majority of surviving babies with low Apgar score grew up without disability. Apgar Score has a correlation with future neurodevelopment hence, subsequent assessment of the child becomes imperative. For a long time, the paediatricians have been using "MILESTONES" (the age of achieving certain skills), as a crude index of the child's development. This has its own limitations because one cannot rely on a single parameter for assessing neuro- development of a child especially if the deviation from the normal is not gross. The importance of detecting developmental delays during infancy and the pre-school years has been repeatedly stressed, because an early diagnosis of neuro developmental delay increases the opportunities for effective therapy. Several screening tests are available for assessment of psychomotor development(Table 1).[3,4]Some of the commonly applied tests

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include the Denver Developmental screening test(DDST) (0-6years), Bayley infant neurodevelopment screener (03-24months), the Battelle developmental inventory screening test (6months-08years) and Brigance screens (0-8years).[5,6]The Denver Developmental Screening Test, 2nd edition, is the most widely used test for developmental screening and is generally accepted worldwide because of its ease of use (Figure 1). It takes approximately 20 to 30 minutes to administer and score. It involves a combination of formal testing, direct observation of the child, and eliciting possible parental concerns using a questionnaire. The test covers four domains, namely gross motor, fine- motor, language and personal - social adaptive behaviour.[7]

This prospective study was undertaken to assess the neurodevelopment in neonates born with low Apgar score. DDST was chosen for early detection of infants with neuro-developmentaldelay because of its simple application and extensive acceptance (Table 2). In this study neonates were followed up for a period of three years.

Aim

To study the prognostic significance of Apgar score regarding neurodevelopment among neonates with low Apgar score in a tertiary care centre in Southern India.

MATERIAL AND METHODS

This was a follow up study of 46 Neonates, who were born in a tertiary care centre in Southern India between 2015-2018. All these babies born with a low APGAR score (score < or =7 in first five mins of life) during this period were included in the study.

This study included mothers in the age group of 22 to 33 years. Most of the mothers belonged to the urban population and a majority were from a metropolitan city (93%).The remaining patients hailed from nearby towns. Mothers with both high-risk and low risk pregnancies irrespective of their gravidity and parity status were included in the study. All the mothers included in the study were registered and attended antenatal check-upsat regular intervals in the obstetric clinic of the hospital. Antenatal period of 38 mothers was uneventful. Remaining eight women had a wide spectrum of antenatal illnesses: Pregnancy Induced Hypertension (PIH) (n=4), pre-existing hypertension (n=1), intrahepatic cholestasis of pregnancy (n=2) and bad obstetric history (recurrent abortions) (n=1). One of the mothers had hypothyroidism in addition to PIH.

Immediately after delivery, the Apgar Score was assessed at 1-min, 5-min and 10-min. A quick assessment was made to detect whether the low Apgar Score was because of depression (due to anaesthesia, drugs etc) or asphyxia per se. This is considered important because those with a low score due to asphyxia may require more intense and prolonged resuscitation.

Neonates were discharged from the hospital between Day 2 to Day 28 depending on the clinical progression and recovery after resuscitation. After discharge, all study group neonates were monitored in the institute's well baby clinic periodically once in every six-months up to the age of three years. The first DDST test was performed at the time of discharge from the hospital. Thereafter, the babies were subjected to the DDST every six months. The babies were accompanied by either of the parents (usually the mother) and the test was performed in presence of the parent.

DDST Procedure: Since the test required active cooperation of the child, every effort was made to make the child comfortable. If the child refuses to do the item even when asked by the parent, the item was scored "R". The child was given three trials to perform each item, before a failure is recorded. A "Delay" is any item failed meant, the child failed an item which 90% of children normally can pass at a younger age. "NO" was not counted as a pass or a fail; a "NO" was not used in the interpretation. At the end of the test the parent was asked if the child's performance son the test was typical of his activities at other times. The test was interpreted as being questionable when there were 2 or more delays in one sector or one or more sectors having one delay and in the same sector the age line does not go through an item which is passed.

Statistical Analysis

Data was collected using a semi structured pretested questionnaire. Collected data was entered in Microsoft Excel. Data is represented in frequencies and percentages. Appropriate statistical tests are applied using SPSS software version 21 for analysis. Chi square test is used for association between the study variables. Statistical significance is considered at $p < 0.05$.

Table 1 Comparision of DDST with Some Other Developmental Scales

Name	Age range	Domains evaluated	Administration time (minutes)	Validity
Denver Development Screening Test (DDST)	0- 6yr	Gross Motor, Fine Motor, Social, Language, Self-help, Cognitive	20	Sensitivity = 0.13 to 0.46 Specificity = 0.87 to 1.00
Denver II	0- 6yr	Gross Motor, Fine Motor, Social, Language, Self-help, Cognitive	35	NA
Developmental Profile (DP II)	0- 9½ yr	Motor, Social, Self-help, Cognitive, Language	35	VC = 0.52-0.72
Cognitive Adaptive Test! Clinical Linguistic Auditory Milestone Scale (CAT/CALMS)	0- 3yr	Visual-Motor, Language'	20	Sensitivity = 0.88 Specificity = 0.67
Early Language Milestone Scale (ELM)	0- 3 yr	Language	15	Sensitivity = 0.97 Specificity = 0.93
Vineland Social Maturity scale scale'"	0-15 yr	Self-help, Locomotion, Occupation, Communication, Self Direction, Socialization	25	VC = 0.40-0.50
		Tests for Indian Children		
Trivandrum Development Screening Chart (TDSC)	0- 2 yr	Gross Motor, Fine Motor, Cognitive	5	Sensitivity = 0.67 Specificity = 0.79
Haroda Development Screening Test for Infants.	0- 2½ yr	Gross Motor, Fine Motor, Cognitive	10	Sensitivity = 0.66 to 0.93 Specificity = 0.77 to 0.94

* Indian adaptation available. VC = Validity coefficients (Correlations between screening test and other measures of intelligence, language or adaptive functions). NA= Not Available.

RESULTS

Maternal Factors Antenatal period of 38 mothers was uneventful. Remaining eight women had a wide spectrum of antenatal illnesses: Pregnancy Induced Hypertension (PIH)

(n=4), pre-existing hypertension (n=1), intrahepatic cholestasis of pregnancy (n=2) and bad obstetric history (recurrent abortions) (n=1). One of the mothers had hypothyroidism in addition to PIH.

Neonatal Factors This study included 30 term infants, 14 pre-terms and 2 post-dated neonates. Majority of the neonates (75%) were appropriate for gestational age (GA), 19.6% were small for GA and 4.3% were large for GA. Nineteen neonates were born by normal vaginal delivery, 13 by Lower Segment Caesarean Section (LSCS) (2 elective and 11 emergency), 13 neonates were delivered *via naturalis* assisted by forceps and one was delivered by vacuum extraction. All neonates were investigated depending on the clinical condition.

Table 2 Summary of Major Points of Screening Tests Mentioned In the Text

Instrument	Age (Months)	Time (Min)	Description
Denver Developmental Screening Test 2Ed (DDST)	0-72	20-30	125 items divided 4 sections: gross motor skills, fine motor/adaptive skills, personal/social and language skills.
Battelle Developmental Screening Test	6-96	30	96 items divided into 7 subsets: personal-social, adaptation, gross & fine motor skills, communication, and cognition.
Bayley Infant Neurodevelopmental Screener	3-24	15-20	Composed of 6 sets of 11-13 items; screens 4 areas: basic neurologic, expressive, receptive, and cognitive functions.
Brigance Screens	0-96	10-15	Screens for fine and gross motor skills, receptive and expressive language, self-help skills, and social-emotional domains; assesses reading and math at older ages.

Table 3 DDST Test Result (5-MIN Apgar Score)

APGAR Score	Normal	Abnormal	Questionable	Total
Mild (5-7score)	14	1	1	16 (32%)
Moderate (3-4 score)	17	2	2	21 (17.8%)
Severe (0-2 score)	5	1	3	9 (19.6%)
Total	36 (78%)	4 (8%)	6 (14%)	

Degree of Asphyxia All neonates (n=46)with low Apgar Score were further subdivided into

- Mild asphyxia (5-7 Score)
- Moderate asphyxia (3-4 Score)
- Severe asphyxia (0-2 Score)

There were 15 cases (32%) of mild asphyxia, 22 cases (48%) of moderate asphyxia and 9 cases (20%) of severe asphyxia.

DDST Findings

Interpretation of the DDST test result at the end of the follow up period yielded the following results.
Normal -36 children (78%)
Questionable - 6 children (14%)
Abnormal - 4 children (8%)

A questionable result was associated with one case of mild asphyxia, two cases of moderate asphyxia and three cases of severe asphyxia. All four babies had delays in various sectors in different combinations. Abnormal test results were obtained in four babies: one born with mild asphyxia, two with moderate asphyxia, and one with severe asphyxia (Table3, 4).

Table 4 CASE-Wise Delays Detected In Various Items Of Ddst Test

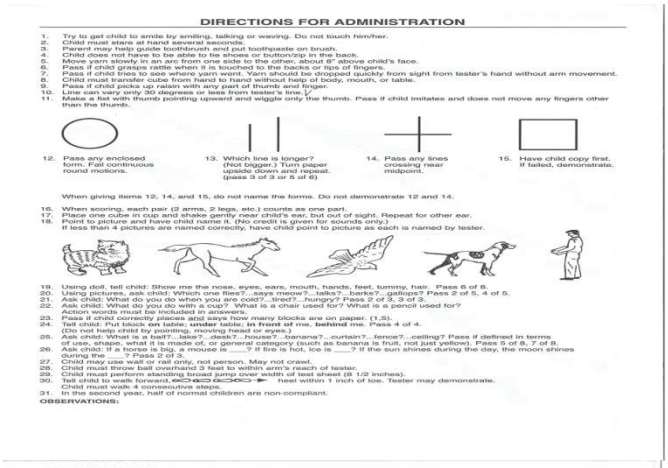
S. No	Gross motor	Fine motor	Social	Language
1	-	3	-	2
2	2	4	-	-
3	3	-	2	-
4	-	3	2	-

Table 5 Degree of asphyxia and DDST findings

Asphyxia	Normal	Questionable	Abnormal	Total
Mild	13	1	1	15
Moderate	18	2	2	22
Severe	5	3	1	9
Total	36	6	4	46

($\mathbf{X^2} = 4.47$, df = 4, $\mathbf{p} = 0.34$)

Hence, 36 babies (78%) with birth asphyxia had a normal neurodevelopment, and 04 (8%) developed neurological delay. No definite conclusion could be drawn in six (14%) babies with questionable results of DDST. Those babies were advised further follow-up. There was no statistical significance between the degree of asphyxia and DDST findings in our study (p = 0.34) (Table 5).



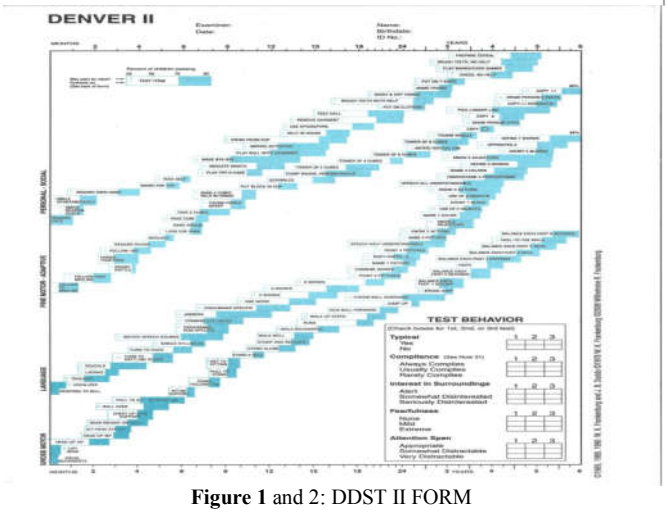


Figure 1 and 2: DDST II FORM

DISCUSSION

Apgar score is a quick and reliable numeric tool to detect birth asphyxia clinically in new-born babies and, in turn, warn the neonatologist about the requirement for urgent resuscitative measures. In past, Apgar score has been inappropriately used to predict neurological outcome.[1]In the current study, severe birth asphyxia was found to be more often associated with a questionable rather than an abnormal test result. Mild and moderate asphyxia were also associated with an equal number of questionable and abnormal test results. A questionable or

abnormal result indicated the need for a closer watch and more frequent follow up. Majority of low Apgar of cases had no future neurological deficit indicating importance of early intervention and good supportive care in babies born with low APGAR to ensure better outcome, both in terms of lowering morbidity and mortality.

In our study of 46 neonates born with low Apgar score 36 (78%) had a normal DDST and only four (8%) showed an abnormal test. This indicates that low Apgar score does not necessarily result in poor developmental outcomes. As brought out in the current study, the final neurocognitive development of the baby depends not on Apgar score but on prompt management of birth asphyxia. Apgar score just provides a convenient method of assessing the newborn at birth and the response to resuscitation if needed.

In a clinical-epidemiological study conducted by Manganaro *et al*., in 1996 concluded that there was a high incidence of prematurity, low birth weight (LBW) and low APGAR Score in infants born to women with PIH in the antenatal period; thereby affecting subsequent development of the newborn.[8] Godula- Stuglik *et al*, (1995) conducted a study on the effect of perinatal risk factors in a new-borns with hypoxic ischemic encephalopathy and found that a complicated delivery was the most important perinatal risk factor.[9]Similar results were found in a meta-analysis conducted by Zhang *et al*.[10]Advanced maternal age, third or more parity, maternal alcohol and tobacco use, maternal diabetes and hypertension, maternal epilepsy and asthma, preterm birth, male sex and low birth weight, and complicated labour have significant association with increased risk of neurodevelopmental problems.[11]

In our series 13 babies had an uncomplicated neonatal period. Twenty-five babies had tachypnea (due to a variety of causes such as transient tachypnea, respiratory distress syndrome or meconium aspiration).Three babies developed generalised tonic-clonicseizure, and one infant developed septicaemia during the neonatal period. Jonas. O *et al*., (1990) have concludedthat persisting low Apgar scores when combined with other risk factors such as problems during the neonatal period would provide more reliable prognostic information than would APGAR scores alone.[12]In our study, the babies with moderate to severe asphyxia (47.82%) had a normal neuro-developmental outcome at the end of 03-year follow up. This further reiterates the fact that low Apgar, as such, does not predict poor neurological outcomes. Prompt institution of neonatal resuscitation is the key to future neurodevelopment of the baby. Babies with Low 05-min Apgar scores fared significantly better in terms of neurodevelopment outcomes than babies with the same low 10-min Apgar scores.[13]

Early identification of children with delayed development has important implications on their treatment, and in preventing future disabilities and, in turn, averting secondary issues like altered family dynamics, peer problems and learning difficulties. Consequently, it is particularly important that every paediatrician adopts simple screening tests to identify developmental delay.[4]

CONCLUSION

The Apgar score is an important and simple numeric system to detect a haemodynamically compromised baby. This numeric system has the advantage to reduce inter- observer variability to a great extent. It does not indicate the future neuro development in babies, just the need for prompt and energetic resuscitation. A delayed resuscitation mayinfluence future neurodevelopment of the baby.

Denver Development Screening Test (DDST) is a simple and useful tool to aid in the early discovery of children with developmental problems. The test can be used by people who do not have any special training in psychological testing. Periodic monitoring of infants, who have suffered birth asphyxia, using the Denver Developmental screening Test will surely help detect subtle deficiencies in the developmental process. Neurological assessment *per se* is a sensible predictor of the future development of the child without the use of various sophisticated investigative procedures.

Acknowledgement

Authors wish to express their heartfelt thanks to Dr Amrut Swami, Assistant Professor, Department of Community Medicine, DVVPF's Medical College, Ahmednagar (Maharashtra) India, for his valuable help in statistical analysis.

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How to cite this article:

Pavithra V and Arun Tyagi (2021) 'A Study of Prognostic Significance of Apgar Score Regarding Neurodevelopment Among Neonates With Low Apgar Score In A Tertiary Care Center In Southern India', *International Journal of Current Medical and Pharmaceutical Research,* 07(08), pp 5878-5882.

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