Neonatal Behavioral Assessment of AFD Infants and Longitudinal Study of Their Development — During One Postnatal Year —

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Abstract It has constantly been observed that cerebral palsy and/or mental retardation develops among premature and high risk infants. Assessment using Neonatal Behavioral Assessment Scale (NBAS) immediately after birth and longitudinal study on development during the first postnatal year were performed on 16 AFD (appropriate for dates) infants whose normal development was anticipated and 21 mature infants, in order to improve the security of early assessment and early habilitation of handicapped children.

NBAS assessment was effective as a means of early intervention, whereby development was enhanced in both AFD and mature infants.

Of the 13 AFD infants who reached one year of age 1 case was hemiplegic cerebral palsy and 2 cases were motor delay. They showed abnormal values in NBAS supplementary items and reflexes at the neonatal period. These itmes were effective for a screening test of high risk infants.

The mental development index (MDI) and psychomotor development index (PDI) were closely associated with the quality of sleep-waking ryhthm and the degree of mother's interaction.

Bull. Sch. Allied Med. Sci., Nagasaki Univ. 3 : 1−12, 1989

Key words : AFD, NBAS, Bayley scale, Development, First one year

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Introduction

NBAS (Neotatal Behavioral Assessment Scale)[3] has been widely used clinically after it was demonstrated to be an effective means of early intervention between the neonatal and the parents. This is also a useful method for the assessment of perinatal high risk infants.

NBAS is comprised of 37 items of behaviroral assessment and 20 items of neurological examination. Nine of the former 37 items are identified as supplementary items for premature or high risk infants. Since the degree of stress they receive is reflected upon the physiological system, the motor system and the state control system[2], the assessment of these may provide a clue to appropriate environments for the growth of infants.

NBAS assessment of AFD infants whose normal development was anticipated was performed and their development 6 and 12 months after birth was studied from the point of view of preventing growth retardation of premature infants (AFD, SFD) with high risk.

Subjects and Methods

Subjects were 16 AFD (by the high risk mother-infant care research team of the Ministry of Health and Welfare 1983) infants who received intensive care at the neonatal intensive care unit (NICU) of the Department of Pediatrics, Nagasaki University, ranging in fetal age from 28 to 35 weeks a mean of 32 weeks, and in body weight at birth from 1255 to 2530 g with a mean of 1866 g, and whose Apgar (AP) scores were 1 min/ 4 points or more (mean 7. 9) and 5 min/ 7 points or more (mean 9. 5). They did not have any additional specific risk.

Assessment by NBAS was performed at 36, 40 and 44 weeks. Assessment of development at 6 and 12 months was conducted using Bayley scales of infant development. Home observation for measurement of the environment[5] was also carried out concurrently.

Assessment at 36 weeks was performed at NICU and that at 40 weeks, 44 weeks, 6 months and 12 months by visiting homes.

The control subjects were 21 mature infants who were born in the Goto Islands. The perinatal risk factor was assessd by the scale of Littman et al[6),7),8)], which was found to be normal. Assessment by NBAS was performed on days 1, 3 and 7 at the hospital and on day 14, at home. Assessment at 6 and 12 months was performed in the same manner as the study subjects.

Results

Lester et al[3] (1982) devised a cluster system in which NBAS test items are compared after dividing into 1. habituation, 2. orientation, 3. motor performance, 4. range of state, 5. regulation of state, 6. autonomic stability and

7. reflexes.

Based on Brazelton's theory that it is undesirable to assign a single summary score to neonates at birth, the maximum score in NBAS items is 1, 5 or 9. In Table I, items that are not linear with respect to optimality are rescored so that, for each item, the higher the score, the "better" the performance

Table 1.

Brazelton Neonatal Behavioral Assessment Scale seven cluster scoring criteria

Items	Clusters
1. Light	Raw score
2. Ratle	Raw score
3. Bell	Raw score
4. Pin-prick	Raw score
	Orientation
5. Inanimate visual.....	Raw score
6. Inanimate auditory	Raw score
7. Inanimate visual-auditory	Raw score
8. Animate visual	Raw score
9. Animate auditory	Raw score
10. Visual auditory	Raw score
11. Alertness.....	Raw score
	Motor
11. Tonus	Recode: 9/1=1; 8/2=2; 7/3=3; 4=4; 6=5; 5=6
12. Maturity	Raw score
13. Pull-to-sit	Raw score
15. Defense	Raw score
20. Activity	Recode: 9/1=1; 8/2=2; 7/3=3; 4/6=4; 5=5
	Range of state
17. Peak of excitement	Recode: 9/1=1; 8/2=2; 4/3=3; 7/5=4; 6=5
18. Rapidity of buildup	Recode: 9/1=1; 8/2=2; 7/3=3; 4=4; 5=5; 6=6
19. Irritability	Recode: 9/1=1; 8=2; 7=3; 6=4; 5=5; 2,3,4=6
24. Lability of state	Recode: 1,7,8,9=1; 5,6=2; 4=3; 3=4; 2=5
	Regulation of state
14. Cuddliness	Raw score
16. Consolability	Raw score
25. Self-quieting	Raw score
26. Hand to mouth	Raw score
	Autonomic stability
21. Tremors	Recode: Invert: 9=1 (1=9); 8=2 (2=8); etc.
22. Startles	Recode: If 1, drop; otherwise invert 2-9 on 8-point scale
23. Skin color	Recode: 5=6; 4=5; 6=4; 3,7=3; 2,8=2; 1,9=1
	Reflexes
	An abnormal score is defined as 0, 1, or 3 for all reflexes except clonus, nystagmus, or TNR where 0, 1, and 2 are normal and 3 is abnormal. Reflex score = total number of abnormal reflex scores

*Numbers represent Brazelton scale item number

Table 2. NBAS seven cluster scores (16 AFD cases)

Cluster	36W	40W	44W
Habituation	7.23±0.77	7.78±0.56	7.79±0.61
Orientation	5.44±0.77	5.81±0.69	6.64±1.24
Motor	5.35±0.60	5.77±0.50	6.28±0.56
State Range	4.30±0.54	3.96±0.59	4.03±0.85
State Regulation	5.55±0.77	5.13±0.81	5.31±1.48
Autonomic Regulation	5.29±0.93	6.29±0.67	6.92±0.82
Reflexes	1.0 ±0.89	0.69±1.14	0.44±0.63

Table 3. NBAS seven cluster scores (21 mature cases)

Cluster	Day 1	Day 3 (USA)	Day 7	Day 14
Habituation	7.14±0.78	7.27±1.20 (6.3)	7.26±0.97	7.40±0.90
Orientation	6.74±1.26	6.81±1.02 (6.0)	6.43±1.10	6.67±1.22
Motor	4.83±0.80	4.97±0.61 (5.3)	5.12±0.86	4.98±0.75
State Range	3.50±1.12	3.74±1.10 (3.9)	3.20±1.17	3.84±1.10
State Regulation	5.89±1.10	5.42±0.95 (5.8)	5.37±1.01	5.29±1.06
Autonomic Regulation	6.63±1.08	6.42±0.82 (5.6)	5.95±1.14	5.87±1.18
Reflexes	0.89±0.74	0.79±0.63 (1.6)	1.05±1.32	0.90±1.45

(Table 1). The cluster score thus obtained for 16 AFD infants and 21 mature infants is shown in Tables 2 and 3, respectively. The cluster score is simply the average of the individual items that make up the cluster.

The cluster score for the AFD group at converted gestational age of 40 weeks was Habituation 7.78±0.56, Orientatino 5.81±069, Motor 5.77±0.50, State Range 3.96±0.59, State Regulation 5.13±0.81, Autonomic Regulation 6.29±0.67 and Reflexes 0.69±1.14, whereas the score on day 3 after birth for the mature group with normal development was Habituation 7.27±1.20, Orientation 6.81±1.02, Motor 4.97±0.61, State Range 3.74±1.10, State Regulation 5.42±0.95, Autonomic Regulation 6.42±0.82 and Reflexes 0.79±0.63. In comparing the two groups, Orientation was higher in mature infants and Motor in AFD infants with a significant difference of $p < 0.01$ (Table 4).

The psychomotor and mental development indices of AFD infants at 6 months after birth by Bayley scales[4] were 69.3±14.1 and 70.7±13.8 at life age, and 93.7±12.0 and 94.6±8.3 at corrected age (age from the date of expected delivery), respectively. The equivalent values of mature infants were 100.5±4.9 and 99.3±9.5, respectively.

Table 4. Comparison of NBAS seven cluster scores between AFD and mature infants

Cluster	AFD (40W)	Mature (Day 3)	Significant Difference ($p<0.01$)
Habituation	7.78±0.56	7.27±1.20	-
Orientation	5,81±0.69	6.81±1.02	+
Motor	5.77±0.50	4.97±0.61	+
State Range	3.96±0.59	3.74±1.10	-
State Regulation	5.13±0.81	5.42±0.95	-
Autonomic Regulation	6.29±0.67	6.42±0.82	-
Reflexes	0.69±1.14	0.79±0.63	-

Table 5. Bayley Test

	6M		12M	
	PDI	MDI	PDI	MDI
AFD 16 cases Chronological Age	69.3±14.1	70.7±13.8	88.0±13.4	89.7±9.4
Corrected Age	93.7±12.0	94.6±8.3	95.6±15.7	102.7±10.2
	N=16	N=16	N=13	(N=13)
Mature 21 cases	100.5±4.9	99.3±9.5	106.5±18.2	118±11.5

The psychomotor and mental development indicies of 13 AFD infants at 12 months became closer to standard values. The respective indices not including 2 cases of motor delay and 1 case of cerebral palsy were 94.1±6.0 and 92.5±7.4 at life age, and 102.8±7.4 and 105.6±6.1 at corrected age. The development indices of mature infants were 106.5±18.2 and 118±11.5, respectively (Tables 5, 6).

The mother's aggressive interaction as one of the environmental factors of nursing assessed at the time of home visit was classified into "great" and "small", and the development indices were compared between the two groups. For the assessment of mother's aggressive interaction, the following 8 items

were selected (Caldwell B. M. & Bradley R. H., 1984[5]): 1. The mother willingly praises the child twice or more. 2. The quality of voice is positive when speaking to the child. 3. She is pleased when the visitor praises the child. 4. She never shouts at the child. 5. She never shows evident hostile feeling or embarrassment. 6. She does not speak ill of, or scold the child. 7. The mother does not restrict or hinder the child's behavior. 8. The mother does not spank the child while the visitor is present. Cases with 6 or more pertinent items were

Table 6 a, b Bayley Test

6−a 6 months after birth

	PDI		MDI	
	Chro. age	(Corr. age)	Chro. age	(Corr. age)
Total	73.2±12.6	(97.1±10.1)	74.7±11.8	(97.5±5.4)
Interaction				
Great	73.0±13.2	(98.6±11.0)	74.4±12.5	(99.0±5.5)
Small	73.5±13.0	(93.8±8.0)	75.3±11.6	(94.3±3.9)

6−b 12 months after birth

	PDI		MDI	
	Chro. age	(Corr. age)	Chro. age	(Corr. age)
Total	94.1±6.0	(102.8±7.4)	92.5±7.4	(105.6±6.1)
Interaction				
Great	97.0±5.7	(106.8±5.2)	93.8±9.5	(108.2±6.2)
Small	89.8±3.2	(96.8±6.2)	90.5±2.6	(101.8±3.5)

(2 motor delay cases and 1 cerebral palsy are excluded.)

Chro. age: Chronological age
Corr. age: Corrected age

calssified as "great" and those with 5 or less as "small".

The difference between the two groups was greater at 12 months than at 6 months (Table 6).

The AFD infants were divided by sleep-waking rhythm at 44 weeks into "good" and "poor" groups and the development indices at 12 months were compared between the two groups. The rhythm of mature infants at 4 weeks after birth is that the definite waking time around lactation in the morning is about 6 o'clock and 9 o'clock. Infants with a sign of circadian rhythm were classified as good, and those without, poor. As the result, the development indices were higher in the good sleep-waking rhythm group compared to the poor rhythm group (Table 7). The psychomotor development index at corrected age showed a significant difference ($p < 0.05$).

Table 7. The relation between sleep-waking rhythm at 44 weeks and PDI and MDI at 12 months

	PDI		MDI	
	Chro. age	(Corr. age)	Chro. age	(Corr. age)
Total	88.0±13.4	(95.6±15.7)	89.7±9.4	(102.7±10.2)
Sleep-waking Rhythm				
Good	93.9±5.3	(103.9±6.8)	92.6±8.8	(107.4±6.0)
Poor	81.2±17.1	(86.0±18.1)	86.3±9.7	(97.2±11.8)

Chro. age: Chronological age
Corr. age: Corrected age

In relation to some NBAS supplementary items (30. cost of attention, 33. robustness and endurance, 34. regulatory capacity, 35. state regulation and 36. balance of motor tone), the degree of stress which is reflected on the autonomic (30, 33), state control (34, 35) and motor (36) systems was assessed. Low values were observed in Case 9 with cerebral palsy and Case 13 with motor delay.

One case of cerebral palsy and one of motor delay were included in 5 cases with abnormal findings in 2 items or more among 17 of 20 reflexes not including ankle clonus, asymmetrical tonic reflex and nystagmus.

Discussion

Behavioral assessment of infants from the neonatal period in addition to neurological examination is basically important for early diganosis of cerebral palsy infants due to intrauterine and/or perinatal risk factors.

In the care of and an early habilitation program for neonates with definite handicap, it is critical to provide an environment to develop such essential behavioral ability as 1) state regulation, 2) regulatory capacity of autonomic system, 3) concentration of attention and 4) motor ability. It is also necessary to provide living aid pertinent to each case in addition to therapeutic exercise.

In assessment of neonates, one is apt to place emphasis on pathological abnormal findings, but the advantage of Brazelton's NBAS is to induce the optimal reflexes, reactions and behaviors of the neonate, whereby assessment of potential ability of the neonate and provision of a better environment are made available. Assessment by NBAS under the presence of the parents plays a role of early intervention for prevention of the disturbance of development.

In comparing the results of a prospective development study of 16 AFD infants and 21 mature infants, mature infants showed a high value in orientation and AFD infant in Motor among the NBAS clusters. There was no significant difference in State Regulation, Autonomic Regulation and other clusters between the two groups. Hence, the difference in Orientation was considered to be based on the innate nature of the mature and immature infants. As to the difference in Motor, it was postulated that the AFD group showed a higher value while being affected by the chronological age under the antigravity outside the uterus.

The 16 AFD cases were given instruction on strengthening interactive behavior, handling and positioning at the time of home visit.

The development indices of the AFD group at 12 months after birth were less than those of the control group. However, when 1 case of cerebral palsy and two cases of motor delay were excluded, all the other infants at corrected age reached standard values (DQ 92% or more) in both psychomotor and mental development indices.

Among the AFD infants studied, there developed 1 case of cerebral palsy (left hemiplegia) and 2 cases of motor delay. The former, 1 year and 4 months old at present, is able to walk by holding something, and the pscychomotor and mental development indices at 12 months at corrected age were 60 and 81, respectively. One of the latter cases was an AFD infant whose gestational period was 28 weeks and body weight at birth was 1380 g, and whose psychomotor and mental development indices were on the borderline. The other AFD case was a shuffling baby with a history of AP score 1 min/4 points, 5 min/7

points, who showed motor development delay but satisfactory mental development.

The study on the 16 AFD infants was made from the viewpoint of promoting development and preventing developmental disturbance. It was noted that NBAS was useful as early intervention whereby development as a whole was promoted. The development indices of mature infants were much greater than the standerd values.

Assessment of "stressed signs" by item 30, 33, 34, 35 and 36 among 9 supplementary items for immature or high risk infants served as an indirect assessment of dysfunction of the central nervous system and autonomic system. Excessively stressed signs in a long period of time could be evidence of damage to the central nervous system. AFD Case 9 with cerebral palsy and Case 13 with development delay showed low values in these items at 44 weeks. Furthermore, it has generally been recognized that neonates with brain damage are included among those whose primitive reflexes which are to be induced in normal neonates are abnormal (mostly weak or absent).

Our previous data[1] indicates that "fall" (Fig. 1) in ability of behavior in the neonatal period such as 1) hypotonia and poor postural reaction, 2)

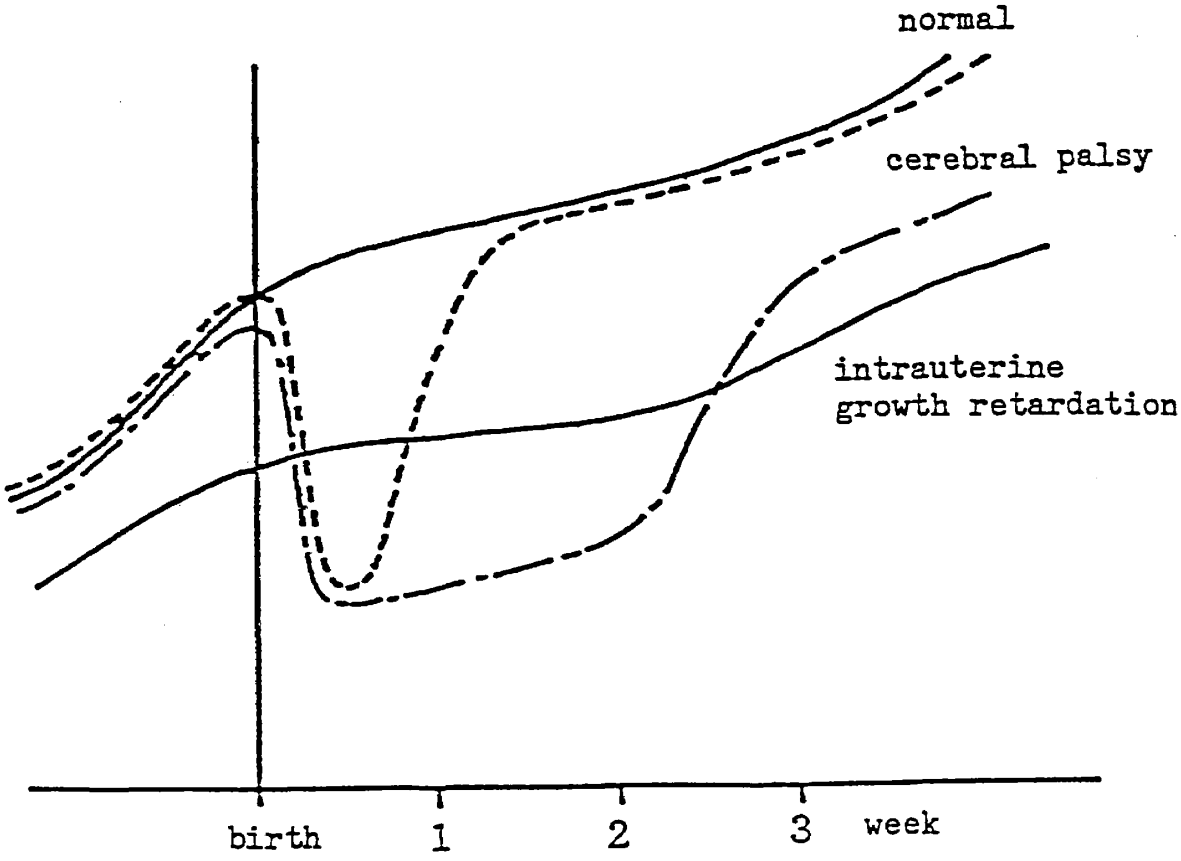

Fig. 1. "fall" of neonatal behavior

diminishedspontaneous movement, 3) weak or absent primitive reflexes, 4) weak or no crying, 5) weak sucking, and 6) neonatal seizure, is observed during the period of episodes of the damage to the central nervous system such as asphyxia, intracranial bleeding and nuclear icterus, and pointed out that an approxi-mate prognosis could be predicted from the period of "fall". NBAS is believed to have the assessment of "fall" made more objectively.

The circadian rhythm[10] in which the living body is adapted to cyclic changes of external environments based on solar light is a basis for the development of infants. The circadian rhythm is established in several months from the neonatal period. The sleep-waking rhythm, which is one of the indices of circadian rhythm, shows a definite sign at 4 weeks after birth and almost is established by 3 and a half months in normal development. On the other hand, babies with brain damage are susceptible to the effects of environment and have difficulty in establishing a proper rhythm. Help in establishing the sleepwaking rhythm is essential in order to establish various body rhythms.

Summary of this paper was reported at the 26 th Japanese Medical Rehabilitation Association Meeting in Sendai, 1989.

Reference

1. Akiyama T.: Early Diagnosis of Cerebral Palsy. Perinatal Medicine, 11: 475−484, 1981. (Japanese)
2. Als H., Lester B. M., Tronick E. Z. and Brazelton T. B.: Manual for the Assessment of Preterm Infant's Behavior (APIB). In Theory and Research in Behavioral Pediatrics, I (Appendix):65−132, 1982.
3. Brazelton T. B.: Neonatal Behavioral Assessment Scale. Clinics in Developmental Medicine No. 88, Blackwell Scientific Publication Ltd., London, 1−104, 1984.
4. Bayley N.: Manual for the Bayley Scales of Infant Development. The Psychological Corporation, New York, 1−176, 1969.
5. Caldwell B.M. and Bradley R. H.: Home Observation for Measurement of the Envirionment (Administration Mannual). University of Arkansas at Little Rock, Little Rock, 1−38, 1984.
6. Littman B. and Parmelee A. H.: Manual for Obstetrical Complications. Department of Pediatrics, School of Medicine and Mental Retardation Center, Neuropsychiatric Institute. Unviersity of California, Los Angeles, 1−9, 1974.
7. Littman B. and Parmelee A. H.: Manual for Pediatic Complication Scales. Department of Pediatrics, School of Medicine and Mental Retardation

Center, Neuropsychiatric Institute. Unviersity of California, Los Angeles, 1−11, 1974.
8. Littman B. and Parmelee A. H.: Manual for Postnatal Complications Scale. Department of Pediatrics, School of Medicine and Mental Retardation Center, Neuropsychiatric Institute. Unviersity of California, Los Angeles, 1−6, 1974.
9. Nugent J. K.: Using the NBAS with Infants and Their Families. March of Dimes Birth Defects Foundation, White Plains, New York, 5−13, 1985.
10. Takahashi S.: Circadian Rhythm and Biological Clock. Mainichi Life, 1987−4 : 20−25, 1987. (Japanese)

(1989年12月27日受理)

ＡＦＤの新生児行動評価と縦断的発達研究

― 生後一年間 ―

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要　旨　長崎大学小児科未熟児室で集中管理を受けた在胎28週から35週のＡＦＤ16例を研究対象とした。

ＮＢＡＳ評価は36、40、44週の計3回施行し、6カ月、12カ月時点での発達評価はＢＡＹＬＥＹ乳幼児発達検査を実施し、併せて、生活環境調査もおこなった。

1、睡眠のリズムと生活環境が1才時点での運動および精神発達指数に大きく影響していた。2、明らかな発達遅滞児2例、脳性麻痺1例を除いた1才時点での発達指数は、運動102.8±7.4、精神105.6±6.1と標準値に達しており、ＮＢＡＳを用いた早期介入がＡＦＤの発達促進に有効であったと推測される。3、発達遅滞児、脳性麻痺児はＮＢＡＳ補足項目と反射項目で低値を示し、high risk児の評価に有効であった。

長大医短紀要 3 : 1－12, 1989