
ORIGINAL ARTICLE

Neurological and Mental Development of
Low-Birth-Weight Infants.
(A Preliminary Report)

by

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Abstract

Fifty-two low birth weight infants were examined with a minimal age of 2 years and nine months old.

Neurologic abnormalities were very high (38.8%), Convulsions predominate the other abnormalities (21.2%), followed by other abnormalities respectively cerebral palsy, multiple handicapped, mental retardation, behaviour disorders, speech problems, hearing defect and minimal abnormalities.

Neurologic impairments were found more in the group of children with weight between 2000 — 2500 grams; and on the appropriate for their gestational age compared to the small for gestational age children.

Intelligence tests on 27 children revealed approximately 50% had an I.Q. below the normal range.

A remarkably high incidence of abnormal EEG recordings (50%) were detected, even on neurologically normal and abnormal infants children did not reveal a distinct correlation with the outcome of these infants.

Introduction

Many studies have shown that a considerable number of low-birth-weight infants with a birth weight of 2500 grams or less have some degree of brain damage manifested in some neurological deficits such as cerebral palsy, behaviour difficulties or depression of scores of intelligence test; as well as lesser neurological impairment (Dann et al., 1958; Holmer et al., Fitzhardinge and Stevens, 1972 and S. Saint Anne Dargaissies, 1977).

Other factors that could be associated with these findings such as prenatal and perinatal complications must also be considered, especially those associated with hypoxia; since neurological sequelae have been found with such complications even in full term infants (Keith and Gage 1964; Hendarto et al., 1974).

The purpose of this study is to evaluate the neurological and mental development of low-birth-weight infants born from Indonesian mothers at Cipto Mangunkusumo General Hospital in Jakarta. Newborns of this size accounted for approximately 30% of all newborns in the Perinatology subdivision of the Dept. of Child Health in this hospital.

This is a preliminary report of a long range study, planned to include as many as possible low-birth-weight infants and examine their neurological and mental development.

Material and methods

A retrospective analysis was carried out on the charts of infants born in the period after 1974, with a body weight of 2500 grams or less. The following data were retrieved: prenatal course of the mother, gestational age, method of delivery, birth weight, Apgar score and postnatal condition. Only infants with complete data were included in this study. To these mothers letters were sent asking them to bring their child for a complete neurologic examination at the Child Neurology subdivision, Dept. of Child Health at the Cipto Mangunkusumo General Hospital.

At the first visit careful histories were obtained, supplementing data already available in the patients hospital records and physical examinations including the child's general measurement were done. Neurological examinations included Electro-encephalographic recordings and X-ray photo of the skull in some children. Consultations to the Ophthalmologic and E.N.T. Departments for visual acuity and hearing defects were done if necessary. Afterwards the child was sent to the psychologist for an intelligence test. The Wechsler Intelligence Scale for children was employed.

Result

Out of the 187 letters sent out to the mothers when this report was made, only 22 (27.9%) have responded and agreed to their child being examined.

There were 18 males and 34 females, their ages ranging from 2 9/12 to 4 5/12 years at the first examination. Gestational age, as determined by the last menstrual period and gestation assesment

were between 26 to 38 weeks. There were 40 infants (76,9%) appropriate for gestational age (A.G.A.) and 12 infants (23,1%) small for gestational age (S.G.A.). (Table 1).

TABLE 1: *Total Number of Children Examined by Birthweight and Gestational Age*

| Birth Weight | A.G.A. Infants | S.G.A. Infants | Total Number |
|--------------|----------------|----------------|--------------|
| 1600 — 1499 | 3 | — | 3 (5,8%) |
| 1500 — 1999 | 12 | 3 | 15 (28,8%) |
| 2000 — 2500 | 25 | 9 | 34 (65,4%) |
| | 40 (76,9%) | 12 (23,1%) | 52 (100 %) |

More than half of the cases (65,4%) were infants with a birth weight between 2000 to 2500 grams.

Twenty children were found to have some degree of neurological impairment (38,4%), of which convulsions represented more than half of them (11 out of 20 neurologically abnormal children, see table 2). There were 7 males and 13 females.

True cerebral palsy, which according to the classical definition is a motor di-

sability associated with a normal or fair intelligence, were found in two children, both females; one of the tetraparetic and the other of the diplegic type.

Another child, also a female, was found to be multiple handicapped, with a motor disability and intellectual impairment, she was tetraparetic and pathologically mentally retarded; she also suffered from febrile convulsions for several times.

TABLE 2: *Neurologic Abnormalities found in "20 Children"**

| A b n o r m a l i t y | N u m b e r |
|--|-------------|
| Convulsions | 11 |
| Cerebral Palsy | 2 |
| Multiple Handicapped | 1 |
| Mental (+ Motoric) Retardation | 2 |
| Behaviour Problems | 3 |
| Speech Problems | 3 |
| Hearing Defect | 1 |
| Hemiparesis (Sequelae of Acute Infantile Hemiplegia) | 1 |
| Minimal Abnormalities | |
| Slight Motoric Retardation | 1 |
| Increased Tendon Reflexes | 1 |
| + Babinsky Reflex | 2 |

* More than one abnormality could be detected in one child.

Mental retardation with an I.Q. of less than 70 and subsequent motoric disability where the mental retardation predominates, were noted in 2 children. Both infants, one male and one female, were born without any complications with a birth weight of respectively 1750 and 2250 grams.

Speech abnormalities were found in 2 male cases, where speech was still monosyllabic at the age of 4 while their intelligence tests were average; in the third one audiologic examination revealed a central hearing loss.

Right hemiparesis was detected in a girl, who developed acute infantile hemiplegia at the age of 2 years after a pro-

longed convulsion with hyperpyrexia she also suffered from several Grand Mal epileptic attacks afterwards.

Slight neurologic abnormalities were found in 4 children with slight motoric retardation, increased tendon reflexes and positive Babinsky reflex, who were otherwise normal

The correlation between neurological abnormalities and gestational age is shown on table 3; more abnormalities were found in infants born appropriate for their gestational age (16 out of 40 or 40%) as compared to the small for gestational age infants (4 out of 12 or 33%).

TABLE 3 : *Correlation between Neurological Abnormalities and Maturity*

| Gestational Age (Weeks) A.G.A. Infants | Total Number | Children With Neurologic Abnormalities |
|---|------------------|---|
| 26 — 28 | 7 | 1 |
| 29 — 30 | 9 | 4 |
| 31 — 32 | 19 | 8 |
| 33 — 35 | 4 | 3 |
| 36 — 37 | 1 | — |
| S.G.A. Infants | 12 | 4 |
| T o t a l | 52 (100%) | 20 (38,4%) |

No profound difference was noted of the neurologic impairments found in the three birth weight groups (Table 4). A slightly higher number of neurologic

abnormalities were found in the 2000 to 2500 birth weight group (16 out of 34 children).

TABLE 4 : *Correlation between Neurologic Abnormalities and Birth Weight*

| Birth Weight (Gm) | Number of Children | With Neurologic Abnormalities |
|-------------------|--------------------|-------------------------------|
| 1000 — 1499 | 3 | 1 |
| 1500 — 1999 | 15 | 3 |
| 2000 — 2500 | 34 | 16 |
| T o t a l | 52 | 20 |

Out of 11 children with convulsions, ten had experienced one or more febrile convulsions since birth. The febrile convulsions were grouped according to Livingston into the simple and malignant febrile convulsions (Table 5).

TABLE 5 : *Type of Convulsion*

| Type of Convulsion | A.G.A. | S.G.A. | TOTAL |
|--------------------|--------|--------|-------|
| Febrile Convulsion | | | |
| Benign | 4 | 2 | 6 |
| Malignant | 3 | 1 | 4 |
| Epilepsy | 1 | — | 1 |
| T o t a l | 8 | 3 | 11 |

There seems to be no marked difference in the occurrence of convulsions between the A.G.A. infants and the S.G.A. infants (20 to 25%, see table 6), but there was a slightly higher number of convulsions in the group with the birthweight of 2000 to 2500 grams.

TABLE 6 : *Correlation between the occurrence of convulsion birth weight and maturity*

| Birth Weight (Gm) | C o n v u l s i o n | | TOTAL |
|-------------------|--------------------------|--------------------------|-------|
| | A.G.A. Infants No. 40 | S.G.A. Infants No. 12 | |
| 1000 — 1499 | — | — | 0 |
| 1500 — 1999 | 3 | 1 | 4 |
| 2000 — 2500 | 5 | 2 | 7 |
| T o t a l | 8 (20%) | 3 (25%) | 11 |

As psychological examinations for intelligence take more time and need more visits to evaluate, until this paper was made for presentation, only 27 intelligence tests were carried out, and tests were still being done on the other children. The result is shown on table 7.

Mental development as determined by the Wechsler Intelligence test showed an I.Q. range varying from 30 to 113. Thirteen out of 27 or approximately 50% of the children tested had I.Q.'s of less than 90. Eleven (39,9 %) were in the average range of 90 to 110, and none had an I.Q. of more than 120.

TABLE 7: Intelligence test of 27 cases

| I.Q. | Birth Weight (Gm) | | | Total |
|--------------------------|--------------------------|---------------------------|---------------------------|-------|
| | 1000 — 1499 (No. = 3) | 1500 — 1999 (No. = 15) | 2000 — 2500 (No. = 34) | |
| Genius | 140 | — | — | 0 |
| Superior | 120 — 140 | — | — | 0 |
| Bright Normal | 110 — 120 | 1 | 5 | 6 |
| Average | 90 — 110 | — | 6 | 5 |
| Slow Learner | 80 — 90 | 1 | 3 | 2 |
| Borderline | 70 — 80 | 2 | 1 | 1 |
| Mentally Retarded | | | | |
| Mild | 50 — 70 | — | — | — |
| Moderate | 30 — 50 | — | 1 | 2 |
| Severe | < 30 | — | — | — |

TABLE 8: Electro-encephalographic recording of 38 cases

| | Group Without Neurologic Impairment (No. = 17) | Group With Neurologic Impairment (No. = 21) | TOTAL |
|-------------------|--|---|-------|
| Normal | 3 | 13 | 16 |
| Borderline | 2 | 1 | 3 |
| Abnormal: | | | |
| Arrhythmia | 5 | 6 | 13 |
| Irritative lesion | 7 | 1 | 6 |
| | 17 | 21 | 38 |

Three cases with pathological mental retardation or an I.Q. of less than 70 were of the moderate mental retardation level (I.Q. 30 - 50), one of the three cases the depression of the I.Q. was found accompanying the motor disability or cerebral palsy.

Electro-encephalographic recordings were done on 38 cases (table 8). A high incidence of abnormal EEG's was detected on both the normal and the neurologically impaired children (19 out of 38, or 50%).

Twelve out of 17 E.E.G.'s of children without neurological impairment were abnormal, mostly of the irritative type, although no clinical evidence of convulsion or epileptic problems were ever encountered.

The irritative foci on the EEG recor-

ding were most frequently found in the temporal region (10 out of 13 recordings with irritative potentials). Histories of the infants showed that abnormal events occurred both in infants who became neurologically normal and neurologically impaired (Table 9).

TABLE 9: Comparison of Histories of 2 Groups, with/without Sequelae.

| History | Of Group without Sequelae (No. = 32) | Of Group with Sequelae (No. = 20) |
|-------------------------------|--|---|
| MOTHER | | |
| Previous Abortus | — | 1 |
| Previous Premature Birth | — | 1 |
| Hyperemesis | 1 | — |
| Hypertension | 3 | 2 |
| Toxemia | 4 | 1 |
| Placenta Previa | — | 2 |
| Twin Pregnancy | — | — |
| DELIVERY | | |
| Breech Presentation | 1 | 1 |
| Premature Rupture of Membrane | — | 1 |
| Vacuum Extraction | — | 1 |
| Sectio Caesaria | 2 | 1 |
| Asphyxia | 10 | 4 |
| NEONATAL PERIOD | | |
| Respiratory Distress | 2 | — |
| Hyperbilirubinemia | 1 | — |
| Neonatal Anemia | 1 | — |

Hypertension of the mother was found more or less to be the same in the group with or without neurological impairment, but toxemia of the mother and asphyxia of the infants were higher in the group without neurological impairment.

Discussion

In a retrospective study such as this one, it is very difficult to correlate the cause and outcome in regard to all the data accumulated; also the 52 infants who represented the material in our stu-

dy were only 27,9% of the survivors of the low birth weight infants in the Cipto Mangunkusumo General Hospital.

Of the three birth weight groups about half were born with a birth weight between 2000 to 2500 grams; only 3 infants were found to have a birth weight between 1000 to 1500 grams; this is understandable as survivors declined with prematurity.

If the histories of the mothers, especially regarding their last menstrual periods were correct and the assessment of the gestational age were accurate, contrary to other studies such as St. Anne-Dargaissies who found that intra uterine growth retardation presented more serious neurological sequelae than the true premature; in our study, more neurological impairments had been found in infants appropriate for their gestational age compared to infants who were small for their gestational age.

As the number of infants in our study is still very small and also we have to consider the possibility that mothers with abnormal children would be apt to respond more eagerly to the letters sent to them to come for neurological examination, it is very hard to take any definite conclusion so far. Nevertheless, it can be concluded that neurological impairment was remarkably very high in our subjects of low birth weight infants (20 out of 52 or 38,8%). Heimer in a study of 319 children in 1964 found 19,7% with neurological abnormalities while St. Anne Dargaissies (1977) found

21,1% out of 286 children with major neurological impairments.

Convulsions predominate the type of neurological impairment in all these infants (11 out of 52 or 21,1%). Except in one, none of the children with convulsions had a history of convulsive disorders in their family. If we take into consideration the possibility that the infants who did not respond to the letters sent to them were normal, the incidence of 11 out of 187 cases or approximately 6% is still higher than the incidence of convulsions in the normal population.

The most frequent type of cerebral palsy usually seen in low birth weight infants was spastic diplegia (St. Anne Dargaissies) and less often a persistent hypotonia with some signs of cerebral damage. Of our two cases with true cerebral palsy, one was tetraparetic and the other diplegic, while one who was multiple handicapped was of the tetraparetic type.

Behaviour disorders of the hyperactive type was clearly noted in 3 children; in one child it was so severe that the mother had to carry her 4 years old son all the time, to be sure that he will not get lost, because of his tendency to run everywhere and pick up any object that he found. The I.Q. of this child was low average. It is known that hyperactivity can occur with minimal brain damage.

Speech defect is a common occurrence in low birth weight infants. Fitzhardinge and Stevens (1972) were of the opinion that speech defects may reflect

a diffuse type of mild brain damage; and delayed speech or immaturity of speech development may be an example of a maturation defect of the brain.

In our subjects the occurrence of 3 children with delayed speech was relatively high, although in one child a central hearing loss was detected, his hearing was not totally impaired as to render his speech problem.

Very interesting to note was the high incidence of EEG abnormalities (19 out of 38 EEG recordings or 50%), which could also reflect the brain damage even without clinical symptoms in the group of neurologically normal children. Fitzhardinge who found EEG's abnormalities in 59% of his male subjects and 69% of his females born small for dates, suggested this to be also an example of the maturation defect; he cited the findings of others who found spotty areas of maturation defects in the brain on autopsies of such infants dying at birth and postulated that such defects may have led to later abnormalities in the inter-relationship of parts of the brain, had the infants survived. Intelligence tests of 27 children, which showed

that about a half of them (13) were below normal intelligence, showed that intellectual functioning was very much effected in low birth weight infants. Eventhough only 3 were found to be pathologically mentally retarded.

As all these children were of the pre-school age, we were unable to predict their future school performance, but we have to bear in mind the possibility of learning problems, which by the look of the intelligence tests would be very high. Bacola et al. (1966) suggested the relationship between the low intelligence and the low birth weight infants, but in our subjects only two infants had suffered from respiratory distress syndrome and he was of the neurologically normal group.

Histories of infants on both the normal and abnormal group showed a variety of conditions which could cause the abnormal and neurological development; but it is very difficult to point out the possible etiologic factors responsible for a given handicap. But there is no doubt that low birth weight infants as a whole, showed a high incidence of abnormal mental and neurological development.

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