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Complex investigation of impaired brain function during the first postnatal months

by

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Complex diagnostic batteries have been applied in 600 neonates and young infants to verify suspected cerebral lesions. A detailed longitudinal study of visual, auditive, nutritive and motor behaviour, as well as neuroradiology are necessary for differentiating between normal variations in brain maturity and early symptoms of a sustained brain lesion leading to defective brain development.

Achievements in gynaecology and perinatology in well equipped centres with well trained staff have considerably reduced the danger of cerebral lesions. According to the literature and our own experience, however, the danger is, far from being eliminated; dysmaturity, hypoxia, IC haemorrhage, malformations of the brain are still grave problems. Every neonate and young infant with symptoms of a suspected cerebral lesion must carefully be examined and followed up. In all such cases the greatest caution must be exercised to reach a correct diagnosis concerning the function of the CNS. Signs of immaturity and normal variations in human brain maturation must clearly be differentiated from pathologic symptoms [3, 6, 23, 26, 27].

Prenatal or perinatal cerebral lesions usually produce complex functional defects including sensory, motor, and mental symptoms. Thus, the diagnostic procedure must be complex to verify all defects and their interrelations and make use of all diagnostic baatteries at disposal.

Defective maturation of the CNS following the sustained lesion is an active process, hence produces aberrant functions correlated to each other. The diagnostic methodology must concentrate on the detection of defects in the existing functions rather than register certain missing activities.

Cerebral lesions producing pathological brain maturation present multiple functional defects. Defective evolution of one functional trend usually handicaps the development of some or of many others. The sustained lesion itself produces multilinear failures in brain development. It is importante to check all developmental gradients including sensory, mental, behavioural and motor functions. The developmental history of defective brain function produced by early lesions is determined first by the lesion and by the conditions of development.

Development of pathologic functions following an intrauterine or perinatal brain lesion is an ontogenetic process. The diagnostic methodology must follow up this pathological evolution with repeated investigations in all suspected infants. This kind of follow up investigation can detect non-manifest defects in the first 0—12 weeks of life in dubious cases.

Thus, to reach an early conclusion concerning the quality of brain development and to detect its pathologic deviation is time consuming for two reasons. First, the complex investigation of a young infant, monitoring his sensory, mental and motor functions, together with neuroradiological assessment, takes 6—10 days. Second, in some cases several diagnostic procedures must be repeated in the first months of life. A rapid survey, a single assessment is in most cases certainly inadequate for detecting defects, or for diferentiating between normal human variations and pathological manifestations.

Material and Methods

Six hundred neonates and young infants were investigated longitudinally. The procedure usually took 6—10 days. It included neuroradiologic investigations such as subdurography, ventrculography, PEG, and CT. The aetiology of cerebral lesions and symptoms of defective cerebral development was as seen in the next Table.

	per cent
Perinatal hypoxia (fetal, neonatal)	60
IC haemorrhage	24
Cerebral malformation	12
Miscellaneous	4
Age distribution	
Prematures	37
Eutrophic	25
Dysmature	12
Term	63
Eutrophic	22
Dysmature	41

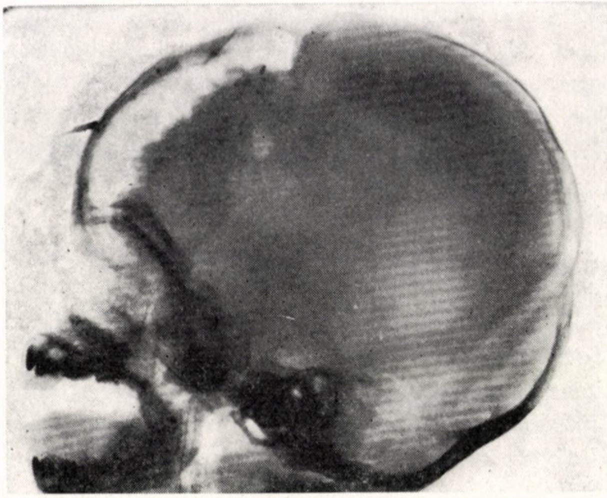
Itinerary of complex diagnostics

Neuromorphological investigation

Regular transillumination of the skull was performed in all patient suspect of having a brain lesion. If transillumination detected a suspicious transpararency, CT was done for further information. In more suspicious cases a transfontanellar tap of the subdural space or the ventricle was performed, followed eventually by introduction of 5—15 ml of air.

Malformations or early accumulation of subdural effusion following IC haemorrhage were discovered in 128 cases in the course of 136 neuroradiological studies (Fig. 1) performed in 600 patients with cerebral lesion.

Measurement of IC pressure (in problematic cases by continuous monitoring), X rays and laboratory analysis of the CSF a protein level above 500—2.000 mg/dl served to



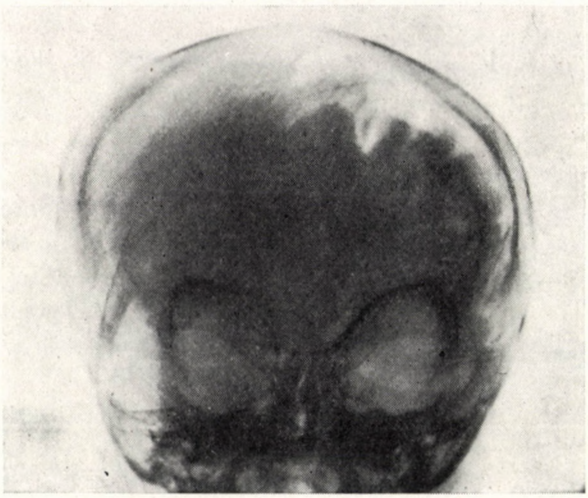


FIG. 1, 2. Chronic subdural effusion. Subdurogram of a 11 week oldinfant, before intermittent aspiration

complete the diagnosis of early accumulation of subdural effusion. In 65 cases early accumulation of subdural effusion was detected and treated with intermittent aspiration for 3—13 weeks. In 58 cases the CSF accumulation was eliminated by aspiration or drainage. Recurrences have not been observed. In 4 cases aspiration was unseccessful, craniotomy had to be done later in 3 patients.

Neurophysiological investigation

Cranial nerves and supranuclear integration

The genetic developmental pattern of the CNS ensures various temporary functional associations of certain cranial nerves to the direction of coordinated special patterns in temporary cooperation. (For example V, VII, IX, XI and XII, for executing the rooting, orienting-sucking-swallowing -breathing pattern.)

Cranial nerves II, III, IV, VI (Visual behaviour.)

Assessment of the pupillary reaction, head rotation to presentation of light, doll's eye phenomenon, investigation of visual fixation of human face, or object-following eye movements were standard methods to study vision and eye muscle coordination. In dubious cases, however, this was not sufficient to reveal all aspects of the visual contact between the infant and its environment and the mother. For this reason, investigation of visual behaviour to stimulation with pure light at various frequencies was adopted in 451 cases. The reaction to visual stimulus was recorded on an 8 channel polygraph (Beckman Dynograph 411—15). Visual response was recorded either in Prechtl's state III, or during nutritive and non-nutritive sucking. The following reactions were recorded and analysed

Orientation (startling, etc.)
Habituation
Dyshabituation.

The presence of normal orientation and habituation was sufficient to verify normal visual contact with the environment. In 36 cases polygraphy detected a severely defective visual behaviour and reduced contact with the environment [4, 11] and in further 46 cases milder deficiencies in visual arousal and vigilance.

Analysis of impairments in eye muscle innervation, and early detection of visual inefficiency were essential for planning early therapy; this consisted of visual training and substitution therapy with aid of other senses (auditive, tactile faculties) if it was necessary. Defective visual behaviour can handicap development of the child-mother-child relation, diminish visuomotor development and skills, object contact and other important gradients in specific human ontogenesis.

Cranial nerves V, VII, IX, X, XII. (Feeding activity, facial innervation)

Assessment of the rooting reflex and reactions to the stimulation of perioral cardial points, mimicking reaction, tongue movement, Babkin reflex, facilitation of sucking reflex by activation of grasp and observation of feeding, were standard methods [1, 21].

In problematic cases objective analysis of the relation of sucking-swallowing-breathing was necessary to determine the nature of the eventual impairment [2, 8]. EEG, EMG were done and sucking was recorded by polygraphy following a special pattern.

Simultaneous recording of orofacial muscle activity by EMG, ECG, of breathing, intrabuccal pressure (sucking) intrapharyngeal pressure and intraoesophageal pressure was performed in 35 cases.

The following types of defective feeding activity were observed:

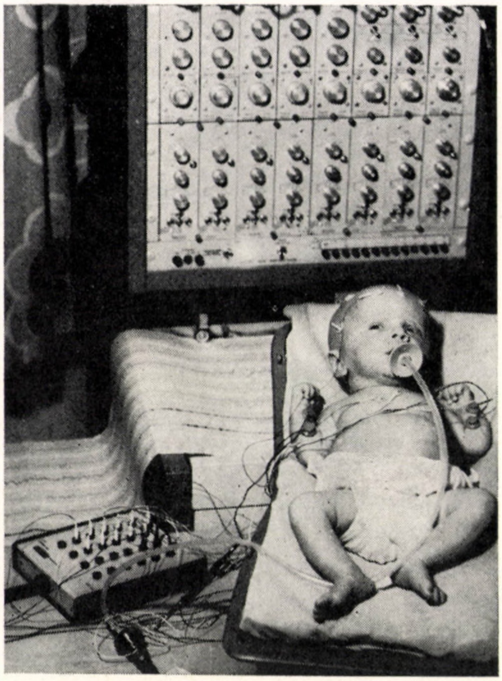


FIG. 3. Polygraphy. Visual stimulation of a 4 week old infant

adequate swallowing and defective sucking. In these cases fluid was forwarded into the pharynx by the tongue without sucking;

defective sucking and swallowing with regurgitation;

effective sucking and swallowing for 10—30 seconds followed by respiratory difficulties and consequent failure to continue feeding.

Another method to differentiate between various types of nuclear and supranuclear lesions was the direct stimulation of the palatopharyngeal muscles with exponential electric current. The current was introduced by special intrabuccal and intranasal electrodes. The threshold of nerve activity was elevated or absent in the case of nuclear lesions, and normal in the case of supranuclear defects [12].

Early diagnosis of neurogenic feeding defects is important, because many of them can be treated by special sucking-swallowing training, and therapeutic electric stimulation of the palatopharyngeal muscles. Early therapy of these defects can prevent special deficiencies which arise later when the development of vocalisation is imminent and early problems including pneumonias due to aspiration.

Cranial nerve VIII (Cochlear nerve). (Acoustic behaviour)

The cochleopalpebral reflex, startling reaction to sound, auditive vigilance of the infant were routinely examined. In case of dubious auditive attention and response, polygraphy was performed during auditive stimulation. Pure sound (40—70 dB) was applied at various frequencies and intensities, together with musical sounds and human speech recorded on tape. Behavioural changes were recorded by polygraphy. Stimulus was applied in Prechtl's III and IV state. In state III the orienting reaction to auditive stimulus was monitored. Sound stimulus with long intervals of 30—60 sec. was applied in order to study arisal of the orienting reaction and the inhibition of restive behaviour [25].

In Prechtl's state IV, the same method was applied to analyse the inhibition of agitative behaviour by orientation. Habituation was investigated by stereotypic repetition of the auditive stimulus, and dyshabituation by changing frequency of the sound. 451 studies of auditive behaviour were performed. In 42 cases severely defective auditive orientation was detected as part of the symptoms of cerebral lesion. Early diagnosis of aberrant auditive behaviour is important, because the condition inhibits contact with the environment, with

FIG. 4. Polygram. Dyshabituation in a 4 week old infant. Alteration of visual stimulus from low to high frequency inhibits habituation and activates a novel orienting reaction

the mother, and can later seriously handicap early development of vocal communication.

We had excellent results with the early application of a stereophonic hearing aid during the first 5 months of life. A definite improvement in hearing ability was experienced if the aid was applied early enough. If it was applied later, the same method had no such effect.

Investigation of motor function and behaviour.

The motor function of the neonate and the young infant includes control of motility and muscle tonus. A thorough analysis of the existent muscle tonus has to include investigations during active, regular movements. Spontaneous motor activity of the infant does not present regularity which is needed to assess eventual deviations in muscle tonus, motility and posture.

The tonus of seemingly hypotonic or hypertonic muscles often changes during active and regular movement. Non-manifest or dubious pathological postures for example, forced lateralisation of the head by increased asymmetric tonic neck reflex, often become manifest only during activation of special motor patterns. Latent hemisymptoms are definitely visualized or recorded by polymyography during execution of several motor patterns. Thus a systematic application of various stimulus positions (SP) and registration of the response (R) offer a suitable method to investigate sensorimotor function. These patterns are more or less stereotypic and offer a good measure to compare muscle tonus, reciprocal innervation, recruitment effect, latency and rhythmicity, force, and special postures during the infant's activity.

The motor control of these elementary sensorimotor patterns is realized through the extrapyramidal system. Much of the activity is mediated by the vestibulo cerebellar and reticulocerebellar pathway systems. Reticulospinal and vestibulospinal tracts are important executive pathways. The spinal cord with its propriospinal system acts as an important rhythm generator of the stereotype patterns [13].

Some patterns such as elementary walk, elementary slide (Bauer reaction), elementary swimming movements (McGraw reaction) [9, 15, 20, 21] and other patterns were used regularly. In problematic cases all the parameters mentioned above were subjected to polymyographic study during activity. The investigative system and some of the patterns are summarized as follows.

Investigation of upper extremital activity.

a) Stimulative position (SP). Graded elevation of the head, graded tilting of the head. Reaction (R): Rhythmic flexion and extension of the arms and fingers, active lordosis of the spine. The fingers open even in spastic condition. The reaction is followed by movements of the lower extremities.

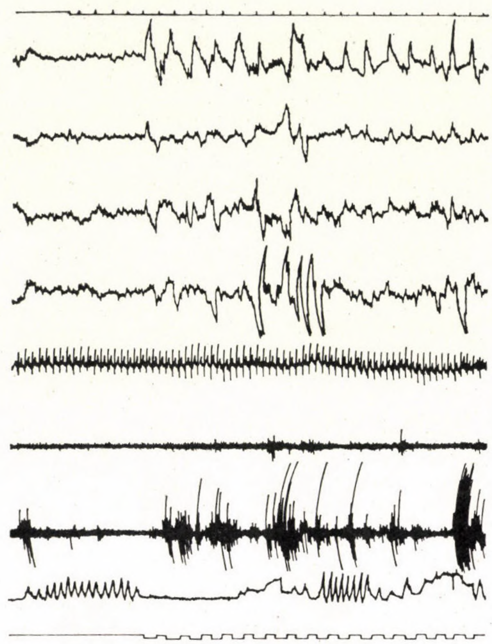


FIG. 5. Polygram. Acoustic stimulation of a 3 week old infant activates an orienting reaction including inhibition of sucking

b) SP: Elevation of the head to 40—50° from the horizontal level, elevation of the chest and moving the infant forward on a plane so that its arms and legs touch the surface. R: Regular, more or less crossed crawling pattern. Elevation of arms, extension of arms and fingers, some support reaction in the arms.

c) SP: Elevation of hips and legs in prone position. R: Support reactions of the upper extremities, recoil reaction, head elevation, lordosis.

d) SP: Forward shift of the infant in the former position. R: Stepping movement of the upper extremities, finger and arm extension in the flexor phase.

a) and *b)* allow to study coordinated movements of the upper and lower extremities, while *c)* and *d)* the reactions of the upper extremities.

Moro's reaction, prehensility (grasp and clinging) defensive reactions of the upper extremities and the startle reaction were studied to evaluate the activities and the developmental gradient of the upper extremities.

Investigation of lower extremital activity.

a) SP: Placement of the infant on a steep surface with its head toward the decline. R: Rhythmic, propulsive thrust of both lower extremities. Alternative flexion and extension of the legs in knees and ankles. Self-propelled and controlled downward slide.

b) SP: Positioning of the infant in prone position on a steep plane with its head toward the incline. Activation of the thrust reaction in both lower extremities by the investigator's palm supporting the soles. R: Rhythmic propulsive extension of both extremities, and consecutive flexion. Seemingly hypotonic muscles may become activated. In increased asymmetric tonic neck reflex the direction of the movement becomes curved, according to the grade of forced head position.). The infant slides upward on the 20—45° steep plane.

c) SP: the head is hold in a 45° angle, the chest is elevated and the infant shifts forward so that only the lower extremities touch the even surface of the table in prone position. R: Regular, crossed flexion and extension of the legs. Elementary crawl. (Spasticity or hypotonia is revealed even in non-manifest cases.). McGraw reaction, Bauer reaction, Gallant reaction, motor patterns of the legs in vertical position (placing, support, elementary walk) were studied routinely.

Investigation of neck and spine activity.

a) SP: The infant is held up in the air by both thighs. R: Repeated elevation of the head and extension of the trunk, integrated reaction through the longitudinal median fascisle, search reaction, fixation of eyes.

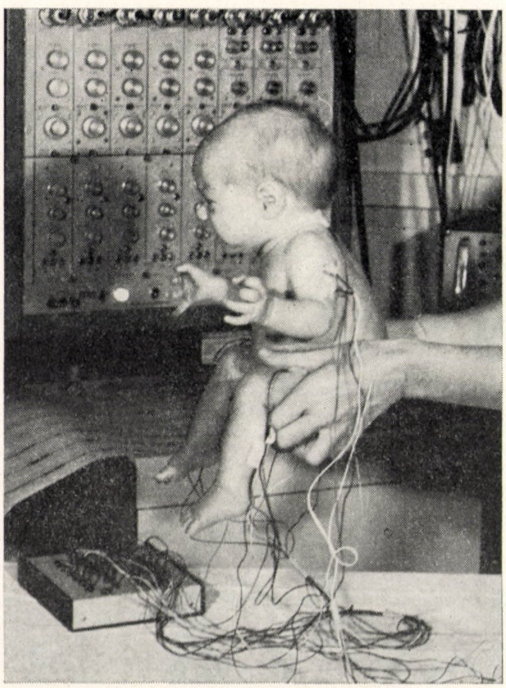


FIG. 6. Polymyography. Analysis of muscle activity in the neck, trunk and extremities in a 6 week old infant, applying the "sitting up in the air" pattern

b) SP: Carefully graded elevation from supine position to sitting. During the manoeuvre the head is spontaneously elevated and the trunk extended.

Both *a)* and *b)* reactions are extremely sensitive and show the early pathological increase in the asymmetric and symmetric tonic neck reflexes.

c) SP: The infant is shifted from the supine toward the sitting position by the investigator's palm supporting the sacral region. R: During the reaction the spine becomes erected, the head is elevated. During reactions *a)*, *b)*, and *c)* hypotonia of the spinal muscles is clearly visible in a paradoxical pathologic distribution of muscle tonus in the neck, spine and extremities.

The Schaltenbrand reaction, Pérez reaction, Peiper reaction in prone lifting of the infant, various chain reactions of the vestibular system, the neck muscles and the trunk were examined regularly.

Investigation of activity and general motor behaviour.

Comparison of the artificially evoked regular sensorimotor patterns and the spontaneous activity of the infant give important information concerning the infant's motor behaviour. Eventual normal variations in activity and motor activity are easily differentiated from pathological performance. In this respect motor reactions during feeding, visual and auditive stimulation are also informative. Assessment of general motor activity is an important step in early differential diagnosis of sensorimotor defects in maturation.

Peripheral nerves.

Manifest or, eventually, non-manifest lesions of the brachial plexus or defects in the lower extremities in case of meningomyelocele are regularly

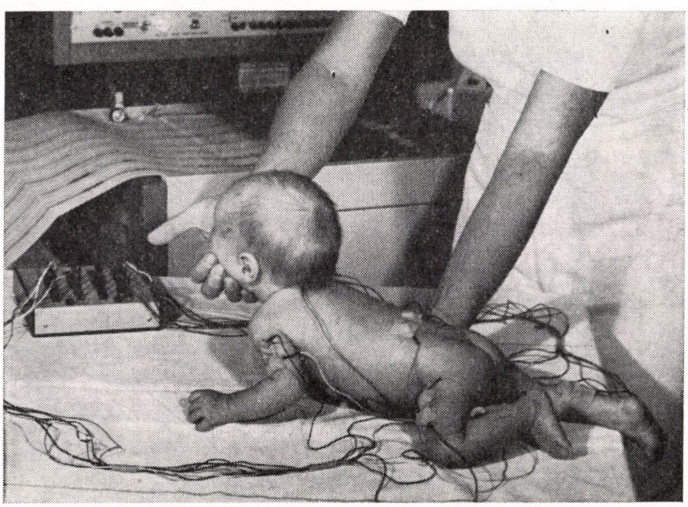


FIG. 7. Analysis of extremital muscle activity during the "elementary crawl" pattern

examined by electric impulse diagnosis, EMG, and through investigation of muscle tonus, posture, motility, etc. Lesions of the cord, cauda and peripheral nerves require immediate treatment by sensorimotor training and

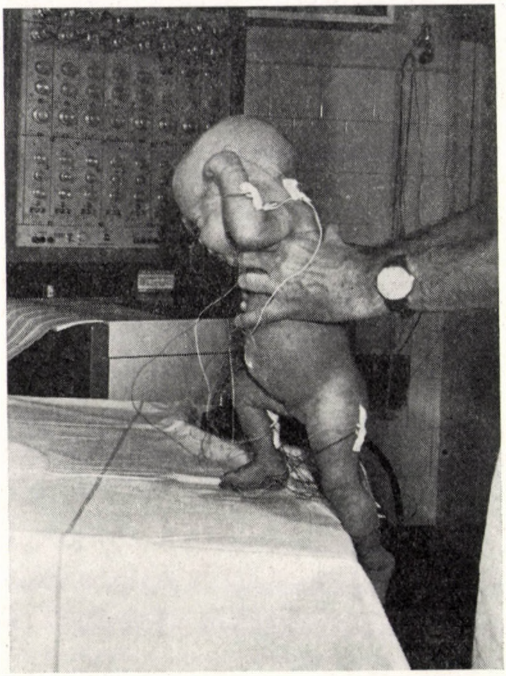


FIG. 8. Polymyography of the placing reaction of the lower extremities in a 4 week old infant with suspected hemiparesis

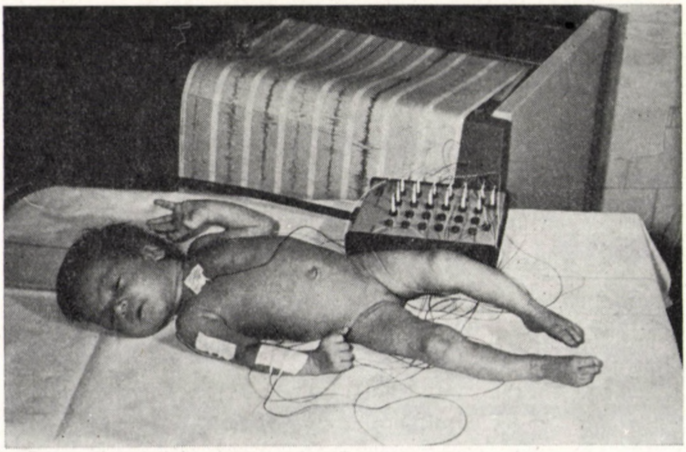


FIG. 9. Polymyography of a 4 week old infant with spasticity and pathologically forced asymmetric tonic neck reflex, in consequence of intracranial haemorrhage and chronic subdural effusion

TABLE I

Feeding behaviour

1. Type of coding	□□ 1–2
2. Modification (No) Suppl. (S)	□ 3
3. Serial No.	□□□□ 4–7
4. Postnatal month	□□ 8–9
5. Feeding behaviour	□ 10
A	
6. Perioral cardinal reflex points	□ 11
7. Nutritive sucking	□ 12
8. Non-nutritive sucking	□ 13
9. Swallowing	□ 14
10. Coordination of sucking-swallowing-breathing	□ 15
11. Prolonged, slow sucking	□ 16
12. Fast sucking	□ 17
13. Forced postural reaction during sucking	□ 18
14. Pharyngeal dysfunction	□ 19
15. Defective sucking	□ 20
16. Aerophagia	□ 21
17. Defective swallowing	□ 22
18. Vomiting	□ 23
19. Regurgitation	□ 24
20. Facilitation of sucking-grasp	□ 25
21. Facial EMG	□ 26
22. Polgraphy (sucking)	□ 27
23. Polygraphy (sucking-swallowing)	□ 28
24. Electrical threshold of palatopharyngeal muscles	□ 29
25. Nuclear lesion	□ 30
26. Supranuclear lesion	□ 31
27. Habituation of sucking	□ 32
28. Dyshabituation of sucking	□ 33
29. External adaptation during sucking	□ 34
30. Therapeutical training of sucking	□ 35
31. Therapeutical training of swallowing	□ 36
32. Electrotherapy of paretic muscles	□ 37
33. Weight increase	□ 38
34. Breast feeding	□ 39

special forms of electrotherapy, thus early differential diagnosis is important.

Vegetative nervous system.

Early assessment of urodynamic and rectal functions during the first 2–10 weeks of life is important, in infants born and operated upon for meningomyelocele.

Urodynamics, rectal function, reaction of the detrusor muscle and the rectum to electric stimulation were studied by polygraphy. Intravesicular and intrarectal pressure, ECG and EEG were recorded simultaneously and if necessary, urography too was performed. As a hydrocephalus often develops and the necessity emerges of an early insertion of a ventriculoatrial valve, detailed neurologic investigation and follow-up are important.

TABLE I *(continued)*

B

35. Plasticity of sucking behaviour	□ 40
36. Finger sucking	□ 41
37. Paresis of oral muscles	□ 42
38. Profuse salivation	□ 43
39. Rumination	□ 44

C

40. Drink from glass	□ 45
41. Feed with spoon	□ 46
42. Consumes solid food	□ 47
43. Chewing	□ 48
44. Unduly abundant feeding	□ 49

45. Mastication	□ 50

E

46. Normal feeding	□ 51
47. Use of spoon	□ 52

48. Date of examination	□□□□□□ 53–58
49. Name of examiner	□□ 59–60

Discussion

Early diagnosis of lesions of the infantile nervous system is a difficult procedure in the absence of some important and undoubtful symptoms. Differentiation between normal variations of brain maturity and signs of a cerebral lesion developing to distinct symptoms require a complex methodology. In many cases not all the items of this diagnostic programme are necessary for correctly assessing the status of the infant, in others a detailed study of all function is unavoidable. — If the symptoms are not apparent, the usually applied neurological assessment procedures are not suitable for determining early neurological defects in the first weeks of life. Spasticity of the limbs, hypotonia of the muscles may be present in completely normal newborns and young infants. The observetion of spontaneous movements, or passive motion of the limbs is hardly adequate to determine the tonicity of the muscles. The assessment of some postural reactions, myotatic reflexes and the general orientative behaviour of the infant cannot substitute a thorough, complex and repeated neurological investigation. Complexity of the investigation, the application of objective techniques are the essential features of a developmental neurological study. Such a method is certainly time consuming. This, however, pays off later. Defects in neurological development, when discovered early enough, offer a much better possibility to treatment and rehabilitation than later. Thus the

TABLE II

Auditive behaviour and speech

1. Type of coding	□ 1–2
2. Modification (No) Suppl. (S)	□ 3
3. Serial No.	□□□□ 4–7
4. Postnatal month	□□ 8–9
5. Development of auditive behaviour	□ 10
A	
6. Cochleopalpebral reaction	□ 11
7. Orientation	□ 12
8. Auditive habituation	□ 13
9. Auditive dyshabituation	□ 14
10. Startling reaction	□ 15
11. Auditory inhibition of restlessness	□ 16
12. Audiometry	□ 17
13. Defective hearing	□ 18
14. Anacusis	□ 19
15. Received stereoacoustic hearing aid	□ 20
16. Needs hearing aid	□ 21
B	
17. Orientation towards source of sound	□ 22
18. Attention towards human speech	□ 23
19. Stability of active attention	□ 24
C	
20. Vocal answer to human sound	□ 25
21. Positive influence of hearing aid	□ 26
22. Development of babbling	□ 27
23. Attention to own babbling	□ 28
24. Movement	□ 30
25. Reacts to musical sound with sound	□ 30
26. Imitates	□ 31
27. Interprets human speech	□ 32
E–F	
28. Uses words in behaviour	□ 33
29. Follows instruction	□ 34
30. Speech development	□ 35

physician investing time into early diagnostic procedures wins this time back in many if not all patients, who later will not present difficulties in the development of locomotion, posture, mental faculties, speech and defects of the sensory system.

During the last 3 years defective cerebral development following prenatal, and perinatal cerebral lesions was detected in 500 cases during the first 5 months of life. In 100 control cases referred to us by physicians for the suspicion of cerebral lesions, de-

TABLE II *(continued)*

A

31. Crying	□ 36
32. Vocalization of vowels	□ 37
33. Vocalization in comfort	□ 38
34. Bronchial diseases	□ 39
35. Otho-laryngeal diseases	□ 40

B

36. Vocalization of consonants	□ 41
37. Monologues	□ 42
38. Prattle	□ 43

C

39. Cyclic words	□ 44
40. Activity correlated with words	□ 45

D

41. Parlance	□ 46

E

41. Syntax	□ 47

F

43. Simple sentence	□ 48
44. Normal speach	□ 49

45. Date of examination	□□□□□□ 50–55
46. Name of examiner	□□ 56–57

tailed investigation found no abnormality. Only 4 of these babies proved later abnormal and needed rehabilitative treatment.

To clarify the correlation of the development of various functions, a coded computerized follow-up system was devised. This programme contains in the algorythm of its code-system all parameters of the complexity in the diagnostic approach.

On the computer programme pages, items in square A represent the parameters studied during the 0—3th months, in B those in the 1—6th months, C in the 0—10th months, D in the 0—15th months, and in E those in the 0—24th months.

Each infant is followed up during treatment or in cases where only observation is required, without treatment. The 11 pages of the computer programme contain the following investigations:

1. Admission. Anamnestic data
2. Supplementary indirect data of history.
3. Investigation of feeding behaviour
4. Investigation of auditive behaviour and speech
5. Investigation of vision and visual behaviour
6. Motor behaviour, motility, posture and muscle tonus

TABLE III

Motor behaviour and muscle tonus control

1. Type of coding	□□ 1–2
2. Modification (No) Suppl (S)	□ 3
3. Serial No.	□□□□ 4–7
4. Postnatal month	□□ 8–9
5. Movement and muscle tonus control	□ 10

A

6. Spontaneous motor dynamics	□ 11
7. Spontaneous head elevation	□ 12
8. Head position in instrumental sitting	□ 13
9. Sitting from supine position	□ 14
10. Sitting in the air	□ 15
11. Bauer reaction	□ 16
12. Bauer reaction on incline	□ 17
13. McGraw reaction	□ 18
14. Active crawling	□ 19
15. Landau reaction	□ 16
16. Pèrez reaction	□ 21
17. Gallant reaction	□ 22
18. Moro reaction	□ 23
19. Grasping	□ 24
20. Clinging	□ 25
21. Placing reaction	□ 26
22. Supporting reaction	□ 27
23. Elementary walk reaction	□ 28
24. Vestibular activity	□ 29
25. Crossed extensor reaction	□ 30
26. Spontaneous muscle tonus	□ 31
27. Active muscle tonus	□ 32
28. Hypertonia	□ 33
29. Normotonia	□ 34
30. Hypotonia	□ 35
31. Floppy	□ 36
32. Spasticity	□ 37
33. Rigidity	□ 38
34. Monoparesis	□ 39
35. Hemiparesis	□ 40
36. Diplegia	□ 41
37. Tetraplegia	□ 42
38. Orthopaedic status	□ 43
39. Paradoxical pathologic muscle tonus	□ 44
40. Tonic asymmetric neck reaction	□ 45
41. Tonic symmetric neck reaction	□ 46
42. Forced asymmetric neck reaction	□ 47
43. Forced symmetric tonic neck reaction	□ 48
44. Adynamia	□ 49
45. Defect in upper extremity	□ 50
46. Defect in lower extremity	□ 51

7. Development of manual behaviour and manual skill

8. Development of infant-mother relation, infant behaviour

9. Development of learning, intellect, activity, sociability

10. Biorythms, EEG, records of somatic and vegetative functions,

TABLE III *(continued)*

B

47. Righting reactions	□ 52
48. Statokynetic reaction I.	□ 53
49. Labyrinth control	□ 54
50. Head movements and position	□ 55
51. Turning from prone to supine	□ 56
52. Turning from supine to prone	□ 57
53. Sitting	□ 58
54. Paradoxical muscle tonus	□ 59

C

55. Sitting up	□ 60
56. Crawling	□ 61
57. Statokynetic reaction II.	□ 62
58. Stance	□ 63
59. Stepping rhytmicity	□ 64
60. Stance and manual play	□ 65

D

61. Suported walk	□ 66
62. Walks alone	□ 67
63. Balance	□ 68

E—F

64. Steps on stairs	□ 69
65. Running	□ 70
66. Hopping	□ 71
67. Walks on uneven surface	□ 72
68. Locomotor deficiency	□ 73
69. General movement deficiency	□ 74

70. Date of examination	75—80 □□□□□□□
71. Name of examiner	□□ 81—82

pathophysiologic data. Pathormorphologic data such as diagnosed malformations, subdural effusions verified by X ray analysis, CT.

11. Results of various early therapies.

Out of the 110 pages of the programme, 3 are presented (Tables I to III). The small squares on the right side of the columns serve for evaluation of the various functions. We use 6 figures (0—5) to label the performance value of the reactions.

On the basis of our experience, we believe that the present method will offer a solid basis to diagnostical needs. Further studies are, however, necessary for a better understanding of the various neonatal and infantile functions.

REFERENCES

1. ANDRÉ-THOMAS, SAINT-ANNE DARGASSIES, S.: Études neurologiques sur le nouveau-né et le jeune nourrisson. Masson, Paris 1952.
2. ARDRAN, G. M.: Some important factors in the assessment of oropharyngeal function. Develop. Med. Child Neurol. **12**, 158 (1970)
3. CALAME, A., REYMOND-GONI, I., MAHERZI, M., ROULET, M., MARCHAND, C.,

Prod'hom, L. S.: Psychological and neurodevelopmental outcome of high risk newborn infants. Helv. paediat. Acta **31**, 287 (1976)
4. Cohen, L. B.: Habituation of infant visual attention. In: Tighe, T. J., Leaton, R. N. (eds.); Habituation. Lawrence Earlbaum Publishers, Hillsdale, N. J. 1976, pp 207–238.
5. Friede, R. L.: Developmental neuropathology. Springer Verlag, Wien 1975.
6. Friedman, S.: Aberrant development in infancy. Lawrence Earlbaum Publishers, Hillsdale, N. J. 1975, pp 217–239.
7. Illingworth, R. S.: The development of the infant and young child, normal and abnormal. Churchill Livingstone, London 1970.
8. Ingram, T. T. S.: Clinical significance of the infantile feeding reflexes. Develop. Med. Child Neurol. **4**, 159 (1962)
9. Joppich, G., Schulte, F. J.: Neurologie des Neugeborenen. Springer, Berlin 1968.
10. Katona, F.: Neue Methoden in der Säuglingsneurologie und Rehabilitation. Acta paediat. Acad. Sci. hung. **15**, 67 (1974)
11. Katona, F., Berényi, M.: Differential reactions and habituation to acoustical and visual stimuli in neonates. Activ. nerv. sup. (Praha) **16**, (1974)
12. Katona, F.: Developmental neurology. In: Kerpel-Fronius, E., Véghelyi, P. V., Rosta, I. (eds.): Perinatal Medicine. Akadémia Kiadó, Budapest 1979. pp 109–134.
13. Kostyuk, P. G.: Supraspinal mechanism on a spinal level. In: Shahani, B. (ed): The motor system: neurophysiology and muscle mechanism, Elsevier, Amsterdam 1975, pp. 211–234.
14. McGraw, M. B.: The swimming behavior of the human infant. J. Pediat **47**, 485 (1939)
15. Menkes, J. H.: Textbook of child neurology. Lea and Febiger, Philadelphia 1980.
16. Müller, D.: Die subakuten Massenverschiebungen des Gehirns unter der Geburt. Georg, Thieme, Leipzig 1973.
17. Müller, D.: Pneumoenzephalographische Anatomie des Kindergehirns. Georg Thieme, Leipzig 1976.
18. Paine, R. S., Oppé, T. S.: Neurological examination of children, Heinemann, London 1966.
19. Papousek, H., Papousek, M.: Cogitive aspects of preverbal social interaction between human infants and adults. In: Ciba Foundation Symposium on Parent-Mother Interaction. Elsevier, Amsterdam 1975 p. 241.
20. Peiper, A.: Die Eigenart der kindlichen Hirntätigkeit. Thieme, Leipzig 1956.
21. Prechtl, F. R. H., Beintema, D. J.: Die neurologische Untersuchung des reifen Neugeborenen. Georg Thiéme, Stuttgart 1976.
22. Prechtl, F. R. H.: Strategy and validity of early detection of neurological dysfunction. In: C. P. Douglas, K. S. Holt (eds.): Mental retardation: Prenatal diagnosis and infant assessment. Butterworth, London 1972, pp. 41–46.
23. Reynolds, E. O. R.: Neonatal intensive care and the prevention of major handicap. In: Ciba Foundation Symposium on Major mental handicap: Methods and costs of prevention. Elsevier, Amsterdam 1978.
24. Saint-Anne-Dargassies, S.: La développement neurologique du nouveau-né à terme et prématuré. Masson, Paris 1974.
25. Sokolov, E. N., Vinogradova, O. S.: Neuronal mechanism of the orienting reflex, Lawrence Erlbaum Publishers, Hillsdale, N. J. 1975.
26. Stewart, A. L., Reynolds, E. O. R.: Improved prognosis for infants of very low birthweight. Pediatrics **54**, 724(1974)
27. Usher, R. H.: Clinical implications of perinatal mortality statistics. Clin. Obstet. Gynec. **14**, 885 (1971)

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