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ASPHYXIA NEONATORUM AND ITS SEQUELAE.*

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THAT keen observer, but somewhat priggish old gentleman, Sir Thomas Browne, propounds the question, "Why, though some children have been heard to cry in the womb, yet so few cry at their birth, though their heads are out of the womb." Let us attempt to answer the query by considering one of the most potent causes of neonatal silence, asphyxia.

It has been said that 90 per cent of all cephalic born children enter the world more or less asphyxiated; whether true or not, the condition is so frequent that "familiarity breeds contempt," and the average physician gives it scant thought beyond immediate attempts at resuscitation. Yet asphyxia of the newborn presents a problem of no little interest and importance and is well worth the time and study which may be given it.

It is greatly to be regretted that statistics are so deficient, that no reliable data are to be had as to the frequency of this condition and its sequelæ in this country. In the recording of stillbirths, boards of health should insist on the reporting of causes of death, and no certificate should be accepted unless this is definitely stated. Were

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this obligatory, I am inclined to believe that a large proportion of neonatal fatalities would be ascribed to asphyxia. In the present day campaign for the prevention of infant mortality, such statistics would be of value in computing the benefits of prenatal supervision and would lead to improved methods in the care of expectant mothers and in delivery technique.

That infant death rate in general is very large is shown by the mortality statistics from the registration area for 1911. In the Children's Bureau Publication No. 4 it is stated that "42 per cent of the infants dying under one year of age did not live to complete the first month of life, and of this 42 per cent almost seven-tenths died as a result of conditions existing before they were born or of injury and accident at birth. Of those that lived less than a week about 83 per cent died of such causes, and of the number that lived less than one day, 94 per cent died of these causes."

The customary division of asphyxia neonatorum into *livida* and *pallida* is a convenient one, for from the appearance of the child we are enabled to determine, with more or less accuracy, whether we are dealing with a lesser or a more serious form of the condition. It should be borne in mind, however, that prognosis is always uncertain. In *livida* the cyanosed face and upper thorax, the strongly pulsating cord, the tonicity of the muscles and the presence of the reflexes are signs, as a rule, of a more or less ephemeral condition. But the "blue" variety may pass into the pale, anemic form, with immediate or near-future exitus. Even resuscitation in such instances does not insure the continuance of life, for a large percentage of these children perish within the first eight days, while from 20 to 30 per cent die within varying periods thereafter. Poppel estimates that the death rate of asphyxiated children within the first week of life is seven times that of those born normal.

The causes which lead to neonatal asphyxia are so numerous and obtain under such different circumstances that, for the purpose of this paper, it will be necessary to mention only the principal factors which enter into its etiology.

During labor the slowing of the fetal heart is indicative of a lessened gas exchange, either from intra-cardial or cerebral pressure, or restriction of the utero-placental area, possibly all three operating to cause increased viscosity of the blood. But this is only temporary, and compensating conditions are probably present preventing permanent damage, the circulatory equilibrium being regained during the intervals of uterine contraction.

When, however, the labor from any cause is unduly prolonged, when a malposition is present requiring operative correction, when coiling of the cord narrows the lumen of the funic vessels, when the fetus is expelled unripe, and when the

forceps are injudiciously employed, the circulatory balance is gradually lost, and asphyxia supervenes.

Among the most important and serious manifestations of neonatal asphyxia are those of cerebral pressure, which must be differentiated from those arising from asphyxia of a purely suffocative type. In the latter the symptoms are usually transitory and give rise to little or no injury to the nervous structures. When death results, autopsy reveals small or punctate hemorrhages into the meninges of the brain and cord, the nervous substance being rarely implicated. Under timely and proper treatment children survive this state even when it has progressed to the pathological degree just noted, and it is altogether probable, in instances of this kind, that the minute extravasations become absorbed without leaving trace of the preceding process.

The occurrence of cerebral pressure symptoms, on the other hand, as seen a *livida*, mark a more extensive and serious involvement of the brain structures. In most, if not all, of these cases the manifestations are the result of intracranial hemorrhage of considerable extent. In these children the face and body surface is extremely pale; there is absence of muscle tonus, the extremities are relaxed and external reflex excitability is wanting. The heart's action is extremely feeble and rapid, as a rule, but it is sometimes slowed, and respiration, once established, is irregular, spasmodic and shallow. The pupils are contracted, strabismus may be present, and hemiplegia and convulsions may develop.

In those children in whom the intracranial hemorrhage is slight at birth but gradually augments during the first hours or days of life, the infant may be born apparently healthy, and at first cry lustily. Later symptoms of cerebral pressure gradually appear, convulsions and paralyzes occur, breathing becomes more and more difficult and shallow, and the child finally succumbs. In other instances death may occur suddenly and unexpectedly, without previous noticeable symptoms.

The following case is illustrative:

K. Male. Born at Detroit Woman's Hospital, January 8, 1913. Position, L. O. A. Spontaneous delivery. Weight of child, six pounds five ounces. Nothing unusual was noticed except a subnormal temperature, 98 to 97.8°. The child cried and continued in good condition, took the breast well, and voided urine and meconium. On the afternoon of the tenth it was found dead in its crib. A diagnosis of cerebral hemorrhage was made. At the autopsy a large clot was found in the occipital region, the blood coming from the superior longitudinal sinus.

Alienists, and especially neurologists, following the publication of Little's paper in 1862, have laid especial stress on these hemorrhages as causative factors in the production of the cerebral

paralyzes of children. Mendal and Mitchel state that 4 per cent of asphyxiated children become idiots, from involvement of the frontal lobes (Peterson); Langdon-Downs raises this to 20 per cent; Voigt emphasizes the relationship between asphyxia and subsequent nervous affections, and other observers agree with Peterson that "conditions attending birth frequently lead to brain lesions in the child." From my own experience it appears that these statements are greatly exaggerated, for in a considerable number of individuals whom I have been able to follow from birth to young adult life, the case herewith reported is the only one that I have met with; while, in my own locality I can learn of but two others. If ninety out of every one hundred children are born more or less asphyxiated, it would be strange indeed if a certain percentage of the mentally blighted and nervously affected in later life did not give a history of this birth incident. In seventy-three cases which Burckhardt was able to follow during a period of years, only one (1.3 per cent) subsequently developed palsy of undoubted cerebral birth origin. The investigations of Walter Hannes in this connection are of particular interest in that they embrace a large number of cases and, for control, compare the subsequent histories of asphyxiated born children with those unaffected at birth. Hannes' material is divided into three series of one hundred and fifty cases each, with the following results:

First Series: Asphyxiated, resuscitated children. Subsequent abnormal nervous or mental development, in 3.2 per cent.

Second Series: Healthy, artificially delivered children. Subsequent abnormal nervous or mental development, in 3.3 per cent.

Third Series: Healthy, spontaneously delivered children. Subsequent abnormal nervous or mental development, in 3.4 per cent.

Similar conclusions were arrived at by Beatus in his recent inaugural dissertation from material from the Breslau Clinic during the years 1900 to 1913.

While not denying the influence of difficult and assisted labor in the production of these post-natal mental and nervous conditions, König has shown that diseases of the individual,—lues, alcoholism, heredity,—are really of greater importance.

From what has been stated, it is evident that while profound asphyxia neonatorum is a disorder of serious import, it is not often directly responsible for the cerebral paralyzes of children,—chiefly, perhaps, for the reason that infants rarely survive the initial stage of the disorder.

My object in bringing before you a subject with which you are quite familiar is, not to rehearse what may be found in every text-book of midwifery, but to direct your attention to infant mortality from neonatal asphyxia and its associated conditions. The fetal death rate from this

cause alone is exceedingly large, and it is quite within the province of modern obstetrics to reduce, or attempt to reduce, this fatality. It is true that a certain percentage of infants will continue to be stillborn, or will die soon after birth, from conditions over which the obstetrician cannot possibly have control, but I am sure that these cases are in the minority, and that more careful supervision can and will reduce the mortality rate. We have only of late years become alive to the importance of continued attention to the pregnant woman during the entire period of gestation. Is it not time that we should also extend our efforts to the prenatal care of the infant? Societies exist for the prevention of infant mortality after the child has entered the world; stations are established in order that pure and wholesome milk may be furnished even to the poorest of our tenement dwellers, and infant welfare associations endeavor to ameliorate the morbidity of these helpless babes through improved hygienic and food conditions. Up to the present, however, too little attention has been given to the "rights of the unborn child," save in the attempted prevention of abortion. Our efforts for the child should begin with the advent of pregnancy, or as soon after as opportunity makes possible. Indeed, conditions rendering the nidation of the ovum doubtful or impossible, should be relieved anticipatory of impregnation. Lues, tuberculosis and other systemic taints should be systematically treated and the future mother put in as good physical condition as possible. Congenital debility in the child should be forestalled by improved housing for the poor and proper food, fresh air and water, in maintaining the well-being of the mother; personal cleanliness, hygiene and the importance of attention to the excretory functions must be taught and reiterated; the evil effects of too strenuous work and over-strenuous exercise must be explained and cautioned against, and even the accustomed daily round of pleasures must be regulated. These matters can be affected among the poor to a large extent as well as among the well-to-do and the rich.

In this connection I desire to call attention to the splendid work accomplished by the Committee for the Reduction of Infant Mortality of the New York Milk Committee,—the saving of 7.7 per cent of lives per 1,000 is a wonderful showing, indicative of what may be done by efficient effort. The Seventh Annual Report of this Committee is well worth perusal of every physician doing obstetric work.* Following this lead the Detroit Board of Health established a prenatal clinic in two divisions at the beginning of this year (1914). While we are still too young in the work to draw conclusions, the outlook is most encouraging.

* In connection with this pamphlet should also be read Publication No. 4 of the Childrens Bureau of the U. S. Department of Labor, entitled "Prenatal Care."

A healthy child in a healthy mother should be the slogan of every one who practices obstetrics.

To accomplish this desired result, however, it is essential that the obstetrician should know his patient and not subject her to the trial of labor before assistance, often too late in the interest of the child, is rendered. The time to act is before the baby is born, as well as after the effects of preceding conditions have become manifested. The state of the pelvic floor and parturient canal should be determined long before the estimated date of confinement, and a familiarity with the size and shape of the bony pelvis is still more important. In every-day obstetric practice pelvimetry is too infrequently resorted to; it should be the rule in every case. Only in this way can we be forewarned of possible future trouble, and be put in a way of anticipating disaster so that weeks or months before the advent of labor, we may deliberately select that method of delivery which will prove best adapted to the safety of both mother and child. A woman whom I delivered in her sixth pregnancy of a healthy living eight pound boy by the abdominal route, might have been spared the deaths of her five preceding children had her former physicians possessed a better knowledge of her anatomy. In elderly primiparæ and in women whose vaginas have a reduced distensibility from natural conditions or disease, Cesarean section offers, in my opinion, the best chances for the child, while it is not more serious for the mother than a prolonged and tedious labor terminated by high forceps. With increasing experience, I am inclined to think that placenta previa and in suitable cases eclampsia will be placed in the same category. Certainly in the latter disorder the child's life would be less jeopardized, in some instances, than when colpohysterectomy with version or forceps delivery is carried out. I am more and more convinced that pregnancy should not be allowed to continue much, if any, beyond its estimated date of termination,—while in mildly contracted pelvis labor should be started from two to three weeks before that date,—in the interest of the child.

As protracted delivery is a fruitful promoter of asphyxia in the neonatus, the integrity of the membranes must be preserved until their purpose is accomplished, so-called "dry labor" averted, and the child forefended from unduly long-continued pressure. We are told that in normal child-birth there must be no disparity between the passenger and the passage, and yet few children would probably be born alive were it not for Nature's conservative measure, cephalic moulding. To prevent excess of this important process, especially when the head is driven repeatedly against too stiff, unyielding tissues, I believe that the rubber bag dilator should be more frequently employed.

Under normal conditions this imbrication of the cranial bones is harmless, and by lessening certain diameters of the fetal head, permits of smooth passage through the bony pelvis. Excessive over-lapping of the bones, however, as seen in protracted labors and misuse of the forceps, is a frequent cause of intracranial hemorrhage and asphyxia, an argument against prolonged labor and for the early proper use of the forceps and against unscientific forceps operations. In spite of the teachings of a hundred years, the average physician still appears to believe that the forceps were invented for dragging the child through the parturient canal whenever Nature fails in her expulsive forces or obstacles are present which uterine contractions are inefficient to overcome. And he is too apt to forget the really tremendous pressure which the forceps wrongly used may exert upon the fetal head, and that squeezed between its blades there is great impairment of the cerebral circulation. To avoid undue continuous pressure and permit of the readjustment of the circulation in brain and meninges, traction should not be too long continued, the forceps blades should always be unlocked between pulls, and a sufficient interval allowed for circulatory re-establishment. In all forceps operations the motto *arte non vi* should be remembered.

Twenty-six years ago I read a paper before the Detroit Academy of Medicine on "Shall the forceps be applied to the after-coming head?" Schroeder and his followers at that time strongly denounced this procedure, declaring that heads which could not be delivered by manual methods should be perforated. I was then inclined to accept the dictum of this great teacher, but I have learned better since, and believe as Crede taught, that the forceps are good servants when properly employed in such cases, and are valuable preventives of those accidents which lead to fetal asphyxia and death. The position of the cord is also given too little consideration. A prolapsed cord, if sufficiently evident, is looked upon as a serious menace to the child and attempts are made at reposition. But who ever argues regarding a short cord? As a pathological entity this is rare, but the results will be the same when the shortening is due to coiling of the funis about the child. In 2,154 infants delivered at the Woman's Hospital (Detroit) this displacement was noted in 328 cases (15 per cent), not a negligible number.

In 868 cases of asphyxia studied by Wicke, the condition was found due to misplaced cord in from 10.7 to 33 per cent. Retarded labor in the presence of good pains and a normal unobstructed passage with dilatable soft parts is usually the result of this condition. Aside from tension on the cord itself, the drag upon the placenta and possible premature separation of that organ must be borne in mind. In all cases the fetal

heart rate should be carefully watched during the whole of labor, and when danger threatens, timely application of the forceps made and prompt delivery effected.

In speaking of rapid delivery, let me here record my opinion that, as regards the ordinary maternal lacerations, these should not be considered whenever the life of the child is threatened. Everything should be done to spare the patient immediate and future suffering, but nine months of pregnancy is a long period of discomfort to endure with nothing to show at the end but a dead infant. The immediate aseptic repair of cervical lacerations of moment and perineal tears give good results and are worth the doing if a live and lusty child is the alternative.

Following birth, in the profound as well as in the milder cases of asphyxia, the gentler methods of resuscitation, as the Ahlfeld bath, Sylvester's, Laborde's and Bird's methods, appear all that is necessary and, persisted in, usually give satisfactory results when such can be expected. In intracranial hemorrhage such rough procedure as the swinging of Schultze should be avoided, since nothing can be thereby accomplish except, perhaps, to increase the hemorrhage.

The use of the pulmotor in the treatment of asphyxia neonatorum is too recent to warrant positive conclusions regarding its efficiency. In intracranial hemorrhage it seems to me it would be of doubtful service. Zahnmeister has pointed out three reasons for the failure of oxygen administration in asphyxia, which appear reasonable in this connection, namely, the possibility of too small contact surface in the lungs, too few oxygen carriers in the blood, and a reduced transportation of oxygen to the tissues on account of the lessened circulation. With a more general and better familiarity with the symptoms and diagnosis of intracranial hemorrhage in the newborn, I believe that the treatment of the future in these desperate cases will lie largely in surgery, and that through its scientific application many children will be rescued to lives of future usefulness that are now considered beyond hope.

"In motherhood, properly instructed and respected," as has been so well said by Mr. Alderman Broadbent, "there lies a potentiality of health and well-being for future generations beyond the dreams of the most enthusiastic sanitarian." And, it may be added, in better obstetrics lies, to a large extent, the prevention of neonatal mortality.

INTRACRANIAL HEMORRHAGE IN THE NEWBORN.

CASE I.

Mrs. H. A., aged 24, Ipara, a highly nervous young woman, with good family history—no miscarriages nor syphilis—was referred to me for confinement by Dr. H. M. Rich. She passed through a normal pregnancy, and fell in labor on the evening of March 28th. The

child was active, the heart tones good, and the breech presented in the left anterior position. The mother's pelvic measurements were:

Cristæ	27 c.m.
Spinæ	22 c.m.
Trochanters	31 c.m.
External conjugate	18 c.m.

The vaginal canal was unusually tight, and the introitus very small and rigid.

Labor pains were excellent, but progress was slow on account of the presentation and the rigidity of the parts. The breech descended into the cavity, there stuck and became impacted. Assistance was attempted, but the pelvic space was so absolutely filled it was only after repeated trials that a blunt hook could be carried over the thigh and the breech brought down. Both legs were extended over the abdomen, and in delivering the left femur was fractured in its upper third. The arms were liberated with great difficulty.

The prolonged labor and efforts at delivery had apparently caused death of the child; the cord tightly wrapped around the neck once was absolutely pulseless and flaccid, and the child's body was relaxed and of pale yellowish color.

Believing that the fetus was dead beyond recovery, and having been requested by the parents to baptise the child in the event of its not surviving, pause was made at this stage of delivery, the nurse sent for a tumbler of water and the rite performed. This procedure must have consumed at least five minutes.

Manual methods having failed the forceps were applied to the after-coming head and delivery effected.

The child's body was allowed to rest across my knees for a few minutes. The cord was then ligated, and extremely faint pulsations felt. These increased during the succeeding few minutes, but remained very feeble. Resuscitation was at once started, by Sylvester's and Laborde's methods, together with vigorous slapping and suspension of the child by the feet. After about twenty minutes the infant gasped, moaned and finally gave a feeble cry.

The following observations on the infant are taken from the very excellent notes made by the nurse, supplemented by my own and those of Dr. Rich.

A male child, weighing seven pounds, born at 6 A. M., March 29th. In the early part of the day the child remained motionless, but at intervals emitted a feeble moan or whimper. At 4 P. M., assisted by Dr. Rich, I put the fractured femur in splints. During the afternoon the child "had spasms of raising and shaking the arms," with frequent stiffening of the body lasting a few seconds. These convulsions occurred especially whenever the child was touched or moved. They were partially controlled by small doses of a sodium bromide solution by mouth.

March 30. The condition remains practically the same.

March 31. Took the breast nicely at 12 o'clock noon, but not as well at 4 and 8 P. M. Cried feebly a good deal during the evening and night.

April 1. Took a little water at 7 A. M. Was somnolent during day and could not be roused. Urinated three times; slight brickdust stain on napkin at 9 P. M. which increased during night. Small doses of Spirits Ether Nitrosi given. Two stools during day. Took about half an ounce of milk from bottle at 10 P. M. Did not rouse all night.

April 2. Still unable to rouse. Took a few drops of milk. Saline enema, one ounce, given at 11 A. M. Retained. Right eye swollen.

April 3. Chene Stokes' respiration. This improved during the day, but became more marked at night. Takes nourishment, one ounce, every two hours.

April 4. Seems weaker. Circulation poor at times. Moans.

April 5. Very little change. Stools still dark; urine almost normal. Chene Stokes' respiration greater part of the time.

April 6. Takes nourishment well, one ounce every two hours. Color clearing up.

April 7. No attempt as yet to open eyes. Circulation poor at times.

April 8. Same condition. Respirations faint and irregular. The fontanelles, especially the anterior, are increasing in size and the sutures are spreading a little. Dr. Rich, who has seen the child several times, suggested lumbar puncture, which he carried out in the afternoon. Respirations eight per minute. Six c.c. of bloody serum withdrawn. Immediate improvement in breathing followed, the respirations becoming more regular and deeper.

During the first few days following the lumbar puncture, the fontanelle several times became very tense, and there was a certain amount of rigidity in the child's limbs, the hands especially being clenched tight. This would disappear, however, in a few hours; the lumbar puncture was not repeated.

April 9. Circulation better, yawns and stretches some. No twitching except in eyelids. Splints removed from leg; moderate callous; leg same length as other, by measurement. The hydrocephalous is checked; no further increase in size of head.

April 10. Drew on breast a few times to-day. Takes nourishment better.

April 11. Yawns and stretches a great deal.

April 12-13. Slight general improvement.

April 14-15. More active. Nurses better. Opened eyes half way for about a second (15th). Weighs six and a half pounds.

April 16-21. Gradual improvement; better color; nurses better; stools slightly better color.

April 22. Opened eyes for a short time. Tremor in hands at times.

April 24. Gave one sharp cry this A. M.

It was early noticed that the child did not see, and Dr. Walter R. Parker was called in to examine the eyes, and kindly furnished the following findings:

O. D. External appearance of the eye is normal, muscular excursion good. Pupil partially dilated, direct reflex absent except for very strong light; consensual reflex present, but very nearly abolished. Unable to determine accommodation reflex. Media clear, head of the nerve white, slight amount of excessive connective tissue about the blood vessels about the head of the nerve, edges well defined, physiological cup nearly absent, slight contraction of the arteries, fundus otherwise normal. O. S. same as right. Diagnosis: Optic atrophy, possibly consecutive to neuritis.

About two months later, at the age of four months, the child began to have severe convulsions at intervals of a few weeks with many lesser ones, so that scarcely a day went by for two years without at least a slight convulsion. Opisthotonos was extreme at these times, and the child often lay for days with the head and heels not more than twelve inches apart. This condition existed with more or less exacerbation for three years. During the last year, convulsions were infrequent. The fists were always tightly clenched, the legs, arms and back muscles spastic. The child could hold up its head for a few seconds, but never sat up nor tried to do so, and it had no use whatever of arms or legs. Intelligence was very limited. There was no evidence of sight, and no attempt at speech, although the hearing was apparently good. Middle ear infection with perforation of drum and discharge of pus occurred on two occasions but properly healed. This had no evident connection with the paralysis.

The nutrition in general was good, and the child grew to normal body length. Neither X-ray or Wassermann were made.

Death occurred suddenly, and without warning, at the age of four years and eleven months. The child was not thought to be ill and was put to sleep as usual at night. Two hours later, when the nurse-maid went in, she found him dead. There was no evidence of convulsion or struggle; maids in the next room had heard no noise. No autopsy.

CASE II.

(Record furnished by Dr. HERBERT M. RICH.)

M. S., age 27 months old, was brought to the Pediatric Service, Out-Patient Department of Harper Hospital, for convulsions, helplessness and constipation. Parents living, well, and family history good. The patient is the seventh of eight children, all living and well except the first which was born at seven months and died soon after.

The mother states that during the labor she was seized with sudden pain while walking; she hurried to the bed, losing her balance, sat down on the child's head, which was pressed against the handwood side-board. Later the baby's head appeared slightly flattened. The birth was otherwise normal. The child's eyes were swollen and closed, but there was no discharge, and the former disappeared within a few days. It was soon after noticed that the child's arms and legs were stiff, and at six weeks convulsions began. Opisthotonos was always present at these times. The convulsions have continued on an average of once a day until recently, when they have been reduced to one a week. The child eats and sleeps well, and there has been no intercurrent disease.

S. P. The child is somewhat undersize, with large head and white skin. Eyes do not react to light, and nystagmus is present. Anterior fontanelle still open and about the size of a silver half dollar; the posterior fontanelle is about the size of a dime. Rickety, rosary chest; otherwise normal. The fists are tightly clenched; knees reflexes increased. The child appears totally unintelligent, and lies stupidly unless hungry or in pain, when it cries like a small baby. There is no evidence of reaction to light or sound, and no effort is made to speak, the child evidently being deaf, dumb and blind. Laboratory examination showed a negative Wassermann for both mother and child. The X-ray did not show the characteristic changes found in hydrocephalous.

By lumbar puncture clear fluid under increased pressure was obtained. The characteristics of tubercular meningitis were not present in the fluid.

The child is still under observation.

CASE III.

(Record furnished by Dr. EDWIN B. FORBES.)

Mrs. W., confined May 5, 1905. During the early months of gestation slight nausea and vomiting; the ninth month was marked by severe pruritus vulvæ, which kept the patient in bed the greater part of the time. History of pregnancy and family history otherwise good. In the latter part of the second stage no progress was made on account of the large fetal head. Forceps were applied, and after an hour's excessive effort a male child weighing ten pounds was delivered. The child was deeply asphyxiated and was with difficulty resuscitated. There was marked overlapping of the parietal bones, but otherwise no external evidence of injury. For the first week of life the infant thrived and exhibited no ill results from the severe labor, but during the second week the nurse noticed that the left arm was paralyzed, and convulsions of short duration developed. These increased in number so that in the course of a few weeks there were several spasms daily. At one month it was apparent that the infant could not see. The child took its food well and was fairly nourished. Idiocy was evident, the condition of spastic paralysis continued, and it remained helpless during the rest of life. The infant died during the fourth year.