

FŒTAL DEATH DURING LABOR¹

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TO see the infant pass from the foetal slumber, into the sleep of death, out of the amniotic sac of this world into the shroud which is the amniotic sac of the next, is to the obstetrician who sets a value on infantile life, both a humiliation and a reproach."

To pass the period of gestation in suspense, discomfort and inactivity only to have the event terminate in a fatality, is to the mother a grievous affliction. Nonetheless, our statistics show that out of every hundred babies born, from four to six die during labor or within a short time thereafter in consequence of the event.

Various factors contribute to this result. Some die from maternal and some from foetal disease of a definite character like syphilis or ræmophilia, cerebral injury or pneumonia, but excluding these as somewhat outside the purposes of this paper we may safely assert that asphyxiation is the form of death that obtains in most cases.

Asphyxia neonatorum is one of the most important and yet one of the least understood of all the phenomena connected with childbirth. It is important, not only for its frequency but for its deadliness. It is little understood because the investigation of its elements, phases, and etiologic conditions is fraught with difficulties that are many times insuperable. However, the clashing together of a few theories may clear the atmosphere and define our problem.

Asphyxiation may be described as that condition of the babe in which no sign of life exists except the heart activities. It is not a pulselessness as the derivation of the word implies, but a lack of respiratory function. It is the partial or complete arrest of the physiological readjustment at birth.

Cases of suffocation due to prolapse of the cord, coiling of the cord about the neck of the child, as well as funicular rupture in labor are not unfamiliar to us but they are so obvious in their mechanism that they need only to

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be mentioned here. It is more practical and more profitable to review some of the foreseeable and sometimes preventable instances of asphyxiation that occur as accidents or incidents of delivery.

So long as the bag of waters remains intact, the danger to the babe is extremely slight except through overlong persistence of the membrane or through intra-uterine interference with the cord. This mishap is, of course, possible at any stage of the pregnancy or labor, but it is far more liable to occur before the onset of the pains.

As soon as the membranes rupture, however, the foetus is exposed to danger. Immediately the uterus becomes smaller, the contractions harder and more frequent while the gas exchange between mother and child is doubtless greatly restricted. The longer the contraction, the shorter the pain-free interval, the greater the danger to the child.

Besides, there is a marked change in the intra-uterine pressure. The diminution that comes on directly after the rupture of the membranes is replaced through the reduction in the size of the organ by a decided increase. "If the column of mercury stood at 80 before the event," says Schultze, "it rises to 150 or more after the liquor amnii escapes."

Usually this pressure is equally distributed over body and head and in normal labors is of no particular consequence, but in certain instances where the membranes rupture prematurely, and in oblique presentations, serious results will follow. In these cases, as well as in presentations of the pelvis, face and brow, where a limb is prolapsed beside the head, or in pelvic contraction, certain parts of the uterus are put under a higher degree of pressure than other portions. This happens occasionally from contact with the irregularly disposed foetal parts or from stimulation of the uterine musculature with localized contractions. An alteration of the blood supply ensues and oxygen starvation begins in the foetal blood while retention of carbon dioxide increases. Under the same conditions compression of the cord or of the placenta may occur, or the spongy placental site may be contracted to a dangerous degree. The definite reduction in the volume of the uterus

may also react in a manner perilous for the foetus.

The soft parts that bound and reinforce the genital canal, normally offer a serious resistance to the passage of the unlucky child and this resistance may be greatly intensified by unusual conditions in the mother or babe. Even physiologically there exists a significant difference in this resistance between the soft parts of primiparas and multiparas.

In the first labor, a marked opposition arises from the integrity and rigidity of the muscles, connective tissue, and elastic structures of the pelvis and especially of the pelvic floor. This finds outward expression in a prolongation of the labor, in particular of the second stage and is associated with an increase of danger to the babe not only from detention but from pressure. It is generally taught and statistics seem to confirm the belief that three times as many stillbirths occur among primiparas as among multiparas.

To these dangers several contributory factors may be added. Thus the primipara may be over thirty years of age, or the child may be a male. Then too an unfavorable presentation, or a difficult position as well as a necessity for operation may increase the peril materially.

That the tissues of an old primipara are less elastic, and the labor somewhat longer is commonly recognized among obstetricians even in the absence of pathology. But in appreciating these cases, we are more likely to estimate the danger to the mother and to minimize or to disregard the peril to the child.

Nonetheless there is a real hazard to the babe in prolonged labors. In proportion to the duration of the second stage it is found that among the deaths primiparas with a stage of one hour furnish 8 per cent, and over two hours 18.3 per cent, while for multiparas the average is one-third less. In another series of 2550 vertex labors reported by Veit, in which the second stage lasted two hours or more, it was found that in the two hour cases, 18.32 per cent were born asphyxiated, 1.7 per cent were stillborn, and 5.5 per cent died later. Among the four hour cases 49.65 per

cent were asphyxiated, 5.59 per cent were stillborn and 6.22 per cent died during the next few days.

Statistics also show, as we would naturally expect considering the presentations in gross, that the vertex is least and the transverse is the most dangerous (39 per cent). Personally some surprise was felt on finding that a face presentation was (13 per cent) only a trifle more than half as dangerous as a breech (22.1 per cent).

This is due, as we understand it, to the fact that the head is the largest and least compressible part of the child's body. Hence as it advances, the canal is slowly dilated, the power of the uterine contractions is definitely increased and when the head is born the rest of the body follows quickly. On the other hand, when the smaller and softer breech precedes, less powerful pains are required and the progress is deliberate. The thorax and finally the head finds the passage imperfectly dilated and the pains not yet developed to full strength. Retardation of the upper half of the body takes place while the lower part is delivered. A pause ensues in the course of the labor. A moderate pause in vertex cases is of no particular consequence since the cord, ordinarily, is not compressed and the child's mouth is free. In breech cases on the contrary, the cord is compressed and the child's mouth is surrounded by liquor amnii or else buried in the soft tissues of the passage. Under these circumstances the child becomes asphyxiated in a few minutes and in from eight to ten minutes will die, for as soon as the umbilicus passes the vulva the cord is squeezed between the pelvic brim and the large head and shoulders of the child and extraction must not be delayed.

Moreover, in vertex cases it is just as important to guard against too great compression of the head as against the excessive prolongation of the labor, for while compression of the skull, in the absence of such injuries as arterial rupture and lesions of the brain, does not of itself produce death, yet it may directly contribute thereto by bringing about a paralysis of the respiratory center. In brain compression, this center becomes obtunded and so retards the mechanism that

no effort at inspiration is made prematurely. Now while this quiescence in the respiratory phenomena may be advantageous sometimes in protecting the child against the aspiration of mucus or liquor amnii, it more commonly happens that a permanent paralysis takes place, and after the conclusion of the labor when the oxygen from the placenta has been shut off, a child with a good heart-beat and a good circulation cannot be made to breathe in spite of the most persistent and conscientious effort. The babe becomes asphyxiated as soon as it is compelled to depend upon atmospheric air and its own inspiratory exertions. This condition is by no means rare for in many cases of foetal death there is no evidence, postmortem, of premature attempts at respiration nor of positive lesions in the skull such as depressed fractures or blood effusions. In fact most babies that are born in asphyxia and are afterward resuscitated are examples of skull compression.

According to the degree of foetal prostration these cases are usually divided into blue asphyxias and pallid asphyxias. Blue babies represent a minor grade of the condition and are therefore the most hopeful to work over. In fact we are not altogether sure that blue babies are markedly abnormal, for the hypercarbonization of the blood, or more accurately, as Carlson contends, the retention of acid products which produces this blueness is a necessary preliminary to respiratory activity. The normal stimulus to the respiratory center must be sought in the tidal fluctuation in the alkalinity of its blood supply which, in turn, is due to carbon dioxide and lactic acid formation. The child does not breathe because it needs oxygen, but the accumulation of carbon dioxide results in a relative acidosis of the blood which irritates the breathing center. It reacts and oxygen is taken in.

In pallid asphyxia, however, the reflexes are lost, the muscle tonus is gone, the cord is collapsed and almost pulseless while the heart beat is feeble and irregular. In fact the child has passed from vagus irritation over to vagus paralysis from which it is only occasionally rescued.

Boys suffer from asphyxiation more frequently than girls, either because as a rule

they are larger and therefore have longer and more difficult labors or because more boys are born than girls or possibly from both of these conditions. In this connection it is pertinent to note that Simpson found the second stage to average 15 minutes longer for boys than for girls.

Contracted pelvis is another cause of foetal asphyxiation for in this complication we not infrequently have the association of a premature rupture of the membranes, stormy pains, prolonged labor, changes in intra-uterine pressure and cerebral compression.

It must not be forgotten that a certain slowness in the expulsion of the child is usually propitious. The pain-free interval is then sufficient for the continuance of placental respiration and the gradual conquest of the pelvic opposition takes place by a non-injurious adaptation. Brain pressure symptoms appear only when the nourishment of the cerebral tissue is interfered with through anæmia or hypervæmia. So long, therefore, as the placental circulation is maintained and in no way diminished or cut off by tetanic contractions, medically induced or otherwise, danger can only arise through paralysis of the breathing centers when the head is exposed to hard or prolonged compression. Moreover, if the child is feeble or already on the verge of extinction through a moderate or a protracted compression, it is easy to see how the application of forceps could bring the disaster to completion. Pure cerebral compression occurs only when, in operative deliveries, the child is drawn by feet or forceps through rigid soft parts or a small pelvis. The cases of asphyxia after hard forceps deliveries are thus explained. The slowing of the heart tones from cerebral compression during the forceps operation can be readily demonstrated if the stethoscope is applied while traction is made.

Ahlfeld brings forward the logical theory that delivery of the child into the vagina with a consequent recession of the uterus over the breech may produce so great a contraction at the point of placental attachment that the babe may be asphyxiated in a short time if the end of the labor is not hastened.

To summarize then we may say that large

babies, rigid inelastic soft parts, premature rupture of the membranes, artificial extraction by feet on forceps, version, moderate pelvic contraction, prolongation of the labor or any other condition which can bring about cerebral compression may be regarded as a determining factor in asphyxiation of the babe. Maternal coma, lung œdema, spasm of the respiratory muscles, premature separation of the normally implanted placenta (only one in 15 lives), and placenta prævia (50 per cent die), all result in foetal suffocation by an obvious process. Even the hæmorrhages from a lacerated cord or traumatized arteries are really forms of asphyxiation by a legitimate extension of the term.

We now come to a question that has long been in the background of our minds. What asphyxiating effect, if any, is produced on the babe *in utero* by an anæsthetic?

Since 1902, this subject has remained more or less uneasily under the dictum of Ballentyne who stated: "While there is evidence to show that chloroform may pass over and enter the blood of the foetus after prolonged administration to the mother, there is no strong evidence that when there it produces any serious effects. As with chloroform, so with ether. Its transmission through the placenta, if not entirely proved is probable, but there is no reason to apprehend a toxic effect unless the anæsthesia be very deep or greatly prolonged." Preyer has shown in his experiments with curare, hydrocyanic acid, and nicotine that in asphyxia of the mother animal, the blood of the umbilical vein of the foetus becomes markedly dark in appearance, indicating that oxygen is being drawn from the foetus to the maternal organism. It is clear, therefore, that if anæsthetics are administered for a long time the foetus may be seriously endangered and if administered up to the point of saturation the foetus may be killed. It is quite plausible also that injurious effects will appear earlier or follow a smaller amount of anæsthetic if the patient is organically diseased or toxic.

Davis, of Chicago, has recently become interested in this subject through his enthusiasm for gas analgesia in labor. His experiments on pregnant guinea pigs have

brought him, as we interpret his careful work, if not to the same at least to nearly the same conclusions as Ballentyne. Davis finds that gas and chloroform are more dangerous to the fœtus than ether but that all anæsthetics have their dangers when the administration is continuous or long maintained. In his opinion the intermittent use of gas, say four or five whiffs at the beginning of each pain and properly mixed with oxygen, can be carried on for a considerable time without injury to the child.

His argument, it seems to us, applies equally to ether and chloroform. These also may be given for a considerable time with safety if given in the way he prescribes for gas. In all cases the vapor has been largely eliminated by the end of the contraction and the normal metabolism is not disturbed during the interval. There is a pervasive elimination of the absorbed gases, most rapid necessarily in the case of nitrous oxide, in which the emunctories of the body must be aided appreciably by the support and energy imparted to the circulation by the powerful pump-like action of the functioning uterus.

The subject of anæsthetics would not be complete without some reference to "twilight sleep" where the accusation of injury to the babe is so commonly heard. Morphine-scopolamine analgesia definitely controls the pain of the first stage and carries the patient well into and frequently through the second. Unquestionably a small proportion of the babes must be in condition to take up the infinitesimal part of the elaborated toxin which might pass over in the maternal blood. But as we have seen in the case of other pain-relieving agents, so in this, the blood of both patients is competent to purge itself though not so freely nor so quickly as from the anæsthetic vapors. Blue babies occur just as often under "twilight" as without it, but no more so.

Masses of statistics are not yet available but observations seem to show that no disastrous effects follow the morphine-scopolamine method, unless the treatment is begun too late or the dosage is too large or too long maintained.

Excluding multiparas with worn out uterine

muscles, we find that old primiparas and women with small genital canals, women with rigid inelastic soft parts and women with highly sensitized nervous systems are the ones who have protracted labors. They will not, or they cannot, use the abdominal muscles to hasten the process. In these women we find all the conditions present for an asphyxiation of the child from prolonged cerebral compression either moderate or severe. Furthermore, it is just these women who cry loudest for anæsthesia and forceps. They very properly get both, but when the child is born and fails to breathe, suspicion is bound to fall upon the anæsthetic or upon the instruments no matter how skillfully or how judiciously they may have been used.

We are left, therefore, in the belief that any anæsthetic which is continuously administered for a long time may be injurious or even fatal to the child in the manner shown by Preyer in his experiments with curare and nicotine. On the other hand we are inclined to believe that any anæsthetic may be safely used if it is given under proper indications, for a relatively short time and intermittently.

A word is necessary regarding pituitrin. It is difficult to overestimate the value of this substance in modern obstetric work and yet foetal death may swiftly follow its ill-advised exhibition. In the roomy unobstructed pelvis of a multipara who has weak, shallow and inefficient contractions in the second stage, pituitrin is a gift from heaven. But where the babe is already advancing laboriously and is somewhat stunned by the hardships of the way, where the os is incompletely dilated or some obstacle to progress exists, the attempt to hasten delivery by the use of pituitrin may bring on tetanic contractions of the uterus and eliminate the pain-free interval for a period long enough, in some cases, to close the placental circulation and asphyxiate the babe. So powerful an agent must be used with extreme caution. Its slowing effect upon the foetal heart tones is easily observed.

On the postmortem changes we need not dwell but a moment. They are quite as variable as in adults. There are some phenomena however that are fairly constant. The subpleural and subpericardial ecchymoses

are nearly always present. They follow, as we believe, the strong inspiratory efforts of the suffocating foetus when the placental circulation is interfered with. There is a sudden and marked enlargement of the thoracic spaces, in which the blood drives furiously, and in which in many instances necessarily, it bursts through the tender capillary walls.

Liquor amnii, vernix caseosa or meconium may at times be aspirated into the trachea, for premature attempts at respiration will inevitably follow the hypercarbonization of the blood.

The diagnosis of foetal death previous to birth is not always easy to determine unless the patient has been under observation before the labor began. The discharge of offensive liquor amnii after the rupture of the membranes is not always significant. The presence of meconium in the discharge may, or may not, be important, although in some cases the occurrence is justly interpreted as due to a relaxation of the sphincter which arises from an irritation of the submucous ganglia of the intestines through a hypervelocity of the blood.

The most definite and reliable information as to the condition of the child is obtained from the foetal heart-tones wherein the signs of cerebral compression and the effects of hypercarbonization of the blood on the vagus are duly registered. Throughout the second stage the heart tones must be counted at frequent intervals and care should be taken to observe them before, during, and after a pain to be sure that the normal rhythm is resumed. The neglect of this precaution may result in the birth of a dead babe that in some instances might have been saved.

Signs of danger are recognized when the heart-beat is greatly diminished or markedly increased; also when an increase in frequency is followed by a retardation. The injection of pituitrin is regularly succeeded by a reduction in the heart-beat, but unless the dosage is too great and the uterus remains contracted too long or, unless the child is already weakening under the adversities of the labor, the heart soon resumes its normal rhythm and strength.

We may say then that the danger signs are

really only three: the slowing of the heart beat, its increased rapidity, and its irregularity.

Slowing is the most common phenomenon and in the absence of pituitrin is almost pathognomonic of carbon dioxide intoxication (or acidosis), with irritation of the vagus. It is pathologic, however, only when it persists during the pain-free interval. Normally it should regain its regularity, volume, and rhythm as soon as the contraction passes away. If it sinks below a hundred (100) in this interval, danger impends and the labor must be terminated.

The next stage of intoxication is shown by a further involvement of the insulted vagus which speeds up the heart to 160 or more beats per minute. The child is now seriously imperiled and delivery is imperative.

The third degree of intoxication is signaled by the irregularity of the heart-beat which means paralysis of the vagus. There is, of course, a maximum and a minimum variation normally occurring during the contraction and in the pain-free interval but when this variation exceeds 50 beats, interference must be attempted in behalf of the child. The cessation of heart tones previously heard clearly, is manifestly diagnostic of foetal death.

It is not germane to this paper to discuss the generally familiar methods of resuscitating an asphyxiated infant. Foetal death is confessedly a failure and a disappointment. The treatment should aim at prevention and we shall, therefore, lay stress upon the precautionary measures which constitute our scientific prolepsis. At the risk of tediousness we must again emphasize the reliability of the foetal heart beat as a danger signal; it behooves us to keep it under close observation.

The objection to the frequent auscultation of the heart tones is very properly based on the disturbance of the clean linen with a consequent contamination of the sterile field but this risk can be minimized by the use of a sterile receiver on the stethoscope and then by having another person either use the instrument himself or else slip the ear tips into the ears of the operator. At all events if the patient is an old primipara, or if for any reason the second stage is unduly prolonged, the heart tones must be carefully controlled.

If pituitrin is given the dose must be small, not to exceed 10 minims, and the effect should be followed with the stethoscope.

If an anæsthetic is required and ether or chloroform is chosen, let it be given *a la reine* and as little as possible. No anæsthetic should be given for more than three consecutive hours without stringent indications. If gas is used we believe with Ferguson that re-breathing should not be permitted for it is dangerous to the child. If the woman is toxic or has a high blood pressure neither gas nor chloroform is admissible. If morphine-scopolamine is employed, the woman must be at least three hours away from the end of her labor.

When the condition of the heart tones indicates danger, the fate of the child will depend upon the possibility of an immediate natural or artificial delivery which may or may not save the child. If the delivery is artificial, whether forceps or version, it is occasionally necessary to complete the dilata-

tion of the soft parts with the hand before beginning the extraction. The operation is justified by the imminence of the peril.

If the subaeration of the blood is partial or only temporary, the child may be resuscitated but if the heart does not beat, the respiration can scarcely be established even though the head be released from pressure.

In conclusion, furthermore, we must add that while the babe may be stimulated to breathe by one or all of the usual methods of resuscitation, the prognosis is not yet altogether favorable since our statistics show that from 10 per cent to 15 per cent of babes born in asphyxia die during the next eight days. The fatality generally results from a continuing atelectasis, from convulsions, paralysis, pneumonia or some form of physical incompetence which prevents the natural and welcome readjustment after birth. Nevertheless the frequent appreciation of the foetal heart tones is the surest criterion of foetal safety.