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LIFE-SAVING METHODS IN STILLBIRTHS.

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A few weeks ago I was called in consultation to the bedside of a young primipara in advanced labor. I found upon examination that the child's head was low in the pelvis, and that the cervix was very nearly dilated. The pains seemed good, but for the past two hours there had been no progress of the presenting part. The extraction of the head by means of forceps was a simple task, but after its birth it was found that the advance of the shoulders was arrested by the cord, which was short and drawn tightly around the neck. The cord was, therefore, divided with scissors, and the child was rapidly extracted. It had reached the pallid stage of asphyxia. All respiratory action was suspended, and the heart-pulsations had apparently ceased.

The child was placed upon the table and wrapped in warm cloths. The mucus was expelled from the posterior fauces and from the nasal passages by mouth insufflation. A No. 8 English gum catheter was then passed into the trachea, and the aspirated mucus was removed by suction. The quantity of mucus in the bronchial tubes was large, and the catheter had to be introduced many times. After preliminary clearing of the trachea and bronchial tubes, direct insufflation was practised. In ten minutes slight heart movements were observed, but these ceased when insufflation was suspended. A little later the child gasped from time to time, usually it seemed in response to the irritation of the catheter when introduced into the trachea. An hour's perseverance in this plan of treatment was rewarded by the appearance of a little color upon the surface of the child. The latter was then immersed in warm water, and when lifted from the bath a stream of spirits was poured from a height upon the epigastrium. No respiratory movements were excited. Schultze swinging-movements were next resorted to, and were followed by Sylvester's method; but in employing the latter it was found necessary to

draw the tongue forward and to depress the base to secure a passage for the entrance of air into the lungs. It was, however, nearly three hours, spent in the use of warm baths, cold sprinklings to the surface, and in the alternating resort to Schultze's and Sylvester's methods, before spontaneous respiratory movements were finally established. The next day the child had repeated attacks of tetanus, but these finally grew infrequent, and after twenty-four hours ceased altogether. The child is now robust and healthy, and the joy of a worshipping household.

I grant this story is a familiar one, and yet the incident has stimulated me to treat of the subject of life-saving methods in stillbirths. I do this the more earnestly because I believe the attitude of the profession in general is one of incredulity as regards the efficacy of the means at our disposal to restore the life of children in the more desperate cases of asphyxia. In my experience it is the usual procedure to spank the child, to immerse it in hot and cold water, and then to wrap it in warm cloths and place it by the fire to die. Yet the object of medical practice is to save life, and for my part I regard the rescuing of a newborn infant from impending death to be as distinctly a professional triumph as the saving of life by ovariotomy, by Cæsarean section, or by the operation for appendicitis.

To do effective work it is necessary for the physician to make himself familiar with the physiological conditions which occasion the first respiratory act, and the secondary pathological changes which result from suspended animation. For the mechanical resources employed to restore the circulation, and to excite spontaneous respiratory movements, should not be selected by divining-rod methods, but should be natural sequences of our knowledge of the disturbed conditions calling for relief.

It is, of course, well known that during the period of gestation the child remains in a state of apnœa, and that the respiratory function necessary to its development is performed by the placenta. So soon, however, as the child is born, in normal cases, the thorax expands, the diaphragm contracts, and pulmonary respiration is established. The premature establishment of pulmonary respiration while the child is still in the utero-genital passage, owing to the absence of an atmospheric medium, is followed by asphyxia, and is the usual cause of stillbirths.

The reason of the first respiratory movement in the child, whether prior or subsequent to its birth, has long been a subject for speculation. Omitting earlier views, at present two theories contend for supremacy. The one formulated by Schwartz maintains that in all cases the respiratory act is due to disturbed placental circulation, and the consequent lack of oxygen in the blood of the child. Preyer, on the other hand, insists that respiration is a reflex movement provoked by cutaneous stimuli. He admits, however, that a venous condition of the blood favors the

action of external stimuli by increasing the irritability of the respiratory centres.

As a contribution to the solution of the questions in dispute, Otto Engstrom[1] has recently reported a series of experiments made by him upon gravid rabbits and guinea-pigs, in Preyer's laboratory. The animals were strapped to a board, and were then immersed in a saline solution (six per cent.), which was kept at blood-heat by a special apparatus. The head of the animal was placed above the fluid. A small incision was then made in the abdominal wall, through which a uterine cornu was allowed to escape into the saline fluid. The uterine walls were next opened opposite the mesenteric attachment at the point of least vascularity. As there was no hemorrhage to stain the saline fluid, it was possible to observe the fœtuses through the membranes in the clear amniotic fluid. When this experiment was performed with address and dexterity, the exposed fœtus remained in a state of apnœa, and the blood in the umbilical vein possessed a bright-red color, in marked contrast with the dark hue of the blood in the umbilical arteries.

If now the cord was compressed through the membranes by the thumb and index-finger of the warmed hand, or by self-closing compressing forceps applied to the cord near to the placenta, and as far from the fœtus as possible, respiration followed in from three to six seconds, and continued until death supervened from asphyxia. The same results followed when the umbilical vein was pricked with a needle, or was divided by scissors. Again, in other cases, to avoid the criticism that external stimuli were not absolutely excluded by the manipulations employed, the mother was asphyxiated by carbonic acid gas, or poisoned by woorari, or bled to death by opening the carotid. Here, too, soon after the blood in the umbilical vein became of a venous hue, respirations occurred as heretofore, though all manipulations were carefully avoided. It is, therefore, demonstrated that fœtal respirations are excited, in the absence of external sources of irritation, so soon as the blood in the umbilical veins becomes darkened, or is cut off from the fœtus.

On the other hand, in another series of cases, where the amniotic sac was exposed under a blood-warm saline fluid, and the apnœa was not disturbed, Engstrom gently pricked the extremities of the fœtus with a needle. Reflex movements were excited, but the apnœa continued. When, however, deep puncture was made, the alæ nasi dilated, the mouth opened, and thoracic inspiration was evoked. The effect was, however, momentary, and the apnœa returned.

Again, in order to reduce the disturbance of the placental circulation to a minimum, Engstrom, following a method invented by Preyer, seized the head of a fœtus with the thumb and index-finger through the

[1] Ueber die Ursache der ersten Athem bewegungen.

abdominal walls, and then cut through the abdominal coverings, the uterine walls, and amniotic sac to the nose of the animal. The nose was then lifted above the saline fluid and exposed to the atmosphere. By means of powerful currents of induced galvanism applied to the nasal organ, respiratory movements were excited, but ceased when the current was removed. It seemed doubtful, however, whether inspiratory acts did occur in either series of experiments, so long as the placental circulation was completely undisturbed. The existence of apnœa in the fœtus is not conclusive evidence that the opening of the uterus, or the compression of the uterine walls produces no derangement in the blood-currents of the placenta. The results were often negative at the beginning of the experiment, but as the blood in the umbilical vein darkened, the electric and mechanical irritants produced more and more marked effects.

From these experiments it becomes evident that when the placental respiration is suspended the accumulation of unknown materials in the blood is capable of exciting the respiratory centre in the medulla oblongata of the fœtus without the aid of peripheral stimuli; but that the latter are capable of exciting the respiratory act before the internal stimuli have increased sufficiently to induce independent action. Again, it is a familiar fact that in moderate degrees of asphyxia in the newborn, after the irritability of the medulla has been lowered to a point at which no response follows from the venous condition of the blood, external stimuli are still capable of exciting respiratory movements.

Engstrom found, too, that when the fœtus had breathed in the amniotic sac, after respirations had ceased, and after the blood in the umbilical vein and arteries had become of the same blue color, and the nose and lips had become cyanotic, it was still possible to excite respirations in some cases by opening the amnion and lifting the head so as to expose it to the air, and in others by pinching the nostrils, the ears, and the mouth.

I shall hardly need to apologize for endeavoring to recall to the memory of my readers the peculiarities of the fœtal circulation. The arterialized blood in the umbilical vein empties partly into the portal vein and is first distributed to the liver, and in part passes by the ductus venosus into the inferior vena cava. The mingled venous and arterial currents then enter the right auricle, and are in early pregnancy directed by the Eustachian valve across the right auricle to the left auricle, and thence pass to the left ventricle. As the heart contracts the blood is driven from the left ventricle to the aorta, and is thence distributed by the large vessels which spring from the latter to the head and upper extremities. The blood returned from the upper portion of the body by the superior vena cava, enters the right auricle, where it passes in front of the Eustachian valve to the right ventricle. With the advance of gestation, however, a gradual disappearance of the Eustachian valve

takes place, so that a part of the blood from the inferior cava enters with that of the superior cava into the right ventricle. The contraction of the right ventricle forces the blood into the pulmonary artery, which distributes an insignificant quantity to the lungs, while the main current passes through the ductus arteriosus to the aorta, by which it is distributed to the lower portion of the body. Now, though the greater part of the regenerated placental blood is distributed to the head and upper part of the body, it is mingled largely with venous blood returning from other organs, and that which goes to the respiratory centre in the medulla oblongata is of a character which would cause dyspnœic manifestations in self-breathing individuals.

During labor, especially in the last stage, the placental aëration of the blood is interfered with by the uterine contractions, and in its passage through the pelvis the surface of the child is subjected to pressure and friction. At birth the body is exposed to the air. These combined causes as a rule are followed by pulmonary respiration, though in some instances of lowered irritability of the medulla, prolonged apnœa follows the birth unless the child is made to cry by vigorous slapping.

As the chest expands in the act of inspiration the lungs fill with air, and the blood from the pulmonary artery pours into the opened pulmonary vessels. The pressure in all the vessels of the body is diminished, though in the thorax a partial compensation takes place from the aspiration of blood from the veins which enter the intra-thoracic space. The diminution of pressure is greatest in the pulmonary artery. The current which empties into the aorta becomes of feeble force, and finally ceases altogether. The ductus arteriosus gradually closes, and the pulmonary circuit becomes complete. The withdrawal of the blood from the pulmonary artery, and the force of aspiration, lower the tension in the aorta. The heart beats more slowly. The resulting diminished arterial pressure is most felt in the extremities. The pulsation of the umbilical arteries as a consequence ceases, and the placental circulation is suspended.

In the asphyxia of newborn infants the suspended animation is, with few exceptions, preceded by intra-uterine respirations. The causes of the latter are to be found in tetanic contractions of the uterus and the consequent diminished blood-supply to the placenta, in premature detachment of the placenta, in compression of the cord, and in the sudden death of the mother. Of these the compression of the cord is by far the most common.

The first effect of the compression of the cord is to arrest the circulation in the umbilical arteries. The pressure in the aorta is thereby augmented, and increased work is thrown upon the left ventricle of the heart. Except in cases where the mouth and nasal passages are closed by pressure, with the expansion of the chest, due to the irritation of the

medulla by the increased venosity of the blood, amniotic fluid, meconium, and mucus are aspirated into the air-passages. When the compression of the cord is temporary the circulation may be restored, and the apnœa may again return; but in cases where the respirations continue, the capillaries of the lungs fill with blood from the pulmonary artery, the intrathoracic venous congestion is increased, and the heart action is lowered. As the irritability of the medulla sinks, the respirations fail, the cavities of the heart fill with venous blood, the lungs are congested, and in some instances sub-pulmonary ecchymoses result from over-distention of the pulmonary vessels. Outside the thoracic cavity, the venous trunks are often distended with blood. This secondary venous stasis is most marked in the vessels of the neck, head, and brain, but to a less degree venous stases are likewise observed in the abdominal organs and in the capillaries of the skin.

After the birth of the child the prognosis is dependent upon the degree of asphyxia. In the milder cases the muscular tonus is preserved, the head does not drop, the extremities are not relaxed, the skin is dusky-red or cyanotic, the conjunctivæ are injected, the umbilical vessels are distended, and the cardiac and umbilical pulsations are slow but forcible. Reflex movements are easily produced by surface irritation. In these cases spontaneous respiratory movements often occur.

In the more advanced stage, the muscular tonus is lost, the head falls to one side, the sphincters are relaxed, the eyes are glazed, reflex movements cannot be provoked, the heart-beats are feeble and infrequent, the umbilical vessels are nearly empty, and the pulse scarcely perceptible. The cutaneous circulation has disappeared, and the surface is pale and cold.

If respirations occur, they are feeble and are not associated with movements of the muscles of the face. The first signs of returning animation are the refilling of the cutaneous capillaries and the restoration of the muscular tonicity. In fatal cases the pulmonary vessels are found to be widely distended, the lungs are heavy and of a dark-red color, and pulmonary, subpleural, subpericardial, and subendocardial ecchymoses are present. The obstruction of the pulmonary circulation further produces congestion of the abdominal viscera and of the brain.

The indications for treatment are in all cases to clear out the air-passages, to restore the irritability of the medulla, to increase the force of the heart contractions, and to relieve the plethora of the heart and of the blood-channels of the thorax.

In cases where the muscular tonus is preserved these indications are, as a rule, easily fulfilled; aspirated fluids and mucus should be cleared from the fauces with the finger. If the nasal passages are obstructed, mouth-to-mouth insufflation should be employed. The child should be made to cry by flagellation, and the respiratory movements should be

further stimulated by alternately immersing the child in hot and cold water. So far the procedure is a familiar one, but in a good number of cases we know that in a few days the skin becomes dusky, the heart action feeble, and the child has been temporarily restored to life only in the end to die of atelectasis. As a means of guarding against this fatal sequence, due in part to imperfect expansion of the lungs, in part to lobular congestion, there is no method that rivals the one of Schultze.

Schultze directs that the child should be grasped in such a manner that the operator's thumbs rest, on either side, upon the anterior thoracic wall, while the index-finger occupies the axilla, and the remaining fingers are placed diagonally across the back. The child is then allowed to hang at arm's length between the knees of the obstetrician, its face being turned to the front. In this position the pectoral muscles are made to draw the superior ribs upward, the abdominal muscles draw the inferior ribs downward, and the weight of the liver causes the descent of the diaphragm. By this means the capacity of the chest is increased and inspiration is produeed. The child is next swung upward, until the arms of the operator reach an almost horizontal position. The swinging motion is then arrested, flexion occurs in the child's lumbar spinal region, its head is directed downward, and its lower extremities fall slowly toward the obstetrician until the whole weight of its body rests upon his thumbs. In this way the chest and abdomen are powerfully compressed, the diaphragm is forced upward, and an efficient expiration results, and any retained adventitious matters are expelled from the air-passages. An inspiration is now produced by reversing the direction of the swing and returning the child to its former position of complete extension, by which manœuvre the chest is made to expand and the diaphragm to descend.

By this method not only is good aëration of the lungs secured, but the forcible expiration expels the materials aspirated from the bronchial tubes. A still more important action, according to Schultze, is the relief of the overloaded vessels as a result of the compression of the entire thoracic contents. Thus, as expiration is produced by the upward swing the blood is pressed from the left ventricle into the aorta, and from the right auricle into the right ventricle. The emptying of the left ventricle makes room for the contents of the left auricle and permits the return current from the pulmonary veins. From the right ventricle the surplus blood finds a passage into the aorta through the ductus arteriosus. With the inspiratory swing blood is aspirated from the peripheral vessels into the blood-channels of the thorax. The aspirated blood is, however, venous, as the semilunar valves prevent regurgitation from the aorta. By alternating the expiratory and inspiratory swinging movements the pump-working of the heart is mechanically set in action. As the blood-

streams pass through the heart cavities the systole increases in force and the arterial tension is restored.

In cases of deep asphyxia, in which muscular tonicity is lost, and the heart movements are scarcely perceptible, the methods at first employed should involve the minimum degree of disturbance to the child. Active movements are, as a rule, speedily followed by the extinction of heart pulsations.

The child should be laid upon a table and covered warmly. After clearing the fauces and nasal passages a No. 8 English elastic catheter should be passed under the guidance of the fingers of the left hand through the larynx into the trachea, and aspirated matters should be carefully removed by suction. This often requires time and the repeated introduction of the tube. Meantime, at intervals, insufflations through the tube into the bronchial tubes should be employed. After each insufflation the chest walls should be compressed with the hand to produce expiration. By this means, little by little, the blood receives oxygen, and the returning irritability of the medulla is manifested by occasional spontaneous respiratory movements. Then the Sylvester's method, which Champneys has shown is followed by the fullest expansion of the air-cells, is of service. Only, to secure favorable results it is often necessary to draw the tongue well forward. So soon as the heart movements become plainly perceptible the child should be placed in warm water, and sprinklings of cold water upon the face should be practised. Finally, the swinging method of Schultze should be employed to complete the establishment of the normal circulation.

But in these cases of deep asphyxia no miracles are to be wrought without patience, watchfulness, and a hopeful spirit. Often, when a certain amount of progress has been obtained, the heart action begins to die out, and we find ourselves obliged to go back to the catheter and insufflations anew. There is, however, no greater joy to the physician than that which comes from watching the gradual restoration to life of a young child, and to know that the life has been saved by the intelligence and the knowledge which God has given to us.