The Care of Premature Babies in Incubators

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It has been customary to fix the period of viability of the child at twenty-eight weeks of intrauterine gestation. But this period undoubtedly varies within relatively wide limits. In this respect much depends upon the nourishment of the fetus prior to birth, the health of the mother during pregnancy, the conditions demanding or leading up to the interruption of pregnancy, the character and duration of labor, the difficulty attending its birth as well as the care of the infant after its advent into the world. In a syphilitic, tubercular or albuminuric mother, in a case of placenta previa, accidental hemorrhage or eclampsia, in a dry protracted labor, after a breech, forceps, or version delivery, the chance of survival of the baby is very much reduced. There are no characteristic appearances, no exact development upon which we can definitely state the age of the infant when it is born. If it is alive, we should carry out the best rules for preserving its existence.

The clinical picture of a premature baby is very characteristic. The movements are very weak, the body is limp, the skin soft and delicate, considerably wrinkled in some places and in others so thin that the superficial veins shine through, the extremities, apparently emaciated from lack of adipose tissue. The lanugo is present and the nails are short. The head is large in proportion to the body, the abdomen prominent, due in a great measure to the relatively large size of the liver. The face is thin and peaked, the cry is short and low. The respirations are irregular and superficial, and often suspended for a time. The little one sucks slowly and weakly and swallows with difficulty. The tissues of the infant, especially the lungs and gastroenteric tract are not yet sufficiently developed to meet the demands of extrauterine life. In the former, even though the baby has cried fairly well, it only uses the anterior lobules of the lungs and is apt from slight causes to acquire a secondary atelectasis in addition to the fetal condition posteriorly. The function of digesting fats and proteids is in a much more undeveloped condition in the premature infant than in the one born at term, and, therefore, should not be depended upon to the same degree as in the older infant. Even absorption from the gastroenteric tract is slow and deficient. The
heart is weak and the foramen ovale is often patulous longer than if the infant were born at term.

The animal heat is very easily affected if the baby is kept in a low temperature, as the temperature becomes subnormal from excessive radiation and so its vitality is impaired. If the temperature of its surroundings is too high, it suffers from a hyperpyrexia which greatly increases its cell metabolism. The tissues of the nose, nasopharynx and mouth are very sensitive and cannot throw off the infections conveyed by dirt and dust. It needs plenty of clean, fresh air. There are, therefore, four problems in the care and management:

1. The maintenance of a proper temperature.

2. The prevention of exhaustion.

3. The administration of the proper amount and kind of nourishment.

4. The avoidance of infection.

At the Sloane Maternity Hospital we have three classes of premature infants: 1. Those treated as babies at term. 2. Those wrapped in cotton. 3. Those placed in the incubator.

The weight, length, appearance of the baby, and even the assumed period of gestation, judging from the mother’s last menstruation, are simply relative in estimating the exact duration of fetal life. It is by far a better procedure to consider the general condition of the infant, together with the above, before we put it into one class or another. The majority of babies would do better if placed in the last class from the beginning. Unfortunately in the hospital we have so few incubators that all cannot be given the best chance. At times indeed we have had to put as many as three infants in one couveuse. Our general rule is to put a baby in cotton whose weight is in the neighborhood of five pounds and surround it by hot bottles. If it does not thrive by these methods or if the temperature falls below normal, we put it in the incubator. Any premature baby weighing four and one-half pounds at birth or less, or if somewhat heavier but in poor condition is placed in the couveuse.

There are many kinds of incubators in use, notably those of Denuce, of Bordeau, who in 1857 produced the first one which gave satisfactory results. In 1880 Tarnier constructed one, which was afterward improved by Auvard. Credé also invented one which was successfully used.

The brooder of Dr. Rotch of Boston, is a very intricate and elaborate affair, in which the baby can be weighed without removal.

The best one is probably that of M. Lion, of Nice, first used in 1891. It is composed of a parallelopiped of metal, standing on iron supports. It can be disinfected without deterioration by means of a steam-stove under pressure or by cleansing with a solution of carbolic acid or with formalin gas. (Fig. 1.)
Ventilation is obtained by means of a tube of about three inches in diameter, entering the compartment low down on the left side. The exit is through a chimney in which is a fan, indicating by its rotation the strength of the current of air. The air on entrance is filtered by a gauze and cotton diaphragm. The front is fitted with glass doors through which the infant can be seen, while at the side is a glass window by means of which the nurse can attend to the infant's wants without removal.

The baby is placed in the middle on a soft pillow, the warm, fresh air circulating around it. The air is kept moist by a large pan of water placed in the bottom. A thermometer is hung close to the door, and a hygrometer is fastened to the posterior wall of the chamber. The heating is effected by means of a siphon through which hot water circulates and which communicates with a reservoir at the side. The temperature is automatically regulated by a metallic thermostat, lifting or lowering a cap over a flame. This apparatus is very expensive, and, therefore, only adapted for use in hospitals or wealthy families. For the past year and a half, besides the Lion incubator, we have used at the Sloane Hospital a cheap modification of the Tarnier or Auvard couveuse, which any carpenter can make at a small expense. The main point in its construction is that there should be plenty of inlets and outlets for free ventilation. The disadvantages of this apparatus are, first the lack of filtration of the air, and second there is no thermostatic regulation of the temperature. The latter, therefore, needs careful attention and a temperature as near constant as possible is obtained by the size of the flame and its nearness to the tube connecting with the main tank of water. (Fig. 2.)

The incubator -- whatever kind is used -- should be placed in the hall or in a large, cool room to get the best fresh air. The direct rays of the sun ought never to strike it, because their heat would quickly unbalance a constant temperature. Before putting a baby into the chamber the apparatus should be thoroughly disinfected, as these infants are very susceptible to infection. The baby should lie on a very soft pillow.

The temperature should vary with the infant. It should be one which would keep the baby's temperature normal without perspiration. We have found 86° to 92° F. to be about right. A variation of a degree or two makes but little difference. If a premature baby is expected, an incubator should be in readiness, and at a proper temperature at the time of its birth. The baby itself, after having been made to cry lustily (not with harsh methods of resuscitation, but relying mainly on hot baths and light titillation, and perhaps easy swinging), is quickly tied off and the cord dressed. After having been weighed and anointed with albolene, but not bathed, it is dressed. A mistake is made in enveloping these infants in cotton. So wrapped up they will be too warm and will perspire too freely. The best clothing is a small light shirt and a napkin from the waist down, pinned over the feet and legs. (Fig. 3.) When the baby is placed in the incubator it should not be removed, except to be weighed or nurse. The latter is not permitted until it is thriving. The weight is taken every five, seven, or ten days, and about once a week the infant is lightly sponged.

The napkins should be changed three or four times a day, only often enough for cleanliness, disturbing the baby as little as possible. Before feeding, however, especially when the baby is stupid or sleepy, a light tap on the hand will make it take the bottle with much less coaxing and more rapidly.
The infant should be kept in the incubator until it has reached the development of full-term, or longer if it is not improving. In many of our cases it was necessary, either for lack of room or at the demand of the mother, to remove them at a fairly early date. This, of course, added to our mortality. Some of the babies, nevertheless, will do well in cotton after having been given a good start in the couveuse. If possible the temperature of the incubator should be gradually lowered almost to that of the nursery before the baby is permanently subjected to the variation in the temperature of the air of an ordinary room.

In the administration of nourishment the amount and quality depends on the age and digestive powers of the infant. Ordinarily six hours after birth, they should be given a warm sugar solution, 5 to 6 per cent. lactose in distilled water, about 3 js. to 3 i. every hour. After twenty-four to thirty-six hours an equal part of breast milk is added. This is obtained by massage and expression, by the breast pumps or by spontaneous expression while a baby is nursing the other breast. This milk for best results is not taken from the mother but from a wet nurse at least seven or eight days post partum, the quality of whose milk is about established, or at any rate a milk comparatively free from colostrum.

The amount is gradually increased a drachm at a time so that by the end of a week, the child is taking 3 vi. to an 3 i. every hour. If the stools are normal, the breast milk can be gradually increased and the sugar solution gradually diminished, or by the addition of a little lime water, the infant can often be put on pure breast milk at the end of two weeks. On this plan there should be little or no vomiting and the stools should be normal or nearly so from the beginning.

The method of feeding can in almost all cases be carried on by means of sucking through a small nipple, especially if a little coaxing is resorted to. In some cases a medicine dropper or a feeder recommended by Rotch can be tried if the baby refuses to suck. In others who are extremely weak and who will not swallow, gavage is necessary. In our experience these cases do not do well, so we like to get back to the bottle as soon as possible. The infants are apt to regurgitate, the milk fills the nares or nasopharynx, and when the baby takes its next inspiration some of the fluid is drawn into the larynx and even into the bronchi. This may cause an immediate asphyxia, an atelectatic area in the lung, a bronchitis, or a bronchopneumonia which will soon end in death.

As soon as the baby is strong enough and gaining, it can be tried at the mother's breast. At first two or three times a day is sufficient. If it does well, the number of nursings is gradually increased to every two hours. At the same time it is generally necessary to feed in between and also supplement the nursing by the bottle.

Dr. Rotch says that the food, carefully prepared at the milk laboratories is the best method of feeding premature infants, even far superior to mother's milk. In our experience, although we have used some weak modifications of cow's milk as fat 1 per cent., sugar 6 per cent. and albuminoids .33 per cent., or even lower percentages, the results have not been satisfactory, except in a very few cases. We have relied mainly on diluted breast milk and have only employed cow's milk in weak proportions when it was impossible to obtain the former. In our opinion, our results would have been much poorer without
the assistance of mother’s milk.

These premature infants lose considerably more in proportion to their birth weight than babies at term. This is due to their immature digestive tract, also to the fact that they are almost invariably intensely jaundiced. They gain very slowly and if at the end of two or three weeks they have reached their birth weight, they have done unusually well.

In some of the babies the color is poor from the beginning and at any time they are especially liable to attacks of cyanosis. For these conditions a little slapping to cause a good cry or the administration of oxygen will dissipate the blueness. Often a few drops of brandy in hot water every two or three hours will prevent further trouble. One must be very sure, however, that nothing has been aspirated into the larynx.

A great danger in the care of these babies is their susceptibility to infections. The incubator itself is a great germ carrier and should be regularly disinfected. The weakness of the lungs and gastroenteric tract makes the infants especially vulnerable. Unless the air is filtered, dirt is carried in continuously, consequently the streptococcus, staphylococcus and pneumococcus are always present, seeking an avenue of entrance. Through the skin in eczematous spots or in areas of irritation, at the navel, through the eyes, nose, mouth, larynx, lungs, stomach and rectum the bacteria can gain admission. To prevent infection then the most careful cleansing is necessary both of the incubator and the baby itself. Undoubtedly most of the deaths of our cases could be traced to this source.

Finally, in the carrying out of the above essentials in the proper management of the premature infant, we require the most patient and painstaking attention on the part of the nurse, and upon her conscientiousness depends the chance of its survival.

Results. -- The statistics are taken from 2,314 births which occurred at the Sloane Maternity Hospital in the two years from October 22, 1897 to October 22, 1898, before which time there had been no incubator in use.

Four hundred and ten of these babies were premature, but of these 74 were still-births, which include macerated fetus, the still-born babies of cases of placenta previa, accidental hemorrhage, eclampsia and the like, leaving 336 for treatment.

Among these cases was a set of triplets and there were 18 pairs of twins; 85 were treated as infants at term, and of these 4 died -- a mortality of 4 1/2 per cent.; 145 were put in cotton, and of these 12 died -- a mortality of 8 per cent. Some of this class should have been placed in the incubator, but for lack of room it was impossible; 106 were incubator babies.

These are divided into two classes: I. Those that died within four days of birth. II. Those that lived longer than four days.
I. Twenty-nine of the incubator babies died within four days. All of these but 3 were more or less asphyxiated at birth; 9 were breech cases, and of these 5 were difficult extractions; 3 after an accouchement forcé in placenta previa. The rest were vertex presentations, but of these 2 were forceps deliveries; 6 were under seven months of uterine gestation; 22 were between seven and eight months along, and 1 eight and a quarter months.

The etiology of the premature labor was an endometritis in 14; syphilis in 2; albuminuria in 1; placenta previa in 3; accidental hemorrhage in 1; persistent vomiting in 1; twin in 1; violence in 1; and in 4 the labor was induced. The largest baby weight 5 9/16 lbs.; the smallest, 2 7/16 lbs. Only 5 infants lived over twenty-four hours; 24 were in such poor condition at birth that they survived only a few hours. In 16 autopsies were held, and in all of these there was marked atelectasis; in 7 hemorrhages of some degree, either into the brain or into the serous membranes; in 2 the foramen ovale was still patent.

II. Seventy-seven incubator infants survived the first four days; 51 were children of primiparae, 27 of whom were out of wedlock; 3 infants were under seven months of gestation; 8 were over eight months, and the rest between seven and eight months along; 9 were breech presentations; 1 a transverse and the rest vertexes; 2 were of triplets associated with albuminuria; 18 were twin deliveries, associated with albuminuria or hydramnios. The cause of the premature labor was endometritis in 27; syphilis in 4; phthisis in 2; albuminuria in 7; accidental hemorrhage in 1; placenta previa in 1; in 2 the labor was induced for albuminuria and eclampsia; 1 was a Caesarean section; another an ectopic gestation; the cause of the rest was unknown. Seven were delivered by forceps; 2 by a version; 1 by accouchement forcé; 1 by Caesarean section, and the ectopic gestation by a laparotomy; 12 were slightly asphyxiated at birth; 9 moderately so, and 5 deeply asphyxiated; 2 after one and a half hours' work of resuscitation, were put in the incubator head downward, and their condition was so poor that they were expected soon to die, but they left the hospital gaining in weight; 5 weighed less than 3 lbs.; 38 between 3 and 4 lbs.; 33 between 4 and 5 lbs.; 1 over 5 lbs.; the average weight was 3 13/16 lbs. During their incubator life 28 had one or more attacks of atelectasis. All but 10 were more or less jaundiced. The initial loss of the infants was from 1 to 17 1/2 ozs.; the average was 7 ozs. These figures are not quite correct, as the babies were weighed at different intervals, some on the fifth day, some on the seventh day, and others not till the fourteenth day.

The period of loss was from five to twenty-two days, the average, eleven days; 10 lost steadily till death; 1 baby was in the incubator only three days, while another lived there eighty-two days. The average time was nineteen days. Some were removed early to make room for others who needed the place more urgently.

Only 3 of the 77 cases vomited. The stools were normal in 32.

One was discharged from the hospital as early as the eleventh day, and others also too soon at their mothers' demand. One was 89 days old, the average was 24 days.

In 16 diluted breast milk was supplemented at times, with a mixture of cow's milk and water with
Russian gelatine and lactose. In 10 a 1, 6, .33 modification was used. In all the rest diluted breast milk was relied upon. Twenty-seven never nursed at the breast of these 12 died. A few nursed as early as the third or fourth day, two or three times a day. Others not for three weeks, and one not till the sixty-eighth day. Of the 77, 13 died in the hospital, a mortality of 16 per cent. The cause of death was atelectasis and bronchitis in 7, acute asphyxia from a curd in the larynx in 1, syphilitic pneumonia in 1, cerebral hemorrhage in 1, gastroenteritis in 3 and a patent foramen ovale and ductus arteriosus in 1. The condition of 3 was poor at the time of discharge, fair in 24 and very good in 37; 32 were above their birth weights and 57 were gaining in weight. To letters written about January 1, 1900, no answer was obtained from 28. Thirteen were reported as having died, 1 of these lived fourteen months, 1 nine months, 1 four and one-half months, 3 lived two months, 6 lived six weeks, 1 only a month. Five of these children died at the Nursery and Child's Hospital and 2 died at Bellevue Hospital. They were bottle fed and the probable cause of death was gastroenteritis. Twenty-one were found to be alive and doing well. Some had nursed and the others were bottle-fed. The oldest baby was twenty-two months and almost all were good, healthy children. One baby at seven months weighed 16 lbs. It weighed 4 1/16 lbs. at birth and nursed its mother after leaving the hospital. The ectopic and the Caesarian babies were in beautiful condition.

STATISTICS.

| Incubators       | Tarnier Saved at 6 months | Tarnier Saved at 6 1/2 months | Tarnier Saved at 7 months | Tarnier Saved at 7 1/2 months | Tarnier Saved at 8 months | Charles Saved at 6 months | Charles Saved at 6 1/2 months | Charles Saved at 7 months | Charles Saved at 7 1/2 months | Charles Saved at 8 months | Sloane Hospital Saved at 6 months | Sloane Hospital Saved at 6 1/2 months | Sloane Hospital Saved at 7 months | Sloane Hospital Saved at 7 1/2 months | Sloane Hospital Saved at 8 months | At the Sloane Hosp. not counting those which died in a few hours |
|------------------|--------------------------|-------------------------------|---------------------------|-------------------------------|--------------------------|---------------------------|-------------------------------|---------------------------|-------------------------------|--------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-------------------------------------------------|
| Saved at 6 months | 16 per cent.             | 10 per cent.                  | ---                       | ---                           | ---                       | ---                       | ---                           | ---                       | ---                           | ---                       | ---                                | ---                                | ---                                | ---                                | ---                                | ---                                | ---                                |
| Saved at 6 1/2 months | 36 per cent.            | 20 per cent.                  | 22 per cent.              | 66 per cent.                  | ---                       | --                       | ---                           | ---                       | ---                           | ---                       | ---                                | ---                                | ---                                | ---                                | ---                                | ---                                | ---                                |
| Saved at 7 months | 49 per cent.             | 40 per cent.                  | 41 per cent.              | 71 per cent.                  | ---                       | --                       | ---                           | ---                       | ---                           | ---                       | ---                                | ---                                | ---                                | ---                                | ---                                | ---                                | ---                                |
| Saved at 7 1/2 months | 77 per cent.            | 75 per cent.                  | 75 per cent.              | 89 per cent.                  | ---                       | --                       | ---                           | ---                       | ---                           | ---                       | ---                                | ---                                | ---                                | ---                                | ---                                | ---                                | ---                                |
| Saved at 8 months | 88 per cent.             | ---                           | 70 per cent.              | 91 per cent.                  | ---                       | --                       | ---                           | ---                       | ---                           | ---                       | ---                                | ---                                | ---                                | ---                                | ---                                | ---                                | ---                                |

From this table our statistics are not as good as Tarnier's unless we omit those babies who were in very poor condition at birth and who died in a few hours.

These cases occurred during the services of Drs. James W. McLane and Edwin B. Cragin, with whose kind permission I report them.
Fig. 1. Lion incubator.

Fig. 2. Cheap incubator in use at the Sloane Maternity Hospital.
Fig. 3. Clothing for incubator baby.

Table I. Cases which died within four days.

Table II. Cases living more than four days.

Table II. Cases living more than four days -- continued.
Table II. Cases living more than four days -- continued.

LITERATURE.

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