The care and feeding of premature infants is a matter of great importance and of considerable interest; and yet -- in this country, at any rate -- it is only of quite recent years that much attention has been paid to the subject.

In this branch of medical science we have a great deal to learn from both the French and the Americans; and whilst the former have devised for us the incubator, the latter, by the introduction of a method of modifying milk according to the physician's prescription, have done a great deal towards simplifying and so rendering easier the difficult task of infant-feeding.

The recent introduction of the Walker-Gordon Laboratory into this country, and the consequent possibility of feeding premature infants with a milk specially modified according to their individual requirements, must be the excuse for again calling attention to a subject which has been so fully considered by other writers, more especially by Rotch, to whom we are greatly indebted, not only for the introduction of this infant-feeding, but also for the very complete detail with which he has perfected its employment.

The results obtained by the use of the incubator in recent years are far better than were anticipated; and now that the details to be observed in the care of premature children are better understood, and more attention is paid to them, we may hope for even better results.

The day has long gone by when all that could be done for a premature baby was to wrap it in wool and place it by the fire -- a method which has been adopted from the earliest times, and which corresponds to the use of the freshly-killed sheep's skin; or the practice, prevalent even quite recently amongst the peasants of Silesia, of placing the premature baby in a jar filled with feathers.
These rude means, however, indicate a perception of the most important principle in the treatment of premature babies -- viz. the maintenance of their temperature, a matter often of extreme difficulty.

The more premature the baby the less its power of producing heat, the greater its capability of losing heat, and the less able is it to withstand cold; and in the ready means it affords of maintaining the child's temperature at a constant level lies the secret of the success of the incubator.

It is difficult to say what is the earliest age at which a premature baby has survived, and in these days, when, unhappily, incubators appear to form an essential part of any popular show, there are, as might be supposed, many rival candidates for the honour of being the youngest baby successfully reared.

The question of the child's weight at birth is, however, of much more importance than its actual age, since the possibility of rearing it depends most of all upon its size and degree of development.

Many authenticated cases are now on record where babies weighing 2 lbs. or less at birth have been successfully reared, and Villemin, at the Société Obstétricale et Gynécologique, reported the case of an infant born in the fifth month. That the child had not had six months of intra-uterine life was shown by the date of its quickening, by its weight -- 30 1/2 ounces -- and by its appearance; it was successfully reared, and at the time of the report was two years old. Charpentier also reported a case where the child was only six and a half months old and weighed 33 1/2 ounces; it was able to take the breast on the twelfth day, and after this thrived and grew well. Barker mentions the case of a child, born apparently upon the 158th day, that weighed 1 lb. and was 9 1/2 inches long. Three and a half years afterwards this child was healthy and thriving. At the time of its birth it was placed in an improvised incubator before the fire.

The good results obtainable by the use of the incubator and artificial feeding are well shown by the following statistics from the Paris Maternité, representing the percentage mortality formerly and more recently:

<table>
<thead>
<tr>
<th>Duration of Pregnancy</th>
<th>Percentage Mortality</th>
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<tbody>
<tr>
<td></td>
<td>Formerly</td>
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<tr>
<td>6 months</td>
<td>100</td>
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<tr>
<td>6 1/2 months</td>
<td>78.5</td>
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<tr>
<td>7 months</td>
<td>61.0</td>
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<tr>
<td>7 1/2 months</td>
<td>46.0</td>
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<tr>
<td>8 months</td>
<td>22.0</td>
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<tr>
<td>8 1/2 months</td>
<td>12.0</td>
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In the Maternity Department of University College Hospital we have had an incubator in use for some years past; but owing to the fact that the department is an extern one, and the consequent difficult there is in obtaining the best possible care and attention for the children at their own homes, the results cannot be compared with the above. The results of the Paris Maternité show, however, what can be done in a Lying-In Hospital, and what should therefore be possible in many cases in private practice where the child can have the requisite care and attention.

The principles to be observed in the care of premature babies can be deduced from the conditions of intra-uterine life.

The child must be protected from impure air and light, carefully guarded from cold, kept at an equable temperature, and supplied with nourishment in an easily digestible form. It has been shown by Eröss that the temperature of a child born at full term falls about 2° within one hour after birth, and he has also shown that the fall of temperature in the case of a premature baby is much greater than this, amounting often to 5° or even 9° F. This rapid loss of heat is due partly to the almost entire absence of subcutaneous fat in very premature infants, and also to the fact that the surface area of the body is, proportionately to the total weight, greater in the premature infant than in the child born at full term, and therefore the loss of heat from the surface of the body in the former is also greater.

A further fact to be taken into consideration is that owing to their general feebleness, and especially to their feeble digestive powers, these children are not in a position to produce any great amount of heat themselves. The first indication, therefore, in the treatment is the careful maintenance of the body temperature.

This can only be done really efficiently by the use of a couveuse or incubator. An apparatus somewhat on the lines of the modern incubator appears to have been first employed by Denuce of Bordeaux, in 1857, who kept alive by this means a premature infant for seventeen days. In 1884 Credé published results which he had obtained since 1864 with an apparatus resembling that of Denuce, which he called a cradle-incubator. In 1880 Tarnier adopted a model suggested by the egg-hatchers in use at that time, and since 1881 a further modification of this by Auvard has been in common use in many of the French maternities. The main objection to these old forms is the difficulty of maintaining the temperature at a constant level. In Auvard's model, where the heat depends either upon hot-water bottles or a hot-water tank, there is considerable risk of the temperature falling to a dangerous extent if the attendant at any time fails to regularly change the bottles or refill the tank, and the regulation of the temperature requires constant attention.

This difficulty has been overcome in a very ingenious manner both in the Lion incubator, used a great deal on the Continent, and in Hearson's, the form commonly employed in this country. In these types the child is placed above a hot-water tank, the heat being supplied by a gas-flame or a lamp. By an arrangement either of a metal spring or of a capsule containing fluid boiling at a certain temperature, both acting through a system of levers, the flame is either turned down when the temperature has reached a certain level, or else a damper is lifted off the chimney so that some of the heat escapes.
externally instead of being entirely utilised to heat the water. By this device a constant temperature, varying only within 1° or 2°, can be maintained automatically night and day without any attention on the part of the nurse.

Rotch has pointed out that an ideal incubator should admit of ready cleaning, and should therefore be of metal; it should be portable, have good ventilation, with some means of both filtering and moistening the entering air; whilst the temperature should be easily raised and capable of being maintained at the same level, and, if possible, provision should be made for weighing the child \textit{in situ}. He has devised an apparatus of copper fulfilling these requirements, but unfortunately its expense will prevent its ever coming into extensive use, and we must therefore be satisfied with less perfect forms of apparatus, which can, however, if used with intelligence, be made to give very good results.

As soon as the premature baby is born it should be placed in the incubator, if one be available; if not, it must be placed in a cradle surrounded by hot-water bottles, and kept in a room at a temperature of 85° to 90° F. Such a temperature renders it impossible for the nurse to remain long in the room, and as a matter of fact it is almost impossible to keep an ordinary room at this temperature for any length of time. If a proper incubator be not at hand, one can be readily improvised with a little ingenuity out of a wooden box partly divided into two by a shelf, the cradle being placed above and hot-water bottles below. If an apparatus with a tank be used, it should have been prepared beforehand, as it takes some little time for the temperature to reach the proper height. The baby is placed in it naked, but completely enveloped, except its face, in cotton-wool. No doubt there is less tendency for its temperature to fall if it be completely clothed, but in the case of very premature children, at any rate, the avoidance of any unnecessary handling is of such extreme importance that it is best not to clothe them. Absorbent cotton-wood should be placed over the buttocks to catch the faeces and urine. This wool must be changed once or twice a day, and weighed so as to determine the weight of excreta passed; in this way a more accurate estimate of the child's weight can be obtained than if the loss from the faecal discharges be entirely neglected.

Every premature baby should be carefully weighed once a day, unless its general condition is so grave as to contraindicate this, as only in this way can a safe guide be obtained as to whether the child is thriving. This is usually the only occasion in the twenty-four hours on which it is necessary to remove the baby from the incubator, and since even this slight amount of disturbance is undoubtedly injurious, the method employed in Rotch's apparatus, where the child can be weighed \textit{in situ}, is of great value.

The average daily increase in weight varies with the total weight of the child, and is, of course, less than in full-term children, amounting only to 1/4 oz. to 3/4 oz. daily. This increase is by no means constant, even if the child be thriving, and these children often remain stationary at the same weight for several days at a time. So long as there is no loss, anxiety need not be felt; but as soon as a steady decrease in weight sets in, the child's life is in danger, and a careful investigation should be carried out with a view to ascertaining and, if possible, correcting the cause, since a very slight loss of weight in these cases is sufficient to determine a fatal result.
The temperature of the incubator should, at any rate to start with, be kept at 90° to 95° F. Its exact level can afterwards be adapted to the condition of the child. If the baby's extremities are cold or its temperature subnormal, the temperature must be raised. The rectal temperature of the infant must be taken twice a day or oftener, and the nurse should have instructions to regulate the temperature of the incubator in accordance with the condition of the child. As a rule, a temperature of about 90° F. will be found to suit most premature children best at first. It is a curious thing how soon after birth a premature baby will begin to perspire if the temperature be too high, and this is at once an indication for lowering it. The temperature of the incubator must also be gradually lowered week by week if the child is well and thriving, so that when the time comes for it to be taken out, it may be able to stand the temperature of a room kept at about 70° F.

The air supplied to the child must be as pure as possible, and for this reason the room in which the incubator is placed should be well ventilated. It is best in hospitals and other places where incubators are used permanently to arrange for the air to be supplied directly from outside the building. In nearly all incubators provision is made by passing the incoming air over water and through wool or canvas to both moisten and filter it. The air of an ordinary apartment is too impure and too irritating for a premature child, and the fact that the air of the incubator can be filtered and moistened is one of the great advantages which its use presents over the ordinary cradle.

It is for this reason, and also because it was found impossible to keep the child's head warm, that Winckel's method of keeping these children in a hot bath failed to give good results. Theoretically, an ideally perfect mode of treatment would be to keep the baby immersed up to its neck in a hot bath at a constant temperature inside an incubator, so that pure air could be supplied to it and, at the same time, its head kept warm.

The baby should not be bathed until it can be taken permanently out of the apparatus. The cotton wool keeps it sufficiently clean, and if it be changed when necessary, daily bathing is not needed, and is, indeed, harmful, and it is best not to apply any oil or ointment to the skin.

Light should be rigidly excluded until nearly full term and the window of the incubator should therefore be covered with a dark cloth.

In considering the feeding of these babies, one has first to decide whether or not they shall be put to the breast. From what has already been said, it will be seen that it is recommended that the child should never be taken out of the incubator if it can be avoided. For this reason it is best in all cases where the baby is very premature not to put it to the breast. Many premature babies do very well upon their mother's milk, and in all cases an attempt should be made to feed the child with this. The milk should be drawn off, and the child fed by a spoon or a dropper.

The latter apparatus, first introduced by Dr. Breck, consists of a small glass tube holding about 1 oz.; one end is so shaped that a teat can be placed upon it, and to the other end is attached a rubber cot. The dropper being full of milk, by squeezing the cot it is easy to fill the back of the child's throat with small
quantities of milk at a time, which are then readily swallowed.

Many of these premature babies are quite unable to suck, and the use of this form of feeder presents many advantages over either a spoon or a tube passed into the stomach -- the so-called gavage. In feeding the baby it is not necessary to take it out of the incubator. Supporting its head with one hand, the nurse can readily manipulate the dropper with the other.

In this way the risk -- a very considerable one in the case of very premature babies -- is avoided of chilling the child during the process of feeding by removing it from the incubator.

In some cases, however, it is found that the mother's milk, even when diluted, does not agree. In explanation of this fact analyses of colostral milk are of considerable interest. Such analyses show that colostral milk contains an excess of proteid and a relatively deficiency of sugar, and this explains both its laxative properties and its marked disagreement with some children. Adriance, too, has shown that in the case of premature confinement the milk often retains its colostral character for a longer time than usual.

In one of Rotch's cases, in which the mother's milk caused marked disturbance, an analysis gave the following result:-- Proteid, 6.8 per cent.; fat, 1.29 per cent.; sugar, 4.10 per cent.; while the analysis of the modified milk which suited the child showed the following percentages:-- Proteid, 0.75 per cent.; fat 1.0 per cent.; sugar, 3.0 per cent. Analyses of the mother's milk in some cases where the babies had died of gastric disturbance, made by Carter and Richmond, showed a marked excess of proteid and a relative deficiency of sugar, such as is seen in colostral milk.

The stomach of a premature baby is a very delicate organ, and if the child lose ground from improper feeding during the first few days of life, its chances of surviving are greatly diminished. It is important, therefore, if the mother's milk, even when diluted, disagrees, that an easily digestible artificial food should be substituted for it, and it is in such cases that the methods introduced by Rotch give such good results. Thus it is possible, by ordering various combinations by prescription, to obtain a milk to suit almost any baby.

The percentages recommended by Rotch in the case of children premature at the twenty-eighth week are as follows:--

Proteid, 0.50 per cent.; fat, 1.0 per cent.; sugar, 3.0 per cent.; 24 meals each of 1 drachm; heat to 167° F. and make slightly alkaline.

These amounts can be gradually increased until at the thirty-sixth week the child will be taking such a mixture as this: Proteid, 1.0 per cent.; fat, 2.0 per cent.; sugar, 5.5 per cent.; and if it thrives, further additions can be made until the composition resembles that of good human milk.

Since the introduction of a milk laboratory into this country, such as has been in successful operation in
America for some years past, and the adoption of a similar method by some of the large dairy companies, it is possible to obtain such modified milk, not only in London, but in almost any part of the country, at an expense very little greater than that of pure nursery milk, and there is every reason to hope that the adoption of this method of feeding delicate and premature babies will give as brilliant results in this country as have been obtained by its use in America.

The milk, modified according to the prescription sent, is heated to 167° F. (Pasteurized), rendered slightly alkaline, and sent out in sterilised sealed bottles, from which it can either, after warming, be given to the baby direct, or first transferred to the dropper.

If modified milk be not obtainable, the child must be fed upon humanised milk, if necessary diluted, or condensed milk sufficiently diluted, or a mixture of boiled cow's milk, water, and cream, in the proportion of about one part of milk to four of water, with half a teaspoonful of cream to the ounce, if it can be obtained fresh and good.

Very premature children must at first be fed every hour, and since the stomach is exceedingly small, not more than one to two drachms must be given at a time. The amount of food given and the intervals between the meals must be very gradually and carefully increased. If the child be very feeble, brandy may be given, about five drops every two hours, repeated as often as may be necessary, and if it at any time becomes markedly cyanotic, oxygen gas should be administered. It may be given from five to ten minutes two or three or more times a day.

In some incubators a special opening is provided for the introduction of oxygen gas, while in others it is necessary to introduce it through the air opening. If it be given in this way, care must be taken that the sudden entrance of a considerable quantity of oxygen does not cool the air of the incubator to a dangerous degree.

In all cases a second thermometer should be placed by the side of the baby, as the thermometer passing through the lid is very likely to be influenced by changes in the external air, and does not give an accurate reading of the temperature in the interior.

If the administration of food by the dropper cause vomiting, gavage must be resorted to. A small soft catheter is introduced into the stomach, and the food poured in by means of a funnel. At the same time, if it be thought advisable, the stomach can be washed out with tepid water. If after the food has been introduced the tube be pinched and quickly withdrawn, vomiting often does not occur. Gavage is, however, much more distressing to the child than the use of the dropper, and the latter should always be employed if possible.

It is obvious that in the care of many premature infants it will be impossible to carry out the treatment described on the grounds of expense and for other reasons, but an endeavour has been made to show what may and should be done in cases where the necessary appliances can be obtained, and where expense is no object.