The Care and Feeding of the Premature Infant.

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*Archives of Pediatrics* 34:609-616, 1917

This paper aims at giving a practical idea of the care and feeding of premature infants and of the results obtained from the methods adopted in the infant's ward at the Burnside Hospital, Toronto.

Nutrition -- The problem of nutrition in these young infants is made doubly difficult by a great demand for food and a poor supply. The demand for food is relatively great because of the increased heat loss of premature infants. In proportion to its bulk the little body has a large surface from which to radiate heat. In addition, the layer of non-conducting fat is thin and the heat regulating mechanism inefficient. To balance this unusual food need there is only a feeble and under developed digestive apparatus, inferior to that of the normal infant. The ordinary infant needs less food yet can use more. Hence the double difficulty.

The prognosis of the nutritional result depends on the cause leading to the prematurity. Children of healthy parents who are prematurely born because of some external reason (twin pregnancy, trauma, etc.) and who show no difference from the normal except backward development present no greater nutritional difficulties than the normal newborn child. It is entirely different, however, when the prematurity is due to some constitutional weakness of the mother (especially lues). Here the constitutional condition is a grave complication to the prematurity. It is self-evident that the possibility of life depends upon the degree of development as indicated by the weight and length of the child. The following table from Pfaundler illustrates this point.
Premature Age Length Mortality the first two weeks of life

<table>
<thead>
<tr>
<th>Weight</th>
<th>Age</th>
<th>Length</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 pounds 3 ounces</td>
<td>6 months</td>
<td>13 3/4 inches</td>
<td>95%</td>
</tr>
<tr>
<td>2 pounds 10 ounces</td>
<td>6 1/2 months</td>
<td>13 3/4 inches</td>
<td>82%</td>
</tr>
<tr>
<td>3 pounds 0 ounces</td>
<td>7 months</td>
<td>15 1/2 inches</td>
<td>65%</td>
</tr>
<tr>
<td>3 pounds 10 ounces</td>
<td>7 1/2 months</td>
<td>16 1/2 inches</td>
<td>42%</td>
</tr>
<tr>
<td>4 pounds 15 ounces</td>
<td>8 months</td>
<td>17 3/4 inches</td>
<td>20%</td>
</tr>
</tbody>
</table>

If good nursing, thriving premature infants are allowed to nurse the breast it will be found that the caloric value per pound ingested from the tenth day of life will be more than 45 calories the usual figure for normal infants. Thus Oberwrath found the average quantity of milk taken by 33 premature infants, measured at 51 different periods during the first 3 months, to be 63 calories per pound of body weight. Birk calls attention to the fact that the normal child receives enough from the breast to satisfy its need, but not so the premature child. They take too much especially on an easy, free-flowing breast. The amount taken by the premature child does not indicate the nutritional need, but rather an over-consumption. The average premature child takes on the second day of life approximately 5 ounces of breast milk; this quantity is gradually increased each day by about 1 ounce till at the end of the tenth day it is taking about 10 to 11 ounces in the 24 hours.

There is no doubt concerning the type of nourishment on which the premature child can be pretty certain to live and thrive. The premature child should have mother's milk. To be sure the technique can be exceedingly difficult when combined with the under-development of the child. We find that it is a weak nurser and cannot stimulate the breasts to secrete. Then it is possible only with the help of a breast pump to bring about lactation; this also is insufficient and is difficult to carry out in the home. Then it becomes necessary to allow another child to start the breasts secreting and to continue the secretion while the premature child is to be fed with expressed or pumped mother's milk; or for the time being, a wet nurse with her child can be secured. On the easy, full breast, the premature child can soon learn the process of actively obtaining milk, while the wet nurse's child can start the flow from the other breasts. In favorable cases the energy of the mother alone can bring results, i.e., when she persists and nourishes her child with the expressed milk until it learns to obtain it in the usual way. As long as the child does not take from the breast it must be fed expressed mother's milk either from the bottle or introduced with a premature feeder or pipette through the mouth. Children who are unable to drink must be fed through a stomach tube. If the children sleep interruptedly they should be spanked or sprinkled with cold water just previous to feeding.

Opinions differ concerning the number of meals required and the interval of feeding, and owing to the
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diversity of opinion this point is by no means settled. The method employed by us has been adopted from observations extending over 2 years, in which these infants on the various intervals have been closely followed. The average premature infant is thus fed every 3 hours for 8 feedings in the 24 hours and if it can be demonstrated that the baby is showing symptoms of dyspepsia (vomiting and green stools) it is fed less often, i.e. every 4 hours, on which schedule it has been shown, the infant will obtain less food per nursing. The 2-hour interval we do not consider necessary and the results obtained are not as uniform as those on the 3-hour interval as has been shown by weighing experiments.

Artificial nourishment of the premature child is always a risky experiment. The weak organism often will be unable to develop on the food. Nutritional disturbances are frequent and in these cases form a severe complication. The first diarrhea of the premature child must be considered a severe disturbance and treated accordingly.

Results have been reported with all kinds of mixtures; fat-poor carbohydrate-rich food; fat-rich carbohydrate-poor mixtures; buttermilk; diluted and undiluted cow's milk and predigested milk. The caloric need is as high in using these mixtures as it is in using mother's milk (60-65).

Because of the greater body surface and immature heat regulation, care must be taken that energy loss through heat dissipation (activity, radiation, water loss), must be reduced to a minimum. This is accomplished by means of an incubator at a temperature of 80° to 85° F. or something devised to keep the child's temperature up to normal.

Absence of fresh air was a disadvantage in an enclosed incubator that even properly regulated heat did not outweigh. The small enclosed incubator truly may be said to have died of suffocation. The incubator employed at the General Hospital is one modeled after that in the Babies' Hospital in New York and consists of glass partitions 4 feet high separating the cubicles. The temperature is 80° to 90° F. with an abundant supply of fresh, moist, filtered air. The window is kept darkened. Equally important with heat and ventilation is the rigid exclusion of all persons from the room except the nurse in charge who must wear a separate gown when in the room and to be free from respiratory infection of any description. Under ordinary circumstances even the physician does not enter the room, but makes his routine inspection of the child held up to the glass door. The reason for these precautions is the great susceptibility of the premature infant to respiratory infections, to which he falls an easier victim than even to nutritional disturbances. In the home the danger of parental infection is great and this danger is multiplied in institutions. Thus it is that up-to-date institutions are adopting the system of cubicles or glass partitions in order to isolate each child so minimizing the risk of respiratory infections. Could this scourge be abolished fully 75% more children would be saved.

Most physicians are not interested directly in the construction of premature rooms with such refinements as glass cubicles and filtered air; but any practitioner is liable to be faced with the problem of devising a household expedient for the same. The following home-made incubator can be constructed with materials ready to hand in a short time and at a trifling cost. Take a 24-inch wicker clothes-basket and pad the bottom with non-absorbent cotton to a depth of 8 inches. On top of this cotton fit a sheet of
oilcloth, sewing the edges through the sides of the basket. On the oilcloth lay a double layer of white flannel and on the flannel a napkin of absorbent cotton. Take half a dozen of 12-ounce citrate of magnesia bottles with wire and rubber corks and cover them with flannel. These bottles are filled with water at 110° F. and hung on the inside walls of this basket. A thermometer hung inside should register a temperature from 80° to 90° F. all the time. At night an oilcloth is spread over the foot half of the basket. The child is bathed as previously described and wrapped completely in two layers of canton flannel with an intervening layer of non-absorbent cotton. This garment covers completely the head, trunk and limbs only the face and buttocks being left uncovered. The underpad of absorbent cotton makes a diaper superfluous and the child is less disturbed by changing. The environment of the basket should follow as closely as possible that described for the premature room.

By the end of the first year a certain number of the premature children have made up the deficiency due to prematurity so that there is hardly any difference between them and normal children. Others require 2 to 3 years, while not a small percentage of cases carry the stamp of prematurity for many years. This is shown in 3 ways: First, greater susceptibility to attacks of sickness. Second, disturbances in the bony and hemopoietic systems. Third, disturbances in the nervous system in general.

The lessened immunity can be explained by the smaller quantity of certain immune substances in the body or by an immaturity of the organs which manufacture it. The anemia is absolutely due to an insufficient iron deposit. It is known that the storing up of iron is accomplished the last 3 months of pregnancy; analogously, the pathologic conditions of the bony system (softness, disposition to rickets is due to a lessened deposition of calcium phosphate); both phosphorus and calcium being stored toward the end of pregnancy. The disturbances of the nervous system can also be accounted for thus, and may be due to an insufficient mineral deposit. It is self-evident that in the pathology of these conditions an insufficient development of nerve centers and tracts play a part.

The physician must keep in mind the possibility of the development of these conditions when treating a premature child. It is within his power to dietetically treat, alleviate or cure these conditions.

To increase the immunity there is no other method that we know of except the use of mother's milk. For the prevention of anemia we must at an early date add foods rich in iron, fruit juices and small quantities of vegetables. Anemia which is already present (not all paleness is anemia) can be quickly helped by using iron. From the fourth month on it is wise to begin the use of codliver oil and phosphorous in order to increase the calcium retention.

Results. Burnside Hospital, Toronto. -- 1 -- Number of cases treated. The total number of cases treated from August, 1914, to September, 1916, was 68, and of these, 45 cases were followed for 1 year.

<table>
<thead>
<tr>
<th>Weights</th>
<th>lbs. oz.</th>
</tr>
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<tbody>
<tr>
<td>Average birth weight (all cases)</td>
<td>3 11 1/2</td>
</tr>
</tbody>
</table>
Average birth weight (died under one year) 3 10  
Average birth weight (survived one year) 4 3  
Lowest birth weight (survived one year) 2 7  
Highest birth weight (survived one year) 5  
Average initial loss (all cases) 6 1/2  
Average initial loss (survived one year) 7  
Average initial loss (dead under one year) 6 3/4  
Average gain in hospital (survivors only) 1 7  
Greatest gain in hospital (patient in 14 weeks) 3 13  

Note. Child weighing more than 3 lbs. 14 oz. at birth will probably live; under that probably die.

Feeding on Discharge.  
Breast milk 31  
Modified cow’s milk 30  
Mixed feeding 3  

Stay in Hospital.  
Average of survivors 8 weeks  

Infantile Complications Not Causing Death.  
Convulsions 1  
Pyloric Stenosis 1  
Idiocy 1  
Secondary anemia 1  

Maternal Complications.  
Eclampsia (one mother died) 9  
Toxemia 4  
Syphilis 2  
Insanity 2  
Nephritis 2  
Chorea 1  
Pernicious Vomiting 1  
Intestinal Obstruction 1  
Gonorrhea 1  
Placenta praevia 1  

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These complications did not affect the infant mortality to any degree.

We feel that conclusions concerning the management of these children should be made only after observations have been carried on over a considerable period of time under intelligent directions, so for these reasons the infants discharged are carefully followed in their homes by the Board of Health Nurses and Physicians and in this way our initial work has been proven to be not in vain, and we have shown that permanent results can be obtained in what might at first appear to be almost hopeless cases.

From the foregoing it will be seen that of 45 cases followed for one year that 42% survived and were living at the end of the first year, 80% survived the first four days and 62% the first three months. The lowest weight of those that survived was 2 pounds 7 ounces, with an initial loss of 4 1/2 ounces. This infant on account of secondary anemia was transfused at the 7th month. Three other infants whose birth weights were 3 pounds or under survived one year. Of the complications producing death 18% were respiratory and 15% digestive, which of course is a remarkably low figure for either of these disturbances. This we felt to be due to the segregation system and the universal employment of mother's milk. Over 50% of the cases were discharged on breast milk alone.

Remarks

The weight of a premature infant is the best criterion as to the prognosis. From our observations, it may be fairly well assumed that a child weighing more than 3 3/4 pounds will probably live, and under that probably die. If an infant weighs under 3 pounds the chances are very poor; every ounce over 3 pounds improves the prognosis. In spite of this, however, one must not despair of the very smallest infants. The early exhibition of breast milk and the continuance of this through the early months offers the best means at our disposal for ensuring survival and combating the various complications to which the premature infant is prone. The premature infant should be carefully observed, especially during the first year, and rickets and anemia to which they are subject should be met with by the proper therapeutic measures.

Figure
Table of cases. Click the thumbnail image at the left to view the table at full size. Warning: the full image is about 235 KB.