

**Staff Meeting Bulletin**  
**Hospitals of the » » »**  
**University of Minnesota**

**The Premature Infant**

STAFF MEETING BULLETIN  
HOSPITALS OF THE . . .  
UNIVERSITY OF MINNESOTA

Volume X

Friday, October 28, 1938

Number 5

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Published for the General Staff Meeting each week  
during the school year, October to May, inclusive.

Financed by the Citizens Aid Society

William A. O'Brien, M.D.

I. LAST WEEK

Date: October 21, 1938  
Place: Recreation Room  
 Powell Hall  
Time: 12:15 to 1:25  
Program: Movie: "Light Waves and  
 Their Uses"

## Announcements

Paranasal Sinusitis  
 F. L. Bryant

## Discussion

L. R. Boies  
 Ralph V. Ellis  
 F. L. Bryant

Present: 130

Gertrude Gunn,  
 Record Librarian

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II. MOVIE

Title: "All In One"  
 Released by:  
 A Jam Handy Production

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III. ANNOUNCEMENTS1. POST-GRADUATE MEDICAL EDUCATIONDISEASES OF SKIN

October 31 to November 5, 1938  
 Center for Continuation Study

Faculty

Henry E. Michelson, Chairman  
 Samuel W. Becker, Associate Pro-  
 fessor of Dermatology, The School  
 of Medicine of the Division of  
 Biological Sciences, University  
 of Chicago - Guest Friday,  
 November 4.  
 Clifton A. Boreen  
 Louis Brunsting, Mayo Foundation  
 John Butler  
 Harry G. Irvine  
 Carl W. Laymon  
 Francis W. Lynch  
 John F. Madden  
 Hamilton Montgomery, Mayo Foundation  
 Paul O'Leary, Mayo Foundation  
 Elmer M. Rusten  
 Samuel E. Sweitzer  
 Louis H. Winer

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2. HONORS

Head Pediatrician, Irvine  
McQuarrie, was made a Fellow in  
 the American College of Dentists,  
 in St. Louis last week in recogni-  
 tion of contributions to dental re-  
 search.

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#### IV. THE PREMATURE INFANT

A. V. Stoesser  
and John A. Anderson

##### Introduction

Prematurity -- the greatest cause of death among newborn infants. This is the statement appearing in current lay journals and magazines. The public is being aroused. Infant mortality figures are too high. Lay writers are asking that something be done. In Minnesota, which has a low mortality rate, 48,000 babies were born in 1937, but 1,956 died before the end of the first year of life. The causes were:

Prematurity	708	cases
Communicable Disease	403	"
Congenital Malformations	246	"
Birth Injury	167	"
All other causes	432	"
	<u>1,956</u>	"

Something is being done. For the past 2 years symposia have been presented to the physicians of Minnesota through the cooperation of the State Medical Association, the Extension Division and the Medical School, and the State Department of Health. The knowledge concerning maternal and child welfare problems have been discussed by the leading obstetricians and pediatricians with the rural physicians. Meanwhile in the larger centers and especially here in Minneapolis special investigations have been carried on.

In 1930 with the reorganization of the Pediatric Department under the direction of Dr. Irvine McQuarrie, the small number of premature babies born in the University of Minnesota Hospitals were closely studied. Rules and regulations concerning the handling of these delicate infants were established. Each year changes were made which lead to more satisfactory results. In 1932, word was received that the Minneapolis General Hospital was experiencing a high premature mortality rate. Permission was received from the staff to investigate this condition. More than 60% of the premature infants were dying in that hospital. A large number of the babies expired with marked diarrhea or with infections such as otitis media and broncho-

pneumonia. Special emphasis was therefore placed on a revision of the isolation technique and the feeding program. Ultimately a rather extensive schedule for the care of the premature infant was worked out. It gave very satisfactory results, the mortality rate dropping four years later, in 1936, to 26%. In order to offer in a practical way the program which has given these results it was thought best to present the suggestions which were given to the physicians and nurses of the premature service in the form outlined below.

##### Definition of Premature

Prematurity refers to infants who are born before the 36th week of gestation and weigh less than 5½ pounds (2,500 grams) and who usually differ anatomically and physiologically from normal full-term infants. Infants having a low birth weight are not necessarily premature, as the smaller size may be inherited characteristic; nor are all infants who have been delivered prematurely necessarily below the average weight of full-term infants. In general, however, prematurely born infants and immature full-term infants who are small at birth require special care. In the following paragraphs the term premature is used to include immature full-term infants, as well as infants born prematurely, coming under the weight classification cited above.

Measurements: Fetuses and Premature Infants

Fetal Age Weeks	Weight		Length		Head Circum. cm.	Chest Circum. cm.
	gm.	lb.	cm.	in.		
24	800	1-3/4	31		24	22.5
26	1040	2-3/8	36			
27	1140	2-1/2	37			
28	1200	2-5/8	38	15	25.5	24
29	1575	3-1/2	39	15-3/8		
30	1700	3-3/4	40	15-3/4	28.4	25
31	1900	4-1/4	42	16-1/2		
32	1975	4-3/8	43	17	30	27
33	2100	4-5/8	44	17-3/8		
34	2250	5	45	17-3/4		
35	2500	5-1/2	46	18-1/8	32	29

Characteristics of the Premature Infant  
including Frequent Pathological Changes

Characteristics

Body puny and weak  
 Adipose tissue scant  
 Lanugo plentiful  
 Skull relatively large,  
     round, later square  
 Fontanels and sutures large  
 Ears soft, small, close to  
     skull  
 Neck short  
 Cry feeble  
 Sucking reflex weak or absent  
 Movements sluggish  
 Temperature low  
 Urine scanty

Pathologic Changes

Cyanosis, apathy  
 Jaundice  
 Vomiting, diarrhea  
 Cerebral hemorrhages  
 Twitching  
 Respiratory infections  
 Skin infections  
 Urinary infections

The Three Most Outstanding Facts to  
Consider in the Management and Feeding  
of the Premature Infant

Premature infants, because of under-development, are at a great disadvantage when compared to normal infants. Due to shorter intra-uterine life, they show under-development of their heat-regulating mechanism. The body temperature tends to fall below normal on slight exposure to cold, and to rise above normal due to high surrounding temperatures. Where the surrounding temperature is not subject to careful regulation, daily variation of body temperature of as much as 5°F. has

been observed.

The respiratory center is also under-developed, which accounts for the large incidence of respiratory failure, and for the frequency of irregular respirations punctuated with long periods of apnea (transient cessation of respiration). These periods may be so long at times as to lead to death from suffocation. Sometimes, however, the apnea of premature infants may be due to intracranial hemorrhage involving the respiratory center, rather than to under-development.

As a corollary of an immature gastrointestinal tract the digestive capacity of premature infants is low; intestinal motility is impaired, and absorption of food is poor. Normal digestive enzymes may be present in reduced amount. The gastric capacity of the premature baby is likely to be disproportionately small and per unit of weight the food and food accessory requirements are greater than those of the normal full-term infant.

### Reception of the Premature Infant

Prematurity is an emergency condition and is frequently precipitate. Preparedness at the time of birth frequently means the difference between life and death to the infant. Two things are of predominant importance: (1) prevention of chilling or exposure over too long periods of time, and (2) asepsis. When the possibility of premature birth is suspected, one must be prepared. In the nursery the heating unit of the incubator (or whatever equipment is employed) is turned on as soon as word is received from the physician.

This equipment is simple and inexpensive. It consists of a white enameled wooden box, supported on four legs with roller casters. When the cover is down, the size of the opening in it may be regulated by sliding panels. The head end of the bassinet in the incubator may be lowered to facilitate the removal of mucus from the infant's respiratory passages. The temperature is controlled by a thermostat and humidity may be added at any time. All of this is obtained in a rather compact portable apparatus.

When the temperature of the incubator and bassinet reaches 100°F., the heating unit is turned off but the temperature is not allowed to fall below 98°F. When the baby arrives the temperature is adjusted so as to maintain body temperatures between 98° and 99.6°F. The heating capacity of the incubator should be such that this can be attained.

In the obstetrical delivery room the baby should be immediately placed in a warm receiving blanket or in sterile absorbent cotton covered with two layers of gauze,

and if his condition permits, and there is no maternal emergency, the cord should be allowed to pulsate for two or three minutes before ligation, during which time it will receive an additional 1 to 2 ounces (30 to 60 cc.) of blood. The baby is placed in the prepared bassinet. The cord may then be tied. A soft absorbent diaper is folded and placed at the buttocks to catch meconium and urine. This is changed as required.

Great care should be taken at delivery to remove mucus from the air passages by carefully wiping the nose and mouth with a piece of soft gauze. The head should be held dependent so that secretions and mucus which have accumulated in the respiratory passages may escape.

Premature infants should not be bathed during the first day or two. It is preferable to cleanse small infants with warm liquid petrolatum or olive oil. All the vernix caseosa need not be removed. The genital and anal regions should be carefully cleansed with sterile water, avoiding trauma.

During the first sixteen hours the baby is observed frequently by the nurse. Orders should be given to notify the physician immediately if cyanosis, irregular respiration, convulsions, pallor or hemorrhage develop. Resuscitation may be efficiently performed within the bassinet.

### Maintaining the Body Temperature of the Premature Infant

Unless otherwise ordered by the physician, the temperature is taken just before feeding time and not more often than every four hours. The body temperature of the premature infant should be maintained between 98° and 99.6°F. and always recorded. Body temperatures lower than 98°F. over long periods of time are probably more hazardous than those slightly above 100°F.

The room temperature should be between 72° and 80°F. and the incubator temperature should be 80° and 86°F. or more, depending in each case on the

amount of heat necessary to maintain the premature infant's body temperature as stated previously. The higher temperature of the bassinet is necessary for the smaller infants. Regulation of incubator temperature is effected by thermostatic control, by turning on and off the electric heating units or lights, by lowering the cover or by hot water bottles, depending upon the type of incubator employed.

The humidity of the room or the incubator is likewise of paramount importance. Relative humidity should be kept between 45 and 55% saturation--particularly in the case of very small premature babies.

Room or incubator temperature and humidity should be recorded at the request of the physician.

No premature infant should be removed from the premature care until it can maintain a normal temperature at all times with the heating unit entirely turned off. This must be considered before a premature infant is discharged.

In view of the many external surroundings which require regulation, a special room should be reserved for the use of the premature baby. In the hospital this is frequently possible and in the home every effort should be made to provide isolation and the desired physical surroundings.

#### Treatment of Asphyxia

All premature infants should be carefully watched for cyanotic attacks during the first days of life, as such attacks may develop suddenly and without warning. Infants below 33 pounds (1500 grams) must be watched very closely. If cyanosis develops shortly after birth the first thought is the removal of mucus.

Mucus is removed from the throat and mouth most effectively by aspirating with a soft rubber ear syringe or a soft rubber catheter attached to a syringe for suction. The mouth is not swabbed out with gauze, as a slight abrasion of

the mucous membrane might occur.

To remove mucus or amniotic fluid from the larynx, trachea, or bronchii, the infant is held with the head dependent, the trachea and larynx are gently stroked toward the mouth and suction is applied to the pharynx.

If the premature infant does not begin to breathe after removal of any obstruction of the air passages, oxygen with 5 to 10% carbon dioxide may be advantageously used, administered by nasal catheter. Rate of flow should be between 60 and 120 bubbles per minute.

Careless handling and traumatizing the infant, or too rapid performance of artificial respiration, is productive of more harm than good and must, therefore, be avoided.

If the premature infant is cyanotic but breathing, insert a small nasal catheter into the nostril so that the tip of the catheter extends to the edge of the soft palate, and give a mixture of 5 to 10% carbon dioxide in oxygen continuously until cyanosis is relieved. It may be desirable to repeat this procedure at regular intervals for several days in case cyanosis persists. Avoid irritation of the nostril.

One minim of epinephrine (1:1000) may be given every hour to the very small infants, until they show definite signs of activity. That may be for three or four days and then the dose may be increased to a maximum of 3 minims every four hours. Some very weak premature infants may require 3 minims every four hours routinely until they are quite definitely active; then every eight hours, every twelve hours, finally, every twenty-four hours until discontinued by the physician. The adrenal glands are probably not very active in these very small premature babies.

#### Intracranial Hemorrhage

If there is evidence of intracranial hemorrhage or hemorrhagic disease of the newborn, whole or citrated blood warmed

must be given deep subcutaneously or intramuscularly at once,  $1/3$  to 1 ounce (10 to 30 cc.) -- depending upon the size of the baby. This blood need not be grouped or matched if given intramuscularly, but should be Wassermann negative. This will be administered by the physician but the set-up should be ready. If bleeding persists, the procedure is repeated every 24 hours for two to three days.

Hemorrhages from the skin, mouth, rectum and genitalia, especially between the third and sixth day after birth should be reported to the physician immediately.

### The Feeding of the Premature Infant

After the first few days the total fluid intake must be maintained at from one-sixth to one-eighth of the body weight in each 24 hours. The sum of the water and milk intake is used to determine the total fluid intake.

Although modifications may be made by the physician, it has been found to be highly satisfactory to permit the premature infant to rest for the first 16 hours of life during which time no fluid or feeding is offered.

Prematures weighing 3.3 pounds (1,500 grams) or less. Water is given at the end of the sixteen hour rest period. Offer 10 cc. (2 teaspoonfuls) every 2 hours during the remainder of the first day and thereafter every four hours. Increase the amount offered by 2 cc. each feeding until  $1\frac{1}{2}$  ounces (45 cc.) are offered. When this volume is reached, decrease by 1 cc. with each administration until 1 ounce (30 cc.) is offered. This decrease in water must be made because the milk feedings are gradually being increased.

If breast milk is available, begin the second day by offering 5 cc. (1 teaspoonful) of boiled breast (human) milk with 2 per cent calcium caseinate (Casec) every 4 hours and increase by 1 cc. with each administration until about  $1\frac{3}{4}$  ounces (50 cc.) are offered. Any further increase or more rapid increase in feed-

ing depends upon the progress made. Where breast milk is routinely available and stored under aseptic conditions, this may be used without additional boiling. The addition of calcium caseinate to the breast milk has been found to definitely reduce the number of cases in which frequent liquid stools have developed, and has led to a most satisfactory and consistent daily gain in weight.

Where breast milk is not available, either one of two formulae may be used with little fear that the premature infant will not be able to adapt itself to the feeding;

1. A mixture consisting of equal parts of unsweetened evaporated milk and water with the addition of three per cent dextri-maltose has given good results.
2. A new preparation has been tried and the response of the premature baby to it equals or even surpasses that of breast milk. This response may be observed in Table I which is a summary of the data obtained after a recent clinical trial of the new formula.

The new mixture is composed of a combination of skimmed milk, virgin olive oil, calcium caseinate and dextri-maltose with a small amount of halibut liver oil. Its composition is based on the observations of Holt, Tow and Marriott in connection with the absorption of fat and the assimilation of protein in the premature infant. Since it can be obtained now in the dry or powdered form, it may be employed in a dilution of 1 ounce of the powder to 5 ounces of previously boiled cooled water, the caloric value of this being approximately the same as the boiled breast milk with the two per cent calcium caseinate.



Table I. Summary of the Data from a Clinical Evaluation of Premature Feeding Formulae

FEEDING FORMULAE	Below 2,000 Grams			Over 2,000 Grams		
	Breast Milk with Casec	Evap. Milk Mixture	Skim. Milk Olive Oil**	Breast Milk with Casec	Evap. Milk Mixture	Skim. Milk Olive Oil**
Number of Cases	12	17	27	39	54	53
Birth Weight in Grams	1812*	1798	1741	2370	2347	2247
Minimum Weight	1685	1679	1639	2249	2207	2120
Total Initial Weight Loss	125	114	100	121	140	127
Day of Minimum Weight	6	7	3	4	4	4
Day Birth Weight regained	14	14	8	8	11	10
Caloric Intake per Kilogram on That Day	124	134	108	108	114	117
Discharge Weight in Grams	2634	2680	2710	2732	2721	2696
Day of Discharge	37	49	36	20	25	23
Caloric Intake per Kilogram on That Day	143	156	147	137	138	146
Average Weight Gain in Grams per Day	<u>35</u>	<u>25</u>	<u>35</u>	<u>30</u>	<u>26</u>	<u>34</u>

Little can be expected in the way of increasing weight until about 45 calories per pound (90 calories per kilogram) are administered. Later the infant will require approximately 50 to 55 calories per pound of body weight and after the first month as much as 60 calories per pound may be needed. In exceptional cases it may be necessary to feed 80 to 100 calories per pound, but in such cases these infants are markedly underweight for their fetal age. In the present routine of feeding not much attention is paid to the total calories. The idea that so many calories per pound or per kilogram should be given has been over-emphasized. A good plan is to feed the premature baby an amount sufficient for an adequate and consistent gain in weight.

Prematures weighing between 3.3 and 4.4 pounds (1,500 to 2,000 grams). Begin by giving water at the end of the 16-hour rest period. Offer 2 teaspoonfuls (10 cc.) of water every 2 hours for the remainder of the first day and thereafter every 4 hours. Increase by 2 cc. with

each administration until almost 2 ounces (55 cc.) are offered; then decrease by 2 cc. until 1 ounce (30 cc.) is offered.

Begin on the second day by giving 2 teaspoonfuls (10 cc.) of boiled breast milk with 2 per cent calcium caseinate, or the skimmed milk-olive oil mixture every 4 hours and increase by 1 cc. with each administration until 2 ounces (60 cc.) are reached. Any further increase or any more rapid increase requires an order by the physician.

Prematures weighing 4.4 pounds (2,000 grams) and more. Begin by giving water at the end of the 16 hour rest period. Start with 3 teaspoonfuls (15 cc.) of water every 2 hours for the remainder of the first day and thereafter every 4 hours. Increase by 2 cc. with each subsequent administration until 2 ounces (60 cc.) are offered; then decrease by 3 cc. each feeding until 1 ounce (30 cc.) is given.

On the second day, offer one-half

ounce (15 cc. of boiled breast milk formula, or if necessary the supplemental feeding every four hours and increase by 2 cc. with each feeding until  $1\frac{1}{2}$  ounces (45 cc.) are offered. The amount offered is then increased by 5 cc. daily, to  $2\frac{1}{2}$  ounces (75 cc.). Following this, additional changes in the feeding depend upon the progress of the case and must be ordered by the physician.

The infants weighing between 2,000 and 2,500 grams may frequently be able to nurse quite early at the breast. Weighing before and after nursing is of paramount importance to determine how much milk has been received. In all cases of prematurity an effort should be made to promote maternal lactation. If the infant is initially too weak to nurse, the breasts should be hand expressed or emptied with a breast pump at regular intervals.

The best test of satisfactory and adequate feeding is a steady gain in weight. The physician should be notified each morning as to whether the infant will take or needs an increase in feeding. Weigh once during the first 24 hours, then every day for three days and thereafter every third day or twice a week. If the baby has lost in weight, it must be weighed daily until it has again made a good gain in weight.

Repeatedly observations have been made that the premature infants who cannot take adequate feeding and who are not gaining satisfactorily in weight may be benefited by receiving additional whole blood. The physician may find that this procedure will often put an end to a refractory period during which there has been little or no gain in weight.

#### Methods of Giving Water and Milk

Three methods are commonly employed:

1. Catheter or tube method is frequently used.
2. Medicine dropper (protected by rubber tip) is used occasionally. The Breck feeder may be tried but it

has the disadvantage of allowing too rapid feeding.

3. Bottle feeding is used but conservation of the baby's strength then is to be considered.

Many babies weighing less than 4.4 pounds (2,000 grams) must be fed by catheter. If this is done a Number 10 or 12 soft French catheter, for small prematures, and a Number 14 French catheter, for larger prematures is employed. Catheter may be marked with silver nitrate four inches from the tip. The sterile catheter or tube is carefully passed, not allowing it to go beyond the four-inch mark. There should be a catheter for each infant. The baby may be supported in a semi-recumbent position, and after becoming quiet is slowly fed. When the procedure is completed, the tube is kinked and removed quickly. The infant is supported in the sitting position in the crib to allow for the expulsion of any air. The baby is watched carefully at the time of feeding and for a while after the tube is removed to see if it is going to regurgitate. If regurgitation should occur, the head and shoulders are lowered at once and the baby is turned face downward. The regurgitated milk is wiped from the mouth and face and the baby is re-fed 15 to 20 minutes later. This nursing care is one of the most important factors in preventing otitis media and bronchopneumonia due to aspiration.

Babies weighing over 4.4 pounds (2,000 grams) may often be fed by medicine dropper. Patience and care on the part of the nurse are prerequisites to success. Drop by drop the fluid is placed on the dorsum of the tongue, trickles down, and is swallowed. Babies usually begin to nurse from the bottle when they approach 5 pounds (2,300 grams) in weight.

Milk or water should not accumulate in the pharynx. It should be ascertained that the baby is swallowing. The accumulation of milk or water in the pharynx will strangle the infant and aspiration is inevitable. This is highly undesirable and often results in aspiration pneumonia.

### Vitamin Requirements

After 10 days or as late as 14 days, premature infants which reach or are between 3.3 and 4.4 pounds (1,500 and 2,000 grams) should receive 5 drops of a concentrated cod liver oil or its equivalent twice daily. This is increased to 10 drops twice a day. Pure strained orange juice (one teaspoonful) is also given twice a day.

Premature infants which reach or are 4.4 pounds (2,000 grams) or more in weight, will receive concentrated cod liver oil or a standardized cod liver oil. If the former is used the amounts given are as indicated in the paragraph above. If cod liver oil is used, start with an amount equivalent to one-half teaspoonful twice daily and increase to one teaspoonful twice a day. As long as the infant receives feedings by tube, the cod liver oil can be added to the milk, but after the feedings are given by bottle, the cod liver oil should be administered separately. About 1 to 2 teaspoonfuls (5 to 10 cc.) of orange juice is offered twice a day.

### Anemia

Premature babies tend to develop a low hemoglobin very readily. A hemoglobin determination should be made no later than the fifth week of life, and if low, should be repeated weekly. Some form of iron administration has been always recommended, beginning at the latest by the fifth week of life.

Liver extract and/or ferric ammonium citrate with or without copper sulphate have given a fair response. The infant may receive each day 1 cc. of a 10 per cent solution of ferri et ammonii citras for each pound or 2 cc. for each kilogram of body weight, and 1/2 cc. of a 0.5 per cent solution of cupri sulphas per pound or 1 cc. of 0.5 per cent solution per kilogram of body weight. Both preparations are placed in the breast milk or in the feeding formula. The copper may be discontinued after a short period of administration.

### Prevention of Respiratory and Skin Infections

Upper respiratory infection, with complications, is one of the chief causes of mortality in premature babies. The nurse or mother in attendance must pay strict attention to even the slightest detail.

Anyone with upper respiratory infections, however slight, should avoid all contact with the premature infant.

Scrupulous care of the hands of nurses, doctors, or those attending the premature baby must be observed before handling the baby, and especially before feeding. The hands should be soaped several times, rinsed thoroughly between each soaping. The hands should not be washed and then the mask adjusted or the door opened.

Masks must be made, or obtained, and changed frequently. The mask is to be worn over mouth and nose.

If the baby develops any evidence of respiratory infection or any skin lesion, isolate it at once, and watch for the first signs of a gastrointestinal disturbance, the treatment of which is outlined below. Skin lesions, especially impetigo contagiosa, must be carefully examined and then may be treated by the nurse or mother under the direction of the physician. Silver nitrate (15 per cent), gentian violet (5 per cent in alcohol), tincture of merthiolate (1:1000) and/or ammoniated mercury (2 per cent) have all been used with success. The physician should leave orders that any sudden spread of the lesions must be reported at once.

### Gastrointestinal Disturbances

If regurgitation or vomiting occurs, no further increases in feeding are made. It may actually be necessary to decrease the volume of feeding and increase the number of feedings. This will be determined by the physician.

The physician should always leave an order to be notified immediately if diarrhea (frequent, watery stools) makes its appearance. This condition requires an increase in the fluid intake and Hartmann's solution is given by hyperdermoclysis. Weak tea or one-half strength Hartmann's solution may be employed in place of all feedings for 12 to 24 hours, after which feeding is again started by using small amounts of the breast milk--calcium caseinate preparation, or the skimmed milk-olive oil formula, and gradually increasing the volume.

If there is no improvement, whole blood is given deep subcutaneously on the second day. Do not temporize. Repeat Hartmann's solution by slow, continuous infusion, giving about 3-1/3 ounces (100 cc.) to small prematures and as much as 6 ounces (200 cc.) to the large infants.

If the premature baby is not gaining in weight and the stools continue to be loose, weigh daily until there is a weight increase, and normal stools.

#### The Influence of the New Program on the Mortality Rate of the Premature Infants

All the premature deaths occurring during a given age period were grouped together. This is shown in Table II. The first period consisted of the initial 48 hours of life. Very little reduction in the mortality rate occurred. The next period was from 48 hours to the 10th day of life. A marked drop in premature deaths took place during this time. This was due to the well controlled feeding schedule which was followed in taking care of about 97% of the babies. The period from the 2nd day to the 10th day of life has been called the "period of adaptation to feeding."

Table II. Mortality Rate of Premature Infants. Part 1.

Year	1930-1931			1931-1932			1932-1933		
Total Number of Prematures	148			155			139		
No. of Deaths--	No.	%	Av.Wt.	No.	%	Av.Wt.	No.	%	Av.Wt.
Less than 1 hr.	7	4.7	1505	5	3.1	1160	12	8.6	960
1 hr. to 16 hr.	18	12.1	1553	22	14.0	1126	19	14.0	1158
16 hr. to 48 hr.	9	6.0	1489	6	3.7	1820	6	4.4	1372
Total up to 48 hr.	34	22.8		33	20.8		37	27.0	
48 hr. to 10 days	34	23.0	2255	27	18.0	2237	5	3.5	1915
More than 10 days	22	15.0	2197	42	27.0	2194	5	3.5	2033
Total over 48 hr.	56	38.0		69	45.0		10	7.0	
Grand Total	90	60.8		102	65.8		47	34.0	

Year	1933-1934			1934-1935			1935-36		
Total Number of Prematures	145			146			120		
No. of Deaths--	No.	%	Av.Wt.	No.	%	Av.Wt.	No.	%	Ave.Wt.
Less than 1 hr.	17	11.7	1069		3.4	1153	3	2.5	1222
1 hr. to 16 hr.	15	10.5	1526	17	11.6	1443	14	11.7	1305
16 hr. to 48 hr.	4	2.8	1240	6	4.1	1332	7	5.8	1924
Total up to 48 hr.	36	25.0		28	19.1		24	20.0	
48 hr. to 10 days	1	0.7	1425	5	3.4	1723	4	3.3	1590
More than 10 days	10	6.9	1662	7	4.9	1694	4	3.3	1907
Total over 48 hr.	11	7.6		12	8.3		8	6.6	
Grand Total	47	32.6		40	27.4		32	26.6	

The final period includes the time from 10th day to day of discharge. A large reduction in premature deaths also appeared in this period, due chiefly to the rigid isolation technique which prevented infections. The majority of the infants died after the tenth day of life as the result of infection. This may be observed in the summary presented in Table III.

It was apparent that the greatest value of the premature program was in assisting the babies to adapt themselves to feeding and in the prevention of infections. Very little, if anything, was accomplished in reducing the mortality rate during the first 48 hours of life,

the so-called "period of resuscitation." In 1936, therefore, greater emphasis was placed on the first few days of life of the premature infant, and especially the first hours of life.

Special precautions were taken to keep the babies warm, artificial respiration by mechanical means was practically eliminated, and continuous CO<sub>2</sub> in oxygen was administered. The results were encouraging as is shown

Table III. Causes of Death in Premature Infants  
(After 48 hours of life)

A	
No. of Cases	No. of Clinical and Pathological Cases
Clinical and Pathological Findings (48 hours to 10 days)	Clinical and Pathological Findings (More than 10 days)
July 1930 to July 1931	
14 Marked diarrhea (feeding problem)	10 Marked diarrhea and resp. infect.
7 Bronchopneumonia	5 Bronchopneumonia
6 Middle ear infection	1 Middle ear infection
4 Atelectasis, birth trauma	1 Atelectasis, birth trauma
3 Marked cyanosis	1 Marked cyanosis
July 1931 to July 1932	
12 Marked diarrhea (feeding problem)	19 Bronchopneumonia
7 Nothing definite (prematurity?)	12 Marked diarrhea & Bronchopneumonia
2 Middle ear infection	11 Middle ear Inf. & Bronchopneumonia
1 Congenital heart disease	2 Marked diarrhea & Resp. Infection
1 Aspiration of milk (aspiration pneum.)	1 Atelectasis
1 Marked cyanosis	

B			
Case No.	Birth Weight (gm.)	Days of Life	Clinical & Pathologic Findings
July 1932 to July 1933			
G-1	2490	4	Nothing definite (prematurity?)
L-2	1000	5	Nothing definite (prematurity?)
C-4	1700	9	Diarrhea & resp. infection
H-5	2280	9	Diarrhea & Middle Ear Infection
C-3	2100	9	Middle ear inf. & br. pneumonia
D-6	2200	14	Marked diarrhea & resp. inf.
M-7	1425	14	Marked diarrhea & resp. inf.
D-8	2075	19	Middle ear inf. & br. pneumonia
C-9	2170	22	Erysipelas
D-10	2300	31	Erysipelas
July 1933 to July 1934			
P-36	1425	6	Marked cyanosis
S-39	1700	12	Marked diarrhea
M-42	2120	12	Bronchopneumonia
B-1	1090	17	Marked cyanosis
S-47	2375	19	Erysipelas
W-40	2490	20	Marked diarrhea
K-13	1475	23	Impetigo
H-12	1360	24	Middle ear infection
M-3	1610	36	Nothing definite (prematurity?)
M-43	1400	47	Bronchopneumonia
M-18	1000	60	Marked diarrhea

Table III (Cont.)

Case No:	Birth Weight (gm.)	Days of Life	Clinical and Pathologic Findings
July 1934 to July 1935			
W-43	2065	4	Br. pneumonia & middle ear infection
W-3	1095	7	Hemorrhagic disease of the newborn
F-41	2200	7	Marked diarrhea
A-7	1835	8	Pneumonia & lung abscess
E-20	1420	8	Marked cyanosis
I-47	2415	14	Marked diarrhea and bronchopneumonia
T-24	1575	18	Marked diarrhea and cyanosis subdural hemorrhage
B-5	1540	20	Marked diarrhea
H-38	1250	21	Marked vomiting and irreg. respiration
J-15	1170	24	Marked diarrhea & br. pneumonia
J-46	1525	29	Marked diarrhea
C-27	1860	84	Marked diarrhea and cyanosis middle ear infection
July 1935 to July 1936			
S-18	2200	6	Marked cyanosis
O-11	1200	7	Nasal hemorrhage & br. pneumonia
O-10	1385	8	Nasal hemorrhage and marked cyanosis
H-13	1575	9	Subarachnoid hemorrhage & hemorrhage into right ventricle
D-30	2300	10	Atelectasis and left hydroureter and hydronephrosis
M-23	1630	12	Marked diarrhea
L-20	1800	20	Marked diarrhea
B-28	1900	24	Marked diarrhea and cyanosis
July 1936 to July 1937			
R-9	1360	10	Atelectasis and br. pneumonia

in Table IV. There was a drop in the mortality rate during the first 48 hours

of life from 20% to 12.1% which aided in reducing the grand total death rate to 13.4%.

Table IV. Mortality Rate of Premature Infants - Part II.

Year	1933-1934		1934-1935		1935-1936		1936-1937	
Total Number of Prematures	145		146		120		89	
No. of Deaths	No.	%	No.	%	No.	%	No.	%
Less than 1 hr.	17	11.7	5	3.4	3	2.5	2	2.2
1 hr. to 16 hr.	15	10.5	17	11.6	14	11.7	3	3.3
16 hr. to 48 hr.	4	2.8	6	4.1	7	5.8	6	6.6
Total up to 48 hr.	36	25.0	28	19.1	24	20.0	11	12.1
48 hr. to 10 days	1	0.7	5	3.4	4	3.3	0	0.
More than 10 days	10	6.9	7	4.9	4	3.3	1	1.1
Total over 48 hr.	11	7.6	12	8.3	8	6.6	1	1.1
Grand Total	47	32.6	40	27.4	32	26.6	12	13.4

There has, however, been a tendency to do too much for the premature baby during the first hours or days of life. In spite of rigid regulations, physicians (obstetricians and pediatricians) and nurses still have the urge to carry on with many of the old methods of resuscitation. During the present year we have had, with the rotation of the staff, short periods during which quite a number of the premature infants have probably expired from careless handling and traumatization.

One of us (J.A.A.) has made and is continuing to make a special study of resuscitation, asphyxia and atelectasis in the full-term and premature babies. The material collected to date is summarized in the outline which follows:

#### 1. Importance of the problem:

It has been stated that the combined still-birth and neo-natal deaths directly attributed to respiratory complications and amenable to treatment are 8 in 100 births, or about 150,000 deaths a year in this country (Yandell Henderson). Approximately 1% of the total immediate fetal mortality has been attributed to asphyxia which may have otherwise responded to proper treatment. The death rate of asphyxiated infants from respiratory difficulty, atelectasis, and complicating pneumonia is seven times greater during the first week of life than the immediate infant mortality rate (Von Rouss). Of 291 deaths occurring during the first 14 days of life, 159 occurred in prematures.

The cause of death in 134 of these was termed "congenital weakness" yet 41 were able to survive a week.

#### 2. Anatomical and physiologic differences of the full term and premature infant:

##### A. Premature characterized by:

1. Relatively insensitive respiratory center demanding greater and more prolonged chemical stimulation.
2. Inadequate temperature and vasomotor control which demands proper and constant environment.
3. Areas of incompletely developed alveoli in lungs lined with several layers of cylindrical cells.
4. Persistence of atelectasis in prematures lasting up to several weeks.
5. Greater delicacy of cerebral and other tissues which makes gentleness imperative.

#### 3. Normal physiology of respiration in infants:

- ##### A. Lungs solid, airless, atelectotic, and completely filled thorax.



B. Inspiration induced by cutaneous stimulation and accumulation of  $\text{CO}_2$  in the blood, exerting effect on respiratory center.

C. Onset of Hering-Breuer reflex:

1. Distention of alveoli produces immediate relaxation of diaphragms.

2. Collapse of lung produces contraction of diaphragm.

3. Blowing down of air over upper part of trachea produces expiration.

4. Current of air upward causes inspiration.

D. Alveoli have a resistance to expansion of about 14 cm. of water.

E. Exchange is about 20-30 cc. with each respiration for first few hours.

#### 4. Neonatal atelectasis:

A. Causes

1. Anatomical and physiologic factors just mentioned.
2. Mechanical obstruction of air passages.
  - a. Amniotic fluid, blood, meconium, mucous, epithelial debris, etc.
  - b. Congenital anomalies of air passages.
3. Intracranial lesions
  - a. Hemorrhage, edema, anemia accompanied by atelectasis commonly.

B. Symptoms:

1. Picture of asphyxia
  - a. Rapid shallow respirations accompanied by cyanosis.
  - b. Periods of apnoea.
  - c. Variable pulse rate, very rapid to very slow with irregularity.

C. Physical examination:

1. Percussion of little help.

2. Auscultation occasionally reveals few rales at bases.
3. X-ray sometimes of value.
4. Must be differentiated, if at all, from intracranial hemorrhage, pneumonia, diaphragmatic hernia, congenital heart, etc., which are invariably accompanied by atelectasis.

D. Treatment - discussed under asphyxia.

#### 5. Asphyxia neonatorum:

A. Asphyxia neonatorum is a disorder of the respiratory mechanism, developing during or shortly after birth, characterized by arrest or irregularity of breathing in association with cyanosis.

1. Intrauterine or congenital asphyxia

- a. Asphyxia livida
- b. Asphyxia pallida

2. Acquired form

B. Etiology

1. Decreased or absent irritability of the respiratory center due to
  - a. Pressure effects of labor producing edema, hemorrhage, perhaps anemia.
  - b. Chemical depression by use of opiates, analgesics and anesthetics.
2. Interference with fetal circulation
  - a. Maternal causes - obstetrical hemorrhage, cardiac decompensation, compression of placenta if membranes have ruptured, anemia, pneumonia.
  - b. Fetal causes - aspirated material atelectasis, cord anomalies and occidants, tumors and defects of respiratory tract.

C. Pathologic physiology and biochemistry

1. In absence of cerebral pathology the chief picture

of asphyxia is that of respiratory obstruction producing

- a. Failure of CO<sub>2</sub> excretion, with its accumulation in blood under increased tension.
- b. Intense respiratory effort, due to stimulation of center, intrauterine or neonatal.
- c. Anoxemia and failure of respiratory center to respond.
- d. Progressive accumulation of blood in right heart with failure and enlargement of liver tissues and other organs.

2. Asphyxia, cerebral in origin, produces a similar mechanism with feeble or absent respiratory attempts, followed by loss of muscle tone and collapse.

#### D. Symptoms

1. Differentiation between asphyxia livida and pallida is made only because symptoms are characteristic and they indicate severity and treatment.

	<u>Asphyxia livida</u>	<u>Asphyxia pallida</u>
	<u>Less Serious</u>	<u>More Serious</u>
Cyanosis	Slight to intense (dusky)	Pallor with cyanosis
Respirations	Absent, irregular, feeble	None, feeble movement of diaphragms
Muscle tone	Good	Poor, flabby
Reflexes	Swallowing and sucking present	Swallowing and sucking absent
Anal Sphincter	Closed, contracted	Open, relaxed
Skin	Warm	Cold
Heart and Pulse	Strong	Weak
		Simulates severe brain injury.

#### E. Complications

1. If successfully treated without recurrence after first 24 hours, usually complete recovery.
2. If recurrence occurs after first day, it is due to atelectasis, further mechanical obstruction by aspiration, pneumonia, congenital heart and other anomalies.

#### F. Treatment

1. Prophylactic - depends entirely on good obstetricians

#### 2. Active treatment

- a. Remove or lessen any resistance to respiration
- b. Relieve anoxemia
- c. Assure good expansion of lung
- d. Prevent washing out of CO<sub>2</sub>
- e. Avoid the use of drugs, cold baths and vigorous calisthenics

#### 3. Use of gases

- a. Inhalation of 6 to 10% CO<sub>2</sub> with an ordinary

- anesthesia mask.
- b. Proper use of nasal catheters for administration of 10% CO<sub>2</sub> and 90% O<sub>2</sub>.
  - c. Intratracheal suction and insufflation with 10% CO<sub>2</sub> and 90% O<sub>2</sub> as proposed by Flagg.
  - d. Mechanical artificial respiration with Drinker respirator.
  - e. Mouth to mouth insufflation (about 4% CO<sub>2</sub> and 19% O<sub>2</sub>) with extreme caution. Remember that over 14 cm. of water pressure will rupture alveoli and invariably result in death.
4. Action of CO<sub>2</sub> and O<sub>2</sub>
- a. In spite of excessive accumulation of CO<sub>2</sub> in blood, additional CO<sub>2</sub> will cause stimulation of a depressed respiratory center and initiate the powerful Hering-Breuer reflex.
  - b. O<sub>2</sub> renders the anoxic respiratory center more sensitive to stimulation.
5. Continuous use of 7-10% CO<sub>2</sub> and 40-50% O<sub>2</sub> advisable in pre-matures because of incomplete development of lungs.

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In spite of the fact that modern methods of resuscitation are still far from satisfactory, the mortality rate of the premature infant can be reduced and has been reduced in Minneapolis. This is the answer to the lay writers who ask that something be done. In a current number of a popular magazine, Paul de Kruif states that Chicago is doing something to "keep babies alive." We are keeping pace with the preventive measures which are being carried out in Chicago.

Furthermore, occasionally one hears the statement that it may not be worthwhile to make such a great effort to save all the premature babies, due to impression that mental retardation predominates among the children prematurely born. We have never felt that this state-

ment was true and fortunately the new department of Child Psychiatry has taken up this problem as one of their research projects. Several years from now we may have the answer to the question, "Does prematurity influence the normal mental development of the child?"

### Summary

Our experience with care of the premature has indicated that there are certain basic principles to be followed:

1. Careful and intelligent nursing is essential.
2. Normal body temperature should be maintained from the moment of birth.
3. Infections, especially those of the respiratory tract, must be prevented.
4. A proper fluid intake should be maintained and the diet should be simple but still adequate enough to supply the caloric needs without causing gastro-intestinal disturbances.

To the above may be added:

1. Resuscitation must be intelligently performed and no violent methods are permissible.
2. The nurse should sometimes be allowed to indicate which method of feeding may give the best results.
3. The premature infant must be furnished quite early with an adequate supply of the vitamins, especially vitamin D.
4. Injections of whole blood subcutaneously and intramuscularly are indicated when intracranial hemorrhage is suspected or known to exist, when there is a gastro-intestinal upset or a secondary anemia with or without evidence of infection, and when there is a failure to gain in weight in spite of an adequate food supply.

V. GOSSIP

Last week your attention was called to the fall meeting of the Minnesota Radiological Society at Rochester on Saturday, Oct. 22. In order to keep the record straight and to preserve the incident for posterity, let us now relate what really happened instead of the meeting. You will recall that we awakened that morning to find the ground covered with a wet, driving snow and the temperature fairly low for this time of year. Our good friends, the Radiologists from the Hospital, Twin Cities, and Duluth hurried through their morning work in order to leave at noon. Although some had promised to take their wives, the majority assured the good ladies that because of the probable lateness of meeting that they had better stay behind and keep the home fires burning. Everything went well as they rolled along talking shop and laughing about the many times they had caught the clinicians flat-footed, etc., etc. Although snow continued to fall, driving was not difficult, and they were making good time as they reached the half-way mark at Cannon Falls. Little did they dream of what was ahead, for a short distance beyond Cannon Falls they struck a heavier driving snow with all the characteristics of a gale. Visibility decreased and speed slowed down as traction became more difficult. Finally the pilot car in charge of Head Radiologist Leo Rigler stopped because a truck had stalled in the middle of the road. In the meantime, the storm had increased to such an intensity that it was practically impossible to see more than a few feet ahead. From then on the story loses its continuity as car after car stalled in the drifts. Friends, separated by a few cars, could not distinguish their neighbors. In the meantime frantic calls for help by the highway police had to wait while the snow plows were being taken out of their summer homes. Cars continued to try to make it until eventually it was reported that nearly 300 cars were involved in the tieup and more than 1000 stranded motorists. Dr. Rigler, collecting his faithful few and ordering them to follow, started out for what appeared to be a farm house. As their

legs became numb from the driving cold wind and snow, they hurried their steps, finally breaking into a dead run. Our boys were not in the best of condition, so when they reached the farmer's shelter, they burst in without much ceremony only to receive a chillier reception than mother nature had given them. The farmer and his wife assured them that they were much more concerned about getting their chickens in to shelter. As the radiologists sat, huddled around the stove, there was a knock at the door, and a gentleman of the old school appeared in the person of Radiologist Herman Jensen, who informed the farmer and his wife as to his identity, the reason for his appearance at their door, and in his best manner begged the hospitality of their abode for himself and friends. P.S.: Herman had practiced in the country. From then on, Herman was the man of the hour. The crowd in the house increased to 15, when another knock startled them, as C.C.C. boys brought in a woman who had collapsed. With the house full of physicians, there wasn't a stethoscope or a pill in the crowd. In the meantime, the storm had become even more violent, but not quite so violent as the appetites of those in the room. As the farmer and his wife made no effort to provide food for the crowd, our Herman again scored. Battling the elements, he caught some chickens which he promptly cleaned and fried. Finding no bread, he mixed up some biscuits, and soon the weary travelers were regaling themselves with sumptuous fare. After dinner, the meeting of the Minnesota Radiological Society was held -- at least the Northern Section. It must be confessed that there was very little business discussed, but at the close of the meeting it was decided to elect the farmer and his wife to honorary membership. This caused great consternation, as the good woman did not feel that she merited this distinction. To make this part of the story complete, we should say that Nettie Stenstrom washed the dishes, --- but she did not. In the meantime, many of the others had stayed in their cars; some from 2:00 Saturday afternoon until early Sunday morning.

Some of the more venturesome went on to Hader, where they found shelter in a small store. It was so full of people that no one could sit down. The C.C.C. boys, while searching cars for people in distress, found a six-months' old baby who needed food badly. Two of them, breaking through drifts brought milk over a rugged two-mile course. The crowd in the store grew more impatient, as one politician after another assured the people of Minnesota by radio of what they had done for them. Invariably the reply was "Where are the snow plows?" Evacuation by C.C.C. trucks started as the victims were conveyed with much sliding and slipping until they finally found a clear road just a few miles ahead where everything was calm and peaceful. The good people of Zumbrota took in the travelers, each home being lighted to signify hospitality within. Every public building was opened and the armory was turned over for shelter. Most of our weary Radiologists spent the balance of the night trying to sleep on boxes or benches, or trying to communicate with

their wives. One, very insistent that the call should go through, as his wife was very nervous, had to have it cancelled because his wife slept so soundly she didn't hear the phone ring. Early Sunday morning the snow plows broke a way through, adding more difficulties, as the combination of plow and drift completely covered many of the cars. During the balance of the morning and part of the afternoon, the weary travelers dug out their cars. Dr. Clement's car was so completely covered it was thought to be lost. After the cars were dug out, it was necessary to thaw the motors, and finally, Head Pilot Rigler and his weary crew returned to Minneapolis at 5:00 p.m. Sunday afternoon without ever having reached Rochester. Everyone joined in a good cheer for the C.C.C., the firemen and citizens of Zumbrota, the telephone operator, and finally our Herman who knew his farmers and cookery. Years from now, when the grandchildren are told of the big blizzard of 1938, the story may be changed but this is the way it was related to me.