decreasing birth weight; and there is a known correlation between head circumference and cellular growth of the brain in early life. Over one hundred surviving infants of birth weights 1500 g and less cared for at Hammersmith Hospital between 1961–1968 inclusive have been studied. Approximately one third had birth weights below the 10th percentile for their gestational age. At later follow-up, significantly more of these small for date children were found to have head circumferences below the 10th percentile than those whose birth weight was appropriate for gestation. In the years 1965–1968, fewer children of the latter group had head circumferences below the 10th percentile than in the years 1961–1964. The incidence of neurological abnormality among them was lower, and it is concluded that their brain growth may have been more satisfactory.

34. Long lasting effects of intrauterine undernutrition. A comparative study of twins of dissimilar birth weight. L. HOHNHAUER. *Univ. Kinderklinik, Innsbruck, Austria.*

Among 26,138 consecutive births (1952–1965) 30 twin pairs were found which matched the criterias: (1) difference in birth weight 300 g or more, (2) identical sex, (3) gestational age 36 weeks or more, (4) no gross abnormalities. Voluntary breast milk intake at day 5 was 73.5 ± 14.7 in the stunted twin vs 62.3 ± 14.1 in the larger one (mean $\pm$ sd, P 0.01). Twenty of them could be reexamined (9 identical, 11 dizygous) at a mean age $8\frac{1}{2}$ yrs (range: $4\frac{1}{2}$ to $17\frac{1}{2}$). Physical "catch up" (height and weight) had occurred in 10 pairs at a mean age of $3\frac{1}{2}$ years. The following differences were found:

Stunted twin	Inferior	Equal	Superior	N	P^1
Head circumference	17	0	3	20	0.01
Arm circumference	15	0	5	20	0.05
IQ (Kramer)	16	(1)	1	17	0.001
School achievement	9	(1)	0	9	0.05
First free walking	11	(8)	1	12	0.01

¹Sign test for comparison of pairs.

Intellectual performance at home as judged by the mother was equal in 10 but inferior in 10 stunted twins ($P = 0.01$). In all 7 pairs aged 11 years or more a disadvantage of the formerly smaller one was evident.

Growth retardation at birth was significantly correlated with suboptimal performances later in life. Since genetic and environmental differences between test and control subjects are practically excluded, the handicaps are ascribed to the prenatal undernutrition. The nutritional deficit is emphasized by the neonatal drinking behavior.

35. Respiratory reflexes in the newly born. G. BODEGÅRD and G. H. SCHWELER. *St. Görans Hosp. and Karolinska Inst., Stockholm, Sweden.*

The Hering-Breuer inflation reflex (H.B.i.r.) and the thoracic respiratory reflex (th.r.r.) have been studied in 17 babies of different postmenstrual ages (30½ to 13 weeks). Pronounced development of the strength of the reflexes have been found indicating the existence of differences in the mechanoreceptor regulation of the breathing between infants of this maturity level and adults.

The H.B.i.r. was studied by tidal volume inflation obtained by occluding the airways at the height of an inspiration. The strength of the reflex was assessed by relating the relative increase of the length of the breathing cycle to the transpulmonary

pressure at the moment of occlusion (thus the pressure which simultaneously stimulates the pulmonary stretch receptors). The reflex was found to be very weak at a postmenstrual age of 32 weeks. It increased to a maximum strength at a postmenstrual age of 36 to 38 weeks. Later on there was a decline of the strength of the reflex.

The th.r.r. was studied as the reflex respiratory response to an added respiratory load and recorded as the change in amplitude of the intraesophageal (=intrapleural) pressure swings caused by airway occlusion. It has earlier been shown in adults that an increase of the respiratory load leads to an increased power generation of the respiratory muscles reflected as an increasing amplitude of the intrapleural pressure swings. In the babies studied the response to an increased respiratory load was found to increase gradually with increasing postmenstrual age indicating increasing maturation of the thoracic respiratory reflex system.

In some babies estimations both of the strength of the H.B.i.r. and the th.r.r. were made at repeated occasions and the same principal development of the reflexes was seen in the single baby as was seen from cross-sectional data in all the infants studied.

Furthermore there was found a dip in the development of the th.r.r. at the time when the H.B.i.r. reaches its maximum which might indicate some kind of competition between the two reflex systems. Such a competitive interaction could also explain why the H.B.i.r. decreases in strength after 38 weeks of age when the th.r.r. continues to increase in strength.

36. Respiratory patterns in newborn infants related to postconceptive age (fetal age + neonatal age). U. SELSTAM and T. OLSSON. *Univ. of Göteborg, and Chalmers Univ. of Technol., Göteborg, Sweden.*

The aim of this paper is to present a method of analyzing respiratory patterns in newborn infants and to present variations of respiration related to postconceptive age, i.e., fetal age + neonatal age. The equipment consists of a tetrapolar impedance plethysmograph with an alarm unit, a Mingograph 81 (Elena-Schönander), and a computer (PDP 12). The respiratory movements are detected from variations in the transthoracic impedance signal. The time intervals between adjacent detections of respiration are recorded in the memory of the computer, programmed for a time interval histogram analysis. Different parameters in the program are clinically estimated. The infants are studied during sleep, shortly after feeding. Other factors influencing respiration, for example, surrounding temperature, light, and background sound, are kept as constant as possible. Data are treated statistically.

With increasing age there is a decrease in the mean frequency of respiration and a decrease in the frequency of periodic breathing and apneic episodes. The top of the histogram, i.e., the most frequent frequency of respiration, increases. When the periodic breathing, which usually is very regular, ceases, there is a period of rather irregular breathing, again followed by increasing regularity of respiration.

37. Alveolar and capillary permeability in the lung of the fetal lamb. I. C. S. NORMAND, R. E. OLVER, E. O. R. REYNOLDS, and L. B. STRANG.

Radioisotope-labeled, metabolically inactive molecules of varying radii (2–13 Å) were used as probes to investigate the permeability properties of the internal cellular lining of the lung in exteriorized fetal lambs (mean gestational age of the two groups: 127 and 140 days). By placing the isotopes in the blood or lung liquid compartments and serially collecting samples of blood,

lung liquid, and lung lymph, information was obtained about the separate capillary and alveolar components of the barrier. The results show that for both parts of the barrier the permeability constants for water-soluble/fat-insoluble molecules increase with diminution in size, and that the alveolar component is much less permeable than the capillary component (e.g., 1,000-fold difference for sucrose). Preliminary studies suggest that the same size dependence holds for fat-soluble molecules, and that for a given size, permeability constants increase with fat solubility. There was no difference between the mature and immature fetuses.

38. Early stages of hyaline membrane disease. N. FRENCK, A. TORRADO, J. M. CHOFFAT, and L. S. PRODHOM. *Hôpital Cantonal Universitaire, Lausanne, Switzerland.*

In 78 preterm infants with HMD, the initial PaO₂ values, in 100% O₂ (hyperoxia test), were lower than expected for age in the first 4 hr of life, then dropped and stayed low for 24 to 72 hr and started to rise. It was also shown that the shorter the gestational age, the earlier the rise and the limit seems to be at 33 weeks gestation. The drop in PaO₂ could be explained by intrapulmonary shunt through increased atelectatic areas or by extrapulmonary shunting (fetal shunts).

The functional residual capacity (FRC), was measured by the close circuit helium dilution method, as an index of pulmonary aeration, in six preterm babies with HMD and was found to be 50% lower than expected value, already before the 4th hr of life, and remained low without any significant change for the first 24 hr. Thus, it can be speculated that the drop in PaO₂ is due to extrapulmonary shunting through the foramen ovale and ductus arteriosus and not to an increase in atelectasis.

39. Fibrinolytic system in infants of low birth weight and/or short gestational period. H. EKLUND and O. FINNSTRÖM. *General Hosp., Malmö, and Univ. of Umeå, Sweden.*

The aims of this investigation were: (1) to study fibrinolytic activity and the development of the different factors of the fibrinolytic system from early "prematurity" up to term and (2) to study the changes, if any, of these factors in infants with postnatal asphyxia, idiopathic respiratory distress syndrome (IRDS), and intracranial hemorrhages. The material consisted of 197 infants in the 25th to 43rd gestational week. Approximately half of the material served as a "control material" to the rest of the infants with postnatal asphyxia and IRDS. Blood was obtained from a catheter in the umbilical artery or vein. Serial sampling was performed in one part of the material. Determinations were made of: fibrinolytic activity on fibrin plates, fibrinolytic split products (FSP) in serum and in serum with addition of ϵ -aminocaproic acid (EACA), fibrinogen, plasminogen, antiplasmin, α_2 -macroglobulin, inhibitors of urokinase activation of plasminogen. Plasminogen and α_2 -macroglobulin increased significantly with increasing length of gestation, while the other factors were at the same levels as in full term newborns throughout. Fibrinolytic activity was demonstrated even in the smallest infants and also in infants which developed IRDS. It was high in some infants with severe hypoxia. FSP in serum-EACA were studied by serial sampling and were found in infants with severe hypoxia and acidosis. The various factors of the fibrinolytic system are sufficiently developed in preterm infants which are capable of producing fibrinolytic activity. The findings argue against the assumption that IRDS is due to a primary deficiency of the fibrinolytic system. It rather lends support to the hypoth-

esis of an increased fibrinolysis in infants with hypoxia and acidosis.

40. Studies by direct calorimetry of thermal balance in the first day of life. G. RYSER and E. JÉQUIER. *Lausanne, Switzerland.*

Using a gradient layer direct calorimeter, total heat losses were measured in 73 full term newborns in three different environments: ambient temperature (T_a) of 30, 32, or 34°. The relative humidity of the air was kept constant at 50%. Esophageal temperature (T_{int}) and mean skin temperature (T_s) were continuously recorded. All experiments lasted at least 1 hr, and the data were obtained when the newborn was quiet. The mean total heat loss ($\pm$ SEM) was at 30°: 41.85 ± 1.29 cal/kg/min; at 32°: 35.40 ± 0.71 cal/kg/min at 34°: 27.80 ± 0.85 cal/kg/min. Total heat loss was proportional to the difference between T_s and T_a . Evaporative heat loss was very constant in these three conditions (even when T_{int} was higher than 37.0°), with a mean of 6.58 ± 0.13 cal/kg/min. This value is a measurement of insensible perspiration. The heat storage (ΔS) was calculated using the following formula: $\Delta S = \text{weight (kg)} \times \text{specific heat of body mass (0.84 kcal/g.C)} \times [(0.6 \times \text{variation of } T_{int}) + (0.4 \times \text{variation of } T_s)]$. ΔS was negative at T_a of 30° (body cooling), and positive at T_a of 34C (body warming). Regression analysis showed a mean heat loss of 36.26 cal/kg/min when the newborns were in thermal equilibrium ($S = 0$) this value corresponds to a calculated $\dot{V}$ O₂ of 7.52 ml O₂/kg/min. This occurred in most babies at 32° (neutral environment). The skin thermal conductance [$C = \text{cutaneous heat loss}/(T_{int} - T_s) \times \text{body surface}$], which is an index of cutaneous blood flow, increased sharply in most babies when T_s reached 35.8° and T_{int} 37.0°. These data indicate that the thermoregulatory mechanisms on the 1st day of life are limited: at low T_a (30°), vasoconstriction and very likely that increase in metabolic rate are not large enough to prevent a fall of T_{int} . At high T_a (34°), vasodilatation occurs, but sweating is not elicited.

41. Oxygen transport capacity in the neonatal period. A. KOIVIKKO, E. LÄNSIMIES, and J. KLOSSNER. *Children's Hosp. and Univ. of Turku, Finland.*

The oxygen consumption of resting lambs is from 8 to 13 ml/min/kg during the 1st week of life. Assuming a cardiac output of 300 ml/min/kg and a hemoglobin of 13 g/100 ml, it may be seen that about one-third of the oxygen transport capacity is used at rest. In the present study lambs 2-7 days old were subjected to shivering during hypothermia. The animals were breathing 100% oxygen and were anesthetized with chloralose. Oxygen consumption, dye dilution curves, pressures of the central arteries, and arterial SO₂ and acid-base balance values were registered. The oxygen consumption of the lambs increased to a maximum of 35 ml/min/kg during shivering. Cardiac outputs increased from about 300 ml/min/kg to 500-700 ml/min/kg in the lambs with the highest values of oxygen consumption. The arterial oxygen saturation did not change at the cardiac output values. These results were also observed when the body temperature had been lowered to about 30°. About one-third of the oxygen carried by the arterial blood was extracted by the organism. Decreasing values of standard bicarbonate were often associated with lowered cardiac outputs. Correction of metabolic acidosis increased cardiac outputs but did not influence the oxygen consumptions. It may be concluded that shivering increases the oxygen consumption and cardiac output in the