Patients and methods

A hundred and eighteen neonates of the study were chosen from the newborn delivered between February 1969 and September 1970 in the Department of Obstetrics, University of Oulu, and from those who were referred to the neonatal unit, Department of Pediatrics from regional hospitals. In August 1971 the study population was completed with 12 normal newborn infants, giving a total number of 130. In this district there are approximately 7,000 births per year.

Clinical data on the maternal history, labour, delivery and neonatal course were recorded.

The patients were divided into groups according to gestational age, birth weight, mode of delivery, neurological symptoms, and other disorders of the newborn. Out of the 130 neonates studied, a total of 30 infants, representing a random sample of normal newborn, constituted a normal control group. The pregnancies and deliveries had been without complications, the gestational age was 38—41 weeks, birth weight was over 2,500 g, and the postnatal course was uneventful.

The patients included four twins, two unrelated twin partners, two infants of the same mother born with an interval of one year and four months, and one case of congenital nephrosis, diagnosed later. Clinical features of the study population are summarized in Table 3.

| Groups                        | Number of Infants | Number of Observations | Observations per Infant |
|-------------------------------|-------------------|------------------------|-------------------------|
| **Sex**                      |                   |                        |                         |
| Female                        | 61                | 524                    | 8.6                     |
| Male                          | 69                | 739                    | 10.7                    |
| Total                         | 130               | 1263                   | 9.7                     |
| **Gestational age**           |                   |                        |                         |
| 28—32 weeks                  | 5                 | 42                     | 8.4                     |
| 33—34 weeks                  | 9                 | 92                     | 10.2                    |
| 35—36 weeks                  | 16                | 180                    | 11.3                    |
| 37—38 weeks                  | 19                | 157                    | 8.3                     |
| 39—40 weeks                  | 54                | 535                    | 9.9                     |
| 41—44 weeks                  | 27                | 257                    | 9.5                     |
| Total                         | 130               | 1263                   | 9.7                     |
| **Preterm infants of 28—36 weeks** | 30                | 314                    | 10.5                    |

1 Including the supplement of 12 normal neonates, which was taken into account only in the normal control group.
Birth weight

| Birth weight | 1020—1549 g | 1550—2049 g | 2050—2449 g | 2450—3049 g | 3050—3549 g | 3550—4049 g | 4050—4620 g | Total |
|--------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------|
| Count        | 6           | 13          | 25          | 26          | 26          | 25          | 9           | 130   |
| Birth weight |             |             |             |             |             |             |             | 1263  |
| Percentile   | 9.0         | 10.0        | 9.6         | 8.5         | 10.4        | 10.0        | 10.8        | 9.7   |

Low birth weight infants (<2500 g)

| Birth weight below the 10th percentile of intrauterine growth curve (134). |
|-------------------------------------------------|
| Count   | Birth weight | Total |
|---------|--------------|-------|
| 45      |              | 9.7   |

Small for date

| Birth weight ≥ 2500 g | 9 | 82 | 9.1 |
| Birth weight < 2500 g | 33 | 327 | 9.9 |
| Total                | 42 | 409 | 9.7 |

Birth weight < 2500 g

| Small for date | 33 | 327 | 9.9 |
| Appropriate for gestational age | 12 | 110 | 9.2 |
| Total           | 45 | 437 | 9.7 |

Birth weight 2500 ≥ g

| Small for date | 9 | 82 | 9.1 |
| Appropriate for gestational age | 76 | 744 | 9.8 |
| Total           | 85 | 826 | 9.7 |

Asphyxia

| Intrauterine | 21 | 157 | 7.5 |
| Postnatal, 1 min Apgar ≤ 6 (12 infants also had signs of intrauterine asphyxia) | 28 | 230 | 8.2 |
| Total         | 49 | 387 | 7.9 |

Cesarean section

| Count | 26 | 263 | 10.1 |

Maternal factors

| Diabetes mellitus | 9 | 96 | 10.7 |
| Primiparity      | 58 | 578 | 10.0 |
| II—V parity      | 60 | 576 | 9.6  |
| ≥ VI parity      | 12 | 109 | 9.0  |
| Previous abortions | 22 | 205 | 9.3  |

Neonatal disorders

| Neurological symptoms | 31 | 264 | 8.5 |
| Infections           | 9 | 92 | 10.2 |
| Congenital nephrosis | 1 | 11 | 11.0 |
| Others               | 23 | 161 | 7.0 |
| Total                | 64 | 528 | 8.3 |

Deaths

| Count | 7 | 35 | 5.1 |

Normal control group

| Count | 30 | 332 | 10.7 |

1 Birth weight below the 10th percentile of intrauterine growth curve (134).
All the newborn were fed on breast milk. Milk feeding was started on the second day, glucose water (about 60 ml/kg/day) was begun at the average age of 12 hours. The newborn who had biochemical abnormalities of blood such as hypoglycemia, hypocalcemia, and acidosis received therapy. Infants with blood glucose ≤ 25 mg/100 ml were treated either with oral 10% or intravenous 10—20% glucose. Symptomatic infants with serum calcium value below 4.0 mEq/l and those without symptoms but with serum calcium ≤ 3.2 mEq/l were treated with oral and/or intravenous calcium gluconate. The acid-base balance of the infants was determined when necessary by the micro-Astrup method (146). Metabolic acidosis was corrected with intravenous sodium bicarbonate according to the base deficit. This therapy was given without delay and effectively. Since it is known that blood acid-base status is related to plasma Mg levels, metabolic alkalosis having a lowering effect (62, 176), the treatment of acidosis, without doubt, markedly modified plasma Mg levels in the 36 newborn of the study who had marked metabolic acidosis. The present investigation, however, was not controlled with regard to the amount of sodium bicarbonate given. Some infants were given extra oxygen in the incubator and many received antibiotics intramuscularly.

Magnesium, as a treatment for toxemia, was not given to the mothers of the study patients.

Plasma Mg, serum calcium, serum phosphorus and blood glucose determined from heel capillary blood samples were followed consecutively during the first five days. In 61 cases the first samples were obtained before the age of two hours. For the first three days two to three specimens were taken daily, on the fourth day two samples and on the fifth, one. If the patient had an umbilical arterial catheter the samples were collected through it. A total of 1263 serial plasma magnesium determinations were performed during the study. On the first day 308 samples were obtained, on the second day 292 samples, and during the third to fifth day 662 samples. An average of determinations per infants during the five days was 9.7, on the first day the average was 2.4, on the second day 2.2, and from the third to the fifth day, 5.1. In 22 cases Mg, Ca, and P concentration of venous cord blood was also determined.

Determinations of magnesium by atomic absorption spectrophotometry.

Specimens were obtained in heparinized (ammoniumheparinate) microhematocrit capillary tubes (Propper Manufacturing Co., INC. Cat. No HCP). Plasma was separated in a hematocrit centrifuge. 0.050 ml of plasma was diluted with 0.800 ml distilled and deionized water. In order to eliminate interference, 0.100 ml of lanthanum solution was added. This was prepared by moistening 58.65 g La₂O₃ (Fluka AG, Chemische Fabrik, puriss.) with water and adding 250 ml strong HCl (Merck, pro analyse) slowly until the substrate was completely dissolved. This was diluted to 1,000 ml distilled and deionized water. As control samples, lyophilisated control serum Monitrol I and II (Dade Division American Hospital Supply Corporation, Miami, Florida, USA), which had known concentrations of magnesium, were used. These concentrations were also checked by weight standards. Control and standard samples were handled in the same way as plasma samples. The calibration curve was linear in the relevant range. Specimens were stored at +4°C in a refrigerator, with the plasma separated. Determinations were done by duplicate measurements, twice a week, in series of 30—50 samples. Hemolytic samples were discarded. All Mg determinations were performed personally by M. Reinilä, M.Sc.

The apparatus was model 290 B Perkin Elmer atomic absorption spectrophotometer which had a burner planned by Boiling (Perkin-Elmer, part No 303-0202). The fuel was acetylene (pressure from bottle 0.8 kg/cm²). Adjustements: fuel flow 14 and air flow 14. Suction was regulated so that the sample was aspirated at the rate of 1 ml/min to the burner. The lamp current was 2 mA, as informed
by the manufacturer. Breadth of slit was 7 Å, and the magnesium absorption band at 2852 Å was used and was obtained with a coarse selection element 209.5 (7, 38, 91, 141, 174, 180).

The validity of micro samples of Mg was evaluated, and the effect of possibly injured heels on Mg determinations was investigated. The analysis of the methodical error was also performed. (See detailed reports in discussion.)

Serum calcium concentration was determined by complexometric titration method using EDTA solution, and Cal-Red as indicator (18, 127). Measurement of serum phosphorus was based on the molybdate method, phosphomolybdate complex being reduced by stannous chloride, the wavelength used in colorimetric determination was 625 my (76). Blood glucose concentration was measured with the glucose oxidase method (164), using the commercial reagent supplied by AB Kabi, Stockholm¹.

Statistical and mathematical analyses were carried out in the Computer Centre of the University of Oulu. Three levels of significance were used: highly significant ($P \leq 0.001$)***, significant ($0.001 \leq P \leq 0.01$)**, and almost significant ($0.01 < P \leq 0.05$)*.

¹ Chemical analyses were performed in the laboratory of the Deaconess' Institute, Oulu; head: M. Reinilä, M.Sc.

21