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NEONATAL "HEPATIC RICKETS" IN PREMATURE INFANTS RECEIVING PARENTERAL ALIMENTATION (PA). MK Farrell, EJ Suchy, RC Tsang, JJ Steichen, JA Whitsett, JC Par-tin, and WK Schubert. Univ. Cinti., Dept. Peds., Cincinnati.

During a six month period, six premature infants (gestation 28-31 wks, weight 790-1180 gm) developed cholestasis and severe metabolic bone disease while receiving parenteral alimentation. Spontaneous long bone fractures occurred in 3/6. Infants received PA amino acid solutions for a mean of 4.5 wks (range 1-9); 4/6 received Intralipid. Hepatic dysfunction (direct hyperbilirubinemia, elevated transaminases) was first noted at a mean of 29 d (range 6-65) after initiation of PA. Osteopenia was evident by x-ray in all. Photon absorptiometry bone mineral analysis (BMA) was decreased in 3/4 infants (Steichen, A.J. Roent. 126: 1283). 25-OH vitamin D (25-OHD) was markedly reduced, < 10 ng/ml in 6/6; normal 20-80 ng/ml (Belsey's). Serum Ca was normal in all and P was 3.1-5.9 mg/dl. One of six infants died of non-hepatic causes. The liver showed cholestasis with extramedullary hematopoiesis, canalicular and hepatocellular stasis and minimal inflammation in two cases examined. Surviving infants were treated with 2500 units vit. D₃ p.o. and Ca 100 mg/kg/d. Fractures healed in 3/3; serum 25-OHD levels normalized in 2/4; serial BMA showed continued poor mineralization in 3/4. Decreased serum 25-OHD may relate to decreased intake, absorption and hydroxylation of vitamin D and decreased enterohepatic circulation of 25-OHD. "Hepatic Rickets" can occur in premature infants who develop cholestasis while receiving parenteral alimentation and should be anticipated by serial measurement of serum 25-OH vitamin D.

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IS HUMAN MILK THE BEST FOOD FOR LOW BIRTH WEIGHT BABIES? Gilbert B. Forbes, University of Rochester Medical Center, Department of Pediatrics, Rochester, NY.

Carcass analysis data show that the body content of N and minerals throughout fetal life are linearly related to body weight when plotted on double log coordinates. Hence they conform to the allometric (heterogonic) equation $Q = bW^k$, where Q is total body content and b and k are constants. When differentiated this becomes $dQ = bkW^{k-1}dW$, which says that N and mineral accretions (dQ) are directly proportional to weight gain (dW) at any given body weight; and since k differs from 1.0 the accretions corresponding to a given weight gain will also vary with body weight. Nomograms (to be presented) based on these equations allow one to read off the retention of N and minerals required to support normal body composition for a given weight and weight gain (maintenance needs are extra).

Application of these data to low birth weight babies indicates that human milk fed in usual amounts cannot meet the growth needs for N, Ca, P, Na and Fe in the face of rapid growth. However, it does contain enough K, Cl, Cu, Mg and S.

For example, the P content of 10 gm of growth tissue in a 1000 gm baby can be calculated from the above formula as follows:

$$dP = 1.45 \times 1000^{0.164} \times 10(dW) = 45 \text{ mg}$$

200 ml human milk (i.e., 200 ml/kg) will provide only 28 mg P, while most commercial formulas will provide about 90 mg P.

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BLOOD POLYAMINE DETERMINATIONS IN CHILDREN WITH LIVER DAMAGE. A.D. Garnica, B.M. Rodgers, O.M. Rennert, U. Florida College of Medicine, Dept. Pediatrics and Surgery and U. Oklahoma, Dept. Pediatrics.

Cell proliferation is associated with tissue polyamine synthesis. Animal studies demonstrate increase in hepatic putrescine, spermidine, and spermine after surgical or chemical liver injury, and have been interpreted to indicate hepatic regeneration. Whole blood polyamines reflect hepatic polyamine changes and were, therefore, measured serially in 16 infants and children with giant cell hepatitis (6), chronic active hepatitis (6), fructosemia (1), and after hepatectomy (3). After hepatectomy the patients' spermidine levels increased 2.5-5.5 times normal, spermine 1.5-3.5. Similar elevations were seen initially in patients with hepatocellular injury, which returned to normal with biochemical resolution of their disease. Blood polyamines were normal-to-elevated in 6 patients with chronic active hepatitis, increased with steroid therapy and returned to normal with continued therapy, in only 1 patient after biochemical remission. Among patients with active disease the mean blood spermidine was 18.87nm/ml (8.31±3.92), spermine 8.6nm/ml (4.98±3.12), spermidine:spermine 2.28 (1.67±1.26). All patients demonstrated a peak spermidine:spermine ratio greater than 4 except two who expired with liver failure.

These data suggest that the course of hepatic injury and regeneration might be monitored through serial measurement of blood polyamines. A deficient polyamine response or persistent polyamine elevation may imply a poor prognosis.

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MILK PROTEIN QUALITY AND QUANTITY: EFFECTS ON ORGANIC ACIDS IN LOW BIRTH WEIGHT INFANTS (LBWI). Gerald E. Gauli, Stephen R. Cohen, David K. Rassin, Bair L.

Chiou, Kirsti Heinonen and Niels C. Rafta. Inst. Res. Mental Retard., S.I., N.Y. and Univ. Helsinki.

Urinary excretion of organic acids (OA) was determined by gas chromatography-mass spectrometry in 105 LBWI (<2100g) randomly assigned to diets of: pooled human milk (HM) or one of four isocaloric formulas varying in prot. quant. (1.5 or 3.0 g%) or qual. (whey:casein of 18:82 or 60:40). Differences were reported previously for pH, neg. base excess and both plasma and urine amino acid conc. as a function of both qual. and quant. of diet prot. The TYR conc. was most increased of the amino acids, and its metabolites, p-OH-phenylacetic and p-OH-phenyllactic acids, are the most increased OA's. The OA metabolites of PHE were not increased in the infants fed the 3.0 g% (18:82) formula (F₄) compared to those fed HM; this finding correlated with the lesser effect of this formula on PHE compared with its effect on TYR. α-Keto-γ-methylolbutyrate, the α-keto acid of MET, was also excreted in higher concs. in the infants fed the F₄ formula compared to HM and correlated with similar effects on MET. Other OAs were less affected or not different.

Thus, biochemical effects of different prot. qual. and quant. in formulas are seen in the OAs as well as in the amino acids. These effects give further evidence of the need for caution in the use of formulas for LBWI in which prot. qual. and quan. have not been evaluated systematically. (Supported by the New York State Department of Mental Hygiene.)

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INTESTINAL MATURATION: CALCIUM (Ca) TRANSPORT. F.

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Our previous study suggested that the permeability of the intestinal mucosa (PIM) to Ca was greater in suckling (S) than in adolescent (A) rats (Pediat. Res. 11:414, 1977). Definitive studies comparing PIM to Ca during development are not available. We compared transport of Ca in the proximal intestine of S (2 week old), W (3 week old) and A (6 week old) rats, using an in vivo recirculation perfusion technique. The perfusates were isotonic NaCl solution containing either 0.4, 1.6 or 3.4 mmoles of CaCl₂/l and Phenol Red 20 mg/l. Ca transport rates (mean±S.E.; μmoles/hr per g. wet wt.) from the different solutions were: 0.4 mmole/l (S, -32.3±6.5; A, -0.1±0.2; p<.001); 1.6 mmole/l (S, -14.8±2.3; A, 1.8±0.4; p<.005); 3.4 mmole/l (S, 27.6±6.0; A, 3.3±0.9; p<.005). Transport (T) rates in W rats were intermediate between those of S and A rats (-4.5±1.6, 5.1±1.3, 19.0±1.5 respectively, from solutions containing 0.4, 1.6 or 3.4 mmole Ca/l). The 8 fold greater net absorption (+T) rate at the high, and much greater net secretion (-T) rate at the low luminal Ca concentrations in S than A rats indicated that PIM to Ca was greater in S than A rats. The reason for the age difference is not known. However, the process of maturation appears to decrease the PIM to Ca, which continues into the post-weaning age. If the age differences in Ca transport is also present in humans, young infants, especially those with low birth weight, could be at risk of losing relatively large amounts of Ca into the intestinal lumen when dietary Ca intake stops abruptly.

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GASTROINTESTINAL IRON ABSORPTION IS SULFHYDRYL DEPENDANT: A PROPOSED MECHANISM FOR INTERFERENCE BY HEAVY METALS. Patricia Pisciotto and Joseph H.

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In iron deficiency, not only iron but lead and cadmium are hyperabsorbed. Although the mechanism controlling iron absorption is still poorly defined, it has been demonstrated that cadmium absorption proceeds via the same mechanism as iron, and cadmium and iron competitively inhibit the absorption of each other. Since cadmium, arsenic and lead are notorious for binding to sulfhydryl groups, we have explored the role of sulfhydryl groups in the regulation of iron absorption.

In the rat, administration of the sulfhydryl blocker diethyl maleate (DEM; 0.6 ml/kg i.p.) 15 minutes prior to p.o. ⁵⁹Fe administration reduced iron absorption to 20% of the control value; when ⁵⁹Fe was administered i.v., DEM had no effect on plasma iron clearance.

The administration of 1 mg/kg arsenic p.o. (as As₂O₃) dramatically inhibited the absorption of a test dose of ⁵⁹Fe administered 3 hours later. Subsequent studies of mucosal glutathione metabolism indicate that GSH rapidly became bound to arsenic such that the effective GSH concentration was reduced. In response to the binding of arsenic to GSH, de novo synthesis of GSH occurred in the mucosal cell; when the GSH status returned to normal, normal iron absorption also resumed. These studies ascribe a role to GSH in iron absorption and explain why the heavy metals interfere with iron absorption.