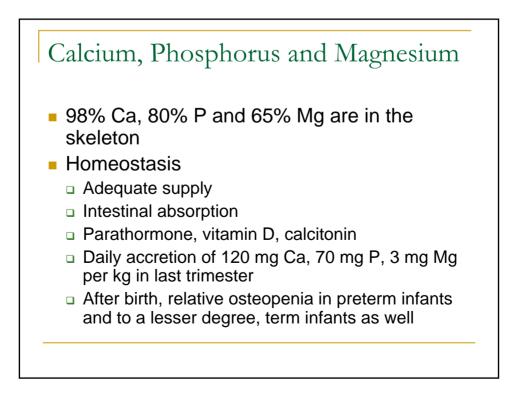
Micronutrient and Calcium Disorders in the Preterm Infant

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Calcium

- 1-2% of adult weight
- 1% of calcium present in skeleton is freely transferable with extracellular fluid
- 55% is present as free ionized calcium, 40% non diffusible complexed with protein, 5% with citrate, bicarbonate and phosphate
- Ionized fraction is the physiologically important fraction



- Ionized calcium is regulated by fluxes at the level of the bones, kidney and intestine
- Controlled by calciotropic hormones > calcium sensing receptor protein
- Any change in extracellular calcium triggers a response with parathyroid hormone [PTH], 1,25-dihydroxycholecalciferol [1,25[OH]₂D₃] and calcitonin

PTH

Decrease in ionized calcium > Ca sensing receptor [CaR] > PTH secretion

Catecholamines, aluminium, histamine, active vitamin D metabolites, glucagon, cortisol, calcitonin > influence PTH

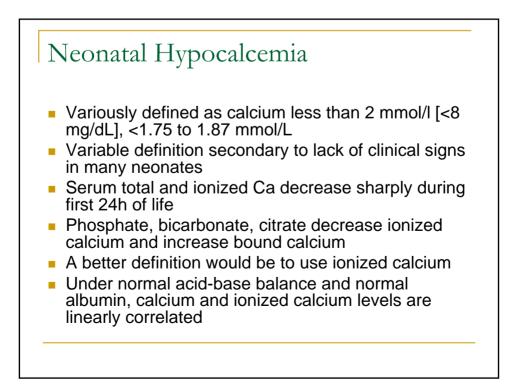
Acute decrease in magnesium stimulates PTH

Placental Transport

- Materno-fetal calcium transfer during third trimester of pregnancy; 1:1.4
- Active transport
- Maternal hypocalcemia can be associated with congenital rickets and neonatal hypocalcemia; bone mass of infant may be related to maternal Vit D status.
- Adequate supply of phosphorus [P] is important for skeletal mineralization
- Active transport, third trimester

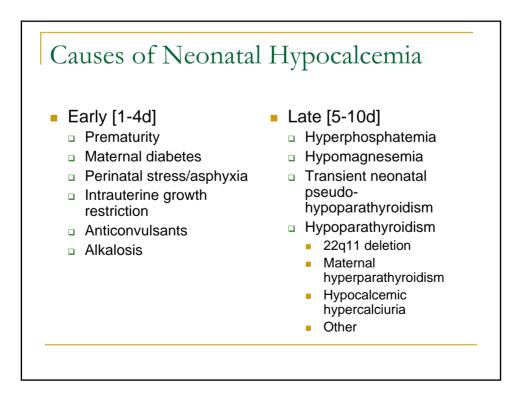
Placental Transport

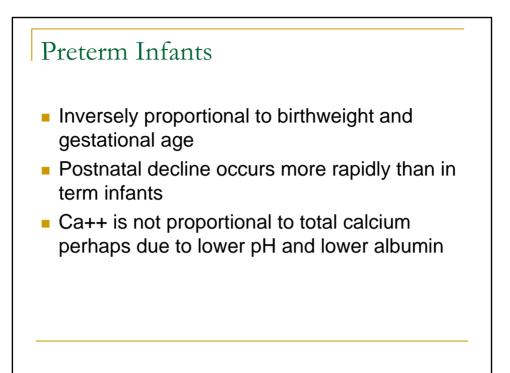
- Towards the end of pregnancy, plasma concentrations of total and ultrafiltrable magnesium are higher in fetus than mother
- Active transport; mechanisms not clear
- Fetal growth alteration , IDM
 - Bone mineral content decreased
 - Increased incidence of hypo calcemia and magnesemia
 - Bone mineral content in SGA decreased

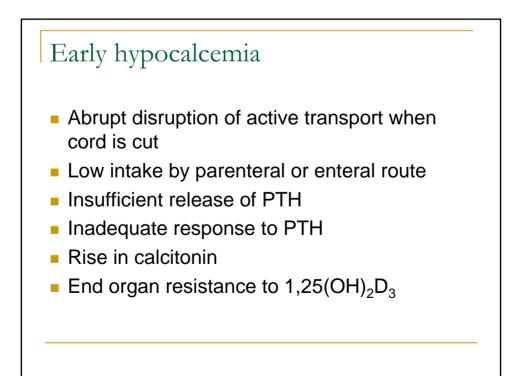


Calcium Absorption

- Active and passive processes in the small intestine
- 60% of intake is absorbed
- Human milk Ca and fortifiers added is similar
- Glucocorticoids inhibit intestinal transfer; phenytoin directly inhibits absorption or indirectly by interfering with vit D metabolism [phenytoin and phenobarbital]







Hypocalcemia

- Temporary
- Increased calcium intake from feedings
- Increased renal P excretion
- Improved PTH function
- Calcium supplementation may facilitate recovery

Other Conditions

IDM

- Exaggerated postnatal drop in Ca
- Prematurity and asphyxia may further contribute
- Related to hypomagnesemia [fetal Mg deficiency and secondary functional hypoparathyroidism]
- Also seen in gestational diabetic offspring
- Correlated with severity of diabetes

Perinatal Asphyxia

- Delayed feeding
- Increased P load due to decreased GFR
- Increased serum calcitonin
- Hyperphosphatemia > induce PTH resistance

Late Hypocalcemia

- More common in term infants
- Elevated P supply
- Relative resistance of the kidney to PTH
- Renal retention of P
- Cow's milk, evaporated milk; high P; human milk has low P
- Ameliorated with current day formulas but still seen
- "transient hypoparathyroidism"

Hypomagnesemia

- Mg deficiency inhibits PTH secretion and its responsiveness
- Neonatal hypocalcemia
- Rare autosomal recessive disorder
 - Primary defect in intestinal transport
 - Chromosome 9
 - PTH low
 - Treat with magnesium



- Diuretics
- Aminoglycosides
- Amphotericin B
- Urinary tract obstruction
 - Renal wasting of Mg
 - Mistaken for hypoparathyroidism
 - Barter's syndrome- hypokalemic alkalosis and hypercalciuria

Clinical Manifestations

- Asymptomatic
- Jitteriness
- Generalized seizures
- Lethargy, emesis, abdominal distention
- Thorough history, examination, CXR [presence of thymus, DiGeorge Syndrome]
- Calcium gluconate

Treatment

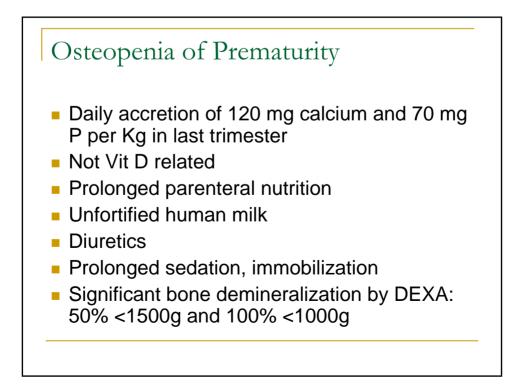
- Complicated by coexisting conditions – asphyxia, hypoglycemia
- Seizures which may a different etiology
- May remain asymptomatic
- Time of onset also needs to be considered

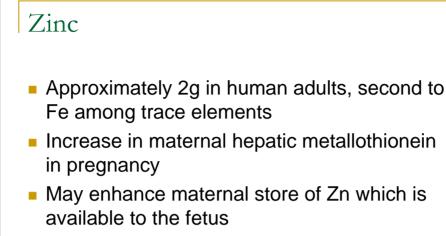
- Calcium salts
- Extravasation, cutaneous necrosis, bradycardia
- Avoid arterial infusions
- Late onset is usually symptomatic and treatment may include change of formula, Mg, Vit D etc

Hypercalcemia

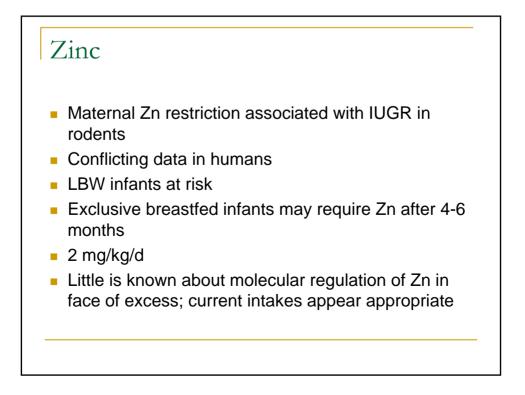
- Iatrogenic
- Disorders of Parathyroid function
- Idiopathic infantile hypercalcemia
- Infantile hypophosphatemia
- Other William syndrome, sub Q fat necrosis

- History
- PE
- Total and iCa
- pH, Total protein, creatinine
- Urinary studies
- Renal ultrasound
- PTH, Vit D
- Molecular genetic studies



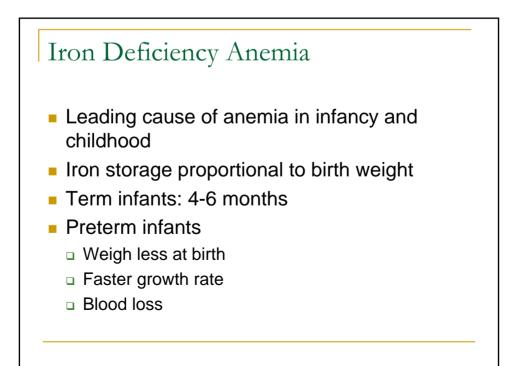


 Fetus at risk only if excessive maternal decline in Zn such as zinc deprivation or alcohol abuse



Zinc Deficiency

- Genetic disorder: Acrodermatitis enteropathica
- Autosomal recessive
- Chromosome 8q24.3
- Encodes for a member of Zn transporter protein
- Defect in absorption or transport
- Low plasma Zn
- Acute vesicobullous, eczematous eruption around eyes, mouth and genitals
- Secondary infection common

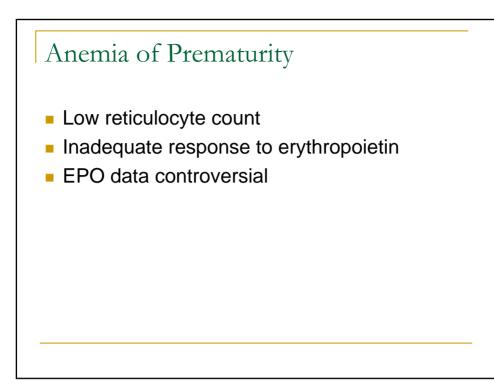


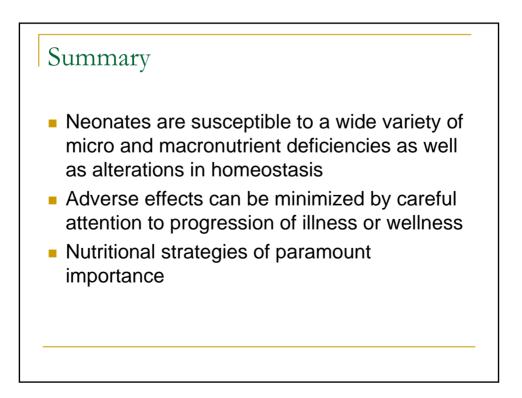
Iron

Term: 1 mg/kg/d from 4 months
Preterm: 2 mg/kg/d from 2 months; may be higher in VLBW infants
Breast milk iron more bioavailable, but may be insufficient after 6 months
Formulas with Fe should always be used
Prolonged parenteral nutrition without iron supplementation will lead to deficiency

Iron

- Bone marrow stores reduced
- RDW increases
- Lower serum iron, ferritin, transferrin
- Hypochromic microcytic anemia
- Free erythrocyte protoporphyrin elevated
- Irreversible cognitive effects demonstrated





Summary

- Exclusive human milk feeding in preterm infants
 - Metabolic bone disease
 - Growth faltering
 - Zinc deficiency
 - Hyponatremia

Summary

- Errors of omission or commission
 - Hypo-hypercalcemia
 - Hypo-hypermagnesemia
 - Hypophosphatemia and resultant hypercalcemia
 - Anemia
 - Prolonged parenteral nutrition
 - Metabolic bone disease
 - Hepatic dysfunction
 - Iron and zinc issues