Nutritional and Supportive Care

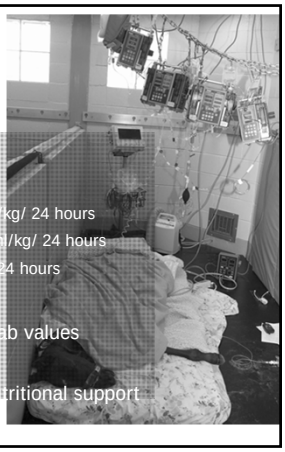
Nutrition During Fetal Life Constant Supply of Nutrients

- Glucose
- Amino acids
- Lipids
- Calcium
- Magnesium
- Fluids

Fetal to Neonate Transition

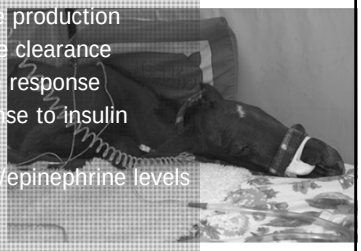
- Neonate must supply and regulate these substances
- Transiently hypoglycemic
  - Low at 2 to 4 hours old
- Hypocalcemia

Nutritional Support



- Early Neonatal Period
- Intravenous fluids
  - For each Kg up to 10 kg - 100 ml/kg/ 24 hours
  - For each Kg from 11-20 kg - 50 ml/kg/ 24 hours
  - For each Kg > 20 kg - 25 ml/kg/ 24 hours
- Dextrose - 4 - 8 mg/kg/min
- Electrolyte concentrations - lab values
  - K - 3 mEq/kg/day
- Until enteral or parenteral nutritional support

Early Neonatal Period Early Hyperglycemia



- Continued glucose production
- Decreased glucose clearance
- Diminished insulin response
- Diminished response to insulin
  - Insulin resistance
- Increased cortisol/epinephrine levels
  - Stress
- Sepsis

Early Neonatal Period Early Hypoglycemia

- Limited hepatic glycogen stores
- Inadequate endogenous glucose production
  - Failure of transition to glucogensis
- High glucose utilization – hypermetabolism
- High risk for developing hypoglycemia
  - Perinatal asphyxia
  - Placentitis
    - FIRS
  - Intrauterine growth retardation
    - Placental insufficiency
  - Cold stress
  - Sepsis

Enteral Feeding Advantages

- Physiologic stimulation
- Metabolic regulation
- Gastrointestinal mucosa integrity
- Gastrointestinal mucosa development
- Lower cost

Enteral Feeding
Requirements for initiating enteral feeding

- No abdominal distension
- No gastric reflux
- Passage of meconium
- Active bowel sounds
- If severe perinatal distress
  - Stable blood pressure
  - Temperatures near 100 F
  - Normal Pao_2
  - Stable blood glucose

Enteral Feeding
Fresh mare's milk

- Preferred source of enteral nutrition
- Unique nutrient composition
- Increased bioavailability of nutrients
- Immunologic properties
- Promotion of maternal-neonate bonding
- Present of hormones, enzymes, growth factors

Enteral Feeding
Other choices

- Frozen mare's milk
- High quality powdered milk replacer
- Goat's milk

Enteral Feeding

- Initially feed 5% of body weight / 24 hours
  - Divided into 12 feedings
- If foal tolerates this volume
- Increase to 10% during the first day
- Normal foal
  - Target of 20-25% of his body weight / day
    - 21% provides the ideal 120 kcal/kg/day

Enteral Feeding
Ill Foal

- Enteral feeding is questionable
  - Trophic feelings
  - 1-2% body wt divided every 4-6 hrs
  - Provide calories / protein using parenteral route
- Permissive underfeeding
  - Over-nutrition associated with sepsis
  - Ill foals are confined
  - Target – enough to maintain anabolism
    - 1-2% weight gain per day
  - Usually 12-14% body weight

Enteral Feeding

- Example 20% - 114 kcal/kg/day
- 110 lb Foal
  - 110 lb X 20% = 22 lb
  - 22 lb X 16 oz/lb = 352 oz/day
  - 352 oz / 12 feedings = 29 oz/feeding
- 50 kg Foal
  - 50 kg X 20% = 10 kg = 10 liters
  - 10 liters / 12 feedings = 833 ml/feeding

Enteral Feeding
Route

- Suckling
- Small Diameter

  Indwelling Nasogastric Tube

Enteral Feeding
Suckling

- Best route - physiologic stimulation
- Abnormal suckling behavior
  - Desperately want to suck
  - Ineffective
  - High risk for aspiration
    - Healthy neonate - few consequences
    - Critical neonate - pulmonary disease
- Feed on demand - at least Q2H

Enteral Feeding
Small Diameter Indwelling Nasogastric Tube

- Feed every two hours
- Bolus feeding
- Rhinitis
- Pharyngitis

Parenteral Nutrition
Intravenous delivery of

- Calories
  - Glucose
  - Lipids
- Protein
  - Amino Acids
- Vitamins
- Trace minerals

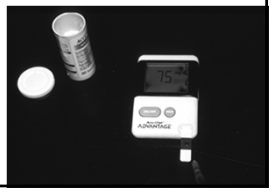
Parenteral Nutrition
Glucose requirements

- Primary source of energy developing fetus
- Term net umbilical uptake

  5 to 8 mg/kg/min (7.2-11.5 gm/kg/day)
- Fetus unable to carry out gluconeogenesis

Glucose Support

- All compromise neonates
  - Will benefit from exogenous glucose support
  - Decrease catabolic state
  - Support their recovery
- Blood glucose interpretation
  - Not relate directly to adequate glucose stores
  - Summation of glucose mobilization/utilization
  - Hypoglycemia
  - Normoglycemia
  - Hyperglycemia



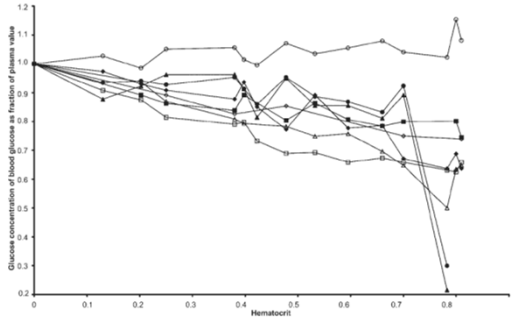
Glucose Measurement

- Bedside monitoring – Glucometers
- Whole blood measurement
  - Electrochemical biosensor
  - Plasma from whole blood
    - Diffuses into, solvates the reagent layer
  - Electrons produced, current generated
  - Photometric test strips
    - Produces a blue color

Glucose Measurement Variation

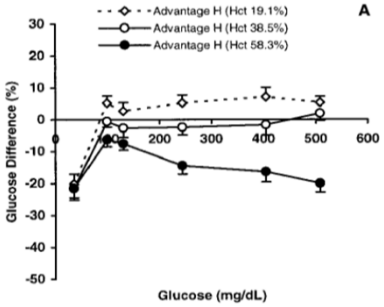
- PCV
- Total protein
- P_{O_2}
- pH
- Model/Instrument
- Reagent strip
  - Handling
  - Age
  - Lot

Glucose Measurement PCV



Püntmann et al Clin Chem Lab Med 2003; 41(6):809–820

Glucose Measurement
PCV and Glucose Level



Tang et al Arch Pathol Lab Med. 2000;124:1135–1140

Glucose Measurement
PCV

- Whole blood vs plasma
- Reagent strip sieve plasma
  - Increased hematocrit may mechanically obstruct diffusion
  - Block the ‘‘holes’’ in the mesh membrane
  - Decrease the volume of plasma available to diffuse
  - Alter blood viscosity, decreasing fluid permeability
  - Rouleau formation

Glucose Measurement
PCV

- Critically ill neonatal foals
  - Microclot formation
  - Sample hemolysis
  - Protein deposition
  - High fibrinogen levels
  - Fibrin aggregation
  - Platelet/other cellular aggregation
  - Other inflammatory phenomena

Parenteral Nutrition
Glucose requirements

- At birth glucose
  - Gluconeogenesis (catecholamine secretions)
  - Hepatic glycogenolysis
  - Umbilical cord rupture - release Glucagon
- At birth the stimulated fetal liver
  - 4 to 8 mg glucose/kg/minute

Parenteral Nutrition
Protein Requirements

- Estimate amino acid utilization late term fetus
- Intrauterine nitrogen delivering - lambs
  - 2.7 to 3.5 gm/kg/day
  - When total energy is > 70 kcal/kg/day
- Increased requirements
  - Stress
  - Infection
  - SIRS

Parenteral Nutrition
Lipid requirements

- Lipids are not utilized by fetus as energy
- Periods of stress - very important
- Neonatal foals utilize lipids as an energy source
  - 40 - 50% of total caloric intake can come from fat

Parenteral Nutrition
Starting Formula
Example - 50 kg foal

- Dextrose - 10 gm/kg/day - 34 kcal/kg
- Amino acids - 2 gm/kg/day - 8 kcal/kg
- Lipids - 1 gm/kg/day - 11 kcal/kg
- Plus vitamins and trace minerals
- Total - 53 kcal/kg
- Nonprotein kcal - 24% lipid
- Nonprotein kcals:gram nitrogen = 139.5

Foal Nutrition
Numbers to Know

- Glucose - 3.4 kcal/gm
- Amino acids - 4.0 kcal/gm
- Lipid - 9.0 kcal/gm
- 6.25 gm amino acids = 1 gm nitrogen
- 1 oz = 30 ml
- 16 oz milk = 1 lb
- Mare's milk - 0.57 kcal/ml

Maternal Bonding
Behavioral therapy

- Mares need contact with foals
  - Sight
  - Smell
  - Touch
  - Hear
- Stimulus for lactation
  - Establish milk flow
  - Maintain milk flow

Nurse Mare Bonding

- Environment
  - Quiet
  - No distractions
  - "Foal's Stall"
- Foal's behavior
  - Vigorous nursing
  - Aggressive nursing
- Foal's Smell
- Foal's physical appearance