CASE STUDY
TRAUMATIC BRAIN INJURY: METABOLIC STRESS
AMANDA GERSON

LEARNING OBJECTIVES

• Demonstrate knowledge of the metabolic response to stress and trauma
• Demonstrate knowledge of the metabolic response to traumatic brain injury (TBI)
• Identify nutrient and protein requirements for children under trauma conditions
• Demonstrate how to calculate enteral nutrition formulas for children

TRAUMATIC BRAIN INJURY

• Severely hypermetabolic and catabolic state
• The more severe the head injury, the greater the release of catecholamines → norepinephrine, epinephrine, and cortisol

TRAUMATIC BRAIN INJURY (MVA)

VIDEO
http://www.youtube.com/watch?v=d5z60H1wfxs

METABOLIC STRESS

• Sepsis (infection)
• Trauma (including burns)
• Surgery

• Metabolic Response to Stress:
  - Involves most metabolic pathways, accelerated catabolism of lean body mass, negative nitrogen balance, muscle wasting
  - Cause hormonal and metabolic changes that alter nutrient needs

PHYSIOLOGIC & METABOLIC CHANGES AFTER INJURY OR BURN
HORMONAL STRESS RESPONSE

Aldosterone
- Corticosteroid that causes renal sodium retention

Antidiuretic hormone
- Stimulates renal tubular water absorption

ACTH
- Acts on adrenal cortex to release cortisol

Catecholamines
- Epi and norepi from renal medulla to stimulate glycogenolysis
- Fat mobilization
- Gluconeogenesis

Cytokines
- Interleukin-1, interleukin-6 and tumor necrosis factor released by phagocytes in response to tissue damage, infection, inflammation

RESPONSE TO CRITICAL ILLNESS

Ebb Phase
- Immediate following injury
- Hypovolemia
- Shock
- Tissue hypoxia
- Decreased cardiac output and oxygen consumption
- Lowered body temperature
- Insulin levels drop

Flow Phase
- Hypermetabolism
- Increased cardiac output begins
- Increased body temperature and energy expenditure
- Total body protein catabolism begins
- Marked increase in glucose production
- FFAs release, insulin, glucagon, cortisol

Hormonal and Cell-Mediated Response
- Marked increase in glucose production and uptake
- Elevated hormonal levels
- Increase in hepatic amino acid uptake
- Protein synthesis
- Accelerated muscle breakdown

Acute Phase Response
- Hypermetabolism
- Hormonal shift to catabolism

Liver
- Increased glycogenolysis, gluconeogenesis
- Increased lipolysis, ketone body production
- Site of Injury/Surgery
- Inflammation, increased blood flow, insulin promotes CHO/TG storage and protein synthesis

Kidney
- Decreased urine volumes, increased Na+, decreased K+ reabsorption

Pancreas
- Decreased insulin release, increased glucagon release

PATIENT: CHELSEA MONTGOMERY

9 year old female admitted to ER after high-speed MVA - head on collision with truck.
- Chelsea was a restrained front seat passenger

Patient History:
- PMH: Full-term infant weighing 9lbs 1 oz, delivered via cesarean. Healthy except for severe nearsightedness
- Good student, competitive gymnast, softball player and participant in Girl Scouts
- Meds: None
- Smoker: No
- Family Hx: Coronary Artery Disease (paternal grandfather); Diabetes (older brother)
PHYSICAL EXAMINATION

- General Appearance: alternating between crying and unconsciousness
- HT: 4'4"
- WT: 61 lb.
- BF: 138/90
- RR: 27 bpm
- Heart: tachycardia, no murmur
- Neurologic: Obtundation and L-sided hemiparesis.
  - No verbal responses. Withdrawal and moaning when touched.
- Chest/lungs: breath sounds bilaterally
- Abdomen: Soft; bowel sounds diminished, linear mark in LUQ

GLASGOW COMA SCALE

- Glasgow Coma Scale (GCS) Score: A neurologic scale used to produce a reliable, objective method of recording the conscious state of a person
  - 3= deep unconsciousness
  - 15= normal state
  - Chelsea’s GCS score= 10

CHELSEA’S CT SCAN

- Department of Radiology: Two areas of increased density in L frontal lobe near vertex
- Frontal lobes are our emotion center and home to our personality
- Involved in motor function, problem solving, memory, language, judgement, social behavior
- Chelsea may be forgetful and have difficulty playing sports

CHELSEA’S MRI REPORT

- Edema and bleeding found in corpus callosum
  - Edema in a TBI is caused by the build-up of water in the spaces of the brain or into the blood-brain barrier
  - Bleeding in the brain is caused by TBI from MVA

DIET HISTORY

- General: Parents indicate that patient had normal growth and appetite
- Usual Dietary Intake:
  - Breakfast: Cereal, juice, milk, toast
  - Lunch: At school cafeteria
  - Snacks: Before sports- cookies, fruit, juice, or milk
  - Dinner: Meat, pasta or potatoes, rolls or bread. Likes only green beans, corn, and salad as vegetables. Will eat all fruits.
  - 24-hour recall: NPO
  - Vit/mineral intake: general multivitamin with iron
NUTRITION ASSESSMENT

NUTRIENT REQUIREMENTS

- Chelsea's energy requirements
  • 45kcal/kg/day
  • 45kcal/27.72/day = **1247 kcal/day** (additional 5 kcal because critically ill)

- Chelsea's protein requirements
  • For critically ill:
  • 1.5-2g/kg/day
  • **55.44g pro/day**

NITROGEN BALANCE

- Nitrogen balance = intake - losses
- Nitrogen intake = 49.5/6.25 = **7.92 grams**
- Nitrogen losses = 14g + 4g = **18 grams**
- N balance = 7.92 - 18 = **-10.08 grams**

To achieve N balance she would need **112.5 gm pro** (18 x 6.25)

Negative Nitrogen balance indicates a catabolic state with a net loss of protein
- Chelsea is experiencing severe stress
- Hypermetabolism is a condition where there is an abnormal increase in the body's basal metabolic rate
- Caused by head injury, her body is trying to heal, causing her metabolism to increase

ALTERED LAB VALUES

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<th>6/3</th>
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<td>15=Low</td>
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<td>Alkaline phos</td>
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<td>241=High</td>
<td>119</td>
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NUTRITIONAL ASSESSMENT

ENTERAL NUTRITION

- Pediasure with fiber @ 25 cc/hr. Increase 10 cc every 4-6 hours to goal rate of 85 cc/hr via continuous drip x 16 hrs
- Volume: 85ml x 16 hr = 1360 ml
- Calories: 1360 x 1 kcal = 1360 kcals
- Protein: 1.360 L x 30 = 41 gm of pro
- Water: 1360ml x 0.85 = 1156 ml

PATIENT CARE SUMMARY SHEET

- Volume of Feeding: 85ml/hr
  • 30 ml water flush
- Note on the evening shift: feeding held for high gastric residuals
- Aspiration and consequences
- When assessing Chelsea’s tolerance to feeding we need to look at emesis and bowel movements on summary sheet
ENTERAL NUTRITION  
JEVITY 1.2

- Continuous feeding to provide at least 1200 kcals, 55 gm pro, 1640 ml water per day  
  - Volume needed: 1000 ml/1.2 = 830 ml  
  - Rate of infusion: 1000/24 = 42 ml/hr  
  - Protein provided: 1000 x 55/1000 = 55.44 gm  
  - Water provided: 1000 x 0.81 = 810 ml  
  - Water needed from flushes: 1640 - 810 = 830 ml/day  
  - 830/6 = 140 ml q 4 hours  
- Continuous Order
  
  Start continuous TF with Jevity 1.2 @ 25 ml/hr via NG tube as tolerated to goal rate of 42ml/h. Flush tube with 140 ml water q 4 hours

NUTRITION DIAGNOSIS

- PES statements
  1. Swallowing difficulty (NC-1.1) related to traumatic brain injury as evidenced by choking and swallowing function when trying to eat  
  2. Inadequate enteral nutrition infusion (NI-2.3) related to intolerance of tube feeding volume as evidenced by documented intake less than estimated energy and protein needs

INTERVENTION

Nutrition Prescription: Start continuous TF with Jevity 1.2 @ 25 ml/hr via NG tube as tolerated to goal rate of 42ml/h. Flush tube with 140 ml water q 4 hours  

- Enteral Feeding
  - Feeding position: 45 degree angle to prevent aspiration, reflux of gastric contents (ND-4.3)  
  - Increase nutrient needs by altering or switching enteral formula (ND-2.1.1)  
  - Possible switch to small bowel feeding if NG tube is not tolerated  
  - Increase additional nutrients for recovery - increased need for B vitamins, thiamin, niacin (ND-3.2.3)

- Swallowing difficulty
  - Increase oral intake as tolerated (ND-1.3)  
  - Plan nutrition therapy: As Chelsea’s recovery proceeds, begin transition to oral diet of soft/pureed foods - Oatmeal, applesauce, Jell-O, mashed potatoes

TRANSITIONING TO ORAL DIET

- As TBI patients’ GCS scores improve and feeding tube is removed they are referred to a speech pathologist for swallow evaluation  
  - Some may suffer from dysphagia for a long period of time  
  - If initial swallow shows aspiration, patient is retested as neurologic condition improves  
  - Often patients can tolerate soft or pureed diets but aspirate thin liquids  
  - Diets are advanced according to the speech pathologist’s recommendations  
  - Intake is usually inadequate to meet nutrition needs for some time because of swallowing difficulties and meds  
  - Some patients remain on enteral feedings to supplement an oral diet until they can meet their goals orally

MONITOR & EVALUATION

- Monitor patient’s swallowing function to determine the safety of oral feedings  
  - Monitor patient’s energy and protein intake daily  
  - Monitor any changes in weight  
  - Monitor patient’s tolerance of feeding regimen (abdominal exam and gastric residuals)  
  - Monitor lab values- blood glucose levels, albumin, prealbumin and AST levels  
  - Monitor patient’s cognitive status  
  - Monitor nitrogen balance to assess metabolic state

EDUCATION NEEDS

- Coordination of care: occupational therapist, speech therapist, physical therapist
- When Chelsea is discharged from hospital, it is important to educate her parents on restricted oral diet of soft foods

REFERENCES