CASE STUDY
TRAUMATIC BRAIN INJURY: METABOLIC STRESS

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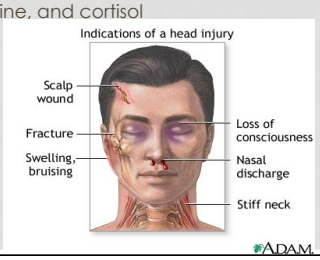
LEARNING OBJECTIVES

- 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 catecholeamines → norepinephrine, epinephrine, and cortisol



TRAUMATIC BRAIN INJURY (MVA) VIDEO

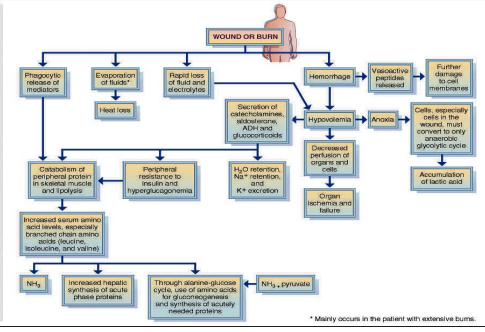
http://www.youtube.com/watch?v=d5z60H1wfxs

METABOLIC STRESS

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

- <u>Metabolic Response to Stress:</u>
  - 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	Flow Phase	Hormonal and Cell-Mediated Response
Immediate following injury	Hypermetabolism	Marked increase in glucose production and uptake
Hypovolemia	Increased cardiac output begins	Elevated hormonal levels
Shock	Increased body temperature and energy expenditure	Increase in hepatic amino acid uptake
Tissue hypoxia	Total body protein catabolism begins	Protein synthesis
Decreased cardiac output and oxygen consumption	Marked increase in glucose production	Accelerated muscle breakdown
Lowered body temperature	FFAs release, insulin, glucagon, cortisol	
Insulin levels drop		

PATHOPHYSIOLOGY

EBB PHASE
Hypovolemia
Shock
Tissue hypoxia
DECREASED:
Cardiac output
O_2 consumption
Body temperature

⇨

FLOW PHASE
Acute phase proteins
Hormonal responses
Immune responses (cell-mediated and antibody)
INCREASED:
Cardiac output
O_2 consumption
Body temperature
Energy expenditure
Protein catabolism

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

HYPERMETABOLIC RESPONSE TO STRESS

CAUSE

Sepsis
Trauma
Fractures
HYPER-METABOLIC RESPONSE
Burns
Stress
Major surgery

http://www.bbc.co.uk/health/physical_health/conditions/headinjury1.shtml

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.
- BP: 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

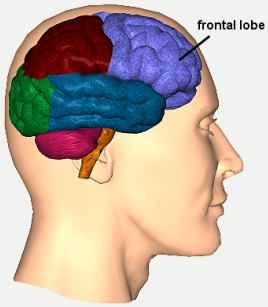
GLASGOW COMA SCALE

- 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

http://www.brainline.org/content/2010/10/what-is-the-glasgow-coma-scale.html

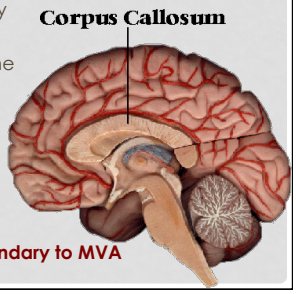
CHELSEA'S CT SCAN

- 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 callosom**
  - 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

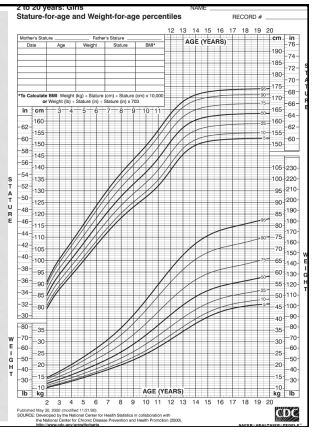


Dx: Closed head injury secondary to MVA

- **Height: 4'4''**
- **Weight: 61 lbs.**

- At 9 years of age→ CDC height and weight charts is the appropriate method to evaluate height & weight

- Chelsea is currently in 50th percentile for weight and the 49th percentile for height for her age



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.

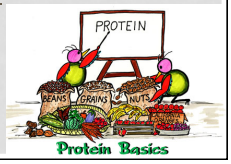
- 24-hour recall: NPO
- Vit/mineral intake: general multivitamin with iron

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**



NUTRITION ASSESSMENT
NITROGEN BALANCE

- **Nitrogen balance= intake-losses**
- Nitrogen intake= 49.5/6.25= 7.92 grams
- Nitrogen losses= 14 grams + 4 grams= 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
- Chesea 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

	Normal	5/24	6/3	Units
Albumin	3.5-5	3.7	**3.3= Low**	g/dL
Prealbumin	16-35		**15= Low**	Mg/dL
Glucose	70-110	**145= High**	109	U/L
ALT	4-36	**105= High**	34	U/L
AST	0-35	**111= High**	**36=High**	U/L
Alkaline phos	30-120	**261=High**	119	U/L

NUTRITIONAL ASSESSMENT
ENTERAL NUTRITION

- Beginning nutrition support…

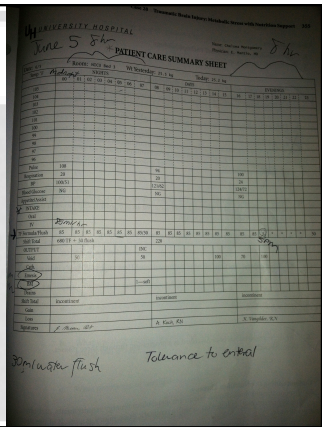
Nutrition Prescription:
Pediasure with fiber @ 25cc/hr. Increase 10 cc every 4-6 hours to goal rate of 85cc/hr via continuous drip x 16 hrs then gradually switch to bolus as patient tolerates. Start bolus q 4 hrs @ 60 cc, then increase 120 cc, then increase 340 cc. Suggest to decrease IVF as TF increases.

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: 85mlx 16 hr= 1360 ml
- Calorie: 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: 1200 ml/1.2= 1000 ml
  - Rate of infusion: 1000/24= 42 ml/hr
  - Protein provided
    - Final volume= 42x24= 1008 ml
    - Protein from final volume= 1.008x55=55.44 g
  - Water provided: 1000x.81= 810ml
  - Water needed from flushes:
    - 1640ml – 810ml= 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**

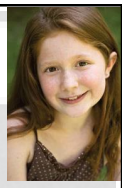
1. Swallowing difficulty (NC-1.1) related to traumatic brain injury as evidenced by choking and swallowing function when trying to eat
2. Inadequate enteral nutrition infusion (NI-2.3) related to intolerance of tube feeding volume as evidenced by documented intake less than estimated energy and protein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

GOALS

- Outcome Goals
- Patient meets estimated enteral needs
- Patient discontinues weight loss
- Patient restores N balance

- Action Goals
- Patient meets nutrient needs from enteral nutrition
- Patients begins a soft foods diet once tolerated
- Patient improves swallowing and chewing function

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 feeling 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 po 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, Jel-O, mashed potatoes

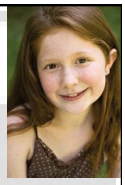
TRANSITIONING TO ORAL DIET

- 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

Rajpal, V, Johnston, J. Nutrition Management of Traumatic Brain Injury Patients. *Support Line*. 2009;31(1) 10-19

http://www.youtube.com/watch?v=-wmt6HlLdoY
Video Fluoroscopy

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

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