Caring

Nutrition and Trauma

Jodie R. Orwig, RDN, LDN

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In the Emergency Room

In the first 12-24 hours post injury, the #1goal is stabilizing the patient, not nutrition.

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In the Operating Room

Goal #2 is surgery, as indicated, to correct the injury

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In the Critical Care Unit

Preservation of organ function

Nutrition???

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What Route is best for Nutrition ?

Every case is unique and depends on the nature of the injury…

1. Oral—preferred choice
2. Tube Feeding—"If the gut works, use it"
3. Parenteral—Impaired GI function

or

A Combination of the above

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Enteral vs. Parenteral Nutrition

- PN indicated if malnutrition present and EN not feasible; if no malnutrition, delay PN for the first 5-7 days
- EN is the preferred route of feeding compared to parenteral nutrition (PN) for the critically ill patient requiring nutrition support (grade B)
  - Reduces infectious morbidity
  - Related to fewer septic complications
  - Prevents atrophy of intestinal villi
  - Maintains gut mucosal barrier-discouraging bacterial translocation

THE GUT IS THE LARGEST IMMUNE ORGAN IN THE BODY

Martindale, R.G., McClave, S.A., Vanek, V.W., McCarthy, M, Roberts, P, Taylor, B, et al. (2009). Guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient: Society of Critical Care Medicine and American Society for Parenteral and Enteral Nutrition. *Critical Care Medicine, 37(5)*, 1-30.

Moore FA, Feliciano DV, Andrassy RJ, et al. (1992). Early enteral feeding, compared with parenteral, reduces postoperative septic complications: the results of a meta-analysis. *Ann Surg*. 216: 172-183

2016 Guidelines for the Provision and Assessment of Nutrition Support Therapy in the Adult Critically Ill Patient: SCCM and A.S.P.E.N.

How much Nutrition Support to provide to Trauma patient?

- Energy and protein needs are increased in trauma to prevent muscle catabolism
- Protein:1.5-2gm/kg
- Calorie: Dietitians use predictive equations or a metabolic cart can be used for determining calorie needs

Is my patient getting enough?

- Weight status
- Wound healing
- Nitrogen balance study

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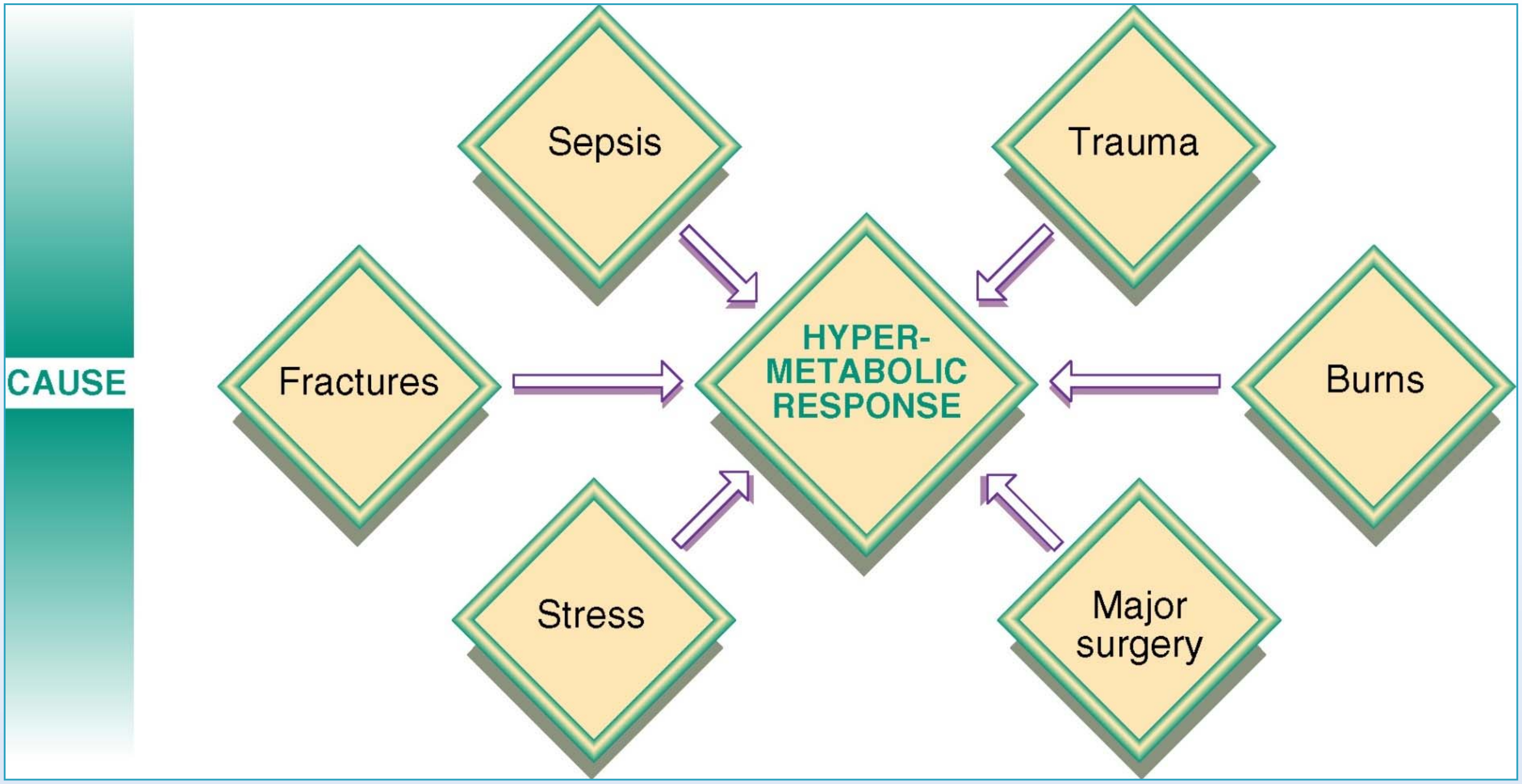
Hypermetabolic Response to Stress– Causes



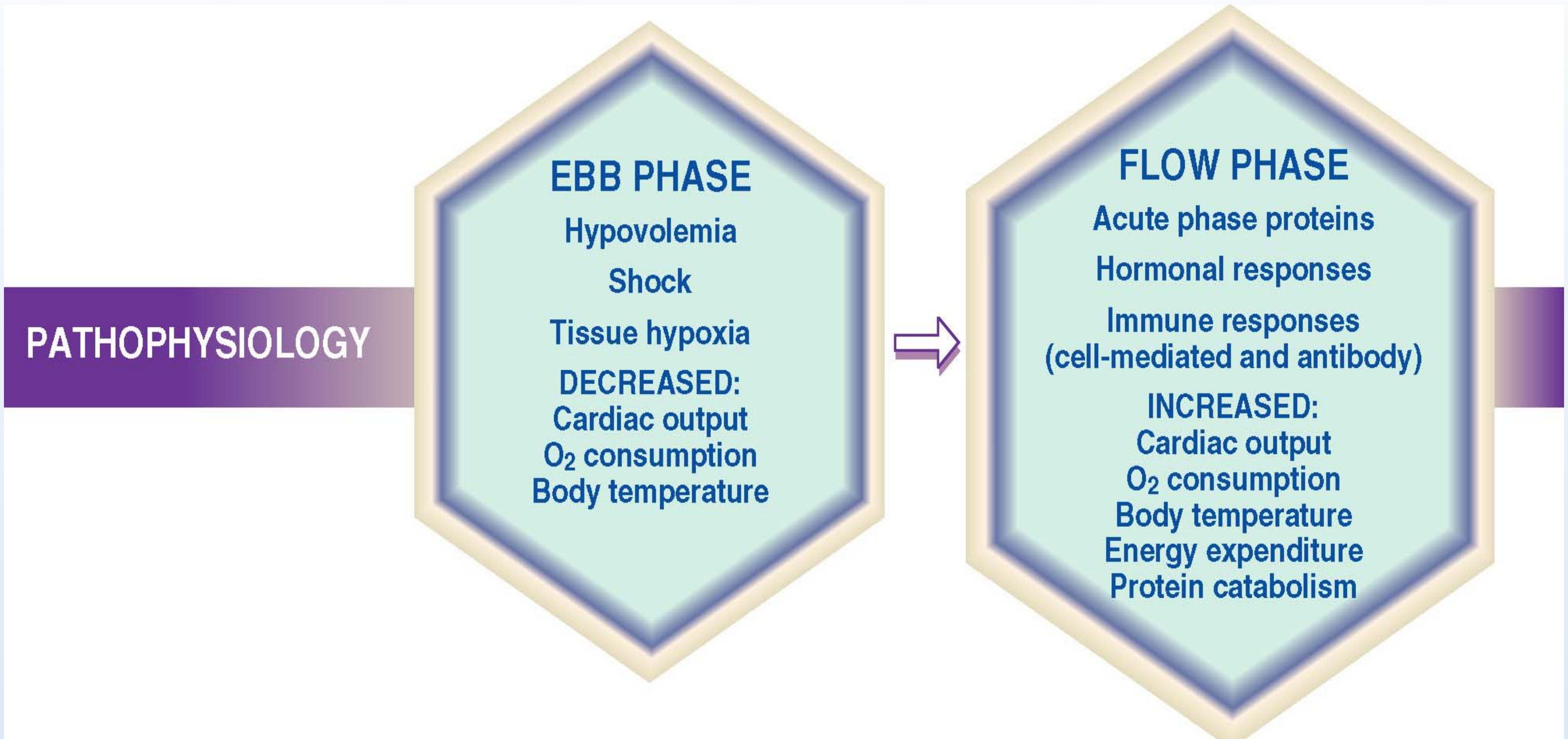
Mahan LK, Escott-Stump S: Krause's food, nutrition, & diet therapy, *ed* 11*, Philadelphia, 2004. Saunders.* Algorithm content developed by John Anderson, PhD, and Sanford C. Garner, PhD, 2000

Comparison of normal, starved, stress states

	Normal	Starved	Stressed
Metabolic rate*	No change	Reduced	Increased
Fuel mixture for energy	Carbohydrate and lipid	Lipids	Carbohydrate
Protein	No change	Preserved	Used for gluconeogenesis

*Metabolic rate is a function of physical activity requirements and body composition

Hypermetabolic Response to Stress–Pathophysiology



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Nutrition Management

- Minimize Protein Catabolism
- Physical Therapy/Exercise
- Plan Nutrition Therapy (oral, enteral, and/or parenteral)

Early Enteral Nutrition

- Feedings started within 24-48 hours following hypermetabolic injury
  - associated with less gut permeability
  - decreased activation and release of inflammatory cytokines (CRP levels)

2016 Guidelines for the Provision and Assessment of Nutrition Support Therapy in the Adult Critically Ill Patient: SCCM and A.S.P.E.N.

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Dellinger RP, Levy MM, Rhodes A, et al (2012) Surviving Sepsis Campaign: International guidelines for management of severe sepsis and septic shock. *Crit Care Med. 2013; 41:580-637*

Complications of overfeeding and underfeeding

- **Overfeeding**
  - Azotemia
  - Hepatic steatosis
  - Hypercapnia, which may lead to prolonged weaning from mechanical ventilation
  - Hyperglycemia
  - Hyperlipidemia
  - Fluid overload
- **Underfeeding**
  - Loss of lean body mass (muscle wasting), including cardiac and respiratory muscles
  - Prolonged weaning from mechanical ventilation
  - Delayed wound healing
  - Impaired host defenses
  - Increased nosocomial infections

Roberts, SR, Kennerly, DA, Keane, D, George, C. (2003) Nutrition support in the intensive care unit: adequacy, timeliness, outcomes. *Critical Care Nurse;* 23: 6

Effects of Propofol

- Needs to be included in the nutrient intake evaluation as it provides 1.1 Kcal/ml
- If calories from propofol are overlooked, patient could be over fed
- If on PN, hold soy based lipids in the critically ill patient for the first week due immunosuppressive and pro-inflammatory factors of soy based lipids. New lipid formulations are on the horizon.
- SMOF lipids—soybean, MCT, olive and fish oil combination (less deterioration of liver enzymes and improved/reversal of intestinal failure-associated liver disease in multiple studies)

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Hypocaloric Feeding

- Clinical indications may include:

Class III obesity (BMI>40)	Sepsis with hemodynamic instability
Refeeding syndrome risk	Multiple organ dysfunction syndrome
Severe malnutrition	Persistent elevations in respiratory rate
Chronic obstructive respiratory disease (COPD)	Hypercapnia
Acute respiratory distress syndrome (ARDS)	Hyperglycemia
Systemic inflammatory response syndrome (SIRS)	Hypertriglyceridemia

Wooley, JA, & Frankenfield, D. (2007). Energy. In M.M. Gottschlich (Ed.), *The A.S.P.E.N. Nutrition Support Core Curriculum: A Case-Based Approach- The Adult Patient* (pp.19-32)

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Enteral Formula Selection

- Immune-modulating formulas should be used for the appropriate patient population (including trauma patients)- grade A
  - Supplementation may include arginine, nucleotides and omega-3 fatty acids which support the immune system and help reduce infection, LOS and ventilator days in surgical and critically ill patients.
  - In patients with severe sepsis use nutrition without specific immunomodulating supplementation (grade 2C)

Martindale, R.G., McClave, S.A., Vanek, V.W., McCarthy, M, Roberts, P, Taylor, B, et al. (2009). Guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient: Society of Critical Care Medicine and American Society for Parenteral and Enteral Nutrition. *Critical Care Medicine, 37(5)*, 1-30.

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Volume vs Rate based Tube Feedings

- Volume based results in patients better receiving their nutrient requirements

Monitoring Tolerance of EN

- Holding EN for gastric residual volumes <500ml in the absence of other clinical signs of intolerance should be avoided (grade B)
  - Not always associated with pneumonia, measures of gastric emptying, or incidence of aspiration
  - May negatively affect patient outcome due to decreased volume of EN

Martindale, R.G., McClave, S.A., Vanek, V.W., McCarthy, M, Roberts, P, Taylor, B, et al. (2009). Guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient: Society of Critical Care Medicine and American Society for Parenteral and Enteral Nutrition. *Critical Care Medicine, 37(5)*, 1-30.

Monitoring Tolerance of EN

- Indicators of Intolerance–nausea, vomiting, abdominal pain, abdominal distention, constipation, and/or diarrhea

- To aid with gastric motility, consider a prokinetic agent (metoclopramide/reglan/erythromycin)

- Advance feeding tube into duodenum (post pyloric)

- Don’t forget bowel regimens

Bowel Regimens

- Constipation from pain medications, iron supplements, bed-bound
- Diarrhea from antibiotics, magnesium-containing antacids, sorbitol-containing elixirs, electrolyte supplements, bacterial colonic overgrowth and GI motility disorders
- Bowel regimen-stool softeners, laxatives, fiber, fluid
- Elemental/predigested formula

Case Study: Stress & Trauma

- Patient presents to ER with GSW to abdomen, resulting in an open abdomen
- OR–gastric resection and resection of jejunum, resulting in GI tract discontinuity
- Sent to Critical Care

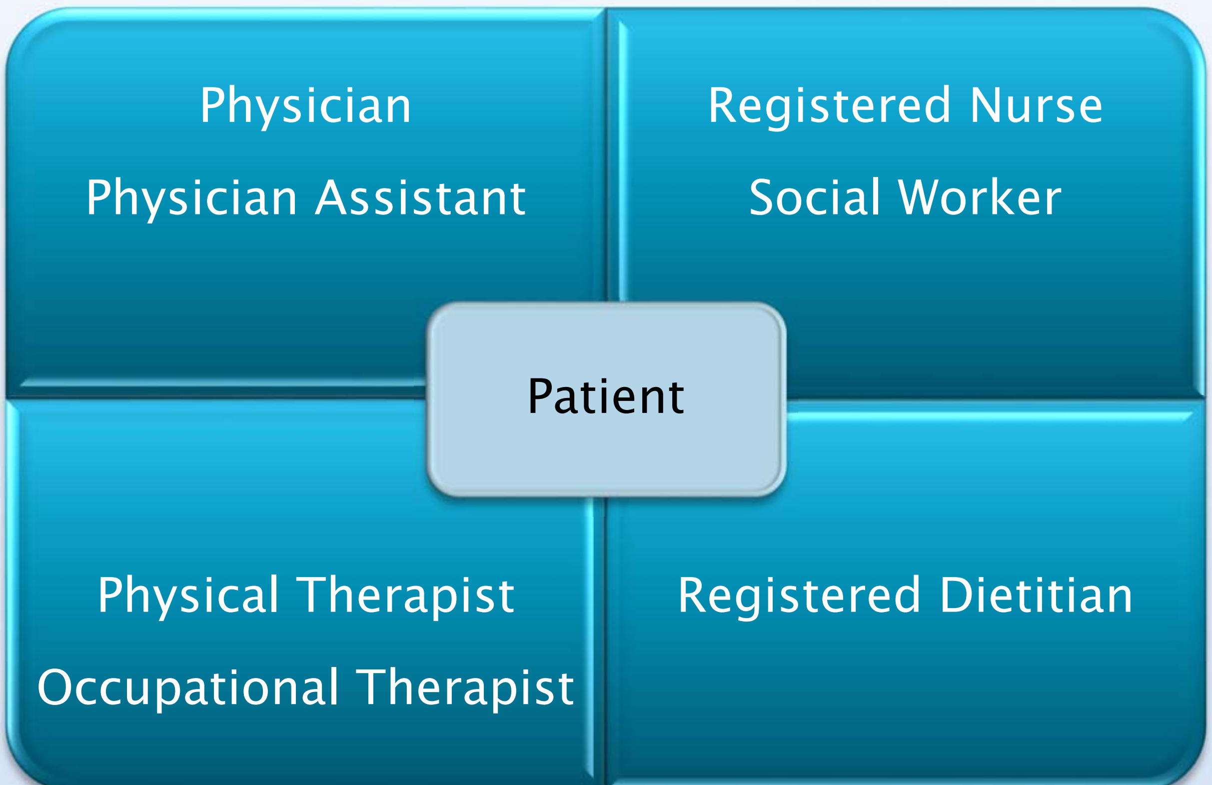
40% of hospital patients are overtly malnourished on admission, 8% severely

Patient with GSW Nutrition Support progression

- TPN clear choice due to discontinuous GI tract coupled with malnutrition dx; start when patient stabilized
- Day 2 started small amount of EN (10cc/hr) in combination with the PN; used immune modulating formula due to trauma and surgery
- Goals: increase EN at tolerated, decrease TPN, meet energy and protein requirements, oral nutrition when appropriate

Working Together

- A multidisciplinary approach is vital in the care and treatment of a trauma patient



TAKE HOME POINTS

- EARLY
- ENTERAL

QUESTIONS?

Nutrition Support–where to begin

- Method depends on multiple factors, including the nature of the patient's injury, and whether or not oral intake is an option
- Patient's lab values are normalizing and soon he can tolerate a small amount of enteral nutrition

Factors contributing to elevated energy needs

- Trauma and stress resulting from the GSW
- Corrective surgeries
- Fluid and electrolyte losses
- Anastomotic leak

Residuals

- Hold for gastric residual of >/=500cc

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Malnutrition

- Malnutrition – two “types” or conditions
  - Simple starvation: inadequate nutrient supply
  - Stress starvation: inability to utilize nutrients or when needs are so high that current intake can not meet demands
- Body responds through physiological adaptations
- How do you identify malnutrition?
  - Nutrient intake prior to admission
  - Physiologic changes that impair nutrient digestion, absorption, utilization and/ or requirements
  - The word nutrient covers macronutrients as well as micronutrients

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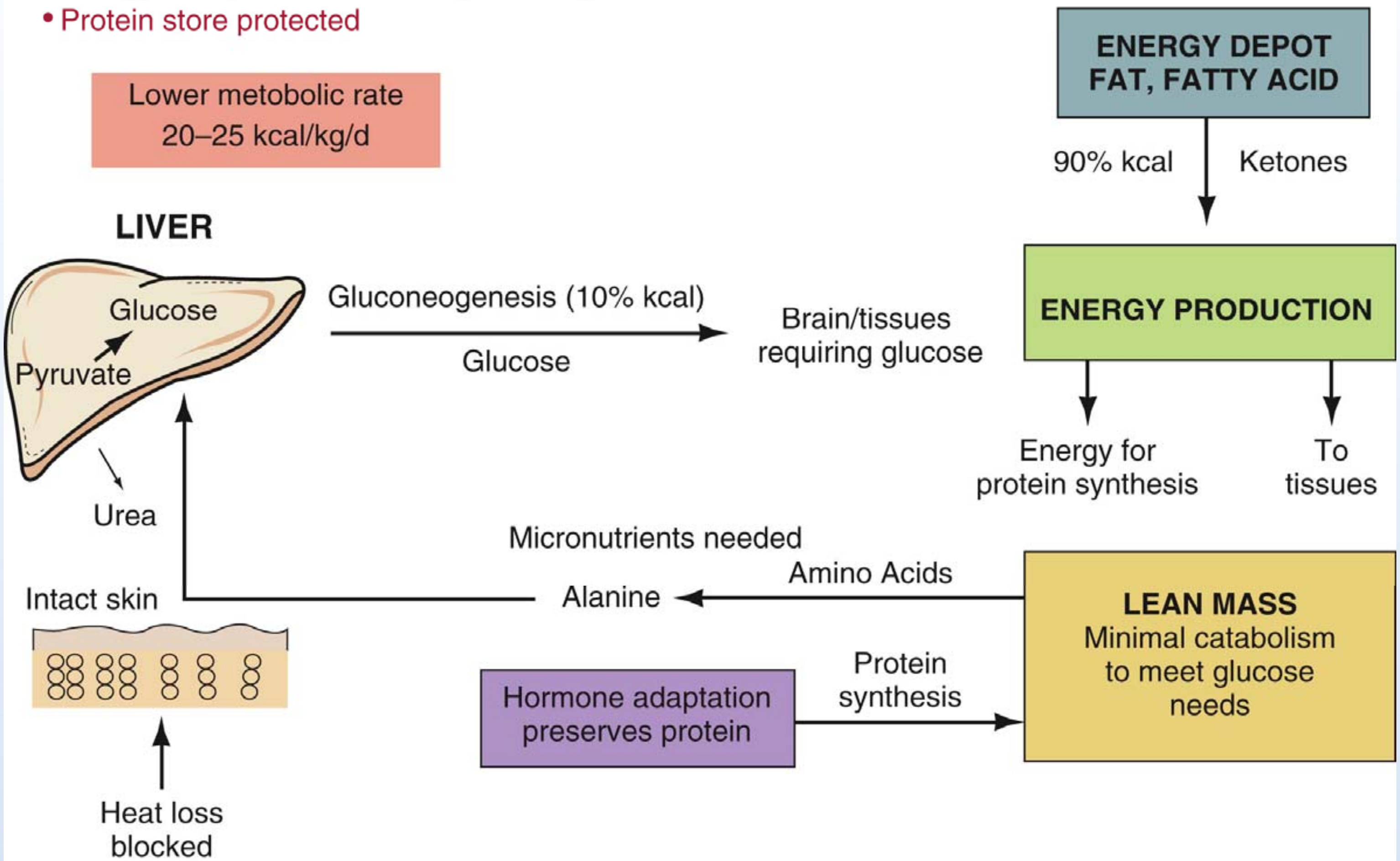
Metabolism Response to Starvation (Short Term)
No Injury or "Stress" (Protective Adaptation Occurs)

- Overall energy needs decrease
- Metabolic rate decreases 20-25 kcal/kg/d
- Energy from fat storage >90% of kcal
- Energy from protein <10% for gluconeogenesis
- Protein store protected



Nelms, MK, Sucher, K, Lacey, K, & Roth, SL (2007) Metabolic Stress and the Critically Ill. In Cossio, Y (ed), *Nutrition Therapy and Pathophysiology, 2nd edition* (pp 685). Belmont, CA: Wadsworth

Table 22.1 Comparison of Metabolism during Normal Nutritional States versus Starvation

Normal Nutritional State	Starvation
Metabolic rate matches current physical activity requirements and body composition.	Decrease in metabolic rate to ensure conservation of energy.
Carbohydrate and lipid are efficiently metabolized sources of energy providing 55%–85% of energy requirements.	Decreased need for glucose utilization.
Protein is used for maintenance of protein structures and to meet ongoing protein synthesis requirements.	Utilization of lipid as main source of energy.
	Preservation of lean mass, minimizing protein loss.

Nelms, MK, Sucher, K, Lacey, K, & Roth, SL (2007) Metabolic Stress and the Critically Ill. In Cossio, Y (ed), *Nutrition Therapy and Pathophysiology, 2nd edition* (pp 683). Belmont, CA: Wadsworth

Complications of Malnutrition

- Malnutrition is common among surgical patients
  - Increases the significance of complications, infections, length of stay, costs, and increased mortality
  - Can cause a loss of muscle and fat mass, reduced respiratory muscle and cardiac function, and atrophy of visceral organ

Bellal et al. (2010) Nutrition in Trauma and Critically Ill Patients. *European Journal of Trauma and Emergency Surgery*, 36 (1), 25-30.

Holmes S. (2007) The effects of undernutrition in hospitalised patients. *Nurs. Stand.*;22:35-38.

Kubrack C, Jensen L. (2007) Malnutrition in acute care patients. *Int. J. Nurs. Stud.*;44:1036-1054.

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Complications of Malnutrition

- Impairs the body's ability to have an effective immune response making infection harder to detect and treat
- Increases the risk of pressure ulcers, delays wound healing, increases infection risk, decreases nutrient intestinal absorption, alters thermoregulation and compromises renal function

Scrimshaw NS, DanGiovanni JP. (1997) Synergism of nutrition, infection and immunity, an overview. *J. Nutr.* ;133:S316-S321.
Holmes S. (2007) The effects of undernutrition in hospitalised patients. *Nurs. Stand.*; 22:35-38.
Kubrack C, Jensen L. (2007) Malnutrition in acute care patients. *Int. J. Nurs. Stud.*; 44:1036-1054.

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Stress

- Metabolic response to stress differs from the responses to starvation.
- During periods of stress, the body goes into a hypermetabolic state in response to acute injury or disease
- Degree of metabolic stress correlates with seriousness of injury

Sepsis

- Sepsis: systemic response to infection
- Severe Sepsis: presence of sepsis with one or more organ dysfunction
- Septic shock: presence of sepsis and hemodynamic instability

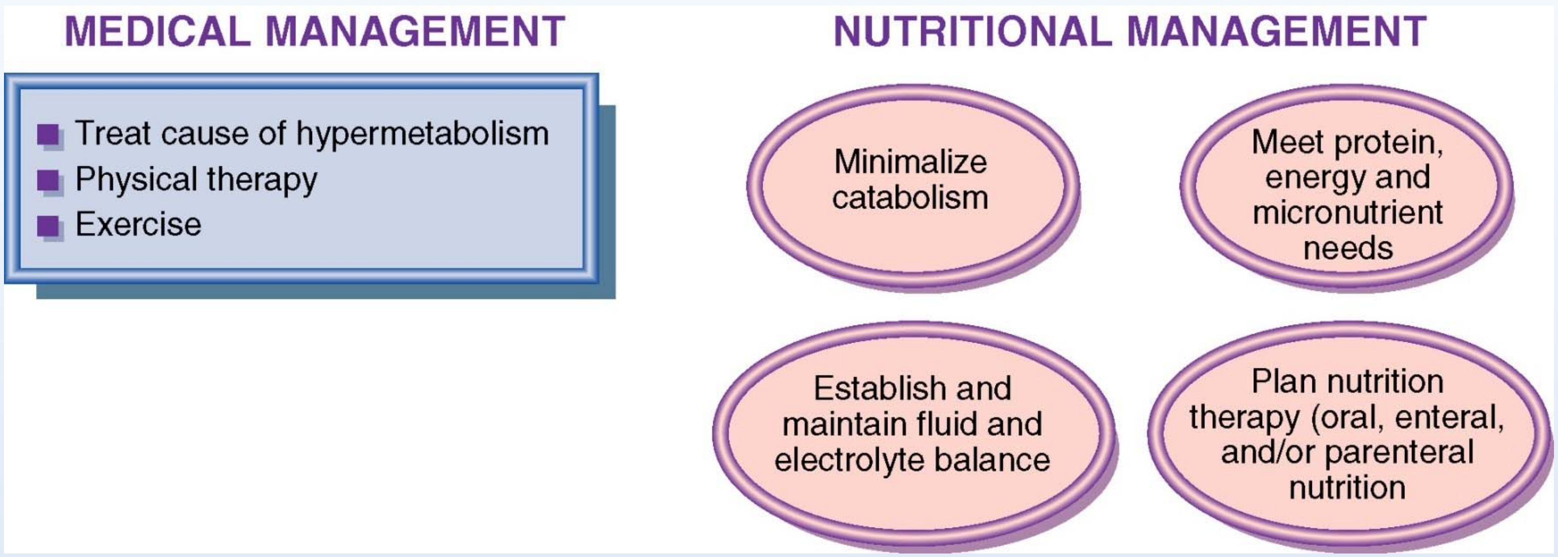
Martindale, RG, Sawai, R, & Warren, M. (2007). Sepsis and Infection. In M.M. Gottschlich (Ed.), *The A.S.P.E.N. Nutrition Support Core Curriculum: A Case-Based Approach- The Adult Patient* (pp.440-454).

Table 22.3 Summary of Metabolic Abnormalities Observed in the Stress Response

- Increased levels of glucagon, cortisol, epinephrine, norepinephrine
- Hyperglycemia and insulin resistance
- Increased basal metabolic rate
- Increased rate of gluconeogenesis
- Catabolism of skeletal muscle
- Increased urinary nitrogen excretion—negative nitrogen balance
- Increased synthesis of positive acute-phase proteins—CRP, fibronectin, ceruloplasmin
- Decreased synthesis of negative acute-phase proteins—albumin, prealbumin

Nelms, MK, Sucher, K, Lacey, K, & Roth, SL (2007) Metabolic Stress and the Critically Ill. In Cossio, Y (ed), *Nutrition Therapy and Pathophysiology, 2nd edition* (pp 686). Belmont, CA: Wadsworth

Stress- Medical and Nutritional Management



Mahan LK, Escott-Stump S: Krause's food, nutrition, & diet therapy, *ed* 11*, Philadelphia, 2004. Saunders.* Algorithm content developed by John Anderson, PhD, and Sanford C. Garner, PhD, 2000. Updated by Marion F. Winkler and Ainsley Malone, 2002.

Stress– Nutritional Management

- Nutrition management
  - Goal is prevention of malnutrition and associated complications
  - Consider status prior to illness, level of injury, current metabolic changes

Nutrition Therapy for Metabolic Stress

- Calorie provision
- Protein
  - Branched-chain amino acids
  - Glutamine: recommended for all burn, trauma, ICU
  - Arginine: caution should be used if utilized in patients with severe sepsis
- Vitamins, Minerals, Trace elements
- Carbohydrate
- Fat

Table 22.6 Possible Prediction Equations

Estimation of total energy requirements for the critically ill patient when indirect calorimetry is unavailable:

A.S.P.E.N. Guidelines for the Provision and Assessment of Nutrition Support Therapy in the Critically Ill Patient

BMI 20–25: 22–25 kcal/kg actual body weight

BMI >30: 22–25 kcal/kg ideal body weight

Mifflin-St. Jeor Equation

REE for females: 10 W + 6.25 H − 5 Age − 161

REE for males: 10 W + 6.25 H − 5 Age + 5

[W = weight in kg; H = height in cm; Age = age in years]

American College of Chest Physicians Equation

REE = 25 × weight (kg)

[If BMI = 16–25, use usual body weight; if BMI >25, use ideal body weight; and if BMI <16, use existing body weight for first 7–10 days, then use ideal body weight.]

Penn State 2003 Equation

REE = (0.85 × value from Harris-Benedict equation) + (175 × T_{max}) + (33 × V_e) − 6,443

[V_e = minute volume (in L/min); T_{max} = maximum body temp in previous 24 hours]

Nelms, MK, Sucher, K, Lacey, K, & Roth, SL (2007) Metabolic Stress and the Critically Ill. In Cossio, Y (ed), *Nutrition Therapy and Pathophysiology, 2nd edition* (pp 688). Belmont, CA: Wadsworth

Ireton-Jones 1997 Equation

REE = (5 × weight) − (11 × age) + (244 if male) + (239 if trauma present) + (840 if burns present) + 1,784

[W = weight in kg; H = height in cm; A = age in years]

Swinamer 1990 Equation

REE = (945 × body surface area) − (6.4 × age) + (108 × temperature) + (24.2 × respiratory rate) + (817 × V_T) − 4,349

[V_T = tidal volume in liters]

Permissive Underfeeding Guidelines:

18–22 kcal/kg IBW

1.5–2.5 g protein/kg IBW

Activity Factors	Average Injury Factors
Out of bed 1.2	Surgery 1.0–1.3
Confined to bed 1.1	Infection 1.0–1.4
	Skeletal trauma 1.2–1.4
	Head injury 1.5

Protein Requirements

RDA 0.8 g protein/kg

Minor surgery 1–1.1 g protein/kg

Major surgery 1.2–1.5 g protein/kg

Burn 1.5–2.0 g protein/kg

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Nelms, MK, Sucher, K, Lacey, K, & Roth, SL (2007) Metabolic Stress and the Critically Ill. In Cossio, Y (ed), *Nutrition Therapy and Pathophysiology, 2nd edition* (pp 688). Belmont, CA: Wadsworth

Hypocaloric Feeding

- Patients are fed below their resting energy expenditure (50%–75%) during critical illness
- Another term: metabolic support
  - Goals are to avoid
    - delayed gastric emptying
    - hyperglycemia with associated electrolyte abnormalities due to inability to utilize excess fuel

Wooley, JA, & Frankenfield, D. (2007). Energy. In M.M. Gottschlich (Ed.), *The A.S.P.E.N. Nutrition Support Core Curriculum: A Case-Based Approach– The Adult Patient* (pp.19–32)

Feeding in Severe Sepsis/Septic Shock

- Avoid mandatory full caloric feeding in the first week but rather suggest low dose feeding (e.g., up to 500 calories per day), advancing only as tolerated (grade 2B)

Dellinger RP, Levy MM, Rhodes A, et al (2012) Surviving Sepsis Campaign: International guidelines for management of severe sepsis and septic shock. *Crit Care Med. 2013; 41:580-637*

Protein Requirements

- Following major injury, patients lose a large amount of body protein via wound exudate and urine during the first 10 days following injury despite moderate nutrition support (~110g/d)
  - Protein needs are therefore increased in this population
- 20-25% of total nutrient intake should be protein (roughly 1.5-2.0 g/kg/day)

Martindale, R.G., McClave, S.A., Vanek, V.W., McCarthy, M, Roberts, P, Taylor, B, et al. (2009). Guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient: Society of Critical Care Medicine and American Society for Parenteral and Enteral Nutrition. *Critical Care Medicine, 37(5)*, 1-30.

Vitamins and Minerals

- Currently, there are no specific guidelines regarding micronutrient requirements in the critically ill patient
  - Lacking objective data; future studies needed to address antioxidant supplementation in this population

Cresci, GA, Gottschlich, MM, Mayes T, & Mueller, C. (2007). Trauma, Surgery, and Burns. In M.M. Gottschlich (Ed.), *The A.S.P.E.N. Nutrition Support Core Curriculum: A Case-Based Approach– The Adult Patient* (pp.455–476).

Carbohydrate

- Hyperglycemia upon admission has been correlated to increased morbidity and mortality in trauma patients
  - Tight blood glucose control with insulin therapy may improve morbidity and mortality
  - Recommended that insulin be used to maintain normoglycemia
- Recommended that glucose be provided at a rate of 3 to 4 mg/kg/min or ~ 50 to 60% of total energy requirements in critically ill patients

Cresci, GA, Gottschlich, MM, Mayes T, & Mueller, C. (2007). Trauma, Surgery, and Burns. In M.M. Gottschlich (Ed.), *The A.S.P.E.N. Nutrition Support Core Curriculum: A Case-Based Approach- The Adult Patient* (pp.455-476).

Fat

- Facilitates protein sparing
- Decreases risk of carbohydrate overload
- Assists in limiting total fluid volume
- Provides essential fatty acids (EFAs)

Fat

- Recommendations in critically ill patients:
  - 10% to 30% of total energy requirements
  - Minimum of 2% to 4% as EFAs to prevent deficiency
- Hypermetabolic patients should be monitored for tolerance of fat delivery
  - May decrease immune function
  - Cause hypertriglyceridemia
  - Cause hypoxemia due to impaired ventilation and perfusion abnormality

Cresci, GA, Gottschlich, MM, Mayes T, & Mueller, C. (2007). Trauma, Surgery, and Burns. In M.M. Gottschlich (Ed.), *The A.S.P.E.N. Nutrition Support Core Curriculum: A Case-Based Approach- The Adult Patient* (pp.455-476).

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Omega-3 vs. Omega-6 fatty acids

- IV fat emulsion in the United States contain omega-6, long-chain triglycerides (LCT)
  - May be proinflammatory and immunosuppressive in critically ill patients
- Enteral formulations contain mixtures of LCT (omega-6 and omega-3) and medium-chain triglycerides (MCT)
  - Produce less proinflammatory metabolites
  - May be beneficial in critically ill patients
  - Upon ingestion, MCT directly absorbed via the portal blood system, bypassing the lymphatic system needed for LCT absorption

Cresci, GA, Gottschlich, MM, Mayes T, & Mueller, C. (2007). Trauma, Surgery, and Burns. In M.M. Gottschlich (Ed.), *The A.S.P.E.N. Nutrition Support Core Curriculum: A Case-Based Approach- The Adult Patient* (pp.455-476).

Early Enteral Nutrition

- Enteral feeding should be started early within the first 24–48 hours following admission (grade C)
- The feedings should be advanced to goal over the next 48–72 hours (grade E)
- Achieving access and initiating enteral nutrition (EN) should be considered as soon as patient is resuscitated and is hemodynamically stable

Martindale, R.G., McClave, S.A., Vanek, V.W., McCarthy, M, Roberts, P, Taylor, B, et al. (2009). Guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient: Society of Critical Care Medicine and American Society for Parenteral and Enteral Nutrition. *Critical Care Medicine, 37(5)*, 1–30.

Enteral vs. Parenteral Nutrition

- Use intravenous glucose and EN rather than total parenteral nutrition (TPN) alone or PN in conjunction with enteral feeding in the first 7 days after a diagnosis of severe sepsis/septic shock (grade 2B)

Dellinger RP, Levy MM, Rhodes A, et al (2012) Surviving Sepsis Campaign: International guidelines for management of severe sepsis and septic shock: *Crit Care Med. 2013; 41:580-637*

Appendix

Grade of recommendation

A—Supported by at least two level I investigations

B—Supported by one level I investigation

C—Supported by level II investigations only

D—Supported by at least two level III investigations

E—Supported by level IV or level V evidence

Level of evidence

I—Large, randomized trials with clear-cut results; low risk of false-positive (alpha) error or false-negative

(beta) error

II—Small, randomized trials with uncertain results; moderate to high risk of false-positive

(alpha) and/or false-negative (beta) error

III—Nonrandomized, contemporaneous controls

IV—Nonrandomized, historical controls

V—Case series, uncontrolled studies, and expert opinion

Martindale, R.G., McClave, S.A., Vanek, V.W., McCarthy, M, Roberts, P, Taylor, B, et al. (2009). Guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient: Society of Critical Care Medicine and American Society for Parenteral and Enteral Nutrition. *Critical Care Medicine, 37(5)*, 1-30.

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MILK CHOCOLATE
Reese's
PEANUT BUTTER
Egg
NET WT
1.2 OZ (34 g)
Anyone have a recipe for these using cauliflower? (asking for a friend😂)

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