# Nutritional Demands of Disease and Trauma

Lecture 89

# Nutritional Requirements

- Based on needs to support optimal physiological function
- Are changed by disease or injury
  - metabolism is altered
    - to prevent further cellular damage
    - to promote repair
  - metabolic priorities shift
  - collateral metabolic pathways emerge

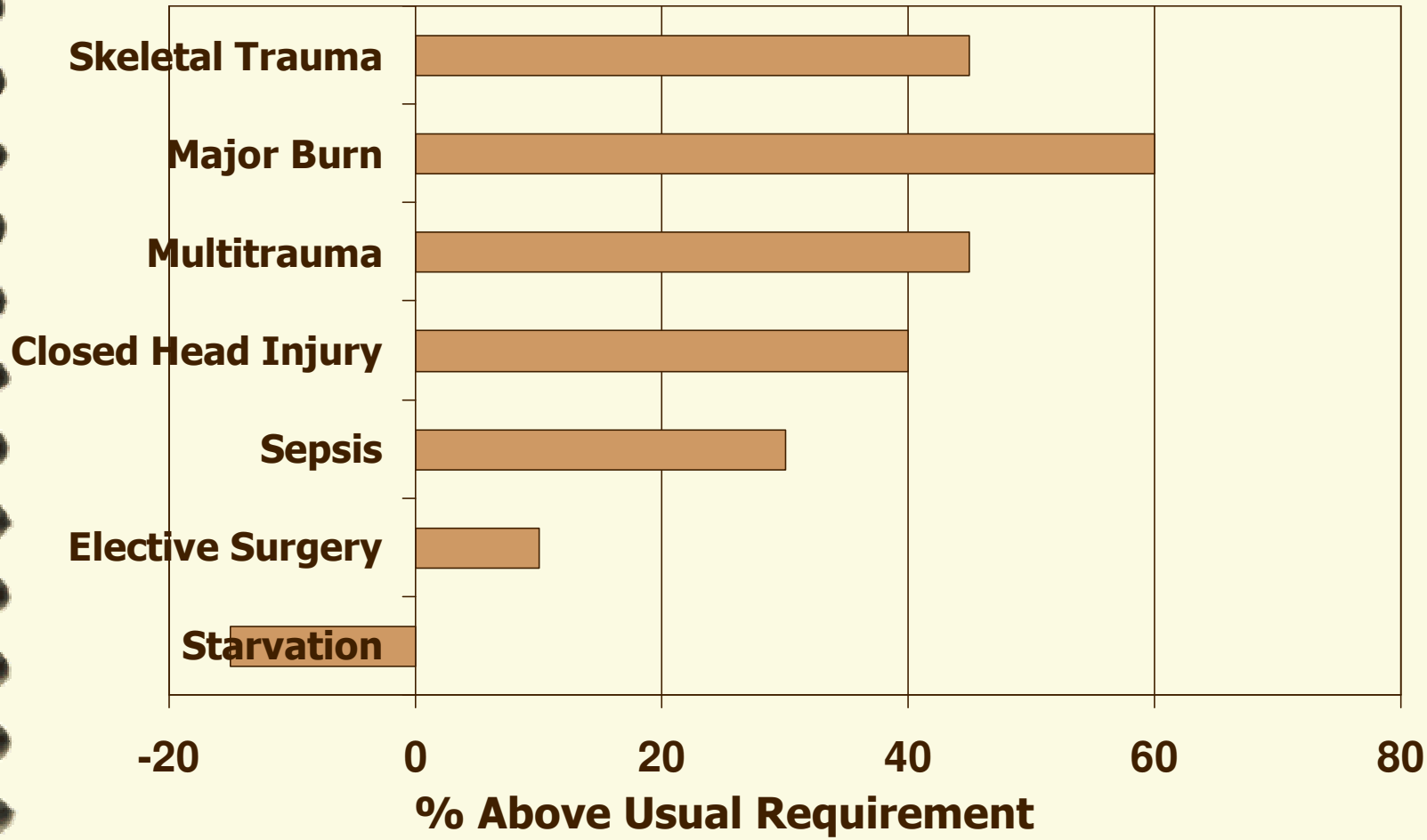
# Nutritional Status

- Reflects how well nutrient needs will be met over a range of metabolic demands
- Predictive of risk of complications
  - infection/sepsis
  - respiratory disease
  - acute renal failure
  - hepatic encephalopathy
  - congestive heart failure
  - multiple organ failure

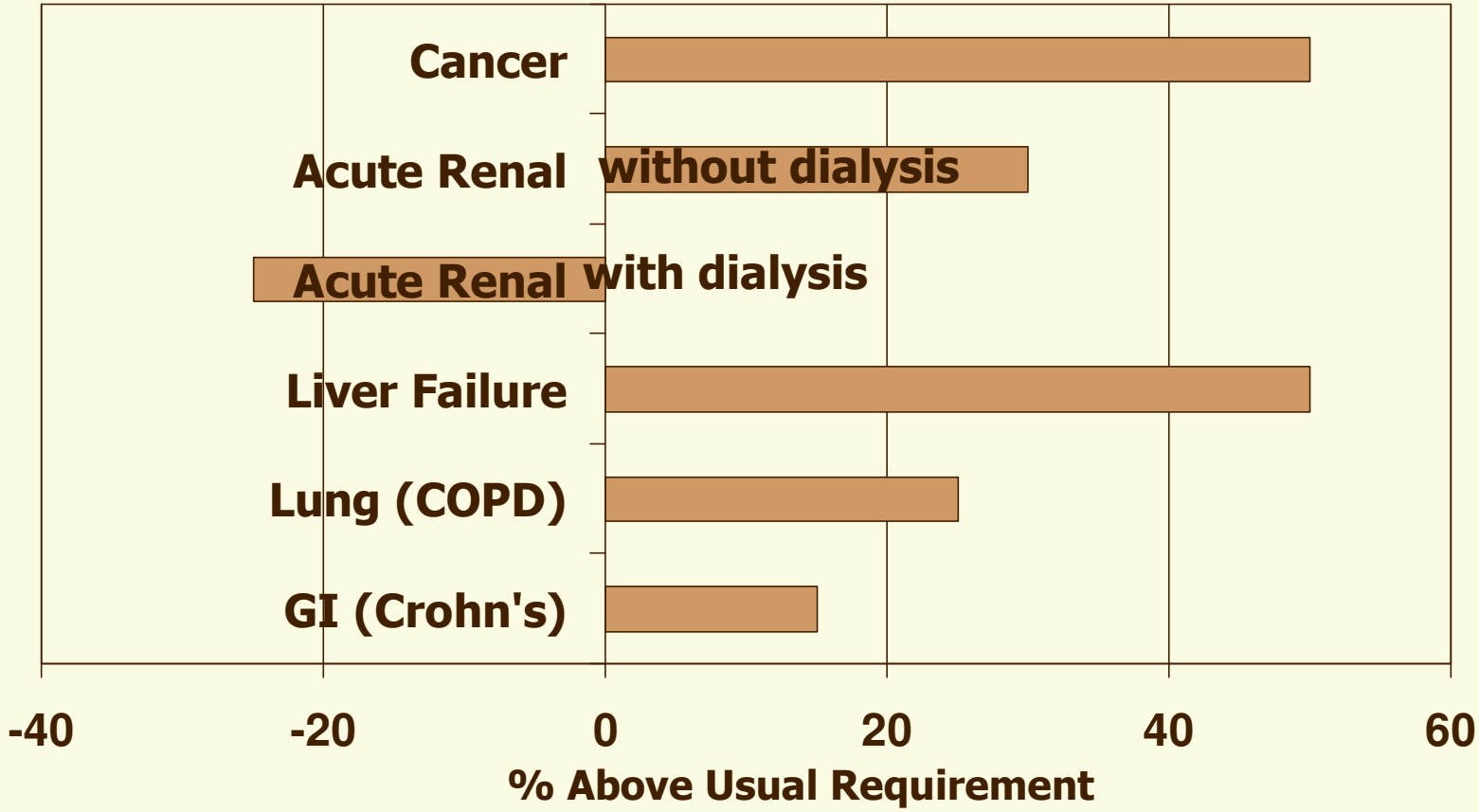
# Change in Energy Requirements Due to Disease or Injury

- Resting energy expenditure increased by 10-50% (injury factor)
  - to support increased metabolic workload
- An additional allowance is added for activity (activity factor)
  - 20 % if confined to bed
  - 30 % if ambulatory

# Change in Resting Energy Expenditure in Trauma



# Change in Resting Energy Expenditure in Disease



# Consequences of unmet energy needs are related to:

- Amount of weight loss
  - 20% loss = immune dysfunction
  - 40% loss = fatal
- Rate of weight loss
  - 15-20% of usual body weight
  - 10% over previous 6 months
  - 5% over previous month
- Composition of weight loss
  - lean body mass

# Critical Nature of Loss of Lean Body Mass

- Lean body mass=cell mass
  - metabolically active compartment
- Individual tissue losses proportional to total loss
  - except brain which is primarily lipid
  - no tissue is spared
- Irreversible at some point
  - critical mass

# Protein requirements are altered to accommodate:

- Immune response
- Increased metabolic activity
- Replacement of damaged cells
- Replacement of protein losses
  - perspiration, blood, exudates, renal, intestinal
  - ↑ if anorexia accompanies fever/infection
  - ↑ by muscle proteolysis
    - up to 35 g/day with metabolic stress

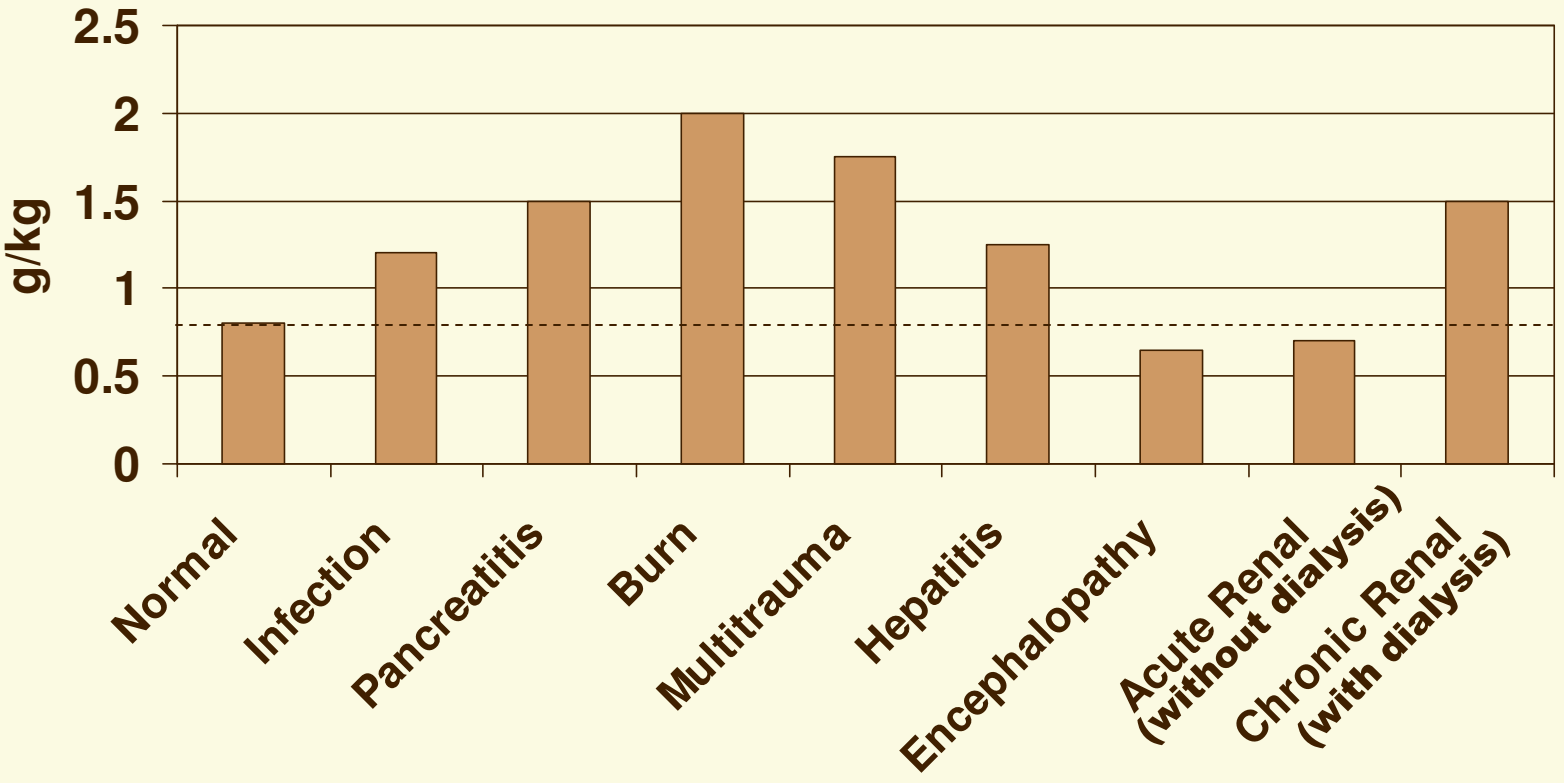
# Characteristics of Metabolic Stress

| Hormonal | Metabolic | Chemical |
|---|---|---|
| ↑ Catecholamines | ↑ REE | ↓ pH |
| ↑ Glucagon | Hyperglycemia | Prostanoids |
| ↑ Corticosterioids | Ketoacidosis | Leukotrienes |
| Insulin Resistance | Uremia | Cytokines |

# Causes of Muscle Proteolysis with Metabolic Stress

- Increased demand for glucose
  - by leukocytes and fibroblasts (wound)
  - elevated catecholamines and corticosteriods
- Increased rate of gluconeogenesis
  - substrates
- Elevated glucagon
- Insulin resistance
- Accelerated by insufficient energy intake

# Effect of Disease and Trauma on Protein Requirements



# Muscle Wasting
# Starvation vs Metabolic Stress

| Characteristic | Starvation | Metabolic Stress |
|---|---|---|
| REE | Decreased | Increased |
| Muscle Catabolism | Energy | Glucose |
| Ketone | Oxidized for Energy | Oxidation Inhibited |
| Insulin Levels | Physiological Low | High/Insulin Resistance |
| Weight Loss | Fat + Protein | Protein |

# Vitamin and mineral requirements are altered to accommodate:

- Increased energy requirements
- Increased rate of protein synthesis
- Activation of immune system
- Increased rate of cell proliferation
- Fluid balance

and also ……

# Vitamin and mineral requirements are also increased to accommodate:

- Hemostasis
  - coagulation and blood loss
- Replacement of muscle mass
- Prevention of further cellular injury
- Detoxification
  - hormones, drugs, microbial toxins

# Disease-Specific Nutritional Adjustments

- Malnutrition contributes to functional deterioration of organ systems
- Disease or injury to organs affects the course of malnutrition
- Dietary adjustments allow nutrients to be processed in the absence of normal function

# Nutritional Effects on Cardiovascular Function

- protein-energy malnutrition/obesity
  - ECG abnormalities
  - myofibrillar degeneration
  - ↓ cardiac contractility
  - congestive myopathy
- vitamin antioxidant deficiencies
  - poor vascular integrity
- protein-energy malnutrition
  - ↓ stroke volume
    - myocardial mass
    - hypometabolism
  - ↓ cardiac strength
- fluid/electrolyte imbalances
  - altered cardiac contractility
  - abnormal BP

# Nutritional Effects on Lung Function

- Stimulation of ventilatory drive
- Maintenance of respiratory muscle mass
- Influence on inflammatory response
- Influence on pulmonary vasomotor tone

# Role of the Gastrointestinal Tract in Maintenance of Nutritional Status

- Release of nutrients from dietary sources
  - digestion
  - absorption
- Regulation of nutrient intake
  - appetite/satiety
- Immunological function

# Nutritional Problems Associated with Gastrointestinal Disease and Injury

- Reduced digestive/absorptive capacity
- Inability or desire to consume nutrients orally
- Increased nutrient losses
- May involve inflammation
- May involve ulceration

# Role of the Liver in Maintenance of Nutritional Status

- Accommodates nutrient stores
- Provides nutrient transport proteins
- Metabolizes amino nitrogen
- Critical to glucose homeostasis
- Activates/deactivates Vitamin D
- Contributes to fluid balance

# Nutritional Problems Associated with Liver Disease and Injury

- Condition-specific effects
  - hepatitis, cirrhosis, liver failure
- Impaired protein metabolism (cirrhosis)
  - ↑ ammonia production and ↓ albumin synthesis
- Abnormal vitamin/mineral metabolism
- Decreased nutrient availability
- Blood glucose and lipid abnormalities
  - hypoglycemia and glucose intolerance

# Role of the Kidney in Maintenance of Nutritional Status

- Disposal of metabolic waste
- Maintenance of blood nutrient levels
- Buffering of body fluids
- Vitamin D activation

# Nutritional Problems Associated with Renal Disease and Injury

- Decreased excretion of nutrients/waste
  - ↓ GFR
- Insulin resistance
- Decreased lipoprotein lipase activity
- Fluid and electrolyte imbalances
- Loss of bicarbonate
- Abnormal calcium/phosphorus metabolism

# Role of the Cardiovascular System in the Maintenance of Nutritional Status

- Delivers oxygen and nutrients
- Transports metabolic waste to disposal sites
- Contributes to fluid and electrolyte balance
- Maintains body temperature
- Influences metabolic rate

# Nutritional Problems Associated with Cardiovascular Disease and Injury

- Reduces cardiac output
- Decreased oxygen delivery
  - hypometabolism
- Accumulation of metabolic waste

# Role of the Respiratory System in the Maintenance of Nutritional Status

- Regulates oxygen uptake
- Regulates carbon dioxide disposal
- Contributes to acid-base balance

# Nutritional Problems Associated with Lung Disease and injury

- Changes fuel source requirement
- Increases energy expenditure for respiration
- Alters acid-base balance

# Adjustments in Protein Requirements

- Restricted intake
  - acute renal disease
  - hepatic encephalopathy
- Increased intake
  - acute renal disease with dialysis
  - chronic renal disease with dialysis

# Adjustments in Energy Requirements

- Increased
  - metabolic stress
  - acute renal disease without dialysis
- Decreased/Unchanged
  - acute/chronic renal disease with dialysis

# Adjustment in Fluid Requirements

- Increased intake
  - fever
  - metabolic stress
- Decreased intake (with sodium restriction)
  - renal disease
  - liver disease

# Micronutrient intakes should be adjusted:

- When energy intakes are increased
- When protein intakes are increased
- For skeletal disease or injury
- With tissue injury
- With fluid imbalances
- With blood loss
- If immune response is activated