Metabolic response to trauma and lines of resuscitation

Debility commonly accompanies surgical illness. It occurs in varying degrees after elective operations, major trauma, burns, infections, and other critical illnesses. Debility is caused by a variety of factors, including specific biochemical and physiologic alterations that usually occur in response to injury and disease, especially those that persist for a long time. Some aspects of surgical care that are common to almost all patients can also cause debility. The metabolic responses to critical illness have been studied in a variety of critically ill patients, especially those with trauma, burns, or sepsis. The responses are often grouped into phases on the basis of their temporary relation to the injury or insult. The so-called ebb phase, which is the early phase of the injury response, is characterized by

1. An elevated blood glucose level,
2. Normal glucose production,
3. Elevated free fatty acid levels,
4. A low insulin concentration,
5. Elevated levels of catecholamines and glucagon,
6. An elevated blood lactate level,
7. Depressed oxygen consumption,
8. Below-normal cardiac output, and

The subsequent phase, the so-called flow phase, is characterized by

1. A normal or slightly elevated blood glucose level,
2. Increased glucose production,
3. Normal or slightly elevated free fatty acid levels, with flux increased,
4. A normal or elevated insulin concentration,
5. High normal or elevated levels of catecholamine and an elevated glucagon level,
6. A normal blood lactate level,
7. Elevated oxygen consumption,
8. Increased cardiac output, and
9. Elevated core temperature.

The ebb phase is dominated by cardiovascular instability, alterations in circulating blood volume, impairment of oxygen transport, and heightened autonomic activity. Emergency support of cardiopulmonary performance is the paramount therapeutic concern. Shock is the prototypical clinical manifestation of the ebb phase. After effective resuscitation has been accomplished and restoration of satisfactory oxygen transport has been achieved, the flow phase comes into play. These responses (ebb and flow) are marked by hyperdynamic circulatory changes, signs of inflammation, glucose intolerance, and muscle wasting. Surgical patients in the ICU usually exhibit these clinical features. When wounds are closed and infection has resolved, repletion of lean tissue and fat stores and restoration of strength and stamina can begin. This final,
anabolic phase often begins near the time of hospital discharge and may persist for months before the patient fully recovers.

Metabolic response to critical illness (Expect and treat)

**Hyperdynamic or hypermetabolic state**

**Expect**
- Tachycardia
- Widened pulse pressure
- Increased cardiac output
- Increased O2 consumption
- Increased minute ventilation
- Increased energy expenditure
- Fever
- Sodium and water retention

**Provide**
- Volume and pharmacologic support of cardiovascular performance as appropriate
- Warm environment (26°–33° C)
- Increased water intake
- Increased caloric intake
- Judicious متعقّل sedation and analgesia

**Muscle wasting**

**Expect**
- Rapid wasting of muscle and loss of strength and endurance
- Increased osmotic load filtered by kidney
- Increased formation and urinary loss of urea
- Increased urinary loss of potassium, phosphorus, and magnesium

**Provide**
- Increased protein or amino acid intake to 15%–20% of total energy
- Increased intake of potassium, phosphorus, and magnesium
- Massage, active and passive exercise, and early mobilization

**Glucose intolerance**

**Expect**
- Hyperglycemia that is aggravated by glucose intake, infection, and other stressors
- Relative insensitivity to insulin, which improves with recovery

**Provide**
- Glucose control
- Human insulin I.V. to maintain blood glucose in a target range of 110–160 mg/dl
- Maintenance of nutritional support
- Glucose as 60%–75% of total energy (5–7 mg/kg/min or 7–10 g/kg/day)
- Lipid as 25%–40% of total energy
Infection
- Initially diagnosed by abrupt changes in fever, leukocytosis, hyperglycemia, pulmonary function, or pulse and blood pressure.
- Culture appropriately to establish microbiologic diagnosis.
- Administer broad-spectrum antibiotics empirically to cover likely pathogens if signs of organ system dysfunction and of sepsis develop.
- Debride necrotic tissue. Establish drainage; remove catheters.
- Prevent contamination of different sites on same patient.
- Prevent cross-contamination between patients.

Hospital treatment
Bed rest:
- Encourage frequent turning, coughing, and deep breathing.
- Encourage active, assisted exercise in bed when feasible.
- Move to chair as soon as possible.
- Use incentive spirometer or similar device.
- Practice good hygiene and skin care, and provide massage.

Food deprivation:
- Limit period of fasting to 3–4 days.
- Begin nutritional support as soon as needed.
- Provide enteral feeding when possible.

Invasive devices:
- Remove as soon as no longer required.
- Remove I.V. lines placed under suboptimal conditions as soon as feasible.
- Consider changing I.V. lines or rotating site every 2 or 4 days.
- Change I.V. site if redness or inflammation develops.

Sleep deprivation:
- Reduce lighting and noise in ICU periodically, especially at night.
- Orient patient frequently to time of day and situation.
- Use sedation judiciously.