General Responses to Injury and Acute Illness

16a - General response to injuries and acute illness

The metabolic response is a complex interaction between many body systems

- Acute inflammatory response
- The endothelium and blood vessels
- Afferent and sympathetic NS activation
- Endocrine response

Acute inflammatory response:

- inflammatory cells (macrophages and neutrophils) and cytokines (IL8, TNFa, IL1, IL6) are mediators
- physical damage to tissue results in local activation of those mediators
- important determinant of the effects of the inflammatory response is whether the effects of mediators remain localized or generalized
- cascade of events result in rapid amplification of stimuli -> within hours, large number of mediators present at injured site -> controlling and mediating inflammatory response
- proinflammatory substances : leucocyte, prostaglandins, kinins, complement, proteases, free radicals
- anti-inflammatory : antioxidant (glutathione, vitamin A&C, protease), protease enzyme inhibitor (alpha-microglobulin), IL10

The endothelium and blood vessel:

- leucocyte accumulation -> adherence -> migration from blood vessel to injured area
- mediated by integrins and intercellular adhesion molecule (ICAM) family
- tissue injure increases the blood flow due to vasodilation -> step up the local delivery of inflammatory cells, oxygen and nutrient
- vasodilation mediated by kinins, prostaglandins, and NO
- capillaries in injured site become more permeable to plasma due to increases the size of intercellular pores -> fluid and colloid particles (albumin) leak -> edema
- tissue factor is exposed -> promote coagulation -> decrease hemorrhage

Afferent and sympathetic NS activation:

- impulse generated mediates the metabolic response to injury
- pain fibres (unmyelinated C fibres and myelinated A fibres) are activated
- stimulated by direct trauma or nerve stimulant (prostaglandins)
- impulses reach thalamus via dorsal horn of spinal cord and lateral spinothalamic tract -> stimulating:

1. sympathetic NS – tachycardia, increase cardiac output, increase adrenaline, noradrenaline -> change in carbohydrate, fat and protein metabolism
2. stimulation of pituitary hormone release

The endocrine response:

- this takes place as direct stimulation from respective glands or due to normal negative feedback mechanism
- helps in maintaining the body fluid’s balance and in the changes to substrate metabolism that occur following injury

1. eg: increase secretion of GH, ACTH, ADH, adrenalin, cortisol, glucagon, rennin, angiotensin
2. eg: reduce in insulin, testosterone, estrogen, thyroid hormone

Consequences of metabolic response to injury:

- hypovolemia
- increased energy metabolism and substrate cycling
- catabolism and starving
- changes in RBC synthesis and blood coagulation

Hypovolemia:

- due to fluid loss (hemorrhage, vomiting, sweating, evaporation from exposed organ during surgey) fluid sequestration (third space loss) – leakiness of endothelium
- body attempts to restore normal fluid status and maintain perfusion to vital organs by fluid and flow-

conserving measures
- fluid-conserving : neuroendocrine response - increase ADH and aldosterone duration of increased usually 48-72 hours
- blood-conserving :

1. by reduced cardiac output -> decrease blood flow to organ
2. Increase energy metabolism and substrate cycling:

Physical work:

- physical work usually decreased because of inactivity, although heart and respiratory muscle work may increase resting energy expenditure increased by up to 50% following severe injury as a result of metabolic changes
- thermogenesis:

1. patient frequently midly pyrexial for 24-48 hours following injuries
2. IL1 resets the temperature-regulating centre
3. pyrexia may also complicate infection occurring after injury
4. metabolic rate increases by 6-10% for each 1`C change in body temp

- basal metabolic rate:
- increased activity of protein, carbohydrate and fat related pathways

Catabolism and starvation: - catabolism: breakdown of complex substrate to form simpler molecules

- carbohydrate – increase glycogenolysis, hepatic gluconeogenesis, insulin resistance tissue, hyperglyceamia
- fat – increase lipolysis, FFA used as energy substrate, FFA to ketones, glycerol to glucose
- protein – increase muscle breakdown, AA converted to glucose, negative nitrogen balance

- starvation: inadequate intake of food to meet metabolic demand

- acute

1. metabolic changes that preserve the glucose supply to brain glycogenolysis, lipolysis

- chronic

1. accompanied by muscle breakdown to release AA
2. gluconeogenesis in liver
3. FFA converts to ketone

Tissue energy supply in the form of glucose, FFA and ketones Brain adapts to utilize ketone as primary energy substrate - these two processes generally occur simultaneously

Changes in RBC synthesis and blood coagulation:

- anemia is common after major surgery or trauma due to bleeding and the hemodilution
- bone marrow production of new red cells is impaired – low erythropoietin, chage in iron metabolism and decrease iron availability
- blood becomes hypercoagulable – transient for 1-2 days -> increase risk of thromboembolism

contributing factor:

- endothelian injury activation of coagulation pathway
- increase activation of platlets
- dehydration and/ reduce venous blood flow due to immobility
- increase circulating of pro-coagulant and decrease anticoagulant

Factors associated with the magnitude of metabolic response to injury:

- patient related :
- genetic predisposition
- coexisting disease
- drug treatments
- nutritional status

acute surgical/trauma-related :

1. severity of injury
2. nature of injury
3. ischemic-reperfusion injury
4. temperature infection
5. anaesthetic technique