Multiple Organ Failure

Multiple Organ Dysfunction Syndrome (Multiple Organ Failure) is the dysfunction of two or more organ systems, in direct relation to the inflammation from a severe infection and, or injury. The dysfunction of the organ system can rapidly progress to its failure and death. Multiple organ dysfunction syndrome, MODS, is often the cause of death for patients after septic shock or major trauma.

Pathophysiology

Primary MODS

Organ is dysfunctional due to direct insult on the system. The insult is generally from an ischemic process, lack of perfusion (shock), thermal heat (burns), and direct infection. The adrenals release catecholamines, due to the stress on the insulted organ. The insult induces the inflammatory cascade and therefore activating the neutrophils and macrophages.

Secondary MODS

The next step is often referred to as the latent period. After the direct injury, the second part of the destruction of the organ system is caused by an increased and uncontrolled inflammatory response. Often times, the increased inflammatory response will begin to injure surrounding systems. As macrophages enter the area they release cytokines (TNF & IL-1). These mediators are directly responsible for the endothelial damage. With the endothelial damage, neutrophils begin aggregating toward the site and increase inflammation. The endothelial cells begin releasing nitric oxide that is directly responsible for vasodilation. The endothelium becomes more permeable.

Neuroendocrine system is also being activated during this latent phase. Homeostasis is unable to be attained. The endocrine system attempts to compensate for the injury and continues to increase levels of catecholamines, cortisol, glucagon, insulin, human growth hormone, anti-diuretic hormone, and endorphins. Endorphins further lead to increased vasodilation. The sympathetic system is also activated in attempts to compensate for fluid loss and hypotension. Complement, coagulation, kallikrein-kinin, fibrinolytic cascades are activated due to endothelial damage. The different cascades are responsible for the stimulation of further dilation, degranulation, increased inflammatory responses, and microvascular thrombosis. With the cascades being activated, a systemic inflammatory response begins.

Neutrophils begin circulating throughout the system. Neutrophils attach to endothelium and quickly release an oxidative burst and ultimately toxic oxygen-free radicals. Neutrophils also release collagenase and elastase that further damages the endothelium and increases permeability. Other mediators released from the neutrophils are platelet-activating factor which directly affects increased phagocytes. Lastly, the neutrophils also release arachidonic acid (https://en.wikipedia.org/wiki/Arachidonic_acid) metabolites. Conclusively, the release of neutrophils systemically directly effects endothelium, vasodilation, vasoconstriction in selective areas, permeability and microvascular coagulation. Macrophages are also activated by the various cascades mentioned above. Macrophages also play a role in producing oxygen-free radicals, nitric oxide, cytokines, proteases, and arachidonic acid metabolites. Often times, the over-activation of the macrophages leads to significantly high levels of cytokines and nitric oxide.

The gastrointestinal lining is very susceptible to injury from the inflammatory mediators. By damaging the lining of the gut, the barrier is also destroyed. This allows bacteria and endotoxins to be released systemically. Inflammation also has the capability to distribute blood flow unevenly. The maldistribution of blood flow is due to endothelium damage, vasodilation, increased permeability, and microvascular coagulation. The maldistribution of blood causes hypoxia and ischemia in different organ systems. Metabolism increases in attempts to meet the body’s increased need for energy. Due to the high requirements, the body begins to break down proteins that are stored in skeletal muscles and visceral organs. It is to be noted that most of the organ damage occurs with reperfusion. Once an organ becomes ischemic and blood flow is returned, oxygen-free radicals are formed causing more damage and ultimately failure.

Epidemiology

Sepsis and septic shock are the most common causes of MODS. However, MODS can also occur by severe injury or infection that causes a systemic inflammatory response. Common causes include: major trauma, major surgery, extensive burns, liver failure, blood transfusions, chronic inflammatory foci, acute inflammatory responses, necrotic tissues, and disseminated intravascular coagulation. The older population is at the highest risk for MODS.

Disease described

Multiple organ dysfunction syndrome was first defined in the 1970’s. MODS has the highest mortality rate in intensive care units today. The mortality rate for a patient with two dysfunctional organs is 54%, while a patient having five or more failing organ systems jumps to 100%. Throughout the years and advancement of medicine, mortality rates for MODS have essentially been unchanged.

Sign and Symptoms

- First 24 hours: low grade fever, tachycardia, tachypnea
- 24-72 hours: lungs failure begins
- 7-10 days: bacteremia, renal, intestinal, and liver failure develops
- 14-21 days: encephalopathy, cardiac failure, death
- Pulmonary: Respiratory failure, pulmonary hypertension
- Gastrointestinal: distention/ascites, diarrhea, bacterial overgrowth, ischemic bowel, hypoactive bowel sounds, intestinal bleeding
- Liver: elevated: liver enzymes, ammonia, and serum bilirubin levels & hepatomegaly
- Gallbladder: tenderness, distention
- Renal: decreased urinary output, increased creatinine and blood urea nitrogen
- Cardiovascular: Increased heart rate, decreased blood pressure, increased oxygen consumption
- Central Nervous System: altered mental status, fatigue, fever

Diagnosis

Frequent assessments and close monitoring for patients at high risk for MODS is essential for early detection. There have been different scoring systems constructed to help establish the severity of dysfunction and illness. Some scoring systems include: Acute Physiology and Chronic Health Evaluation II and III (APACHE II and APACHEIII), sequential organ failure assessment (SOFA), and MODS score. Once the illness is scored, it is important to be monitoring vitals, hemodynamics, and laboratory tests.

Treatment

Early identification is critical. The initial injury needs to be identified and quickly treated. Therapy is to decrease the infection (antibiotics/removal of source). Often times, a combination of antibiotics will be given treat more organisms (gram negative and gram positive). Supplemental oxygen is delivered to keep up with the body’s demand. Blood transfusions are often administered due to decreased hemoglobin. Intravenous fluids are administered to restore intravascular fluid. Isotonic crystalloid solutions and colloids are often the solutions given to maintain volume. Supporting the specific organ system being affected is also necessary. For example: mechanical ventilation, enternal feedings, and dialysis.

Links

References

- Martin, L. L., Cheek, D. J., & Morris, S. E. (2014). Shock, multiple organ dysfunction syndrome, and burns in adults. In K. L. McCance & S. E. Huether (Eds.), Pathophysiology: the biologic basis for disease in adults and children (7 ed. pp. 1668-1698). St. Louis, MO: Elsevier.