Skin Failure

What Happens When This Organ System Fails?

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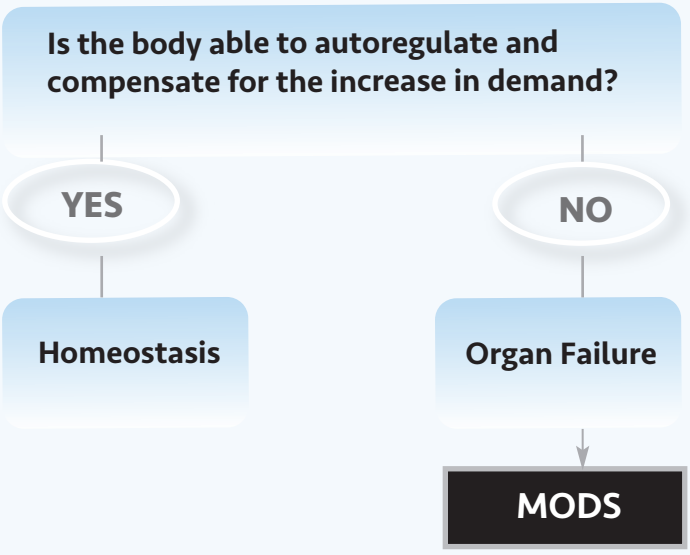
Multiple Organ Dysfunction Syndrome (MODS) is the physiologic abnormality involving two or more organ systems simultaneously. It's a process rather than a single event and is categorized as a dysfunction because, while potentially life-threatening, it can be reversed. In acutely ill patients, the altered organ function hinders the body's ability to maintain homeostasis without intervention. MODS typically involves the following organ functions: respiratory, cardiovascular, renal, hepatic, neurologic, hematologic and may also include the immune and endocrine systems.

Primary MODS begins with an initial insult causing dysfunction to the organ (i.e.disease, infection, trauma). Ischemia caused by hypoperfusion – *a reduction in the amount of blood flow to the organ* – triggers an inflammatory response. Secondary MODS follows with an exaggerated inflammatory response, causing endothelial damage and the potential for hypercoagulation of the blood. Clots may develop in the vital organs. Systemic hyperinflammation occurs throughout the body. This massive inflammatory response raises cardiac output and venous return while decreasing oxygen (hyperdynamic circulation). Calorie and fuel requirements begin to rise along with oxygen needs (hypermetabolism). But impaired perfusion reduces the oxygen getting to the cells. With each incident, a chain reaction of adverse events is set in motion, ultimately leading to tissue necrosis and complete organ failure. (*See page 2 algorithm.*)



So, what happens when the skin fails? The integumentary system is the largest organ in the human body and includes the epidermis, dermis, hypodermis, associated glands, hair and nails. It functions as a physical barrier between the external and internal environments, protecting against pathogens, promoting immunity and initiating wound healing. The skin is indispensible. But the debate still wages among healthcare workers on the concept of total skin failure. In the early 90s, John La Puma connected the dots between organ and skin failure. His view was if organs such as the heart or kidneys were failing it stood to reason that the skin could fail as well.

Three Main Factors Affecting Blood Flow

- Endothelial Function
- Mechanical Forces
- Tissue Environment

Skin failure is categorized as acute, chronic and end-of-life. In the acutely ill patient, changes in the skin are directly linked to the illness at hand. Hypoperfusion causes the skin and underlying tissue to die synchronous with multiple organ failure. Further opinion identifies that when tissue tolerance is so severely compromised, cells cannot survive in the midst of impairments such as hypoxia or mechanical stresses. This included pressure injuries occurring concurrently with skin failure on the same patient.

While there is no clear-cut criteria for diagnosing acute skin failure (ASF), there is agreement that ASF is not a pressure injury. As such it can't always be prevented or treated with conventional methods. The fact remains that the skin is the largest organ in the body and, while often excluded from MODS, it is as susceptible to failure as any other organ system.

Not all Skin Breakdown can be Avoided

The Progression of Multiple Organ Dysfunction Syndrome (MODS)

Primary MODS — The direct result of a well-defined insult in which organ dysfunction occurs early and can be attributable to the insult itself

First Insult to the Organ

Ischemia — An inadequate blood supply to an organ or part of the body

Hypoperfusion
Reduction in the amount of blood flow marked by hypotension and coldness of the skin

Inflammatory Response
Neutrophils & macrophages become primed at areas of tissue damage caused by bacteria, trauma, etc., with resultant edema

Primed neutrophils & macrophages release mediators that damage the endothelial tissue

Secondary MODS — A consequence of a host response identified within Systemic Inflammatory Response Syndrome (SIRS)

Inflammation amplified due to change in leukocytes signaling a proinflammatory state

Second Insult to the Organ

Additional tissue injury, infection, organ ischemia

Systemic Hyperinflammation
Inflammation that occurs throughout the whole body

Hypercoagulation
Increased coagulation with the potential of causing blood clots that can travel to other vital organs

Endothelial Damage
Damage to the thin layer of cells lining various organs and cavities of the body, such as blood, heart and lymphatic vessels

Massive Inflammatory Response
Large scale inflammation throughout the entire body marked by fast heart rate, low blood pressure and low or high white blood cell count

Each of the above events contribute to:

- **Impaired Clotting**
- **Microvascular thrombosis**
- **Impaired microvascular circulation**
- **Organ ischemia**
- **Vasopermeability with fluids and protein leaking into interstitial fluid**
- **Plasma cascades**
- **Vasodilation**
- **Chemotaxis**
- **Coagulation**
- **Massive amounts of chemical mediators poured into tissues and systemic circulation**
- **Neutrophils adhering to the endothelium**
- **Respiratory burst**
- **Oxygen-free radicals**
- **Acidosis**
- **Endothelial damage**
- **Tissue cell damage**

Ultimately causing:

Tissue Necrosis

Hyperdynamic Circulation

- Cardiac output
- Venous return
- Oxygen delivery

Hypermetabolism

- Calorie requirements
- Fuel needs
- Oxygen needs

Maldistribution of Blood Flow

- Impaired perfusion
- Decreased oxygen to cells
  - Vasodilation
  - Vasoconstriction
  - Increased capillary permeability

BACKGROUND

Mr. F was a 73 year old male with a medical history of gastrointestinal bleed and Parkinson's Disease. A motor vehicle accident left him with multiple fractures and a closed head injury. He developed respiratory failure, became ventilator dependent and was later transferred to a long-term acute care facility for ventilator weaning.

METHOD

Upon admission to the LTAC facility, Mr. F was found to be at high risk for pressure injuries and a pressure-relieving device was implemented along with other AHRQ preventive measures.

RESULT

Mr. F had no skin breakdown upon admission, however during his 55-day stay at the long-term acute care facility he developed **26 nosocomial wounds**. On day fifty-five, Mr. F died. An autopsy report revealed Multiple Organ Dysfunction Syndrome (MODS) as the cause of death. Recognizing the skin as an organ system that failed during the MODS process helped identify a major causative factor for the wounds that developed.

CONCLUSION

The skin is the largest organ of the body and is often is not considered in MODS, however, it is as susceptible to failure as any other organ system. The massive inflammatory response in MODS alters endothelial function and tissue environment, ultimately leading to tissue necrosis. Although mechanical forces (pressure and shear) were contributing factors in this patient's wounds, Multiple Organ Dysfunction Syndrome made tissue necrosis inevitable. Until the pathophysiology of MODS-like occurrences is fully understood, pressure injury formation cannot be completely avoided.

Day 1 — Zero Pressure Injuries

DEFINITIONS

- **Microvascular thrombosis:** Characterized by disordered clot formation and disordered inflammation.
- **Impaired microvascular circulation:** Damage to the larger vessels/arteries.
- **Organ ischemia:** Insufficient blood flow to one of the body's organs.
- **Vasopermeability:** Permeability of a blood vessels. The extent to which a blood vessel is permeable.
- **Interstitial fluid:** Fluid found in the spaces around the cells.
- **Vasodilation:** Dilation of the blood vessels
- **Chemotaxis:** The phenomenon by which cell movement is directed in response to an extracellular chemical gradient.
- **Neutrophils:** The biggest number of white blood cells that kill and digest bacteria and fungi to help a body fight infections and heal wounds.
- **Respiratory burst:** The increase in cell metabolism and oxygen consumption, coupled with the release of reactive oxygen species (ROS)
- **Oxygen-free radicals:** Reactive molecules which can react with every cellular component.
- **Macrophages:** Specialized cells involved in the detection, phagocytosis and destruction of bacteria and other harmful organisms.
- **Acidosis:** A condition in which there is too much acid in the body fluids.

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