DEFINITION
Malignant hyperthermia (MH) is defined as a potentially lethal syndrome caused by a hypermetabolic state that can be precipitated by the administration of volatile inhalation anesthetic agents and depolarizing anesthetic agents, such as succinylcholine. The triggering agent causes an increase in intracellular calcium ion concentration producing a chain of reactions. Emphasis is placed on the rapid recognition of signs and symptoms related to hypermetabolism. These include, but are not limited to, tachycardia, dysrhythmias, tachypnea, hypercarbia, respiratory acidosis, metabolic acidosis, masseter muscle rigidity, generalized muscle rigidity, elevated body temperature, cyanosis, myoglobinuria, rhabdomyolysis, skin mottling, hyperkalemia, diaphoresis, rapid temperature elevation, hemodynamic instability, and coagulopathy. Potential triggering agents include, but are not limited to, volatile inhalation agents and succinylcholine.

PATHOPHYSIOLOGY
MH is a fulminating hypermetabolic state occurring in genetically predisposed individuals when exposed to triggering agents. The primary defect in MH resides in the skeletal muscle at the level of calcium transfer in the muscle cell. The resultant intracellular hypercalcemia leads to hypermetabolism, which in turn results in increased oxygen consumption, and disruption of the cell membranes. Because of the inability of muscle tissue to return to a resting state in the susceptible patient, the primary signs of MH begin to appear.

INCIDENCE AND MORTALITY
The incidence of MH is variously reported to be 1:15,000 in children and 1:50,000 in adults who receive a general anesthetic. Mortality has been reduced from as high as 70% to less than 10%. The major factors in the decreased incidence of MH is related to increased awareness, introduction of Dantrolene, the reliable predictor - caffeine-halothane contracture test, and sophisticated monitoring techniques.

POPULATION AFFECTED
Every patient who is about to undergo general anesthesia should be screened for a family history of MH. Approximately 50% of MH-susceptible individuals have had a previous triggering anesthetic without developing MH. MH is rare in infants, and the incidence decreases after 50 years of age. Males more commonly develop MH than females.

SOCIOECONOMIC FACTORS
Patient with known susceptibility must deal with the terrible preoperative anxiety. They need continual reassurance that everyone is aware of the potential and a plan of anesthesia has been developed to avoid an occurrence. Beyond the psychological and emotional factors, there are physical sequelae to an episode of MH, and the treatment is expensive.

FUTURE IMPLICATIONS
Other drugs (Haldol and phenothiazine) and physiologic conditions (Neuroleptic malignant syndrome) have been known to stimulate a syndrome that closely resembles MH. Other physiologic indicators of an MH-like syndrome may include rhabdomyolysis and myoglobinuria. Extreme stress and heat stroke also may be precipitating factors.

PREOPERATIVE ASSESSMENT
Identify physiological status and assess for risk factors:
- Family history
- Previous clinical episode (e.g., sign and symptoms of MH during anesthesia)
- Diseases possibly related to MH
  - Central-core disease
  - Duchenne muscular dystrophy
  - King-Denborough syndrome
  - Schwartz-Jampel syndrome
  - Fukyama type congenial muscular dystrophy
  - Becker muscular dystrophy
Periodic paralysis
  < Neuroleptic malignant heat syndrome
  < Myotonia congenital
  < Sarcoplasmic reticulum adenosine triphosphate
  < Deficiency syndrome and mitochondrial myopathy

**DIAGNOSIS OF MH**
  < Unanticipated (e.g., doubling or tripling) increase in end-tidal CO₂
  < Unexpected tachycardia, tachypnea and jaw muscle rigidity (prolonged masseter spasm)
  < Respiratory and metabolic acidosis
  < Total body rigidity

**Masseter Muscle Rigidity**
  < severe, sustained contracture of the jaw muscle, after administration of succinylcholine- causes difficulty in intubation
  < not relieved by further does of succinylcholine or a nondepolarizing muscle relaxant.
  < MH may follow immediately, after a delay of 20 minutes or more

**Fever**
  < may see an increase of 1 degree C every few minutes
  < palpable warmth in viscera, anesthesia tubing, soda lime canisters (with soda lime possible turning blue)

**General Observations**
  < metabolic acidosis

**Renal**
  < myoglobinuria (eg., cola-colored urine)
  < Urinary output

**Cardiovascular**
  < tachycardia
  < progression of the syndrome can lead to dysrhythmias such as VF and sudden cardiac arrest
  < urinary output

**Laboratory Test Abnormalities**
  < increase in creatine phosphokinase, lactate dehydrogenase, myoglobin, and carbon dioxide pressure
  < reduced pH
  < abnormal coagulation studies
  < magnesium, calcium, phosphate, and potassium imbalance

**Muscle Rigidity**
  < most patient exhibit whole-body rigidity
  < absence of muscle rigidity does not rule out MH

**Skin**
  < generalized erythematous flush
  < mottling of skin
  < cyanosis secondary to generalized vasoconstriction and accelerated oxygen consumption by muscles
  < diaphoresis