CONDITION

Malignant hyperthermia

Malignant hyperthermia is an inherited reaction to certain anesthetic medicines that causes a dangerous rise in muscle activity and body temperature.

WHAT IT IS
Inherited severe reaction to certain anesthetic medicines

BODY SYSTEM
Muscles, metabolism, heart and circulation

MAIN SYMPTOMS
Rising carbon dioxide, muscle rigidity, rapid heartbeat, high temperature

WHAT CAUSES IT
Inherited muscle calcium-control changes plus anesthetic triggers

HOW IT IS DIAGNOSED
Muscle contracture testing or a causative genetic variant

MAIN TREATMENT
Stop triggers, dantrolene, cooling, and intensive supportive care

CAN IT BE CURED?
No, inherited susceptibility remains lifelong

IS IT AN EMERGENCY?
Yes, any suspected reaction during or after anesthesia

LONG-TERM OUTLOOK
Normal daily life when triggering anesthetics are avoided

Overview

Malignant hyperthermia is a rare but serious reaction to certain medicines used during general anesthesia. It causes muscle cells to release too much calcium. The muscles then contract and use energy at an extreme rate, producing heat, acid, and carbon dioxide.

Despite the name, a high temperature may not be the first sign. Rising carbon dioxide, a fast heartbeat, or muscle rigidity often appears earlier. The reaction can worsen quickly without treatment.

People who are susceptible are usually well in everyday life. They may have had previous anesthetics without a problem. A reaction happens only when a susceptible person is exposed to a triggering medicine, although related muscle problems after extreme heat or exercise have been reported in some people with certain genetic changes.

Malignant hyperthermia is not an allergy, infection, or contagious illness. It is an inherited condition affecting how skeletal muscles control calcium.

A reaction can usually be avoided when the anesthesia team knows about the risk. Safe, non-triggering anesthesia options are available for surgery, childbirth, dental treatment, and other procedures.

Symptoms

Symptoms most often begin during general anesthesia or soon afterward. Because the person may be unconscious, the anesthesia team usually notices the first signs through monitoring equipment.

Possible signs include:

Not every reaction looks the same. A person may not have all these signs, and the speed of onset can differ. High temperature alone does not confirm malignant hyperthermia.

Muscle cells can break down during a reaction. This is called rhabdomyolysis . It releases muscle proteins and potassium into the blood, which can affect the kidneys and heart.

- An unexpected, continuing rise in exhaled carbon dioxide
- A fast or irregular heartbeat
- Tight or rigid muscles, sometimes first noticed in the jaw
- Rapid breathing if the person is breathing without a ventilator
- A fast-rising body temperature, often a later sign
- Acid building up in the blood
- High blood potassium
- Dark brown or cola-colored urine from muscle breakdown

Causes and risk factors

The main triggers are volatile anesthetic gases and succinylcholine, a muscle-relaxing medicine sometimes used to place a breathing tube. Other types of anesthesia do not trigger malignant hyperthermia, including local and regional anesthesia and many intravenous medicines.

Susceptibility is usually linked to a genetic change affecting calcium movement inside muscle

cells. Changes in the RYR1 gene are the most common known cause. Changes in CACNA1S and, more rarely, STAC3 can also be involved. Some susceptible people do not have a currently identifiable genetic change.

The condition often follows an autosomal dominant inheritance pattern. This means a person with a causative genetic change may pass it to a child. However, inheritance can be more complicated in some families, and not everyone carrying a genetic change has had a reaction.

Factors that raise concern include:

Having received general anesthesia safely before does not rule it out. A reaction may occur after several earlier exposures without difficulty.

- A previous suspected malignant hyperthermia reaction
- A close relative with confirmed susceptibility
- An unexplained death or severe reaction during anesthesia in the family
- A known causative genetic variant
- Certain inherited muscle conditions, including some forms of central core disease

Diagnosis

During an acute reaction, treatment begins immediately based on the pattern of signs. Anesthesia staff do not wait for a confirmatory test.

Blood and urine tests help assess the reaction and its complications. These may measure blood acidity, carbon dioxide, potassium, creatine kinase from damaged muscle, and myoglobin released into blood or urine. These findings support the diagnosis but do not, by themselves, prove lifelong susceptibility.

After recovery, two main forms of testing can investigate susceptibility.

A muscle contracture test measures how a fresh muscle sample responds to caffeine and halothane under laboratory conditions. It is called the caffeine-halothane contracture test in North America and the in vitro contracture test in Europe. The biopsy and testing must be performed at a specialist center.

Genetic testing can identify a disease-causing change in genes such as RYR1 or CACNA1S. A confirmed causative variant can establish susceptibility and may allow relatives to have targeted testing. However, a negative genetic result does not rule out malignant hyperthermia because not every causative change is known or detected.

Medical records from any suspected reaction are useful. Details such as anesthetic medicines,

monitoring results, blood tests, treatment, and response can help a specialist assess what happened.

Treatment and management

A malignant hyperthermia reaction is treated as an emergency. The anesthesia team stops all triggering medicines and gives high-flow oxygen while switching to a non-triggering anesthetic plan if the procedure must continue.

The main medicine is dantrolene . It reduces the abnormal release of calcium inside muscle cells. Additional doses may be needed according to the person's response and specialist protocols.

Other treatment may include:

The person is monitored closely after the initial reaction is controlled because symptoms can return. Care commonly continues in a recovery or critical-care setting until temperature, muscle injury, heart rhythm, and laboratory results are stable.

Long-term management focuses on preventing another exposure. Your health record should clearly state confirmed or suspected malignant hyperthermia susceptibility. Wearing a medical identification bracelet or carrying an alert card can also help in an emergency.

- Active cooling when body temperature is high
- Intravenous fluids
- Treatment for high potassium and abnormal blood acidity
- Medicines for certain abnormal heart rhythms
- Monitoring and support for kidney function
- Repeated blood, urine, temperature, and heart checks

Complications

Without prompt treatment, the intense muscle activity can affect several organs. Possible complications include:

Modern monitoring, rapid recognition, and access to dantrolene have greatly improved treatment. The risk of complications is higher when recognition or treatment is delayed.

Symptoms can sometimes return after seeming to settle. Continued observation after a reaction is therefore different from routine recovery after anesthesia.

- Severe muscle breakdown
- Dangerous potassium levels and abnormal heart rhythms
- Acute kidney injury
- Problems with blood clotting
- Fluid buildup in the lungs
- Brain injury related to extreme temperature or circulation problems
- Cardiac arrest and death

Prevention

The inherited susceptibility itself cannot currently be prevented or removed. An episode can usually be prevented by avoiding triggering anesthetic medicines.

Before any procedure involving anesthesia or sedation, tell the anesthesia team if you or a relative has:

Do this even if the procedure seems minor or you have previously received anesthesia safely. The team can prepare the anesthesia machine, select non-triggering medicines, and make sure emergency treatment is available.

Local anesthesia, nerve blocks, spinal or epidural anesthesia, and many intravenous anesthetics are not malignant hyperthermia triggers. The safest choice still needs to match the procedure and your health needs.

Close relatives may benefit from assessment at a malignant hyperthermia or inherited muscle-condition service. Until risk has been clarified, clinicians may advise treating an at-risk relative as susceptible when anesthesia is planned.

- Confirmed malignant hyperthermia susceptibility
- A causative genetic result
- A previous unexplained reaction during anesthesia
- A family history of severe anesthesia problems

Living with it and what to expect

Most susceptible people have no symptoms in ordinary life. Malignant hyperthermia does not usually cause ongoing fever, daily muscle rigidity, or progressive loss of strength. Many people

live without limits apart from taking precautions around anesthesia.

You can still have operations and procedures. Planning may take extra time because the anesthesia team must use a trigger-free technique and prepare suitable equipment. Emergency surgery is also possible when staff know to treat you as susceptible.

Keep copies of test results, specialist letters, and records from any previous reaction. Electronic records may not be shared between every hospital, dental office, or country. A medical alert card or bracelet provides information if you cannot speak for yourself.

Some RYR1-related conditions can also be associated with muscle weakness, muscle pain, or muscle breakdown after intense exercise, illness, or heat. This does not affect everyone with malignant hyperthermia susceptibility. Repeated severe cramps, weakness, or dark urine after exertion deserves medical assessment rather than being assumed to be part of the condition.

Family members may have different test results and experiences. One relative's safe anesthetic does not prove that another relative is not susceptible. Genetic counseling can help explain inheritance, testing options, and what a result means for children or siblings.

When to get medical help

Emergency help is needed for a suspected reaction. During anesthesia, the clinical team will begin emergency treatment. After a recent procedure, seek emergency help for rapidly worsening symptoms such as severe muscle rigidity, a rapidly rising temperature, breathing difficulty, confusion, a very fast or irregular heartbeat, or dark brown urine.

Severe muscle pain, weakness, collapse, or dark urine after extreme heat or strenuous exercise also needs urgent assessment. These symptoms can indicate major muscle breakdown from several possible causes.

A mild fever after surgery is not automatically malignant hyperthermia. Many other conditions can cause fever. However, a fever that rises quickly or occurs with rigidity, breathing problems, confusion, or a racing heartbeat needs emergency attention.

Routine, non-emergency follow-up is appropriate if you have a family history, an old unexplained anesthesia reaction, or questions about testing. Arrange this before planned surgery when possible so records can be reviewed and a safe anesthesia plan documented.

Common questions

Can I have general anesthesia if I am susceptible?

Yes. An anesthesia team can use a trigger-free technique that avoids volatile anesthetic gases and succinylcholine. Planning in advance allows the facility to prepare appropriate equipment, medicines, and monitoring.

Is malignant hyperthermia an allergy?

No. An allergy involves the immune system. Malignant hyperthermia is an abnormal response inside muscle cells caused by inherited susceptibility and exposure to specific anesthetic triggers.

Can I have a reaction even if earlier anesthetics were safe?

Yes. Some susceptible people have several uneventful anesthetics before their first reaction. Previous safe anesthesia does not reliably rule out susceptibility.

Does every high fever during surgery mean malignant hyperthermia?

No. Fever has many causes, and body temperature may rise late in malignant hyperthermia. Anesthesia staff consider the complete pattern, including carbon dioxide levels, heart rate, muscle rigidity, blood acidity, and the medicines used.

Will my children inherit it?

They may. Many cases follow an autosomal dominant pattern, meaning each child of someone with a causative variant may inherit that variant. The exact family risk is best established from confirmed testing and genetic counseling.

Can malignant hyperthermia happen without anesthesia?

A classic malignant hyperthermia crisis is triggered by specific anesthetic medicines. Some people with related RYR1 changes can experience muscle breakdown with extreme heat, illness, or strenuous exercise, but this is not the usual presentation and does not occur in everyone.

Sources

- GeneReviews: Malignant Hyperthermia Susceptibility , NCBI Bookshelf
- Managing a Crisis , Malignant Hyperthermia Association of the United States
- Safe and Unsafe Anesthetics , Malignant Hyperthermia Association of the United States
- Recognising and managing a malignant hyperthermia crisis , European Malignant Hyperthermia Group
- Hopkins PM, Girard T, Dalay S, and colleagues. "Malignant hyperthermia 2020: Guideline from the Association of Anaesthetists." Anaesthesia . 2021;76(5):655-664



- Gonsalves SG, Dirksen RT, Sangkuhl K, and colleagues. "Clinical Pharmacogenetics Implementation Consortium guideline for the use of potent volatile anesthetic agents and succinylcholine in the context of RYR1 or CACNA1S genotypes." Clinical Pharmacology & Therapeutics . 2019;105(6):1338-1344