CONDITION

Hydrofluoric acid poisoning

Hydrofluoric acid poisoning is a potentially serious toxic injury caused by skin contact, inhalation, or swallowing.

WHAT IT IS
Toxic injury from hydrogen fluoride or hydrofluoric acid exposure

BODY SYSTEM
Skin, eyes, lungs, digestive tract, heart, and nerves

MAIN SYMPTOMS
Burning pain, skin damage, breathing trouble, irregular heartbeat

WHAT CAUSES IT
Contact with hydrogen fluoride or hydrofluoric acid

HOW IT IS DIAGNOSED
Exposure history, examination, ECG, and blood electrolyte tests

MAIN TREATMENT
Immediate decontamination, calcium treatment, monitoring, and supportive care

CAN IT BE CURED?
Sometimes - prompt treatment can stop toxicity

IS IT AN EMERGENCY?
Yes - any known or suspected exposure

LONG-TERM OUTLOOK
Often good after rapid treatment; severe exposure can be fatal

Overview

Hydrofluoric acid poisoning happens after exposure to hydrogen fluoride or to hydrofluoric acid, which is hydrogen fluoride dissolved in water. Exposure can affect the skin, eyes, lungs, or digestive tract.

Unlike many acid burns, hydrofluoric acid does more than damage the surface. Fluoride ions can travel into deeper tissue, where they bind to calcium and magnesium. These minerals help nerves, muscles, and the heart work normally. A significant exposure can therefore cause dangerous changes in heart rhythm, sometimes before the skin injury looks severe.

Hydrofluoric acid is used in glass etching, metal cleaning, semiconductor production, and some industrial processes. It may also be present in certain rust removers, masonry cleaners, and automotive wheel-cleaning products.

Pain and visible skin changes can be delayed, especially with more dilute products. A small-looking exposure should not be used to judge whether poisoning is serious. Any known or suspected exposure needs immediate specialist advice and emergency assessment.

Symptoms

Symptoms depend on the concentration, amount, route of exposure, and length of contact. Concentrated products may cause immediate pain and tissue damage. More dilute products may not hurt until hours later.

Skin exposure can cause:

Eye exposure can cause severe pain, tearing, redness, sensitivity to light, and blurred vision. Damage to the clear front surface of the eye, called the cornea, may threaten sight.

Breathing hydrogen fluoride gas, mist, or fumes may cause coughing, throat irritation, chest tightness, wheezing, or shortness of breath. Lung inflammation and fluid buildup can sometimes appear after a delay.

Swallowing hydrofluoric acid can burn the mouth, throat, food pipe, and stomach. Possible symptoms include drooling, vomiting, abdominal pain, difficulty swallowing, or vomiting blood.

When fluoride affects the whole body, symptoms may include weakness, muscle cramps, numbness, confusion, seizures, low blood pressure, or an irregular heartbeat. These effects are related to disturbances in calcium, magnesium, and potassium levels.

- Burning, deep pain, or tingling
- Redness, swelling, or pale areas
- Blisters or open wounds
- Pain beneath a fingernail or toenail
- Tissue damage that becomes clearer over time

Causes and risk factors

Poisoning occurs when hydrogen fluoride or hydrofluoric acid touches the body, is breathed in, or is swallowed. It is not contagious.

Occupational exposure is an important risk. People who work with glass, metals, electronics, chemical manufacturing, petroleum processing, or industrial cleaning products may encounter hydrofluoric acid.

Risk outside the workplace may come from automotive or household products containing fluoride compounds. The concentration may not be obvious from the product name, so the label and safety data sheet are important.

Factors associated with more serious poisoning include:

Even a relatively small skin exposure can be serious if the product is concentrated. A wider exposure to a dilute product can also allow enough fluoride to enter the body to cause systemic poisoning, meaning effects beyond the original contact area.

- A concentrated product
- Contact with a large area of skin
- Exposure lasting more than a brief period
- Contact involving the face, eyes, hands, or nails
- Breathing fumes in an enclosed space
- Swallowing any amount
- Delayed removal of contaminated clothing or delayed rinsing
- Existing heart, lung, or kidney problems

Diagnosis

Diagnosis starts with identifying a possible exposure. The product container, label, concentration, safety data sheet, and estimated time of contact can help the emergency team. Do not delay leaving for emergency care to collect this information.

There is no single test that rules hydrofluoric acid poisoning in or out. The diagnosis is based on the exposure history, symptoms, examination, and signs of tissue injury.

An electrocardiogram, or ECG, records the heart's electrical activity. It may show changes caused by low calcium, low magnesium, high potassium, or direct fluoride toxicity. Continuous heart monitoring may be needed after a significant exposure.

Blood tests commonly check calcium, magnesium, potassium, kidney function, and the body's acid balance. These tests may need to be repeated because abnormal results can develop over time. Blood fluoride testing is not usually available quickly enough to guide emergency treatment.

Eye exposure requires prompt examination and thorough irrigation. An eye specialist may assess the cornea and other eye structures. Breathing symptoms may lead to oxygen measurements, chest imaging, or other tests for lung injury.

Treatment and management

Treatment begins with stopping exposure and removing the chemical. This must be done without exposing another person.

Move away from fumes into fresh air if it is safe to do so. Do not enter a contaminated enclosed space without appropriate protective equipment. Remove contaminated clothing and jewelry while avoiding bare-hand contact with the chemical. Rinse affected skin or eyes immediately with plenty of clean, lukewarm water.

Do not delay rinsing while looking for a special solution. Do not try to neutralize hydrofluoric acid with another chemical because this can produce heat and worsen injury.

If hydrofluoric acid has been swallowed, do not make yourself vomit. Do not eat, drink, or take a neutralizing product unless a poison center or emergency professional directs you to do so.

After skin decontamination, calcium gluconate may be applied as a gel to bind fluoride near the affected area. Persistent pain or deeper injury may require calcium delivered by a trained professional through local injection, a vein, or an artery. Calcium gluconate gel must not be placed in the eye.

Hospital care may include:

Treatment may continue until pain is controlled, tissue injury has stopped progressing, heart monitoring is reassuring, and electrolyte levels remain stable. Serious exposures may require intensive care.

- Continuous ECG and blood pressure monitoring
- Repeated calcium, magnesium, and potassium testing
- Calcium or magnesium replacement
- Oxygen and breathing support
- Pain relief and specialist burn care
- Treatment of abnormal heart rhythms
- Surgery for dead or deeply damaged tissue

Complications

The main local complication is deep chemical injury. Damage may extend into fat, muscle, tendons, bone, or the tissue beneath a nail. Healing can involve infection, scarring, nail loss, stiffness, reduced sensation, or limited movement. Some wounds require removal of damaged

tissue or skin grafting.

Eye complications include corneal injury, ongoing inflammation, scarring, and loss of vision.

Inhalation may lead to severe airway irritation or pulmonary edema, which means fluid in the lungs. Breathing problems can worsen after the person has left the exposure area.

Fluoride entering the bloodstream may cause dangerously low calcium or magnesium, abnormal potassium levels, low blood pressure, seizures, and life-threatening heart rhythms. Cardiac arrest and death are possible after severe exposure.

These complications are not inevitable. Rapid decontamination, fluoride-binding treatment, and monitoring can reduce the risk.

Prevention

Most hydrofluoric acid exposures are preventable. The safest approach is to avoid products containing it when a less hazardous alternative can do the job.

At work, follow the product-specific safety procedures and training. Use the protective gloves, clothing, eye protection, ventilation, and respiratory protection required for that task. Not every glove material protects against hydrofluoric acid.

Keep products in their original, clearly labelled containers. Never transfer the chemical to a food or drink bottle. Do not mix it with other cleaners or chemicals.

Before using a product, check the label and safety data sheet for hydrogen fluoride, hydrofluoric acid, ammonium bifluoride, or related fluoride compounds. Plan how to reach running water and emergency help before beginning work.

Store products securely and away from children. Dispose of them through an approved hazardous-waste service rather than pouring them into a drain or ordinary rubbish.

Workplaces using hydrofluoric acid need an exposure-response plan. This includes accessible washing facilities, appropriate first-aid materials, staff training, and a clear route to emergency care.

Living with it and what to expect

Hydrofluoric acid poisoning is usually an acute event rather than a continuing illness. If exposure is recognized quickly and there is no deep injury or systemic toxicity, symptoms may settle as the area heals. Follow-up is still important because tissue damage can become more visible after the initial assessment.

Superficial skin injuries may heal over days to weeks. Deeper burns can take longer and may need repeated wound care or surgery. Injuries involving the hands may require physiotherapy or occupational therapy to preserve movement and function.

After an eye exposure, follow-up checks may continue until the cornea has healed and vision is stable. Lung follow-up may be needed if coughing, breathlessness, or abnormal tests persist.

People who survive systemic poisoning without major tissue, heart, or brain injury may recover without ongoing fluoride toxicity. Long-term problems are more likely to result from the original burn, eye injury, lung injury, or a period of reduced oxygen supply than from fluoride remaining in the body.

Routine follow-up may include wound checks, repeat blood tests, eye examinations, or rehabilitation. New pain, worsening redness, discharge, fever, reduced movement, or changes in vision or breathing should be assessed promptly rather than waiting for the next planned appointment.

When to get medical help

Treat any known or suspected hydrofluoric acid exposure as an emergency. Begin rinsing immediately and call emergency services or your regional poison center. Pain does not need to be present before you seek help.

Emergency help is especially important after:

Do not drive yourself if you feel unwell or if systemic poisoning is possible. Bring the product label or safety data sheet if this can be done without delaying care or causing further exposure.

After emergency treatment, attend planned wound, eye, lung, or burn follow-up. Contact the treating service sooner if pain returns, the wound deepens, movement decreases, or symptoms begin to worsen.

- Any eye exposure or swallowing
- Breathing fumes, mist, or gas
- Exposure to a concentrated or unknown-strength product
- Contact over a large area or beneath a nail
- Chest pain, breathing difficulty, weakness, confusion, or muscle cramps
- Fainting, seizures, or a fast or irregular heartbeat

Common questions

Can a hydrofluoric acid burn be painless at first?

Yes. Lower-concentration products can cause delayed pain and skin changes. Fluoride may still be moving into deeper tissue during this time. Lack of immediate pain does not make the exposure safe.

Is hydrofluoric acid the same as hydrochloric acid?

No. Both can cause chemical burns, but hydrofluoric acid also releases fluoride ions that bind calcium and magnesium. This creates a risk of deep tissue injury and dangerous heart rhythm changes.

Can a small hydrofluoric acid burn be dangerous?

Yes. Risk is affected by concentration, contact time, location, and the total amount absorbed. A small area exposed to a concentrated product can cause serious poisoning.

Should I wash hydrofluoric acid off with water?

Yes. Start rinsing immediately with plenty of water. Do not wait for calcium gel or another special treatment before beginning decontamination. Emergency and poison-center advice is still needed after rinsing starts.

Will the injury leave a scar?

Superficial injuries may heal without major scarring. Deep burns can cause scars, nail damage, altered sensation, or reduced movement. The final appearance may not be clear until the wound has fully healed.

Should I keep calcium gluconate gel at home?

People who use hydrofluoric acid at work should follow their workplace's exposure plan. Calcium gluconate gel is not a substitute for immediate rinsing or emergency care, and it is not suitable for every exposure site. Home users should avoid hydrofluoric acid products when safer alternatives are available.

Sources

- Agency for Toxic Substances and Disease Registry. Medical Management Guidelines for Hydrogen Fluoride .
- Centers for Disease Control and Prevention. Hydrogen Fluoride: Chemical Fact Sheet .
- National Institute for Occupational Safety and Health. NIOSH Pocket Guide to Chemical Hazards: Hydrogen Fluoride .

- UK Health Security Agency. Hydrogen Fluoride: Properties, Incident Management and Toxicology .
- McKee D, Thoma A, Bailey K, Fish J. A review of hydrofluoric acid burn management . Plastic Surgery. 2014;22(2):95-98.