

Smoke Inhalation

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Smoke Inhalation Overview

The number one cause of death related to fires is smoke inhalation. An estimated 50%-80% of fire deaths are the result of smoke inhalation injuries rather than [burns](#).

Smoke inhalation occurs when you breathe in the products of combustion during a fire. Combustion results from the rapid breakdown of a [substance](#) by heat (more commonly called burning). Smoke is a mixture of heated particles and gases. It is impossible to predict the exact composition of smoke produced by a fire. The products being burned, the temperature of the fire, and the amount of [oxygen](#) available to the fire all make a difference in the type of smoke produced.

Smoke Inhalation Causes

Smoke inhalation damages the body by simple asphyxiation (lack of oxygen), chemical irritation, chemical asphyxiation, or a combination of these.

- **Simple asphyxiants**
 - Combustion can simply use up the oxygen near the fire and lead to death when there is no oxygen for a person to breathe.
 - Smoke itself can contain products that do not cause direct harm to a person, but they take up the space that is needed for oxygen. [Carbon dioxide](#) acts in this way.

- **Irritant compounds**

- Combustion can result in the formation of chemicals that cause direct **injury** when they contact the skin and **mucous** membranes.
- These substances disrupt the normal lining of the **respiratory** tract. This disruption can potentially cause swelling, **airway** collapse, and respiratory distress.
- Examples of chemical irritants found in smoke include sulfur dioxide, **ammonia**, **hydrogen chloride**, and chlorine.

- **Chemical asphyxiants**

- A fire can produce compounds that do damage by interfering with the body's oxygen use at a cellular level.
- Carbon monoxide, **hydrogen cyanide**, and hydrogen sulfide are all examples of chemicals produced in fires that interfere with the use of oxygen by the **cell** during the production of energy.
- If either the delivery of oxygen or the use of oxygen is inhibited, cells will die.
- **Carbon monoxide poisoning** has been found to be the leading cause of death in smoke inhalation.

Smoke Inhalation Symptoms

Numerous signs and symptoms of smoke inhalation may develop. Symptoms may include **cough**, shortness of breath, **hoarseness**, **headache**, and **acute** mental status changes.

Signs such as soot in the airway passages or changes in **skin color** may be useful in determining the degree of injury.

- **Cough**

- When the mucous membranes of the respiratory tract get irritated, they secrete more **mucus**.
- Bronchospasm and increased mucus production lead to **reflex** coughing.
- The mucus may be either clear or black depending on the degree of burned particles deposited in the **lungs** and **trachea**.

- **Shortness of breath**

- This may be caused by direct injury to the respiratory tract, leading to decreased oxygen delivery to the blood, the decreased ability of blood

to carry oxygen because of chemicals in smoke, or the inability of the body's cells to use oxygen.

- The patient may have rapid **breathing** as they attempt to compensate for these injuries.

- **Hoarseness or noisy breathing**

- This may be a sign that fluids are collecting in the upper airway and may cause a blockage.
- Irritant chemicals may cause **vocal cord spasm**, swelling, and constriction of the upper airways.

- **Eyes:** Eyes may be red and irritated by the smoke, and there may be burns on the corneas in the eyes.

- **Skin color:** Skin color may range from pale to bluish to cherry red.

- **Soot**

- Soot in the nostrils or **throat** may give a clue as to the degree of smoke inhalation.
- The nostrils and **nasal** passages may be swollen.

- **Headache**

- In all fires, people are exposed to various quantities of carbon monoxide.
- The patient may have no respiratory problems, but may still have inhaled carbon monoxide.
- Headache, **nausea**, and **vomiting** are symptoms of carbon monoxide poisoning.

- **Changes in mental status**

- Chemical asphyxiants and low levels of oxygen can lead to mental status changes.
- Confusion, **fainting**, **seizures**, and **coma** are all potential complications following smoke inhalation.

When to Seek Medical Care

If the smoke inhalation victim has no signs or symptoms, home observation may be

appropriate. If in doubt, call the doctor or go to the local [emergency department](#) for advice.

Seek medical attention if the patient experience the following symptoms with smoke inhalation:

- Hoarse voice
- Difficulty breathing
- Prolonged coughing spells
- Mental confusion

Decide whether to call an ambulance for assistance.

- Someone with smoke inhalation can get worse quickly.
- If such a person were transported by private vehicle, significant injury or death could occur on the way that could have been avoided if that person were transported by emergency medical services.

Exams and Tests

A number of [tests and procedures](#) may be performed. Which tests are performed depends on the severity of the signs and symptoms and is at the discretion of the doctor.

- **Chest x-ray**
 - If the patient has respiratory complaints such as persistent cough and shortness of breath, a [chest x-ray](#) should be done.
 - The initial [chest x-ray](#) may be normal despite significant signs and symptoms.
 - A repeat chest x-ray may be necessary during the observation period to determine if delayed lung injury is occurring.
- **Pulse oximetry**
 - A light [probe](#) is typically attached to the finger, toe, or earlobe, to determine the amount of oxygen in the blood.
 - Pulse oximetry may be inaccurate if the patient has [low blood pressure](#), and enough blood is not getting to parts of the body where the probe is attached.
- **Blood tests**
 - [Complete blood count](#): This test is done to determine if there are enough [red blood cells](#) to carry oxygen, enough white blood cells to fight

infection, and enough platelets to ensure clotting can occur.

- Chemistries (also called basic metabolic profile): This test reveals any changes of pH in the blood that may happen because of interference with oxygen diffusion, transport, or use. Serum electrolytes (sodium, potassium, and chloride) can also be monitored. Renal (kidney) function tests (creatinine and blood urea nitrogen) are also monitored.
- Arterial blood gas: For people with significant respiratory distress, acute mental status changes, or shock, an arterial blood gas may be obtained. This test may help the doctor to determine the degree of oxygen shortage.
- Carboxyhemoglobin and methemoglobin levels: These levels should be measured in all smoke inhalation victims with respiratory distress, altered mental status, low blood pressure, seizures, fainting, and blood pH changes. It is now routinely done in many hospitals whenever arterial blood gas is assessed.

Smoke Inhalation Treatment

Self-Care at Home

Remove the person with smoke inhalation from the scene to a location with clean air.

Make sure that you are not putting yourself in danger before you attempt to pull someone from a smoke-filled environment. If you would be taking a serious risk to help the person, wait for trained professionals to arrive at the scene.

If necessary, CPR should be initiated by trained bystanders until emergency medical help arrives.

Medical Treatment

A number of treatments may be given for smoke inhalation.

- **Oxygen**

- Oxygen is the mainstay of treatment.
- Oxygen may be applied with a nose tube, mask, or through a tube down the throat.
- If the patient has signs and symptoms of upper airway problems (hoarseness), they will most likely be intubated. The doctor places a tube down the throat to keep the airway from closing due to swelling.
- If the patient has respiratory distress or mental status changes, they may also be intubated to let the staff help with breathing, to suction off mucus, and keep the patient from choking on secretions.

- **Bronchoscopy**

- **Bronchoscopy** is procedure performed through a small scope to directly look at the degree of damage done to the airways and to allow for suctioning of secretions and debris.
- Usually bronchoscopy is done through an **endotracheal tube** after the patient receives adequate sedation and **pain** relievers.
- Bronchoscopy may be necessary if the patient has growing **respiratory failure**, fails to demonstrate clinical improvement, or a segment of the lung remains collapsed.

- **Hyperbaric oxygenation (HBO)**

- If the patient has carbon monoxide **poisoning**, hyperbaric oxygenation may be considered.
- Hyperbaric oxygenation is a treatment in which the patient is given oxygen in a **compression** chamber.
- Some studies have demonstrated that hyperbaric oxygenation causes a reduction in symptoms of the nervous system, and if the patient has carbon monoxide poisoning, it may make recovery quicker.
- The indications for and availability of this treatment vary depending on the institution and the region in which the patient is hospitalized.

Next Steps

Follow-up

Once the patient leaves the hospital, follow-up care is typically arranged. The patient should return immediately to the emergency department if they feel that their condition is worsening after **discharge** from the hospital.

- Medications may be prescribed, such as various inhalers and **pain medications**.
- The patient may notice shortness of breath with minimal exertion.
- It may take time for the lungs to fully heal, and some people may have scarring and shortness of breath for the rest of their lives. Avoid triggering factors, such as **cigarette smoke**.
- Persistent hoarseness of the voice may occur in people who have sustained

burn or smoke inhalation injuries or both. Early attention to these problems, many of which are treatable surgically or behaviorally or both, could lead to an improved voice.

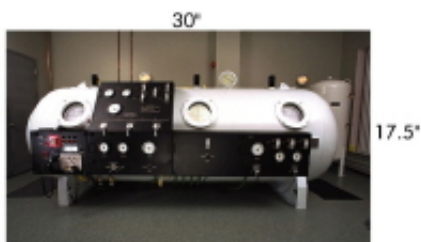
Prevention

Prevention is key when discussing smoke inhalation. Numerous prevention strategies can be employed to avoid exposure to smoke.

- Smoke detectors should be placed in every room of occupied buildings. This should ensure early detection of smoke to allow plenty of time for evacuation.
- Carbon monoxide detectors should be placed in locations at risk for carbon monoxide exposure (such as from malfunctioning furnaces, gas water heaters, kerosene space heaters, propane heaters and stoves, gasoline or diesel generators, and boats with a gasoline engine).
- Escape routes and plans for how to escape should be worked out prior to the [onset](#) of a fire and reviewed often.
- Numbers for the police, fire department, and your local [poison control center](#) should be kept in a visible place in the event of an emergency. Find your [poison control center](#) now by checking the Web site of the [American Association of Poison Control Centers](#).

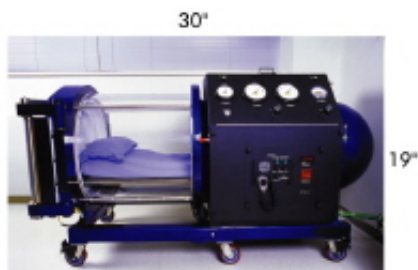
Multimedia

Media file 1: State-of-the-art hyperbaric oxygen chamber by HyperTec.



Media type: Photo

Media file 2: State-of-the-art single person chamber by HyperTec.



Media type: Photo

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Last Editorial Review: 10/18/2007

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