

Mercury (Hg)
CAS 7439-97-6; UN 2024 (liquid compounds)

Synonyms include colloidal mercury, quicksilver, liquid silver, metallic mercury, and hydrargyrum.

- **Persons exposed to elemental mercury vapor do not pose a significant risk of secondary contamination to response personnel outside the Hot Zone. Persons whose skin or clothing is contaminated with liquid mercury can contaminate response personnel by direct contact or off-gassing vapor and can also contaminate equipment leading to a risk of chronic exposure for response personnel.**
- **Elemental mercury is a heavy, shiny, silver-white, odorless liquid. It is nonflammable, but releases toxic vapor, especially when heated. Because mercury is odorless, it does not provide any warning of hazardous concentrations.**
- **Inhalation is the primary route of exposure to elemental mercury vapor or aerosols, which are readily absorbed. Virtually no elemental mercury is absorbed from the gastrointestinal tract or by the skin. Mercury crosses the placenta and can be transferred to infants via breast milk.**

Description

There are three classes of mercury: metallic elemental mercury (quicksilver, Hg^0), inorganic mercurial salts (e.g., Hg_2Cl_2 , Hg^+ , HgCl_2 , Hg^{+2}), and organic mercurials (e.g., methylmercury, phenylmercury). Adverse effects from exposure to mercury differ depending on the form and the route of exposure. This Medical Management Guideline focuses on elemental mercury. At room temperature, metallic or elemental mercury is a heavy, shiny, silver-white, odorless liquid. It is only slightly volatile at room temperatures and significantly more volatile when heated. Elemental mercury is nonflammable and has low solubility in both water and organic solvents.

Routes of Exposure

Inhalation Inhalation of mercury vapor is the primary route of exposure to elemental mercury. Inhaled vapor is almost completely absorbed by the lungs about up to 80%. Neither liquid mercury nor mercury vapor has an odor and thus, **chemical odor provides no warning of hazardous concentrations**. Mercury vapor is heavier than air and may therefore accumulate in poorly ventilated or low-lying areas.

Children exposed to the same levels of mercury vapor as adults may receive larger doses because they have greater lung surface area:body weight ratios and increased minute volumes:weight ratios. In addition, they may be exposed to higher levels than adults in the same location because of their short stature and the higher levels of mercury vapor found nearer to the ground.

Skin/Eye Contact Elemental mercury vapor is very slowly absorbed through the skin in high concentrations, but causes irritation of both skin and eyes and may produce contact dermatitis.

Ingestion Elemental mercury, a liquid at room temperature, is essentially nontoxic when ingested because virtually none (less than 0.1%) is absorbed. Anatomic gastrointestinal abnormalities such as enteric fistulas or intestinal perforation can sequester sufficient quantities of ingested elemental mercury to allow significant oxidation and subsequent absorption.

Sources/Uses Elemental mercury is inexpensively produced by heating mercury-containing ores and condensing the vapor. Metallic mercury has many applications in the electrical industry (e.g., alkaline batteries, electrical switches, lights), in dental amalgams, and in medical equipment (e.g., thermometers, electroanalysis). In the chemical and mining industries, mercury is used as a catalyst in reactions to form polymers, in manufacturing chlorine and caustic soda, and in extracting gold from ore. Mishandled or spilled mercury from devices used in the home or workplace is often the source of unintentional exposures.

Standards and Guidelines

OSHA PEL (permissible exposure limit) = 0.1 mg/m³ (vapor) (ceiling)

NIOSH IDLH (immediately dangerous to life or health) = 10 mg/m³

Physical Properties

Description: Liquid is shiny, silvery-white, and heavy; vapor is colorless and odorless.

Warning properties: Odor is inadequate to warn of toxic exposure.

Molecular weight: 200.59 daltons

Boiling point (760 mm Hg): 674 °F (356.72 °C)

Freezing point: -102 °F (-38.9 °C)

Specific gravity: 13.6 at 77 °F (25 °C) (water = 1.00)

Vapor pressure: 0.002 mm Hg at 77 °F (25 °C)

[Note: Although the vapor pressure of elemental mercury is low, at 24 °C, an atmosphere that is fully saturated with mercury vapor contains approximately 18 mg/m³. The levels attainable in indoor airs at room temperature can therefore greatly exceed safe levels and result in poisoning.]

Gas density: 6.9 (air = 1)

Water solubility: 0.006% at 77 °F (25 °C)

Flammability: Nonflammable

Incompatibilities

Elemental mercury reacts vigorously with ground mixtures of sodium carbide, aluminum, lead, or iron. A violent exothermic reaction, possibly an explosion, occurs when mercury comes in contact with chlorine dioxide, lithium, or rubidium. It also reacts with acetylenic compounds, ammonia, azides, boron diiodophosphide, ethylene oxide, methyl azide, methylsilane, oxygen, oxidants, and tetracarbonylnickel. Pure dry ammonia and mercury do not react even under pressure and heat, but if water is present, a compound forms that can explode during depressurization. Heating mercury vapor produces mercuric oxide, which is highly irritating to mucous membranes and more likely than elemental mercury vapor to cause chemical pneumonitis.

Health Effects

- **The major route of exposure to elemental mercury is inhalation of mercury vapor. Symptoms of acute toxicity following high-level exposure to mercury vapor occur within hours of the exposure.**
- **Respiratory symptoms include corrosive bronchitis with fever chills and dyspnea, which can progress to pulmonary edema or fibrosis. Abdominal cramps, diarrhea, renal dysfunction, visual disturbances, and central nervous system damage leading to neuropsychiatric disturbances and intention tremors may also occur.**
- **Mercury vapor can cross the blood-brain and placental barriers. It is also excreted in breast milk. Children may be at increased risk for pulmonary toxicity and are more likely to develop respiratory failure.**

Acute Exposure

Many acute health effects are associated with exposure to high levels of elemental mercury vapor. Respiratory symptoms may predominate (cough, sore throat, shortness of breath). Gastrointestinal effects are frequent in the initial set of symptoms (metallic taste, nausea, vomiting, diarrhea, abdominal pain) as are CNS effects such as headache, weakness, and visual disturbances. Several days after the initial exposure, symptoms are more similar to those that develop following inorganic mercury poisoning, including ptyalism (heavy salivation), enteritis, and renal damage; there can also be chronic CNS effects, which develop as a result of the ability of absorbed elemental mercury to cross the blood-brain barrier.

Children do not always respond to chemicals in the same way that adults do. Different protocols for managing their care may be needed.

Respiratory

Acute exposure to high levels of elemental mercury vapor can cause chemical pneumonitis. Within a few hours of exposure, dyspnea, chest pain, and dry cough develop, often associated with fever, chills, and headache. Symptoms might resolve or gradually progress to pulmonary edema, respiratory failure, and death.

The acute mercury-induced lung damage usually resolves completely, but some cases of diffuse pulmonary fibrosis, restrictive lung disease, and chronic respiratory insufficiency have been reported. At autopsy, microscopic examination of lung tissue reveals interstitial pneumonitis, necrotizing bronchitis, bronchiolitis, and atelectasis.

Children may be more vulnerable to gas exposure because of relatively increased minute ventilation per kg and failure to evacuate an area promptly when exposed.

Renal Acute high-dose inhalation of elemental mercury vapor has been associated with proteinuria, nephrotic syndrome, temporary tubular dysfunction, acute tubular necrosis, and oliguric renal failure.

Cardiovascular Acute inhalation of high levels of elemental mercury vapor can cause tachycardia and hypertension. In children, tachycardia associated with the inhalation of elemental mercury vapor might be related to a non-allergenic hypersensitivity reaction to mercury.

Gastrointestinal A metallic taste, salivation, dysphagia, abdominal cramps, diarrhea, and nausea have been reported following inhalation of large amounts of elemental mercury vapor. Oral and dermal exposures to elemental mercury are not normally associated with GI symptoms.

Dermal Dermal reactions associated with dermal contact with liquid elemental mercury or the vapor are rare. Acrodynia (or pink disease) is associated with hypersensitivity to mercury absorbed from vapor inhalation or dermal exposure. Symptoms of acrodynia include abnormal redness of the skin, followed by peeling of skin on the hands, nose, and soles of the feet.

CNS Acute inhalation of mercury vapor may produce CNS effects such as headache, weakness, and visual disturbances.

Potential Sequelae Respiratory effects from high-dose acute exposures might resolve or gradually progress to adult respiratory distress syndrome (ARDS), respiratory failure, and death. Patients with severe pulmonary toxicity can develop interstitial fibrosis and residual restrictive pulmonary disease. Other sequelae of exposure to elemental mercury include effects on the CNS and kidneys. These can occur after high-dose acute inhalation exposure and are similar to the effects observed following chronic lower-dose exposures (see below).

Chronic Exposure

Repeated or continuous exposure to elemental mercury can result in accumulation of mercury in the body and permanent damage to the nervous system and kidneys. Classic symptoms of poisoning include neuropsychiatric effects, renal impairment, and oropharyngeal inflammation. The neuropsychiatric effects include tremor, anxiety, emotional lability, forgetfulness,

insomnia, anorexia, erethism (abnormal irritation, sensitivity, or excitement), fatigue, and cognitive and motor dysfunction.

Although less common, neuromuscular changes (weakness, muscle atrophy, and muscle twitching) and polyneuropathy (paresthesias, stocking-glove sensory loss, hyperactive tendon reflexes, slowed sensory and motor nerve conduction velocities) have also been reported.

A delayed idiosyncratic non-allergic hypersensitivity to mercury called acrodynia (pink disease) is sometimes seen in children chronically exposed to mercury vapor; in some cases, it occurs when exposure lasts for only a few days. Symptoms include irritability, sleeplessness, sweating, severe leg cramps, and a painful peeling rash.

Chronic exposure may be more serious for children because of their potential longer latency period.

Carcinogenicity

The Department of Health and Human Services (DHHS), the International Agency for Research on Cancer (IARC), and the Environmental Protection Agency (EPA) have not had sufficient evidence to classify elemental mercury as a carcinogen or a noncarcinogen.

Reproductive and Developmental Effects

Elemental mercury is not included in *Reproductive and Developmental Toxicants*, a 1991 report published by the U.S. General Accounting Office (GAO) that lists 30 chemicals of concern because of widely acknowledged reproductive and developmental consequences.

Chronic inhalation of elemental mercury vapor has not been shown to have any effect on spermatozoa in men. An increased incidence of spontaneous abortion among the wives of men chronically exposed to elemental mercury has been reported.

In female workers, menstrual disorders (dysmenorrhea) have been associated with chronic exposure to high concentrations of mercury vapor. At high levels, inhaled elemental mercury is able to cross the placental barrier, but fetotoxic or significant developmental effects have not been well studied in humans. Adverse developmental effects have been observed in animals but not humans.

Prehospital Management

- **Victims exposed to mercury vapor do not pose secondary contamination risks to rescuers. Rescuers may treat urgently ill patients without concern about acute secondary contamination to themselves or their equipment.**
- **Victims whose skin or clothing is visibly contaminated with liquid mercury can contaminate rescuers' equipment, clothing, or the indoor environment. Contamination of clothing or equipment can result in a subsequent chronic inhalation hazard to others as the elemental liquid mercury off-gasses.**
- **Symptoms of acute exposure to elemental mercury vapor inhalation occur within hours of the exposure and consist of cough, chills, fever, and shortness of breath. Symptoms might resolve or gradually progress to a chemical pneumonitis, adult respiratory distress syndrome (ARDS), respiratory failure, and renal failure. Inhalation of mercury vapor can also cause nausea, vomiting, diarrhea, renal dysfunction, visual disturbances, and CNS damage.**
- **Treatment of acute mercury exposure generally consists of removal of the patient from further exposure followed by support of respiratory and cardiovascular function. There is no antidote for mercury, but chelation therapy is warranted in some cases.**

Hot Zone

Rescuers should be trained and appropriately attired before entering the Hot Zone. If the proper equipment is not available, or if the rescuers have not been trained in its use, call for assistance from a local or regional HAZMAT team or other properly equipped response organization.

Rescuer Protection

Elemental mercury vapor can be highly toxic if inhaled and can cause a life-threatening chemical pneumonitis and respiratory failure. Both the liquid and vapor forms of elemental mercury are poorly absorbed through the skin. Heating mercury vapor produces mercuric oxide, which is highly irritating to mucous membranes and more likely than elemental mercury vapor to cause chemical pneumonitis. Mercury clean-up kits are available which can remove the liquid without spreading contamination.

Respiratory protection: Positive-pressure, self-contained breathing apparatus (SCBA) is recommended in response situations that involve exposure to potentially unsafe levels of elemental mercury.

Skin protection: No special clothing is needed unless mercury vapor is being heated; in that case chemical protective clothing is recommended to avoid contamination. However, gloves and

foot protection are recommended as mercury spreads under nails etc., very easily. Any clothing that comes in contact with liquid mercury should be properly decontaminated or disposed of to prevent the possibility of subsequent chronic exposure to off-gassed mercury vapor.

ABC Reminders

Quickly access for a patent airway, ensure adequate respiration and pulse. If trauma is suspected, maintain manually and apply a cervical collar and a backboard when feasible.

Victim Removal

If victims can walk, lead them out of the Hot Zone to the Decontamination Zone. Victims who are unable to walk may be removed on backboards or gurneys; if these are not available, carefully carry or drag victims to safety.

Consider appropriate management of chemically contaminated children, such as measures to reduce separation anxiety if a child is separated from a parent or other adult.

Decontamination Zone

Victims exposed only to mercury vapor who have no skin or eye irritation may be transferred immediately to the Support Zone. Other patients will require decontamination as described below.

Rescuer Protection

If exposure levels are determined to be safe, decontamination may be conducted by personnel wearing a lower level of protection than that worn in the Hot Zone (described above).

ABC Reminders

Quickly access for a patent airway, ensure adequate respiration and pulse. Stabilize the cervical spine with a collar and a backboard if trauma is suspected. Administer supplemental oxygen as required. Assist ventilation with a bag-valve-mask device if necessary.

Basic Decontamination

Victims who are able may assist with their own decontamination. Remove and double-bag contaminated clothing and all personal belongings.

Wash exposed skin and hair with mild soap and water (preferably under a shower). Rinse thoroughly with water. Use caution to avoid hypothermia when decontaminating children or the elderly. Use blankets or warmers when appropriate.

Flush exposed or irritated eyes with plain water or saline for at least 5 minutes. Remove contact lenses if easily removable without additional trauma to the eye. If pain or injury is evident, continue irrigation while transferring the victim to the Support Zone.

In cases of ingestion, **do not induce emesis**. Elemental mercury is not readily absorbed from the gastrointestinal tract and generally does not produce acute toxicity from this route of exposure. Activated charcoal is not effective for ingested mercury exposure.

Consider appropriate management of chemically contaminated children, such as measures to reduce separation anxiety if a child is separated from a parent or other adult. If possible, seek assistance from a child separation expert.

Transfer to Support Zone

As soon as basic decontamination is complete, move the victim to the Support Zone.

Support Zone

Rescuers may treat urgently ill patients without concern about acute secondary contamination to themselves or their equipment. However, rescuer clothing or equipment that has been contaminated with liquid mercury can cause chronic exposures to rescuers from off-gassed mercury vapor. Be certain that victims have been decontaminated properly (see *Decontamination Zone* above) and that any rescuer equipment or clothing that has been contaminated with liquid mercury is properly decontaminated or disposed of. Victims who have undergone decontamination or have been exposed only to vapor pose no serious risks of secondary contamination. In such cases, Support Zone personnel require no specialized gear.

ABC Reminders

Quickly access for a patent airway. If trauma is suspected, maintain cervical immobilization manually and apply a cervical collar and a backboard when feasible. Ensure adequate respiration and pulse. Administer supplemental oxygen as required and establish intravenous access if necessary. Place on a cardiac monitor.

Additional Decontamination

Continue irrigating exposed skin and eyes, as appropriate.

In cases of ingestion, **do not induce emesis**. Elemental mercury is not usually absorbed from the gastrointestinal tract and does not produce acute toxicity from this route of exposure. Activated charcoal is not effective.

Advanced Treatment

In cases of respiratory compromise secure airway and respiration via endotracheal intubation. If not possible, perform cricothyroidotomy if equipped and trained to do so.

Treat patients who have bronchospasm with aerosolized bronchodilators. The use of bronchial sensitizing agents in

situations of multiple chemical exposures may pose additional risks. Consider the health of the myocardium before choosing which type of bronchodilator should be administered. Cardiac sensitizing agents may be appropriate; however, the use of cardiac sensitizing agents after exposure to certain chemicals may pose enhanced risk of cardiac arrhythmias (especially in the elderly). Mercury poisoning is not known to pose additional risk during the use of bronchial or cardiac sensitizing agents and sympathomimetic bronchodilators may reverse bronchospasm in patients exposed to mercury.

Consider racemic epinephrine aerosol for children who develop stridor. Dose 0.25–0.75 mL of 2.25% racemic epinephrine solution in 2.5 cc water, repeat every 20 minutes as needed, cautioning for myocardial variability.

Patients who are comatose, hypotensive, or have seizures or cardiac arrhythmias should be treated according to advanced life support (ALS) protocols.

Transport to Medical Facility

Only decontaminated patients or patients not requiring decontamination should be transported to a medical facility. “Body bags” are not recommended.

Report to the base station and the receiving medical facility the condition of the patient, treatment given, and estimated time of arrival at the medical facility.

If elemental mercury has been ingested, prepare the ambulance in case the patient vomits. The vomit might contain elemental mercury that can contaminate the transport vehicle. Have a suction apparatus ready and prepare several towels and double-sealable plastic bags to quickly clean up and isolate vomitus.

Only a professional mercury clean-up kit with a self-contained vacuum system should be used to decontaminate the transport vehicle. Ordinary vacuum cleaners can vaporize elemental mercury and increase the concentration of airborne mercury.

Multi-Casualty Triage

Consult with the base station physician or the regional poison control center for advice regarding triage of multiple victims.

Patients with evidence of significant inhalation exposure such as cough, shortness of breath, nausea, or headache and patients who have ingested large amounts of elemental mercury should

be transported to a medical facility for evaluation. Asymptomatic patients who have not had a significant exposure and show no evidence of respiratory-tract irritation may be discharged from the scene after their names, addresses, and telephone numbers are recorded. Those discharged should be advised to seek medical care promptly if symptoms develop (see *Patient Information Sheet* below).

Emergency Department Management

- **Victims exposed to mercury vapor do not pose secondary contamination risks to rescuers. Victims whose skin or clothing is visibly contaminated with liquid mercury can contaminate equipment, clothing, or the indoor environment by translocation of the liquid, but do not pose a risk of acute secondary exposure for hospital personnel.**
- **Contaminated clothing or equipment will subsequently pose a chronic inhalation hazard to others as the elemental liquid mercury off-gasses. Victims do not pose risks of secondary contamination after their clothing is removed, the mercury is contained, and their skin is washed.**
- **Symptoms of acute inhalation exposure to elemental mercury vapor occur within hours of the exposure and consist of coughs, chills, fever, and shortness of breath. Symptoms might resolve or gradually progress to a chemical pneumonitis, adult respiratory distress syndrome (ARDS), respiratory failure, renal failure, nausea, vomiting, and diarrhea. Exposure may also result in visual disturbances and CNS damage.**
- **There is no antidote for mercury. Treatment consists of cessation of exposure, supportive care, and timely chelation therapy when warranted.**

Decontamination Area

Previously decontaminated patients and patients exposed only to mercury vapor who have no skin or eye irritation may be transferred immediately to the Critical Care Area. Others require decontamination as described below.

Be aware that use of protective equipment by the provider may cause fear in children, resulting in decreased compliance with further management efforts.

Because of their relatively larger surface area:body weight ratio, children are more vulnerable to toxicants absorbed through the skin. Also emergency room personnel should examine children's mouths because of the frequency of hand-to-mouth activity among children.

ABC Reminders

Evaluate and support airway, breathing, and circulation. In cases of respiratory compromise secure airway and respiration via endotracheal intubation. If not possible, surgically create an airway.

Treat patients who have bronchospasm with aerosolized bronchodilators. The use of bronchial sensitizing agents in situations of multiple chemical exposures may pose additional risks. Consider the health of the myocardium before choosing

which type of bronchodilator should be administered. Cardiac sensitizing agents may be appropriate; however, the use of cardiac sensitizing agents after exposure to certain chemicals may pose enhanced risk of cardiac arrhythmias (especially in the elderly). Mercury poisoning is not known to pose additional risk during the use of bronchial or cardiac sensitizing agents. Sympathomimetic bronchodilators may reverse bronchospasm in patients exposed to mercury vapor.

Consider racemic epinephrine aerosol for children who develop stridor. Dose 0.25–0.75 mL of 2.25% racemic epinephrine solution in 2.5 cc water, repeat every 20 minutes as needed, cautioning for myocardial variability.

Patients who are comatose, hypotensive, or have seizures or ventricular arrhythmias should be treated in the conventional manner.

Basic Decontamination

Patients who are able may assist with their own decontamination. Remove and double-bag contaminated clothing and personal belongings.

Wash exposed skin and hair with mild soap and water (preferably under a shower). Rinse thoroughly with water. Use caution to avoid hypothermia when decontaminating children or the elderly. Use blankets or warmers when appropriate.

Flush exposed or irritated eyes with plain water or saline for at least 5 minutes. Remove contact lenses if easily removable without additional trauma to the eye. If pain or injury is evident, continue irrigation while transferring the victim to the Critical Care Area.

In cases of ingestion, **do not induce emesis or give activated charcoal**. Elemental mercury is not usually absorbed from the gastrointestinal tract and is unlikely to cause any acute toxicity from this route of exposure. Decontamination is not necessary. However, if an individual with gastrointestinal perforation or fistula ingests an extremely large amount, the mercury might be retained for a long period in the GI tract and decontamination should be considered. Cathartic whole-bowel lavage (repeated once daily) or even surgical removal might be necessary at a later time depending on radiographic evidence of large pockets of mercury. In cases of large-volume ingestion, obtain an abdominal radiograph to document the location of the mercury, and explain to the patient the importance of follow-up. The patient should be referred to a primary-care or specialist physician for follow-up.

If elemental mercury has been ingested and the patient vomits, the vomitus might contain elemental mercury that can contaminate the emergency department. Have a suction apparatus ready and prepare several towels and double-sealable plastic bags to quickly clean up and isolate any mercury. If there is widespread contamination, only a professional mercury clean-up kit with a self-contained vacuum system should be used to decontaminate. Ordinary vacuum cleaners can vaporize elemental mercury and increase the concentration of airborne mercury.

Critical Care Area

Be certain that appropriate decontamination has been carried out (see *Decontamination Area* above).

ABC Reminders

Evaluate and support airway, breathing, and circulation as in *ABC Reminders* above. Establish intravenous access in seriously ill patients if this has not been done previously. Continuously monitor cardiac rhythm.

Patients who are comatose, hypotensive, or have seizures or cardiac arrhythmias should be treated in the conventional manner.

Fluids should be titrated to maintain acceptable urine output and blood pressure. Care must be taken not to overhydrate the patient.

Inhalation Exposure

Administer supplemental oxygen by mask to patients who have respiratory complaints. Treat patients who have bronchospasm with aerosolized bronchodilators. The use of bronchial sensitizing agents in situations of multiple chemical exposures may pose additional risks. Consider the health of the myocardium before choosing which type of bronchodilator should be administered. Cardiac sensitizing agents may be appropriate; however, the use of cardiac sensitizing agents after exposure to certain chemicals may pose enhanced risk of cardiac arrhythmias (especially in the elderly). Mercury poisoning is not known to pose additional risk during the use of bronchial or cardiac sensitizing agents and sympathomimetic bronchodilators may reverse bronchospasm in patients exposed to mercury vapor.

Consider racemic epinephrine aerosol for children who develop stridor. Dose 0.25–0.75 mL of 2.25% racemic epinephrine solution in 2.5 cc water, repeat every 20 minutes as needed, cautioning for myocardial variability.

Young children are particularly susceptible to the acute pulmonary effects of mercury vapor. Both adults and children are treated by respiratory support and in some cases, mechanical ventilation may be necessary.

Early dyspnea can indicate upper-airway obstruction from swelling, reflex bronchospasm, or direct pulmonary injury, which all require treatment. Patients require careful assessment for stridor, wheezing, and rales. Patients who have chemically induced adult respiratory distress syndrome (ARDS) do not usually benefit from digoxin, morphine, afterload reduction, or diuretics. Supplemental oxygen, delivered by mechanical ventilation and positive end-expiratory pressure, if needed, are standard treatments. Corticosteroids and antibiotics have been commonly recommended for treatment of chemical pneumonitis, but their effectiveness has not been substantiated.

Skin Exposure

Elemental mercury does not cause a chemical burn. Washing the exposed skin with soap and water should remove any residual liquid mercury.

Eye Exposure

Ensure that adequate eye irrigation has been completed. Test visual acuity. Examine the eyes for conjunctival or corneal damage and treat appropriately. Patients should be referred to an ophthalmologist when they have apparent or suspected corneal injury.

Ingestion Exposure

In cases of ingestion, **do not induce emesis or give activated charcoal**. Elemental mercury is not usually absorbed from the gastrointestinal tract and does not produce acute toxicity from this route of exposure. Decontamination is not necessary. However, if an individual with gastrointestinal perforation or fistula ingests an extremely large amount, the mercury might be retained for a long period in the GI tract and decontamination should be considered. Mercury is radiopaque and abdominal radiographs should be obtained in all cases of ingestion. Cathartic whole-bowel irrigation (with a polyethylene glycol [PEG-3350] electrolyte lavage solution, repeated once daily) or even surgical removal might be necessary depending on the radiographic evidence of the amount of mercury present.

*Antidotes and
Other Treatments*

Chelation therapy should be considered for any patient with a clear history of acute elemental mercury exposure who is symptomatic. However, the decision to chelate for a particular patient should be made only by professionals experienced in the use of chelation, preferably in consultation with the regional poison control center.

Chelation therapy becomes less effective in reducing the severity of poisoning and the risk of sequelae as time after exposure increases. Since timely administration of the chelating agent is essential for its efficacy, when treating significantly symptomatic patients, it might be necessary to administer the chelating agent prior to laboratory confirmation of mercury overexposure. Do not chelate an asymptomatic patient without the guidance provided by blood and 24-hour urine mercury levels. There may be no apparent benefit in chelating patients with established neurotoxicity after chronic exposure.

The most frequently used agent for acute inorganic mercury exposures is dimercaprol (also known as BAL). BAL, however, has been found to increase brain mercury in mice exposed to short-chain organic mercury; such an increase could lead to increased neurotoxicity. The implications for the use of BAL in humans are unclear, and no information is available on the effects of BAL following exposure to inhaled elemental mercury. Since elemental mercury has toxicokinetic properties more similar to organic mercury than inorganic mercury, chelation with 2,3-dimercaptosuccinic acid (DMSA) should also be considered (see below).

The standard dosage regiment of BAL for inorganic mercury poisoning is 3 mg/kg IM every 4 hours for 2 days, and every 12 hours thereafter for 7 to 10 days or until 24-hour urinary excretion levels are less than 50 µg/L. Contraindications to BAL include concurrent use of medicinal iron (which can form a toxic complex with BAL), organic mercury poisoning, pre-existing renal impairment, and pregnancy (except in life-threatening circumstances). Patients often complain of pain at the injection site. Adverse effects are dose-related and may include: pain, a self-limited increase in heart rate and blood pressure; nausea; vomiting; headache; burning sensation of the lips, mouth, throat, and eyes; lacrimation; rhinorrhea; salivation; muscle aches; burning and tingling in the extremities; tooth pain, diaphoresis; chest pain; anxiety; and agitation. Dimercaprol must not be administered in patients with glucose-6-phosphate dehydrogenase deficiency, because it can produce hemolysis.

Oral agents such as 2,3-dimercaptosuccinic acid (DMSA) or D-penicillamine have been used as alternatives when dimercaprol toxicity or intolerance develops. DMSA has very few side effects and is approved for the treatment of pediatric lead poisoning in the United States. Although not currently an FDA-labeled indication, DMSA has been used to treat mercury poisoning and is undergoing further evaluation. DMSA might prove to be the treatment of choice for methylmercury because of its lower toxicity.

Other Treatments

Alkalinization of the urine stabilizes the dimercaprol-metal complex, and has been recommended to protect the kidneys during chelation therapy. There is no role for hemodialysis in removing mercury. However, hemodialysis might be required for supportive therapy in the treatment of renal failure and it might enhance the removal of the dimercaprol-mercury complexes.

Laboratory Tests

The diagnosis of acute mercury toxicity is partly clinical, based on symptoms of respiratory distress. Laboratory evaluation of acute mercury poisoning should also include a complete blood count and differential, serum electrolytes, glucose, liver, and renal function tests, and urinalysis. Obtain hourly intake/output and urine pH in severely ill patients when renal perfusion is in question. Pulse oximetry might yield insufficient information to carefully monitor impending pneumonitis, ARDS, or respiratory failure. Chest radiography and serial ABG measurements are recommended for severe inhalation exposures.

Blood and urine mercury levels are useful to confirm exposure but there is no definite correlation between blood and urine mercury levels and degree of mercury toxicity. Blood mercury level confirms whether the exposure was recent, because the initial half-life for the elimination of blood mercury is 3 days. Urinary mercury levels indicate the total mercury body burden since mercury is largely excreted by the kidneys. The half-life of elimination for whole body mercury is 60 to 90 days. Urinary mercury levels are generally below 10 µg/L. Blood mercury levels are generally less than 40 µg/L and should not exceed 50 µg/L. Long-term exposure to mercury can be estimated from levels in hair.

If large-volume ingestion (more than the contents of a thermometer) is suspected, abdominal radiographs should be ordered to detect and follow the transit of any mercury (which is radiopaque) in the gastrointestinal tract. Neuropsychiatric testing, nerve conduction studies, and urine assays for N-acetyl-

**Disposition and
Follow-up**

B-D-glucosaminidase and β_2 -microglobulin have been used to assess delayed and chronic nervous system and renal toxicity.

Consider hospitalizing patients who have a suspected serious exposure and/or persistent or exhibit progressive respiratory symptoms.

Delayed Effects

Respiratory effects from high-dose exposures might resolve or gradually progress to ARDS, respiratory failure, and death. Infrequently, severe pulmonary effects can progress to interstitial fibrosis and residual restrictive pulmonary disease. Other potential sequelae of exposure to elemental mercury include effects on the kidneys and central nervous system. These effects can occur after high-dose acute exposure to mercury vapor, and are similar to the effects observed from chronic lower-dose exposures. **Children under 30 months of age are at increased risk for pulmonary toxicity and are more susceptible to death from respiratory failure.**

Patient Release

Exposed patients who are asymptomatic, but who might have been exposed to mercury vapors, can be discharged, but should be subsequently tested for blood or urine mercury levels and advised about potential delayed effects. Patients should be advised to seek medical attention promptly if symptoms develop (see the *Elemental Mercury—Patient Information Sheet* below).

Follow-up

Obtain the name of the patient's primary care physician so that the hospital can send a copy of the ED visit to the patient's doctor.

Follow-up laboratory evaluation of respiratory, gastrointestinal, renal and nervous-system status should be arranged for severely exposed patients.

Reporting

If a work-related incident has occurred, you may be legally required to file a report; contact your state or local health department.

Other persons may still be at risk in the setting where this incident occurred. If the incident occurred in the workplace, discussing it with company personnel may prevent future incidents. If a public health risk exists, notify your state or local health department or other responsible public agency. When appropriate, inform patients that they may request an evaluation of their workplace from OSHA or NIOSH. See Appendices III and IV for a list of agencies that may be of assistance.

Mercury (Hg) Patient Information Sheet

This handout provides information and follow-up instructions for persons who have been exposed to elemental mercury.

What is elemental mercury?

Elemental mercury metal is a very heavy, shiny, silver-white, odorless liquid at room temperature. It is used to make many different kinds of products including electrical switches, batteries, and medical devices such as thermometers. It is used in industry to manufacture chlorine and process gold ore. The body does not readily absorb liquid mercury through the skin or stomach. However, the liquid evaporates at room temperature, especially when heated. If inhaled, mercury vapors can be highly toxic.

What immediate health effects can be caused by exposure to elemental mercury?

Inhaling high concentrations of mercury vapor can cause a cough, chills, fever, and shortness of breath, and sometimes nausea, vomiting, and diarrhea. These symptoms do not usually develop immediately: they might appear a few hours after exposure. Symptoms might resolve or gradually progress to cause serious damage to the lungs and kidneys. Unintentional swallowing of liquid mercury usually causes no health effects.

Can elemental mercury poisoning be treated?

Typically, low-level exposure to elemental mercury leads to no lasting health effects and treatment is not needed. Severely affected individuals must be hospitalized.

Are any future health effects likely to occur?

A single small exposure from which a person recovers quickly is not likely to cause delayed or long-term effects. After a serious exposure, damage to the lungs, kidneys, and central nervous system might occur.

What tests can be done if a person has been exposed to elemental mercury?

Specific tests for the presence of mercury in blood and urine can be useful to assess the level of exposure. If a severe exposure has occurred, x-rays and blood and urine tests might show whether or not the lungs and kidneys have been damaged. Testing is not needed in every case.

Where can more information about elemental mercury be found?

If the exposure happened at work, you might be required to contact your employer and the Occupational Safety and Health Administration (OSHA). Employees may request a Health Hazard Evaluation from the National Institute for Occupational Safety and Health (NIOSH).

You can obtain more information about mercury from your regional poison control center; your state, county, or local health department; the Agency for Toxic Substances and Disease Registry (ATSDR); your doctor; or a clinic in your area that specializes in occupational and environmental health. Ask the person who gave you this form for help in locating these telephone numbers.

Follow-up Instructions

Keep this page and take it with you to your next appointment. Follow *only* the instructions checked below.

- Call your doctor or the Emergency Department if you develop any unusual signs or symptoms within the next 24 hours, especially:
- coughing, wheezing, chest tightness, or shortness of breath
 - excessive saliva (spit)
 - decreased urine or change in color
- No follow-up appointment is necessary unless you develop any of the symptoms listed above.
- Call for an appointment with Dr. _____ in the practice of _____.
When you call for your appointment, please say that you were treated in the Emergency Department at _____ Hospital by _____ and were advised to be seen again in _____ days.
- Return to the Emergency Department/ _____ Clinic on (date) _____ at _____ AM/PM for a follow-up examination.
- Do not perform vigorous physical activities for 1 to 2 days.
- You may resume everyday activities including driving and operating machinery.
- Do not return to work for _____ days.
- You may return to work on a limited basis. See instructions below.
- Avoid exposure to cigarette smoke for 72 hours; smoke may worsen the condition of your lungs.
- Avoid drinking alcoholic beverages for at least 24 hours; alcohol may worsen injury to your stomach or have other effects.
- Avoid taking the following medications: _____
- You may continue taking the following medication(s) that your doctor(s) prescribed for you: _____

- Other instructions: _____

- Provide the Emergency Department with the name and the number of your primary care physician so that the ED can send him or her a record of your emergency department visit.
 - You or your physician can get more information on the chemical by contacting: _____ or _____, or by checking out the following Internet Web sites: _____; _____.

Signature of patient _____ Date _____

Signature of physician _____ Date _____