

Formaldehyde (HCHO) CAS 50-00-0; UN 1198, UN 2209 (formalin)

Synonyms include formalin, formic aldehyde, methanal, methyl aldehyde, methylene oxide, oxomethane, and paraform.

Persons exposed only to formaldehyde vapor do not pose substantial risks of secondary contamination. Persons whose clothing or skin is contaminated with a solution of formaldehyde can cause secondary contamination by direct contact or through off-gassing vapor.

- **Formaldehyde is a colorless, highly toxic, and flammable gas at room temperature that is slightly heavier than air. It has a pungent, highly irritating odor that is detectable at low concentrations, but may not provide adequate warning of hazardous concentrations for sensitized persons.**
- **It is used most often in an aqueous solution stabilized with methanol (formalin).**
- **Most formaldehyde exposures occur by inhalation or by skin or eye contact. Formaldehyde is absorbed well by the lungs, gastrointestinal tract, and, to a lesser extent, skin.**

Description

Formaldehyde is a nearly colorless gas with a pungent, irritating odor even at very low concentrations (below 1 ppm). Its vapors are flammable and explosive. Because the pure gas tends to polymerize, it is commonly used and stored in solution. Formalin, the aqueous solution of formaldehyde (30% to 50% formaldehyde), typically contains up to 15% methanol as a stabilizer.

Routes of Exposure

Inhalation

Most formaldehyde exposures occur by inhalation or by skin/eye contact. Formaldehyde vapor is readily absorbed from the lungs. In cases of acute exposure, formaldehyde will most likely be detected by smell; however, persons who are sensitized to formaldehyde may experience headaches and minor eye and airway irritation at levels below the odor threshold (odor threshold is 0.5 to 1.0 ppm; OSHA PEL is 0.75 ppm). **For sensitized persons, odor is not an adequate indicator of formaldehyde's presence and may not provide reliable warning of hazardous concentrations. Odor adaptation can occur.** Low-dose acute exposure can result in headache, rhinitis, and dyspnea; higher doses may cause severe mucous membrane irritation, burning, and lacrimation, and lower respiratory effects

such as bronchitis, pulmonary edema, or pneumonia. Sensitive individuals may experience asthma and dermatitis, even at very low doses. Formaldehyde vapors are slightly heavier than air and can result in asphyxiation in poorly ventilated, enclosed, or low-lying areas.

Children exposed to the same levels of formaldehyde 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 formaldehyde found nearer to the ground.

Skin/Eye Contact

Ocular exposure to formaldehyde vapors produces irritation and lacrimation. Depending on the concentration, formaldehyde solutions may cause transient discomfort and irritation or more severe effects, including corneal opacification and loss of vision. Formaldehyde is absorbed through intact skin and may cause irritation or allergic dermatitis; rapid metabolism makes systemic effects unlikely following dermal exposure.

Children are more vulnerable to toxicants absorbed through the skin because of their relatively larger surface area:body weight ratio.

Ingestion

Ingestion of as little as 30 mL (1 oz.) of a solution containing 37% formaldehyde has been reported to cause death in an adult. Ingestion may cause corrosive injury to the gastrointestinal mucosa, with nausea, vomiting, pain, bleeding, and perforation. Corrosive injuries are usually most pronounced in the pharyngeal mucosa, epiglottis and esophagus. Systemic effects include metabolic acidosis, CNS depression and coma, respiratory distress, and renal failure.

Sources/Uses

Formaldehyde is synthesized by the oxidation of methanol. It is among the 25 most abundantly produced chemicals in the world and is used in the manufacture of plastics, resins, and urea-formaldehyde foam insulation. Formaldehyde or formaldehyde-containing resins are used in the manufacture of chelating agents, a wide variety of organic products, glass mirrors, explosives, artificial silk, and dyes. It has been used as a disinfectant, germicide, and in embalming fluid. In the agricultural industry, formaldehyde has been used as a fumigant, preventative for mildew in wheat and rot in oats, a germicide and fungicide for plants, an insecticide, and in the manufacture of slow-release fertilizers. Formaldehyde is found in construction materials such as plywood adhesives. Formaldehyde also is or has been used in

the sugar, rubber, food, petroleum, pharmaceuticals, and textiles industries.

Standards and Guidelines

OSHA PEL (permissible exposure limit) = 0.75 ppm (averaged over an 8-hour workshift)

OSHA STEL (short-term exposure limit) = 2 ppm (15 minute exposure)

NIOSH IDLH (immediately dangerous to life or health) = 20 ppm

AIHA ERPG-2 (emergency response planning guideline) (the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action) = 10 ppm

Physical Properties

Description: Nearly colorless gas with a pungent, irritating odor

Warning properties: Odor is detectable at less than 1 ppm, but many sensitive persons experience symptoms below the odor threshold.

Molecular weight: 30.0 daltons

Boiling point (760 mm Hg): - 6 °F (-21 °C)

Vapor pressure: 3883 mm Hg at 77°F (25 °C)

Gas density: 1.07 (air = 1)

Water solubility: 55% at 68 °F (20 °C)

Flammability: Flammable gas between 7% and 73% at 77 °F (25 °C) (concentration in air); combustible liquid (formalin)

Incompatibilities

Formaldehyde reacts with strong oxidizers, alkalis, acids, phenols, and urea. Pure formaldehyde has a tendency to polymerize.

Health Effects

Formaldehyde is an eye, skin, and respiratory tract irritant. Inhalation of vapors can produce narrowing of the bronchi and an accumulation of fluid in the lungs.

- **Children may be more susceptible than adults to the respiratory effects of formaldehyde.**
- **Formaldehyde solution (formalin) causes corrosive injury to the gastrointestinal tract, especially the pharynx, epiglottis, esophagus, and stomach.**

The systemic effects of formaldehyde are due primarily to its metabolic conversion to formate, and may include metabolic acidosis, circulatory shock, respiratory insufficiency, and acute renal failure.

Formaldehyde is a potent sensitizer and a probable human carcinogen.

Acute Exposure

Formaldehyde vapor produces immediate local irritation in mucous membranes, including eyes, nose, and upper respiratory tract. Ingestion of formalin causes severe injury to the gastrointestinal tract. The exact mechanism of action of formaldehyde toxicity is not clear, but it is known that it can interact with molecules on cell membranes and in body tissues and fluids (e.g., proteins and DNA) and disrupt cellular functions. High concentrations cause precipitation of proteins, which results in cell death. Absorption from the respiratory tract is very rapid; absorption from the gastrointestinal tract is also rapid, but may be delayed by ingestion with food. Once absorbed, formaldehyde is metabolized to formic acid, which may cause acid-base imbalance and a number of other systemic effects.

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

CNS

Malaise, headache, sleeping disturbances, irritability, and impairment of dexterity, memory, and equilibrium may result from a single, high level, exposure to formaldehyde.

Respiratory

Even fairly low concentrations of formaldehyde can produce rapid onset of nose and throat irritation, causing cough, chest pain, shortness of breath, and wheezing. Higher exposures can cause significant inflammation of the lower respiratory tract, resulting in swelling of the throat, inflammation of the windpipe

and bronchi, narrowing of the bronchi, inflammation of the lungs, and accumulation of fluid in the lungs. Pulmonary injury may continue to worsen for 12 hours or more after exposure.

Previously sensitized individuals can develop severe narrowing of the bronchi at very low concentrations (e.g., 0.3 ppm). Bronchial narrowing may begin immediately or can be delayed for 3 to 4 hours; effects may worsen for up to 20 hours after exposure and can persist for several days.

Exposure to certain chemical irritants can lead to Reactive Airway Dysfunction Syndrome (RADS), a chemically- or irritant-induced type of asthma.

Children may be more vulnerable to corrosive agents than adults because of the relatively smaller diameter of their airways.

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

Metabolic

Accumulation of formic acid can cause an anion-gap acid-base imbalance. If formalin is ingested, absorption of the methanol stabilizer may contribute to the imbalance and can result in an osmolal gap, as well as an anion gap.

Immunologic

In persons who have been previously sensitized, inhalation and skin contact may cause various skin disorders, asthma-like symptoms, anaphylactic reactions and, rarely, hemolysis. The immune system in children continues to develop after birth, and thus, children may be more susceptible to certain chemicals.

Gastrointestinal

Ingestion of aqueous solutions of formaldehyde can result in severe corrosive injury to the esophagus and stomach. Nausea, vomiting, diarrhea, abdominal pain, inflammation of the stomach, and ulceration and perforation of the oropharynx, epiglottis, esophagus, and stomach may occur. Both formaldehyde and the methanol stabilizer are easily absorbed and can contribute to systemic toxicity.

Ocular

Exposure to low concentrations of formaldehyde vapor can cause eye irritation, which abates within minutes after exposure has ended. Formalin splashed in the eyes can result in corneal ulceration or cloudiness of the eye surface, death of eye surface cells, perforation, and permanent loss of vision; these effects may be delayed for 12 hours or more.

<i>Dermal</i>	Exposure to formaldehyde vapor or to formalin solutions can cause skin irritation and burns. In sensitized persons, contact dermatitis may develop at very low exposure levels.
<i>Potential Sequelae</i>	In survivors of inhalation injury, pulmonary function usually returns to normal. Eye exposure to high concentrations of formaldehyde vapor or formalin can eventually cause blindness. Narrowing of the esophagus and severe corrosive damage to the stomach lining can result from ingesting formalin.
Chronic Exposure	The major concerns of repeated formaldehyde exposure are sensitization and cancer. In sensitized persons, formaldehyde can cause asthma and contact dermatitis. In persons who are not sensitized, prolonged inhalation of formaldehyde at low levels is unlikely to result in chronic pulmonary injury. Adverse effects on the central nervous system such as increased prevalence of headache, depression, mood changes, insomnia, irritability, attention deficit, and impairment of dexterity, memory, and equilibrium have been reported to result from long-term exposure. Chronic exposure may be more serious for children because of their potential longer latency period.
<i>Carcinogenicity</i>	The Department of Health and Human Services has determined that formaldehyde may reasonably be anticipated to be a carcinogen. In humans, formaldehyde exposure has been weakly associated with increased risk of nasal cancer and nasal tumors were observed in rats chronically inhaling formaldehyde.
<i>Reproductive and Developmental Effects</i>	<p>There is limited evidence that formaldehyde causes adverse reproductive effects. The TERIS database states that the risk of developmental defects to the exposed fetus ranges from none to minimal. Formaldehyde is not included in <i>Reproductive and Developmental Toxicants</i>, a 1991 report published by the U.S. General Accounting Office (GAO) that lists 30 chemicals widely acknowledged to have reproductive and developmental consequences.</p> <p>There have been reports of menstrual disorders in women occupationally exposed to formaldehyde, but they are controversial. Studies in experimental animals have reported some effects on spermatogenesis. Formaldehyde has not been proven to be teratogenic in animals and is probably not a human teratogen at occupationally permissible levels. Formaldehyde has been shown to have genotoxic properties in human and laboratory animal studies producing sister chromatid exchange and chromosomal aberrations.</p>

Special consideration regarding the exposure of pregnant women is warranted, since formaldehyde has been shown to be a genotoxin; thus, medical counseling is recommended for the acutely exposed pregnant woman.

Prehospital Management

Victims exposed only to formaldehyde gas do not pose significant risks of secondary contamination to personnel outside the Hot Zone. Victims whose clothing or skin is contaminated with a formaldehyde-containing solution (formalin) can secondarily contaminate personnel by direct contact or through off-gassing vapor.

Inhalation of formaldehyde can cause airway irritation, bronchospasm, and pulmonary edema.

Absorption of large amounts of formaldehyde via any route can cause severe systemic toxicity, leading to metabolic acidosis, tissue and organ damage, and coma.

There is no antidote for formaldehyde. Treatment consists of supportive measures including decontamination (flushing of skin and eyes with water, gastric lavage, and administration of activated charcoal), administration of supplemental oxygen, intravenous sodium bicarbonate and/or isotonic fluid, and hemodialysis.

Hot Zone

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

Rescuer Protection

Formaldehyde is a highly toxic systemic poison that is absorbed well by inhalation. The vapor is a severe respiratory tract and skin irritant and may cause dizziness or suffocation. Contact with formaldehyde solution may cause severe burns to the eyes and skin.

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

Skin Protection: Chemical-protective clothing is recommended because formaldehyde can cause skin irritation and burns.

ABC Reminders

Quickly access for a patent airway, ensure adequate respiration and pulse. If trauma is suspected, maintain cervical immobilization 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 formaldehyde vapor who have no skin or eye irritation may be transferred immediately to the Support Zone. All others require decontamination (see *Basic Decontamination* 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 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 personal belongings.

Flush liquid-exposed skin and hair with plain water for 3 to 5 minutes. Wash area thoroughly with soap and water when possible. Use caution to avoid hypothermia when decontaminating children or the elderly. Use blankets or warmers when appropriate.

Irrigate exposed or irritated eyes with plain water or saline for 15 minutes. Remove contact lenses if easily removable without additional trauma to the eye. If pain or injury is evident, continue eye irrigation while transferring the victim to the Support Zone.

In cases of formalin ingestion, **do not induce emesis**. Victims who are conscious and able to swallow should be given 4 to 8 ounces of water or milk. Gastric lavage with a small bore NG tube should be considered if it can be performed within 1 hour after ingestion. The effectiveness of activated charcoal administration is unknown, but it is suggested following lavage (administer activated charcoal at 1 gm/kg, usual adult dose 60–90 g, child dose 25–50 g). A soda can and straw may be of assistance when offering charcoal to a child.

Consider appropriate management of chemically contaminated children at the exposure site. Also, provide reassurance to the child during decontamination, especially if separation from a parent occurs. 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

Be certain that victims have been decontaminated properly (see *Decontamination Zone* above). Persons who have undergone decontamination or who have been exposed only to vapor pose no serious risks of secondary contamination. Support Zone personnel require no specialized protective gear in such cases.

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. Watch for signs of airway swelling and obstruction such as progressive hoarseness, stridor, or cyanosis.

Additional Decontamination

Continue irrigating exposed skin and eyes, as appropriate.

In cases of formalin ingestion, **do not induce emesis**. If water has not been given previously, administer 4 to 8 ounces of milk or water if the patient is able to swallow.

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). Formaldehyde poisoning is not known to pose additional risk during the use of bronchial or cardiac sensitizing agents.

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 dysrhythmias should be treated according to advanced life support (ALS) protocols. Treat acidosis with intravenous sodium bicarbonate (adult dose = 1 ampule; pediatric dose = 1 Eq/kg). Further bicarbonate therapy should be guided by arterial blood gas (ABG) measurements. Hemodialysis should be considered in patients with severe acid-base disturbances that are refractory to conventional therapy or in cases with significant methanol levels.

If evidence of shock or hypotension is observed begin fluid administration. For adults, bolus 1,000 mL/hour intravenous saline or lactated Ringer's solution if blood pressure is under 80 mm Hg; if systolic pressure is over 90 mm Hg, an infusion rate of 150 to 200 mL/hour is sufficient. For children with compromised perfusion administer a 20 mL/kg bolus of normal saline over 10 to 20 minutes, then infuse at 2 to 3 mL/kg/hour. Follow with administration of dopamine (2 to 20 µg/kg/min) or norepinephrine (0.1 to 0.2 µg/kg/min), if necessary.

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 formaldehyde has been ingested, prepare the ambulance in case the victim vomits toxic material. Have ready several towels and open plastic bags to quickly clean up and isolate vomitus.

Multi-Casualty Triage

If possible, consult with the base station physician or the regional poison control center for advice regarding triage of multiple victims.

Patients who have ingested formalin or have symptoms (e.g., severe wheezing or dyspnea) or obvious injuries (e.g., skin or eye burns) should be transported immediately to a medical facility for evaluation.

Patients who have no eye, skin, or throat irritation, or only mild or transient symptoms may be released 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

Hospital personnel in an enclosed area can be secondarily contaminated by direct contact, by vapors off-gassing from heavily soaked clothing, or from the vomitus of victims who have ingested formaldehyde. Patients do not pose serious contamination risks after contaminated clothing is removed and the skin is thoroughly washed.

Inhalation of formaldehyde can cause airway irritation, bronchospasm, and pulmonary edema.

Absorption of large amounts of formaldehyde via any route can cause severe systemic toxicity, leading to metabolic acidosis, tissue and organ damage, and coma.

There is no antidote for formaldehyde. Treatment consists of supportive measures including decontamination (flushing of skin and eyes with water, gastric lavage, and administration of activated charcoal), administration of supplemental oxygen, intravenous sodium bicarbonate and/or isotonic fluid, and hemodialysis.

Decontamination Area

Previously decontaminated patients and patients exposed only to formaldehyde vapor who have no skin or eye irritation may be transferred immediately to the Critical Care Area. Other patients will require decontamination as described below. Because formaldehyde is absorbed (although poorly) through the skin, don butyl rubber gloves and apron before treating patients. Formaldehyde readily penetrates most rubbers and barrier fabrics or creams, but butyl rubber provides good skin protection.

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 for corrosive injury because of the frequency of hand-to-mouth activity among children.

ABC Reminders

Evaluate and support airway, breathing, and circulation. Children may be more vulnerable to corrosive agents than adults because of the smaller diameter of their airways. 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). Formaldehyde poisoning is not known to pose additional risk during the use of bronchial or cardiac sensitizing agents.

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 dysrhythmias should be treated in the conventional manner.

Correct acidosis in the patient who has coma, seizures, or cardiac dysrhythmias by administering intravenously sodium bicarbonate (adult dose = 1 ampule; pediatric dose = 1 Eq/kg). Further bicarbonate therapy should be guided by ABG measurements. Hemodialysis should be considered in patients with severe acid-base disturbances that are refractory to conventional therapy or in cases with significant methanol levels.

If evidence of shock or hypotension is observed begin fluid administration. For adults, bolus 1,000 mL/hour intravenous saline or lactated Ringer's solution if blood pressure is under 80 mm Hg; if systolic pressure is over 90 mm Hg, an infusion rate of 150 to 200 mL/hour is sufficient. For children with compromised perfusion administer a 20 mL/kg bolus of normal saline over 10 to 20 minutes, then infuse at 2 to 3 mL/kg/hour. Follow with administration of dopamine (2 to 20 µg/kg/min) or norepinephrine (0.1 to 0.2 µg/kg/min), if necessary.

Basic Decontamination

Patients who are able may assist with their own decontamination.

Because contact with formalin may cause burns, ED staff should don chemical-resistant jumpsuits (e.g., of Tyvek or Saranex) or butyl rubber aprons, rubber gloves, and eye protection if the patient's clothing or skin is wet with formalin. After the patient has been decontaminated, no special protective clothing or equipment is required for ED personnel.

Quickly remove and double-bag contaminated clothing and personal belongings. Flush exposed skin and hair with water (preferably under a shower) for 5 minutes. If possible, wash hair and skin with soap and water, then rinse thoroughly with water. Use caution to avoid hypothermia when decontaminating children or the elderly. Use blankets or warmers when appropriate.

Flush exposed eyes with water or saline for at least 15 minutes. Remove contact lenses if easily removable without additional trauma to the eye. An ophthalmic anesthetic, such as 0.5% tetracaine, may be necessary to alleviate blepharospasm, and lid retractors may be required to allow adequate irrigation under the eyelids. If pain or injury is evident, continue irrigation while transporting the patient to the Critical Care Area.

In cases of formalin ingestion, **do not induce emesis**. If water has not been given previously, administer 4 to 8 ounces if the patient is alert and able to swallow. The effectiveness of activated charcoal administration is unknown, but may be beneficial (if not administered previously) following lavage if it can be performed within 1 hour after ingestion (administer activated charcoal at 1 gm/kg, usual adult dose 60–90 g, child dose 25–50 g). A soda can and straw may be of assistance when offering charcoal to a child. (More information is provided in *Ingestion Exposure* under *Critical Care Area* below.)

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. Children may be more vulnerable to corrosive agents than adults because of the relatively smaller diameter of their airways. 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 dysrhythmias should be treated in the conventional manner. Correct acidosis in the patient who has coma, seizures, or cardiac dysrhythmias by administering intravenously sodium bicarbonate (adult dose = 1 ampule; pediatric dose = 1 Eq/kg). Further bicarbonate therapy should be guided by ABG measurements. Hemodialysis should be considered in patients with severe acid-base disturbances that are refractory to conventional therapy or in cases with significant methanol levels.

If evidence of shock or hypotension is observed begin fluid administration. For adults, bolus 1,000 mL/hour intravenous saline or lactated Ringer's solution if blood pressure is under 80 mm Hg; if systolic pressure is over 90 mm Hg, an infusion rate of 150 to 200 mL/hour is sufficient. For children with compromised perfusion administer a 20 mL/kg bolus of normal saline over 10 to 20 minutes, then infuse at 2 to 3 mL/kg/hour. Follow with administration of dopamine (2 to 20 µg/kg/min) or norepinephrine (0.1 to 0.2 µg/kg/min), if necessary.

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). Formaldehyde poisoning is not known to pose additional risk during the use of bronchial or cardiac sensitizing agents.

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.

Observe patients who are in respiratory distress for up to 12 hours and periodically repeat chest examinations and order other appropriate studies. Follow up as clinically indicated.

Skin Exposure

If formalin or high concentrations of formaldehyde vapor were in contact with the skin, chemical burns may result; treat as thermal burns.

Because of their relatively larger surface area:body weight ratio, children are more vulnerable to toxicants absorbed through the skin.

Eye Exposure

Continue irrigation for at least 15 minutes. Test visual acuity. Examine the eyes for corneal damage and treat appropriately. Immediately consult an ophthalmologist for patients who have severe corneal injuries.

Ingestion Exposure

Do not induce emesis. Give 4 to 8 ounces of water to alert patients who can swallow if not done previously. If a large dose has been ingested and the patient's condition is evaluated within 30 minutes after ingestion, consider gastric lavage and endoscopy to evaluate the extent of corrosive injury to the gastrointestinal tract. Care must be taken when placing the gastric tube because blind gastric-tube placement may further injure the chemically damaged esophagus or stomach. Extreme throat swelling may require endotracheal intubation or cricothyroidotomy. The effectiveness of activated charcoal in binding formaldehyde is unknown, but may be beneficial (if not administered previously) following lavage if it can be performed within 1 hour after ingestion (administer activated charcoal at 1 gm/kg, usual adult dose 60–90 g, child dose 25–50 g). A soda can and straw may be of assistance when offering charcoal to a child.

Because children do not ingest large amounts of corrosive materials, and because of the risk of perforation from NG intubation, lavage is discouraged in children unless intubation is performed under endoscopic guidance.

Toxic vomitus or gastric washings should be isolated (e.g., by attaching the lavage tube to isolated wall suction or another closed container).

*Antidotes and
Other Treatments*

There is no antidote for formaldehyde. Treat patients who have metabolic acidosis with sodium bicarbonate (adult dose = 1 ampule; pediatric dose = 1 Eq/kg). Further correction of acidosis should be guided by ABG measurements.

Hemodialysis is effective in removing formic acid (formate) and methanol and in correcting severe metabolic acidosis.

If methanol poisoning from ingestion of formalin is suspected, as indicated by a serum methanol level of greater than 20 mg/dL or elevated osmolal gap, start ethanol infusion. With 10% ethanol, the loading dose is 7.5 mL/kg body weight; maintenance dose is 1.0 to 1.5 mL/kg/hour; and maintenance dose during hemodialysis is 1.5 to 2.5 mL/kg/hour. In this setting, the target blood level of ethanol is 0.1 mg/dL.

Laboratory Tests

Routine laboratory studies for all exposed patients include CBC, glucose, and electrolyte determinations. Additional studies for patients exposed to formaldehyde include urinalysis (protein,

casts, and red blood cells may be present), methanol level, osmolal gap, and ABG measurements (to monitor acidosis in severe toxicity). Chest radiography and pulse oximetry may be helpful in cases of inhalation exposure. Plasma formaldehyde levels are not useful.

**Disposition and
Follow-up**

Consider hospitalizing patients who have evidence of systemic toxicity from any route of exposure.

Delayed Effects

Patients who have substantial ingestion exposure may develop aspiration pneumonitis or renal failure and should be admitted to an intensive care unit for observation. Corrosive gastritis, fibrosis of the stomach (shrinkage and contracture), hematemesis, or edema and ulceration of the esophagus may occur.

Patients who have inhalation exposure and who complain of chest pain, chest tightness, or cough should be observed and examined periodically for 6 to 12 hours to detect delayed-onset bronchitis, pneumonia, pulmonary edema, or respiratory failure.

Formaldehyde poisoning can cause permanent alterations of nervous system function, including problems with memory, learning, thinking, sleeping, personality changes, depression, headache, and sensory and perceptual changes.

Patient Release

Patients who are asymptomatic should be observed for 4 to 6 hours, then discharged if no symptoms occur during this period. Advise discharged patients to seek medical care promptly if symptoms develop (see the *Formaldehyde—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.

Patients with symptoms of seizures, convulsions, headache, or confusion, need to be followed for permanent central nervous system dysfunction with neurobehavioral toxicity testing, with particular attention to problems with memory, personality changes, and perceptual dysfunction.

Patients with injury to the mucous membranes of the respiratory or gastrointestinal tracts should be monitored for the development of ulceration or fibrosis.

Patients who have corneal injuries should be reexamined within 24 hours.

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.

Formaldehyde

Patient Information Sheet

This handout provides information and follow-up instructions for persons who have been exposed to formaldehyde or formalin.

What is formaldehyde?

Formaldehyde is a nearly colorless, highly irritating gas with a sharp odor. It dissolves easily in water and is found in formalin (a solution of formaldehyde, water, and methanol). Formaldehyde is used in the manufacture of plastics; urea-formaldehyde foam insulation; and resins used to make construction materials (e.g., plywood), paper, carpets, textiles, paint, and furniture.

What immediate health effects can result from formaldehyde exposure?

Formaldehyde can cause irritation of the eyes, nose, and throat, even at low levels for short periods. Longer exposure or higher doses can cause coughing or choking. Severe exposure can cause death from throat swelling or from chemical burns to the lungs. Direct contact with the skin, eyes, or gastrointestinal tract can cause serious burns. Drinking as little as 30 mL (about 2 tablespoons) of formalin can cause death. Formate, a formaldehyde metabolite, can cause death or serious systemic effects. Generally, the more serious the exposure to formaldehyde, the more severe the symptoms. Previously sensitized persons may develop a skin rash or breathing problems from very small exposures.

Can formaldehyde poisoning be treated?

There is no antidote for formaldehyde, but its effects can be treated, and most exposed persons get well. Patients who have had a serious exposure (with signs and symptoms such as tearing eyes, running nose, or severe or persistent coughing) may need to be hospitalized. Patients with direct exposure to very concentrated vapors or liquid or who have swallowed formalin may require intensive hospital treatment and may experience long-term effects.

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 severe exposure, some symptoms may not occur for up to 18 hours. See *Follow-up Instructions* for signs and symptoms to watch for. If any of them occur, seek medical care. Long-term, repeated exposure to formaldehyde in the workplace may cause cancer of the nasal passages.

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

Specific tests for the presence of formaldehyde in blood or urine may be available, but the results generally are not useful to the doctor. If a severe exposure has occurred, blood and urine analyses and other tests may show whether the lungs have been injured or if systemic effects are possible. If seizures or convulsions have occurred neurobehavioral toxicity testing may be necessary. Testing is not needed in every case.

Where can more information about formaldehyde be found?

More information about formaldehyde can be obtained 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. If the exposure happened at work, you may wish to discuss it with your employer, the Occupational Safety and Health Administration (OSHA), or the National Institute for Occupational Safety and Health (NIOSH). Ask the person who gave you this form for help in locating these telephone numbers.

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, difficulty breathing or shortness of breath
 - chest pain, irregular heart beats
 - increased pain or a discharge from your eyes
 - increased redness or pain or a pus-like discharge in the area of a skin burn or other wound
 - fever
 - unexplained drowsiness, fatigue, or headache
 - stomach pain, vomiting, or diarrhea

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 _____