BASF Chemical Emergency Medical Guidelines

Styrene (C_6H_5-CH=CH_2) C 1

Information and recommendations for doctors at hospitals/emergency departments

- **Patients exposed only to styrene vapor do not pose a significant risk of secondary contamination. Patients whose clothing or skin is contaminated with liquid styrene (boiling point 145°C, 293°F respectively) can secondarily contaminate rescue and medical personnel by direct contact or evaporation of styrene.**
- **Styrene is irritating when it comes in contact with the eyes, skin, and throat and causes headache, nausea, vertigo, dizziness, weakness, disorientation, and unconsciousness. Central and peripheral neuropathy has been noted.**
- **There is no antidote to be administered to counteract the effects of styrene. Treatment consists of supportive measures.**

1. Substance information

Styrene (C_6H_5-CH=CH_2), CAS 100-42-5
Synonyms: vinylbenzene, phenylethylene, cinnamene
Styrene is, at room temperature, a colorless to yellow, oily liquid with a boiling point of 145°C, respectively 293°F. Both vapor and liquid are potential fire and explosion hazards. Styrene has a sweet, sharp odor at air concentrations of 0.017 – 1.9 ppm, with rapid olfactory fatigue. It is slightly soluble in water, but soluble in alcohol, ether, and acetone. Styrene undergoes spontaneous polymerization. Carbon monoxide may be released in a styrene fire.

Styrene is an organic solvent with a high evaporation rate used in the manufacture of polystyrene plastics, protective coatings, styrenated polyesters, copolymer resins with acrylonitrile and butadiene, and as a chemical intermediate. Styrene-butadiene rubber is the most widely employed type of synthetic rubber.

2. Routes of exposure

Inhalation — **Most exposures occur by inhalation.** Styrene is readily absorbed by the respiratory tract.

Skin/eye contact — It is absorbed through the skin causing systemic effects

Ingestion — Styrene is absorbed from the gastrointestinal tract. However, ingestion is uncommon in occupational settings, but may be aspirated.

3. Acute health effects

Systemic — **Styrene causes headache, nausea, vertigo, dizziness, weakness, disorientation, and unconsciousness.** Acute exposure to high concentrations may produce signs of upper respiratory irritation, followed by asphyxia, muscular weakness, cardiac arrhythmia, coma and death from respiratory paralysis. Central and peripheral neuropathy and alterations in liver enzymes have been noted after long-term exposure.

Respiratory — Styrene is irritating to the upper respiratory tract.

Dermal — Irritation of the skin may be caused by direct contact to liquid styrene.

Ocular — Eye contact to vapor or liquid styrene causes burning discomfort, spasmodic blinking or involuntary closing of the eyelids, redness, and tearing.

Dose-effect relationships — Dose-effect relationships are as follows:

Styrene concentration		Effect
0.017-1.9 ppm	-	Odor threshold (Note: rapid olfactory fatigue)
50 ppm	-	subjective complaints including headache, fatigue, difficulty in concentrating
100 ppm	-	Mild irritation of eyes and throat
400 - 500 ppm	-	Moderate, but tolerable irritation
800 ppm	-	Immediate eye and throat irritation, increased nasal secretion, metallic taste, drowsiness and vertigo
2,500 ppm	-	dangerous to life within 8 hours
10,000 ppm	-	dangerous to life within 20 to 30 minutes

The time-weighted average concentration for a conventional 8-hour workday and a 40-hour workweek to which it is believed that nearly all workers may be repeatedly exposed, day after day, without adverse effect is 50 ppm. The workplace threshold limit value for short term exposure (15 minutes with 60 minutes between successive exposures in this range) without suffering from irritation, chronic or irreversible tissue damage, or narcosis is 100 ppm (TLV-TWA, USA, NIOSH).

Potential sequelae

If the patient survives the initial 48 hours after inhalation exposure, recovery is likely. After acute exposure, pulmonary function usually returns to normal in 7 to 14 days. Complete recovery is usual; however, symptoms and pulmonary deficits may persist. Pulmonary tissue destruction and scarring may lead to chronic dilation of the bronchi and increased susceptibility to infection. Central and peripheral neuropathies (disturbance of psychomotor performance, persistent or premature dementia, distal hypesthesia and decreased nerve conduction velocities) and ototoxicity have been observed in chronically exposed workers.

4. Actions

Decontamination

Patients exposed to styrene require decontamination.
Patients who are able and cooperative may assist with their own decontamination. If clothing is contaminated, remove and double-bag the clothing.

Assure that exposed or irritated eyes have been irrigated with plain water or saline for at least 20 minutes. If not, continue eye irrigation during other basic care.

Remove contact lenses if present and easily removable without additional trauma to the eye.

Assure that exposed skin and hair have been flushed with plain water for at least 15 minutes. If not, continue flushing during other basic care. Protect eyes during flushing of skin and hair.

Assure that following ingestion mouth was rinsed with plenty of water and afterwards charcoal as a slurry (240 ml water/30 g charcoal) has been administered. Emesis not recommended due to the potential for esophageal irritation and aspiration.

Initial treatment

Therapy will be empiric; there is no specific antidote to counteract the effects of styrene.

If inhalational exposure exceeds 100 ppm (for 15 minutes or more), if symptoms, e. g. eye irritation or pulmonary symptoms have developed, or if no exposure concentration can be estimated but exposure has possibly occurred:
Administration of oxygen

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- **Administration of 8 puffs of beclomethasone (800 µg beclomethasone dipropionate) from a metered dose inhaler.**

Patients with severe clinical respiratory symptoms (e.g. bronchospasms, stridor) should be treated as follows:
a) Nebulization of adrenaline (epinephrine): 2 mg adrenaline (2 ml) with 3 ml NaCl 0.9% and inhale through a nebulizer mask.

b) Administration of a ß2-selective adrenoceptor agonist, e.g., four strokes of terbutaline or salbutamol or fenoterol (one stroke usually contains 0.25 mg of terbutaline sulfate; or 0.1 mg of salbutamol; or 0.2 mg of fenoterol); this may be repeated once after 10 minutes.
Alternatively, 2.5 mg salbutamol and 0.5 mg atrovent may be administered by nebulizer mask.
If inhalation is not possible, administration of terbutaline sulfate (0.25 mg to 0.5 mg) subcutaneously or salbutamol (0.2 mg to 0.4 mg over 15 minutes) intravenously.

c) Intravenous administration of 250 mg methylprednisolone (or equivalent steroid dose).

Patients with clinical signs of a toxic lung edema (e.g. foamy sputum, wet crackles) should be treated as follows:
a) Start CPAP-therapy (Continuous Positive Airway Pressure Ventilation).
b) Intravenous administration of 1000 mg methylprednisolone (or an equivalent steroid dose) is recommended.

Intubation of the trachea or an alternative airway management should be considered in cases of respiratory compromise. When the patient's condition precludes this, consider cricothyrotomy if equipped and trained to do so.

Note: Efficacy of corticosteroid administration has not yet been proven in controlled clinical studies.
If styrene gas or liquid styrene has been in contact with the skin, irritations may result; treat as thermal burns.
After eye exposure, irritation may result; treat as thermal burns. Immediately consult an ophthalmologist.

Laboratory tests

The diagnosis of acute styrene toxicity is primarily a clinical one, based on the irritation and CNS effects together with known or strongly suspected styrene exposure. Urinary mandelic acid excretion indicates exposure (biological exposure index: 1 g mandelic acid / L in the urine).

Further evaluation and treatment

Standard exposure history, physical examination, and vital signs, and spirometry should be obtained. Routine laboratory studies should include a complete blood count, blood glucose and electrolyte determinations.

Prophylactic antibiotics are not routinely recommended, but may be used based on clinical signs of pneumonia.

Patient release/ follow-up instructions

Clinically asymptomatic patients exposed to a concentration of **less than 100 ppm** (depending on the period of time exposed) **as well as patients who have a normal clinical examination and no signs or symptoms of toxicity may be discharged after an appropriate observation period in the following circumstances:**

a) The evaluating physician is experienced in the evaluation of individuals with styrene exposure.
b) Information and recommendations for patients with follow-up instructions are provided verbally and in writing. Patients are advised to seek medical care promptly if symptoms develop or recur.
c) The physician is comfortable that the patient understands the health effects of styrene.

d) Site medical is notified, so that the patient may be contacted at regular intervals in the 24-hour period following release from the emergency department
e) Drinking of alcoholic beverages should be forbidden for at least 72 hours.
f) Heavy physical work should be precluded for 24 hours.
g) Exposure to cigarette smoke should be avoided for 72 hours; the smoke may worsen the condition of the lungs.

Patients who have serious skin or eye injuries should be reexamined in 24 hours.

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