

CHAPTER 8

SMOKES

8-1. General

a. Smokes obscure vision and are used to hide troops, equipment, and areas from detection. Chemicals used to produce smokes include hexachloroethane, grained aluminum, and zinc oxide (HC) mixture, special petroleum oils (fog oil (SGF2)), diesel fuel, red phosphorus (RP) in a butyl rubber matrix, and white phosphorus (WP) plasticized or impregnated in wool felt wedges. Sulfur-trioxide chlorosulfonic acid solution (FS) and titanium tetrachloride (FM) are seldom used in current operations. The chemical composition of the petroleum-based and colored smokes are similar to the bulk materials from which they are generated. The ignition of the HC mixture produces primarily zinc chloride and only traces of CG and CO. Burning phosphorus mixtures produce smokes composed of highly concentrated (60-80 percent) polyphosphorus acids.

b. Most smokes are not hazardous in concentrations which are useful for obscuring purposes. However, any smoke can be hazardous to health if the concentration is sufficient or if the exposure is long enough. Medical personnel should be prepared to treat potential reactions to military smokes once such smokes have been introduced to the battlefield. Exposure to heavy smoke concentrations for extended periods (particularly if near the source of emission) may cause illness or even death. Except with oil smoke, high concentrations of smoke generated in closed spaces are extremely dangerous. High concentrations of HC smoke generated under these conditions have caused fatalities. **NEVER** use HC munitions indoors or in closed compartments.

8-2. Protection Against Smokes

The protective mask gives the respiratory tract and the eyes adequate protection against all smokes. The protective mask should always be worn when smoke screens are in use. Both FS and FM are highly corrosive acids in liquid form; always wear protective clothing when handling them. Solid WP is an incendiary and should not be handled. Skin irritation can occur upon exposure to the phosphorus smokes because of their high acid content. Zinc chloride has produced skin lesions and burns, generally at the site of a recent injury such as an abrasion, burn, or chapping. If diesel fuel is left on the skin too long, it can produce dermatitis. Personnel can reduce

exposure to smokes by rolling down their sleeves. Showering and laundering clothing following exposure to smokes will also reduce the risk of skin irritation and sores.

8-3. Petroleum Oil Smokes

a. *Physical Properties.* These smokes are produced by vaporizing fuel oils in smoke generators or engine exhausts. The generator or engine exhaust vaporizes either SGF2 or diesel fuel and forces it into the air where it condenses into a dense white smoke.

b. *Physiological Properties.* Petroleum oil smokes are the least toxic smokes. They seldom produce ill effects. Even prolonged exposure to these smokes has not been known to cause lipid pneumonia.

8-4. Zinc Oxide Mixtures

a. *Properties.* Zinc oxide mixture is a combination of hexachloroethane, aluminum powder, and zinc oxide. On burning, the mixture produces zinc chloride which rapidly absorbs moisture from the air to form a grayish white smoke. The more humid the air, the more dense the HC smoke. This smoke can be dispersed by grenades, candles, pots, artillery shells, and special air bombs. HC smoke has a sweetish, acrid odor, even at moderate concentrations. HC smoke can elicit nose, throat, and chest irritation, cough, and slight nausea in some individuals. At high concentrations, severe respiratory distress is present which may be fatal.

b. *Pathology.* Primary damage is largely confined to the upper respiratory tract and is due to the irritant and corrosive action of zinc chloride. Hyperemia of the larynx, trachea, and large bronchi occur, along with functional narrowing of the smaller air passages. In severe exposures, chemical pneumonia with some pulmonary edema appears. Growth of cuboidal epitheliums from the bronchioles into the alveoli (sometimes completely lining or filling the alveoli) is often seen in fatal cases, with widespread evidences of anoxia (bronchiolitis fibrosa obliterans).

c. *Symptoms.* Case reports of accidental exposure to moderate and high concentrations of HC smoke have shown a syndrome which includes delayed onset of more severe symptoms and slow resolution. The immediate signs or symptoms include tightness in the chest, sore throat or hoarseness, and cough. At higher exposure levels there is paroxysmal coughing, nausea,

and retching. With supportive therapy, these symptoms disappear rapidly and the patient appears normal within 6 hours. The onset of fever, rapid pulse rate, malaise, shortness of breath, retrosternal pain, abdominal cramps, and cyanosis can occur up to 48 hours after exposure. Chest x-rays associated with severe exposures have demonstrated a dense, diffuse, infiltrative process present in one or both lung field(s). Repeat chest x-ray films will show progression of the infiltrate even though the physical examination of the chest is normal. Final resolution of the infiltrate may be delayed for a month or longer, even though the patient is asymptomatic during this period. In fatal cases, shock and respiratory insufficiency, as well as infection, are the causes of death.

d. Self-Protection. Put on the mask at once in all concentrations of HC smoke. If nausea, vomiting, or difficulty in breathing develops, report for medical treatment as soon as the combat situation permits. Meanwhile, carry on with the combat duties as fully as possible.

e. Treatment. The early symptoms due to bronchial constriction may be relieved by the subcutaneous injection of 0.5 mg (0.5 ml of a 1:1000 solution) of epinephrine hydrochloride, repeated in 20 to 30 minutes if necessary. Aspirin will help relieve general discomfort. If exposure has been heavy, administer BAL in oil IM. The dose and procedure are the same as for arsenical vesicants (sec III, chap 4), except that injections are continued for 48 hours at 4-hour intervals. Therapeutic efficacy of BAL in oil has been challenged. Steroid therapy has been considered efficacious and oxygen therapy required (see para 5-3, chap 5).

f. Prognosis. The prognosis is related entirely to the extent of the pulmonary damage. All exposed individuals should be kept under observation for at least 48 hours. Most individuals recover in a few days. At moderate exposures, some symptoms may persist for 1 to 2 weeks. In severe exposures, survivors may have reduced pulmonary function for some months after exposure. The severely exposed patient may progressively develop marked dyspnea, cyanosis, and die.

8-5. Sulfur Trioxide-Chlorosulfonic Acid

a. Properties. Sulfur trioxide-chlorosulfonic acid is a standard smoke mixture for aircraft spray tanks. It is a heavy, strongly acid liquid which, when dispersed in the air, absorbs moisture to form a dense white fog consisting of small droplets of hydrochloric and sulfuric acids. In moderate concentrations, it is highly irritating to the eyes, nose, and skin.

b. Pathology. Local inflammation of the eyes, respiratory tract, and skin may be seen after severe exposures to the smoke. Contact with liquid FS produces acid burns.

c. Symptoms. The symptoms are usually limited to a prickling sensation of the skin. However, exposure to heavy concentrations or long exposures to ordinary field concentrations may result in severe eye, skin, and respiratory tract irritation. Conjunctival irritation and edema, lacrimation, and mild photophobia may occur. Mild cough and soreness in the chest and moderate chemical dermatitis of the exposed skin are occasionally seen. Splashes of liquid in the eye are extremely painful and cause mineral acid burns with corneal erosions. Liquid FS on the skin may cause painful acid burns.

d. Self-Aid. Wear the mask in all concentrations of FS smoke which cause coughing, irritation to the eyes, or a prickling sensation of the skin. If the skin is splashed with liquid FS, wash it off at once with water. If liquid FS gets into the eye, forcibly hold the eye open and flush it with water, then report for medical treatment as soon as the combat situation permits.

e. Treatment.

(1) *Eye.* Irrigate the contaminated eye with water or saline solution as soon as possible. Examine the cornea for erosion by staining it with fluorescein. If corneal erosion is severe, transfer the patient to the care of an ophthalmologist. If this is not practicable, mydriasis should be accomplished with the use of atropine sulfate.

(2) *Skin.* Wash irritated skin or skin burns with water and then with a sodium bicarbonate solution. After washing, treat the burns as thermal burns of like severity.

f. Prognosis. The skin burns, conjunctival lesions, and respiratory irritation heal readily. Corneal erosions are more serious and may lead to residual scarring.

8-6. Titanium Tetrachloride

a. Properties. Liquid FM is a corrosive which decomposes on contact with moist air, yielding a dense white smoke composed of titanium dioxide, titanium oxychloride, and hydrochloric acid. It may be dispersed as an aircraft spray or by explosive munitions.

b. Pathology. Liquid FM produces acid burns of the skin or eyes.

c. Symptoms. Exposure of the eyes to the spray will cause conjunctivitis with lacrimation and photophobia, but this seldom causes significant corneal injury. Liquid splashes cause acid burns of the skin and severe eye injury including some corneal erosion.

d. Self-Aid. Wear the mask in all concentrations of FM smoke which irritate the nose or the throat. Wash any liquid splash off the skin with water. If spray or liquid splash has entered the eye, forcibly open the eye and flush it with water, then report for medical attention as soon as the combat situation permits.

e. Treatment. The treatment is similar to that for FS (para 8-5 *e*).

f. Prognosis. The prognosis is good except in rare instances where corneal erosions may lead to some permanent scarring.

8-7. White Phosphorus Smoke

a. Properties. White phosphorus is a pale yellow waxy solid that ignites spontaneously on contact with air. The flame produces a hot, dense white smoke composed of particles of phosphorus pentoxide, which are converted by moist air into phosphoric acid (para 9-4). It is usually dispersed by explosive munitions. The WP smoke irritates the eyes and nose in moderate concentrations. In an artillery projectile, WP is contained in wedges which ignite immediately upon exposure to air and fall to the ground. Up to 15 percent of the WP remains within the charred wedge and can reignite if the felt is crushed and the unburned WP is exposed to the atmosphere.

b. Pathology. For burns due to particles of burning WP, see paragraph 9-4.

c. Symptoms. Field concentrations of the smoke may irritate the eyes, nose, and throat. Casualties

from WP smoke have not occurred in combat operations.

d. Self-Aid. Wear the protective mask in all concentrations of WP smoke that cause any cough or irritation. Since the WP remaining in felt wedges can cause thermal injury, do not handle the charred wedges on the ground without protective covering. For self-aid against particles of burning WP, see paragraph 9-4 *a*.

e. Treatment. Generally, treatment of WP smoke irritation is unnecessary. Spontaneous recovery is rapid. For treatment of thermal injury due to large particles of burning WP, see paragraph 9-4 *b*.

f. Prognosis. No permanent injury results from exposure to WP smoke.

8-8. Red Phosphorus Smoke

This smoke is similar to WP smoke, see paragraph 8-7 for information.

8-9. Colored Smokes

a. Properties. These smokes are produced by explosive dissemination of dyes.

b. Physiological Properties. There are no reports of ill effects produced by exposure to these smokes.