

See November 1976 Progress

Chemical Safety Data Sheet SD-18

PROPERTIES AND ESSENTIAL INFORMATION

FOR

SAFE HANDLING AND USE

OF

ETHYLENE DICHLORIDE

Chemicals in any form can be safely stored, handled or used if the physical, chemical and hazardous properties are fully understood and the necessary precautions, including the use of proper safeguards and personal protective equipment, are observed.

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MANUFACTURING CHEMISTS ASSOCIATION

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Chemical Safety Data Sheet

ETHYLENE DICHLORIDE

PREFACE

Ethylene dichloride is a *flammable liquid* which produces toxic and flammable vapor when mixed with air. It is toxic by inhalation, by contact with the skin or mucous membranes or by ingestion.

The threshold limit value has been established at 50 ppm. Exposure to higher concentrations of vapor causes irritation to the eyes, nose and throat. Symptoms may also include nausea, vomiting and drowsiness.

Gaseous products of combustion of ethylene dichloride contain noxious gases such as hydrogen chloride and phosgene. Sources of ignition should be eliminated from work areas.

The full text of this chemical safety data sheet should be consulted for details of the hazards of ethylene dichloride and suggestions for their control.

FIRST AID — SEE PAGE 18

Odor Threshold	100 ppm (vol.)
Specific Gravity (grams/milliliter @ 20/4°C.)	1.256
Vapor Density (air = 1) (grams/liter)	3.42
Vapor Pressure (@ 20°C., 68°F.)	67 mm HG
Viscosity (millipoise)	8.42
Water Solubility, percent by weight,	
ethylene dichloride in water	0.81 @ 20°C. (68°F.)
water in ethylene dichloride	0.15 @ 20°C. (68°F.)
Threshold Limit Value	50 ppm (25°C. and 760 mm Hg) vapor or gas; 200 mg/m ³ particulate in air (1970 ACGIH)

3. HAZARDS

3.1 HEALTH HAZARDS

Ethylene dichloride is toxic by inhalation, by prolonged or repeated contact with the skin or mucous membrane, or when taken by mouth.

3.1.1 Warning Properties

Ethylene dichloride has a sweetish chloroform-like odor. High concentrations are irritating to eyes, nose, and throat. Lower concentrations which through chronic exposure may produce systemic damage are not always detectable by smell.

3.2 FIRE HAZARDS

3.2.1 Ethylene dichloride is a flammable liquid and produces toxic and flammable vapor when mixed with air at ambient conditions. Precautions such as eliminating ignition sources, inerting, bond-

ing, compliance with National Fire Codes, etc. should be taken when handling this material. Gaseous products of combustion contain noxious gases such as hydrogen chloride and phosgene.

3.3 INSTABILITY HAZARDS

Ethylene dichloride is thermally stable under normal conditions.

3.4 REACTIVITY HAZARDS

Ethylene dichloride undergoes no known hazardous or violent chemical reaction; however, the material is a flammable liquid (Flash Point 55°F.). Flammable Limits are from 6.2% to 15.9% in air; and autoignition temperature is 775°F. See section 6 on fire fighting.

4. ENGINEERING CONTROL OF HAZARDS

(See NFPA No. 30)

4.1 BUILDING DESIGN

4.1.1 Processes and storage facilities should not be located near open flames or high-temperature operations since ethylene dichloride is flammable and decomposes at high temperatures to form corrosive, irritating and otherwise undesirable products.

4.1.2 Standard fire walls are recommended for the isolation of larger equipment and storage tanks. Fire partitions having a fire resistance of 1-3 hours may be used to isolate areas involving ethylene dichloride from other areas.

4.1.3 Not less than two means of exit should be provided from each separate room or building in which ethylene dichloride is stored, handled, or used. No portions of such a room or building should be farther than 75 feet from the nearest exit. Additional exits should be provided depending upon the number of persons in the building. (See NFPA Standard No. 101 Life Safety Code.)

4.1.4 All exit doors should open out in the direction of travel and should be provided with panic hardware. Fire doors should open out in the direction of travel and be of an approved type.

4.1.5 Explosion vents are a safeguard to reduce destruction damage to buildings, ducts, mixers, blenders, driers, and similar equipment in which flammable vapors are liable to concentrate. Approved explosion venting windows, roof and wall panels, skylights, light windows, diaphragms, etc. are available to relieve pressures caused by burning vapors. Since the required area of explosion vents depends upon such factors as the intensity of an explosion, vapor temperature, type of structure, the type of vent closure, etc., the determination of vent ratios should be made by experienced engineers and safety and fire protection specialists. Consideration may be given to explosion suppression systems. (Reference: Guide for Explosion Venting, NFPA No. 68.)

4.1.6 Fire resistive stair enclosures with self-closing fire doors may be required for multi-storied buildings.

4.1.7 The need for segregating floor drains from sanitary or process sewer systems should be considered.

4.2 EQUIPMENT DESIGN

4.2.1 Vents from relief valves and process vents should be to a safe location.

4.2.2 Totally enclosed systems are preferable for processes handling ethylene dichloride. Opening equipment during the operation, or removal of materials should be avoided. A commercial combustible gas indicator is useful for periodic inspections, or to locate leaks.

4.2.3 Partially enclosed systems: Processes where solid materials are extracted or treated with ethylene dichloride are usually totally enclosed, but part of the equipment is opened periodically to remove solids. A method of complete removal of the vapors from residual materials before the equipment is opened should be provided. Positive means of preventing a back up of fumes into any central inert gas supply that may be used should be provided.

4.2.4 Open container: High concentrations of hazardous vapors may be discharged from open or partially open containers. Open equipment should be avoided, but if such equipment is necessary, the working area should be provided with mechanical ventilation to prevent the accumulation of hazardous vapors.

4.2.5 Processes where ethylene dichloride is being used should be designed so that the operator is protected from contact with this material in any of its physical states. Adequate ventilation and good operating procedures should be established which assure maximum security and protection for the operator.

4.2.6 It is essential for safety that the equipment be used and maintained as recommended by manufacturer.

4.2.7 Clean water in ample quantities should be immediately available at unloading stations. Stand deluge type safety showers, blankets, and special baths for flushing the eyes are recommended.

4.3 VENTILATION

4.3.1 The workroom or operating area may be provided with general ventilation. However, since ethylene dichloride is heavier than air, mechanical exhaust ventilation, preferably of the downdraft type should be provided. The most important consideration in ventilation should be to insure a substantial air flow away from the work area to prevent the unsafe accumulation of explosive mixtures and/or toxic concentrations. When mechanical ventilation is used the electrical equipment should meet National Electric Code requirements.

4.3.2 Under abnormal conditions, such as leak or spills, emergency ventilating equipment may be necessary. It should be available for immediate use.

4.3.3 Forced draft ventilating systems should be so arranged that a fire in the building will automatically shut them down. They should also be provided with remote manual controls. Local ventilation at relief points is better than depending on dilution ventilation. All ventilating systems require periodic inspection.

4.4 AIR ANALYSIS

4.4.1 A program of air analysis will be required to assure control of inhalation exposures below the threshold limit of 50 ppm. Continuous monitoring will afford an early warning of slow developing leaks and a record of personnel exposure.

4.4.2 When checking concentrations of ethylene dichloride in the air, care is required to make certain that the sample is representative of the air breathed by the workers, and of the daily fluctuations which may occur.

4.4.3 It should be kept firmly in mind that the use of instruments and test procedures for the detection of ethylene dichloride in the air requires specially trained personnel.

4.5 ELECTRICAL EQUIPMENT

4.5.1 To help insure safe operation, wiring should be installed in accordance with the National Electrical Code, Article 500.

4.5.2 In areas where ethylene dichloride vapors are present during normal operations, motors, controls switches, lights, etc., should conform to Class I, Group D, Division 1 (Explosion Proof) electrical classification.

4.5.3 In areas where ethylene dichloride vapors are not normally present, or may be present only during emergency conditions, the electrical equipment should conform to Class I, Group D, Division II electrical classification. (National Electrical Code, Article 500.)

4.5.4 No heating apparatus capable of reaching the autoignition temperature of 775°F. should be used. Flash lights, if used, should be a type approved for the exposure.

4.5.5 Ethylene dichloride flowing through or being discharged from a line generates static electricity.

In areas where flammable vapor-air mixtures may exist, electrically isolated sections of metallic piping should be bonded to the rest of the system (or grounded) to prevent external sparks which might produce ignition. (See Recommended Practice on Static Electricity, NFPA No. 77.)

4.5.6 Before ethylene dichloride is poured or discharged from one metal container to another, the two vessels should be either grounded or electrically interconnected by bonding. Any ground this is adequate for power circuits (or lightning protection) is more than adequate for protection against static electricity. This applies to all metal and pipe lines. Where drive belts are necessary, conductive "V" belts are recommended. Pulley and drive shafts should be grounded. Nonconductive drive belts are liable to accumulate a static charge, and their use should be avoided.

5. EMPLOYEE SAFETY

5.1 EMPLOYEE EDUCATION AND TRAINING

5.1.1 Safety in handling ethylene dichloride depends upon the effectiveness of employee education, training, and supervision. Unauthorized and untrained employees should not be permitted in areas where it is being handled.

5.1.2 The education and training of employees to work safely and to use the personal protective equipment or other safeguards provided for them is a responsibility of supervision.

5.1.3 Employee education and training should emphasize the need of handling ethylene dichloride according to approved safety methods, in order to avoid spilling or splashing, leaks, inhalation of the vapor, or ingestion.

5.1.4 Before being placed on the job, employees should be instructed thoroughly in the proper handling of ethylene dichloride. Older employees should be reinstructed periodically. Each employee should be instructed not to use ethylene dichloride for personal cleaning purposes.

5.1.5 Each employee should know the location, purpose, and maintenance of personal protective equipment and be thoroughly trained when and how to use this equipment.

5.1.6 Each employee should know the location of safety showers, blankets, eye baths or hubbler drinking fountains for flushing the eyes, and hose lines.

5.1.7 Employees should be trained to report to the proper authority all suspected leaks or equipment failures, and any signs of illness or skin irritation.

5.1.8 Each employee should know what to do in an emergency and should realize the necessity for prompt application of first aid in case of contact with ethylene dichloride liquid or exposure to the vapor.

5.2 PERSONAL PROTECTIVE EQUIPMENT

5.2.1 Availability and Use

Personal protective equipment is not an adequate substitute for good, safe working conditions, adequate ventilation, and intelligent conduct on the part of employees working with ethylene dichloride. It is, however, in many instances the only practical means of protecting the worker, particularly in emergency situations. One should appreciate that personal protective equipment protects only the worker wearing it, and other unprotected workers in the area may be exposed to danger.

The following personal protective equipment should always be used for the purposes mentioned and as specified in HEALTH HAZARDS, and in other sections of this Data Sheet.

5.2.2 Eye Protection

5.2.2.1 Cup-type plastic or rubber framed goggles, equipped with the approved impact resistant glass or plastic lenses, should be worn whenever there is danger of the material coming in contact

with the eyes, such as when handling bulk quantities, when there is danger of splashing or if the material is under pressure.

5.2.2.2 Metal or plastic rim safety spectacles with side shields may be used when continuous eye protection is desirable, as in laboratories.

5.2.2.3 Plastic shields (full length, 8" minimum) with forehead protection may be worn in addition to chemical safety goggles where complete face protection is desirable. Chemical safety goggles should always be worn as added protection where there is danger of material striking the eyes from underneath or around the sides of the face shield.

5.2.3 Respiratory Protection

5.2.3.1 Respiratory protection equipment must be carefully maintained, inspected, cleaned, and sterilized at regular intervals, and always before use by another person. Personnel wearing such equipment must be carefully instructed in its operation and limitations. Available types are described below.

(a) Self-contained breathing apparatus which permits the wearer to carry a supply of air compressed in the cylinder allows considerable mobility. The length of time a self-contained breathing apparatus provides protection varies according to the amount of air carried.

(b) Positive pressure hose masks which are supplied by blowers requiring no internal lubrication. The wearer must be able to use the same route for exit as for entrance and must take precautions to keep the hose line free of entanglement. The air blower must be placed in an area free of contaminants.

(c) Air-line masks, supplied with clean compressed air, suitable for use only where conditions will permit safe escape in case of failure of the compressed air supply. These masks are usually supplied with air piped to the area from a compressor. It is essential that the air is not contaminated by oil decomposition from inadequate cooling at the compressor. Unless the air supplied from a plant system has been certified as "breathing air" and is under regular control to make sure it is not contaminated, it is usually safer to use a separate compressor of the type not requiring internal lubrication. Pressure reducing and relief valves as well as suitable traps and filters, must be installed at all mask stations. An alternative arrangement frequently used is high pressure breathing air from standard (200 cu. ft.) cylinders, with a demand type valve and face piece. This arrangement may also be used with 50-100 lb. clean piped plant air and as an additional precaution with the demand mask, a small cylinder of compressed air may be worn for use as an emergency escape from the area. Consult a reliable safety equip-

ment dealer for details on the proper use of Bureau of Mines approved equipment.

(d) Industrial Canister-Type Gas Masks, equipped with full face pieces and approved by the U.S. Bureau of Mines, fitted with the proper canister for absorbing vapor, will afford protection against concentrations not exceeding 2 per cent by volume when used in accordance with manufacturer's instructions. The oxygen content of the air must not be less than 16 per cent by volume. The masks should be used for relatively short exposure periods only and when there is no odor of ethylene dichloride inside the facepiece. They are not recommended for use in an emergency since, at that time, the actual vapor concentration is unknown and an oxygen deficiency may exist. The wearer must be warned to leave the contaminated area immediately on detecting the odor of a harmful vapor. This may indicate that the mask is not functioning properly, that the vapor concentration is too high, that the canister is exhausted, or that the mask is not properly fitted. Because of the limitations outlined *restricted usage* of canister masks is considered appropriate.

NOTE: Where other gas having little or no odor may be encountered in addition to *ethylene dichloride*, the mask should be equipped with an "all purpose canister" and a "timing device" as approved by the U.S. Bureau of Mines.

(e) Chemical Cartridge Respirators may be used to avoid inhaling disagreeable but relatively harmless concentrations of *ethylene dichloride* vapor. These respirators, however, are not recommended for protection where toxic quantities may be encountered.

CAUTION: Filter-type respirators do not offer protection against gases or O₂ deficiency and are unsuitable for use when working with *ethylene dichloride*.

5.2.4 Head Protection

5.2.4.1 "Hard" hats should be worn where there is danger from falling objects. If "hard" hats are not considered necessary, soft brimmed hats or caps may be worn to give protection against liquid leaks and splashes.

5.2.4.2 "Bump caps" are satisfactory in areas where there is little or no hazard from falling objects. They will give protection from liquid leaks and splashes.

5.2.5 Foot Protection

5.2.5.1 Ethylene dichloride attacks natural rubber. Leather safety shoes with built in toe caps

are recommended for workers handling containers of ethylene dichloride. Overshoes of a more impervious material, such as Neoprene, may be worn over leather safety shoes. Footwear should be thoroughly cleaned and ventilated after contamination.

5.2.6 Body, Skin, and Hand Protection

5.2.6.1 Sustained or intermittent skin contact with liquid ethylene dichloride may produce dermatitis at the site of contact. It is imperative that contaminated clothing be removed promptly and laun-

dered or thoroughly dried before re-use. Affected areas of the body should be washed thoroughly with soap and water (except the eyes). As a general hygienic measure, facilities for personal cleanliness should be provided, and washing before lunch and at the end of the day should be encouraged. Clothing made of Neoprene or other impervious material may be worn to protect the body against ethylene dichloride splashes. These garments must be cleaned inside and out should they be contaminated. Protective clothing should be examined frequently and discarded at the first evidence of deterioration.

6. FIRE FIGHTING

6.1 GENERAL

6.1.1 The following extinguishing agents may be used on ethylene dichloride fires: water spray or "fog," foam, carbon dioxide, and dry chemical. For large ethylene dichloride fires, the most effective agents are water spray and foam. Exposed equipment should be cooled with water.

6.1.2 The technique of smothering an ethylene

dichloride fire by gently applying water, and then letting it layer out has been used with some success.

6.2 SPECIAL HAZARDS

6.2.1 The products of combustion contained in the smoke contain noxious gases such as hydrogen chloride and phosgene which are both toxic and corrosive. Self contained breathing apparatus should be worn.

7. SHIPPING, LABELING, HANDLING AND STORAGE

7.1 SHIPPING CONTAINERS

7.1.1 Ethylene dichloride is classified by the Department of Transportation as a *flammable liquid*. Unless exempted, it must be packed in DOT specification containers when shipped by rail, water, or highway, and all of the DOT Regulations regarding loading, handling, and labeling must be followed. For a complete list of authorized containers see 173.118 and 173.119 of the Regulations.

7.1.2 Usual Shipping Containers

7.1.2.1 Wooden boxes, DOT Spec. 15A, 15B, 15C, 16A, 19A, or 19B, with inside metal, glass or earthenware containers, maximum capacity of inside containers is 10 gallons for metal and one gallon for glass or earthenware except that single inside containers up to 3 gallons are permitted. See DOT Regulations 173.119(8).

7.1.2.2 Fiberboard boxes, DOT Spec. 12B, with inside containers of glass, plastic or metal not over one gallon each. Packages may not contain more

than four glass containers if their capacity exceeds five pints each.

7.1.2.3 Metal drums, returnable, DOT Spec. 5, 5A, 5B, 5C, or 5M. Recommended maximum size: 55 gallons. DOT Regulations 173.119(2).

7.1.2.4 Metal drums, nonreturnable, DOT Spec. 17C and 17E and 17H. DOT Regulations 173.119 (3) (4).

7.1.2.5 Tank cars, DOT Spec. 103, 103W, 104, 104W, or 105A. DOT Regulations 173.119 (12) and pertinent parts of 179.

7.1.2.6 Tank Trucks, DOT Spec. MC300, MC301, MC302, MC304, or MC305. DOT Regulations 173.119(17).

7.2 PRECAUTIONARY LABELING OR IDENTIFICATION

7.2.1 Each container (including tank cars) should carry an identifying placard, label or stencil.

7.2.2 The Manufacturing Chemists Association recommends that all containers of ethylene dichloride should bear a label as shown. The text is designed

ethylene dichloride and other dangerous articles. Tank trucks must be marked as required by DOT Regulations 177.823(b).

ETHYLENE DICHLORIDE

WARNING! FLAMMABLE HARMFUL IF INHALED

Keep away from heat, sparks, and open flame.
Avoid breathing vapor.
Keep container closed.
Use with adequate ventilation.
Avoid prolonged or repeated contact with skin.
Do not take internally.

FIRST AID: If inhaled, remove to fresh air. If not breathing give artificial respiration, preferably mouth-to-mouth. If breathing is difficult, give oxygen. Call a physician.

In case of:

Fire—Use water spray, foam, dry chemical, or CO₂.
Spill or Leak—Flush area with water spray.

MCA Chemical Safety Data Sheet SD-18 available.

for the product as shipped for industrial use. It should be used in addition to or in combination with any specific wording required by law. Since individual statutes, regulations, or ordinances may require that particular information be included in a label, that certain information be displayed and in a particular manner, or that a specific label be affixed to a container, the use of this label text will not necessarily insure compliance with such laws. Such laws include the Federal Hazardous Substances Labeling Act, Federal Insecticide, Fungicide and Rodenticide Act, and similar state and municipal legislation.

7.2.3 The proper shipping name is *ethylene dichloride* and must show on the outside of shipping containers.

7.2.4 Tank cars and boxcars, must bear the DOT "Dangerous" placard as specified in DOT Regulation 174.552. Motor vehicles or trailers transporting 1,000 pounds or more gross weight of ethylene dichloride must be marked with the FLAMMABLE placard or with the DANGEROUS placard when transporting 1,000 pounds or more gross weight of

7.2.5 Unless exempted, packages containing inside containers of one quart capacity or larger must be packed with filling holes up and outside containers must be plainly marked "This Side Up." Refer to DOT Regulation 173.401(c) and 173.118.

7.2.6 Unless exempted by 173.118, drums and each box containing inside containers must bear the DOT "Red Label" for flammable liquids as set forth in DOT Regulations 173.405(a). Exempt quantities must omit label in accordance with 173.404(b).

7.2.7 DOT Regulations require that the red label for the flammable liquids must be removed, defaced, destroyed, or covered by the DOT white "Empty" labels, before empty containers are returned to the shipper. The DOT "Dangerous" placards on the side and ends of cars must be removed or reversed in a manner required by DOT Regulation 174.562 after emptying.

7.2.8 The empty tank car must be offered to the receiving carrier either without placards, or preferably with four (4) "Dangerous—Empty" placards.

7.3 HANDLING—GENERAL

7.3.1 All precautions must be taken to guard against health and fire hazards whenever ethylene dichloride is handled. The area should be posted with NO SMOKING or other appropriate warning signs as required. If leaks or spills occur, only properly trained personnel should remain in the area. Leaking containers should be removed to the outdoors or to an isolated well ventilated area, and the contents transferred to other suitable containers. All spills should be flushed away promptly with water.

7.3.2 The unloading dock and the surrounding area should be considered as a Class I Group D hazardous location as defined by the National Electrical Code. Conformance of electrical installation in the area to Division 1 or Division 2 requirements of the NEC depends upon such local conditions as proximity to other hazardous locations, congested areas, etc.; therefore, a qualified fire protection engineer or the fire insurance carrier concerned should be consulted.

7.3.3 Railroad locomotives and automotive equipment capable of causing ignition should be excluded from the dock or vapor areas during both the unloading and loading operations.

7.4 SMALL CONTAINERS

7.4.1 The storage and handling of ethylene dichloride in glass containers is not recommended except in small containers for laboratory use. Amber glass containers are recommended. Five gallon metal cans may also be used. Safety cans with pouring outlets equipped with tight-fitting caps or valves normally closed by springs and with fire baffles in the outlets should be used.

7.4.2 Indoor storage areas should be protected with automatic sprinklers. See NFPA No. 30.

7.4.3 For waste disposal of small containers of ethylene dichloride and of materials contaminated with it, see Section 9.

7.5 NON-BULK CONTAINERS

7.5.1 Drums, Metal

7.5.1.1 Drums should be unloaded carefully to prevent damage. Do not drop or bump them.

7.5.1.2 Each shipment should be examined carefully for leaking drums. If any are found, they should be handled with particular care by turning the leaking part up, and should be removed to a safe place where the leakage can be stopped or the contents transferred to a sound container.

7.5.1.3 Before emptying, substantially support the drums and block them to prevent movement.

Bond the drum or discharge nozzle to the receiving container if the discharge system is open. See NFPA No. 77.

7.5.1.4 To remove the body plug, place the bung up, block the drums to prevent movement, and use a bung or plug wrench. Stand to one side and face away during the operation. After the plug starts, give it one full turn. If internal pressure exists, allow it to vent to atmospheric pressure; then only should the plug be loosened further or removed.

7.5.1.5 The preferable safe method for emptying drums is by pump. Electrical pumps should have explosion proof motors except in freely ventilated areas. If drums are emptied by gravity, the faucets should be self closing. Pressure should never be used, especially air pressure.

7.5.1.6 Metal drums to be returned to the supplier must be completely drained and all openings (for bungs, plugs, etc.) must be closed tightly. DOT regulations concerning return labeling must be observed. If a metal drum is to be scrapped, it should be steamed to remove traces of ethylene dichloride vapor and rendered impossible for reuse by crushing or piercing.

7.6 BULK CONTAINERS

7.6.1 Tank Trucks

7.6.1.1 The use of tank trucks is authorized by DOT Regulations. Section 173.115 to 173.119 inclusive and Part 177 of those regulations must be followed where applicable. Local rules, regulations and ordinances must be observed.

7.6.1.2 Ordinarily all operations concerning the tank truck and its appurtenances (fittings, pump, hose, etc.) are the responsibility of the operator. Therefore, loading and unloading operations should be carried out by reliable and properly instructed employees in cooperation with him. The shipper should be consulted for details on proper unloading procedure.

7.6.1.3 Before unloading a tank truck, the engine must be stopped and not started again during the entire loading or unloading operation. Truck brakes should be set and the wheels blocked.

7.6.1.4 To prevent sparking due to static electricity generated by liquid flow a bond should be established between the loading pipe and the cargo tank before loading/unloading operations are started. See NFPA No. 77.

7.6.1.5 It is preferable that truck loading/unloading facilities be level and paved and so located that the truck can be easily, and safely maneuvered to the unloading spot.

7.6.1.6 Air pressure should never be used for unloading tank trucks of ethylene dichloride.

7.6.1.7 **Damage Enroute**—In case a tank truck of ethylene dichloride becomes damaged enroute so that it cannot proceed safely to its destination, every effort should be made to park it where it will not endanger traffic or property. The police and fire department should be notified and the public warned to stay away. The truck should be parked, if possible, in a vacant lot and away from an area in which there is a concentration of people. Follow MCA Chem Card precautions as available or contact producer for safe disposal instructions.

7.6.2 Tank Cars

7.6.2.1 For general and detailed instructions regarding the unloading of tank cars containing flammable liquids, see MCA Manual Sheet TC-4 and the Regulations of the Department of Transportation. A few of these instructions follow.

7.6.2.2 Shipper's instructions for unloading should always be followed, and all caution markings on both sides of tank or dome should be read and observed.

7.6.2.3 In the event of a tank car fitting failure or leak that cannot be stopped by following previous instructions from the shipper, immediately telephone or wire him for further instructions.

7.6.2.4 See that the train or engine crew accurately spots the car at the unloading line. The unloading track should be level. The brakes should be set, wheels blocked by standard rail clamps, blue warning signs placed and other safe practices followed as outlined in MCA Manual Sheet TC-4.

7.6.2.5 Derails should be placed at one or both ends of the unloading track approximately one car-length from the car being unloaded, unless the car is protected by a closed and locked switch or gate.

7.6.2.6 All tools and implements used in unloading the car should be kept free from oil, dirt, and grit.

7.6.2.7 Before the manhole cover or the outlet valve is opened, the tank car should be relieved of all internal pressure.

7.6.2.8 Tank cars should be unloaded by means of an approved pump through the dome connection rather than through the bottom outlet. Air pressure must never be used. The car should be vented through an approved flame arrester during unloading.

7.6.2.9 After tank cars have been moved, it is important that they be inspected carefully, since leaks may develop in transit.

7.6.2.10 As soon as a tank car is completely unloaded, disconnect the unloading line and replace closures on all tank openings. Close and securely fasten the dome cover. DOT Regulations concerning return placarding should be observed.

7.6.2.11 Empty tank cars should be returned as promptly as possible, in accordance with instructions received from the shipper. The shipper's routing instructions should always be strictly followed.

7.7 STORAGE (See NFPA No. 30)

Ethylene dichloride is noncorrosive at normal atmospheric temperatures when dry (moisture-free). In contact with water at elevated temperatures ethylene dichloride corrodes iron and certain other metals.

7.7.1 Indoor Storage

7.7.1.1 When filled drums or other containers are stored indoors, they should be stored in non-combustible, well ventilated structures. Consult your state and city Fire Codes and your insurance carriers.

7.7.1.2 When filled drums or other containers are stored in separate storage rooms, trapped floor drains should be provided. The floors should be pitched to the drains and the latter should lead to a safe location and be properly trapped. In case no drains are provided, four inch curbs or a drained gutter, covered with an appropriate grill, should be constructed at door openings. In either case, only those with proper protective equipment should attempt to clean up ethylene dichloride spills.

7.7.1.3 Storage areas should be provided with automatic sprinklers or some adequate extinguishing system desirable on interior storage. (See NFPA No. 30).

7.7.1.4 Oxidizing materials should not be stored nearby.

7.7.1.5 Since ethylene dichloride is light sensitive, small quantities should be stored in amber glass bottles.

7.7.2 Bulk Storage

7.7.2.1 Iron and steel are suitable metals for storage tanks.

7.7.2.2 Atmospheric tanks should be located at least 100 feet and pressure tanks at least 150 feet from ignition sources such as boiler houses. Tank supports should be of reinforced concrete, brick, or steel. If steel is used, it should be fireproofed. Tanks should be located at distances from property lines, buildings, and from each other as required by any governing statutes, regulations, or ordinances, and

by the authority having jurisdiction. (See NFPA No. 30).

7.7.2.3 Where adequate spacing and segregation are not maintained, protection against exposure to fires may be required. The use of automatic sprinklers or water spray systems may be necessary.

7.7.2.4 Electrical installations should conform to the requirements of the National Electrical Code for Class I, Group D hazardous locations.

7.7.2.5 Each tank should be equipped with a vent terminating outdoors and protected by a flame arrester (flash screen) or pressure vacuum vent.

Emergency fire conditions should be considered in designing storage tank vents. Vents should be sized according to the suggested Flammable Liquids Ordinance of the NFPA or any local governing ordinances.

7.7.2.6 All openings in the system should terminate outdoors and be protected by flame arresters (flash screens).

7.7.2.7 Gauge glasses should be guarded.

7.7.2.8 Large outside above-ground storage tanks should be properly diked to confine the liquid in the event of tank failure.

8. TANK AND EQUIPMENT CLEANING AND REPAIRS

8.1 JOB EVALUATION AND PREPLANNING

8.1.1 Cleaning or making repairs inside a tank which contained ethylene dichloride is particularly hazardous because of its harmful properties and flammability.

8.1.2 Equipment and tank cleaning and repair should be under the direction of thoroughly trained personnel who are fully familiar with all of the hazards and the safeguards necessary for the safe performance of the work. All precautions pertaining to education, protective equipment, and health and fire hazards should be reviewed and understood.

8.1.3 The hazardous nature of tank inspection, cleaning, and repair requires that the foreman and crew be selected, trained, and drilled carefully. The preparation of a step by step work procedure for the entire job, recognizing all possible hazards as they might occur, developing safe procedures and designating suitable protective equipment, has been found to be particularly effective in maintaining work safety.

8.2 TANK OR EQUIPMENT CLEANING

8.2.1 Tanks and equipment, pumps, lines and valves should always be drained and thoroughly cleaned before being repaired. Workmen should never be allowed to attempt to repair equipment while it is in operation and the lines in service.

8.2.2 Post danger signs prominently to prohibit smoking, use of open flames and unauthorized personnel in the area where tank or equipment is to be cleaned.

8.2.3 The tank or equipment to be repaired must first be emptied of all liquids. Then pipe lines into or out of the tank should be disconnected, preferably

by removing a complete small section and providing a blank flange on the open end to protect against human error and unsuspected leaks. Valves and blank flanges in the pipe line must not be relied upon alone.

8.2.4 If pipe sections are to be removed and flanges opened, the lower bolts should be loosened first and, although the lines have been flushed, care should be taken to avoid personal contact with the liquid draining, or dripping from the equipment. All spillage from the lines or equipment should be removed immediately by flushing to the drain with large quantities of water.

8.2.5 Steam is recommended for cleaning ethylene dichloride vapor and accumulations from tanks. After steaming, the tank should be flushed with water. Repeat the steaming and washing until the tank is free of flammable vapor.

8.3 PREPARING FOR TANK ENTRY

8.3.1 Special ventilation and a continuous fresh air supply are required during the entire time men are cleaning, inspecting, or repairing the tank. Ventilation can be accomplished by exhausting or removing vapors from the bottom of the tank either through its bottom openings, or by exhausting the vapors from the tank bottom (or top) by means of a large rubber hose or flexible duct where tanks have a top opening only. The blowers or exhausters used for ventilation should be cleaned frequently so that moving parts will not set up friction heat which may cause ignition of the vapor. On tanks having only a top opening, care must be exercised to ensure complete removal of vapors from the entire tank. Care must also be taken to avoid having exhaust gases recycled into the tank.

8.3.2 No workman should enter a tank or vessel that does not have a manhole opening large enough to admit him while wearing his safety harness, life line, and respiratory protective equipment. It should be ascertained that the tank or vessel can be left by the original entrance. In some cases, it is advisable to have a block and tackle positioned on a tripod or otherwise fastened above the manhole.

8.3.3 Proper personal protective equipment should be worn by anyone entering a tank for inspection, cleaning, or repairs.

8.3.4 Danger signs should be placed suitably to indicate when workmen are in the tank.

8.3.5 Lock electrical switches in the off position, remove drive belts, and otherwise completely safeguard against accidentally starting the agitating equipment or other moving parts located inside the tank or adjacent to the entrance.

8.3.6 The portable electric lights and power tools should be suitable for use in classified areas, should be in good condition, and the metal noncurrent carrying parts should be electrically bonded to the ground.

8.3.7 It should be ascertained that all sources of ignition have been eliminated from the vicinity of the tank and that vapor flow from tank is controlled.

8.3.8 In addition to protecting the workmen actually engaged in cleaning and repairing the tank, attention should be paid to the protection of workers in nearby areas.

8.4 ENTRY AND WORK WITHIN TANK

8.4.1 No one should enter a tank or confined space until a work permit has been signed by an authorized person indicating that the area has been tested and found to be safe. Before directing men to enter a tank, an inspection of the interior should be made by the foreman who should be equipped with an airline mask or self-contained breathing apparatus, together with rescue harness and life line. Another person should be on guard during the inspection.

8.4.2 Workers entering tanks should be equipped with suitable personal protective equipment, preferably self-contained or airline breathing apparatus. At least one other person should be observing operations from outside the tank at all times.

8.4.3 During the course of the work, frequent tests should be made to determine that the atmosphere in the tank is being maintained within the safe range.

This precaution is necessary because residues not completely removed by washing may recontaminate the tank atmosphere.

If any flammable vapors are present, the cleaning process should be repeated until the tank or vessel is free of vapor. The air should also be tested for oxygen content.

If the work extends over a considerable period, or is interrupted, frequent and regular tests of the atmosphere within the tank should be made to determine whether recontamination has taken place. A new work permit should be issued before resumption of work.

8.4.4 An attendant should be present at the point of entry whenever another person is in the tank. If work is being done in an isolated area, arrangements should be made to have at least two additional assistants available at all times. Each person entering a tank should wear an approved safety harness with a rope attached. An individual rope securely fastened outside the tank must be provided at the manhole cover for each person.

8.5 EMERGENCY RESCUE

8.5.1 A supplied-air respirator (hose mask) or self-contained breathing apparatus, together with rescue harness and life-line should always be located outside the tank entrance for rescue purposes, regardless of the type of respiratory equipment or air supply which is provided for employees inside the tank. The air intake of the hose mask should be kept in an uncontaminated area.

8.5.2 Under no circumstances should a rescuer enter a tank to remove a victim of overexposure without proper respiratory protection, a safety harness and an attached life line. The free end of the life line should be manned by an attendant located outside the tank. Another attendant should be immediately available to assist in the rescue if needed. The rescuer should be in view of the outside attendant at all times or in constant communication with him.

8.5.3 If a tank cleaner or repairman is overcome by fumes, he should be removed to fresh air immediately. Artificial respiration should be applied if breathing has stopped, and a physician summoned at once.

8.6 REPAIRS TO TANKS OR EQUIPMENT

8.6.1 Repairs to interiors or exteriors of tanks or equipment, including repairs to steam coils, cutting, riveting and welding, should be permitted only

after thoroughly cleaning and testing of the tank to make sure it is free of vapors and after a work permit has been issued by an authorized person.

8.6.2 All outside welding or burning on tanks or equipment which have contained ethylene dichloride should be done only after such containers have been completely purged with steam. Steam lines should be bonded to prevent accumulation of static

charges. Purging should be continued while the repair work is in progress. Filling empty tanks with inert gas or purging with air are other methods which may be used in outside welding or burning.

8.6.3 In all cases, if repair work is interrupted, the tank atmosphere should be checked thoroughly and a new work permit issued before resumption of work.

9. WASTE DISPOSAL

9.1 The disposal of waste ethylene dichloride and materials contaminated with it is subject to Federal, state, and local regulations regarding health and pollution.

9.2 Disposal of small quantities may be accomplished by removal of the waste to a safe location away from buildings or other combustible structures, then pouring the mixture on dry sand, or earth and then cautiously igniting it. Disposal of large quantities of ethylene dichloride may be accomplished by

atomizing the liquid into an approved type of combustion chamber equipped with a vent gas water scrubber.

9.3 Waste mixtures containing ethylene dichloride should not be allowed to enter those drains or sewers where there might be danger of the vapor igniting.

9.4 Ethylene dichloride has a low chemical oxygen demand, does not interfere with biological treatment, and is easily aerated out of water solutions.

10. MEDICAL MANAGEMENT

10.1 HEALTH HAZARDS

10.1.1 Ethylene dichloride is toxic by inhalation, by contact with skin or mucous membranes, or by ingestion. Prolonged, excessive or repeated exposure to the product in any form is hazardous.

10.1.2 The signs and symptoms of excessive absorption are: headache, mental confusion, depression, fatigue, loss of appetite, nausea, vomiting, cough, loss of sense of balance, and visual disturbances. There may also be diarrhea with bloody stools, suppression of urine, edema, jaundice, and blood in the urine.

10.1.3 The signs and symptoms of ethylene dichloride poisoning given in 10.1.2 are the result of injury to the kidneys, adrenal glands, lungs, and digestive and nervous systems. The clinical picture varies with the type and degree of exposure, whether single or multiple.

10.1.4 Toxic Effects After Inhalation

The threshold limit value adopted by the American Conference of Governmental Industrial Hygienists is 50 ppm. Exposure to higher concentrations of vapor causes irritation of the eyes, nose and

throat. There may also be nausea, vomiting and some drowsiness. Ethylene dichloride, like other chlorinated hydrocarbons, has an anesthetic action.

10.1.4.1 Acute Poisoning

10.1.4.1.1 Inhalation of an excessive amount of vapor over a short period of time may cause acute poisoning. The initial effects are irritation of eyes, nose and throat, fullness in the head with mental confusion. There may be dizziness, nausea and vomiting. If the workman is not immediately removed from the vapor he may become unconscious.

10.1.4.1.2 Some conditions under which acute poisoning may occur are as follows:

(a) Spills.

(b) Working in enclosures or tanks without adequate protection.

10.1.4.2 Subacute Poisoning

10.1.4.2.1 Subacute ethylene dichloride poisoning may result from prolonged or repeated work in an atmosphere containing excessive concentrations of ethylene dichloride, but under conditions

10.1.4.1.1
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in which the amount absorbed is not sufficient to cause loss of consciousness.

10.1.4.2.2 Workers with subacute poisoning may become acutely ill and suffer from headaches, fatigue, nausea, vomiting and dizziness with visual disturbances. There may be edema and suppression of the urine. Jaundice may occur.

10.1.4.2.3 Some conditions under which subacute poisoning may occur in employees are as follows:

- (a) Inadequate ventilation,
- (b) Faulty handling or lack of containment of the liquid or vapor.
- (c) Failure of the individual to observe precautionary measures.

10.1.4.3 *Chronic poisoning.* The symptoms would be similar to those encountered in subacute poisoning except there are no acute symptoms, since the poisoning results from absorption of less material over a longer period of time.

10.1.5 Toxic Effects from External Contact

10.1.5.1 Skin

Ethylene dichloride is absorbed through the skin though it takes quite large doses to cause serious systemic poisoning. When ethylene dichloride is held close to the skin within a cuff, such as is used in skin-absorption experiments, quite severe irritation and moderate edema and necrosis may be observed. Ordinary contact with ethylene dichloride on the skin where it is not held by the clothing does not cause serious difficulties. Repeated or prolonged contact, however, may cause a rough, red, dry skin due to extraction of fatty materials. It may result in cracking and a "chapped skin."

10.1.5.2 Eyes

Eye exposure to vapor or liquid produces lacrimation, burning and other symptoms of irritation. Immediate eye irrigation will prevent serious injury.

10.1.6 Toxic Effects After Oral Intake

The initial symptoms of toxic amounts of ethylene dichloride taken by mouth are irritation of the gastro-intestinal tract, with nausea, vomiting and diarrhea with bloody stools. This may be followed by the general symptoms of poisoning enumerated above.

10.2 PREVENTIVE HEALTH MEASURES

10.2.1 Ventilation

10.2.1.1 The best way to avoid toxic effects is to handle ethylene dichloride in a closed system. Where this is impractical, sufficient ventilation should be provided to keep the concentration of vapor below 50 ppm in the work room air. The odor of ethylene dichloride at hazardous concentrations may not always be detectable and does not give adequate warning to prevent injury.

10.2.1.2 General ventilation can be used to avoid overexposure to vapors resulting from small leaks which escape detection. Local ventilation can be used at sites of known release of vapors to the air. However, the use of ventilation to control exposure of workmen can result in an air pollution problem if the discarded air reaches an inhabited area.

10.2.2 Employee Education

10.2.2.1 Employees should be instructed to report any signs or symptoms, and to seek medical attention promptly.

10.2.2.2 Anyone with potential exposure to ethylene dichloride should be made aware of its hazardous properties and instructed to observe proper precautions.

10.2.3 Preplacement Physical Examinations

Some people are more susceptible to chlorinated hydrocarbons than others. The danger to such individuals can be minimized by a preplacement physical examination. Exposures to ethylene dichloride even in concentrations known to be nonhazardous to normal individuals should be prohibited in:

- (a) Alcoholics
- (b) Obese individuals
- (c) Undernourished individuals
- (d) Those with pulmonary diseases, peptic ulcer, high blood pressure, and diseases of the liver, kidney or heart.

10.2.4 Periodic Physical Examinations

Employees who are exposed regularly to ethylene dichloride should be examined, at least semi-annually. Physical examinations should be required also when any symptoms of poisoning, such as enumerated above are present in employees. Discovery of symptoms of ethylene dichloride poisoning may indicate some defect in operation. This would serve as an indication to examine other exposed employees for early signs of poisoning.

11. FIRST AID

11.1 GENERAL PRINCIPLES

11.1.1 Most important in the case of any poisoning is quick removal from exposure. In the case of ethylene dichloride poisoning, this means first removing the patient from the contaminated atmosphere and, insofar as possible, removing the ethylene dichloride from the skin, eyes and gastro-intestinal tract.

11.1.2 Give the patient fresh air by moving him to a well ventilated room free of vapors and by dispersing any crowd. If breathing has ceased, start artificial respiration at once.

11.1.3 Adrenalin or similar acting drugs should never be given to a person suffering from ethylene dichloride poisoning, because these drugs may precipitate abnormal heart rhythms.

11.1.4 Keep the patient quiet and comfortably warm but not hot.

11.2 SPECIFIC ACTIONS

11.2.1 Inhalation

A person showing symptoms of ethylene dichloride vapor poisoning should be removed promptly from the contaminated area. In case breathing has stopped, artificial respiration should be started immediately. If oxygen inhalation apparatus is available, oxygen should be administered only if one familiar with the operation of the apparatus is present to administer it.

A physician should be called at once.

11.2.2 Skin Contact

All contaminated clothing should be removed

at once. Clothing, including shoes, soaked in ethylene dichloride should be removed and not worn again until thoroughly dry. All affected areas should be washed thoroughly with abundant water and soap. For serious or persistent cases of skin trouble and for signs and symptoms of generalized poisoning, a physician should be consulted.

11.2.3 Contact with Eyes

If liquid ethylene dichloride has entered the eyes, they should be washed promptly with copious quantities of water for at least 15 minutes. It is advisable to irrigate the eyes gently with water at room temperature in order to minimize additional pain or discomfort. Ethylene dichloride vapor can produce injury to the eyes if the exposure is intense or prolonged. Eyes should be irrigated for vapor exposure in the same manner as for liquid exposure. Medical attention should be obtained in all cases of eye exposure.

11.2.4 Taken Internally

If a person has swallowed ethylene dichloride, he should be made to vomit by drinking a glassful of mustard water, lukewarm salt water, or soapy warm water. If necessary, the patient should be encouraged to stick his finger down his throat to induce vomiting. This procedure should be repeated at least three times and then followed by the administration of a tablespoonful of epsom salts. A physician should be called at once.

Never give anything by mouth or attempt to cause vomiting if the patient is unconscious or having convulsions.

- (4) Clarke, C. A.: Personal communication (1968).
 (5) Gorman, J. G., V. J. Freda: Personal communication (1968).
 (6) Jennings, E. R.: Personal communication (1968).
 (7) Gorman, J. G.: Personal communication 1967.
 (8) Zipursky, A., L. G. Isaacs: Canad. med. Ass. J. 97 (1967), 1245. - Lewis, M.; Bowman, J. M.; Peddle, L.; Kaira, H., B. Chown: Personal communication (1967).
 (9) Robertson, J. G.: Communication read at Europ. Congr. of Perinatal Med., at Berlin, 27.-30. 3. 1968.
 (10) Bartsch, F.: Personal communication (1968).
 (11) Vermeylen, C.: Personal communication (1968).
 (12) Hamilton, E. G.: Obstet. and Gynec. 30 (1967), 812. - Personal communication to J. G. Robertson, C. A. Clarke.
 (13) Hindemann, P.: Bibl. gynae. (Basel 1966), p. 23.
 (14) Pollack, W., H. O. Singher, J. G. Gorman, V. J. Freda: The prevention of Isoimmunization to the Rh-Factor by passive immunization with Rh₀ (D) Immune-Globulin (Human). American Association of Blood Banks Oct. 21.-24. 1967 (New York). Scientific Exhibit and abstract in "Transfusion" (N. Y.). To be published.

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Clinical Features, Pathogenesis and Management of Dichloroethane Poisoning¹

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Summary: A 57-year-old man died of therapy-resistant cardiovascular failure 24 hours after ingestion of an dichloroethane-containing embrocation. Apart from gastro-enterocolitis and hepatic necrosis he developed a severe haemorrhagic diathesis. The complex disturbance of the haemostatic mechanism, which included thrombocytopenia and reduced activity of all clotting factors examined (Factor I, II, V, VII and XIII), was ascribed to consumption ("using up") of these substances by disseminated intravascular coagulation ("Verbrauchskoagulopathie") and secondary hyperfibrinolysis. Therapeutic principles for the management of oral dichloroethane poisoning are suggested taking into account the likely pathogenesis. They include prompt gastric lavage with addition of paraffin (in which dichloroethane dissolves), measures to protect the liver, continuous supervision and adjustment of blood gases. Incipient consumption of the clotting factors is counteracted by heparin infusions. Cardiovascular function is supervised by continuous registration of the electrocardiogram, even after apparent improvement in the patient's condition or subsidence of the initial stupor. Should renal failure occur, treatment is the same as for other types of acute renal failure.

Some analgesic and anti-inflammatory embrocations include dichloroethane ($\text{CH}_2\text{-Cl-CH}_2\text{-Cl}$) as their main hyperaemia-inducing constituent. Accidental or deliberate ingestion of such embrocations which are meant solely for external use, may result in severe and sometimes fatal dichloroethane poisoning (2, 3, 13).

To the few reports of poisoning by swallowing dichloroethane a further case is added here. It was characterized by very severe cardiac arrhythmias and disturbances of the clotting mechanism causing a haemorrhagic diathesis due to intravascular consumption of clotting factors.

Case Report

At about 18.30 on November 4, 1966, patient R., a 57-year-old man, swallowed, presumably with suicidal intent, about 40 ml of an initially unidentified embrocation used by him for the relief of rheumatic complaints. He was admitted to hospital at 20.00 on the same day in a somnolent condition. As the patient could not be roused, information about the poison swallowed was unobtainable.

Relatives could not be contacted. The expired air smelled strongly of camphor. A few minutes after admission to hospital the patient vomited about 300 ml of a bilious liquid smelling of camphor and about 30 minutes later voided copious, apparently normal, faeces on three occasions. Otherwise there were no alarming signs of severe poisoning.

Clinical Features and Course

Apart from a postgastrectomy scar external appearance was normal. There were no demonstrable neurological defects, cyanosis, dyspnoea, oedema, jaundice, skin rash or haemorrhagic diathesis. Blood pressure was constant at 140/80 mm Hg. The electrocardiogram (ECG) showed sinus tachycardia of about 100/minute and ventricular extrasystoles but normal A-V conduction.

Serum glutamic-oxaloacetic transaminase (SGOT) and serum glutamic-pyruvic transaminase (SGPT) activities were normal (4.5 IU and 6.7 IU, respectively). After gastric lavage, which produced only small quantities of food residue, infusion of a 5% Ringer-laevulose solution combined with strophanthin and antibiotics was instituted. Oral paraffin, which binds ethane dichloride and in this way prevents or delays its absorption, was not given as there was no information on the type of poison (9). A gas analyser which would have immediately detected the presence of halogenated hydrocarbons

¹ Translated from Dtsch. med. Wschr. 93 (1968), 2002.

in the expired air was not available at that time. In view of the continued improvement in the patient's condition no further therapeutic measures were adopted.

On the morning of November 5th, twelve hours after admission to hospital, the patient responded to stimuli. It was only then, 14 hours after the accident, that the patient and relatives who had since been summoned by telephone provided the information that he had swallowed Marament®. This embrocation is made up of: 100 g dichloroethane, 2.0 g oil of pine-needles, 0.2 g methyl salicylate, 0.05 mg cobra (*Naja tripudians*) toxins and an unspecified emulsifier in 100 ml of the liquid.

At about 8.30, almost immediately after the toxic nature of the remedy had become known, the patient's condition suddenly deteriorated with dyspnoea, orthopnoea and progressive clouding of consciousness. Blood pressure could no longer be recorded. At 8.40, during attempts at improving the circulation, cardiac arrest suddenly supervened.

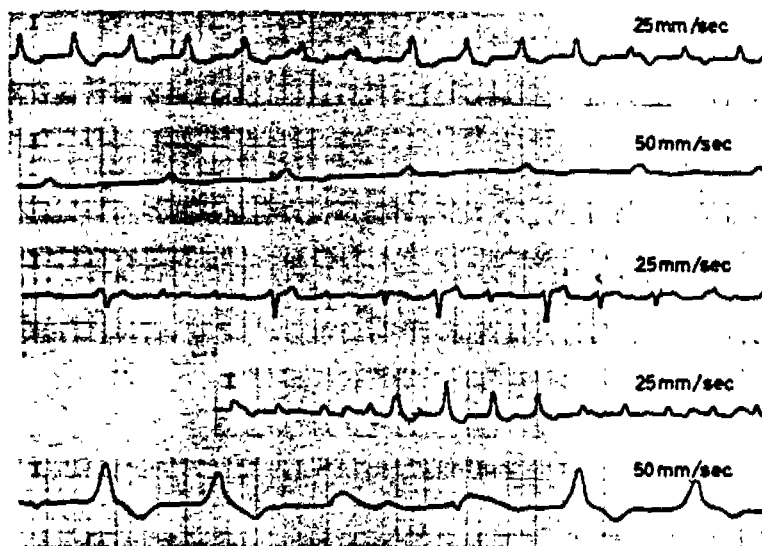


Fig. 1. Electrocardiogram recorded on 5 November 1966, after successful resuscitation: probably complete atrio-ventricular dissociation with changing site of pacemaker.

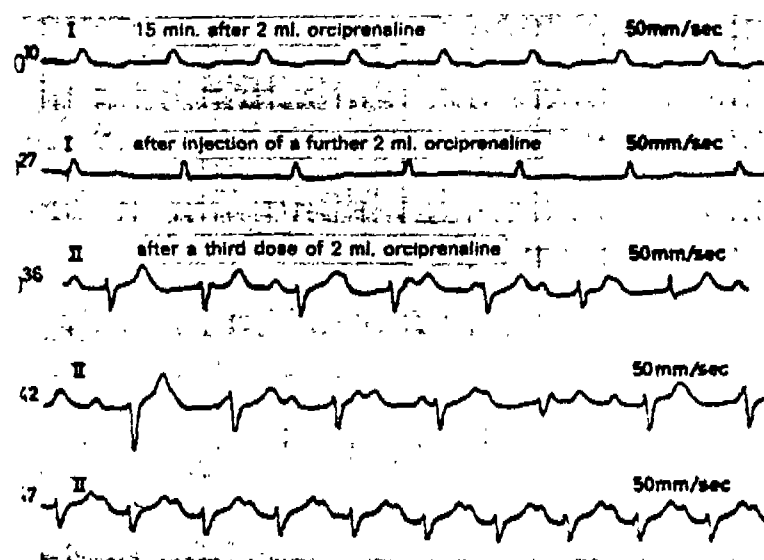


Fig. 2. Electrocardiogram recorded at 10.10-10.47 a.m. on 5 November 1966: sinus tachycardia after injection of a total of 6.0 ml of orciprenaline (Alupent®).

After successful resuscitation by external cardiac massage for 25 minutes and artificial respiration with oxygen (by intubation) the ECG showed complete atrio-ventricular block with a regular idio-ventricular rate of 70/minute. The P-waves, so far as they were discernible, indicated an atrial rate of 75/minute (Fig. 1).

The ventricular and atrial rates responded to the intravenous injection of 1.0 mg orciprenaline with a rise to 85/minute and 120/minute respectively. Finally, complete A-V block subsided and a regular rhythm of 110/minute returned (Fig. 2).

Rapid infusion of Haemaccel®, sodium bicarbonate, 5% Ringer-laeulose solution and noradrenaline succeeded at about 10.40 (two hours after cardiac arrest) in restoring the circulatory state to normal. Unaided by adrenergic agents the blood pressure rose to 105/85 mm Hg and the patient responded to stimuli.

ECG recordings (precordial leads) showed episodes of right bundle branch block. 17 hours after the accident the sinus rhythm was again disturbed by occasional ventricular extrasystoles which became more frequent in the course of the next half hour (Fig. 3). After a further two hours, P-waves were no longer discernible; but the possibility that they were fused with the preceding T-waves could not be excluded.

During the day the ventricular extrasystoles became more frequent and changes in the site of impulse origin resulted in episodes of parasystole. 24 hours after ingestion of the poison the blood pressure fell rapidly within 30 minutes and cardiac arrest occurred.

During resuscitation attempts prolonged bleeding from venipunctures drew attention to an increased bleeding tendency.

At 10.40, after nodal rhythm and stable circulatory conditions had become re-established and consciousness was gradually returning, massive haematemesis occurred, presumably due to profuse bleeding from the gastro-intestinal mucosa. It effectively precluded oral administration of paraffin which even then might still have proved beneficial. Up to 14.00 a total of 1,500 ml of blood-containing gastric contents had been evacuated, partly by vomiting and partly by suction catheter. An analysis of the clotting factors (at 15.00) showed maximal reduction of Factors II, V, VII and XIII and complete defibrination, fibrinogen being no longer demonstrable in the tyrosine-tryptophan test (12). The platelet count had dropped to 14,300/mm³, fibrinolysis (Piper's method [10]) was increased to four times its normal value and pro-activator levels were below 10%. The thrombelastogram showed the blood to be incoagulable. Thrombin time after fibrinogen substitution was 59 seconds instead of the normal 12 seconds.

The complex coagulation disorder with thrombocytopenia and reduced activity of all coagulation factors was attributed to the consumption of these substances in a process of disseminated intravascular coagulation ("Verbrauchskoagulopathie") and to secondary hyperfibrinolysis (5, 7). The patient was given 5,000 U heparin by intravenous drip over a period of two hours and he was also given intravenously Cohn's fraction as a fibrinogen substitute, 4.0 g of ε-amino-caproic acid as an anti-fibrinolytic agent and 2.0 ml Vitamin K₁ (phytylmenadione).

A further estimation of clotting factors at 18.00 showed a rise in fibrinogen level to 16 mg/100 ml and in the platelet count to 20,000/mm³. Factors II, V and VII remained low. As was subsequently confirmed at necropsy, the liver at that time was already irretrievably damaged. The steep rise of SGOT to 1,860 IU, of SGPT to 450 IU and of

lactate dehydrogenase to 4,555 IU and the reduction of serum-albumin concentration to 1.59 g/100 ml and of plasma-cholesterol to 76 mg/100 ml were presumably attributable to fulminating yellow atrophy of the liver. The abnormally high lactate-dehydrogenase activity may have possibly been due to haemolysis.

Blood-gas analysis (Astrup's method) after massive infusion of a total of 920 mEq. of sodium bicarbonate revealed extreme acidemia (pH 6.8) which was partly of metabolic (reduced base excess and standard bicarbonate) and partly of respiratory origin (marked increase in CO_2 tension). At the time the blood samples were taken the patient was already moribund. He died at approximately 20.00, about 24 hours after ingestion of the poison, of irreversible cardiac and circulatory failure.

Necropsy Findings

The most striking feature was acute yellow atrophy of the enlarged (1,800 g) and flabby liver. The cut surface showed irregular yellowish-brown mottling. Through the microscope the lobular structure was discernible only as a shadow outline.

The portal canals were crowded closely together. Goldner's stain revealed very dark, homogeneous and lumpy hepatic cells with only a few nuclei. Distended cells, hyaline bodies and large intracellular fat droplets were also seen. Only a few hepatic cells were of normal appearance.

Both ventricles were hypertrophied and the right one was also dilated. On microscopic examination the myocardial fibres were thickened and the cell nuclei enlarged and irregular. There were also recent, predominantly perivascular, focal necroses of the myocardial fibres (Fig. 4*). The coronary arteries were slightly arteriosclerotic but not narrowed.

The lungs showed bilateral chronic emphysema, membranous pleural adhesions, considerable congestion and oedema. Microscopic examination revealed both occluding and non-occluding thrombi in the small lung arteries and capillaries, of not quite recent origin (Figs. 5 and 6).

The haemorrhagic diathesis manifested itself in haemorrhages into the mucosae of oesophagus, stump of the stomach (after a Billroth II gastrectomy) and rectum, and into the subepicardial, subendocardial and myocardial tissues. Bleeding into the intestinal wall was noticeable in some jejunal loops. The attempts at resuscitation had resulted in fracture of several ribs, subpleural haematoma and haemothorax of minor degree on the left side.

Discussion

The signs and symptoms presented by this case of dichloroethane poisoning corresponded closely to the clinical picture described by others. Characteristic features were an initial stage of stupor followed by the development of gastro-enterocolitis, hepatic necrosis, haemorrhagic diathesis and cardiogenic shock within 48 hours. The frequently observed involvement of the kidneys was absent in our case. Toxic effects of dichloroethane resemble those produced by other halogenated hydrocarbons, especially carbon tetrachloride, chloroform and ethane tetrachloride. All these agents have in common that, being fat-soluble, they have narcotic effects and taken orally they cause gastrointestinal damage and necrosis of the liver and kidneys. The renal lesions generally do

* Figs. 4-6 are on p. 66.

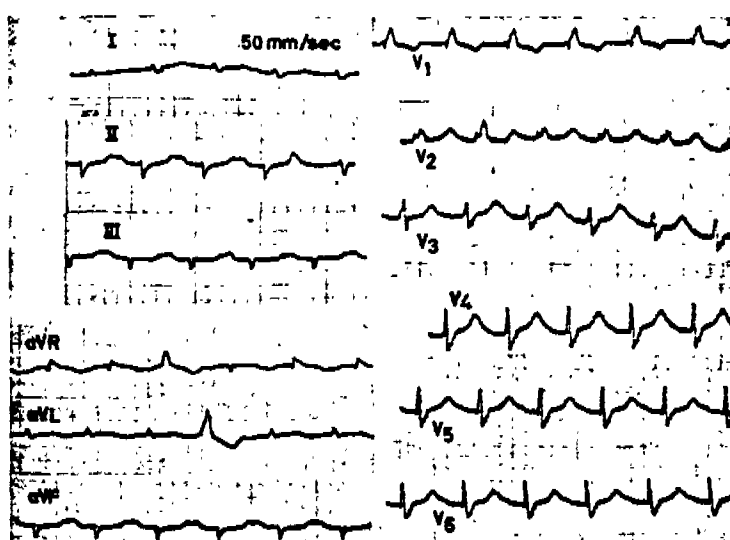


Fig. 3. Electrocardiogram taken at 10.53–10.58 a.m. on 5 November 1966. The tracings (the leads were not recorded simultaneously) show, first, sinus tachycardia with some extrasystoles; on the right: complete right bundle branch block has developed which may indicate acute cor pulmonale.

not develop until after a latent period of 24–48 hours (9). Cardiac arrhythmias and particularly ventricular fibrillations have been observed after poisoning with chloroform and carbon tetrachloride (4) and Friese (3) also noticed in a case of ethane dichloride poisoning a transient inversion of the T-wave in leads V_5 – V_6 , such as occurs in rudimentary infarction of the anterior wall. The haemorrhagic tendency that accompanies carbon tetrachloride and dichloroethane poisoning has been ascribed to a massive reduction in prothrombin concentration.

The post-mortem examination in our case revealed not only the signs of haemorrhagic diathesis but also thrombi in the pulmonary arterioles and capillaries. Taking into account the complex changes in the haemostatic mechanism and the not unfavourable effects of heparin administration, the assumption appears justified that the dramatic reduction in the platelet count and clotting factors was a sign of their marked depletion, the substrates having been consumed in the process of coagulation (8). This interpretation receives support from the fact that fibrinogen has a half-life of 3–4 days (1); the drop in the platelet count and plasma Factor I could not, therefore, be accounted for by the onset of hepatic necrosis and the resulting interference with the formation and synthesis of plasma clotting factors. As to the accompanying hyperfibrinolysis, this was presumably a reactive process to dissolve the fibrin thrombi as is frequently observed in generalized intravascular clotting (7).

Whether dichloroethane can trigger intravascular clotting is so far unknown. Being a fat solvent it might damage the platelet membrane and thereby release platelet Factor III; or it might activate the clotting process by inducing haemolysis and thereby releasing pro-coagulant erythrocytic lipoproteins (erythrocytin [11]). The snake venom in the embrocation (snake bites may cause intra-

For the article by Turina et al. (pp. 49-50)

Crohn's Disease of the Oesophagus



Fig. 1. Crohn's disease of the oesophagus. Oesophagram: severe degree of stenosis with thread-like irregular lumen immediately above the diaphragm. Conical narrowing of the oesophagus above the stenosis.



Fig. 2. Same case as Fig. 1. Resected specimen of the distal oesophagus and proximal part of the stomach showing a 2 cm long granulomatous stenosis (S) below the upper margin of the resection.



Fig. 3. Same case. Ulcer floor with non-specific granulation tissue and compact lymph follicles in the residual parts of the tunica propria, also in the submucosa which is fibrotic and hyperaemic. Magnification $\times 35$.



Fig. 4. Same case. Muscularis propria with compact lymph follicles. Magnification $\times 88$.

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Clinical Features, Pathogenesis and Management of Dichloroethane Poisoning

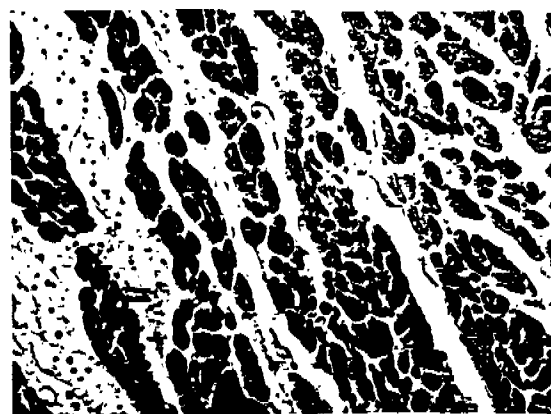


Fig. 4. Heart-muscle necrosis. Goldner's trichome stain. Magnification $\times 140$.

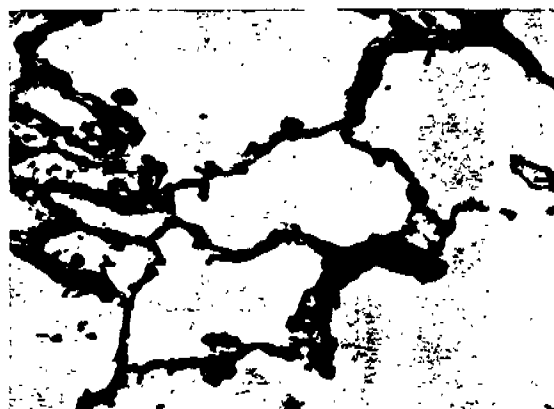


Fig. 5. Hyaline thrombi in lung vessels. Goldner's trichome stain. Magnification $\times 140$.

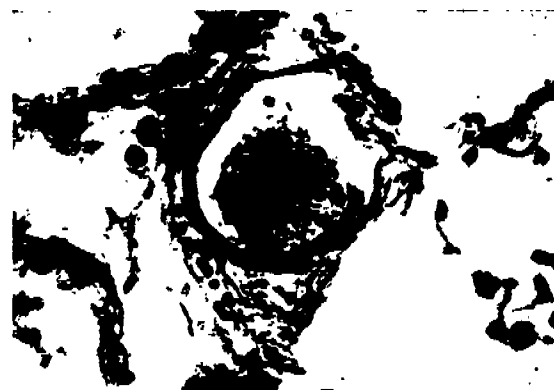


Fig. 6. Hyaline thrombus in lung vessels. Goldner's trichome stain. Magnification $\times 240$.

The Morbid Anatomy of Marburg Virus Disease



Fig. 1. Irregularly arranged areas of necrosis (dark) affecting single cells and cell groups in the liver. Case 1 (PM No. 378/67). Formalin, Goldner, $\times 100$.

ascular clotting) can be excluded as a causal factor as the poison was taken by mouth. The severe damage to the organs induced by dichloroethane could possibly bring about the release of tissue thromboplastins which, in connection with the excessive acidemia and circulatory failure, could cause a shift in the physiological balance between fibrinolysis and clotting towards the latter.

There is also the possibility that the cardiac arrhythmia and the consequent reduction in cardiac output (cardiogenic shock) played a causal role in the pathogenesis of intravascular clotting. On the other hand, the dilatation of the right ventricle and development of acute cor pulmonale with cardiac arrhythmia, cardiogenic shock and myocardial necroses could equally well originate from intravascular coagulation and the resulting, histologically proven, blocking of the pulmonary circulation by thrombi. If this latter hypothesis is accepted the haemorrhagic diathesis, the cardiac arrhythmia and the disseminated necroses in the intestine and kidneys could be attributed to the action of a single mechanism since the fully developed syndrome of intravascular coagulation is characterized by fractionation of, and haemorrhages into, various organs.

Conclusions

The clinical picture presented by dichloroethane poisoning is determined by the quantity of poison ingested. In man the tolerated single dose is not more than 10 ml, with a maximal daily dose of 3.0 ml (9). As there is no known specific antidote, measures to counteract the effects of orally taken dichloroethane are primarily confined to attempts at reducing or slowing down absorption of the poison from the gastro-intestinal tract. Further therapeutic measures aim at preventing acute hepatic failure and at restoring the disordered haemostatic mechanism, acid-base balance and cardiovascular function. Selective therapy directed to the restoration of a particular functional system is impossible. From considerations of the pathogenetic mechanism, published reports and our own observations some general principles for dealing with oral dichloroethane poisoning emerge:

- 1) Alertness to the possibility of dichloroethane poisoning is important. Inadequate specification of some dichloroethane-containing preparations as potentially dangerous is liable to mislead patients, relatives and the attending physician.
- 2) Analysis of the expired air by a gas analyser for the presence of chlorinated hydrocarbons, unless this type of poison can be absolutely ruled out.
- 3) Prompt gastric lavage, provided there is no contraindication, with addition of paraffin; then administration of 100–150 ml of paraffin and saline purges, either by mouth or indwelling stomach tube. Paraffin administration repeated every 6–8 hours for the first 24–48 hours.

4) Prompt measures to protect the liver similar to those employed in acute yellow atrophy (6). Repeated laboratory tests.

5) Supervision and constant adjustment of blood gases and steps to ensure excretion of an alkaline urine. Sodium bicarbonate administration should be supplemented by THAM, because the latter is more effective in counteracting intracellular acidosis.

6) Prompt and continuous analysis of the clotting factors to ensure that an incipient consumption of platelets and fibrinogen is immediately checked by an infusion of heparin (20,000 U in 24 hours). This therapy is applicable even in the presence of gastro-intestinal haemorrhage. If defibrination has already occurred, heparin combined with Cohn's fraction I as a fibrinogen substitute is given by infusion.

7) Continuous supervision of cardiovascular function with continuous recording of the ECG.

8) Administration of water and electrolytes as required and symptomatic treatment of the gastro-enterocolitis which is an almost invariable complication. Intestinal haemorrhages resulting in a critical reduction in haemoglobin concentration may require blood transfusion.

9) Renal failure setting in 24–48 hours after ingestion of the poison is a potential complication of the third stage of dichloroethane poisoning. Its occurrence depends on the quantity swallowed, the interval between ingestion and beginning of treatment and the success of the antecedent therapeutic measures. Treatment is the same as for acute failure from other causes.

10) An apparent improvement in the patient's condition after the initial stuporous stage has subsided must not lead to premature slackening of the therapeutic efforts.

References

- (1) Amris, A., C. J. Amris: *Thrombosis, Diarrhea, Haemorrhage*. (Stuttgart) 11 (1964), 404.
- (2) Brass, K.: *Dtsch. med. Wochr.* 74 (1949), 553.
- (3) Friese, G., H. H. Sessner: *Med. Welt* (Stuttgart) 1961, 102.
- (4) Friese, G.: *Differentialdiagnose der Herzkreislauferkrankungen* (Berlin-Heidelberg-New York, 1961).
- (5) Hardaway, R. M.: *Syndromes of Disseminated Intravascular Coagulation* (Springfield, 1966).
- (6) Knauff, H. G.: *Munch. med. Wochr.* 105 (1963), 1; 27.
- (7) Lusch, H. G., D. Henne, K. Huth, W. Sandritter: *Amer. J. Cardiol.* 20 (1967), 381.
- (8) McKay, D., W. Margareten: *Arch. inter. Med.* 120 (1967), 129.
- (9) Moeschlin, S.: *Klinik und Therapie der Vergiftungen* (Stuttgart, 1959).
- (10) Piper, W., H. G. Buchberger: *Med. Welt* (Stuttgart) 1963, 385.
- (11) Quick, A. J., J. G. Georgatos, C. V. Hussey: *Amer. J. med. Sci.* 128 (1954), 207.
- (12) Ratnoff, O. D., C. Menzies: *J. Lab. clin. Med.* 37 (1951), 316.
- (13) Struhler, H.: *Dtsch. med. Wochr.* 74 (1949), 1542.

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