Emergency Care for Victims of

CHEMICAL ACCIDENTS

by Dr. Renaud Leroux

Emergencies involving dangerous substances are a daily occurrence in Canada. Many such emergencies are caused by fires that produce harmful chemicals such as carbon monoxide, hydrogen cyanide (used in the manufacture of armchairs), or hydrochloric acid (from products containing polyvinyl). And with more than 35,000 chemical products on the market, the potential for accidents is staggering. Other common emergencies involve transportation of dangerous goods, by truck and rail.

Less common, but full of disastrous potential, are earthquakes, landslides, or tornadoes that could break gas pipelines or tanks holding hazardous substances of all kinds.

As it is not always apparent if chemicals are involved, anyone arriving at the scene of an accident or a disaster, regardless of its nature, should behave as if hazardous substances were present until proof to the contrary. Unwary rescuers may risk serious injury, or death, and may delay rescue efforts.

Treating Casualties Different for Chemical Accidents

Emergency medical services are accustomed to treating casualties suffering from a wide variety of injuries, with each one requiring different treatment. This contrasts with a chemical accident, however, where the majority of victims will have varying degrees of the same injuries, needing a limited range of treatment. For example, victims of a chemical accident will usually have burns to the skin and eyes or respiratory problems because they have inhaled gaseous substances. Some products will be absorbed through the skin, mucous membranes and lungs, or sometimes they will be ingested. Exposure to certain chemicals can cause a condition known as methaemoglobinaemia that adversely affects the blood's ability to transfer oxygen. This condition can be treated successfully by administering the antidote, methylene blue. (See Table I for a list of selected chemicals and their corresponding antidotes.)

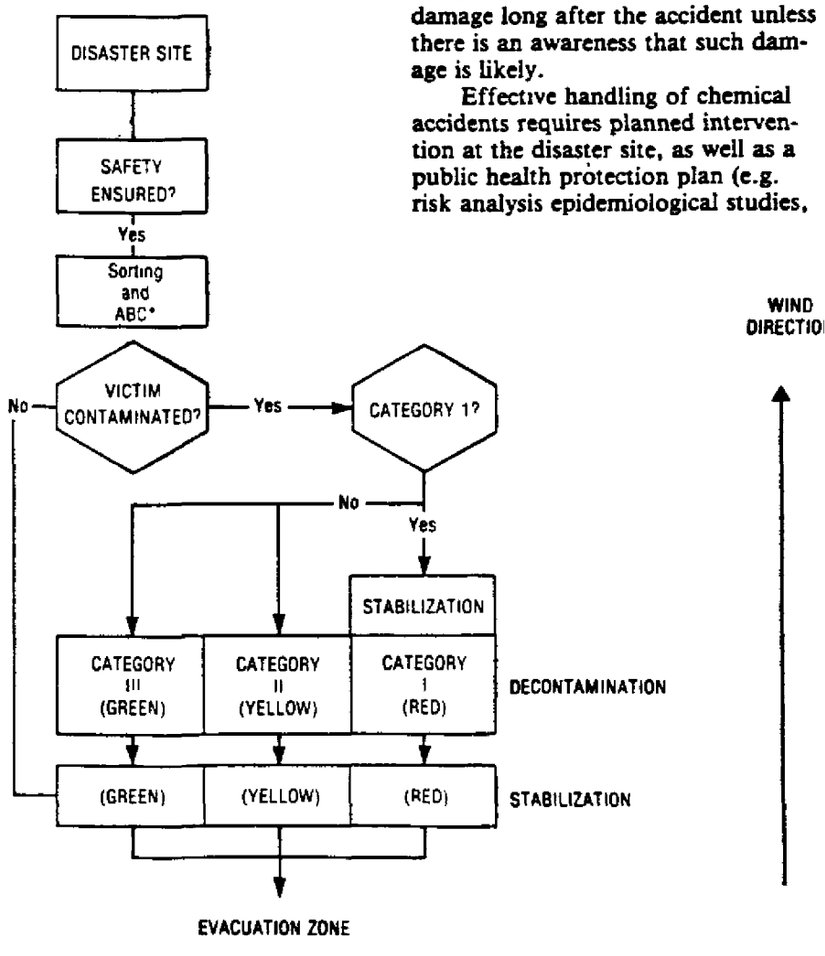
Often, because of inexperience, first-aid personnel and other first responders at the disaster site constitute the greatest number of victims.

Chemical accidents creating a great many victims such as the one at Bhopal, India, are, fortunately, rare. Usually the number of victims does not exceed 20. Nevertheless, chemical accidents are insidious and can cause damage long after the accident unless there is an awareness that such damage is likely.

Effective handling of chemical accidents requires planned intervention at the disaster site, as well as a public health protection plan (e.g. risk analysis epidemiological studies,

FIGURE 1

Emergency Medical Services Personnel Site Management for a Chemical Disaster



*Airways breathing and circulation

TABLE I
SPECIFIC CHEMICALS AND ANTIDOTES

CHEMICALS	ANTIDOTES
ORGANIC PHOSPHORUS COMPOUNDS	ATROPINE
CYANIDE	ANTICYANIDE KIT (Eli Lilly)
HYDROFLUORIC ACID	CALCIUM GLUCONATE

TABLE II
OPERATIONAL PLAN HAZARDOUS MERCHANDISE

1. ENSURE YOUR OWN SAFETY
   - Maintain an appropriate distance from the hazardous material.
   - Wear complete protection and a self-contained breathing apparatus.
2. IDENTIFY THE RISK CLEARLY
   - Identify the hazardous substance
   - Report the identification number
3. DEFINE A SAFETY PERIMETER
   - Limit access of disaster relief personnel and curious spectators.
   - Evacuate persons in danger on the perimeter
   - Establish a decontamination zone.
4. OBTAIN ASSISTANCE AND INFORMATION
   - Ask for reinforcements (Urgence Environnement, Dépt Santé Communautaire, etc.)
   - Call CANUTEC — (613) 996-6666.
5. REDUCE CONTACT WITH THE SUBSTANCE
   - Except if lives are in danger
   - If it is necessary to close an *important* valve

Taken from: GIGNAC L., *PLAN D'OPÉRATION MARCHANDISE DANGEREUSE*, Emergency Plan of the City of Sainte-Foy, May 1988, p 2. Reproduced with permission.

and public health monitoring). Planning must include a method for sorting and organizing on site, as well as an area for assembling non-contaminated victims, and a separate one for contaminated victims (Figure 1).

Precautions for First Responders

When chemical products are not properly contained, the effects can be hazardous, for example:

- the product is volatile and takes the place of atmospheric oxygen
- the new gaseous mixture is explosive
- the mixture is absorbed by the skin and mucous membranes.

Because of such dangers, first responders should have on hand a sufficient number of self-contained breathing apparatus (with compressed air), an explosimeter, an oxymeter, a carbon monoxide meter, and special protective outergarments that also protect the wearer's face, hands, and feet, as well as the breathing apparatus. Inexpensive protective suits are available that will protect wearers' against most chemical products for a reasonable length of time. (See M.F. Fingas, *Emergency Preparedness Digest*. July-September 1988.) Emergency response services should have sufficient protective clothing on hand to deal with the risks identified in their community. The municipality should establish mutual aid agreements with neighbouring municipalities, or with private sector companies (24-hour service), to allow quick access to additional equipment, as was done during the fire at Saint-Basile-le-Grand, Que.

Table II shows recommended initial actions of first responders when they arrive on the scene. The general procedure is set out in Table III.

Medical Response

Because dealing with chemical accidents requires a high degree of preparation and specialized personnel and equipment that few municipalities have, emergency medical personnel should be ready to deal with such accidents as they are likely to be the first ones to arrive on the scene to assist ill-prepared first responders.

Emergency medical personnel should have appropriate equipment to avoid becoming contaminated. They should also know how to manage a site containing hazardous substances, how to identify products, and what resources are available to accomplish these tasks. Ambulance operators and medical teams dispatched to the scene should always bring their usual equipment in case of rain, rubber gloves, protective goggles, masks, CANUTEC manuals, the telephone number of the provincial poison-control centre, and a foam-type fire extinguisher. They should also learn how to communicate effectively with CANUTEC and the poison-control centre.

Although the product identification label, waybill and shipping certificate (in the case of chemical products) will be useful in identifying the substance, all these means are limited. Further information should be obtained from the driver, and CANUTEC personnel can obtain more details from the company that is shipping the chemicals. (Odours of some chemicals are described in Table IV).

The golden rule that emergency medical services personnel must observe at the scene of any disaster "to ensure their own safety," is absolutely vital when an accident involves hazardous substances. If this rule is not observed, rescuers could find themselves among the group of victims. If there is the slightest risk of even an odourless emanation, unprepared rescuers should refrain from rushing to the assistance of victims. It is therefore important to clearly evaluate the circumstances and the products involved before approaching the victims.

Initial emergency care for victims will involve checking victims' airways, breathing and circulation (ABC). Usually, the next step is rapid decontamination on the accident or disaster site when hazardous substances are involved, unless it is not recommended, or impossible. All these activities are in addition to the usual tasks of emergency medical services personnel such as sorting, assembly, stabilization and evacuation of the injured. To ensure a smooth decontamination process, emergency medical services personnel should establish a decontamination area in a safe place with convenient access to a system for collecting contaminated clothing and water. Incidentally, it would be wise for municipalities to make provision for a water tank truck for these purposes in their

municipal emergency plan. Rules governing the response of emergency medical services personnel at the site are described in Figure 1, and a system for decontamination of the site is suggested in Table V.

Although the literature on emergency medical services does not reflect beyond any doubt the absolute necessity of dispatching medical teams to the site of a disaster, military experience, European experience and the evaluation of many disasters in which such teams have responded tend to show their usefulness in reducing the loss of life.

Since emergency medical services will be active on the site at the same time as firemen, policemen, public works, the carrier or the manufacturer (and on the property of the municipality or that of a private company), it is important that everyone be properly identified with distinctive clothing or markers to avoid confusion. Emergency medical services personnel should clearly identify themselves, define their roles among themselves, clearly identify a leader, select a command post, and a site manager to whom the medical operations leader (chief sorter or chief ambulance attendant) will refer and report the progress of medical operations.

The medical operations leader will ensure, in co-operation with the site manager, that the medical teams are working under safe conditions. They should work together to designate a sorting area and an area for assembling the victims who should be placed upwind of the disaster site to avoid contamination, but near enough to the site to facilitate transport on stretchers.

The chief sorter should designate personnel to sort victims and be responsible for decontamination, stabilization and evacuation operations.

When there are many victims, it is essential to use a simple sorting and prompt treatment method known as START.* This method employs only three clinical parameters: breathing, circulation, and whether the patient is conscious. Other sorting methods such as trauma score, triage index and crams scale involve too many clinical parameters that are difficult to use under stressful conditions, plus they are very long, and easy to forget.

Although it is necessary, early minimum decontamination (to stop the intoxication process and dispersion of products) will delay the evacuation of patients. Medical teams must therefore be equipped with advanced stabilization (life support) equipment. To assist emergency responders, the Emergency Measures Division of the Ministère de la Santé et des Services sociaux of Quebec is preparing a

* *Hoag Memorial Presbyterian Hospital, Newport Beach, California, U.S.A.*

TABLE III
EMERGENCY SITUATION
EVALUATION OF THE SITUATION AND THE ACTION TO BE TAKEN

1. OBSERVATION
   - Explosion/risk of explosion
   - Fire/risk of fire
   - Spill/risk of spill
   - Other

2. IDENTIFICATION OF PRODUCTS
   - Hazardous products
   - Products that are hazardous if fire is present
   - Products that are hazardous when they react with other substances
   - Products that can contaminate the environment
   - Non-hazardous products

3. POSSIBLE ACTION
   - Evacuate the site
   - Extinguish the fire
   - Contain the spill
   - Stop the substance from spilling any further
   - Neutralize the substance
   - Leave as is
   - Other

4. EVALUATION OF RISKS AND BENEFITS OF EACH ACTION

RISKS	BENEFITS
Loss of life of emergency personnel	Saving lives
Loss of safety equipment	Protecting property
Loss of control of the situation	Protecting the environment
Bad publicity	Controlling the danger
Legal liability	Reducing inconvenience
	Saving money
	Good publicity
	Medal for bravery

5. DECISION

6. ACTION

For No. 2. (Identification of products), the sources of information are shipping forms, shipper, carrier, driver and plates (in that order). Further, one must be extremely careful when chemical names are communicated orally

Taken from GIGNAC L., *PLAN D'OPÉRATION MARCHANDISE DANGEREUSE*, Emergency Plan of the City of Sainte-Foy, May 1988, Annex A. Reproduced with permission.

TABLE IV
ODOUR OF CERTAIN CHEMICAL PRODUCTS

ODOUR	PRODUCT
Almonds	Cyanide
Rotten eggs	Sulfides
Garlic	Arsenic, phosphorus, organic phosphorus compounds
Shoe polish	Nitrobenzene
Disinfectants	Phenol, creosote
Violets	Turpentine

publication on this subject. The publication will propose a separate kit of specific antidotes (Table I).

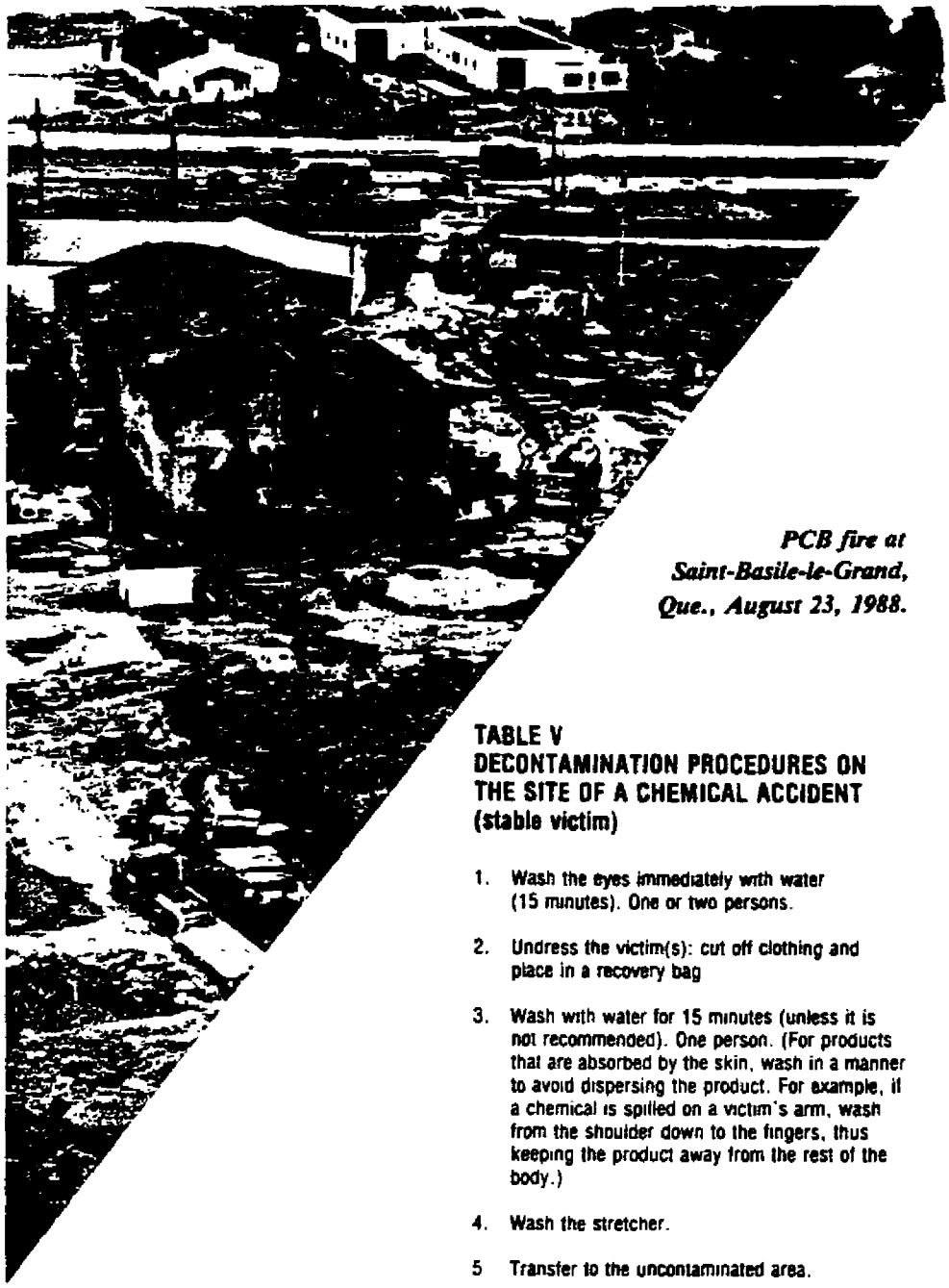
Normally, disaster victims should be evacuated immediately to a hospital when chemical products are involved because many victims develop severe (and potentially fatal) breathing problems. Since decontamination (Table V) would delay treatment of the injured, medical teams will have to determine whether advance life support should be given before evacuation.

Rescuers Need Effective Communications

Communications are often a stumbling block during disasters. Too many emergency response personnel try to use the communication channels ineffectively or each different group may have a good system, but may be unable to communicate with other groups. It is vital for medical personnel on a disaster site to communicate among themselves, preferably in person or, if not, by radio on a private frequency. The chief sorter must also be able to communicate with the site manager on the same frequency or another one which connects the leaders of the various groups of emergency responders (maximum of 10).

During Exercise BRAVO 110,* it became apparent that medical personnel were not very familiar with communications equipment and that this can be a serious problem. Where this is the case, a policeman could, resources permitting, provide radio-communications for the chief sorter. Sound emergency planning should include training in radio-communications.

The exercise involved a simulated air crash of 110 passengers. Following the air crash, there were 81 survivors, 29 injured who required immediate treatment (red), 20 moderately injured (yellow), and 10 injured who were able to walk (green). (See Figure 1.)



PCB fire at Saint-Basile-le-Grand, Que., August 23, 1988.

TABLE V
DECONTAMINATION PROCEDURES ON THE SITE OF A CHEMICAL ACCIDENT (stable victim)

1. Wash the eyes immediately with water (15 minutes). One or two persons.
2. Undress the victim(s): cut off clothing and place in a recovery bag
3. Wash with water for 15 minutes (unless it is not recommended). One person. (For products that are absorbed by the skin, wash in a manner to avoid dispersing the product. For example, if a chemical is spilled on a victim's arm, wash from the shoulder down to the fingers, thus keeping the product away from the rest of the body.)
4. Wash the stretcher.
5. Transfer to the uncontaminated area.
6. Ensure that the water is collected and recovered (site manager)
7. Ensure that the decontamination teams are adequately protected (double pair of gloves, boots, long-sleeved raincoat with hood, mask and protective glasses)

Whether a disaster is of a chemical or other nature, first responders and others involved in managing the emergency would be well-advised to use a crisis management technique known as SMEAC (Situation-Mission-Execution-Administration-Communication).** This method permits emergency responders to adapt their decisions as the situation evolves. □

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** BRAVO 110 was a regional exercise held May 20, 1986, jointly with the Quebec Airport at Ste. Foy, the Town of Ste. Foy, and all the establishments and organizations of the health network which participates in an emergency response plan for disasters in the Quebec-Levis region, as well as the Emergency Measures Division of the Ministère de la Santé et des Services sociaux of Quebec. This report is available from the author*

*** See J.D.W. Peters' article "Crisis Management — Further Thoughts," in this same issue, in which he describes the SMEAC method*