GENERAL DISTRIBUTION

OCDE/GD(94)1

ENVIRONMENT MONOGRAPH NO. 81

HEALTH ASPECTS OF CHEMICAL ACCIDENTS

GUIDANCE ON CHEMICAL ACCIDENT AWARENESS, PREPAREDNESS AND RESPONSE FOR HEALTH PROFESSIONALS AND EMERGENCY RESPONDERS

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Paris 1994

COMPLETE DOCUMENT AVAILABLE ON OLIS IN ITS ORIGINAL FORMAT

Copyright IPCS/OECD/UNEP/WHO, 1994

Contents

[1] The Table of Contents of the *Practical Guides* begins on page 29.

Introduction

The three guidance documents in this book

Health Aspects of Chemical Accidents contains three guidance documents. Draft versions of each document were prepared for the April 1993 Workshop on Health Aspects of Chemical Accidents at Utrecht, the Netherlands, as a basis for discussion. All three guidance documents were revised following the Workshop.

General Guidance Document

The purpose of the *General Guidance Document* is to assist managers and other decision-makers in developing appropriate policies for chemical accident prevention, preparedness and response. Since it focuses on the health aspects of chemical accidents, this document is primarily directed to decision-makers in the health field including, for example, officials in ministries of health, labour and industry; local and regional health authorities; hospitals; poisons information centres (PICs); and occupational health centres.

Many other organisations and officials need to consider the health aspects of chemical accidents, and to work closely with members of the health professions on chemical accident prevention, preparedness and response. The *General Guidance Document* is therefore also directed to those in public authorities, industry, civil defence and rescue services, etc. who take part in chemical accident contingency planning.

Practical Guides

While the *General Guidance Document* is intended to serve as a basis for policy development, the *Practical Guides* treat health aspects of chemical accident prevention, preparedness and response in a more detailed and technical way. The *Practical Guides* cover:

- health-related information and communications needs;
- the organisation and planning of health-related response to chemical accidents;
- health aspects of chemical accident response – including treatment at the accident site, transport of victims, treatment at hospitals and other facilities, and rehabilitation and follow-up of victims; and
- health-related training and education.

The *Practical Guides* will be of use to health professionals responsible for the care of chemical accident victims, as well as to anyone at the operational level in, for example, public authorities, hospitals and other treatment facilities, civil defence and rescue services, specialised information centres, and industry with responsibilities for chemical accident contingency planning.

Checklist for Action

In the *Checklist for Action* a series of items are set out, as a memory aid, concerning what needs to be done in planning and implementing health-related chemical accident prevention, preparedness and response measures. This document is meant to assist those with overall managerial responsibility for chemical accident contingency planning, and for liaison with other responsible parties in various areas.

Bibliography

The Bibliography included here, while not exhaustive, could be of use in locating relevant publications or more detailed information on the topics addressed in the guidance documents.

The Utrecht Workshop

The Workshop on Health Aspects of Chemical Accidents was organised by four collaborating international organisations:

- the International Programme on Chemical Safety (IPCS);
- the Organisation for Economic Co-operation and Development (OECD);
- the United Nations Environment Programme Industry and Environment Programme Activity Centre (UNEP IE/PAC);
- the World Health Organization-European Centre for Environment and Health (WHO-ECEH).

The Workshop was held on 13-16 April 1993 at Utrecht, the Netherlands. It was hosted by the University Hospital, Utrecht, in collaboration with Utrecht University, the National Institute of Public Health and Environmental Protection, and the Armed Forces Medical Organisation. Financial support was provided by the Dutch Ministries of Housing, Physical Planning and Environment; of Foreign Affairs; of Internal Affairs; and of Welfare, Public Health and Culture.

The Utrecht Workshop was attended by approximately 100 professionals from more than 25 countries in different parts of the world, including eleven OECD Member countries, and from five international organisations. The guidance documents have been prepared based on the input of these professionals. While detailed agreement on the texts of the guidance documents was not sought, the Workshop participants reached a general consensus on the contents of each document, indicated where revisions were needed, and provided written comments following the Workshop.

Collaborating international organisations

Information is given below on the four international organisations that collaborated in the preparation of these documents, and in the preparation of the Utrecht Workshop. This information focuses in particular on their activities related to chemical accident prevention, preparedness and response.

IPCS

Intense international concern about the dangers of chemicals for humanity and the natural environment expressed at the United Nations Conference on the Human Environment in Stockholm, Sweden, in 1972, as well as in the recognition by the World Health Assembly in 1977 of the need for international action, led to the establishment in 1980 of the International Programme on Chemical Safety (IPCS) by the World Health Organization (WHO), the United Nations Environment Programme (UNEP) and the International Labour Organisation (ILO). The IPCS, located at WHO Headquarters in Geneva, was set up to provide an internationally evaluated scientific basis on which countries may develop their own chemical safety measures, and to strengthen national capabilities for prevention and treatment of harmful effects of chemicals and for managing the health aspects of chemical emergencies.

In fulfilling its mandate the IPCS works with other international, intergovernmental and non-governmental organisations, associations and professional bodies which have important activities in the field of chemical safety. Since its establishment, the IPCS has disseminated international evaluations of some 120 chemicals and groups of chemicals, 1205 food additives, 655 residues of pesticides, and 30 residues of veterinary drugs in food. These evaluations are published in different types of documents adapted to the needs of the user, ranging from the scientist and technical expert, the administrator and decision-maker to the person at the shop floor. Some 14 volumes have been published on methodology for risk assessment, including validation of test methods. A series of major activities to support national poisons control programmes has been established, including preparation of the INTOX poisons information package and evaluation of the efficacy of antidotes and other substances used to treat the harmful effects of chemicals. Some 50 training courses have been organised throughout the world.

The United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro, Brazil, in June 1992, recognised the need to ensure the environmentally sound management of toxic chemicals, within the principles of sustainable development and the improvement of quality of life for humankind.

Promotion of effective international co-operation with respect to prevention of, preparedness for, and response to emergencies and accidents involving chemicals, including management of poisoned patients, follow-up of sequelae, and accident site clean-up and rehabilitation, is one of the important aspects of environmentally sound management of chemicals identified by UNCED. The IPCS provides the health and medical aspects of this area of international co-operation.

The ILO, as a collaborating organisation in the IPCS, contributes to the IPCS its technical work in the field of chemical accident prevention, preparedness and response. Following major industrial accidents such as those of Bhopal, Seveso and Mexico City, the ILO accelerated its activities in the field of the prevention of major industrial accidents and the mitigation of their consequences, including work on emergency preparedness. The ILO has since published a manual on major industrial accidents and executed a number of technical co-operation projects on the organisation of major hazard control systems in developing countries. These activities have been reinforced by a number of training workshops in this field, and culminated in the adoption by the International Labour Conference of the *Convention concerning the Prevention of Major Industrial Accidents* (No. 174) and its accompanying *Recommendation concerning the Prevention of Major Industrial Accidents* (No. 181) in 1993.

This book does not reproduce the extensive work conducted by the ILO in the field of major industrial accidents – referred to here as chemical accidents and chemical emergencies – including their control and the mitigation of their consequences. In addition to Convention No. 174 and Recommendation No. 181, mentioned above, attention is also drawn to the following ILO publications prepared as a contribution to the IPCS: *Major Hazard Control: A Practical Manual* (ILO, 1988), *Code of Practice on the Prevention of Major Industrial Accidents* (ILO, 1991), *Code of Practice on Safety in the Use of Chemicals at Work* (ILO, 1993), and *A Training Manual on Safety and Health in the Use of Chemicals at Work* (ILO, 1993).

OECD

The OECD (Organisation for Economic Co-operation and Development) is an intergovernmental organisation grouping 24 industrialised countries.[1] It provides a forum where Member countries discuss issues of common interest, and where they co-ordinate and, as appropriate, harmonize their national policies.

Work on chemical accidents, as part of the OECD Environment Programme, began in 1988 when a special high-level Conference on Accidents Involving Hazardous Substances was hosted by the French authorities. As a follow-up, the OECD Accidents Programme was established, *inter alia* to develop common principles, procedures and policy guidance related to accidents. An Expert Group on Chemical Accidents was formed to undertake this work.

---

[1] The OECD Member countries are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The Commission of the European Communities takes part in OECD work. Yugoslavia has participated in many OECD activities.

The Expert Group, composed of national experts nominated by Member countries as well as of representatives of relevant international organisations, works closely with representatives of industry, labour and non-governmental organisations. It has also sought to include representatives of non-OECD countries in all workshops and other appropriate activities.

Based on the outcome of several international workshops, and numerous consultations, the OECD published in 1992 a comprehensive guidance document entitled *Guiding Principles for Chemical Accident Prevention, Preparedness and Response*. This document sets out guidance for public authorities, industry, labour and others related to all aspects of chemical accident prevention, preparedness and response with respect to fixed installations that manufacture, handle or store hazardous substances. It also includes sections on investments and aid programmes relating to hazardous installations in non-OECD countries. Many thousands of copies have been distributed worldwide. The Guiding Principles are available in English, French and Russian. They are being translated into Spanish.

The OECD has also published two "Users Guides", one on hazardous substance data banks and the other on information systems useful to emergency planners and responders. The Users Guides make it possible for anyone concerned with chemical accident prevention, preparedness and response to learn about the nature of, and how to access, relevant data banks and information systems in OECD countries.

With UNEP IE/PAC, the OECD has published an *International Directory of Emergency Response Centres*. The Directory contains information on response centres in both OECD and non-OECD countries that are available to callers worldwide.

Among the objectives of the current OECD Chemical Accidents Programme are work on the implementation and elaboration of the Guiding Principles, and increasing co-operation with non-OECD countries.

UNEP IE/PAC

The Industry and Environment Office (IEO) was established by the United Nations Environment Programme in 1975 in order to bring industry and government together to promote environmentally sound industrial development. The office, which has since become the Industry and Environment Programme Activity Centre (UNEP IE/PAC), is located in Paris. Its goals are:

1) to encourage the incorporation of environmental criteria in industrial development plans;

2) to facilitate the implementation of procedures and principles for the protection of the environment;

3) to promote the use of safe and "clean" technologies; and

4) to stimulate the exchange of information and experience throughout the world.

IE/PAC provides access to practical information and develops co-operative on-site action and information exchange, backed by regular follow-up and assessment. Among the tools it has developed to carry out its work are: technical reviews and guidelines; the *Industry and Environment* review; and a technical query-response service.

The **Awareness and Preparedness for Emergencies at Local Level (APELL) Programme** has also been developed by IE/PAC. The main goal of this programme, launched in co-operation with industry and government, is to prevent technological accidents and their impacts through assistance to decision-makers and technical personnel in improving community awareness of hazardous installations, and in preparing response plans should unexpected events at these installations endanger life, property or the environment.

Over 6000 copies of the APELL Handbook have been distributed throughout the world. It is available in English, French, Italian, Spanish, Portuguese, Russian, Arabic, Chinese, Czech, Hungarian, Indonesian and Thai. Ongoing APELL activities include: seminar/workshops for senior-level participants from industry, government, academia and non-governmental organisations; the *APELL Newsletter*, which is published twice a year and appears as a supplement to *Industry and Environment*; and the development of complementary materials to help implement APELL. The UN Conference on Environment and Development mentioned the extension of APELL as part of Agenda 21.

WHO-ECEH

The Regional Office for Europe of the World Health Organization (WHO/EURO) has played an important role in initiating work on emergency response to chemical accidents. In the early 1980s, a document on *Administrative Guidelines on Planning Emergency Response Systems for Chemical Accidents* (*Health Aspects of Chemical Safety*, Volume 1) was published. The activities that followed included the convening of the World Conference on Chemical Accidents in Rome in 1987, and the issuing of a *Guide for Public Officials on Rehabilitation following Chemical Accidents* in 1989.

In the European Charter on Environment and Health, which was adopted by the Ministers of Environment and Health of the Member States of the European Region of WHO in 1989, one of the priority issues of the environment and health requiring actions to be taken was "contingency planning for and response to accidents and disasters". It is in this context that the WHO-European Centre for Environment and Health (WHO-ECEH), the establishment of which was a consequence of the adoption of the Charter, views its mandate to co-operate on the development of guidance documents on *Health Aspects of Chemical Accidents*. These documents will be of use to the Centre’s work in the area of technical co-operation with Member countries, in particular with countries from Central and Eastern Europe.

GENERAL GUIDANCE DOCUMENT

Introduction

This *General Guidance Document* is intended to be used as policy guidance by managers and other decision-makers involved in chemical accident prevention, preparedness and response activities. As it focuses on the health aspects of chemical accidents, this document is particularly directed to officials in the health field including, for example, those in ministries of health, labour and industry; regional and local health authorities; hospitals; poisons information centres (PICs); and occupational health centres. It is also directed to other organisations and officials who need to consider health aspects of chemical accidents and to work closely with health professionals on chemical accident prevention, preparedness and response.

A draft version of the *General Guidance Document* was prepared as a basis for discussion at the IPCS/OECD/UNEP(IE/PAC)/WHO-ECEH Workshop on Health Aspects of Chemical Accidents at Utrecht, the Netherlands, in April 1993. It was revised following the Workshop, where the text was thoroughly discussed and suggestions were made for its improvement. This document has benefitted from the collective experience of the approximately 100 professionals who attended the Workshop, representing a cross-section of expertise from different parts of the world. Thus the document should provide sound, up-to-date and practical advice, applicable worldwide.

For the purposes of this document, the terms "chemical accident" or "chemical emergency" are used to refer to events or dangerous occurrences resulting in accidental releases of a substance or substances hazardous to human health and/or the environment. These events include fires, explosions, leakages, or releases of hazardous substances that can cause the death of, or injury to, a large number of people.

This document has been prepared as policy guidance. More detailed and technical information on the subjects addressed herein can be found in the *Practical Guides* that follow, as well as in the publications listed in the Bibliography. For example, the *General Guidance Document* addresses the treatment of chemical accident victims in only a very preliminary way. Since it is not intended as a technical guide for members of the health professions, there are only general references to triage and specific medical treatment. The treatment of accident victims is addressed in greater detail in Chapter 3 of the *Practical Guides*.

The policy guidance in this document was developed with the recognition that there must be flexibility in its application due to the significant differences which exist among countries and regions with respect to, for example, legal and regulatory infrastructures, culture, and resource availability.

It should be noted that this guidance is specific to health aspects of chemical accidents. General guidance applying to health professionals *and to others* is available in a number of documents already published by the four co-operating organisations. These include the ILO Manual on *Major Hazard Control* and its *Convention concerning the Prevention of Major Industrial Accidents* (No. 174), the OECD *Guiding Principles for Chemical Accident Prevention, Preparation and Response*, and the UNEP APELL (Awareness and Preparedness for Emergencies at Local Level) Handbook and associated materials.

A. Preparedness planning: general

1. One of the aims of emergency planning should to prevent and minimise adverse human health effects in the event of a chemical accident.

2. Public authorities at the regional/state and national levels generally have the main responsibility for protecting the health of the population.

   (i) Public health authorities should take the lead in developing the health-related components of preparedness plans at national, regional/state and local levels, as part of overall emergency planning.

   (ii) Emergency planning is a multidisciplinary task. There must be close co-operation among the various parties involved in planning and response, including both medical and non-medical organisations.

3. The roles and responsibilities of the individuals and organisations who would be involved in emergency response, as well as lines of authority, should be clearly established in emergency plans. From the health field, the parties involved should include:

   - health ministries;
   - local and regional authorities;
   - members of the health professions;
   - hospitals and other treatment facilities;
   - occupational safety and health inspectorates and factory inspectorates;
   - information providers, including poisons information centres (PICs); and
   - suppliers of pharmaceuticals and equipment.

4. The resources (including personnel, equipment, supplies and funds) that will be made available in the event of a chemical accident should be identified in emergency plans. Decisions concerning who will have the authority to release and use these resources should be made before such an accident occurs.

5. Well before any chemical accident that might occur, information and communications needs should be examined. Parties who need information (for example, those involved in organising health-related chemical accident response, first responders, those in the health field at all levels, and the potentially affected public), and the types of information they need, should be identified. Plans for obtaining and disseminating the needed information (including to the public via the media) should then be carefully drawn up and tested.

6. Emergency plans should identify information providers (see Section C below) and sources of emergency response assistance.

7. Health professionals should make it their responsibility to be aware of local emergency medical plans and their roles within these plans.

8. Those involved in emergency planning should have access to information concerning the nature and extent of hazardous substances in relevant installations and, to the extent possible, the substances being transported in the region. Hazard inventories are an important means of identifying possible emergency situations. An emergency event reporting system may be of use, so that emergency planners can know the history of emergency events in the area. Planners should also have information concerning the nature of the chemical accidents that could occur, and the population potentially affected in the event of an accident. This information is needed in order, *inter alia*, to ensure that an appropriate response capability, including medical personnel, equipment and supplies, can be made available.

9. It should be recognised during emergency planning that, in addition to the possible short- and long-term biological effects of accidents, psychological effects could appear during or shortly after the accident, or at a later date.

   (i) Thus, planning should include the identification of groups at risk for stress reactions; an assessment of information available to the public; an assessment of networks through which information is likely to pass; and plans for an information network that could be activated if needed.

   (ii) In high-risk areas, epidemiological data and internationally accepted instruments for the assessment of mental health impacts should be available, so that monitoring can take place in the event of an accident.

10. The organisation and planning of health-related response to chemical accidents should include provision for veterinarians and other persons familiar with the care of livestock and pets.

B. Preparedness planning: availability of equipment, supplies and facilities

11. As part of the emergency planning process, the types of emergency medical equipment and facilities needed in order to respond to different types of emergencies should be determined. These include transportation facilities, decontamination equipment for on-site and hospital use, and personal protective equipment for the use of response and decontamination personnel.

(i) Adequate access to such equipment and facilities should be ensured.

(ii) In an emergency, the rapid transformation of facilities normally used for other purposes may be necessary. For example, if a hospital and/or transport route to a hospital lie within an accident area, it may be impossible to transport accident victims for some time. Plans should therefore be made for providing alternative premises such as schools, sports facilities and tents where accident victims can be taken and where medical care can be provided until a hospital or other treatment facility can receive victims.

(iii) All emergency equipment should be in working order, reliable, effective, and available at short notice in the event of a chemical emergency.

12. As part of emergency planning, it should be ensured that up-to-date antidotes are available, as well as other pharmaceutical products that might be required, including oxygen.

(i) If public health authorities are unable to ensure the availability of adequate supplies of suitable antidotes, the industry that uses or produces the chemical(s) in question should be required to make these antidotes available in sufficient quantities.

(ii) Sufficient quantities of the appropriate emergency medicines should be available, and should be kept updated, at installations where chemicals are handled.

(iii) Emergency treatment facilities, medical centres or hospitals near hazardous installations, or relevant poisons information centres, should also stock appropriate emergency medicines and antidotes.

13. Since the equipment and other resources available for medical response to a chemical accident will often be limited, consideration should be given to pooling of resources by neighbouring communities. Such resources could include, for example, emergency medical personnel, ambulances, decontamination units and intensive care facilities.

14. As part of emergency planning, hospitals and other treatment facilities should develop systems for receiving and handling large numbers of patients at one time, including triage and arrangements for patient identification and documentation.

(i) Hospitals and other treatment facilities should maintain an inventory of available equipment that might be needed, and should have up-to-date information on how to obtain additional equipment (for example, ventilators). Plans should be in place for sending patients to other hospitals or facilities when necessary equipment is not available.

(ii) These facilities should have a designated telephone line, in service 24 hours a day, every day of the year, for use by emergency services in the event of an accident. This line, not available for general use, should be listed at emergency telephone centres.

(iii) These facilities should maintain a register of health professionals who would be called upon to respond to emergencies in a pre-planned way, including a roster showing who is available on a particular day.

(iv) These facilities should also have a system in place for alerting other relevant medical practitioners as needed in the event of an accident, especially those active in the fields of toxicology and critical care, as well as general practitioners.

(v) Mechanisms for case follow-up should be established by these facilities before an accident occurs.

C. Preparedness planning: sources of information

15. Each country should ensure that centres are established to organise the collection, collation and dissemination of information for use during chemical emergency planning and response. These could include specialised information centres.

(i) In many countries, poisons information centres exist at local, regional/state and national levels to provide information needed for health-related response to chemical emergencies. In addition, the establishment of chemical emergency centres has been seen as necessary for adequate chemical emergency response in many countries that have either high production capacities for chemical products or large volumes of chemicals in transit.

(ii) Such specialised information centres should be capable of providing relevant information in an emergency on the diagnosis, treatment and rehabilitation of victims exposed to chemicals, and on the prevention of further exposure. This information should be available on a 24-hour basis every day of the year.

16. Poisons information centres and chemical emergency centres in different countries or regions should undertake to share information and experience. Networking of centres should be promoted where appropriate. Lists of national and international experts should be established.

(i) Where there is the possibility of an accident with transboundary effects, or where there is international movement of chemicals, mechanisms should be established for international co-operation.

(ii) Efforts should be made to overcome any problems associated with language differences that could hinder co-operation among specialised information centres. This could be done, for example, through the use of harmonized numeric codes or standardized expressions.

17. Industry has the principal responsibility for providing reliable information on the chemical(s) it stores, handles, reprocesses, manufactures and distributes, or which are otherwise used in the workplace.

(i) Industry should ensure that the information needed for emergency planning and response is easily available, and that it is provided to emergency services and specialised information centres, as appropriate. This includes information on composition, and on toxicological and other relevant properties.

(ii) Arrangements should be made to guarantee confidentiality of information, where appropriate.

18. Health care providers (hospitals, medical emergency planners, poisons information centres, etc.) should actively contact local industries to discuss their own information needs, as well as the type of advice or information health professionals may be able to provide.

19. During emergency planning, communication links should be established for ensuring the availability and dissemination of the information needed by emergency response personnel, including health professionals, in order to care for those exposed to chemicals during an accident.

(i) Communication links should include channels of communication with specialised information centres, as well as with local industry, customs and transport officials, and medical and surgical suppliers.

(ii) Access to needed information could be furthered through the use of computer information systems.

(iii) Planning should take into account the possibility that normal means of communication (for example, telephone/fax lines) may be interrupted during emergency situations.

20. Systems should be in place for continuous updating of the information available to health professionals and other parties as emergency response progresses, including via the media for dissemination to the public.

21. The information provided for emergency preparedness and response activities should be clear and concise and geared to the audience to which it is addressed. For example, the nature of the information provided to fire and police services will be different from that provided to health professionals.

22. Any information system should be regarded as a tool to be used by professionals, as an aid to their judgement, and never as a substitute for expert judgement.

23. During the transport of chemicals, vehicles should be equipped with placards identifying the chemical(s) being carried and their hazard classification.

(i) These placards should be easily readable from a distance and should utilise an internationally accepted identification system.

(ii) Where there is a risk to human health from the release of their cargo, vehicles should carry additional information on the nature of the chemical(s) being transported and corresponding safety measures. This information should include, as appropriate, treatment for those coming into contact with the chemical(s); emergency response actions in the event of an accident (for example, spill or fire); and the telephone number of an emergency response contact.

D. Emergency response

24. In principle, medical personnel should not enter a contaminated area. They should only work at casualty assembly points, to which accident victims are brought after decontamination. Only exceptionally should medical personnel need to enter the accident area, for example to carry out triage or give life-saving treatment.

(i) If medical personnel are needed to assist in the contaminated area or during decontamination procedures, they should be properly equipped. When indicated, they should wear protective equipment while working under adverse or toxic conditions. They may also need protective equipment at hospitals or other treatment facilities, especially during decontamination of accident victims. Medical personnel should therefore receive training in the use of this equipment.

(ii) As a rule, medical personnel should be guided by rescue personnel who have been trained to work in contaminated areas.

25. Health professionals at or near the scene of the accident should become part of the information chain. The following information needs to be disseminated and updated regularly:

- identification of the chemical(s) involved or, if this is unavailable, of the category of chemicals involved, together with information on the symptoms of victims, in order to give indications as to the possible course of action to follow;

- the number and type of patients expected and their degree of exposure;

- risk possibilities at the accident site;

- the need for personal protection;

- first aid possibilities and limitations;

- additional medical information from poisons information centres and hospitals, such as symptomology, antidote therapy or specific treatments;

- resources available (for example, decontamination and hospital facilities, biological monitoring services, poisons information centres); and

- the registration (and triage) system being used.

26. Based on available preliminary information concerning the site and the chemical(s) involved, and the interpretation that has been made of this information, the on-site co-ordinator should decide on actions to take immediately, including actions intended to avoid or limit the exposure of individuals. The co-ordinator should also take measures to avoid the contamination of rescue workers if there is a possibility of continuing exposure.

(i) In this regard, the on-site co-ordinator should determine whether there is a contaminated area that should be entered only by personnel wearing protective clothing. This decision may need to be made in co-operation with a medical co-ordinator or industrial hygienist, if available.

(ii) It should also be determined at an early stage whether there is a need for decontamination facilities at the accident site, or at hospitals and other treatment facilities, and whether there is a danger that those responding to the accident will be contaminated by exposure to accident victims.

27. Triage for chemical accident victims should follow the rules that apply generally in emergency situations.

(i) It is important that triage be a continuous process. Each victim should be re-evaluated at regular intervals. Victims' conditions may change, as may available resources.

(ii) As a general rule, children are more sensitive to toxic substances and therefore normally should be given higher priority for medical care.

28. Hospitals and other treatment facilities should put their emergency plans into effect as soon as it is known that there is a possibility of patients arriving.

29. Hospitals, other treatment facilities and poisons information centres that may be involved in responding to the chemical accident should be provided with information on the chemical(s) involved, the type of accident (spill, fire, etc.), and the likely number of victims as soon as possible.

(i) This information should be used to make an early determination of possible toxic effects, as well as of the required therapy or care.

(ii) It is desirable that protocols supplied by the poisons information centre be followed, particularly if accident victims are taken to a number of hospitals or other treatment facilities.

30. If a hospital or other treatment facility is located within a chemical accident area, doors, windows and ventilation systems should be shut (or shut off) immediately. This rule should be part of emergency preparedness planning.

E. Treatment of the injured

31. In chemical accidents, there are four main direct routes of exposure: inhalation, eye exposure, skin contact and ingestion. None of these routes of exposure is mutually exclusive.

32. The treatment of persons who have been exposed to chemicals should normally follow generally accepted principles for the management of emergency situations. However, these principles will need to be adjusted to take account of the special conditions in effect following chemical accidents.

33. The purpose of the initial care given at the accident site should be to give the injured the treatment they need in order to be in the best possible condition to be taken to the hospital or other treatment facility.

(i) This is especially important where exposed persons may have to be transported considerable distances, or in mass casualty situations where it may take time to transport them to treatment facilities.

(ii) In addition to general first aid measures, it may be necessary to begin other treatment at the accident site. For this reason, special equipment and drugs should be made available at the site, as necessary.

34. The treatment of acute poisoning is based on four main principles that may be utilised to varying degrees, depending on the circumstances of the exposure and the characteristics of the toxic agent. These principles are:

(i) the removal of the toxic agent to prevent further local damage or absorption into the body;

(ii) symptomatic and supportive therapy;

(iii) specific ("antidotal") therapy; and

(iv) enhancement of (poison) elimination.

35. Decisions concerning the decontamination of exposed persons should be based on the type and severity of their injuries and the nature of the chemical contaminants.

(i) If decontamination does not interfere with essential treatment, it should be performed. If it cannot be performed, the victim should be wrapped to reduce contamination of other personnel or of vehicles, and off-site emergency medical personnel should be alerted to potential contamination or to specific decontamination procedures.

(ii) Before a patient who has been exposed to chemicals is admitted to a hospital or other facility, necessary decontamination should be performed. Otherwise, the treatment unit may be rendered unusable. Decontamination stations should be located at every hospital or other facility where patients exposed to chemicals might be admitted.

36. Following exposure to certain chemicals, relatively unaffected persons may need to be placed under observation for one or more days. Plans should be made for setting up suitable observation units in, for example, hotels, schools, etc.

F. Training and education

37. Public health and education authorities should ensure that medical and paramedical professionals involved in emergency response activities are well trained and educated, in order to be able to function effectively under stressful circumstances.

(i) The training of medical and paramedical professionals should include, for example, the principles of medical toxicology and emergency medicine, including the use of antidotes. Relevant health professionals should also be made familiar with: the chain of command during a chemical emergency; models of in-hospital command and control; the identification of decontaminated and non-decontaminated patients; the use of triage; the psychological reaction of victims, emergency responders and the public; and the methods for diagnosing and treating a large number of potential patients.

(ii) Training and education of emergency response personnel should include the development of an understanding of the meaning of the health-related information likely to be available at the site of an accident including, for example, hazard identification systems used when chemicals are transported.

(iii) In addition to training their own members in their professional responsibilities and in understanding the responsibilities of other professionals, the health professions should also contribute, where appropriate, to the training of those outside the health sector who will be involved in emergency response activities.

(iv) The training of health professionals should be repeated periodically in order to keep knowledge up-to-date and to provide specific information concerning local conditions and procedures.

38. The medical aspects of on-site as well as off-site emergency plans should be tested under simulated conditions. Public health authorities should take part in regular exercises with other relevant authorities involved in emergency response, in order to test emergency plans and train medical emergency response personnel.

(i) Unannounced tests of the total plans, or relevant parts of these plans, should be carried out, even under adverse conditions.

(ii) Attention should be paid to specific elements of these plans, such as: the availability of equipment; the availability of needed information; and the availability of communications between, and co-ordination of, the various parties involved.

(iii) Following each exercise, a full evaluation and critique should be made and the findings circulated to all the parties concerned. Feedback on training sessions and simulation exercises should be used to review and revise emergency plans, as appropriate.

39. Emergency medical personnel should familiarize themselves with the types of injuries that might occur as the result of exposure to hazardous chemicals, including variations due to routes of exposure (and possible routes of exposure according to the nature of the accident).

40. First responders (police, fire and ambulance personnel) should be trained and educated to be able to take appropriate actions to minimise the human health effects of a chemical accident.

(i) This training and education should, as a minimum, allow first responders to become familiar with: the characteristics of different types of chemical accidents; protective measures, including the use of protective clothing and equipment; contamination hazards and procedures, and indications for decontamination; specific first aid measures; and the psychological effects of major chemical accidents on patients and emergency personnel.

(ii) Detailed information should be provided to first responders concerning, *inter alia*, how the various parties, including medical personnel, should work together, and the identification, triage and initial treatment of accident victims.

(iii) Training of first responders should be repeated at regular intervals.

(iv) While it is the responsibility of the management of response services to ensure that their personnel are fully trained, members of the health professions should be prepared to advise and assist where appropriate.

41. Industry should provide initial (as well as regular follow-up) training of workers in how to avoid, and react to, different types of chemical emergencies. Occupational health and safety specialists should play an important role, where they are available. Members of the health professions should be prepared to provide advice and assistance on how to incorporate health information into the safety training of workers.

G. Communication with the public

42. Emergency planning should take into account the need to ensure that accurate and appropriate information, including that which is health-related, is provided to the public regularly. For example, the public potentially affected in the event of an accident should be given information concerning what they should do in order to protect their health if there is an accident or an imminent threat of an accident.

43. Information given to the potentially affected public should emphasize the avoidance of exposure to, or any type of direct contact with, chemicals through staying indoors with windows or vents closed and the mouth and nose covered with a wet towel. Members of the health professions should be prepared to contribute to the provision of information to the community.

44. Co-ordination between health professionals and the media should be developed, in order to ensure that health-related information disseminated in regard to chemical accidents is accurate and consistent. Public health authorities should be consulted when statements are issued to the media concerning health aspects of chemical accidents.

H. Accident investigation and follow-up

45. All persons exposed to toxic chemicals during an accident, whether they appear to be affected or not, should be properly registered to allow for short- and long-term follow-up. The onset of symptoms may be delayed for hours or days following exposure.

(i) It may be necessary to seek out exposed persons in various ways for adequate observation and, where necessary, treatment.

(ii) The follow-up of those exposed to chemicals is very important from a scientific as well as therapeutic point of view, as for many chemicals little or no information is available regarding the human health effects of acute exposure.

46. During accident investigations, victims should be interviewed as soon as possible after the accident.

47. Following an accident, a psychiatrist or psychologist should be available, *inter alia*:

- to provide emotional support to rescue workers;
- to collaborate closely with information services;
- to assist in screening activities for mental health problems in risk groups; and
- to assist in setting up a network for treatment of cases of stress reaction.

I. Research and development

48. Research to improve the treatment of adverse health effects of chemical accidents should be encouraged by health authorities and industry. This could include the development of new antidotes and decontamination procedures.

PRACTICAL GUIDES

Contents

Illustrations

Introduction

Organisation of the Practical Guides

The *Practical Guides* are set out in four chapters:

1. Health-related Information and Communications Needs;

2. Organising and Planning Health-related Response to Chemical Accidents;

3. Health Aspects of Chemical Accident Response; and

4. Health-related Training and Education for Chemical Accident Prevention, Preparedness and Response.

The Annex gives a brief overview of current chemical hazard identification systems.

These *Practical Guides* are intended for the use of members of the health professions who may be called upon to assist the victims of chemical accidents. They are also addressed to those at the operational level in, for example, public authorities (at the national, regional or local level), hospitals and other treatment facilities, civil defence and rescue services, poisons information centres (PICs), chemical emergency centres, and industry with responsibilities for preparing and implementing chemical accident contingency plans.

It is recognised that the responsibilities of the various parties involved in chemical accident prevention, preparedness and response vary from country to country, and even within countries. Differences also exist in, for example, health sector interfaces, emergency response procedures, and accident follow-up.

International co-operation in the preparation of the Practical Guides

Four international organisations worked together to organise the preparation of the Practical Guides: the International Programme on Chemical Safety (IPCS); the Organisation for Economic Co-operation and Development (OECD); the United Nations Environment Programme Industry and Environment Programme Activity Centre (UNEP IE/PAC); and the World Health Organization-European Centre for Environment and Health (WHO-ECEH).[1]

---

[1] For brief descriptions of the work of each of the four collaborating organisations, especially their activities related to chemical accident prevention, preparedness and response, see pages 7-10.

The four collaborating organisations brought together medical and other types of experts involved in chemical accident prevention, preparedness and response in Africa, Asia (including the Middle East), Europe, and North and South America to help develop an international perspective on the issues addressed in the *Practical Guides*.

A draft of the *Practical Guides* was reviewed at the 13-16 April 1993 Utrecht Workshop on Health Aspects of Chemical Accidents, organised by the four collaborating organisations, and was subsequently revised based on the discussions at the Workshop.[1]

The *Practical Guides* will be used by these organisations in their respective activities to improve chemical accident prevention, preparedness and response. They will be used by IPCS in promoting effective international co-operation with respect to chemical accidents, and in strengthening national medical capabilities for the prevention and treatment of the harmful health effects of chemical accidents. They will also be used by OECD in expanding its *Guiding Principles for Chemical Accident Prevention, Preparedness and Response: Guidance for Public Authorities, Industry, Labour and Others for the Establishment of Programmes and Policies related to Prevention of, Preparedness for, and Response to Accidents Involving Hazardous Substances*, published in 1992.

The Guides will be used by UNEP IE/PAC in the Awareness and Preparedness for Emergencies at Local Level (APELL) process. Finally, they will be used to provide technical input to the WHO Programme on Emergency Preparedness Planning, which addresses the health aspects of major disasters, and in the development of training material for use by WHO Regional Offices in their chemical safety activities. In particular, the WHO-European Centre for Environment and Health will make use of the *Practical Guides* in technical co-operation with its member countries.

Definition of "chemical accident"

For the purposes of this document, the terms "chemical accident" and "chemical emergency" are used to refer to an event or dangerous occurrence resulting in the release of a substance or substances hazardous to human health and/or the environment in the short or the long term. Such events or occurrences include fires, explosions, leakages or releases of toxic substances that can cause illness, injury, disability or death to (often a large number of) human beings.

While dispersed populations may be affected through contamination of water or the food chain resulting from a chemical accident, the exposed population is frequently either inside or immediately outside an industrial site. In an urban area, the exposed population may be in the vicinity of a ruptured vehicle that has been transporting hazardous substances. Less frequently, the exposed population is at some distance from the accident site, including possibly in areas across national borders. Potentially affected areas in neighbouring countries could include those with limited chemical emergency response plans or capabilities.

[1] For more information on the Utrecht Workshop, see pages 6-7.

This definition needs to be set alongside the concept of a "chemical incident", in which an exposure arising from releases of a substance or substances may result in illness or the possibility of illness. The number of people affected by a chemical incident may be very few (even just one), and illness, disability or death may occur a considerable time (for example, several years) after the exposure.

In addition to human health effects, chemical accidents may result in extensive or long-term damage to the environment, with considerable human and economic costs.

Some ways of classifying chemical accidents

From the health perspective, there are a number of ways of classifying chemical accidents, none of which is complete or mutually exclusive. For example, classification could be based on: the chemical(s) involved, amount released, physical form, and where and how the release occurred; the sources of the release; the extent of the contaminated area; the number of people exposed or at risk; the routes of exposure; and the health or medical consequences of exposure.

a) Chemicals involved

The chemicals involved in an accident could be grouped according to whether they are:

- dangerous substances (for example, explosives, flammable liquids or solids, oxidizing agents, toxic substances and corrosives);
- additives, contaminants and adulterants (in, for example, drinking water, food and beverages, medicines and consumer goods); or
- radioactive products (not dealt with in the *Practical Guides*).

Classification according to the amount of the chemical released should account for its hazardous properties (for example, one kilogram of cyanides is more dangerous than one kilogram of chlorine gas).

b) Sources of the release

Releases may result from human activity or be of natural origin.

- *Anthropogenic* sources include manufacture, storage, handling, transport (rail, road, water and pipeline), use and disposal.
- Sources of *natural origin* include volcanic and other geological activity, toxins of animal, plant and microbial origin, natural fires and minerals.

c) Extent of the contaminated area

Accidents could be classified according to whether they:

- were contained within an installation and affected no one outside;
- affected only the immediate vicinity of an installation;
- affected a wide area around an installation; or
- were highly dispersed.

d) Number of people exposed or at risk

Chemical accidents could be classified by the number of people affected, calculated in terms of deaths, injuries, and/or evacuees. However, the severity of a chemical accident cannot be determined solely on this basis. All the known circumstances and consequences of an accident must be taken into account in assessing its severity.

e) Routes of exposure

From the health perspective, routes of exposure could be a means of classifying chemical accidents. There are four main direct routes of exposure:

- inhalation (see Sections 3.2.1 and 3.3.3.1);
- eye exposure (see Sections 3.2.2 and 3.3.3.2);
- skin contact (see Sections 3.2.3 and 3.3.3.3); and
- ingestion (see Sections 3.2.4 and 3.3.3.4)

None of these routes of exposure is mutually exclusive.

f) Health or medical consequences

Chemical accidents could also be classified according to the health or medical consequences, or according to the system/organ affected. Examples would be accidents giving rise to carcinogenic, dermatological, immunological, hepatic, neurological, pulmonary or teratogenic effects.

Special features of chemical accidents

In principle, the organisational structure that exists to respond to other types of accidents (for example, natural disasters) could be used in the event of a chemical accident. From the health perspective, however, chemical accidents have several special features. These are outlined below:

- A "pure" chemical exposure (i.e. human exposure to chemicals without mechanical trauma) can produce a finite number of predictable health effects. Not all victims will have the same collection of effects, which will be dependent on routes of exposure, duration of exposure and individual susceptibilities.

- There may be a toxic zone that can only be entered by personnel wearing full protective clothing. In principle, ambulance and other medical personnel should never enter such a zone.

- Individuals exposed to chemicals may constitute a risk for rescue personnel, who could become contaminated by the chemicals left on the exposed persons. Therefore, early decontamination should preferably take place before those exposed are given definitive treatment.

- Hospitals (and other treatment facilities) and the roads leading to them may be located in the toxic zone, so that access is blocked and new patients cannot be received for a considerable period of time. Plans should therefore be drawn up for temporary treatment facilities in schools, sports centres, tents, private homes, etc.

- For many chemicals, general knowledge of their properties and effects may not be complete. Effective systems should therefore be identified and established for obtaining essential information on the chemical(s) of concern and providing this information to rescue workers and other persons who need it.

- Inventory activities need to be carried out to identify risks (fixed and mobile), and to identify resources available for taking care of exposed persons who suffer corrosive and thermal burns and those in need of ventilatory support.

- A number of exposed persons may need to be kept under observation for one or two days even though they do not have symptoms.

1. Health-related Information and Communications Needs

1.1 Introduction

Information is a critical element of chemical accident prevention, preparedness and response. Information and communications needs, information sources, and communications links are considered in general terms in this chapter.

Well in advance of any chemical accident that might occur, information and communications needs should be examined. Plans should then be carefully drawn up for meeting these needs, and procedures for obtaining and disseminating information should be tested. These activities must not be left until an accident has taken place.

1.1.1 Parties who need information

The nature of the information needed differs according to whether it is addressed to, for example, first responders from the police and fire services, medical personnel and other health professionals, or the general public. The types of information needed by first responders and health professionals will depend on their position in the treatment or information chains (see Sections 1.2 and 3.3.1).

All information should be clear, concise, and presented in a form that is readily understandable by those to whom it is addressed.

The parties who need information include the following:

- **Those involved in organising and planning health-related aspects of chemical emergency response** (including relevant public health personnel) need access to information on the nature and amounts of chemicals present at installations and the processes being carried out at the installations. To ensure that adequate response capability is available (including trained personnel, medical supplies and equipment), they also need information on the types of chemical accidents that could occur and the population that would potentially be affected.

- **First responders** need to be able to obtain information rapidly at the scene of the accident, including information on the chemical(s) involved, the population at risk, how to care for accident victims, how to protect themselves, and the location of hospitals and other treatment facilities.

- **Those in the health field at all levels**, in order to provide adequate care for victims exposed to chemicals, need information on the chemical(s) involved, including hazards, acute and possible delayed health effects, first aid measures, and when decontamination procedures are indicated, as well as more detailed treatment information including specific therapy options such as giving of antidotes.

- **The potentially affected public** should receive information on how to behave in the event of a chemical accident in such a way as to minimise health risks and, where practicable, should be involved in drills. The public should also be provided with information during the emergency situation, so they can take appropriate action to protect themselves and their families.

(Also see Chapter 4: "Health-related Training and Education for Chemical Accident Prevention, Preparedness and Response".)

1.1.2 Obtaining and disseminating information

The availability of information, and the conditions for disseminating it, will vary according to the accident's location, the type of accident, and other factors. However, as much of the information needed for chemical accident response as possible should be available before an accident occurs. Arrangements should therefore be made to collect, keep up-to-date, and disseminate at the local level information on:

- the types and quantities of chemicals being processed, used, stored and transported in the area;

- hazardous points, processes and activities;

- chemicals that might be released from industrial and commercial installations, including the forms and quantities of these chemicals;

- possible protective and remedial measures being taken or available locally; and

- lists of experts on particular chemicals or groups of chemicals from industry, public authorities, etc. (these lists to be updated by industry: see Section 1.4.2).

In order for an evaluation of the chemical accident and its possible effects to be made (for example, by a specialised information centre: see Sections 1.2.4 and 1.3), information must be available on:

- the locations of major concentrations of chemicals;

- the number of workers at particular installations;

- the number of inhabitants in an area or region;

- the location of schools, hospitals, shopping centres, transport terminals, etc.; and

- water supply, in the event of contamination.

For effective information provision and dissemination once an accident has occurred, formal chains of communication are needed. Links should therefore be established in advance among all appropriate parties, taking account of the need to be able to respond to a wide range of possible chemical accident scenarios.

Emergency preparedness planning should take account of the fact that normal means of communication may not function adequately in emergency situations (for example, telephone lines may be damaged or insufficient). For such cases, back-up systems should be available.

An overflow of telephone calls is to be expected in the event of a chemical emergency. Information providers should be prepared for such a situation, discouraging panic and disseminating advice as rapidly as possible. They should be able to maintain direct contact with emergency responders via radio on appropriate frequencies.

Amateur radio operators can be very effective in helping transmit information within the community and at greater distances.

The evaluation of the chemical accident, and of information and communications needs, should begin as soon as first responders arrive at the accident site. Often the first to arrive will be the police or fire services. Pre-hospital health professionals may also quickly become active.

Information on the nature and extent of the accident, and appropriate response measures, should be continuously updated – beginning with the information supplied by the person who reported the accident, which may not be wholly accurate or complete.

During emergency preparedness planning, it should be recognised that once an accident occurs, information (for example, medical, chemical or other technical information) will need to be provided as rapidly as possible, preferably by experts. Specialists trained in retrieving such information (for example, from medical reference books or on-line databases) may need to question those seeking the information in order to establish the level of information required.

Information on chemicals is increasingly widely available. Care should nevertheless be taken in selecting appropriate information for a specific purpose. Information obtained from general sources often needs to be interpreted by an expert before it can be applied to a particular situation. For example, the information in textbooks or databases may be out of date.

No prepared information source can take the place of experts, where they are available. Some technical judgement will invariably be required, for example to take account of the quantity of the chemical(s) involved, the accident location, chemical dispersion, and variations in health effects and their observed features.

In each country, one or more specialised information centres should exist for the purpose of organising the collection, collation and dissemination of information needed for chemical accident prevention, preparation and response. In a large country, it may be appropriate to have a network of such centres suitably linked.

Information provided at the time of the accident should not be restricted to physical, chemical and toxicological properties of the chemical(s) involved. It should extend to information on how the chemical is transported, and practical advice on how to respond to, for example, spills and fires, including whether to evacuate the exposed population. This information should also cover basic first aid and identify local sources of expertise, as well as appropriate treatment facilities.

It is imperative that, if multiple information providers are routinely used, they act in concert in responding to any particular chemical accident in order to ensure that consistent information is provided. This will require direct contact among the various information providers.

1.2 Types of information needed

1.2.1 Before a chemical accident occurs

Various types of information are needed for awareness and for emergency preparedness planning (see, *inter alia*, Section 2.2, Section 2.3.5, and Chapter 4). Before a chemical accident occurs, all parties who may take part in emergency response, as well as the public, should be made aware of how information concerning such an accident can be obtained.

1.2.2 At the chemical accident site

To take care of victims, **first responders** at the accident site need to know immediately the chemical(s) involved, associated hazards, and first aid measures. Such basic information is generally found on safety data sheets or transport emergency cards (see the Annex to the *Practical Guides*), which may also indicate whether a specific treatment is possible – for example, treatment with antidotes. Data sheets or cards *should* be easily available where chemicals are manufactured or transported. Nevertheless, users ought to be aware that the quality and usefulness of the information they provide varies widely, particularly in regard to health effects.

Vehicles that transport dangerous goods carry transport emergency cards. Rescue services (police and fire services, etc.) often carry data sheets or cards in their vehicles.

In the case of minor chemical incidents, and where trained health professionals are available (for example, nurses), the information provided on data sheets or cards may be sufficient. If more detailed information is required on the chemical(s) involved and their health and environmental effects, rapid communications will need to be established with a specialised information centre such as a poisons information centre or chemical emergency centre (see Sections 1.2.4 and 1.3).

In many parts of the world, data sheets or transport emergency cards are not always available. Those responding to a chemical accident must therefore locate other sources of information such as a poisons information centre, chemical emergency centre, occupational health services (occupational physicians, industrial hygienists), or even a local chemist, pharmacist or health worker.

Health professionals at the site of a chemical accident, such as ambulance personnel, paramedics and medical teams (doctors and nurses), will need more detailed information on symptoms, signs and therapeutic measures, especially in situations where specific therapy (for example, with antidotes) is to be given at the accident site. This type of information can be provided by a poisons information centre or other specialised information centre.

For a number of chemicals, where specific therapy is possible or where the chemical is known to be handled, stored or transported in large quantities, specific treatment instructions should be available at local hospitals and other treatment facilities. It should be possible to bring these instructions to the accident site, if necessary. Examples are given in **Table 1.1** of chemicals for which treatment instructions should be readily available.

Specific treatment instructions should be compiled, distributed and updated regularly by national or regional poisons information centres, with the assistance of industry.

Health professionals will also need information concerning hospitals and other treatment facilities created on an emergency basis for admittance of patients and provision of supportive or other special care. Doctors, for example, need to know the number of beds available at emergency units or intensive care centres, as well as the availability of respirators or other specialised equipment, antidotes, and other necessary pharmaceuticals. Where appropriate, industry should assist in collecting this information.

1.2.3 At hospital level

At hospital level, more detailed information is needed on hazards, symptoms, treatment and follow-up of victims and of the potentially exposed population. Not only do the immediate health effects of the chemical need to be known in detail, but also the secondary and chronic effects and potential sequelae. The medical and other professional staff or advisers at specialised information centres should be able to provide the medico-toxicological information needed by the treating physicians.

1.2.4 At specialised information centres

Centres that specialise in providing information on chemicals, such as poisons information centres and chemical emergency centres (see Section 1.3), should be able to provide appropriate information on the chemical(s) involved in the accident and their health and environmental effects. However, it should be stressed that these specialised centres also need to *receive* information on the accident and on observed effects. It is of the utmost importance to establish dialogue and exchange of information between emergency responders and the professionals at an information centre, and, where appropriate, between different information centres. Victims' symptoms, the degree of exposure, the time elapsed, the number of people affected, and many other types of information are needed, not only to assess the chemical emergency but also to predict what may be expected to happen.

The information centre also needs to know how health-related response to the accident is being co-ordinated, so that it can provide any advice needed in regard to the transport and admittance of patients. This is especially important when a large number of victims must be transported to various medical (or forensic medical) units.

Table 1.1

Some chemicals for which specific treatment instructions should be readily available in the event of exposure

Acetonitrile	Metal fumes (metal fume fever)
Acids	Methaemoglobin-forming agents
Alkalies	Mercury and its derivatives
Ammonia	Nitrites
Arsenics	Nitrobenzene
Carbon monoxide	Nitrogen gases
Chlorine	Organophosphates
Combustion products	Petrol
Cyanides	Phenols
Formaldehyde	Phosgene
Hydrofluoric acid	Phosphorus (yellow, white)
Hydrogen sulphide	Sulphur dioxide
Irritant gases (in general)	Vinyl chloride
Liquified petroleum gas, LPG	

1.3 Obtaining information from specialised information centres

Additional information will invariably be needed to supplement the information already available at the accident site from on-site or local sources, such as safety data sheets and transport emergency cards (see Section 1.2.2 and Annex), or as a result of emergency preparedness planning. It may also be possible to obtain this information from specialised information centres such as poisons information centres and chemical emergency centres.

1.3.1 General procedures

Specialised information centres should be accessible 24 hours a day, every day of the year, so that they can respond if a chemical accident occurs.

Enquiries relating to health effects may be received from:

- first responders, including police and fire services, who need to know, for example, the first aid measures that may be required before health professionals arrive as well as the precautionary measures to take in order to avoid being contaminated while responding to the chemical emergency (or while taking part in site decontamination later);

- health professionals who go to the site of the accident, or who transport or care for victims;

- the public affected by (or located in the vicinity of) the accident, who may need reassurance as well as practical advice;

- the media (radio, television, press, etc.), whose job is to keep the public informed about the accident (see Section 2.3.5);

- public authorities responsible for health and environmental protection, who need to know the possible immediate, medium- and long-term consequences of the accident.

The information provided by the information centre should be direct, concise and accurate. It should not be speculative or inflammatory. For each enquiry, the information centre should adapt its information and advice to specific circumstances, including the nature of the accident and the condition of victims. The centre should also take into consideration the type of enquiry, the level of technical understanding of the person making the enquiry, and the purpose for which the information will be used.

The information centre should be able to provide the following types of information:

- information on the chemicals involved in the accident:

    - physical-chemical properties;

    - toxicological properties;

- clinical effects of the chemical, including acute, delayed and long-term effects;

- possible transformation or degradation products of the chemical, for example in contact with water, by pyrolysis, etc.;

• information on medical treatment addressed to the lay (not medically qualified) person, the general practitioner, and the medical expert in a specialised area such as intensive care:

- signs and symptoms expected following different types of exposure such as inhalation, skin absorption and ingestion;

- advice on how to decontaminate the patient;

- medical treatment, including use of antidotes, depending on the circumstances, severity of the victims' condition, and availability of hospital or intensive care facilities;

- advice on how to make a triage of cases, particularly when many victims are involved, taking into consideration the number of victims, the local circumstances, and the availability of antidotes, supportive health care facilities or special equipment;

- advice on the collection and storage of samples for toxicity and other analyses;

- advice on protective measures that can be taken by medical and emergency response personnel to avoid becoming contaminated themselves;

- the location of antidotes and other drugs;

- the location of laboratories and the types of analyses they are able to do.

The information centre may also need to provide the following types of information:

• information on medical facilities available to respond to the emergency:

- the locations of, for example, health care centres and dispensaries, rural or local hospitals, and main central hospitals, together with the types of facilities they have available, the number of beds, and the availability of supportive care measures, mechanical ventilators, oxygen supply, and special equipment;

- means of transporting victims (ambulances, helicopters, etc.);

• information on how to contact essential services:

- when and how to contact central authorities;

- whom to contact in local authorities, and at what times;

- how to contact police, fire and other rescue services;
- who has the local co-ordinating role in an emergency;
- lists of experts from industry, public authorities, etc. on particular chemicals or groups of chemicals (to be updated by industry: see Section 1.4.2).

Information centres should work with local authorities at the time of an accident to gain access to information on chemical inventories at involved facilities and information on the population at risk. Centres may maintain such information for facilities in their immediate vicinity.

There may be a need to establish voluntary arrangements with local industry in order to obtain the required information (see Section 1.4.2). In some cases, there is a legal requirement that public authorities must be notified of high-risk activities involving chemicals. Relevant information should be made available to the information centre.

Information on (or people who have had) experience with previous accidents involving industrial chemicals may be available at many installations, but will not always be available outside them. It is of the greatest importance for information centres to have access to such information and/or experts.

Activities should be undertaken to ensure the exchange of information and experience among different health-related services and specialised information centres. It is particularly important for different types of national information centres that perform complementary roles in collecting and disseminating information of use in chemical accident prevention, preparation and response to establish and maintain good communications links. For example, basic information such as chemical identification, hazards and toxicity is needed by both poisons information centres and chemical emergency centres. Unnecessary duplication of data and associated costs can be avoided if communications links are established at an early stage.

1.3.2 Poisons information centres (PICs)

In many countries, information needed for health-related response to chemical accidents is provided by poisons information centres (PICs), which may exist at local, regional/state and national levels.[1] A directory of poisons information centres is available.[2]

A poisons information centre may act as the local focal point for chemical accident response (see also Section 2.2). It should therefore be prepared to provide adequate information rapidly in an acute situation. In the process of building up a toxicological data bank, the poisons information centre should collect information on all chemicals likely to be involved in accidents in its area (for example, region or country), including the less frequently used industrial chemicals, reactive intermediates and related matters.

---

1 The functions of a poisons information centre are described in *Guidelines for Poisons Control* (World Health Organization, 1993).

2 "Yellowtox" *Directory of Poisons Information Centres* (published jointly by the IPCS and the World Federation of Poisons Information Centres, 1993).

Various inventory activities must precede this activity. Poisons information centres should request or collect information from relevant institutions and bodies on:

- the chemical(s) involved and their effects;
- high-risk points, processes and/or activities;
- which chemicals might be released, and in what forms and quantities; and
- possible protective and remedial measures.

Poisons information centres need to know the exact location, capabilities and capacities of toxicological analytical services, as well as of emergency transport facilities. They need to work closely with all public authorities involved in chemical accident response including fire, police, emergency medical and public health agencies. This involvement needs to include active participation in planning for the management of such accidents.

The types of information outlined above should be gathered by the poisons information centre itself when emergency preparedness planning has not yet been adequately organised, or requested from public authorities when such planning exists and is effective. There is often a legal requirement that public authorities be notified of high-risk activities involving the use of chemicals, along with their location and place of storage. Consequently, appropriate information in this respect could also be made available to poisons information centres.

In some countries, poisons information centres previously identified as local focal points for chemical emergencies are informed when dangerous cargoes are to be transported or high-risk activities involving chemicals undertaken.

Poisons information centres share medical information and experience internationally through various professional bodies, such as the World Federation of Associations of Clinical Toxicology Centres and Poison Control Centres, and its member national and regional associations, as well as through the activities of the International Programme on Chemical Safety (IPCS). Centres should contribute their data relative to chemical accidents to any relevant international, freely accessible data base.

1.3.3 Chemical emergency centres

Ideally, each country should have a national chemical emergency centre specifically designed to provide assistance in the event of a chemical accident. It should operate on a 24-hour basis, every day of the year. Such a response centre may be set up by major chemical producers, hospitals or governments. It may be an independent entity, or be established in combination with a poisons information centre. It should in any case maintain a close liaison with a poisons information centre to ensure that necessary medical advice can be provided.

When such chemical emergency centres exist in addition to, or in connection with, poisons information centres, they will generally be responsible for providing information on physical risks (for example, fire, explosion) and their management, while the poisons information centres will be responsible for providing health-related information.

The establishment of chemical emergency centres has been seen as a key requirement for adequate response in many countries that have either high production capacities for chemical products or large volumes of chemicals in transit. For example, in the United States there is a Chemical Transportation Emergency Center (CHEMTREC), established by the Chemical Manufacturers Association, in Washington, D.C.; in the United Kingdom there is a National Chemical Emergency Centre at Harwell; in Germany there is a National Response Centre at BASF Ludswigshafen; and in Argentina there is a National Chemical Emergency Centre in Buenos Aires.

In some countries, an existing poisons information centre also acts as a chemical emergency centre. In Algeria and Uruguay, the national poisons information centre acts as the national chemical emergency centre.

Chemical emergency centres in different countries or regions can be mutually supportive, sharing information and experience in order to improve their response capabilities. With increased international transport of chemicals, there is an even greater need for these centres to establish communications links with each other. This was a basis for the initiative recently undertaken by the European Petrochemical Association (EPCA), together with the European Chemical Industry Council (CEFIC), in establishing the ICE (International Chemical Environment) project. One of the main elements of ICE is to assist in establishing international links between existing centres and to encourage countries that do not currently have a national chemical response centre to develop one.

The communications links established by ICE have proved particularly valuable in Europe when, for example, chemical transport accidents involving an imported chemical product occur. Those responding to the accident can obtain information through their national response centre, which can communicate in turn with a response centre in the exporting country.[1]

It has been agreed that English will be used for international communications between such response centres. In some cases, language problems might be largely overcome by using numeric codes or standardized expressions.

---

[1] See also *International Directory of Emergency Response Centres* (OECD and UNEP IE/PAC, 1991).

1.4 Other sources of information

1.4.1 Chemical databases and information systems

A number of databases and information systems can be used to obtain information on chemicals, including health effects.[1] They are frequently accessed via interactive on-line access or available on disk (including CD-ROM). CD-Rom versions are being developed for the novice user, and in emergency situations can often be used for a first analysis. Further information can be obtained, using other sources, by information experts at medical/specialised libraries or at, for example, poisons information centres and provided to the appropriate persons for expert interpretation.

In an acute situation, first responders and health professionals normally do not have time to use such systems. Moreover, in general they are not trained to search different sources and evaluate the information obtained. The professional information providers at poisons information centres and chemical emergency centres, on the other hand, are familiar with accessing information in this way and, when necessary, evaluating it.

The use of one or more of the databases or information systems now accessible should be thoroughly investigated before investing the considerable resources necessary to develop a database of one's own.

Databases and information systems should only be used by those with proper training. Once evaluated, information can be disseminated to the appropriate parties.

1.4.2 Industry

In general, industry has the principal responsibility for providing reliable background information on the chemicals it stores, handles, reprocesses, manufactures and distributes, or that are used in the workplace. The highest level of information (in terms of both amount and sophistication) on a specific chemical product is available from product manufacturers.

Industry should ensure that this information is readily available, and is provided to public authorities, poisons information centres and chemical emergency centres as appropriate. One way this can be done is by making available an expert (i.e. a scientifically qualified employee such as a plant manager). It is important to pick someone to work with chemical emergency planners and responders who not only has technical knowledge but can also work with those who are not scientifically trained.

Industry should provide specialised information centres with updated lists of experts in industry, public authorities, etc. who can advise on specific chemicals.

---

[1] See, for example, *Users Guide to Hazardous Substance Data Banks Available in OECD Member Countries* and *Users Guide to Information Systems Useful to Emergency Planners and Responders Available in OECD Member Countries* (both published by the OECD in 1991).

1.4.3 International organisations

Several international organisations prepare evaluated data on chemicals for use by member states in developing their own chemical safety measures. For example, the following publications are available from the International Programme on Chemical Safety (IPCS):

- *Environmental Health Criteria documents* are designed for scientific experts responsible for the evaluation of the risks posed by chemicals to human health and the environment. They give a summary of the literature on the physical, chemical and toxicological properties of a chemical, and provide an evaluation of the risks to human health and the environment.

- *Health and Safety Guides* are designed for a wide range of administrators, managers and decision-makers in various ministries and governmental agencies, as well as in commerce, industry and trade unions, who are involved in various aspects of using chemicals safely and avoiding environmental health hazards. These are short documents summarizing toxicity information in non-technical language, and providing practical advice on matters such as safe storage, handling and disposal of the chemicals, accident prevention and health protection measures, first aid and medical treatment in cases of exposure leading to acute effects, and clean-up procedures.

- *International Chemical Safety Cards* summarize essential product identity data and health and safety information on chemicals. They are designed to provide evaluated information for use at the shop floor level in factories and agricultural and other workplaces.

- *Poisons Information Monographs (PIMs)* are designed for poisons information centres and others. They give medical advice on prevention and treatment of poisoning, summarize the basic chemical, physical and toxicological properties of the substance, and provide advice on diagnosis and patient management, including analytical toxicological methods.

The (IPCS) Guidelines for Poisons Control include a list of databases used for medical response to chemical emergencies. In addition, the IPCS is producing a computerised poisons information package, *IPCS/INTOX*.

The UNEP International Register of Potentially Toxic Chemicals (IRPTC) provides data profiles on chemicals.

The International Labour Organisation (ILO) *Manual on Major Hazard Control* and the ILO Codes of Practice on *Safety in the Use of Chemicals at Work* and on *Prevention of Major Industrial Accidents*, which are contributions to IPCS, provide important guidance and practical advice, particularly in relation to accident prevention in the workplace and the responsibilities of industry in the field of chemical accident prevention and response.

A collection of some 80,000 *Chemical Safety Sheets*, as well as information on workplace legislation, are available from the ILO's Occupational Safety and Health Information Centre (CIS).

1.5 Communications links

As already indicated in this chapter, good communications are essential in order to implement and co-ordinate effective chemical emergency response. However, communications problems may arise as a result of equipment failure or overload, or of stress-related human error.

The principal communications links that need to be ensured include: links between specialised information centres and persons working at the accident site; links within and between hospitals and other treatment facilities; and links between the media and those delegated to handle media relations.

2. Organising and Planning Health-related Response to Chemical Accidents

2.1 Introduction

This chapter considers the contribution of members of the health professions to general chemical emergency planning. It does not give detailed advice on drawing up a health-related Major Accident Plan, although the main elements of such a plan are outlined (see Section 2.3.1). This chapter does give advice on the special aspects of major chemical emergencies that health professionals need to consider and plan for in advance of any accident occurring.

Section 2.2 outlines roles and responsibilities for emergency preparedness planning and emergency response. Attention is drawn to the need for local awareness and preparedness programmes, the importance of hazard identification and evaluation, and sources of information useful in health-related emergency planning. Section 2.3 goes on to consider chemical emergencies in relation to the elements of a health-related Major Emergency Plan. Sections 2.4 and 2.5 go into more detail on equipment and protection of personnel. Section 2.6 treats provision for accident investigation and follow-up. Finally, Section 2.7 briefly describes veterinary considerations in chemical accident response.

In every major chemical emergency it is necessary to minimise harm to the population at risk, which may call for evacuation. Where there has been adequate planning, evacuation is usually carried out only if there is an immediate hazard such as an explosion, or a longer-term hazard such as contamination of air, soil or water by highly toxic substances. It may be preferable to provide advice on personal protection and sheltering, rather than to carry out a poorly planned and executed evacuation. Emergency plans should provide clear guidance on evacuation policy under local conditions.

2.2 Organisation of chemical accident response

2.2.1 Roles and responsibilities

Many countries have recognised the need to plan for disasters of various kinds. In some cases, this responsibility has been given to existing bodies such as the armed forces or civil defence services. In others, special organisations have been set up for disaster management. Input from the health professions is required for disaster planning in general. All hospitals or other facilities that receive acute or emergency cases should have a Major Accident Plan, which should be linked to the emergency plans of other concerned bodies, for example local authorities and the police, fire and rescue services. The Major Accident Plan should provide for co-operation with other hospitals or health facilities in cases where there are large numbers of casualties.

In several countries, close co-operation between civil and military services has been established for coping with major accidents. Such co-operation can have clear advantages for both services in terms of optimal use of available emergency resources, and of access to a larger number of trained medical personnel. Ultimate or overall command should be clearly established, and agreement should be reached regarding the integration of functional leadership of operations and medical responsibilities. Training and education exercises need to be undertaken jointly (see Chapter 4).

Health professionals (including relevant public health personnel) should contribute to the emergency preparedness planning process, as well as making it their responsibility to be aware of local emergency medical plans and their roles within them. Where there is no central organisation co-ordinating the roles and responsibilities of independent medical practitioners, those practitioners should make their own plans for responding to emergencies, as necessary.

In this context, health authorities and hospitals need to consider and prepare for the special features and requirements of chemical accidents. These may include the need for: emergency medical information on a 24-hour, seven-day basis; specialised personnel, drugs and equipment; provision for decontamination and prevention of further contamination at all stages; and long-term epidemiological follow-up and psychological/psychiatric care.

Public officials (including relevant public health personnel) at the regional/state and national/federal levels need to ensure that these aspects are covered in the preparation of local and regional disaster plans.

Emergency plans should include a list of information providers, and of sources of emergency response assistance, in neighbouring or potentially affected countries. Exposure beyond national borders is possible, and should be taken into account when emergency response plans are drawn up. (For health-related information needs, see Chapter 1).

In many countries, the task of organising and planning health-related response to chemical accidents is performed by poisons information centres (PICs) at local, regional/state and national levels (see Section 1.3.2). These specialised information centres should make themselves aware of existing emergency plans and their roles in them. Besides acting as a source of toxicological information and advice, and in some cases undertaking a co-ordinating and/or management role, poisons information centres are an important means of collecting and collating exposure data and clinical case data for assessing the real and potential consequences of a chemical accident.

The role of the poisons information centre needs to be publicised. It should be contactable on a 24-hour basis, and should be staffed by specialists. It is most important that if emergency duty officers are expected to provide technical information, they have a sufficiently clear understanding of the nature of the information they are giving out to enable them to discuss this information with an enquirer.

The organisation and planning of health-related response to chemical accidents should include provision for veterinarians and other persons familiar with the care of livestock and pets.

2.2.2 Awareness and preparedness

In the context of emergency preparedness planning involving major chemical hazards, regional/state and national governments should encourage local awareness and preparedness programmes, for example by encouraging the application of UNEP's Awareness and Preparedness for Emergencies at the Local Level (APELL) process or similar activities (see page 10).

Local authorities, in turn, should be prepared to take part in APELL or a similar programme, including the exchange of all relevant information with local industry and the community. This will enable a co-ordinated emergency response plan to be developed at the local level. Hospitals and other treatment facilities, health professionals and poisons information centres/chemical emergency centres should be involved in this process.

2.2.3 Co-operation in preparing hazard inventories

Hazard inventories are an important means of identifying possible emergency situations, so that the availability of appropriate expertise, equipment and medicines in the event of an accident can be ensured. Hazardous situations within a specified geographical area, including hazardous facilities and activities, as well as the existence of hazardous (toxic) chemicals, should be identified. It should be noted that the handling and storage of chemicals occurs not only at chemical installations, but also at many other workplaces including manufacturers who use the chemicals, off-site storage areas, and warehouses. The possibility of chemical accidents occurring during transport (including loading and unloading) should also be considered.

In carrying out hazard inventories, health services should liaise and closely co-operate with other public authorities or organisations that might also be involved in responding to a chemical accident. Those who might assist in carrying out such inventories include local authorities and those responsible for environmental protection and preventive medicine, police and fire services, hospitals, emergency control centres, civil defence and military authorities, and industry. For example:

- local fire and police services may be able to identify risk installations, transport routes, etc.;

- customs and transport officials may be able to advise on importation, distribution and movement of chemical products; and

- meteorologists may be able to give advice on the effects of the weather on chemical dispersion.

Public authorities involved in community health care provision should contribute to the process of identifying and evaluating local situations that are potentially hazardous. Where other organisations with a formal responsibility for undertaking hazard evaluations do not exist, or in the absence of an effective interface between the local health authority and local industry, it may be necessary for local health care providers to make their own hazard evaluation(s).

Hospitals should actively contact local industries, and these industries should actively give hospitals and related facilities information concerning the presence of hazardous chemicals. These activities can be initiated by local or national authorities.

Information needed by health professionals in order to plan their response to a possible chemical accident is addressed in Chapter 1. However, in addition to the obvious sources of information (poisons information centres, chemical emergency centres, industry), public health authorities should consider approaching suppliers of antidotes and other drugs, and of resuscitation, protection and decontamination equipment, who can advise on their use and availability.

2.3 Major Accident Plans and chemical emergencies

2.3.1 Main elements of a health-related Major Accident Plan

A health authority's Major Accident Plan should contain at least the following elements (normally agreed to by the responsible officials involved):

- a command and control system, and provision for an emergency communications system;
- provision, where appropriate, for a hospital "flying squad" (see Section 2.3.3), which would be sent to the scene of the accident;
- adequate provision for the transport of patients;
- decontamination facilities;
- hospital-level arrangements:
  - bed clearance;
  - patient reception area;
  - patient identification and documentation;
  - samples from patients, on which to base follow-up analysis;
  - drugs and equipment;
  - protective clothing;
  - staff call-up;
- information to relatives/the general public, directly and through the media, and relations with the media;
- standing down of emergency services;

- follow-up and evaluation of patients;

- training in the use of the Plan, practical testing of the Plan, and evaluation of the test results;

- relations with others involved in emergency response.

Regional/state and national/federal governments need to look at preparedness planning for large-scale emergencies that extend beyond local, or even national, boundaries.

The following paragraphs refer specifically to chemical accidents and their consequences. Follow-up and evaluation of patients is addressed in Section 3.5, and training and education (including procedures for testing emergency preparedness plans) in Chapter 4. Therefore, those matters are omitted here.

2.3.2 Command and control and emergency communications

The primary task of first responders such as police and fire services is to assess the accident scene, and then create order and establish lines of communication, even when this seems to limit initial rescue and containment activities. In the immediate area of an accident, information should be made available on contamination hazards, decontamination procedures, where applicable, and public safety.

In several countries, co-ordination teams or command groups have been created. They are designated to be located at the perimeter of the accident site. The location of such a team or group should be well indicated, so that it is clear this is the emergency information point. The service responsible for organising this point will vary from country to country, but should be clearly designated in the emergency plan.

In many cases, the command and control vehicle will be supplemented by additional vehicles from other services. Once at the site, the command and control centre/vehicle should be prominently located, although away from any danger of exposure to chemicals.

To make decisions on the management of the accident and its victims, the on-site co-ordinator will need to be informed rapidly about:

- the type and amount of chemicals involved in the accident, as well as handling and containment advice;

- the number of potentially contaminated persons, rescue capabilities, and the capacity of local treatment facilities;

- the weather, the immediate environmental conditions, and the likelihood of exposure of rescue workers;

- the number of rescue workers active at the site, the location of these workers, and ways to communicate with them;

- the availability of additional resources, including a hospital "flying squad" and on-site medical co-ordinator.

In addition, the on-site co-ordinator should be responsible for overseeing the activities of all responders in the contaminated zone, together with other factors that may affect the safety of all responders including the need to relocate safe zones or generally evacuate the entire area if conditions dramatically worsen.

Communications can be established from and to the scene of the accident by a variety of methods, for example telephone, fax, radio, pager, or any appropriate combination of these. It is essential that both the quality and reliability of the means of communication be of a high standard. From experience in previous accidents, it appears that most information is requested using radio communication. Sufficient frequencies and an adequate number of radios should therefore be available. During preparations for responding to an accident, the compatibility of radio frequencies should be checked and adaptations should be carried out as necessary. If possible, the frequencies used by the different services should be separated so that a specific frequency or radio operator will not be overloaded.

The possibility of obtaining help from amateur radio operators should be considered, where appropriate.

Medical personnel need to be able to communicate directly with poisons information centres/chemical emergency centres, in order to optimize the available information and allow hospitals and other treatment facilities to prepare for the patients they will be handling. If at all possible, this important information, when obtained directly, should be conveyed to the command and control centre so that a clear overview of the situation can be maintained by those in overall charge.

Conditions at the site of the accident may well be chaotic. Accurate communication of chemical or trade names of any product involved is essential. It is common practice for those in charge at accident sites to request information on chemicals from local emergency telephone centres operated by public authorities or industry.

To ensure accurate communications, it is highly desirable to have an information checklist specifically designed for completion by the person in charge at the accident site. The checklist can guide or prompt the obtaining of relevant details. These details are recorded in a manner that facilitates interaction with a technical expert.

Emergency operators should use a special form, on which the most important questions to be asked are prepared/outlined, and which will serve as a memory aid. Guidelines or instructions should have been given the emergency operators regarding:

- further callers, who may or may not be referring to the same accident;
- the telephone numbers of ranking officers in charge of the various emergency services;
- the telephone numbers of hospitals, other treatment facilities, specialised information centres, and important industrial sites in the area;
- back-up telephone numbers and alternative communications arrangements for use in emergencies.

2.3.3 Emergency medical response

Health authorities must decide, in the light of their own resources and priorities, whether or not to plan for the presence of hospital medical and other personnel at the site of the accident.

Medical personnel who go to the scene of a major accident expect, and are expected, to begin the diagnosis and initial treatment of victims if this has not already been begun by first responders, especially those from the fire and rescue services. However, the prioritization of victims (triage) is an important aspect of health professionals' on-site role. (Triage is dealt with more fully in Section 3.3.2).

Medical personnel also have an important part to play by assisting the co-ordinator in determining the accident area, and in making decisions on the provision of decontamination facilities and evacuation of the accident area. These requirements should be borne in mind when the composition of a flying squad for chemical emergencies is being decided. Any medical personnel participating in field activities need to be well trained for this purpose.

The extent of the accident area needs to be determined, in order to make it possible to take decisions on the care of victims and the safety of the public and the environment. If a chemical accident takes place in a factory, the occupational health service needs to have plans for at least a general approach to accident response, taking into account existing facilities that could be used to manage exposed accident victims, including their decontamination, examination and treatment. When accidents occur in public buildings, for example indoor swimming pools, such treatment facilities are less likely to exist. However, health authorities can prepare plans for this type of emergency situation. Local authority disaster plans should consider that transport accidents can take place anywhere.

Preliminary information from the site should include: the type of accident; characteristics of the site (factory, public building, school, etc. and whether it is in a rural or industrial area); the danger of further accidents (fires, explosions, crashes); and the presence or release of toxic chemicals. Based on this information and its interpretation, for example by a poisons information centre/chemical emergency centre, the on-site co-ordinator will need to decide on actions to be taken immediately, including those intended to avoid or limit the exposure of humans and the environment. Ultimately, this may involve complete evacuation of the accident area. Medical input to these decisions is a necessity, and this is best provided on-site.

The on-site co-ordinator also has to determine whether there is a contaminated area that should be entered only by personnel wearing full protective clothing. Where possible, this determination should be made in co-operation with the medical co-ordinator and/or an industrial hygienist.

In addition, the on-site co-ordinator must determine whether there is a possibility of contamination of rescue workers, by continued exposure or by contact with victims. It is also important to decide at an early stage whether there is a need for decontamination facilities at the site, or at the hospital or other treatment facility. The medical co-ordinator will be required to advise on these points.

There should be a system for registering the workers in the accident area, and the means of maintaining contact with them. There should be regular monitoring of the workers' situation, in addition to updating of the general information available to them.

2.3.4 Hospital-level arrangements

The elements identified under this heading at 2.3.1 above are common to general health-related Major Accident Plans for responding to all types of emergencies. However, the following points in particular should be in relation to chemical emergencies.

A large-scale chemical emergency may produce large numbers of patients with burns and/or respiratory damage. It may be desirable to alert regional or national burns units and arrange for patients to be transferred there directly from the scene of the accident. Similarly, it may be appropriate to make the same arrangements with intensive care units in other hospitals for patients needing ventilation. If a decision is taken to treat victims in general acute beds, then practicable plans must also exist for adequate staffing and equipment of these beds.

The hospital laboratories and pharmacy will need to be alerted to the possibility of a large influx of requests for analyses and pharmaceuticals.

The reception area needed for large numbers of casualties will usually be larger than that of the average hospital accident and emergency department. This area will also need to be equipped with showers for decontaminating victims. Decontamination areas should have isolated air handling systems (and possibly also water containment systems) in order to avoid spreading the chemical contamination.

The clerical process of identifying and documenting patients is the same as in any major emergency. However, this process needs to be co-ordinated, not only during initial treatment but also during the taking of initial samples from all patients. Taking of samples is partly for treatment, but is also carried out as a basis for epidemiological follow-up – a requirement associated with chemical emergencies that does not apply in many other types of disaster. This implies both the availability of technicians and equipment, and co-operation with registration staff to ensure that no one is missed.

It is important to consider drugs, equipment and protective clothing in emergency preparedness planning in relation to chemical accidents. Antidotes and other drugs need to be available – if not immediately within the hospital, then at least within a short time.

The possibility of large numbers of patients needing help with breathing implies the availability or obtainability of mechanical ventilators. An inventory of available ventilators should be carried out, bearing in mind that manual ventilation is possible but requires a considerable number of personnel.

Flying squad personnel will need appropriate protective clothing, which may also need to be provided for medical and nursing personnel receiving still-contaminated patients (see Sections 2.5 and 3.3.3). All such personnel need to be thoroughly trained in the use of protective clothing and the limitations it produces in certain procedural activities.

All Major Accident Plans should provide for calling in extra staff and for maintaining an up-to-date register of names and telephone numbers. Where chemical emergencies are concerned, these should cover medical practitioners with experience in toxicology and intensive care, and nursing staff with experience using mechanical ventilators.

2.3.5 Information to the public and relations with the media

Dissemination of information to the public in the event of a chemical accident needs to be considered well in advance of such an accident actually occurring. It will be necessary to warn the potentially affected public that an accident has occurred, or is likely to occur, and to provide information on what should be done to minimise possible adverse effects.

It is important to ensure that the system for communicating with the public is clear, and that it includes designation of those responsible for providing information directly or through the media. Health-related Major Accident Plans should provide for input to this system, particularly concerning public health precautions and the number and condition of victims.

A media plan is an integral part of the overall emergency plan. The media have enormous responsibility for how the public will react to a chemical emergency. This is turn means that those responsible for managing the emergency, including health professionals, are responsible for ensuring that the media are given correct information. This process will be easier if contact has already been made with representatives of the media, and if an understanding has already been developed on how to proceed if a chemical accident occurs.

Information given in the immediate area of the accident to first responders must be considered as likely to become available to the public. However, information provided by the caller making the first report of the accident, or information passed on to first responders, is often inaccurate or incomplete. As far as possible, only information known to be factual should be disseminated.

Personnel operating in the field should not be expected to handle media relations. Instead, they should be instructed to refer media representatives to those designated to pass on information. Ideally, a press officer should be readily available and briefed to answer questions within the limits of the information known to be factual. The press officer must be able to obtain general health advice, and details on the number and condition of victims, from health professionals for onward transmission. The press officer should have regular contacts with psychological experts (see Section 3.4).

2.3.6 Standing down of emergency medical services

In general, decisions about standing down of emergency services should be taken in conjunction with the overall site co-ordinator and never in isolation. For the emergency medical services, this will in effect mean that a hospital flying squad, if any, should never leave the site until the site co-ordinator is satisfied that it has completed its job (as outlined in 2.3.3 above) and that its members will from then on be better occupied back at base.

Emergency medical personnel should be prepared to contribute to a general debriefing on the functioning of the overall emergency plan and lessons to be learned.

2.4 Emergency equipment, medicines and antidotes

2.4.1 Emergency equipment

The types of emergency equipment needed to meet specific types of emergencies should be determined, and this equipment (for example, specially designated emergency response vehicles) obtained. All emergency equipment should be in working order, highly reliable, effective, and available when an emergency occurs.

The best storage areas for emergency equipment should also be determined. The value of storing such equipment near the sites of possible emergencies should be assessed, with consideration given to ease of accessibility and protection from unauthorised use. Periodic checks need to be carried out on the equipment's adequate functioning.

As part of emergency preparedness planning, it should be ensured that adequate medical facilities are available, including transportation facilities. In an emergency, this may mean the rapid transformation of facilities normally used for other purposes.

Decontamination equipment for on-site and hospital use and, as appropriate, protective equipment for medical personnel are discussed in Sections 2.5 and 3.3.3.

2.4.2 Medicines and antidotes

Where suitable antidotes exist to chemicals produced by industry, industry should be required to ensure the availability locally of the antidotes if obtaining them is a problem for the health authorities. Essential emergency medicines, kept up-to-date, should be available at or near installations handling toxic chemicals for use by authorized health professionals. Emergency medical facilities, medical centres or hospitals in proximity to such installations – or, if necessary, poisons information centres in the region – should also stock appropriate emergency medicines and antidotes to deal with the consequences of a major chemical accident (see **Table 2.1**).

For a limited number of poisonings (for example, by cyanides, organophosphates) and under certain circumstances (long distances to treatment facilities, limited means of transport) it is desirable to be able to begin antidote treatment at the accident site. Vital supportive treatment should always be started as soon as possible.

Public health and education authorities should ensure the basic training of all medical and paramedical professionals, as appropriate, in the use of emergency medicines and antidotes. A suggested list of medical equipment and medicines (other than antidotes) required for chemical emergency response is given in **Table 2.2**.

Table 2.1

Antidotes and other drugs that may be needed in the event of a chemical accident

The choice and availability of antidotes may vary from country to country.

Antidote/drug:	**Indication:**
Amyl nitrite (for inhalation) **1**	Cyanides, nitriles
Atropine (for injection) **1**	Organophosphates, carbamates
Budesonide (for inhalation)* **1,2**	Irritant gases
Betamethasone (for injection) **1,2**	Irritant gases
Calcium gluconate (topical) **1**	Hydrofluoric acid
Calcium salts (for injection) **	Hydrofluoric acid
Cobalt edetate	Cyanides (nitriles)
Copper solution * **1**	Phosphorus white (yellow)
Dimercaprol *	Arsenic, mercury
Dimercaptopropane sulphonate (DMPS) * (for injection) (tablets)	Arsenic, mercury
Dimercaptosuccinic acid (DMSA) * (for injection) (tablets)	Arsenic, mercury
Hydroxocobalamin (for injection) **1**	Cyanides, nitriles
4-Dimethylaminophenol (4-DMAP)	Cyanides
Methylthionine (methylene blue) (for injection) *	Nitrites, nitrobenzene (and other methaemoglobin-forming agents)
Obidoxime (for injection) ***1**	Organophosphates
Oxygen **1**	Carbon monoxide, cyanides, hydrogen sulphide, irritant gases, nitriles

Table 2.1 (continued)

Antidotes and other drugs that may be needed in the event of a chemical accident

Antidote/drug:	**Indication:**
Polyethylene glycol 400 (topical) **1**	Phenol
Potassium permanganate + sodium bicarbonate (topical) *** 1**	Phosphorus, white (yellow)
Pralidoxime (for injection) *** 1**	Organophosphates
Salbutamol (for inhalation) *** 1**	Irritant gases
Sodium nitrite **1**	Cyanides, nitriles
Sodium thiosulphate (for injection) **1**	Cyanides, nitriles
Terbutaline sulphate (for inhalation) *** 1**	Irritant gases
Tetracaine hydrochloride (eye drops) *** 1**	For eye irrigation
Toluidine blue (for injection) *****	Nitrites, dinitrobenzene (and other methaemoglobin-forming agents)
Xanthine derivatives	Irritant gases

***** *Can be replaced by an equivalent substance or preparation.*

****** *Excluding calcium chloride.*

1 *Use may be required at the accident site.*

2 *These indications for the use of corticosteroids remain controversial.*

Table 2.2

Basic portable facilities and equipment needed for emergency treatment of poisoned patients

For maintenance of respiratory function:

Oxygen supply
Laryngoscopes
Endotracheal tubes
Masks (oxygen)
Suction system (mechanical)
Self-inflatable bag
Tracheostomy set (including tubes)
Mechanical portable ventilator

For maintenance of cardio-circulatory functions:

Cardiac monitor
Defibrillator
External pacemaker

For symptomatic and specific treatment:

Fluids (colloids and crystalloids)
Pharmaceuticals (including antidotes and electrolytes)

For decontamination:

Portable showers
Water supply, soap and specific washing solutions
Eye-washing equipment (including local anaesthetics)

Other necessary items:

Bladder catheters
Containers for samples (chemical and biomedical)
Liquid disinfectants
Wound dressing material
Blankets, bedsheets, robe (for patients following decontamination)
Plastic bags (for contaminated clothing and other material)
Protective equipment for emergency personnel

2.5 Personal protection of those responding to chemical accidents

2.5.1 Personal protective equipment

In the case of accidents such as explosions or fires, personal protective equipment may have to be used to afford full protection to personnel responding to them. In all situations, protective clothing should be leak-proof and made of chemical-resistant material(s) that combine the greatest degree of comfort with the maximum level of protection.

Two categories of protective clothing exist:

- chemical protective clothing (CPC);
- respiratory protective equipment (RPE).

CPCs include garments, gloves, boots, coveralls with head gear, and fully encapsulating suits. These are available in three categories: light duty (for exposure to dilute acids and alkalies), medium duty (adequate for most chemicals), and heavy duty (for exposure to extremely hazardous and corrosive chemicals). It should be remembered that chemicals may penetrate suits over a period of time, and that subsequent exposures to different chemicals may lead to reactions within the material of the suit, diminishing its effectiveness. Consideration should be given to providing single-use (disposable) suits, in order to avoid the risks of using suits previously contaminated.

There is also a range of RPEs, to be used in toxic or oxygen-deficient environments. This equipment can be divided into two types: emergency escape units, which can be used for short periods to allow escape from toxic atmospheres; and self-contained breathing apparatus, which gives a longer period of protection to individuals either entering or escaping from dangerous or toxic situations.

Contaminated protective clothing should always be washed, or hosed down, before the user or rescue worker takes it off. This will ensure a longer service life, and prevent contamination of the next person who uses it.

All protective equipment should be:

- stored in a manner that prevents it from being damaged by an accident;
- easily accessible; and
- regularly inspected and maintained, with replacement as necessary.

Appropriate selection of protective clothing is critical, and therefore should be undertaken by qualified personnel such as an industrial hygienist or safety officer. Where this is not possible, advice should be sought from the fire service, poisons information centre or chemical emergency centre. Personnel designated to use protective equipment should be well trained in how to use it correctly. This training should be reinforced by being included in regular disaster simulation exercises.

2.5.2 Protection of rescue workers and medical personnel

In responding to chemical accidents, there may be a danger that rescue personnel will be exposed to toxic chemicals. For this reason, protective equipment needs to be available for use. Personnel from rescue (fire) services should be familiar with different types of protective equipment, and should use it as required (for example, to work in a contaminated area or to rescue victims).

Medical personnel should, in principle, never enter a contaminated area. They should only work at casualty assembly points, to which the injured are brought after decontamination. Only exceptionally should medical personnel need to enter the accident area, for example to carry out triage or give life-saving treatment. They may need to assist in decontamination procedures, but in that case they should be properly equipped, for example with a gas mask in case there is a change in wind direction that would expose them to a toxic chemical. Rubber gloves, a protective suit, rubber boots and other protective equipment should also be available.

As a rule, medical personnel should be guided by rescue personnel who have been trained to work in such an environment. When indicated, they should wear protective equipment all the time they are working under adverse or toxic conditions. They may also need protective equipment at hospitals or other treatment facilities, especially during decontamination of victims.

2.6 Accident follow-up and evaluation

The purpose of an accident investigation is to establish all the facts relating to an accident and the response to it, draw conclusions from these facts, and make recommendations for preventing similar accidents. The right approach to accident investigation should be to establish the cause rather than apportioning blame.

Accident investigations and their findings are a crucial part of every occupational health and safety programme. Responsible organisations should have a policy requiring accidents or "near-misses" to be investigated, analysed and reported on.

2.6.1 Accident investigators

A health and safety professional or inspector should make an independent investigation of every significant accident. He or she should make a written report to the proper official, or to the health and safety committee. Specialised training and analytical experience can enable this person to search for all the facts and submit a detailed, unbiased report.

The health and safety committee in many companies is concerned with a range of activities. Accident investigation is an important function. Ordinary investigations would normally be handled in a routine manner, but in important cases the chairman of the company may call an emergency meeting of the committee with instructions to conduct a special investigation. In some companies, a special committee may be set up to investigate and report on accidents or on health issues.

2.6.2 Accident investigation techniques

In order to obtain as accurate evidence as possible, the accident investigation should be undertaken immediately after the accident. Wherever possible, the accident should be discussed at an early stage with the injured person(s) to obtain their version/account of events. If the injured person(s) is (are) sent home, to a treatment centre, or to a hospital, the follow-up may have to be postponed until they are well enough to be visited.

Witnesses should be interviewed as soon as possible after the accident. In taking their evidence, care should be exercised to differentiate between verifiable/measurable facts and what may later be shown to be hearsay or opinion. Witnesses should be interviewed individually, although if they wish they may be accompanied by a legal representative or legal counsel. The object of the investigation (to establish the cause of the accident and not to apportion blame) should be clearly explained.

2.6.3 Information collection

The purpose of the accident investigation is to discover information concerning the accident and how it occurred, as well as the nature of any injuries sustained, and to record the relevant facts (see also Section 3.5.3). The records, both individually and collectively, should provide insights into the areas, conditions and circumstances to which accident prevention and response efforts could most profitably be directed.

Information on the health consequences of chemical accidents need to be made available to other health professionals who will deal with similar accidents in the future. Such data should, whenever possible, be published and should be contributed to or included in appropriate established databases.

2.6.4 Analysis of accident investigations

Simply to obtain information and report on the accident will not prevent its recurrence. Circumstances or conditions should be corrected. It is often only after carrying out a thorough analysis of several accident investigations that inadequate policies or procedures, or failures in management systems, become apparent. The study of a single case, on the other hand, may not point clearly to the necessary corrective actions that need to be taken, either in terms of better prevention or better preparedness and response.

2.7 Veterinary considerations in chemical accident response

Veterinary impact is an important consideration during chemical accident response, as well as during follow-up and rehabilitation phases. Animals can be used as sentinels to detect chemical exposure (and unsuspected pollution). A careful observation of domestic and wild animals may provide useful information concerning the type of chemicals involved and the area affected. Fish mortality is of special interest in detecting pollution of rivers and watersheds.

Domestic animals need particular attention in chemical accidents. They may need special treatment, or may need to be sacrificed. The evacuation of animals may need to be organised. In addition, the question of how to handle dead animals deserves attention.

During accident follow-up, the monitoring of domestic and wild animals may provide information of value for understanding the effects of chemicals (see also Section 3.5.2).

3. Health Aspects of Chemical Accident Response

3.1 Definitions: acute and chronic (intermittent) exposures

For many chemicals, the biological and/or health effects following acute exposure to high concentrations can be quite different from those produced by low-level chronic or intermittent exposure. For example, the acute effects of exposure to benzene consist predominantly of central nervous system toxicity, while low-level and chronic intermittent exposure can result in bone marrow depression.

Definitions of acute and chronic (intermittent) exposure have been derived mainly from animal experiments. However, under experimental conditions it is far easier to determine the duration of exposure than in the case of chemical accidents involving humans. Although *acute exposures* have been defined as being of a duration not longer than 24 hours, when a chemical accident occurs the exact time at which exposure begins is often difficult to define. First, one needs to be clear whether exposure has in fact occurred; and if so, for what period of time people were exposed.

Chronic (intermittent) exposures may occur where there is environmental contamination (pollution) or where toxic chemicals are present in the food chain. In these situations, however, the problem tends to be an acute one and the relevant authorities will need to take whatever action is necessary. Apart from measures to reduce exposure and, if possible, avoid further exposure, a formal risk assessment is necessary to determine whether the exposure will result in any adverse health effects, either currently or in the future. During the period of that risk assessment, those with problems and complaints which they attribute to the exposure should have the opportunity to consult a physician who can evaluate their symptoms and signs and supply them with information about a possible link to the exposure.

3.2 Routes of exposure

In most cases, symptoms and signs exhibited by chemical accident victims are immediate or are delayed for only one or two hours. In some cases, however, the features of toxicity may appear days, weeks, months or even years after the acute exposure. Symptoms and signs may be local (eyes, skin, respiratory tract, gastrointestinal tract), systemic or both. The most common acute systemic features are expressed in the central nervous system (excitation, depression), circulatory system (vasodilatation, arrhythmias, cardiovascular depression), respiratory tract, gastrointestinal tract (malaise, vomiting, diarrhoea), and in the blood (methaemoglobinaemia, haemolysis). Delayed features may be seen in any organ system, but most commonly in the respiratory tract (delayed-onset pulmonary oedema), kidneys, liver and blood-forming organs.

In the case of major chemical accidents, the most common type of exposure is inhalation of gases stored under pressure, which spread rapidly and over a wide area. Other likely routes of exposure in this context are the eyes and skin. Ingestion of a toxin is more likely to occur if drinking water or food have been contaminated, either by accident or deliberately.

3.2.1 Inhalation

In chemical accidents involving the exposure of a large number of persons, the main route of exposure will be by inhalation, of gases, fumes, aerosols or respirable dust. The result of exposure of the airway to chemicals may consist of local effects on the mucous membranes at different levels, as well as of other effects due to absorption through the lungs. Immediate symptoms may arise, as well as symptoms which appear after a (more or less) symptom-free (latent) interval.

Toxic inhalants (gases, vapours, aerosols and dusts) are characterised by their physical properties and pathophysiological effects, which in turn determine the clinical findings on presentation. Five categories of noxious agent are recognised: irritant inhalants; systemic poisons; combined irritants and systemic poisons; inert gases; and hot gases.

Irritant inhalants produce toxicity by causing mucosal damage of the respiratory tract. The location and severity of the injury will depend upon the reactivity, concentration, particle size and water solubility of the substance and on duration of exposure. Previous underlying disease, especially of the respiratory tract, plays an important role in this context. It is important to distinguish two groups of irritant gases, i.e. (i) those causing immediate features of toxicity and (ii) those causing only minor and/or no immediate symptoms or signs of toxicity.

Inhalants that are highly water-soluble (for example, acids, alkali, ammonia, hydrogen chloride, hydrogen fluoride) dissolve in the water phase of the upper respiratory tract mucous membranes and typically will not reach the lower respiratory tract unless exposure is prolonged or high concentrations of gas are inhaled. These gases usually produce immediate symptoms such as watering of the eyes, rhinitis, pharyngitis, cough and, in severe cases, laryngeal oedema.

Following exposure to high gas, vapour or dust concentrations, reflex circulatory or respiratory arrest may occur. Where there is prolonged exposure, there may be damage to the lower respiratory tract. This is even more likely to occur with the chemicals that are intermediate in their water solubility (for example, halogen gases, hydrogen halides, phenol, sulphur dioxide). Otherwise, it is mainly the inhalant chemicals of low water solubility that damage the lower respiratory tract in low concentrations and following short exposure, causing pneumonitis, alveolitis and pulmonary oedema, sometimes without any significant effects on the upper respiratory tract or eyes (for example, chlorine, hydrogen sulphide, isocyanates, mercury vapour, nitrogen oxides, phosgene).

Usually, early respiratory symptoms are prominent, giving an indication of the severity of exposure. However, attention should be paid to the fact that initial signs of respiratory tract damage may be lacking in the case of, for example, nitrogen oxides and phosgene. Following the onset of initial symptoms, there is usually a latent period during which the patient suffers little discomfort. This period may last between 30 minutes and 24-48 hours, and rarely 72 hours.

This latent period is followed by the development of respiratory symptoms and pulmonary oedema due to increased capillary permeability. In severe cases, pulmonary oedema may appear during or shortly after the chemical exposure.

Apart from chemical irritation, other effects on the respiratory tract may result. Isocyanates, for example, cause an asthma-like syndrome. This asthma-like syndrome has two different mechanisms. One is attributable to the fact that isocyanates are sensitisers of the respiratory tract, giving asthmatic symptoms, particularly after repeated exposure to low concentrations of the isocyanate. The other mechanism is that isocyanates may alter the biological response to beta-adrenergic stimulation or may induce local histamine release, thereby causing bronchoconstriction that does not appear until after a latent period of several hours.

Chemicals that are inhaled may also cause *systemic poisoning* without any respiratory tract symptoms. Symptoms of systemic poisoning vary according to the toxic substance and its target organs. Almost all types of toxic damage may be seen, and symptoms and signs may be immediate or delayed. The most prominent immediate features are those arising from the central nervous and cardiovascular systems. Hydrogen cyanide and hydrogen sulphide, for example, block cellular utilization of oxygen, causing cellular hypoxia and impairment of the central nervous and circulatory systems almost immediately. This is also true of carbon monoxide, which in addition prevents delivery of oxygen to the cell by blocking haemoglobin oxygen transport capacity.

Organophosphates are potent inhibitors of cholinesterases, resulting in accumulation of acetylcholine at synapses in the nervous system and at myoneural junctions, giving rise to cholinergic poisoning. Volatile hydrocarbons are narcotics causing central nervous system depression. Halogenated hydrocarbons also sensitise the myocardium to endogenous and exogenous catecholamines, causing arrhythmias, predominantly ventricular, and sudden death due to ventricular fibrillation. Inhalation of oxidizing agents (nitrites and nitrobenzene) causes methaemoglobinaemia. Aside from carbon monoxide, gases of combustion may include hydrogen cyanide (from polyurethane, wool, silk, etc.) and irritant gases (nitrogen oxides, hydrogen chloride, sulphur dioxide, isocyanates, acrolein, ammonia etc.).

Toxic inhalants that are *both irritant inhalants and systemic poisons* also exist: for example, hydrogen sulphide, ozone, acetylene and some metal fumes.

Biologically *inert* gases are not toxic in themselves, but in high concentrations or in poorly ventilated rooms they displace oxygen from air and thereby cause hypoxia. Gases of this type are hydrogen, carbon dioxide, methane and liquid gas. Inhalation of *hot gases* may cause thermal burns to the mucous membranes of the entire respiratory tract; acute onset of laryngeal oedema may occur after a latent period of hours.

3.2.2 Eye exposure

Eye injuries affecting a number of persons are most likely to result from gases, vapours or dusts, although splashes of liquids into the eye may occur in an industrial accident or in a road or railway accident where the toxic substance is widely disseminated. Eye injuries in these situations will often be combined with skin lesions, respiratory tract injuries, or systemic poisoning.

Eye damage is usually the result of lachrymatory action, corneal epithelial injury or keratitis. These effects may be immediate or delayed. Some substances cause severe and deep injuries almost immediately, while others cause only superficial damage which is reversible.

3.2.3 Skin contact

Skin exposure to toxic agents may cause local injury alone, or local injury and systemic poisoning. Systemic poisoning may even be the only feature, as a result of absorption through intact skin. Although the skin is usually an effective barrier to toxic chemical absorption, intact skin behaves in a manner similar to other cellular membranes. Toxic agents penetrate the skin at rates determined by their lipid solubility: lipid-soluble substances are readily absorbed through the skin. Organic solvents used as vehicles for certain industrial chemicals may also enhance skin absorption. Inflammation, rubbing or other causes of increased skin blood flow will further increase chemical absorption. Skin damage seen, for example, in the case of corrosive burns may destroy the natural barrier properties of the skin. As a result, non-soluble lipid substances may be absorbed and cause systemic poisoning. Even a first degree burn may impair or destroy the barrier properties of the skin.

Damage resulting from skin-chemical contact is usually a chemical or corrosive burn, and may be classified in the same manner as thermal burns (see **Table 3.1**). Characteristic lesions are seen after acid or alkali burns. Only the superficial layers of skin are affected in mild cases of chemical burns due to these types of agent, while in severe cases all skin layers and possibly also the underlying tissue are damaged. Local damage is most often seen directly after skin exposure to the toxic agent, but in some situations the initial signs of local damage may be lacking although advanced local damage appears later. For example, phenol and phenol-like compounds initially anaesthetise the skin, thus masking the typical sign of local damage – pain. After skin contact with low concentrations of hydrofluoric acid solutions, initial signs of skin damage (and hypocalcemia) are lacking, but several hours later signs of skin damage and subcutaneous tissue damage appear. Fluoride ion penetrates the skin and interferes with cellular membrane calcium ions, causing cellular necrosis. Strong hydrofluoric acid solutions produce an immediate local skin burn.

Systemic poisoning after skin absorption through intact skin is most likely to occur following contact with lipid-soluble substances. Once skin absorption has occurred, clinical features of toxicity can appear after a symptom-free interval of minutes, hours or even days, depending on the type of damage and target organs. Features of central nervous system toxicity, such as excitation, convulsions, CNS depression and coma, appear soon after the exposure, as do cardiovascular signs of toxicity. Methaemoglobinaemia and hemolysis may also be early features of toxicity. Signs of renal and hepatic damage are not usually present until one, two or more days after exposure.

Table 3.1

Suggested classification of corrosive burns

For exposure to corrosive substances with skin damage, classification can be made according to the principles applying to thermal burn injuries.

Group 1 (life-threatening injury):
Dermal and full-thickness injuries exceeding 50% of body surface area.
Group 2a (severe injury):
Full-thickness injuries of 10-50% or dermal injuries of 20-50% of body surface area.
Group 2b (moderate injury):
Full-thickness injuries of 2-10% or dermal injuries of 10-20% of body surface area.
Group 3 (mild injury):
Full-thickness injuries of 2% of body surface area, or dermal injuries of less than 10% of body surface, or epidermal injuries.

3.2.4 Ingestion

Following ingestion of corrosive, oxidizing or coagulative substances, there is a risk of local injury to the gastrointestinal tract. Low-viscosity substances such as petroleum distillates of the kerosene type are associated with a risk of aspiration into the airway with consequent effects on the lungs. A risk of systemic poisoning after ingestion of a toxic substance is of course present if the substance is absorbed through the gastrointestinal tract.

Poisoning may also occur through the ingestion of chemically contaminated food or water, or even pharmaceuticals. Large numbers of victims may be involved.

Long-term exposure through placenta and mother's milk can occur due to environmental and food chain pollution with persistent toxic substances

3.3 First actions

3.3.1 Rapid identification of chemicals

An attempt should be made at once to identify the chemical(s) involved in the accident. Hospitals, poisons information centres and chemical emergency centres are among the organisations that should receive this information without delay, together with details on the type of accident (chemical spill, liquid or gas leakage, fire, etc.).

If the chemical(s) concerned have not been (or perhaps cannot be) identified, knowledge of the general category to which they belong (solvents, pesticides, irritant gases), together with information on the symptoms of the victims, can help responders decide on the appropriate course of action. In the case of fires, a number of combustion products may be formed (see **Table 3.2**).

Health care units should use the information provided on the chemicals involved, etc. to make an early determination of possible toxic effects and mechanisms (local or systemic toxicity, acute or delayed toxicity), as well as whether any specific therapy is relevant or whether symptomatic care will be sufficient treatment.

The health professionals at or near the scene of the accident should become part of the information chain. The information, which needs to be updated regularly, should contain:

- all the information available to first responders;
- the number and type of patients expected, and their degree of exposure;
- any new information concerning the type of chemicals involved and, where measured, the concentrations involved;
- additional medical information from poisons information centres and hospitals, such as symptomology, antidote therapy or specific treatment;
- the registration (triage) system used (for example, contamination, duration of exposure, current location, medical treatment already given).

Table 3.2

Examples of combustion products

Combustion product:	**Material:**
Carbon monoxide	Most materials
Hydrogen cyanide	Wool, cotton, silk, polyurethanes
Nitrogen oxides	Nitrocellulose, polyamides
Hydrogen chloride	Polyester resins (some) Polyvinyl chloride (PVC) Chlorinated hydrocarbons
Sulphur dioxide	Sulphur compounds, coal, mineral oil
Isocyanates	Polyurethanes
Acrolein	Petroleum products
Phosgene	Polyvinyl chloride
Ammonia	Polyamides, wool, silk, phenol resins
Hydrogen fluoride	Teflon (polytetrafluoroethylene) and other fluoride-containing compounds
Bromic acid	Bromine-containing compounds

3.3.2 Triage principles

Triage is a process that takes place both at the accident site, during transport, and at treatment facilities. It consists of the assessment and classification of the condition of the exposed persons, and of the designation of priorities for decontamination, treatment and transport to various treatment facilities.

Triage is a continuous process and must be carried out at regular intervals, taking into account the patient's condition and at what point in the treatment chain it occurs. A patient's condition may change dramatically when given a particular therapy, either improving or worsening. Or there may be a change in available resources.

Where there is no lack of resources (personnel, materials, medicines, transport vehicles, etc.) all injured persons should receive optimal care. However, in situations where resources are lacking, it may be necessary to withdraw therapy to severely injured persons, only giving them palliative treatment, in favour of less severely injured persons who are more likely to survive. In these situations, caring for one severely injured person could require so many resources that, as a result, a number of the less severely injured would not receive appropriate care.

Triage is a complicated process. It should in principle be carried out by the medically best trained and experienced personnel, both at the accident site and at treatment facilities. However, in situations where there is "only" a chemical exposure without complicating mechanical trauma injuries, all persons will have the same type of damage even though of different magnitudes. In such situations, it may be possible to give instructions to less thoroughly trained medical personnel in how to perform triage to facilitate caring for a large number of injured persons.

Classification for triage after chemical exposures follows the same principles as that for other types of accidents. Existing symptomatology is usually the basis for classification. However, one special "chemical group" can be identified: those exposed to a chemical who do not present immediate symptoms, but in whom severe symptoms might be present after a time delay for hours (for example, exposure to certain irritant gases like phosgene and nitrogen oxides, or skin exposure to chemicals being absorbed through the skin). These persons need proper observation and possible immediate treatment.

The grouping could be made as follows:

- patients with life-threatening injuries, who are in immediate need of treatment or transport;

- patients with moderate and severe injuries, who can wait for treatment or transport;

- patients with mild or no injuries, who are not in need of any treatment;

- severely injured patients, only in need of palliative treatment; and

- patients with no symptoms, but in whom delayed symptoms are to be expected, and who are therefore in need of observation, possible immediate treatment, and transport to treatment facilities.

Persons with hysterical reactions might need to be taken care of immediately and separated from others, to avoid spreading anxiety.

Life-threatening conditions are those affecting either respiration or circulation, directly or indirectly.

Acute respiratory impairment may be due to a blocked airway (tongue, foreign bodies, blood and secretions, laryngeal oedema) or severe pulmonary disorders (massive secretions, severe bronchospasm, impaired gas exchange). Interference of respiration on the cellular level (for example, poisoning due to carbon monoxide, cyanides, hydrogen sulphide) is also included here.

Acute circulatory impairment might be due to hypovolemia resulting from external or internal bleeding. Extensive burns, both thermal and chemical, may very soon lead to excessive fluid loss and hypovolemia. Relative hypovolemia and severe hypotension may be seen due to peripheral vasodilatation. Cardiodepression and severe arrhythmias are life-threatening conditions.

In order to facilitate triage a classification of certain types of injuries can be performed. Examples of such classification are given in Table 3.1 and **Table 3.3**.

As a rule, children are more sensitive to toxic substances (due to a more rapid metabolism and circulation, and less subcutaneous fat). They should normally, therefore, be given higher priority for medical care, along with other sensitive groups (such as pregnant women, the aged, and those with pre-existing health problems.

In the case of fires, the toxic and thermal damage may complicate the assessment and treatment of injured persons, as may also mechanical trauma associated with toxic exposure.

3.3.3 Treatment principles

The treatment of acute poisoning is based on four main principles that may be utilised to varying degrees, depending on the circumstances of the exposure and the characteristics of the toxic agent. These principles are: (i) the removal of the toxic agent to prevent further local damage or absorption into the body; (ii) symptomatic and supportive therapy; (iii) specific ("antidotal") therapy; and (iv) enhancement of (poison) elimination.

Maintaining vital functions (for example, by preventing airway obstruction, assisting ventilation, replacing fluid losses) is of obvious importance. Removal of the toxic agent to prevent further local damage or absorption into the body is also of crucial importance in the initial treatment of victims at a chemical accident site. However, decontamination should never be allowed to delay treatment aimed at maintaining vital functions and should preferably take place before transportation to hospitals or other treatment facilities. Symptomatic and supportive therapy is always applicable in the treatment of poisoning. In the majority of instances, this is the only type of treatment required to permit full recovery from poisoning.

As stated above, the classification of severity and treatment can be standardized, at least to a certain extent. Aside from first aid, there are instances where specific treatment with, for example, antidotes may profoundly influence the outcome of the poisoning. However, antidotal therapy is effective in reducing morbidity and mortality of only a limited number of types of poisoning (see Table 2.1). A universal antidote does not exist, and antidotal therapy should only be used where there are specific indications. It may, however, need to be started before the injured person is transported to a hospital or other treatment facility. In certain circumstances, it can be delegated to health care personnel with non-medical training – for example, instructions can be given that certain specific measures should be employed if victims show certain characteristic features of toxicity.

Following exposure to some chemicals, victims and equipment may become contaminated. When caring for the injured, the rescuer(s) may be contaminated if not properly protected or if the injured person has not been properly decontaminated beforehand. Transport vehicles may become contaminated, and sometimes unusable for long periods of time, if contaminated persons are transported in them. Similarly, large areas of hospitals may become unusable because of the presence of contamination. This may be the case, for example, when accidents involve ammonia, which is extremely pungent and persistent.

Procedures for decontamination of victims may include sluicing with copious quantities of water, the use of brushing-off powders, and removal of contaminated clothing. Contaminated clothing should be handled and disposed of safely (for example, in double plastic bags). These decontamination procedures should be carried out as soon as possible. In some emergency situations, decontamination may be an essential part of life-saving first aid. In some other emergency situations, decontamination may aggravate the injury or delay life-saving efforts. The decision whether to decontaminate a victim should be based on the type and severity of the injury and the nature of the chemical contaminants. If decontamination does not interfere with essential treatment, it should be performed. If decontamination cannot be performed, the victim should be wrapped in blankets, plastic, or rubber to reduce contamination of other personnel, and off-site emergency medical personnel should be alerted to the potential contamination, or to specific decontamination procedures.

3.3.3.1 Inhalation

In the event that irritant or toxic gases are inhaled, exposure should be terminated as soon as possible. Note that the rescuer may need protective clothing and a protective breathing mask.

Following exposure to *irritant gases*, the victim should rest, if possible in a semi-recumbent position to take account of the possibility of pulmonary oedema developing. Oxygen should be administered as soon as possible. Physical activity and hypoxia increase the risk of pulmonary oedema. Apart from optimal symptomatic and supportive therapy, including bronchodilators (by inhalation and systemically) and ventilatory support, see **Figures 3.1 and 3.2**.[1]

---

[1] Administration of corticosteroids by inhalation and systemically is sometimes recommended as soon as possible to minimize pulmonary damage. However, it should be noted that this therapy remains controversial and that no controlled studies to demonstrate its clinical efficacy are yet available.

Table 3.3

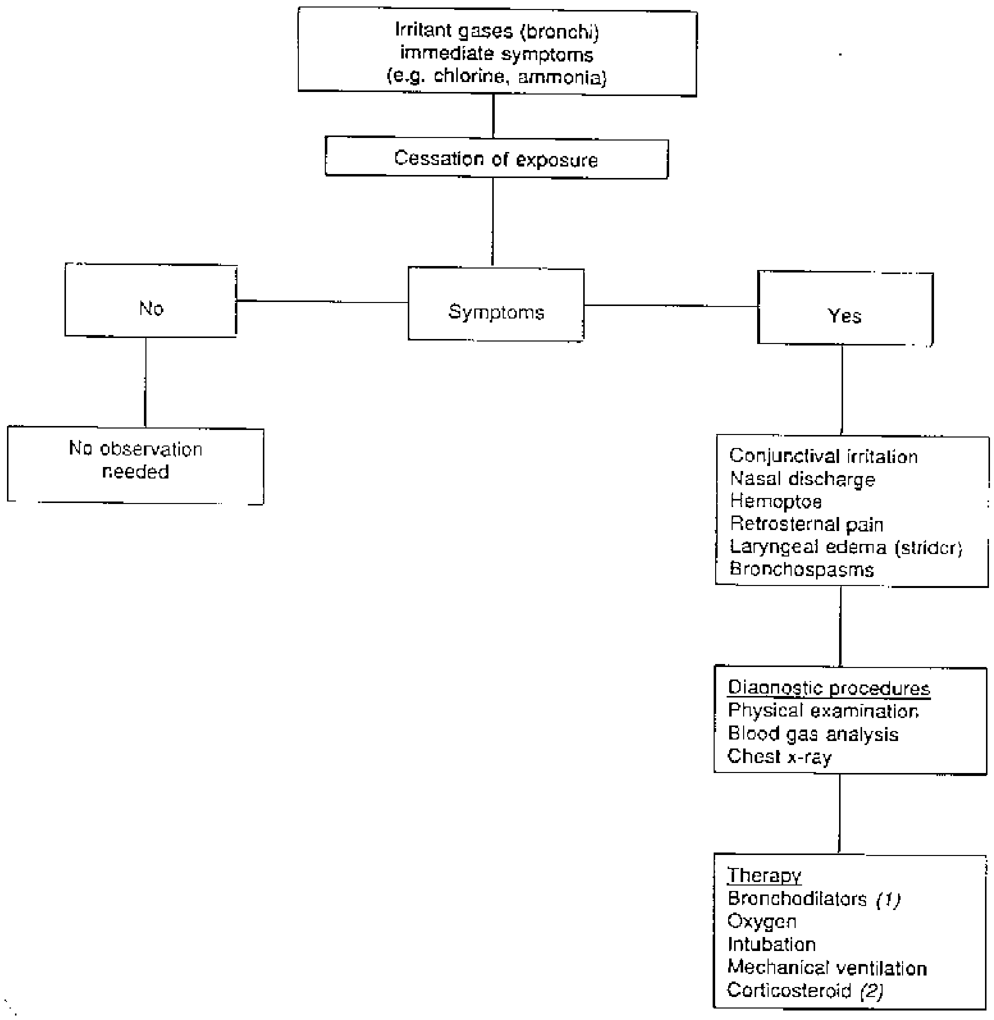
Classification of exposure to irritant gases

For exposure to irritant gases, the severity of clinical features of toxicity may be graded as follows:

Group 1 (life-threatening injury):
Injured persons with intense irritant-induced cough, respiratory insufficiency, and systemic effects.
Group 2 (severe injury):
Injured persons with strong irritant-caused cough, respiratory difficulties, but no systemic effects.
Group 3 (mild injury):
Injured persons with moderate or slight irritant-caused cough, eye symptoms/signs and, possibly, headache.

Figure 3.1

Inhalatory exposure to irritant gases - I

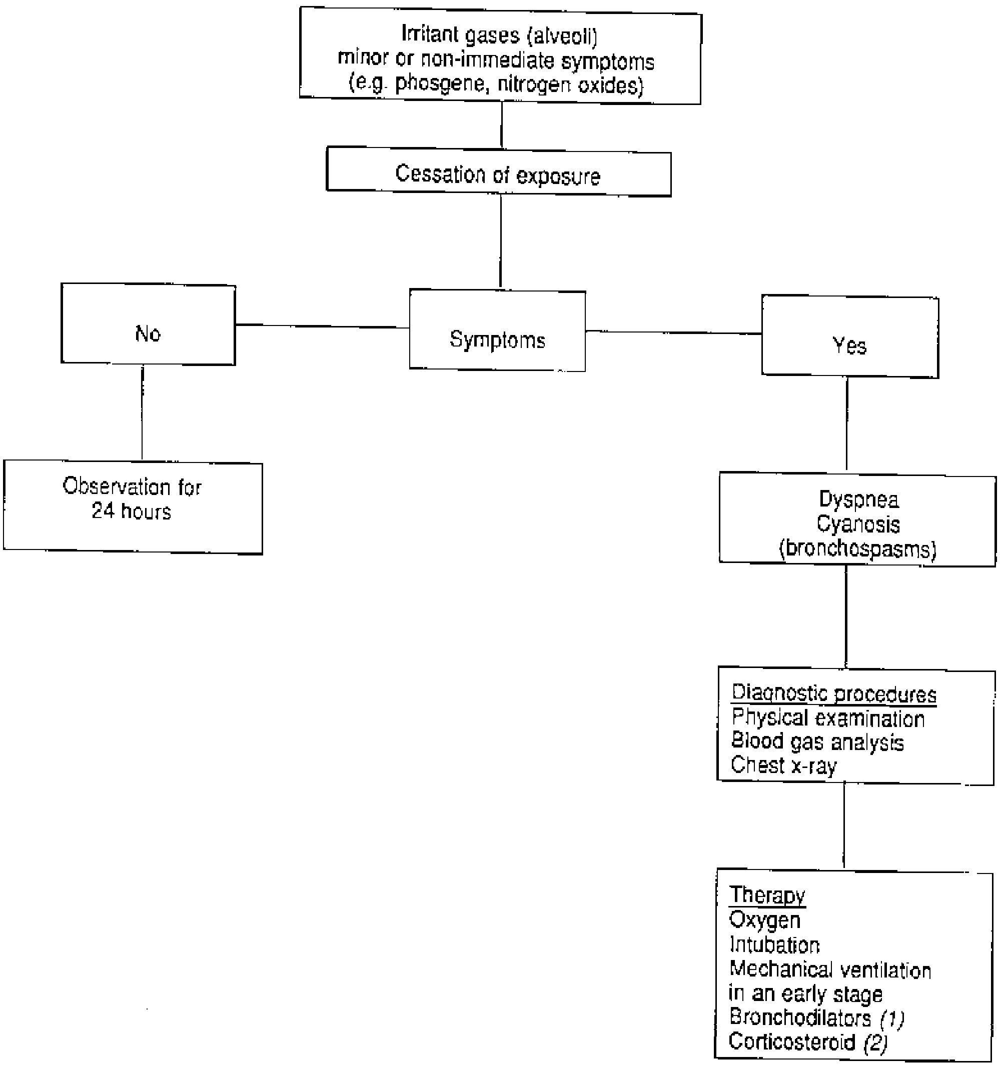


(1) Bronchodilators (xanthine derivatives, beta 2 adrenergic medicines).

(2) The role of corticosteroids is doubtful. No double blind, well evaluated study is known on the effectiveness of corticosteroids in inhalation toxicology.

Figure 3.2

Inhalatory exposure to irritant gases - II

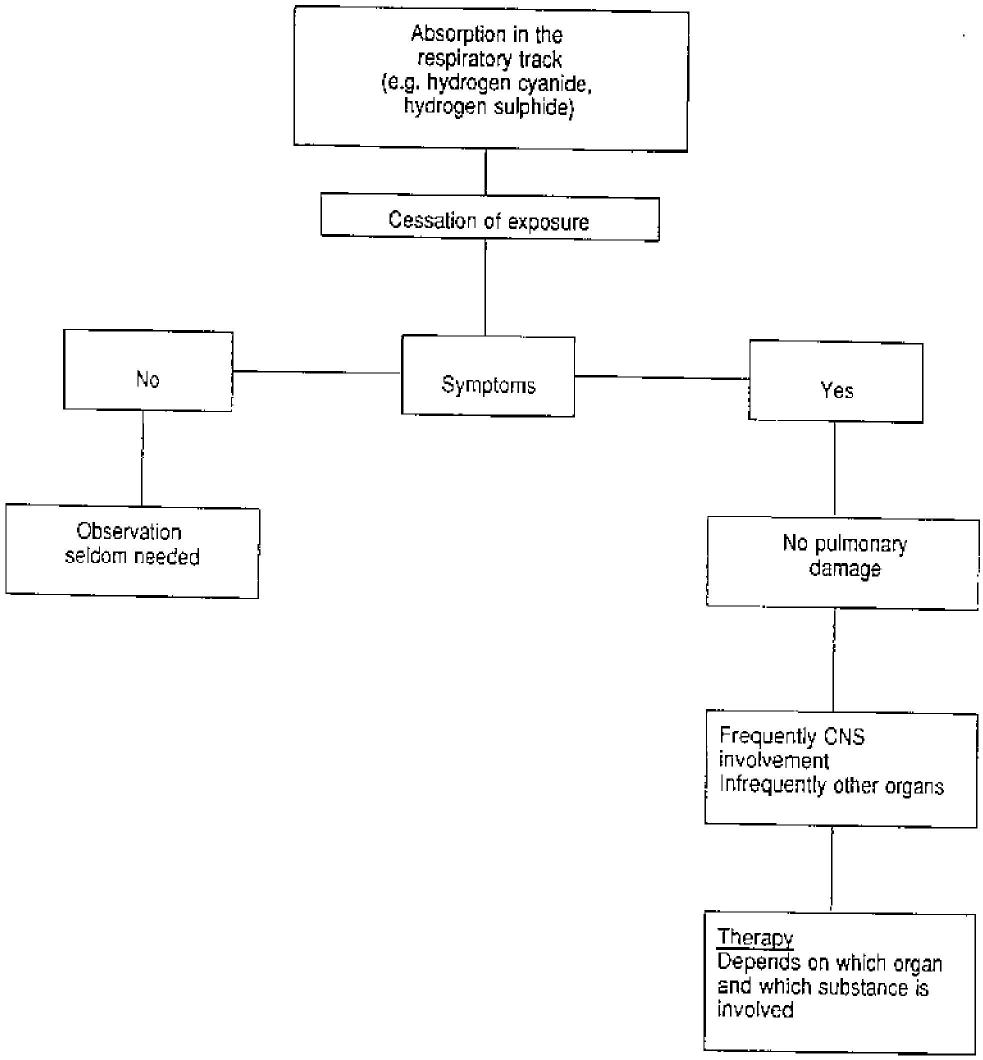


(1) Bronchodilators (xanthine derivatives, beta 2 adrenergic medicines).

(2) The role of corticosteroids is doubtful. No double blind, well evaluated study is known on the effectiveness of corticosteroids in inhalation toxicology.

Figure 3.3

Inhalatory exposure to toxic gases - III



Following exposure to gases that produce *systemic poisoning*, treatment should be guided by the specific toxicant inhaled and the victim's symptoms and signs of toxicity. If the victim is unconscious, oxygen should be given. In addition to being a form of supportive therapy, oxygen reduces the toxicity of carbon monoxide and probably that of hydrogen cyanide and hydrogen sulphide also. Additional specific treatment, such as antidotal therapy, is of critical importance in some types of poisoning such as that due to hydrogen cyanide, organophosphates, heavy metals and methaemoglobin-forming agents (nitrites, nitrobenzene) and should preferably, when applicable, be given promptly at the site of the accident (see **Figure 3.3**).

3.3.3.2 Eye exposure

Immediate or "first aid" decontamination of eyes should be carried out with the utmost speed, usually by flooding the exposed eye with water to reduce damage from surface exposure to chemicals. For continuing irrigation, ordinary tap water or physiological saline solutions are the first choices. Time should not be wasted in looking for special irrigation fluid. Despite the theoretical advantage of using special agents for neutralizing certain chemicals, this type of treatment has seldom provided a significant advantage over immediate irrigation with water or saline, both of which are usually much more readily available for first aid treatment.

It should always be determined whether the patients are wearing contact lenses. If so, they should be removed.

Beginning dilution and flushing as soon as possible after injury is especially critical following caustic exposure. Transportation to a hospital should not be considered as being more important than thorough on-site irrigation. As eye pain causes blepharospasm, the victim needs assistance in keeping the eyelids open. A topical anaesthetic will facilitate adequate eye irrigation and make the patient more comfortable. Common practice is to irrigate for 15-30 minutes to be sure of thorough cleansing. However, if the nature of the chemical contaminant is known definitely, the irrigation used should be adjusted accordingly. For severe alkali burns, irrigation should be continued for some time, initially for at least 15-30 minutes and repeatedly thereafter for several hours. For acid burns, irrigation should be performed for 15 minutes; for minor irritants, irrigation for a few minutes is usually sufficient.

All corrosive burns of the eye should be followed up by a formal ophthalmological examination.

3.3.3.3 Skin contact

Following exposure of the skin to toxic chemicals, flushing of *all* areas of potentially contaminated skin with copious amounts of water should be commenced as soon as possible. Contaminated clothing, shoes, wrist watches and jewellery should be removed to facilitate adequate flushing and saved in closed bags.

Note that *copious* amounts of water should be used, especially when heat production is likely to be pronounced, for example following application of water to strong acids such as sulphuric acid. Flushing with water should be continued for at least 15 minutes. Special provisions may need to be taken. Following exposure to yellow phosphorus, for example, the contaminated part of the body should be kept underwater or dressed with wet dressings, as yellow phosphorus ignites in the air.

After adequate flushing, the skin should be washed thoroughly with soap (non-abrasive) and water, especially where there is a risk of chemical absorption through the skin. After skin exposure to corrosives, the risk of severe fluid loss should be considered and, where appropriate, the victim should be given intravenous fluids at an early stage.

In some cases, application of an antidote to the skin is of crucial importance. For hydrofluoric acid burns, calcium gluconate gel should be applied. Fluoride ion is then bound to the calcium in a stable, inert complex, thereby preventing the fluoride ion from penetrating the skin and causing severe tissue damage and possible systemic poisoning. In the case of phenol, polyethylene glycol should be used as a cleansing solvent because phenol is poorly soluble in water. For yellow phosphorus, a mixture of potassium permanganate and sodium bicarbonate solutions (or copper solution) may be used to reduce the toxic effect.

3.3.3.4 Ingestion

Following ingestion of an unknown substance that may involve a risk of poisoning, some advocate giving the patient one to two glasses of water or a demulcent agent. Emesis should never be induced until it is certain that this measure is suitable. Emesis should never be induced in persons whose general condition is affected (circulation, respiration, consciousness), or if there is a risk of seizures, or following ingestion of corrosive substances or petroleum distillates (mainly of the kerosene type). In many cases, peroral administration of activated charcoal may be indicated to adsorb the toxicant, thereby preventing absorption from the gastrointestinal tract. Therapy is otherwise symptomatic and supportive, but in certain cases antidotal therapy may be indicated, for example in the event of intoxication with cyanides, organophosphates and arsenic.

3.3.4 Provision of medical assistance and decontamination

3.3.4.1 At the accident site

In addition to first responders from the police and fire services and from ambulance services (including paramedics), medical personnel may be sent to the accident site (see Section 2.3.3). In principle, medical personnel should never enter the accident area. They should always work in a safe place, well removed from this area.

The purpose of initial care at the accident site is to give victims needed treatment, so that they are in the best possible condition to be transported to a hospital or other treatment facility. This is especially important where they may have to be transported considerable distances, or in mass casualty situations where moving victims to treatment facilities may take a long time because of their large number.

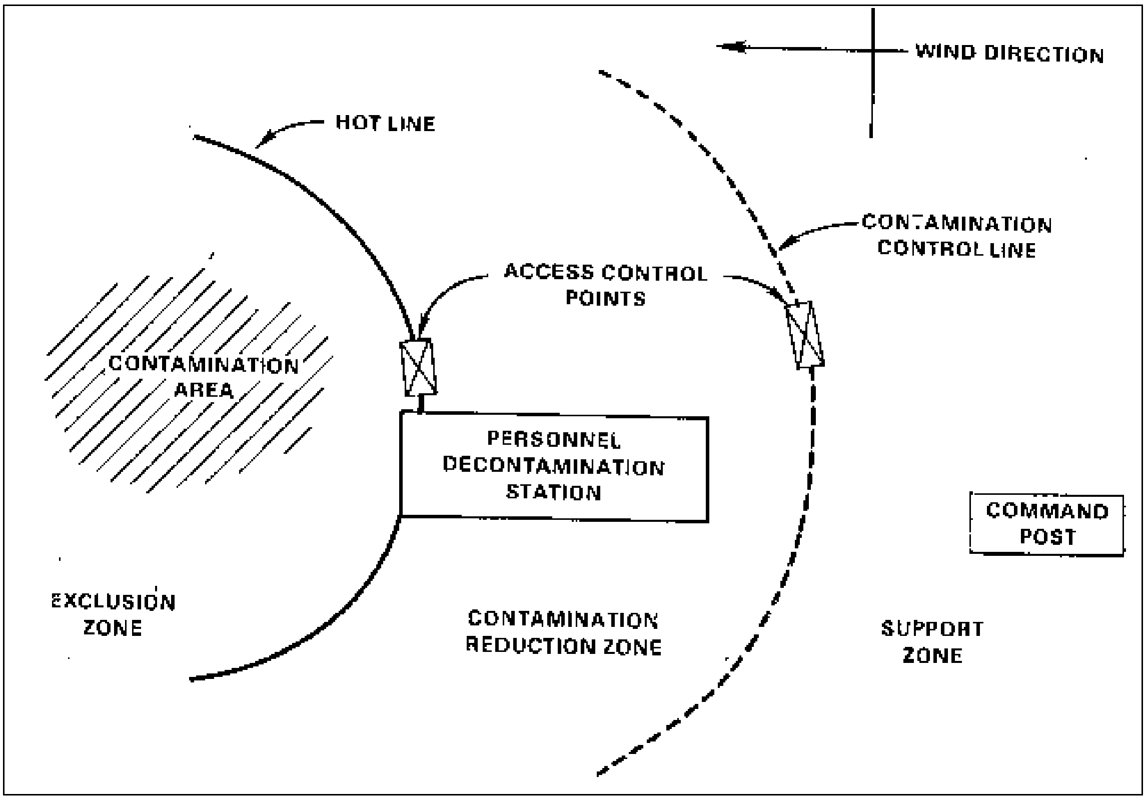
In addition to general first aid measures such as airway protection, giving of parenteral fluids, pain relief, skin and eye irrigation, etc., it may be justifiable in some cases to begin more specific treatment at the accident site. For this reason, special equipment, as well as antidotes and other drugs, should be available at the site.

Where decontamination is necessary, victims should always be adequately decontaminated before being taken to the casualty assembly point (see **Figure 3.4**). A decontamination station should be set up in the immediate vicinity of the point of access to the inner cordon, so that contaminated persons (and rescue personnel) can be sluiced liberally with water. Warm water should be used when possible, so that they do not become chilled unnecessarily. For this reason, plenty of warm water is needed at the accident site.

It is often best for personnel from rescue services/fire services to decontaminate victims before they are taken to an assembly point. The responsibility for setting up decontamination stations at the accident site needs to be allocated beforehand (probably to rescue or fire services).

Figure 3.4

Diagram of accident site work zones



Source: Standard Operating Safety Guides, US Environmental Protection Agency, 1988

Medical personnel may be required to assist in decontamination. In that case, it may be necessary for them to have personal protective equipment. They should be trained in the use of this equipment and in decontamination procedures (see Section 2.5).

Contaminated clothing, shoes, etc. should be removed as soon as possible. Therefore, clothes, blankets, etc. adequate for a large number of people need to be available. Preferably, victims should be decontaminated before they are moved to assembly points.

3.3.4.2 During transport

The transport of contaminated persons puts transport personnel at risk and may prevent the vehicle being used further until it can be decontaminated. Persons contaminated with volatile chemicals should not be transported by helicopter unless thoroughly decontaminated. Near crashes have resulted from adverse effects on flight crews during transport.

If contaminated victims need to be transported in emergency vehicles, appropriate precautions should be taken to protect both personnel and equipment. Such actions can include plastic wrapping of victims, plastic lining of the vehicle, leaving windows open, and use of CPCs (chemical protective clothing) by transport personnel.

According to their clinical features of toxicity, a priority classification can be made for the transport of victims to hospitals (or other treatment facilities). In the case of exposure to agents with a possible latent period prior to the onset of toxicity, those who were most exposed should be transported to hospitals for clinical observation. The hospitals will need to have adequate ventilation equipment.

Before and/or during transport, the receiving hospitals should be informed as far as possible of the general condition of the patients prior to their arrival. The hospitals can then obtain information about specific treatment from the relevant poisons information centre. Severely injured patients should be transported after initial stabilization, and some preliminary decontamination should be considered. Hospitals need to know in advance whether further decontamination needs to be performed.

During transport, initial therapy should continue (oxygen, ventilation, parenteral fluids, pain relief, etc.). Equipment for eye irrigation should be available in ambulances and other vehicles transporting victims exposed to chemicals. Decontamination personnel may also, of course, need to wear suitable protective equipment.

As victims may vomit while being transported, the necessary provisions should be taken to avoid spillage in the vehicle (for example, by having basins, towels, plastic bags or other containers available).

3.3.4.3 At hospitals and other treatment facilities

Hospitals and other treatment facilities need to put their emergency response plans into effect the moment they are informed that a possibility exists that accident victims will arrive. They can combine information received from the medical co-ordinator at the site with information from the poisons information centre. It is desirable that protocols supplied by the poisons information centre be followed, particularly if patients are taken to a number of hospitals.

Medical assistance teams can assist in the admission of groups of people. However, experienced teams of this nature do not exist in every country. It is important that any evaluation and treatment follow the same protocol for all patients.

Before a patient who has been exposed to chemicals is admitted to a hospital, decontamination should have been performed whenever necessary, preferably outside the emergency room. If a patient who has not been decontaminated following exposure to ammonia or phenol, for example, is brought into an emergency unit, this unit may be rendered unusable for a considerable period of time thereafter. Depending on existing ventilation equipment, other parts of the hospital may also become unusable.

A decontamination station should in most cases be connected with the emergency unit – for example, at the ambulance entrance or in a special room with separate ventilation and, if possible, with an air lock. It should also be possible to sluice patients while they are lying down. Clothing should be removed before or during sluicing and placed in, for example, plastic bags. Plenty of warm water is needed for this purpose.

For decontamination at a hospital, the staff should be equipped with protective equipment. The responsibility for setting up decontamination stations at hospitals and other treatment facilities should be allocated (probably to the relevant health authority).

Once patients arrive, continuity of treatment based on vital signs is the first priority. Following initial stabilization, a full clinical examination should be performed, as well as any additional investigations required (for example, X-rays, ECG, EEG, laboratory analyses). Samples should be taken for analysis in accordance with agreed protocols. Specific and supportive treatment should be continued.

In general, the treatment of victims exposed to chemicals follows generally accepted principles for the management of emergency situations. However, these principles need to be extended and adjusted to take account of special conditions that obtain following chemical accidents.

In cases of exposure to irritant gases, a large number of persons may require ventilation. The hospital should have made an inventory of available ventilators, or have determined where or how to obtain additional equipment, as well as personnel to perform manual ventilation. Plans should also be made for sending patients to other hospitals or facilities where this equipment is available, if necessary.

Following exposure to, for example, irritant gases, a number of relatively unaffected persons may need to be placed under observation for one or more days. Plans should be made for setting up suitable observation units in schools, hotels, etc.

In cases of exposure to corrosives, a large number of persons may require treatment for chemical burns. Plans that already exist for taking care of a large number of victims with thermal burns should then be implemented.

For a limited number of chemicals, specific antidotal therapy may be required following exposure. Emergency (disaster) stocks of antidotes should therefore be available in every region. Table 2.1 lists some antidotes and other drugs that may be of value in the event of a chemical accident.

If the hospital or other treatment facility, and/or the transport route from the accident site, lie within the accident area, it may be impossible to transport the injured for some time. Alternative premises such as schools, sports facilities, tents, etc. to which the injured may be taken, and where more or less advanced medical care can be provided until the hospital or other treatment facility can receive patients, should be planned for. A casualty assembly point (assembly point for the injured) can be designed to meet this need. Alternative transport routes should also be identified in advance.

If a hospital or other treatment facility lies within the accident area, it is important to be able to shut doors and windows, as well as to be able to shut off ventilation systems, immediately. This rule should be included in the local emergency preparedness planning of hospitals and other treatment facilities. In cases where a drifting gas cloud has passed, the premises should be aired before the ventilation system is restarted.

Where experience is limited or lacking, it is important to plan for taking samples at the most critical stage of accident response for later analysis (blood, urine, head space samples in case of exposure to solvents). If not planned for in advance, sample-taking may be forgotten. How it is to be carried out should be decided on a case-by-case basis. Initially, it is advisable to take two 10 ml. blood samples in heparin tubes. One of these should be centrifuged and the plasma separated. The plasma and the tube of whole blood should be frozen. Urine samples should also be taken, one portion of the diurnal urine being kept and frozen.

3.4 Psychological and psychiatric effects

Chemical accidents often have psychological and psychiatric effects, apart from the direct or indirect biological effects of toxic chemicals on the nervous system. These are related to the perception of the accident by either individuals or groups. Even if there has been no actual exposure, the *perceived* risk may cause stress reactions.

The general public has a tendency to consider all chemical substances as being extremely hazardous. Stress reactions to chemical accidents occur frequently, and may overshadow the importance of organic health effects. Experience has shown that a significant increase in stress-related psychiatric and psychosomatic symptoms may occur when there is a major environmental threat. The effects may be seen even many years after such an event.

Reactions to disasters may have the following common characteristics:

- uncertainty about the nature, extent and future implications of the accident – for oneself as well as family and friends;

- housing and job insecurity due to evacuation and/or the fear of contamination of homes, a drop in orders for local products, etc.;

- social rejection of those who are considered to be "contaminated";

- a media siege that may aggravate fears that the worst has happened; and

- cultural pressure related to often-conflicting public opinion on what to expect and how to behave (for example, in regard to whether exposed pregnant women will undergo an abortion).

3.4.1 Determinants of stress reactions

The stress reactions of the public will mainly be determined by three groups of variables:

- the characteristics of the accident itself;

- information about the accident and the manner in which this information is disseminated; and

- individual characteristics of those exposed to potential harm.

3.4.1.1 Nature and extent of the accident

The characteristics of an accident that may determine the reaction of individuals or groups include its scale, the substances involved, and the course of events. Some accidents have an obvious beginning or an acute phase. However, in other cases exposure (or the threat of exposure) to dangerous chemicals may have existed for some time before it became known to the authorities and/or the public.

3.4.1.2 Information and communications

Information concerning a potential health hazard may cause considerable alarm, even when it is unclear whether any real harm is likely to occur. The available information, and the manner in which it is communicated, may be important intermediate variables in determining subsequent reactions.

The information available concerning an emergency situation may shape the psychological reactions that ensue:

- Information available beforehand may result in a feeling of being threatened before an accident actually occurs.
- There may be a period of uncertainty and confusion following an accident.
- The public often suspects that official information is coloured by political and/or economic interests.
- There may be a problem with understanding what is meant by measured concentrations, threshold levels, etc. of (toxic) chemicals.
- There may be different perceptions of whether the situation is under control.

If a chemical emergency occurs, official information should be disseminated regularly (see Chapter 1). This is particularly important in view of the following:

- Information circulated through informal communications networks in, for example, schools, factories and companies is usually received in the early stages following an event, is often inaccurate, and may cause marked stress reactions;
- Most major chemical accidents receive extensive media coverage. While such coverage can be a valuable source of information for the public, there is a risk that inaccurate or contradictory information may aggravate the situation.
- The public may not pay attention to information at the time it is disseminated by the media, or may not be able to find this information when they need it.
- Information may also be transmitted through telephone services. Such a service can be an important supplement to the media. It provides information on request, thereby adding to the individual's sense of control.

3.4.1.3 Personal characteristics

Personal characteristics may determine the reaction of various groups. For example:

- Personal involvement (severity of personal injury or loss, amount of warning received, opportunity to control events or to escape) is obviously one of the most significant factors;
- Rescue workers and their direct helpers may be prone to moderate or severe stress reactions.
- Parents of young children are usually among those at risk for stress reactions.
- Persons with pre-existing mental health problems (15-20 per cent of the average population) are also at risk for stress reactions.

- Level of education, general coping skills and, in particular, emergency preparedness through education, training or experience (see Chapter 4) are some of the factors that may affect psychological reactions.

3.4.2 Features of stress reactions

Depending on the type of accident, stress reactions may have these specific features:

- *Acute reactions:* Some persons exhibit maladaptive behaviour such as immobilizing fright, emotional breakdown, uncontrolled fright, or irresponsible heroic behaviour. A more common type of reaction in the acute phase is emotional stunning. This type of reaction usually leaves goal-directed behaviour more or less intact. It may last from hours to days after the accident.

- *Intermediate reactions:* In the first weeks to months after a serious traumatic event, symptoms of post-traumatic stress are common. These include: intrusive memories of the event (for example, nightmares), sleeping problems, irritability and heightened startle response, depressed or anxious mood, and feelings of guilt.

- *Late and chronic reactions:* Independently of whether symptoms have been present in the acute phase, a chronic stress syndrome may emerge, sometimes not until years after an event. Such a chronic syndrome is especially likely to occur in cases where exposure to chemicals involves a long-term threat to health, for example after exposure to dioxins. This syndrome has several features in common with the post-traumatic syndrome described above. Non-specific somatic complaints, often related to hyperactivity of the adrenergic system, may be more prominent, as may be hostility and distrust. Such chronic reactions may be complicated, and may be sustained by the fact that victims are often met with social rejection because they are considered to be "contaminated".

3.4.3 Recommendations

Preparation for emergency response should include the identification of groups at risk for stress reactions, as well as an assessment of information available to the public and means of communicating it. In high-risk areas, epidemiological data and internationally accepted instruments for the assessment of mental health impact should be available so that monitoring activities can begin immediately.

Plans should be in place for keeping the public informed during the different stages of an emergency. In high-risk areas, there should be detailed plans for putting an information network in operation as soon as it is needed. A telephone service for use by the public should be established, as well as a plan for communicating with the public through the media (see Chapter 1).

Emergency teams who deal with the aftermath of an accident involving exposure (or the risk of exposure) to toxic chemicals should preferably include a psychologist or psychiatrist who will perform the following tasks, among others:

- provide emotional support to rescue workers and the friends and families of victims;
- collaborate closely with information services;
- assist in screening activities for mental health problems in risk groups; and
- assist in setting up a network for treatment of cases of stress reaction.

In most cases, mental health treatment should be organised through existing mental health facilities.

3.5 Accident follow-up

Short-term and long term follow-up of victims exposed to toxic chemicals may be of importance from both the therapeutic and scientific point of view. For this reason, proper registration of *all* persons exposed, regardless of whether or not they have (or have had) symptoms, is of vital importance.

The onset of symptoms following exposure to chemicals may be delayed for hours or even days. It may be necessary to seek out these individuals in different ways so that adequate observation and, where necessary, adequate treatment can be given.

From the scientific point of view, short-term and long-term follow-up of those exposed to chemicals and evaluation of the accident are essential. For many chemicals, little or no information is available regarding their effects on human health. Any experience it is possible to obtain is therefore of the utmost importance. Even in the case of exposure of small groups, it is important to gather and evaluate data for use in epidemiological studies in the future.

3.5.1 Initial activities

Samples for biological monitoring of exposed individuals or groups of individuals should be taken immediately, or as soon as possible during initial response. In the case of chronic or intermittent exposure, it is advisable to take biological samples during or immediately after exposure has ended. If the initial samples are not taken, it may be impossible to assess later whether individuals were exposed or not, making follow-up and epidemiological studies difficult if not impossible. The importance of active fact-finding during the initial stage should therefore be stressed.

Environmental samples form the basis for assessment of the exposure when it is not possible to take biological samples from all exposed humans. Sampling of the environment (water, food, air, soil) is needed in order to study the sources and routes of exposure. The history of environmental pollution – the time sequence of events – can provide useful information for the decision-making process, especially in determining how long and in what ways the population has been exposed to the agent.

Epidemiological studies should be planned carefully, as they are often time-consuming and expensive. Decisions made in the initial phase will determine the future follow-up. These decisions may be made based on limited information, which may make planning difficult. The exposed group and comparison groups for epidemiological studies should be selected so that the contrast with the exposure time is maximised.

3.5.2 Post-disaster follow-up

In the case of intermittent exposure, environmental monitoring can be extremely helpful. The history and time sequence of pollution can be explored, for example by sediment analysis of lakes or rivers for surface water pollution. This provides a good basis for historical exposure assessment.

Animals can be used as a sentinel for environmental disasters. For example, in the Minimata disasters cats developed "cat dancing disease" before humans became ill. Biological monitoring of animals can be carried out by veterinarians.

Casualties can be followed up, based on information from hospital admission records. It is more difficult to follow up those who have been exposed but do not have symptoms, or who have not received treatment. In the case of agents causing long-term effects (for example, cancer), follow-up should be organised and relevant population groups should be established for comparison with those exposed, in order to be able to study the incidence of outcome in relation to the exposure. The follow-up should be discontinued at a stage where the cost-benefit ratio of the follow-up becomes unacceptable.

Follow-up is expensive, but in the long run it can be cheap compared to ignorance. Without adequate follow-up, one can find oneself in a hopeless situation of frustrating attempts to investigate the effect of an accident on human health without any relevant data. Funding mechanisms for accident studies are lacking in most countries, and much relevant data for follow-up have therefore been lost.

National and local governments, and industry associations and companies, need to be aware of the great importance of follow-up studies and of the need to start collection of information and samples from the outset, in the event of an accident occurring. This will require not only financial but also organisational resources, for example making technicians and facilities available. Follow-up accordingly needs to be provided for at the planning stage. Funding agencies should be encouraged to regard follow-up studies in poorer countries as projects that deserve support.

3.5.3 Accident recording

Health and other types of information related to each chemical accident should be recorded in an appropriate, harmonized manner in order that others can learn from the experience. Such information should include a description of the event, including quantities, chemicals and conditions, any relevant measurements made in quantitatively assessing the exposure, and a summary of the number of exposed and injured persons, any health treatments given, the response, and long-term effects.

4. Health-related Training and Education for Chemical Accident Prevention, Preparedness and Response

4.1 Introduction

For those in the health field as well as other parties, training and education play a very important part in chemical accident *preparedness and response* (see also Chapter 1, "Health-related Information and Communications Needs", and Section 2.2 on the organisation of chemical accident response). National and international programmes such as UNEP's Awareness and Preparedness for Emergencies at Local Level (APELL) process provide training in the implementation of agreed joint emergency response plans. Training should be conducted periodically, at least once a year for professional groups. New personnel should receive training as soon as practical.

Appropriate training and education can also play an important part in accident *prevention*. For example, workers who are aware of potential risks to life and health are more likely to be safety-conscious. The implications for those in the health field are that they need to consider their role, not only in training their own personnel (both in their professional responsibilities and in understanding the responsibilities of other professionals), but also in contributing to the training of others.

4.2 Groups to be trained and educated, and parties who should take part in training and education

Training and education should be geared to the educational level of each group being trained or educated. The following groups need to be given various types and levels of training and education:

4.2.1 The community

People living in the vicinity of chemical installations and other workplaces where chemicals are handled have the right to know about the risks involved with chemicals. They should also be trained in how to react in emergency situations.

These people need to be told what to do in case of chemical emergencies, for example chemical spills, ruptures of large chemical containers, or sudden releases of gas or vapour. Training and education should emphasize avoidance of exposure or any type of direct contact with chemicals, through staying indoors with windows or air intakes (vents) closed and the mouth and nose covered by a wet towel.

In view of the variations in the educational level of the general population, it is evident that information should be presented in a simple, comprehensive and appealing way. Video presentations, illustrated booklets or flyers, and similar materials may be appropriate means of providing basic information on how to react in cases of emergencies involving chemicals. The use of the media in disseminating such information (for example, through local or regional television programmes) may be appropriate under certain circumstances.

Various parties should contribute to the preparation of educational materials for the general public, including not only members of the health professions and volunteer organisations like the Red Cross, but also public authorities, non-governmental organisations (NGOs), and civil defence and rescue services.

The responsibility for ensuring that appropriate information is being provided to the public lies with the local, state/regional, or national public authorities. However, where public authorities are not able to fulfil this responsibility completely due to, for example, resource limitations, they should be able to rely on industry (including major chemical users) to participate in training and education. The division of responsibility between public authorities and industry in this regard should be clearly defined.

Industry should prepare information in advance for dissemination in the potentially affected area in the event of an accident. This information ought to include what people can do on their own, and how they should behave during an emergency. Local installations where people from the potentially affected area work should provide this type of information in advance of any potential accident. This can also be done when the concentrations of toxic substances are just over threshold levels, without there being a need for direct action. In such a case, explanations need to be supplied concerning the meaning of threshold levels and, occasionally, of preventive measures.

4.2.2 Workers

Workers have the right to be educated regarding the potential hazards of chemicals, as well as regarding appropriate preventive measures. In addition to information on how to avoid different types of chemical emergencies, they should be supplied with information on how to react in emergency situations.

The training and education of workers should be provided on different levels and using various means. Upon employment, workers in chemical installations and other workplaces where chemicals are handled should be given extensive initial training highlighting the types of chemical hazards involved, the consequences of exposure, how to avoid dangerous levels of exposure, and the actions to be taken by individual workers and their supervisors in emergencies. Such training should be well organised and presented in an interesting manner, making use of different means including lectures and video presentations. Such training should not be a one-time-only event; refresher courses should be given at regular intervals.

Worker training should also include practical exercises under conditions of simulated chemical accidents. In addition, simple charts showing clearly the major preventive measures and the steps to be taken by the workers in the event of chemical accidents (and other types of acute exposure) should be made available and displayed in such a way as to draw workers' attention.

Provision of training to workers is the responsibility of the employer.

At facilities where they exist, occupational health and safety (OHS) specialists have an important role to play. Health professionals should be prepared to advise and assist these specialists, where they exist, and otherwise to advise industry management on how to incorporate health information into the safety training of workers.

4.2.3 First responders

First responders (such as the police, fire and ambulance services, and in some areas the coast guard) should at a minimum be made familiar with: the characteristics of different types of chemical accidents; protective measures, including the use of protective clothing and equipment; contamination hazards; decontamination indications and procedures; specific first aid measures; and the potential psychological/psychiatric effects of major chemical accidents on victims and on those taking part in emergency response.

Detailed information should be provided concerning: the chain of command at the accident site; how the various organisations and authorities work together in an emergency situation; and the identification, triage and initial treatment of victims.

Again, education should not be restricted to the provision of information by different means, but should include regular practical exercises at different levels covering single aspects such as first aid or decontamination procedures, as well as simulations of both small-scale and large-scale chemical accidents. Simulation training exercises should be directed towards situations involving the specific chemicals manufactured, stored or transported in the area.

Regular in-service education should be arranged, in order to keep this information up-to-date and supply specific information on standard operating procedures in the local area.

It is the responsibility of the management of emergency response services to see that their personnel are fully trained. Members of the health professions should, however, be prepared to advise and assist where necessary.

4.2.4 Medical personnel and other health professionals

Concepts of mass casualty management and specific information on chemical emergencies should be part of the training of physicians, nurses and paramedics from the earliest stages, covering both theory and practice. Health professionals should be made familiar with: the chain of command at and during a chemical emergency; models of in-hospital command and control; the identification of decontaminated and non-decontaminated patients; the use of triage; the psychological reaction of victims, emergency responders and the public; and the methodology for diagnosing and treating a large number of potential patients. Personnel with responsibility for decontamination of victims should be adequately trained in decontamination procedures and the use of CPCs (chemical protective clothing) and appropriate respiratory protection devices.

Background material for this type of training and education should consider the needs of the group of health professionals addressed. The provision of background material will require the participation of specialists from different medical sub-disciplines. Specialists from poisons information centres, chemical emergency centres, and other emergency centres should be involved.

Regular in-service education should be arranged by health authorities in order to keep this knowledge up-to-date and supply specific information on standard operating procedures in local areas.

Staff at poisons information centres, chemical emergency centres and other emergency centres should receive regular updating of information and should ensure that they receive this updating by whatever means are appropriate. Industry and public authorities should provide assistance in this regard.

4.3 Joint training and exercises

In addition to the training and education of the groups mentioned above, it is very important that all those with specific responsibilities in chemical emergency response should receive joint theoretical and practical training in the use and implementation of jointly agreed national and international emergency response plans. This will enable them to practise their skills, and to become familiar with taking part in a broad co-operative effort to respond to a chemical accident. It is of great importance that those with responsibilities in the event of a chemical accident are personally acquainted, and that they are used to working effectively with one another. This can only occur with comprehensive planning and training involving all key personnel.

Training should include communications exercises, small-scale (hospital and emergency service) response exercises, and full-scale simulations involving industry, health professionals, emergency services, and others with responsibilities in this area such as civil defence services and military authorities.

The medical aspects of on-site as well as off-site emergency response plans should be tested under simulated conditions. Unannounced tests of the total plan or relevant parts of the plan should be carried out, even under adverse conditions. Attention should be given to specific elements of the plan, such as: the availability of equipment; the availability of needed information; and the availability of communications between, and the co-ordination of, various parties.

Following each exercise, a full evaluation and critique should be made and the findings circulated to all the parties concerned.

Training in the implementation of plans should be scheduled regularly in order to allow well trained response teams to maintain their effectiveness at all times.

The trainers themselves need to be properly trained and kept up-to-date. Video presentations, films and other audiovisual aids, and case studies/accident analysis reports could be used to make training more effective. Lessons learned from the evaluation of exercises, and from the investigation of actual accidents or near-misses, should also be included.

Public authorities at all levels could provide training and course materials, including audiovisual materials, to trainers in order to facilitate their work.

Industry should take a leading role in implementing joint training and exercises, and could provide resources for these activities.

Annex:

Chemical Hazard Identification Systems

First responders to a chemical accident need to know right away the chemical(s) involved, the associated hazards, and first aid measures. Much basic information on chemical hazards can generally be found on *safety data sheets and transport emergency cards*. Often the information most immediately available on hazards is found on *labels and placards*, the focal point of which is the United Nations Substance Identification Number and United Nations Hazard Classification. In addition, to provide rapid initial information on chemical hazards and appropriate response actions, some countries have adopted a *hazard grouping system*.

Each of these methods of identifying chemical hazards is discussed below.

Safety data sheets and transport emergency cards

Identifying the chemical(s) involved in an accident is not always simple. Chemical releases within installations may be readily recognised and identified from the chemicals used and processes employed at the installation, unless they are products of chemical reactions or of thermal decomposition. Concerning chemical releases from transport accidents, the necessary information should be made available by the responsible personnel (either owners or operators of the transport vehicle), or it should be obvious from shipping documents, safety data sheets, or placards and symbols on containers. Nevertheless, for various reasons first responders may have great difficulty identifying the substances released and, in fact, may not even recognise the hazards unless there is a sensory cue such as a strong, pungent odour or eye and skin irritation.

In some countries, Material Safety Data Sheets (MSDSs) containing basic information are legally required to accompany each product supplied to an end-user. MSDSs are intended primarily for the employers of people handling the product, so that they in turn may disseminate the information to their employees. MSDSs are not necessarily intended for emergency responders, but they can be used by scientific staff to advise the emergency responders.

MSDSs have existed for many years in a wide variety of formats, with a broad range of data quality and quantity. The IPCS and the European Community produce such cards (ICSCs, or International Chemical Safety Cards). They are translated into several languages and include: identification of the substance and manufacturer; chemical composition; information on hazards; first aid information; firefighting measures; accidental release measures; handling and storage information; exposure control and protection measures; physical and chemical properties; stability and reactivity; and toxicological information. They also contain ecological, disposal, transport, regulatory and other information.

An ICSC card is shown in **Figures A.1 and A.2**. When used together with additional information, such as that setting out first aid measures, MSDSs are a valuable source of general information for follow-up procedures beyond the initial action level. Before they can be utilised fully by response teams, however, they may require expert interpretation.

Additional, more detailed information may be carried by a vehicle driver. Within the European Community, regulations require that written emergency instructions be carried in the vehicle cab. The European Chemical Industry Council (CEFIC) has produced a series of instructions called TREMCARDS. There are currently approximately 800 of these cards covering chemical substances, grouped substances having similar properties, and mixed loads of packaged goods. A typical TREMCARD is shown in **Figure A.3**.

The emergency instructions provided supply:

- information on the nature of the danger inherent in the substance carried, and safety measures that need to be taken to avert it;
- action to be taken and treatment to be given to persons coming into contact with the substances carried;
- measures to be taken in the event of fire;
- measures to be taken in the event of breakage or deterioration of packages of the substance(s) carried, particularly in the case of spillage following a road traffic accident; and
- an emergency contact telephone number for specialist advice.

The TREMCARD is written using internationally agreed, standard sentences with approved translations.

Labels and placards

When accidents occur on-site at production facilities, adequate information and technical expertise are generally readily available. At storage facilities or reprocessing plants, however, information may be restricted to product labels, supported by additional information such as data sheets. The transport of chemicals presents situations with perhaps the greatest accident potential and greatest difficulties in accident response. Lack of information concerning the chemical(s) involved, and problems in rapidly locating experts familiar with them, can exacerbate these difficulties.

A focal point of most information systems for hazardous substances is the globally recognised United Nations Substance Identification Number, together with the United Nations Hazard Classification. Although limited in scope, this system can provide basic facts about the substances involved in an accident while more substantial information is being sought. The UN Hazard Classification contains nine numeric groups, as listed in **Table A.1.** Each hazard class is represented by a warning diamond. Examples are shown in **Figure A.4**.

Figure A.1

International Chemical Safety Card (front)

SULPHURIC ACID

ICSC: 0362

CAS # 7664-93-9
RTECS # WS5600000
ICSC # 0362
UN # 1830
EC # 016-020-00-8

Oil of vitriol
H_2SO_4
Molecular mass: 98.1

HAZARD SYMBOLS
Consult national legislation

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Not combustible. Many reactions may cause fire or explosion.	NO contact with flammable substances.	NO water.
EXPLOSION			In case of fire: keep drums, etc., cool by spraying with water but NO direct contact with water.
EXPOSURE		AVOID ALL CONTACT!	IN ALL CASES CONSULT A DOCTOR!
☐ Inhalation	Sore throat, cough, laboured breathing.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest, half-upright position, artificial respiration if indicated, and refer for medical attention.
☐ Skin	Pain, serious skin burns.	Protective gloves, protective clothing.	Remove contaminated clothes, rinse skin with plenty of water or shower, and refer for medical attention.
☐ Eyes	Pain, severe deep burns.	Face shield or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
☐ Ingestion	Severe pain, vomiting, shock.	Do not eat, drink, or smoke during work.	Rinse mouth, give plenty of water to drink, do NOT induce vomiting, and refer for medical attention.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Evacuate danger area, collect leaking liquid in sealable containers (extra personal protection: complete protective clothing including self-contained breathing apparatus).	Separated from other materials (see Notes), store in stainless steel containers.	Unbreakable packaging; put breakable packaging into closed unbreakable container. UN Haz Class: 8 UN Pack Group: II FURTHER INFORMATION ON LABELLING: *Consult national legislation*

ADDITIONAL INFORMATION

Figure A.2

International Chemical Safety Card (back)

IMPORTANT DATA	**PHYSICAL STATE; APPEARANCE** COLOURLESS, OILY HYGROSCOPIC LIQUID, WITH NO ODOUR. **CHEMICAL DANGERS:** On combustion, forms toxic fumes (sulphur oxides). Upon heating, toxic fumes are formed. The substance is a strong oxidant and reacts violently with combustible and reducing materials. The substance is a strong acid, it reacts violently with bases and is corrosive to most common metals forming a flammable gas (hydrogen — see ICSC # 0001). Reacts violently with water and organic materials with evolution of heat. **OCCUPATIONAL EXPOSURE LIMITS:** TLV: 1 mg/m^3 (as TWA); 3 mg/m^3 (as STEL) (ACGIH 1989-1990). PDK: 1 mg/m^3 (USSR 1980). **ROUTES OF EXPOSURE:** The substance can be absorbed into the body by inhalation of its aerosol and by ingestion.	**INHALATION RISK:** Evaporation at 20°C is negligible; a harmful concentration of airborne particles can, however, be reached quickly by spraying! **EFFECTS OF SHORT-TERM EXPOSURE:** The substance is very corrosive to the eyes, the skin, and the respiratory tract. Corrosive on ingestion as well. Inhalation of an aerosol of this substance may cause lung oedema (see Notes). **EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:** Lungs may be affected by repeated or prolonged exposure to an aerosol of this substance. Risk of tooth erosion upon repeated or prolonged exposure to an aerosol of this substance.
PHYSICAL PROPERTIES	Boiling point (decomposes): 340°C Melting point: 10°C Relative density (water = 1): 1.8 Solubility in water: Miscible Vapour pressure, kPa at 146°C : 0.13 Relative vapour density (air = 1): 3.4	
ENVIRONMENTAL DATA	Possible harmful effects to aquatic life due to acidity.	

NOTES

The symptoms of lung oedema often do not become manifest until a few hours have passed and they are aggravated by physical effort. Rest and medical observation is therefore essential. NEVER pour water into this substance; when dissolving or diluting always add it slowly to the water. Store in an area having corrosion resistant concrete floor.

Transport Emergency Card: TEC (R)- 10b
NFPA Code: H 3; F 0; R 2; W

ADDITIONAL INFORMATION

Figure A.3

TREMCARD

[redacted]

Class 3 ADR
Item 3b

CARGO **CYCLOHEXANE**

- Colourless liquid with perceptible odour
- Immiscible with water
- Lighter than water

NATURE OF HAZARD

- Highly flammable (flash-point below 21 C)
- Volatile
- The vapour is invisible, heavier than air and spreads along ground
- May form explosive mixture with air particularly in empty uncleaned receptacles
- Heating will cause pressure rise with risk of bursting and subsequent explosion

BASIC PERSONAL PROTECTION

- Goggles giving complete protection to eyes
- Plastic or rubber gloves
- Eyewash bottle with clean water

IMMEDIATE ACTION BY DRIVER Notify police and fire brigade

- Stop the engine
- No naked lights. No smoking
- Mark roads and warn other road users
- Keep public away from danger area
- Keep upwind

SPILLAGE

- Shut off leaks if without risk
- Use explosion-proof electrical equipment
- Contain or absorb leaking liquid with sand or earth or other suitable material
- Prevent liquid entering sewers, basements and workpits; vapour may create explosive atmosphere
- Warn everybody - explosion hazard
- If substance has entered a water course or sewer or contaminated soil or vegetation, advise police

FIRE

- Keep container(s) cool by spraying with water if exposed to fire
- Extinguish preferably with dry chemical, halones, waterspray or foam
- Do not use water jet

FIRST AID

- If substance has got into the eyes, immediately wash out with plenty of water for several minutes
- Remove soaked clothing immediately
- Seek medical treatment when anyone has symptoms apparently due to inhalation

Additional information TELEPHONE

33
1145

COPYRIGHT BY CEFIC Prepared by CEFIC from the best knowledge available; no responsibility is accepted that the information is sufficient or correct in all cases

[redacted]

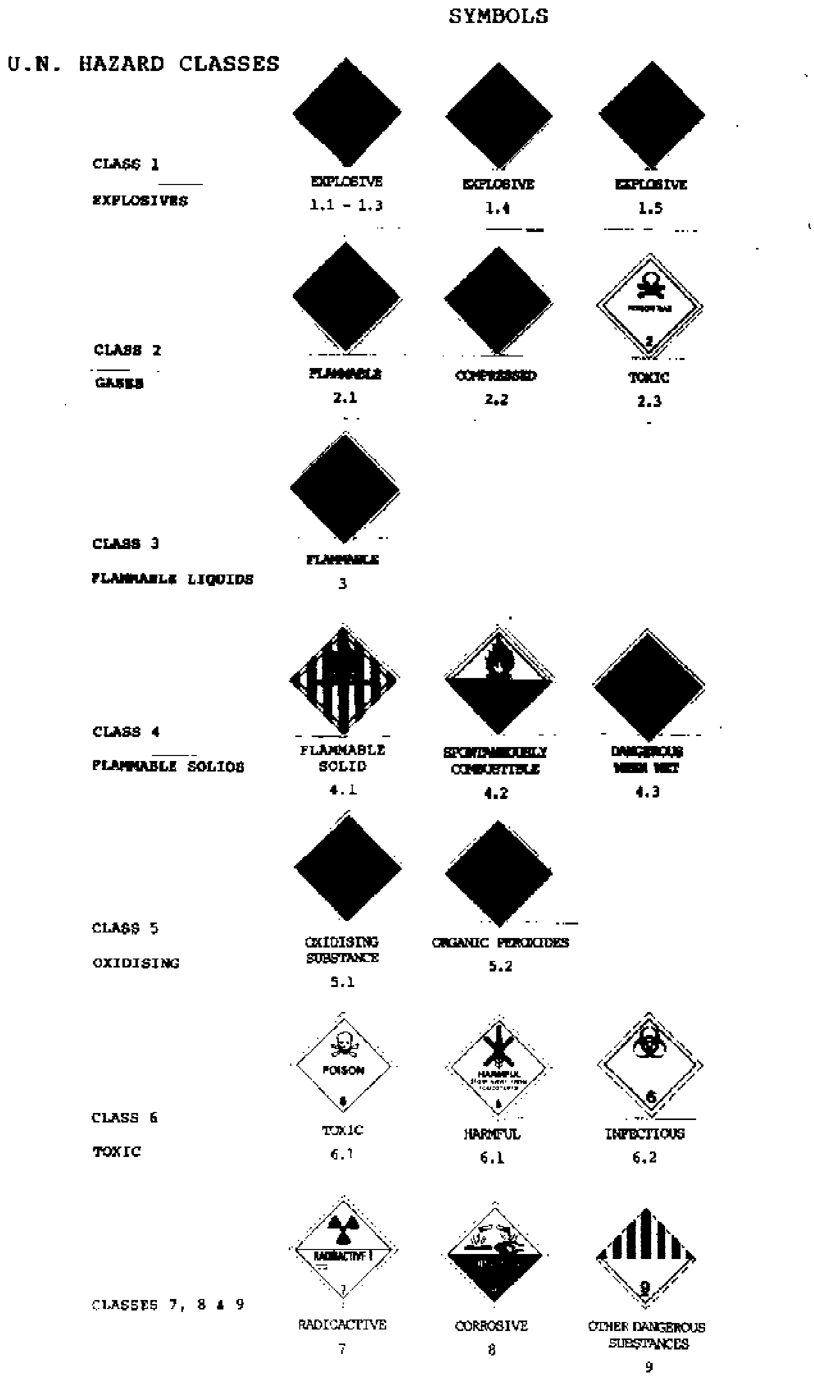
Table A.1

UN Hazard Classification

UN Class		Hazard Type
1		Explosives
	1.1-1.5	Mass explosion hazard ... ... Very insensitive substances
2	2.1	Flammable gases
	2.2	Non-flammable non-toxic gases
	2.3	Toxic gases
3		Flammable liquids
4	4.1	Flammable solids
	4.2	Spontaneously combustible substances
	4.3	Substances dangerous when wet
5	5.1	Oxidizing substances other than organic peroxides
	5.2	Organic peroxides
6	6.1	Poisonous (toxic) substances
	6.2	Infectious substances
7		Radioactive substances
8		Corrosive substances
9		Other dangerous substances

Figure A.4

UN Hazard Classification warning diamonds



During transport of chemicals, particularly in bulk quantities (for example, >3000 litres), vehicles should bear placards that can be seen at a distance from all angles. Such placards should display, as a minimum, a UN warning diamond indicating the principal hazard class of the substance being carried. This information can be supplemented by additional information, such as the UN Substance Identification Number, additional hazard identification, or even an initial action response code to aid prompt action by fire and other emergency services should the vehicle be involved in an accident. The information on the placards can also provide the basis for obtaining more detailed information from computer information systems or from the manufacturer of the chemical.

The product label can be regarded as the initial source of information, always assuming of course that it is not too damaged to be read. The information provided on the label should include a proper shipping name with information on hazard, risk and safety precautions. For example, the labelling of chemical products originating within the European Community is bound by a series of Directives requiring specified information to be displayed, including code numbers/phrases relating to risk and safety, which has been agreed to throughout the twelve Member States. **Figure A.5** shows such an EC product label.

It is very important that any information displayed on a vehicle be readily understandable by anyone likely to respond. In this regard, it should be recognised that an educational programme is a prerequisite for introducing any such substance and hazard identification scheme.

The placard shown in **Figure A.6** is used on vehicles within Europe. It shows a Hazard Identification Number (HIN) above a UN Substance Identification Number.

The Hazard Identification Number is based on the UN Hazard Classification, where the first digit indicates the primary hazard as follows:

2 Gas
3 Flammable liquid
4 Flammable solid
5 Oxidizing substance
6 Toxic substance
8 Corrosive

Explosives and radioactive materials are not covered by this scheme.

The second and third figures (secondary hazards) are:

0 No meaning

1 Explosive risk

2 Gas may be given off

3 Flammable risk

5 Oxidizing risk

6 Toxic risk

8 Corrosive risk

9 Risk of violent reaction from spontaneous decomposition or self-polymerisation

Where the figures for the primary and secondary hazards are the same, an intensification of the primary hazard is indicated. Where the code is preceded by an "X", the use of water is prohibited. Thus the placard in the figure indicates that:

- the substance is potassium metal (UN Substance Identification Number);
- it is a flammable solid which may give off a gas which is flammable; and
- it must not be allowed to come into contact with water.

Another placarding system adopted in some countries incorporates a simple two or three character (emergency action) code, as shown in **Figure A.7**. The placard specifies the first aid action to be taken by emergency

By reference to the associated HAZCHEM card, most commonly available within the fire service, it can be seen that the code provides such information as:

- whether the spillage should be washed away or contained;
- what fire extinguishing agent should be used;
- whether there is a risk of violent reaction;
- whether there is a need to evacuate the area; and
- what protective clothing to wear.

Hazard grouping systems

Some countries have adopted a "grouping" procedure as a method of providing rapid initial identification of chemical hazards and response actions. This procedure is based on selecting physical and chemical properties of substances. Each grouped emergency response guide, which can be presented as an information sheet, is allocated a reference number. This procedure has the advantage of dealing with large numbers of chemicals while using relatively few data sheets.

The grouped response guides are designed for initial response only: they provide generic rather than specific information. Each numbered data sheet relates to a United Nations Substance Identification Number.

Regrettably, the way this classification system is drawn up allows for over- or under-grouping of the chemicals. Furthermore, the group number allocated to specific chemicals by one organisation may be unrelated to the number assigned by another organisation. As a consequence, it is necessary to ensure that a group number quoted in relation to a UN number is referred to the appropriate source document by the user. This is particularly important in countries using different documentation systems.

Currently, the only known link between a response guide number and its corresponding information is the Group Text TREMCARDS produced by CEFIC. In this case, the first digits relate to UN Hazard Class. For example, "30G30" identifies a Class 3 flammable liquid, followed by Group Text sequential Number 30.

A grouped response guide publication prepared by the Canadian Transport Emergency Centre (CANUTEC) is shown in **Figure A.8**. Similar grouped guides have been produced by the United States Department of Transportation and by the Danish Fire Service.

Figure A.5

EC product label

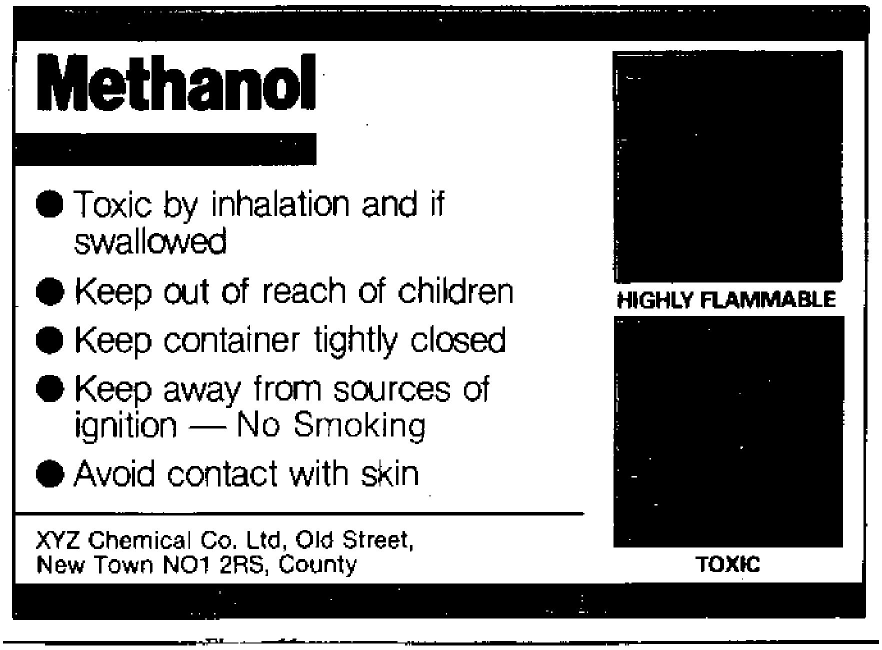


Figure A.6

European placard

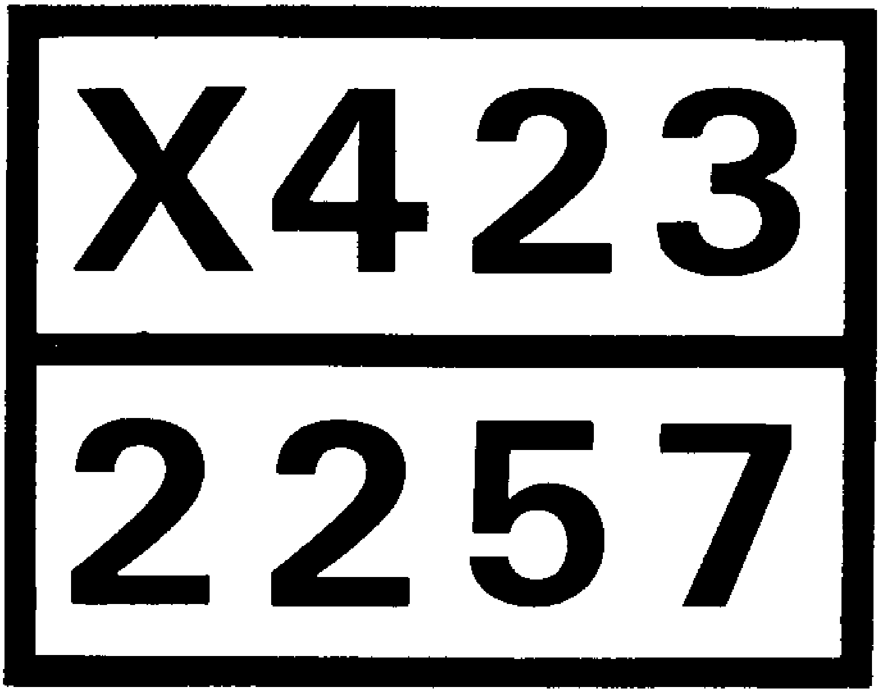
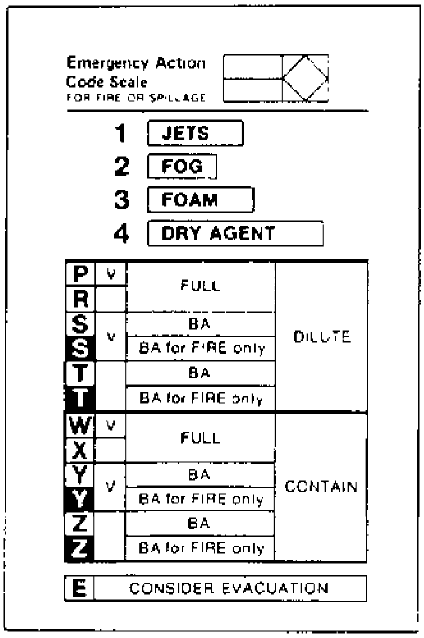


Figure A.7

Placard with emergency action code and HAZCHEM card



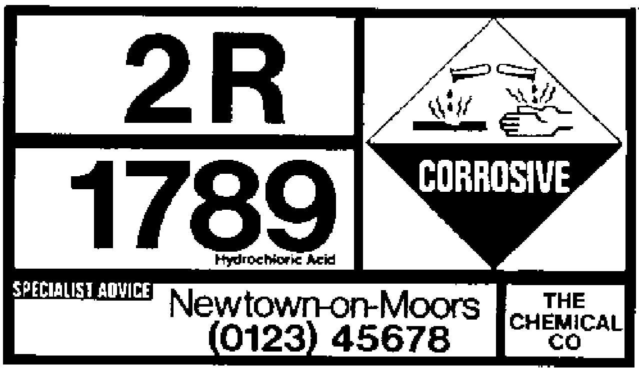


Figure A.8

Grouped response guide

Potential Hazards

Fire or Explosion

- HIGHLY FLAMMABLE: Will be easily ignited by heat, sparks or flames.
- Vapours will form explosive mixtures with air.
- Vapours may travel to source of ignition and flash back.
- Most vapours are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks).
- Some may decompose (E) or polymerize (P) explosively when heated or involved in a fire.
- Many liquids are lighter than water.
- Containing vessels may explode when heated.
- Vapours from runoff may create explosion hazard indoors, outdoors or in sewers.

Health

- Poisonous, may be fatal if inhaled, swallowed or absorbed through skin.
- Inhalation or contact with substance may irritate or burn skin and eyes.
- Fire will produce irritating, corrosive and/or poisonous gases.
- Runoff from fire control or dilution water may pollute waterways.

Public Safety

- IMMEDIATELY CONTACT CANUTEC (613-996-6666, collect)
- Spill or leak area should be isolated immediately for at least 25-50 m in all directions. • Keep upwind. • Keep unauthorized personnel away.
- Keep out of low areas.
- Ventilate closed spaces before entering.

PROTECTIVE CLOTHING

- Wear SCBA and fully-encapsulating, vapour-protective clothing recommended by the manufacturer or CANUTEC when handling these substances.
- Structural firefighter's protective clothing is not effective for these materials.

EVACUATION

Large Spill

- Consider initial downwind evacuation for at least 300 m.

Fire

- When any large container (including rail and road tankers) is involved in a fire, consider initial evacuation for 1000 m in all directions.

For general information, call CANUTEC (613) 992-4624

Emergency Response

Fire

Caution: All these products have a very low flash point: Use of water spray when fighting fire may be inefficient.

Small Fire • Use dry chemical, CO_2, alcohol foam or water spray.

Large Fire • Use water spray, fog or alcohol foam. • Do not use straight streams. • If without risk, move undamaged containing vessels or packages from fire area.

Fire Involving Tanks or Car/Trailer Loads

- Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. • When impossible, immediately withdraw from hazard area and let burn.
- Cool containing vessels with flooding quantities of water until well after fire is out.
- Do not get water inside containing vessels.
- Withdraw immediately in case of rising sound from venting safety devices or discolouration of tank.
- ALWAYS stay away from tank ends.

Spill or Leak

- ELIMINATE all ignition sources (no smoking, flares, sparks or flame in immediate area). • All equipment used when handling the product must be grounded.
- Do not touch or walk through spilled material. • Stop leak if without risk.
- Prevent entry into waterways, sewers, basements or confined areas.
- A vapour suppressing foam may be used to control vapours.
- Absorb with earth, sand or other non-combustible material and transfer to container.
- Use clean non-sparking tools to collect absorbed material and place it into loosely covered plastic or fibreboard containers for later disposal.
- Water spray may be used to knock down vapour clouds.
- DO NOT GET WATER INSIDE CONTAINING VESSELS.
- Contact CANUTEC for assistance on disposal.

First Aid

- Remove victim to fresh air. • Apply artificial respiration if victim is not breathing. • Administer oxygen if breathing is difficult. • Do not use mouth-to-mouth method if victim ingested or inhaled the substance; use the Holger Nielsen method (back pressure-armlift) or proper respiratory medical device.
- Remove immediately contaminated clothing and shoes. • In case of contact with material, immediately flush skin or eyes with running water for at least 15 minutes. • Keep victim warm and quiet.
- Obtain immediate medical care.
- Ensure that attending medical personnel are aware of identity and nature of product(s) involved, and take precautions to protect themselves.
- Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed.

For general information, call CANUTEC (613) 992-4624

CHECKLIST FOR ACTION

NOTE: This Checklist is intended for use by those with overall managerial responsibility for chemical accident contingency planning and implementation, and for liaison with other responsible parties in various areas. The Checklist follows the general structure of the Practical Guides, which can be consulted for detailed information as appropriate.

1. *Health-related information needs, systems and services*

1.1 Have information needs (for example, the parties who may need information and the types of information they are likely to need) been considered, planned for and tested as part of the emergency planning process, i.e. in advance of a chemical accident actually occurring? (See Sections 1.1 and 1.2 of the *Practical Guides*.)

1.2 Do you know how to obtain immediate expert advice in the event of a chemical accident? Has contact been established with your national or local/regional poisons information centre (PIC) or national chemical emergency centre, if either exists?[1]

1.3 Has consideration been given to the use of computerised databases and information systems? Some of these can be accessed at no charge; others are available commercially.[2] If you have access to databases or information (for example, computer modelling) systems, have the appropriate personnel been trained in their use?

1.4 Has a system been established for collecting and updating relevant information from manufacturers concerning chemical products? Is the information provided (for example, on Material Safety Data Sheets) adequate for: (i) health and environmental protection? (ii) decontamination? (iii) first aid? (iv) treatment and follow-up of victims? (v) site clean-up? and (vi) disposal measures?

1.5 Is relevant health and environmental information available concerning hazardous chemicals stored, handled or transported in your country or region? Has a system been established for collecting and updating relevant information on the storage, handling and transport of such chemicals?

---

1 See the joint OECD and UNEP IE/PAC *International Directory of Emergency Response Centres* (1991), and the "Yellowtox" *Directory of Poisons Information Centres* (1993), published jointly by IPCS and the World Federation of Poisons Information Centres.

2 See, for example, *Users Guide to Hazardous Substance Data Banks Available in OECD Member Countries* and *Users Guide to Information Systems Useful to Emergency Planners and Responders Available in OECD Member Countries*, both published by OECD in 1991. These Users Guides are available in English, French and Spanish.

1.6 Is there a harmonized hazard classification and labelling system for chemicals in your country? Is such a system applied at all storage and processing facilities, and during the transport of chemicals?

1.7 Has a system been established for updating information on health facilities that would be available in the event of a chemical accident and the services they provide, including laboratory services?

1.8 Has a pro forma reporting system been developed for use by the officer in charge at the site of an accident to enable relevant details about the accident, including health and environmental impacts, to be collected systematically? Is there a mechanism for accident follow-up? Is there a mechanism to allow information from such a reporting system, and from accident follow-up, to be used in the evaluation or updating of emergency plans?

1.9 Is there a system in place for managing communications during an emergency: (i) between specialised information centres and personnel at the accident site? (ii) with and between health facilities? and (iii) with the media and the public? Have these plans been tested under accident simulation conditions?

2. Health-related organisation and planning

Organisation

2.1 Do members of the health professions include possible chemical accidents in their emergency planning? Is health-related chemical emergency planning integrated into overall emergency planning in your country or region?

2.2 Has each local public health authority been told who has the responsibility (for example, local government or civil defence) for co-ordinating overall on-site and off-site awareness and preparedness plans? Are these local public health authorities part of a local awareness and preparedness programme (for example, with a poisons information centre, or through APELL[1] or a similar programme) that includes the identification and evaluation of chemical hazards in the community?

2.3 Bearing in mind differences in local conditions, has the value of establishing contacts with military medical services in regard to chemical emergency awareness, preparedness and response been considered?

[1] For a brief description of UNEP IE/PAC's APELL programme, see page 10.

2.4 Have hospitals and other treatment facilities developed an adequate system for (standardized) patient identification and documentation in the event of a chemical accident?

Communications

2.5 Within the health field, have the chain of command and lines of communication in the event of a chemical accident been established as part of the planning process? Has consideration been given to the need to create a co-ordinating team or command group which would be located at the perimeter of the accident site? Are there mechanisms for co-ordination between medical personnel and rescue services?

2.6 Do emergency plans include the provision of adequate means of communication in the event of a chemical accident, i.e. radio, telephone, fax, pager, or any combination suitable to local circumstances?

2.7 Do plans include guidance for emergency telephone operators concerning the health aspects of chemical accidents? Does this guidance also give instructions on how to obtain from the initial informant the maximum possible information needed by health professionals?

2.8 Do plans provide for information (for example, on relevant medical treatment and local medical resources) to be available to first responders as soon as possible at the scene of an accident? Is there a system for registering emergency workers in the accident area?

2.9 Do plans provide for direct communication between medical personnel and other experts at the accident site and at treatment facilities?

Planning

2.10 Do hospitals and other treatment facilities in the area have Major Accident Plans? Do these plans take account of the possibility of large-scale chemical accidents and their special requirements (for example, particular medicines and equipment and a record of those medical practitioners in the area with experience in toxicology and intensive care)?

2.11 Do plans provide for determining the accident area, and the area where exposed patients will be dealt with at the treatment facility, so that contamination of medical personnel can be avoided?

2.12 Has the identification and evaluation of chemical hazards in the area been carried out? Have local public health authorities actively sought information on potential hazards from local industry?

2.13 Does a co-ordinated chemical emergency plan exist for the area? Are local health authorities and health professionals contributing to this plan? Do emergency medical plans mesh with the emergency plans of other services (for example, local government, civil defence, emergency rescue services, etc.)? Do they link with the activities of poisons information centres and/or national chemical emergency centres, where these exist?

2.14 Do plans provide for a "winding down" procedure, so that the withdrawal of various groups of personnel can be co-ordinated?

2.15 Do plans consider the need for veterinarians, for example where animals might be used as "sentinels" for human exposure?

Medicines and emergency equipment

2.16 Have arrangements been made to ensure the availability of adequate quantities of the medicines (including antidotes), medical equipment and protective clothing likely to be required in the event of a chemical accident? Has consideration been given to the best place to store them? Is their condition checked regularly? Have arrangements been made to maintain equipment and replace outdated medicines?

Follow-up and evaluation

2.17 Are health professionals involved in plans for the investigation of chemical accidents, for the purposes of analysis, corrective action and improved training?

2.18 Are local health authorities and health professionals contributing adequately to the evaluation of emergency response performance?

3. Health-related response to chemical accidents

First actions

3.1 Do plans provide for initial care and medical evaluation of possibly exposed persons by health professionals at the accident site?

3.2 Do health-related planning and training draw attention to the need to set priorities, according to the nature and extent of the accident, between life-saving first aid, decontamination, and commencement of antidotal therapy?

3.3 Do plans provide for the setting up of decontamination stations at the site of the accident, for adequate supplies of warm water for decontamination, and for the distribution of clothes and blankets to those whose contaminated clothing has had to be removed?

3.4 Do plans provide for the setting up of temporary treatment stations in cases where it may not be possible to transport the victims to a hospital or other treatment facility for some time? Have alternative transport routes been identified for use where the usual transport route from the accident site lies within the accident area? Do hospitals' plans include preparedness measures in case they are within the accident area (for example, shutting off of ventilation systems)?

3.5 Do vehicles for the transport of victims to hospitals or other treatment facilities have suitable equipment, such as ventilators and eye irrigation equipment?

3.6 Do hospitals have adequate provision for decontamination stations?

3.7 Are poisons information centre protocols available at hospitals or other treatment facilities, to ensure consistent treatment of similarly affected patients?

3.8 Have plans been made for taking and recording samples from patients?

3.9 Do hospitals have an inventory of ventilators? Does the hospital staff know where to obtain additional equipment and trained personnel quickly or, alternatively, where to transfer patients to receive this treatment?

3.10 Do existing Major Accident Plans contain provisions for the treatment of large numbers of patients with thermal burns that can be put into effect if a chemical accident produces victims with this type of injury?

3.11 Have plans been made to set up observation units, for example in schools or hotels, over a period of several days?

3.12 Do hospitals and other treatment facilities have enough stores of antidotes and other medicines to take care of a large number of persons exposed to chemicals?

Psychological and psychiatric reactions

3.13 Do plans provide for inclusion of psychological and/or psychiatric expertise?

3.14 Do plans include provisions for:

- identification of groups at risk for stress reactions?
- assessment of information available to the public, and of networks through which this information is likely to pass?
- immediate monitoring of stress reactions?
- providing the public with up-to-date information at different stages of the emergency, including through a telephone information service?

3.15 Has the need for psychological support of rescue workers, and the friends and families of victims, been given adequate consideration?

Accident follow-up

3.16 In addition to samples from patients (see 3.8 above), do plans provide for taking environmental samples?

3.17 Has consideration been given to the planning of epidemiological studies?

3.18 Has the need for veterinarians been considered in case animals are used in accident follow-up?

3.19 Has consideration been given to the follow-up of those who have been exposed but do not have symptoms, or those who may not have not received treatment and therefore have not been regarded as casualties?

4. *Training and education*

4.1 Is there in your community a programme of public training and education in what to do in the event of a chemical emergency? Are you doing all you can to encourage industry to accept responsibility for organising this programme? Are local health personnel contributing fully to these activities?

4.2 Are members of the health professions available to advise and assist occupational health and safety specialists or industry management in regard to the inclusion of information on emergency situations in the health and safety training of workers?

4.3 Are members of the health professions available to advise and assist rescue service managers in the initial training and regular in-service education of rescue service personnel?

4.4 Are regular in-service programmes arranged to keep health professionals' knowledge up-to-date in this area, and to supply specific information on local emergency procedures?

4.5 Are all those health professionals with specific responsibilities in chemical emergency response receiving joint (i.e. including all services involved in chemical accident response) theoretical and practical education in the use and implementation of jointly agreed emergency response plans? Does this training cover information gathering and local emergency information systems? Have the medical aspects of on-site and off-site plans been tested under simulated conditions? Have the results of such tests been evaluated and disseminated? Are the lessons learned from these evaluations fed back into the training process?

4.6 Are there adequate curricula for different professional groups who may have to deal with chemical accidents?

4.7 Are there sufficient human resources (i.e. teachers) to implement such curriculae? Do these teachers receive regularly training related to chemical accidents?

BIBLIOGRAPHY

Bibliography: Health Aspects of Chemical Accidents

Although this Bibliography is not exhaustive, it could be of use in locating relevant publications or more detailed information on topics addressed in the guidance documents. A few of the references are annotated.

The references have not been organised into categories. They are listed in alphabetical order, and under authors' names (rather than, for example, the names of the responsible agencies or organisations) where available.

Ackermann-Liebrich, U.A., Braun, C. and Rapp, R.C. (1992) Epidemiologic Analysis of an Environmental Disaster: The Schweizerhalle Experience. *Environmental Research* 58, 1-14.

Agency for Toxic Substances and Disease Registry. See United States.

Aldous, J.C. (1991) *Chemical Hazards and Health: The Role of Public Health Physicians*. London School of Hygiene and Tropical Medicine, UK. (Policy report submitted for an MSc in Community Medicine.)

Alexeef, George V., et al. (1989) Problems associated with the use of Immediately Dangerous to Life and Health (IDLH) values for estimating the hazard of accidental chemical releases. *Am Ind Assoc Journal* 50(11), 598-605.

APPEN (Asia-Pacific People's Environment Network) (1987) *The Bhopal Tragedy – One Year After*. Sahabat Alam Malaysia, 37 Lorong Birch, 10250 Penang, Malaysia. (Contains interviews with victims and doctors and transcriptions of documents, including letters and minutes giving information about treatment of victims.)

Australian Counter Disaster College (1988) *Toxic Chemical Accidents*. Australian Counter Disaster College, Mount Macedon, Victoria, Australia. (Papers and recommendations from a symposium held at the College on 5-9 October 1987.)

Barbera, Joseph et al. (1991) *Critical Care Clinics* 7(2). (Various articles covering disaster management; man-made disasters; search, rescue and evacuation; assessment of pre-hospital and hospital response in disaster.)

Barbera, Joseph A. and Cadoux, Claude G. (1991) Search, Rescue and Evacuation. *Critical Care Clinics* 7(2).

Barrier, Geneviève (1989) Emergency medical services for treatment of mass casualties. *Critical Care Medicine* 17(10).

Baxter, P.J. (1986) From Flixborough to Bhopal: is legislation enough? *British Journal of Industrial Medicine* 43, 1-5.

Baxter P.J. (1990) Responding to Major Toxic Releases. *Annals of Occupational Hygiene* 34(6), 615-620.

Baxter, P.J. (1990) Review of major chemical incidents and their medical management. In: V. Murray (ed.) International Congress and Symposium Series No. 155: *Major Chemical Disasters – Medical Aspects of Management.* See V. Murray (ed.).

Baxter, P.J. (1991) Major chemical disasters – Britain's health services are poorly prepared (leading article) *British Medical Journal* 302, p. 61.

Baxter, P.J., Davies, P.C. and Murray, V. (1989) Medical Planning for toxic releases into the community: the example of chlorine gas. *British Journal of Industrial Medicine* 46(4), 177-285.

Beech, J.W. (1985) Planning for Emergencies. Symposium on Industrial Accidents and the Risks to the Community. *Chemistry and Industry* 13, 436-437.

Bertazzi, Pier-Alberto (1989) Industrial disasters and epidemiology. *Scandinavian Journal of Work, Environment and Health* 15, 85-100.

Binder, S. (1989) Deaths, injuries and evacuations from acute hazardous materials releases. *American Journal of Public Health* 89, 1042-1044.

Boer, Jan de (1990) Definition and classification of disasters: introduction of a disaster severity scale. *Journal of Emergency Medicine* 8, 591-595.

Borak, J., et al. (1991) *Hazardous Materials Exposure, Emergency Response and Patient Care*. Prentice Hall, Inglewood Cliffs, New Jersey. (A textbook dealing with most aspects of chemical emergencies.)

Bourdeau, P. and Green, G. (1989) (eds.) *Methods for Assessing and Reducing Injury from Chemical Accidents*. IPCS Joint Symposia 11, SGOMSEC 6. John Wiley and Sons, Chichester PO19 1UD, UK. (Papers and recommendations from a workshop held 27 January-2 February 1987 in New Delhi, India. Also see Pokorny et al.

British Association for Immediate Care (BASIC) (1985) *Guide to Major Incident Management*. BASIC, Ipswich, Suffolk. (Contains articles on hospital disaster planning; the roles of the police, fire and ambulance services; the Medical Incident Officer and the Mobile Team; and equipment for mobile medical teams.)

Bruzzi, P. (1983) Health Impact of the Accidental Release of TCDD at Seveso. In: F. Coulston and F. Pocchiari (eds.) *Accidental Exposure to Dioxins: Human Health Aspects*. Academic Press, New York, 215-228.

Calamari, D. (1992) The role of ecotoxicology in the assessment of human exposure to chemical substances. *Human and Experimental Toxicology* 11, 307-310.

CANUTEC (1992) *Dangerous Goods Initial Emergency Response Guide*. Transport Canada (CANUTEC), Canada.

Cates, A.T. (1992) Shell Stanlow fluoroaromatics explosion – 20 March 1990: assessment of the explosion and blast damage. *Journal of Hazardous Materials* 32, 1-39.

Chemical Industries Association (1986) *Recommended Procedures for Handling Major Emergencies*. Reference No. RC 20, 2nd edition. London, 17 pp.

Chemical Industries Association (1989) *Guidelines for Chemical Sites on Offsite Aspects of Emergency Procedures*. Extension Notes to CIA publication, *Recommended Procedures for Handling Major Emergencies*. London, 6 pp.

Commission of the European Communities (CEC) (1984; 1988; 1991) Directive 67/548/EEC and amendments: "Directive on the approximation of laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances" (the "Dangerous Substances Directive"). *Offical Journal of the European Communities*, L251 Vol. 27, 19 September 1984; L133 Vol. 31, 30 May 1988; L180 Vol. 34, 8 July 1991. Brussels.

Commission of the European Communities (CEC) (1986). *Aims and practices of transfrontier emergency planning within the EC countries in case of an accident in a nuclear installation*. Luxembourg, 28 pp.

Commission of the European Communities (CEC) (1990) *Lessons Learnt From Accidents in the United Kingdom Involving Dangerous Chemical Substances*. Volume One: *Report and Conclusions. A Study for the Commission of the European Communities, Joint Research Centre, ISPRA.* Technica Consulting Scientists and Engineers, Stockport, England.

Commission of the European Communities (CEC) (1991) Directive 88/379 EEC: "Directive on the approximation of laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous preparations" (the "Preparations Directive"). *Offical Journal of the European Communities* No. L 76/35 22. Brussels.

Conseil Européen des Fédérations de l'Industrie Chimique (CEFIC) and National Chemical Emergency Centre (NCEC) (1991) *TREMCARDS Reference Edition*. NCEC, Harwell, UK.

Cooke, Matthew W. (1992) Arrangements for on-scene medical care at major accidents. *British Medical Journal* 305(6856), 748.

Cumberland, R.F. (1982) The control of hazardous spills in the United Kingdom. *Journal of Hazardous Materials* 6(3), 277-288.

Cumberland, R.F. (1991) The National Chemical Emergency Centre. *Chemistry in Britain*. July, 643-645.

Danon, Y. and Bar, Y. (1990) Planning and activities of toxicology centres for mass casualties. *Voen Med Zh* 8, 72-73.

Davies, P.A. and Lees, F.P. (1992) The assessment of major hazards: the road transport environment for conveyance of hazardous materials in Great Britain. *Journal of Hazardous Materials* 32, 41-79.

Dayan, A.D. (1992) Risk assessment – scientific aspects. *Medical Toxicology* 5(15), 61-72. (Paper presented at the EUROTOX conference in Maastricht, the Netherlands.)

Doeglas, H.M.G., et al. (1961) The margarine disease *Arch. Dermatol.* 83, 175-181.

Doepel, David C. (1993) Psychological preparedness and crisis management: theory and practice. *Industrial and Environmental Crisis Quarterly* 7(4), 279-92. Industrial Crisis Institute Inc. and Bucknell University, USA.

Doyle, Constance J. (1990) Mass casualty incident: integration with pre-hospital care. *Emergency Medicine Clinics of North America* 8(1), 163-175.

Doyle, J.C., et al. (1983) Acute Exposure to Hazardous Materials. Chapter 14 in: L.M. Haddad and J.F. Winchester (eds.) *Clinical Management of Poisoning and Drug Overdose*. W.B. Saunders Company, Philadelphia/London/Toronto/Mexico City/Rio de Janeiro/Sydney/Tokyo. (Covers special features of chemical accidents in relation to general toxicolgy.)

Duckworth, G.J. (1991) Consultants in communicable disease control: currently lacking resources, power, and training. *British Medical Journal* 303, 483-4.

Dutch Institute for the Working Environment and Dutch Chemical Industry Association (1991) *Chemical Safety Sheets*. DIWE and DCIA, the Netherlands.

European Chemical Industry Ecology and Toxicology Centre (ECETOC) (1991) *Emergency Exposure Indices for Industrial Chemicals*. Technical Report No. 43. Brussels, 69 pp.

Evans, R.J. and Evans, R.C. (1992) Reviews in Medicine: Accident and Emergency Medicine - I *Postgraduate Medical Journal* 68, 714-734.

Evans R.J. and Evans, R.C. (1992) Reviews in Medicine: Accident and Emergency Medicine - II. *Postgraduate Medical Journal* 68, 786-799.

Feldstein, D. Bruce, et al. (1985) Disaster training for emergency physicians in the United States: a systems approach. *Annals of Emergency Medicine* 14(1).

Fisher, Judith M. (1990) The British Association for Immediate Care (BASICS): its experience in major disasters, with special reference to the role of the medical incident officer. *Injury: The British Journal of Accident Surgery* 21, 45-48.

Froebe, L.R. (1985) State and national resources for community spills: disaster preparedness in the USA. *Journal of Hazardous Materials* 10(1), 107-124.

Gelbke, H.C. (1992) Industrial aspects of risk assessment. *Medical Toxicology* 5(6), 73-74. (Paper presented at the EUROTOX Congress in Maastricht, the Netherlands.)

Gow, H.B.F. and Kay, R.W. (1988) *Emergency planning for industrial hazards*. Elsevier, Amsterdam, 387 pp.

Grandjean, P. and Tarkowski, S. (eds.) (1984) *Toxic oil syndrome: mass food poisoning in Spain.* World Health Organization, Regional Office for Europe, Copenhagen. ISBN 9289010215. (Report of a WHO meeting at Madrid, 21-25 March 1983.)

Grimmer, H. and Joseph, A. (1959) An epidemic of infectious erythema in Germany. *Arch. Dermatol.* 80, p. 283.

Guha-Sapir, Debarati (1991) Rapid assessment of health needs in mass emergencies: review of current concepts and methods. *World Health Statistics Quarterly* 44(3), 171-181. (Disaster Epidemiology Research Centre, School of Public Health, Louvain Catholic University, Brussels.)

Haines, John (1990) *IPCS African Workshop on Major Chemical Accidents*. International Programme on Chemical Safety (IPCS), Geneva. (Major chemical accidents/incidents, 1950-1988.)

Hayes, M. (1991) Emergency action under COSHH: anticipating chemical accidents. *Occupational Health Review* 32, 24-26.

Hayward, R. (1992) Building on ICE. *Hazardous Cargo Bulletin*, April, 69-70.

Hazarika, S. (1987) *Bhopal: The Lessons of Tragedy*. Penguin Books, New Delhi.

Hines, C. Kenneth (1985) *The Medical Incident Officer and the Mobile Teams*. The British Association for Immediate Care, pp. 4-19.

Hines, C. Kenneth and Robertson, Brian (1985). *Equipment for Mobile Medical Teams*. The British Association for Immediate Care, pp. 19-21.

Hines, K., et al. (1988) Chemical Accidents. Chapter 27 in: P. Baskett and R. Weller (eds.) *Medicine for Disasters*. Wright, London/Boston/Singapore/Sydney/Toronto/Wellington, 376-390. (Covers special features of chemical accidents in relation to disaster medicine.)

Houston, Alan (1986) *Dangerous Chemicals – Emergency First Aid Guide*, 2nd edition. Croner Publications Ltd.

Huguenard, P. and Desfemmes, C. (1986) Emergency aid disaster medicine applied to the technological field. *Convergences Medicales* 5(6), 449-451.

Hunter, Paul R. and Mannion, Philip T. (1992) Doctors and control of major releases of chemicals. *British Medical Journal* 304, 1116-1117.

Hushon, J.M. (1986) Response to chemical emergencies. *Environmental Science and Technology* 20(2), 118-121.

Illing, H.P.A. (1989) Assessment of toxicity for major hazards: some concepts and problems. *Human Toxicology* 8, 369-374.

International Labour Organisation (ILO) (1988) *Major Hazard Control. A Practical Manual*. ILO, Geneva.

International Labour Organisation (ILO) (1991) *Code of Practice on the Prevention of Major Industrial Accidents*. ILO, Geneva.

International Labour Organisation (ILO) (1993) *Code of Practice on the Use of Chemicals at Work*. ILO, Geneva.

International Labour Organisation (ILO) (1993) *Convention concerning the Prevention of Major Industrial Accidents* (No. 174). ILO, Geneva.

International Labour Organisation (ILO) (1993) *Recommendation concerning the Prevention of Major Industrial Accidents* (No. 181). ILO, Geneva.

International Labour Organisation (ILO) (1993) *A Training Manual on Safety and Health in the Use of Chemicals at Work.* ILO, Geneva.

For other ILO publications, see Section 1.4.3 of the Practical Guides.

International Programme on Chemical Safety (IPCS)/Commission of the European Communities/ World Federation of Associations of Clinical Toxicology Centres and Poison Control Centres (1993) *Guidelines for Poisons Control*. IPCS, Geneva. (Considers the role of Poisons Information Centres (PICs) in the prevention of and response to poisonings, and provides technical guidance, model formats for collecting and storing essential data at PICs, and information on library support.)

International Programme on Chemical Safety (IPCS) and the Global Environment Monitoring and Assessment Research Centre (1992) *Chemical Pollution: A Chemical Overview*. IPCS, Geneva.

International Programme on Chemical Safety (IPCS) and the World Federation of Poisons Information Centres (1993) "Yellowtox" *Directory of Poisons Information Centres*.

For other IPCS documents, see Section 1.4.3 of the Practical Guides.

International Register of Potentially Toxic Chemicals (IRPTC). See United Nations Environment Programme.

Jacobs, M., et al. (1979) An emergency medical system approach to disaster planning. *Journal of Trauma* 19(3), 157-162.

Jarvis, S.N., et al. (1985) Illness associated with contamination of drinking water supplies with phenol. *British Medical Journal* 290, 1800-1802.

Jones, G., Knorowski, D. and Greenwell, M. (1993) *Selected US Experiences with Chemical Emergencies*. Presented at the IPCS Working Group on International Toxicolvigilance, 1-3 April. US Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry.

Kalins, R.V. (1987) *Emergency Preparedness and Response. Plant/Operations-Progress* 6(1), 6-10.

Keck, G. (1991) *Chemical Accidents and Emergencies: Veterinary Aspects*. Centre National d'Informations Toxologiques Vétérinaires, Ecole Nationale Vétérinaire de Lyon, BP 83, 69280 Marcy l'Etoile, France. (Duplicated paper on the role of veterinary services in chemical emergencies. Also gives further references.)

Koplan. J.P, Falk, H. and Green, G. (1990) Public Health Lessons from the Bhopal Chemical Disaster. *Journal of the American Medical Association* 264(21), 2795-2796.

Krishna Murti, C.R., Rantanen, J., et al. (1989) *Prevention of chemical accidents: the health dimension*. World Health Organization. Hemisphere Publishing, London, 150 pp.

Kulling, P. (1992) Major Chemical Accidents: Medical and Organisational Aspects. In: J-L. Vincent (ed.) *Yearbook of Intensive Care and Emergency Medicine 1992*. Springer Verlag, Berlin/Heidelberg/New York/London/Paris/Tokyo/Hong Kong/Barcelona/Budapest. (Includes examples of major chemical accidents, acute health effects of toxic chemicals, treatment, and health sector preparedness. Tables detail emergency storage of antidotes for use at the site of the accident and in hospitals.)

Kuratsune, M., et al. (1971) Poisoning caused by rice oil contaminated with polychlorinated biphenyl. *HSMHA Health Report* 86, 1083-1091.

Kuratsune, M., et al. (1972) Epidemiological study on Yosho, a poisoning caused by ingestion of rice oil contaminated with a commercial brand of polychlorinated biphenyl. *Environmental Health Perspective* 1, 119-128.

Kurttio, P. (1992) *Technological Disasters in Africa*. WHO Panafrican Centre for Emergency Preparedness and Response, Addis Ababa, Ethiopia. (Analyses response to questionnaire issued in September 1991 to all African member states of WHO, concerning current state of preparedness for technological disasters.)

Kvetan, Vladimir (1991) Disaster management. *Critical Care Clinics* 7(2), 257-484.

Lave, B. and Ennever, F.K. (1990) Toxic substances control in the 1990s. *Annual Review of Public Health* 11, 69-87.

Lave, L.B. and Upton, A.C. (1987) Regulating Toxic Chemicals in the Environment. In: Lave, L.B. and Upton, A.C. (eds.) *Toxic Chemicals: Health and the Environment*. Johns Hopkins University Press, Baltimore.

Lenga, Robert E. (1988) *The Sigma-Aldrich Library of Chemical Safety Data*, 2nd edition, two volumes. Sigma-Aldrich Corporation.

Lavoie, F.W., Coomes, T., Cisek, J.E. and Fulkerson, L. (1992) Emergency department external decontamination for hazardous chemical exposure. *Veterinary and Human Toxicology* 34(1), 61-64.

Lechat, M.F. (1991) The epidemiology of health effects of disaster. *Epidemiologic Reviews* 12, 192-198.

Leonard, Ralph B. and Teitelman, Uri (1991) Manmade Disasters. *Critical Care Clinics* 7(2), 293-320.

Lindgard-Jorgensen, P. and Bender, K. (1992) *Community Documentation Centre on Industrial Risk (CDCIR): Review of Environmental Accidents and Incidents*. Joint Research Centre CDCIR, Ref. No. 776-Dkb1-IV.3. EUR. 1 4002 EN, pp. I-83.

Lowermoor Incident Health Advisory Group (1989) *Water Pollution at Lowermoor, North Cornwall.* HMSO, London.

Lowermoor Incident Health Advisory Group (1991) *Water Pollution at Lowermoor, North Cornwall (Second Report).* HMSO, London.

Lugar, R.M. (1991) *Health and Safety Plan for operations performed for the Environmental Restoration Program*. Department of Energy, Washington, D.C. NTIS/DE91018758, 200.

McAlpine, D. and Arake, S. (1958) Minamata disease: an unusual neurological disorder caused by contaminated fish. *The Lancet* (1958), 629-631.

Madan, I. (1992) The toxic hazards of firefighting. *Occupational Health Review* 33, 17-18.

Magos, L. (1988) Thoughts on life with untested and inadequately treated chemicals. *British Journal of Industrial Medicine* 45, 721-726.

Mantovani, Ad, et al. (1990) *Veterinary Action in Disasters*. CEMEC Monographs No. 5. European Centre for Disaster Medicine, Ospedale de Stato, 47301 Repubblica de San Marino.

Margerison, T., Wallace, M. and Hallenstein, D. (1986) Seveso: The disaster before the accident. *New Scientist* 1239, 334-336.

Matthews, Peter (1985). *The police role in major incidents*. The British Association for Immediate Care, pp. 3-6.

Mercier, M. (1990) Introductory remarks. In: V. Murray (ed.) International Congress and Symposium Series No. 155: *Major Chemical Disasters – Medical Aspects of Management*. See V. Murray (ed.).

Misra, V., et al. (1991) Risk Analysis in hazardous industries. *Regulatory Toxicology and Pharmacology* 13(1), 62-69.

Moskowitz, P.D. and Fthenakis, V.M., Approaches to identifying, characterizing and managing risks from accidentally released toxic gases. In: J. Saxena (ed.) *Hazard Assessment of Chemicals*, Vol. XIII. Hemisphere Publishing Corporation, New York and London. ISBN 1-56032-024-9.

Moskowitz, P.D., et al. (1989) Approaches for identifying, characterizing and managing risks from accidentally released toxic gases. American Conference of Governmental Industrial Hygienists, *Industrial Hygiene Science Series: Hazard Assessment and Control Technology in Semiconductor Manufacturing*. Conference at Cincinnati, Ohio, 20-22 October 1987. Lewis Publishers, Inc., Chelsea, Michigan. ISBN 0-87371-132-7, pp. 271-284.

Moss, John (1985). *The Role of the Ambulance Service*. The British Association for Immediate Care, pp. 10-13.

Moxon, Julian (1992) Will accidents always happen? *New Scientist* 17 October, pp. 22-23.

Mrvos, R., Dean, B.S. and Krenzelok, E.P. (1988) A poison centre's emergency response plan. *Veterinary and Human Toxicology* 30(2), 138-140.

Munro, N.B., Watson, A.P., Ambrose, K.R. and Griffin, G.D. (1990) Treating exposure to chemical warfare agents: implication for health care providers and community emergency planning. *Environmental Health Perspectives* 89, 205-215.

Murray, V. (ed.) (1990) International Congress and Symposium Series No. 155: *Major Chemical Disasters – Medical Aspects of Management*. Royal Society of Medicine Services Ltd, 1 Wimpole Street, London W1M 8AE; *or* 7 East 60th Street, New York, NY 10022. (Proceedings of a meeting held by the Royal Society of Medicine on 21-22 February 1989 in London. Contains papers on likely causes, immediate and planned responses, problems of definition and identification, management of resulting medical conditions, and follow-up.)

Murray, V. and Wiseman, H. (1991) The National Poisons Unit: the Development of Electronic Databases and their Proposed Use for Chemical Disaster Management. Chapter 15 in: D. Parker and J. Hanmer (eds.) *Hazard Management and Emergency Planning – Perspectives on Britain*. James and James Science Publishers Ltd, 5 Castle Road, London SW1 8PR, pp. 219-225. (Reviews international developments in computerised information systems for medical management of chemical disasters.)

Murray, V.S.G., et al. (1987) *Epidemiology of Acute Occupational Poisoning: A Multicentre Accident and Emergency Department Survey*. Report for the Commission of the European Communities (CEC) DG V. Brussels.

National Academy of Sciences/National Research Council (1984) *Toxicity Testing: Strategies to Determine Needs and Priorities*. National Academy Press, Washington, D.C.

National Chemical Emergency Centre (NCEC) (1993) *CHEMDATA – Rapid Information for the Emergency Services*. NCEC, Harwell, UK. (International chemical emergency response database, designed primarily for responders to chemical accidents and easily loaded onto a personal computer. Provides basic information on hazards, precautions, protection and regulations, covering 17 datafields on over 70,000 products. Produced in English, French, German, Dutch and Spanish and updated every six months.)

Nemery, B. (1987) Bright red blood of Bhopal victims? (letter) *British Journal of Industrial Medicine* 44(4), 287-8.

New, Bill (1992) *Too Many Cooks? The Response of the Health-Related Services to Major Incidents in London*. Kings Fund Institute, UK. (Criticises response of the health-related services to five recent major incidents in London: the Kings Cross fire; the Clapham, Purley and Cannon Street rail crashes; and the Marchioness riverboat sinking. Concludes that London's hospital major accident plans are not well co-ordinated.)

Nichols, A.B. (1988) Emergency response keyed to local planning. *Journal of Water Pollution and Control Federation* (3, Part 1), 325-331.

Noji, E.K. (1991) Natural Disasters. *Critical Care Clinics* 7(2), 271-292.

Oreilly, J.T. (1987) *Emergency response to chemical accidents: planning and coordinating solutions*. McGraw-Hill, USA, 375 pp.

Organisation for Economic Co-operation and Development (OECD) (1991) *Users Guide to Hazardous Substance Data Banks Available in OECD Member Countries* (GD 91/102) OECD, Paris. (Available in English, French and Spanish.)

Organisation for Economic Co-operation and Development (OECD) (1991) *Users Guide to Information Systems Useful to Emergency Planners and Responders Available in OECD Member Countries* (GD 91/103). OECD, Paris. (Available in English, French and Spanish.)

Organisation for Economic Co-operation and Development (OECD) (1992) *Guiding Principles for Chemical Accident Prevention, Preparedness and Response: Guidance for Public Authorities, Industry, Labour and Others for the Establishment of Programmes and Policies related to Prevention of, Preparedness for, and Response to Accidents Involving Hazardous Substances*. OECD Environment Monograph No. 51. GD(92)43. OECD, Paris. (Available in English, French and Russian. A Spanish version will be published.)

Organisation for Economic Co-operation and Development (OECD)/United Nations Environment Programme Industry and Environment Programme Activity Centre (UNEP IE/PAC) (1991) *International Directory of Emergency Response Centres*. OECD Environment Monograph No.43/UNEP IE/PAC Technical Report Series No. 8. OECD/ UNEP, Paris. (Contains information on centres around the world that are accessible to callers worldwide, usually 24 hours a day, and that share information internationally.)

Panamerican Health Organisation (PAHO) (1992) *Desastres Tecnologicos*. "Biblio-Des" (Bibliografias selectivas sobre desastres, Extracto del Desindex) No. 4. PAHO, Costa Rica. (Selected bibliography on technological disasters. Citations in original languages, with annotations in Spanish.)

Parmentier, N. and Nenot, J.C. (1989) Radiation damage aspects of the Chernobyl accident *ATMOS* 23(4), 771-775.

Pepe, P.E. and Kvetan, V. (1991) Field management and critical care in mass disasters. *Critical Care Clinics* 7(2), 401-420.

Perry, Audrey R. and Iglar, Albert F. (1990) The accident at Chernobyl: radiation doses and effects. *The American Society of Radiologic Technologists* 61(4), 290-294.

Philip, R. (1990) Environmental health training within public health medicine. *Public Health* 104, 465-471.

Phillips, J. Linda (1992) Regional relationships between toxic releases and environmental and human exposure to toxic substances. *Bull. Environ. Contam. Toxicol.* 48, 795-802.

Plante, Dennis M. and Walker, James S. (1989) EMS Response at a Hazardous Materials Incident: Some Basic Guidelines. *Journal of Emergency Medicine* 7, 55-64.

Plunkett, R. (1987) *Handbook of Industrial Toxicology*, 3rd edition. Edward Arnold.

Pocchiari, F. and Silano, V. (1982) *Contingency planning for and response to emergencies and accidents involving toxic chemicals*. Third International Symposium on Chlorinated Dioxins and Related Compounds, Saltzburg, Austria, 12-14 October.

Pokorny, J., Dolezal, V. and Noji, E.K. (1989) Planning for the emergency medical service response to chemical disaster. In: P. Bourdeau and G. Green (eds.) *Methods for Assessing and Reducing Injury from Chemical Accidents*. SCOPE 40. Scientific Group on Methodologies for the Safety Evaluation of Chemicals. IPCS Joint Symposia 11. SGOMSEC 6. 1987. John Wiley and Sons, Chichester, 199-210. Also see Bourdeau and Green (eds.)

Quarantelli, E.L. (1991) Disaster planning for transportation accidents involving hazardous materials. *Journal of Hazardous Materials* 27(1), 192-198.

Ricci, Edmund and Pretto, Ernesto (1991) Assessment of Prehospital and Hospital Response in Disaster. *Critical Care Clinics* 7(2).

Robertson, J.S. (1993) Chemical Disasters, Real and Suspected. *Public Health* 107, 277-286.

Rosenberg T. (1992) *Hazard Identification and Evaluation in a Local Community*. UNEP IE/PAC Technical Report Series No. 12. UNEP IE/PAC, Paris. (English version of a handbook originally issued by the Swedish National Rescue Services Board, published in co-operation with the Swedish government as a contribution to UNEP's APELL (Awareness and Preparedness for Emergencies at Local Level) programme. Also available in French.)

Rosser, R. and Dewar, S. (1991) Therapeutic flexibilty in the post disaster response. *The Royal Society of Medicine* 84(2), 2-3.

Rowland, A., et al. (1990) Water contamination in North Cornwall: a retrospective cohort study into the acute and short-term effects of the aluminium sulphate incident in July 1988. *Royal Society of Health Report* 110, 166-172.

Runyan, Carol W., et al. (1992) Risk factors for fatal residential fires. *New England Journal of Medicine* 327(12).

Rutherford, William H. (1990) The place of exercises in disaster management. *Journal of Injury* 21, 58-60.

Salmon, A.G. (1986) Bright red blood of Bhopal victims: cyanide or MIC? *British Journal of Industrial Medicine* 43, 502-504.

Satyanarayana, K. and Rao, P.G. (1992) Improved equation to estimate flash points of organic compounds. *Journal of Hazardous Materials* 32, 81-85.

Savage, E.A. Peter (1985). *Hospital Disaster Planning*. The British Association for Immediate Care, 22-28.

Sax, N. Irving and Lewis, Richard J. (Snr.) (1987) *Hawley's Condensed Chemical Dictionary*, 11th edition. Van Nostrand Reinhold.

Sax, N. Irving and Lewis, Richard J. (Snr.) (1989) *Dangerous Properties of Industrial Materials*, 7th edition. Van Nostrand Reinhold.

Saxena, Jitendra, *Hazard Assessment of Chemicals.* Hemisphere Publishing Corporation, New York. ISBN 1-56032-024-9.

Semple, A.B. and Johnston, J.K. (1978) *Practical Guide for Medical Officers of Environmental Health*. Nuffield Provincial Hospitals Trust, London.

Sidal, V.W., et al. (1992) Public Health Responses to Natural and Human-Made Disasters. Chapter 74 in: J. Last and R. Wallace (eds.) *Public Health and Preventive Medicine*. Appleton and Lange, Norwalk, Connecticut, pp. 1174-1186.

Silano, V. (1984) *Evaluation of Public Health Hazards Associated with Chemical Accidents*, 2nd edition (corrected). Panamerican Centre for Human Ecology and Health, PAHO/ WHO, Mexico. (Reviews types of chemical accidents, evaluation of hazards, prevention, and the value or otherwise of retrospective studies.)

Sorensen, J.H., Carnes, S.A. and Rogers, G.O. (1992) An approach for deriving emergency planning zones for chemical munitions emergencies. *Journal of Hazardous Materials* 30(3), 223-242.

Swedish National Board of Health and Welfare (1991) *Care of Casualties in Chemical Disasters*. Socialstyrelsen, Distributionscentralen, 10630 Stockholm, Sweden. (Official recommendations. Covers organisation and planning, the accident area, hospitals, follow-up, effects of injury and how to deal with them, training and the literature.)

Tarasankar, P., Griffin, G.D., Miller, G.H., et al. (1993) Permeation measurements of chemical agent stimulants through protective clothing materials. *Journal of Hazardous Materials* 33, 123-141.

Thanabalasingham, T., et al. (1991) Hospital response to a chemical incident: report on casualties to an ethyldichlorsilane spill. *British Medical Journal* 302, 101-102. (Report on the management of a minor incident in June 1990 in London. Highlights failures in communication and inadequate preparation, e.g. absence of protective clothing for Accident Department staff and the police.)

Thompson, J. (1991) Theoretical issues in responses to disaster. *The Royal Society of Medicine* 84(2), 19-22.

Tierney, K.J. (1981) Community and organisational awareness of and preparedness for acute chemical emergencies. National Invitational Conference on Planning for and Response to Acute Chemical Emergencies at Columbia, Ohio, 14-15 July 1980. *Journal of Hazardous Materials* 4(4) 331-342.

(United Kingdom) Department of Health (1988) *Public Health in England: the Report of the Committee of Inquiry into the Future Development of the Public Health Function*. HMSO, London.

(United Kingdom) Department of Health (1990) New group of experts to advise on any future incidents of water contamination. DH Press Release 90/495, London.

(United Kingdom) Health and Safety Executive (1983) *The Fire and Explosions at B & R Hauliers, Salford, 25 September 1982*. HMSO, London.

(United Kingdom) Health and Safety Executive (1990) *Arrangements for responding to nuclear emergencies*. HMSO, London, 24 pp.

(United Kingdom) Health and Safety Executive (1991) *Release of chemicals from International Biosynthetics Ltd. A report of the investigation by the Health and Safety Executive into the chemical emission from International Biosynthetics Ltd. on 7 December 1991*. HMSO, London, 16 pp.

(United Kingdom) Home Office and National Chemical Emergency Centre, Harwell (NCEC) (1992) *HAZCHEM List No. 7*. HMSO, London.

(United Kingdom) Home Office/Scottish Office (1993) Incidents involving radioactive materials. *Technical Bulletin* 2/1993. HMSO, London, 108 pp.

(United Kingdom) Ministry of Health (1962) *Emergency treatment in hospital of cases of acute poisoning*. HMSO, London.

(United Kingdom) National Health Service Management Executive (NHSME) (1990) *Emergency Planning in the NHS: Health Service Arrangements for Dealing with Major Incidents*. HMSO, London.

United Nations Committee of Experts on the Transport of Dangerous Goods (1991) *Recommendations on the Transport of Dangerous Goods* (the "Orange Book"), 7th revised edition. United Nations, New York.

United Nations Economic Commission for Europe (UNECE) (1992) *European Agreement covering the International Carriage of Dangerous Goods by Road (ADR).* United Nations, New York.

United Nations Environment Programme Industry and Environment Programme Activity Centre (UNEP IE/PAC) (1988) *APELL – Awareness and Preparedness for Emergencies at Local Level: A Process for Responding to Technological Accidents*. UNEP IE/PAC, Paris. (The Handbook of UNEP's APELL programme, outlining a ten-step process for instituting or improving joint planning for prevention of and response to technological accidents. The APELL Handbook is available in English, French, Italian, Spanish, Portuguese, Russian, Arabic, Chinese, Czech, Hungarian, Indonesian and Thai.)

United Nations Environment Programme Industry and Environment Programme Activity Centre (UNEP IE/PAC) (1990) *Storage of Hazardous Materials*. UNEP IE/PAC Technical Report Series No. 3. UNEP IE/PAC, Paris.

For publications of the United Nations Environment Programme's International Register of Potentially Toxic Chemicals (IRPTC), see Section 1.4.3 of the Practical Guides.

(United States) Agency for Toxic Substances and Disease Registry (1992) *Emergency medical services: a planning guide for the management of contaminated patients*. US Department of Health and Human Services, Public Health Service, Atlanta, Georgia. (*Managing Hazardous Substances Incidents*, Vol. 1.)

(United States) Agency for Toxic Substances and Disease Registry (1992) *Hazardous Substances Emergency Events Surveillance (HSEES). Draft Protocol, 12/31/92.* US Department of Health and Human Services, Public Health Service, Atlanta, Georgia.

(United States) Agency for Toxic Substances and Disease Registry (1992) *Hospital emergency departments: a planning guide for the management of contaminated patients*. US Department of Health and Human Services, Public Health Service, Atlanta, Georgia. (*Managing Hazardous Substances Incidents*, Vol. 2.)

(United States) Agency for Toxic Substances and Disease Registry (1994) *Medical management guidelines for acute chemical exposures*. US Department of Health and Human Services, Public Health Service, Atlanta, Georgia. (*Managing Hazardous Substances Incidents*, Vol. 3.)

(United States) Environmental Protection Agency, Federal Emergency Management Agency, and US Department of Transportation (1987) *Technical Guidance for Hazards Analysis* (OSWER-88-001). Washington, D.C.

(United States) National Response Team (1987) Hazardous Materials Emergency Planning Guide (NRT-1). NRT, Washington, D.C.

(United States) National Response Team (1990) *Developing a Hazardous Materials Exercise Program: A Handbook for State and Local Officials* (NRT-2). NRT, Washington, D.C.

Volans, G.N., et al. (1987) Cyanide poisoning: the UK National Poisons Unit experience 1963-1984. In: B. Ballantyne and T.C. Mars (eds.) *Clinical and Experimental Toxicology of Cyanides*. Wright, Bristol, UK.

Waeckerly, Joseph F. (1991) Disaster planning and response. *New England Journal of Medicine* 324(12), 815-821.

Wilkins and Williams (1991) Operation Desert Storm: Task force on disasters and critical care. *Critical Care Medicine* 19(7).

William, J. MacKenzie (1985) *The Fire Service Role in Major Incidents.* The British Association for Immediate Care, pp. 6-10.

Windholz, Martha (ed.) (1989) *The Merck Index*, 11th edition. Merck and Co Inc.

World Health Organization (WHO) *Prevention of Chemical Accidents*. Hemisphere Publishing Corporation, New York.

World Health Organization (WHO) (1981) *Planning Emergency Response Systems for Chemical Accidents – Administrative Guidelines*. European Co-operation on Environmental Health Aspects of the Control of Chemicals – Interim Document 1. WHO Regional Office for Europe, Copenhagen, Denmark. (Outlines a model emergency response system and desribes the then current status of systems of contingency planning and emergency response to chemical accidents in Europe. Presents case studies on the accidents at Seveso, 1976, and Mississauga, 1979).

World Health Organization (WHO) (1984) *Toxic Oil Syndrome: Mass Food Poisoning in Spain*. WHO Europe, Copenhagen, Denmark.

World Health Organization (WHO) (1989) *Prevention of Chemical Accidents – the Health Dimension*. WHO Regional Office for Europe/Hemisphere Publishing Corporation, New York/Washington/Philadelphia/London. (Report of the World Conference on Chemical Accidents held on 7-10 July 1987 in Rome.) ISBN 0-89116-946-6.

World Health Organization (WHO) (1990) *Protocols on Rapid Health Assessment*. WHO Emergency Preparedness and Response, Emergency Relief Operations, Geneva. In particular:

- ERO/EPR 90.1.1 *Introduction to Rapid Health Assessment*
- ERO/EPR 90.1.2 *Rapid Health Assessment in Epidemics: First Steps*
- ERO/EPR 90.1.9 *Rapid Health Assessment in Chemical Emergencies*

(Practical guidance covering the purpose of assessment, the importance of preparedness, conducting the rapid assessment, and techniques for surveys during rapid assessment.)

World Health Organization (WHO) (1991) *African Workshop on Technological Disasters*. National Public Health Institute, Finland. (Proceedings of the African Workshop on Health Sector Management in Technological Disasters held on 26-30 November 1990 in Addis Ababa, Ethiopia.)

World Health Organization (WHO)/Food and Agriculture Organization (FAO) Collaborating Centre for Research and Training in Veterinary Public Health, *Catastrophes Chimiques et Actions Vétérinaires*. WHO/FAO Collaborating Centre, Istituto Superiore de Sanita, Laboratorio di Parassitologia, Viale Regina Elena 299-00161 Rome, Italy. (Report, in French, of a conference held at CEMEC in San Marino on 29-31 October 1990. Contains a summary in Arabic.)

World Health Organization (WHO)/Istituto Superiore di Sanità, Rome, and International Programme on Chemical Safety (IPCS) (1987) *World Conference on Chemical Accidents, Rome, July 1987*. CEP Consultants, Edinburgh.

Worthing, Charles R. (ed.) (1987) *The Pesticide Manual – A World Compendium*, 8th edition. The British Crop Protection Council.

Ziegler, A. (1992) Chemical risk assessment: a tool for disaster prevention. *Journal of Hazardous Materials* 31, 233-239.