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AN EPIDEMIOLOGICAL APPROACH TO THE MANAGEMENT

OF

CHEMICAL INCIDENTS

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In recent years there have been considerable advances in legislation and associated technological measures in preventing chemical accidents in Europe and North America, but these have not been matched by a comparable development in medical planning. The value of epidemiological methods in evaluating the health impact of disasters is slowly becoming more widely understood, but the need for an epidemiological approach to chemical disasters still lacks general acceptance. This chapter is intended to promote the view that health professionals should be involved in both the planning and the response phases in a chemical emergency, that the medical role should not be confined to the treatment of casualties in the hospital setting, and that the epidemiological approach is an important part of disaster management. Thus health workers need to collaborate with other disciplines not only in data gathering but also in applying the knowledge obtained to emergency management. This chapter will describe the steps to be taken for the successful management of the medical aspects of a major chemical incident and the ways in which health professionals should interact with other emergency personnel and decision makers.

BACKGROUND

The main hazards posed by the chemical industry are large vapour or flammable gas explosions, fires, and toxic releases. The accidental escape of gases stored in large quantities under pressure or the release of mixtures of substances from uncontrolled chemical reactions or fires may result in highly toxic chemicals being carried in plumes for long distances over populated areas where exposures to very low concentrations may have serious acute or chronic health effects. The behaviour and dispersion of plumes of gases under different weather conditions and in different types of release is an important determinant of exposure.

One of the earliest technological accidents to highlight the the typical problems to be faced in a hazardous release was the graphite fire in the reactor at Windscale, England, in 1957. A disaster arising from widespread contamination by radioactive emissions was averted by bringing the fire under early control and also by the speed with which contamination of the air and the environment around the plant was rapidly evaluated, resulting in the banning of human consumption of milk from herds contaminated by radio iodine fallout. As well as being a portent of things to come, the two major reactor accidents at Three Mile Island and Chernobyl, this accident illustrated how industrial processes can have health consequences far off-site, and the importance of design and building safe plant as well as having the means of dealing efficiently with major accidents and limiting their health and environmental consequences. Another feature that radiation and chemical accidents share should be noted: although they may have no obvious acute health impact, with few or no casualties, the potential long-term health hazard to large numbers of people can be the overriding concern and constitute a disaster.

The counterparts to these reactor accidents were the chemical releases in the incidents at Seveso, Italy, in 1976 and Bhopal, India, in 1984. In the Seveso incident, the exothermic chemical reaction involved in the chemical production of 245-trichlorophenol at the Icmesa plant went out of control, resulting in a chemical cloud containing 1.2k dioxin being released into a heavily populated area, but it took days before the enormity of the chemical contamination became appreciated. At Bhopal, the release of 40 tonnes of the highly irritant gas methyl isocyanate over the city at night resulted in an immediate and devastating health impact with the loss of 2,500 lives and a further 100,000 people being affected, mainly from injury to the respiratory tract and the eyes. In this, the world's worst chemical accident, little was known about the human health effects of methyl isocyanate at the time, apart from its irritancy potential to produce acute pulmonary oedema. Both of these incidents reflect the dilemmas that will face emergency workers having to respond to chemical disasters in the future: the problems of accurately identifying the chemical or chemicals that have been released and the paucity of data that exists on the vast majority of chemicals in regular commercial usage. An acknowledgment of these deficiencies is an essential pre-requisite in understanding why the epidemiological approach should form a fundamental part of disaster management, and why information gathering should start at the beginning of the disaster response.

IMMEDIATE EMERGENCY MEDICAL MANAGEMENT

The most common type of accidental release is the spillage or leakage of a substance during its distribution by pipeline, water, rail or road. Most of these events usually only pose a hazard to those immediately involved in the transport of the chemical or its clean-up. Many small releases in chemical plants may only affect those on site and the outside emergency service personnel. Chemicals that often feature in major releases are chlorine, ammonia, sulphuric acid, hydrogen chloride, phosgene, hydrogen sulphide, and nitrous fumes. An accidental release will become a major disaster if sufficient amounts of a toxic agent are released into the air to impact on people off site or in the general community when large numbers of people may be exposed. Many chemicals, including those listed above, have acute irritant effects on the eyes, skin and the respiratory passages and lung parenchyma and the immediate medical management of casualties will initially revolve around dealing with these, and with some agents there may be systemic effects as well.

At the scene

Initially there may be no information on the identity of the chemical involved and casualties will need to be managed on general principles. Thus emergency personnel should ensure they do not put themselves at risk and where appropriate the fire brigade should decontaminate casualties before they receive other than immediate life-saving treatment. As health workers are generally poorly trained in responding to chemical incidents the thorough decontamination of casualties is sometimes ignored. First aid measures may include dealing with thermal burns and the effects of mechanical trauma if an explosion has occurred, as well as the usual measures for maintaining the airway, breathing and the circulation.

At the hospital

Specific antidotes for the effects of a given chemical are available for only about a dozen of the over 70,000 chemicals in regular commercial use and in most instances the management of hospitalised patients will involve general supportive measures only. In most instances, then, hospital treatment can begin before the chemical(s) have been accurately identified. It is common to find that the response to the effects of irritant gases and vapours, and combustion products, is non-cardiac pulmonary oedema which if severe will go on to produce the adult respiratory distress syndrome (ARDS). Standard protocols for treating and preventing these pulmonary effects should therefore be available in hospitals as part of their disaster plans: treatment of the effects of irritants on the eyes and skin is also a necessary part of such protocols.

SHORT TERM MEDICAL MANAGEMENT

Whilst the first aid and treatment of any acute casualties from a toxic release is under way confirmation of the identity of the type of chemical or chemicals involved will be needed, followed by obtaining available information on the likely acute and chronic health effects. In the case of a chemical reaction that has gone out of control, or a fire involving the combustion of a collection of chemicals, e.g. in a chemical warehouse, the task of identifying the key chemicals may be exceedingly difficult or impossible. In addition, anything like a full toxicological evaluation is available only for a small percentage of the chemicals now in use and so the information available in the data banks of poison centres or chemical companies is likely to be exceedingly limited, particularly as far as long-term effects are concerned. However, a rapid assessment of the systemic toxicity of the agent or agents involved must be attempted with regard to:

- acute organ injury
- chronic organ damage
- reprotoxicity
- carcinogenicity

At the same time in all major toxic releases evacuation of the population at risk has to be urgently considered. With releases of short duration, such as a passing plume of an irritant gas, the protection afforded by buildings with their doors, windows and ventilation systems closed is substantial and it is usually better for people to stay inside rather than attempt to evacuate. But if an acute release is predictable and there is enough time, or in the event of a prolonged chemical fire and there is a concern that the situation might deteriorate, then the balance shifts in favour of evacuation. The other condition when evacuation should be considered is in the event of contamination of the ground, water, or crops as a result of fumigation or fallout from a plume. An integrated evaluation of the health impact of a toxic release, even if it is into the air, must include the risk of exposure through ingestion of contaminated water or crops, or by direct contact through skin absorption, as well as through inhalation. Surface and ground water may be contaminated by a toxic spill or through the use of water to put out fires by the emergency services.

In assessing systemic toxicity in a chemical release, and on deciding the need for evacuation, expert medical and toxicological advice is required and this should ideally have been included in pre-planning for such an emergency. There may be few if any acute health effects for the emergency services to deal with, but a major disaster may nevertheless have occurred because of the risk of contamination or exposure leading to chronic health effects. Unfortunately it is in the area of chronic effects that toxicological information on most chemical substances is lacking. Chemicals can cause long-term injury to any organ system in the body, but of most immediate importance as far as the population is concerned will be the hazard of carcinogenesis and teratogenicity, but other organ damage should also be considered (Table 1), which may have a latent period of weeks, months or even years before it appears. Examples of such latency in chemical disasters have been recorded following prolonged exposures from toxic releases into food (Table 2). Thus the most severe chemical disasters have arisen as the result of food contamination because people were unable to tell from the taste or smell of the food that serious contamination had occurred and also because the prolonged latent period resulted in many thousands becoming exposed before the illness first presented in the victims.

INFORMATION NEEDS IN A CHEMICAL DISASTER

From the foregoing it is obvious that the effective management of a major chemical incident will depend upon fulfilling certain key information needs. As has been emphasised the chemical released may be identifiable but its acute and chronic health effects may not be known or predictable, or there may be delay in identifying the agent which could lead to defective decision making, such as a failure to advise on the appropriate need for evacuation. Similar problems faced emergency workers at Bhopal and Seveso. Another problem is when the chemical agent is readily identifiable and there has also been an outbreak of acute health effect, but the extent or severity of the health impact may be unknown, as occurred with the release of aluminium sulphate into the water supply at Camelford, UK, in 1988. Another situation is when a disaster strikes in the form of deaths due to a sudden chemical release the identity of which may be unknown (e.g. Lake Nyos, Cameroon, in 1986 when about 1700 people were killed by a gas that was later identified as CO_2) or an illness whose cause is unknown but suspected to be due to an environmental toxic factor and where the route of exposure is unknown (e.g. Toxic Oil Syndrome, Spain, 1981). Finally, a common scenario is when a mixture of chemicals has been released and there are no obvious health effects in the exposed population, or indeed it is not known whether people have been exposed at all, e.g. in fires of warehouses storing chemicals, waste dumps for plastics and rubber tyres, and deliberate arson, e.g. Kuwait oil fires (1991).

These four different scenarios are summarised in Table 3. Closing information gaps is the task for a multidisciplinary emergency team working together to make an epidemiological assessment of the health needs of the stricken population and the health hazards they may face.

THE EPIDEMIOLOGICAL APPROACH USING THE RISK ASSESSMENT MODEL

Quantified risk assessment is a procedure that is used to quantify the health risk of a substance or, in a separate context, to predict the overall risk from plant or equipment failure in planning for acceptable or tolerable risks prior to and in the prevention of disasters. The steps involved can serve as a useful model in providing an information pathway to be followed. The key information needs on which to base judgements on health risk in a disaster, and which will need to be constantly revised as the emergency unfolds, are identified below. It is evident that very accurate data collection in the post-impact phase of any disaster is an ideal hardly ever likely to be achieved, so the assessment of risk in the end will be more a matter of judgement than in the form of mathematical probability statements. The steps to be followed in undertaking a quantified risk assessment are hazard identification, exposure assessment, dose response assessment and risk characterisation, and these will now be described.

Hazard identification (Table 4)

An urgent need at the outset is to determine if the agent or agents is causally linked to a health effect of concern, beginning with the confirmation of the source and type of release. For instance a chemical plant or storage facility should be investigated to determine the stock inventory and the types of intermediate chemicals that may be formed during a chemical process. It is important to appreciate that a chemical inventory for a warehouse can be consumed in a fire and it may take weeks before a full assessment of the chemicals involved can be made. Where chemical processes have gone out of control, or could have been sabotaged, it is necessary for scientists wearing suitable protective clothing to enter the plant and obtain samples from the process and to determine the nature of any chemical reactions that may have occurred together with the products which could have been released.

The emergency services have routine access to chemical data banks which can be searched to identify the known health effects of the putative agent released, and this information can be used to form a preliminary classification of the hazard to those exposed. In the U.K. chemicals being transported may be identified from transport emergency (TREM) cards held by the driver, or Hazchem codes displayed on the vehicle.

At the same time basic information should be obtained on the population believed to have been exposed in the chemical release. From the outset it may be difficult to know whether there has been exposure, or it may be obvious from a large number of affected casualties. In either case preliminary clinical data on patients attending should be sought from the hospital accident and emergency departments involved. If deaths have occurred the victims should be subject to urgent autopsies after the pathologists have considered the possibility of any risk of contamination to themselves. Even fairly preliminary information will be important in tentatively confirming the nature of the release. Where a large area is suspected to have been fumigated or contaminated by a plume then a surveillance system incorporating major hospitals and health centres should be established via a telephone or fax network. Family practitioners should also be contacted and advised on the types of symptoms to look out for in mild cases of exposure.

Fires pose special problems and they are also common events. The heat of a fire normally drives a toxic plume away from a local community who may carry on an almost normal existence despite the emergency nearby. In certain incidents evacuation may nevertheless be necessary because of the risk of explosion and there may be the possibility of fallout affecting a wide area or the risk of fumigation should the heat of the fire fall and weather conditions change, e.g. an inversion during the night time. These factors should all be considered in fires which continue burning for several days. The dangers of fallout from a chemical fire were experienced in the deliberate burning down of a chemical warehouse in Salford, England, in 1982: after the fire had been extinguished the local population, which had been evacuated because of an explosion risk, returned to find a chemical powder on the ground for as far as 14 miles away. The emergency services made a fundamental error in advising the householders to sweep this away before the chemical powder had been subject to careful analysis.

Exposure assessment (Table 5)

This step involves defining the extent of human exposure. Wherever possible an environmental or clinical marker may be needed to clarify who has or has not been exposed and if possible the degree of exposure. With point-source releases simple classifications using maps to identify low, moderate and high exposure, should be drawn up as soon as possible, and clinical and environmental surveys should be considered to aid in this task.

It is axiomatic that in the exposed population, particularly those suffering from symptoms, blood and urine samples should be collected and stored for subsequent toxicological analysis. The collection of these samples should not be omitted at the height of the emergency unless the hospital facilities have been overwhelmed. The failure to collect blood samples during the Bhopal emergency led to subsequent confusion over whether cyanide had been released and this could have been of major import for those providing the emergency treatment.

Urgent environmental monitoring should also be considered in the event of an airborne release which is continuing and appropriate samples should be obtained of the air, ground and water for evidence of contamination. Presently, emergency air monitoring poses problems in setting up equipment in time and space, though there is little excuse for delay in the event of fires or releases persisting for days. Locating suitable air sampling devices in populated areas and keeping these running intermittently during the emergency period are invaluable in reassuring the public if later analysis shows these tests to be negative and are also vital for determining the level of exposure to a chemical when this has occurred. So far there have been hardly any reported incidents in which emergency air monitoring has been successfully undertaken and this fact poses a challenge to investigators and instrument manufacturers for the future. In the absence of satisfactory monitoring for air pollution at the time of the incident the main indicators of the potential hazard to human health and the distribution of any toxic contamination may be the extent of damage to vegetation, together with observations of the health of birds, animals and fish. Fires involving the combustion of plastics such as polyvinyl chloride will release quantities of hydrogen chloride which rapidly combines with water vapour to form hydrochloric acid and evidence of metal corrosion in the environment should be sought after such a fire.

Retrospective computer modelling of plume dispersion from the point source of the release (recreating wind direction, wind speed and the amount of material involved) may also be revealing.

For releases into water, food and drink, or where an airborne release may have led to a contamination of these, it is essential to urgently collect samples, but where households have been affected and where there are no clues as to likely vehicles of exposure a review of previous incidents involving serious food contamination have shown that the most common chemical carriers are cooking oil, alcoholic beverages, dairy products and flour, and these foods should always be at the forefront of suspicion.

Dose response assessment

The third step involves determining the relation between the level of exposure and the risk of health effects. The fulfilling of this information need is a task primarily for the epidemiologist who should establish data bases for case control studies of the casualties and prospective cohort studies of the exposed populations. The advantages of case control studies of those manifesting toxic effects include identifying the risk factors in explaining why they and not others have been affected. These factors may include individual susceptibility or important differences in type of exposure. Cohort studies are necessary for identifying long-term health effects but it is essential that study populations are capable of being characterised at least on a judgement of the main levels of exposure. To achieve this it is necessary that registers of exposed individuals are established as soon as possible in the post-impact phase of a disaster and this information gathering should begin at the earliest possible stage in the emergency as described above. In the Seveso incident there were long delays in setting up epidemiological studies and at Bhopal the follow-up has been so limited that we know hardly anything more about the health effects of methyl isocyanate than before the disaster happened. It is therefore essential that the necessary organisational apparatus is put in place to ensure that the scientific study of the exposed population is maintained until follow-up is complete.

Risk characterisation

This step is placed at the end in logical sequence but this is the vital information gap that should be undertaken and revised throughout the emergency. It is essential in emergency management to delineate the short-and long-term human risk including the uncertainties of predictions. The information is essential for the immediate and long-term medical management of casualties and the exposed population, as a risk assessment will form the scientific basis for a decision on evacuation. As far as the long-term effects are concerned it may take many years of epidemiological follow-up to confirm or refute these.

The undertaking of experimental toxicology using animal studies is often essential for obtaining information on the underlying mechanisms of any health effects that appear. As in the Toxic Oil Syndrome, animal models may be essential to confirm an aetiological hypothesis where a suspect agent has been identified through epidemiological or clinical investigation. In this outbreak in which over 600 people died and 20,000 others were affected, animal studies involving samples of rape seed oil suspected of being chemically contaminated have failed to reproduce the clinical symptoms in animals and have therefore left open the nature of the agent that was thought to have been the cause of human effects.

It is important to realise that any amount of information in favour of a given cause or hypothesis is not confirmatory proof and where, for example, the causal role of an agent is in doubt it is essential to agree on the necessary tests required to refute one or other of the causal hypotheses put forward. This Popperian approach is summarised by Briskman:

"In the absence of any empirical means of eliminating either of (two theories) is false the fact that both can be shown to agree with many observed facts says not a jot for the truth of either".

Needless controversy on causal issues can bring scientists into disrepute in the eyes of politicians and the general public, and one way forward for those caught in such disputes, which are common outcomes in major chemical incidents, is to agree together on a plan of hypothesis testing by refutation of any convincing resolution of such conflicts is to be achieved.

UNDERTAKING A RISK ASSESSMENT

It is evident that a chemical disaster, or even a complex chemical incident, cannot be managed without much essential data gathering taking place during the emergency phase and that this is just as important a task as the more routine ones which are widely undertaken by emergency services. A review of major chemical disasters has shown how the emergency responses in these can be faulted by the failure to adequately characterise the hazard and the human health risks with the result that an overall management had been delayed or ineffective. Epidemiological methods provide the scientific tools for the collection and evaluation of health data in populations after a disaster has struck. The investigative health team must proceed to evaluate the hazard to health and feed back the information to clinicians and decision makers on the disaster co-ordinating team who in turn can provide advice to the media and public at large. This ideal has hardly ever been met in major environmental disasters. The examples of the limitations of the health hazards in major chemical disasters are given below, but the reader is referred to the references for further examples and more details.

Airborne releases

Seveso, Italy, 1976

The chemical cloud containing dioxin and corrosive chemicals (mainly caustic soda) caused chloracne in 187 children, deaths in birds and animals, and killed vegetation in the affected zone. Chloracne is the hallmark of exposure to dioxins but it took 13 days for the presence of dioxin to be confirmed. Evacuation of the residents from the contaminated area did not begin until two weeks after the release. Environmental studies eventually showed that the soil in the worst affected zone had become heavily contaminated with TCDD. Epidemiological studies were not started until 1979.

Because of the limitations of existing chemical analytic techniques it was not possible to successfully analyse serum samples for dioxin until 1988, when the highest levels ever reported in humans were found in a sample of the most exposed individuals.

Bhopal, India, 1984

About 40 tonnes of methyl isocyanate were accidentally released from the Union Carbide plant, resulting in 2,500 deaths and over 100,000 injuries from the irritant effects of the gas. Hospital facilities were inundated with casualties. Inadequate clinical and pathological investigations were performed and there was a delay in chemical engineers gaining entry to the plant in order to study the process. As a result the cause of the leak and whether other chemicals were involved remains in dispute. Medical records and epidemiological follow-up of survivors have been incomplete.

Eruption of Mount St Helens, USA, 1980

Explosive volcanic eruptions are analogous to chemical releases from industrial installations, with the potential for the emission of respirable ash particles and toxic gases. The massive eruption of Mount St Helens resulted in a heavy ash fall over a widely populated area of Washington State in Idaho. There were concerns over the toxicity of ash and its effect on human lungs. This is one of the few examples where the emergency response has been adequate and it is quoted as an exemplary model of how to cope with a disaster through the proper use of technology, public education, a co-ordinated emergency response, and a thorough evaluation of the health effects using epidemiological methods and toxicological studies.

Gas burst from Lake Nyos, Cameroon, 1986

The release of a cloud of dense gas which left about 1,700 people dead was in contrast to the Mount St Helens eruption as it occurred in a remote area in a developing country. The identity of the gas was never confirmed but it was most likely to have been carbon dioxide. This was deduced from chemical studies of the lake water as well as the limited findings from epidemiological study of the presenting signs and symptoms in casualties arriving at two hospitals near the affected area. No pathological or toxicological investigations were possible.

Foodborne chemical releases

Minamata, Japan, 1953 to the present

Investigation of the this well-known epidemic or organic mercury poisoning was hampered by inadequate clinical knowledge at the beginning when the characteristic illness was misdiagnosed as an infection. Not until 1960 was organic mercury identified in seafood and some years passed until in 1968 the source of the chemical was confirmed as the local chemical factory. Epidemiological studies were slow to start and have been incomplete. These delays meant that the ban on fishing in the bay area was not introduced until 1968 by which time tens of thousands of local people had consumed contaminated fish.

Iraq, 1971/2

This epidemic of organic mercury poisoning was, in contrast, rapidly identified as being due to the consumption of wheat treated with methyl mercury as by 1970 the clinical syndrome of organic mercury poisoning and the hazard of mercury seed dressing was well known in the scientific community. As a result the exposure time was only two weeks to two months before the problem came under control, and although possibly thousands of people died or were left seriously affected many victims improved in contrast to the victims affected by the same syndrome at Minamata.

CONCLUSION

Emergency planners must therefore incorporate data gathering as an integral part of their emergency response plans, not only for evaluating the health needs of a population in a major disaster but also to put emergency management on a scientific basis. To achieve this a pre-planned team will be needed to collect all the clinical, pathological, epidemiological, biochemical, and environmental data necessary and the steps they should follow are those of a quantified risk assessment as described above. Such a team will need to involve physicians and scientists from different disciplines and would normally have to be deployed near to the scene as part of the emergency response. In many countries this team of experts would need to be established on a national basis to be available as back-up to local emergency officials who lack the necessary epidemiological, laboratory, and toxicological skills. Opportunities for data gathering in emergencies are not repeatable and mistakes in this critical period are not likely to be forgiven by exasperated decision makers or alienated communities, both groups frustrated by lack of information needed to either reassure or direct the medical management. For such teams to be effective health workers need to appreciate that they have an important role in the planning and response to chemical disaster which is over and above a data gathering exercise. The expert health professional will need to interpret and act on the data the team gathers, and his or her advice should be an essential part of the key decisions that need to be made in the management of a chemical disaster.

TABLE 1: EXAMPLES OF CHRONIC TOXIC INJURY

Carcinogenic	Primary liver cancer (suspected)	Polychlorinated biphenyls	Yusho incident Japan, 1968
Teratogenic	Cerebral palsy syndrome	Organic mercury	Minamata, Japan, 1953-present
Immunological	Abnormal lymphocyte function	Polybrominated biphenyls	Michigan, U.S.A.,1973
Neurological	Distal motor neuropathy	Tri ortho cresyl phosphate	U.S.A. 1930
Pulmonary	Parenchymal damage	Methyl isocyanate	Bhopal, India, 1984
Hepatic	Porphyria cutanea tarda	Hexachlorobenzene	Turkey, 1955-61
Dermatological	Sicca syndrome (Toxic Oil Syndrome)	Unknown	Spain, 1981

TABLE 2: TOXIC RELEASES INTO FOOD: EXAMPLES OF LATENCY

Agent	Disease	Mean Latency
Hexachlorobenzene (Turkey, 1955-61)	Porthyria cutanea tarda	6 months
Methyl mercury (Japan, 1953-present)	Organic mercury poisoning	years
Methyl mercury (Iraq, 1971/2)	Organic mercury poisoning	2 weeks-2 months
Polychlorinated biphenyls (Japan, 1968)	Yusho	71 days

TABLE 3: TOXIC RELEASES: INFORMATION GAPS

Chemicals	Health Effects	Example
+	-	Bhopal, Seveso
+	+	Camelford, UK
-	+	Lake Nyos, Toxic Oil Syndrome
-	-	Fires, eg warehouses (Salford 1982)

TABLE 4: HAZARD IDENTIFICATION - INFORMATION NEEDS

Source of release	Inventory of processes and materials, intermediates, products. Chemical samples.
Exposed population	Clinical and pathological findings in casualties. Hospital surveillance data.
Data banks	Known health hazards of agents.

TABLE 5: EXPOSURE ASSESSMENT - INFORMATION NEEDS

AIRBORNE RELEASES	
Exposed population	Test blood and urine samples
Environment	Sample air, ground and water for contamination
	Assess vegetation damage
	Assess health of birds, animals, fish
	Look for corrosion of metal, damage to paint, etc
Plume dispersion	Do retrospective computer modelling
WATER, FOOD AND DRINK RELEASES	
	Urgently collect suspect samples in surveys of affected households (e.g. edible oil, alcoholic beverages, dairy products, flour

REFERENCES

Baxter PJ Major chemical disasters (editorial). Brit. Med. J. 1991; 302:61-62.

Baxter PJ Review of major chemical accidents and their medical management. In: Murray V, ed. Major Chemical Disasters: Medical Aspects of Management. London: Royal Society of Medicine, 1990:7-20.

Baxter PJ A multi-disciplinary approach to the medical management of man-made and natural toxic disasters. In: Duffy JC, ed. Health and Medical Aspects of Disaster Preparedness. New York: Plenum Press/:161-174.