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TRAUMA

Major disaster management in chemical warfare

G. Betts–Symonds

A disaster is internationally defined as: a catastrophic event which, relative to the manpower and resources available, overwhelms a healthcare facility and usually occurs in a short period of time'.

War produces such events following every major engagement, resulting in continuous streams of casualties with injuries reflecting the type of campaign being fought and weapons used.

Chemical weapons are designed more to injure than to kill, as has been demonstrated in conflicts that have involved the use of such weapons where mortality has been 3–5%. However, the use of such weapons when overlaid on conventional injury cause added medical problems along with a massive tactical contamination problem. It is therefore essential that disaster planning and training takes account of these hazards in areas where such a threat exists, in order to save the maximum number of lives and prevent secondary casualties among hospital and rescue staff.

The principles outlined in this paper apply equally well to civilian disasters involving the many hazardous materials of industry being transported daily on roads, railways and in the air.

This paper will give an overview of the nature of chemical weapons and of some of the medical/tactical problems when disaster involves chemical warfare agents.

THE NATURE OF CHEMICAL WARFARE AGENTS

There are numerous chemical weapons in the military arsenals of the civilized world, but these can be divided into three groups:

- Vesicants
- Nerve agents
- Blood agents

The limited military experience with the use of such weapons in warfare has shown that the mortality rate is 3–5% yet the percentage of casualties needing prolonged medical care has been consistently high. From a

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military strategy point of view this is ideal, since the side that wins the war is usually the army who can inflict the highest number of casualties 10 000 dead soldiers are not a logistical problem since medical care and resources are not required The same number of chemically-injured military personnel require tremendous technological and manpower resources over a long period of time, thus weakening the affected side

Vesicants

These chemical agents have a corrosive action on body tissue and are often referred to as 'blister agents' They cause blistering of the skin among other more potentially lethal effects.

The most common agents in this group are sulphur mustard, nitrogen mustard, lewisite and phosgene oxide

The mustards were thought to have been discovered in the 1800s and their first large scale military use was at Ypres in Belgium against the British in 1917, when 0.5 million casualties resulted.

Mustards were also thought to have been used against Ethiopia by the Italians in 1936 and against the Chinese by the Japanese in the late 1930s. They were confirmed as having been used by Iraq against Iran during the 1984–1988 period.

Characteristics and injuring mechanisms (Table 1)

Mustard agent is an oily liquid which varies in colour from clear to dark brown. It has an odour reminiscent of garlic, onion or mustard (hence the name of mustard gas). Since it is oily and much denser than air it is relatively persistent, and when deposited in an area it remains a potential hazard for a long period of time.

The medical effects of mustard gas on the unprotected body are more incapacitating than lethal. The three main areas attacked are the eyes, the respiratory system and skin which suffer the effects of the corrosive action of the agent.

No antidote exists, therefore treatment is symptomatic. Since blistering takes hours to develop, decontamination may minimize the injury Eye irrigation must be carried out immediately Pulmonary effects require management of pulmonary oedema Mechanical ventilation may be necessary in some cases. Once decontaminated, the chemical burns are treated conventionally with emphasis on the management of shock and the prevention of infection.

Table 1 Mechanisms of injury – Vesicants

• Eye injury • Respiratory damage • Local burns to the skin	
Management in the field	Immediate decontamination Eye wash Manage respiratory problems Evacuate
Management in hospital	Deal with respiratory problems Pulmonary oedema Ventilate Burns treatment Anti-shock Ophthalmic management Labor-intensive care
Prognosis	Good Long recovery period

Nerve agents

This is a group of Organophosphates which inhibit the action of cholinesterase which is responsible for the hydrolysis of acetylcholine. This disrupts normal neurotransmission at cholinergic synapses throughout the body. The cholinergic synapses are located in the neuromuscular endplates of the peripheral voluntary nervous system, in the central nervous system and at the parasympathetic presynaptic ganglia of the autonomic nervous system.

Characteristics and injuring mechanism (Table 2)

The important agents in this group include taban, soman, sarin and VX. They vary from being colourless to light brown liquids, odourless and tasteless even when mixed in aqueous solution in toxic amounts.

Table 2 Mechanism of injury – Nerve agents

Causes acute cholinergic crisis	Muscarinic effects Nicotinic effects Central nervous system effects
Management in the field	Mask the casualty to prevent further injury Immediate antidote – Atropine – Pralidoxime – Valium Airway management Arrest any bleeding Decontaminate Evacuate
Management in hospital	Airway management Atropine Pralidoxime Valium Ventilate Management of conventioanl injury
Prognosis	Depends on 1 Concentration absorbed 2 Time elapsing before antidote 3 Early evacuation

The effects of nerve agents on the Neuromuscular junction

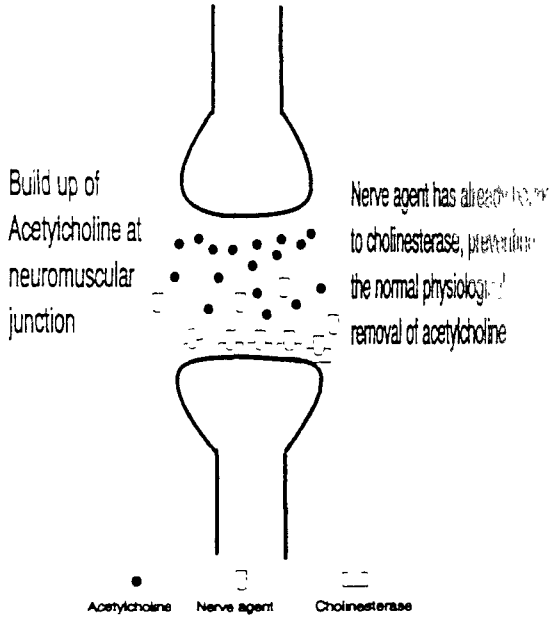

Fig 1

Persistence of these agents varies, VX being the most highly persistent and dangerous.

Absorption into the systemic circulation is either by inhalation of gas or direct percutaneous penetration binding to cholinesterase and blocking the removal of acetylcholine by competitive inhibition (Fig. 1).

This creates muscarinic, nicotinic and central nervous system manifestations related to the degree of exposure. Death may result from respiratory failure if not treated quickly Some agents become irreversibly bound to cholinesterase very quickly, necessitating immediate treatment. Successful treatment depends upon immediate administration of nerve agent antidote in the field These antidotes include intramuscular Pralidoxime, Atropine and Diazepam. They are continued over 24–48 hours in large doses which are determined by response to therapy (Fig 2).

Blood agents

These include hydrogen, cyanide and cy gen chloride. Casualties subjected to the fer acute cyanide poisoning. To the unpro tected person, they are quickly fatal unless im mediate antidote is given.

Characteristics and injuring mecha (Table 3)

Blood agents are poisonous to the body due to the agent having an affinity for an enzyme called Cytochrome Oxidase. It binds and in activates this enzyme, which is required for utilization of oxygen at cellular level. Cyanide prevents this and the result is a cellular le asphyxiation. The person exposed will have an immediate rise in rate and depth of respirations, followed by convulsions, respiratory

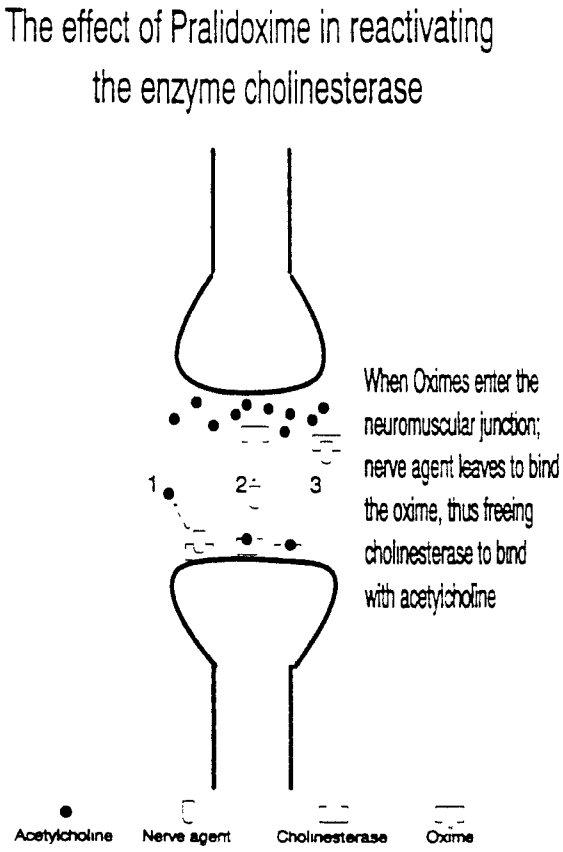

Fig. 2

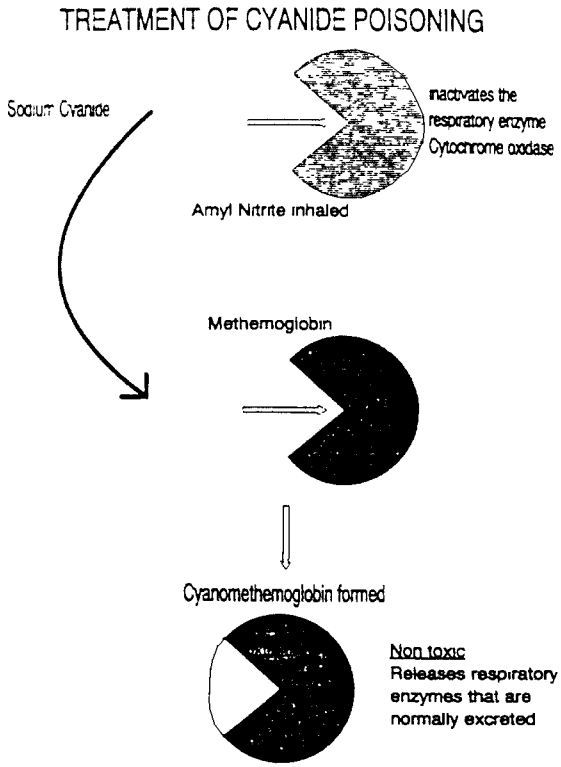

Fig 3

arrest and cardiac arrest Irritation of the eyes may also be seen with Cyanogen Chloride.

Treatment must begin immediately in the field, or the person will never reach a medical facility. The treatment includes inhalation of amyl nitrite, masking of the person, dealing with any life-threatening injury, and immediate evacuation. Further nitrite therapy is continued with sodium nitrite and sodium thiosulfate in the medical facility (Fig. 3).

The prognosis is poor, but with timely management recovery is greatly improved.

TACTICAL PROBLEMS OF MASS CHEMICAL-INJURY

Casualties

General hospitals receiving battle casualties from forward areas should not normally have to deal with the immediate management of chemical injury. Decontamination and field management will normally have been done prior to evacuation.

However, when a chemical attack occurs on civilians in towns and cities, general hospitals may have to initiate decontamination procedures.

It is for this reason that chemical warfare disaster plans must be made wherever this is a significant threat. Failure to prepare could mean that civilian casualties with both conventional and chemical injury will be brought into the nearest hospital for treatment. This could result in the hospital being effectively removed from operation until decontamination can take place, and poses special danger to the hospital staff already on duty.

Hospital site team responses within the city
Any mass casualty situation which also involves the presence of chemical agents must

Table 3 Mechanism of injury – Blood agents

Cyanide binds to cytochrome oxidase	Causes asphyxiation at cellular level
Management in the field	Immediate inhalation of Amyl Nitrite Mask the casualty Airway management Arrest life-threatening conventional injury Decontamination Evacuation
Management in hospital	Airway management Further Nitrite therapy with Sodium Nitrite/Sodium Thiosulfate Ventilation in some cases
Prognosis	Death quickly without immediate Amyl Nitrite Recovery quickly with timely treatment

DANGER – Oxygen combined with Amyl Nitrite vapour is an explosive mixture

be approached with extreme caution All casualties, irrespective of their conventional injury, must be triaged as potentially contaminated. Properly protected personnel must render aid. Persons without protection will create secondary casualties and compound the size of the incident.

The hospital site team must be specialized and trained to deal with casualties in a contaminated environment. This includes full protective clothing. This protective clothing makes intervention in the field nearly impossible. Intervention is aimed at considering life-threatening effects of both the conventional and chemical injury. The priority of treatment of chemical injury over conventional injury depends on the nature of the agent involved.

If a nerve agent accompanies a conventional injury, priorities include masking the casualty, administering the antidote and then continuing with airway, breathing and circulation. Clothing must not be removed and airway management is restricted to repositioning the person. Evacuation is accomplished according to priority and salvageability of the entire scene. Only those casualties most likely to survive should be removed first. The rescuer must consider both the conventional injury and the time elapsed since chemical injury. The administration of an antidote also impacts on the decision since the effects with certain agents become irreversible despite treatment without delay.

ADJUSTING DISASTER PLANNING AND TRAINING IN CHEMICAL WARFARE

Most healthcare institutions have an emergency plan aimed at coping with a disaster scenario. However, this is mostly directed at casualties of a conventional nature. It may include the following elements:

- The alert
- Response in terms of site teams
- Changing of normal hospital functions
- Designating of specific areas within the hospital for particular category of casualty
- Transfer and discharge procedure
- Predetermined routing and flow of casualties
- Dynamic triage based on injury and salvageability

In situations where there is thought to be significant risk of chemical weapons in civilian areas the above concepts apply. However additional changes must be made. These additions include:

1. The treatment of unfamiliar medical injury
2. Protecting the hospital from contamination and its personnel from becoming secondary casualties.

Protecting the hospital and personnel from contamination is crucial.

Decontamination must be effected outside the medical facility for both contaminated casualties and those where previous decontamination cannot be confirmed

Medical and chemical triage must be applied to ensure that those patients requiring intervention before decontamination are routed accordingly Specific routing prior to hospitalization is required This must be strictly policed without exception Personnel and vehicles working in treatment areas must be designated as 'contaminated' or 'clean' and only operate in their areas (Fig 4)

The hospital must provide the following extra facilities outside, away from their building:

- Contaminated emergency room
- Decontamination units – walking and stretcher

Conventional disaster routing overlaid with chemical warfare agents

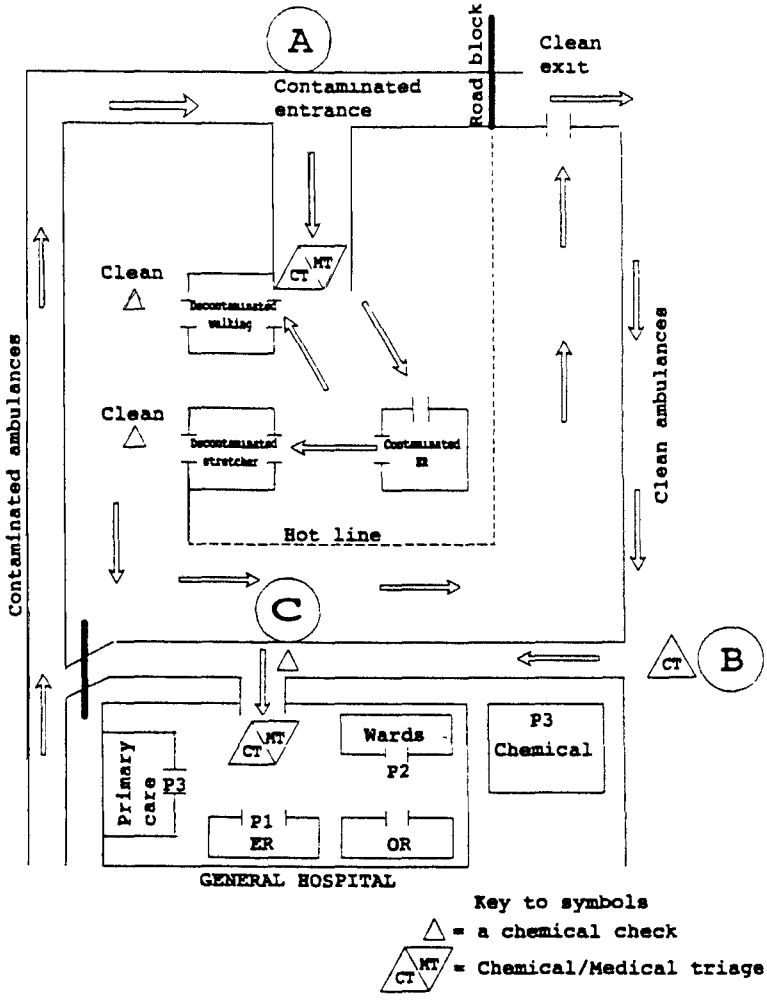

Fig. 4

- Holding area for expectant contaminated casualties
- Separate observation facility for minor chemical casualties only

Additional staff training must include knowledge and use of the following

1. Special protective clothing
2. Emergency management of chemical injury
3. Scope of treatment possible in the contaminated environment
4. Limitations of staff in full protective clothing
5. Ambulance personnel training (differences from usual procedures)
6. Training of security personnel in the use of chemical detectors.
7. Application of chemical triage over medical triage.

Contaminated emergency room

Consideration must be given here to what is the most life-threatening: the conventional injury or the chemical agent poisoning.

A casualty with severe nerve agent poisoning will die without immediate management. He may also have a serious conventional injury. The priority is to give nerve agent antidote, manage the airway and then the conventional injury.

Conversely, the casualty with a serous conventional injury and mustard gas poisoning may require emergency management of the conventional injury first because this agent is not usually fatal. The emergency room (ER) physician and nurse must be able to respond appropriately in each case. During triage, only life-threatening problems are dealt with in the contaminated ER. The first priority is to get casualties decontaminated so that they can be managed more effectively in the conventional hospital setting.

Casualties must be chemically checked following decontamination. Clean casualties are routed to the main hospital for further management. Any casualty who is not clean must be re-routed for further decontamination. This may mean returning a casualty to the contaminated ER for life-threatening management or indeed designation as expectant. The casualty's chances of survival may decrease if decontamination must be repeated

Further chemical checks with a detector are done at the entrance to the main hospital which is the central triage point Triage based on conventional and chemical injury can take place and normal hospital disaster plan action applies. The length of time elapsing between injury and hospital care is a decisive factor in casualty survival The importance of the 'Golden Hour' is well documented It is obvious, therefore, that casualties with a good survival potential, if they could go directly to the main hospital, may become 'expectant' in a chemical warfare overlay.

CONCLUSION

Clearly, disasters involving chemical warfare agents require additional specialized training and preparedness training. All health care facilities where the risk of chemical warfare exists have a duty to make provision for such casualties.

Pre-hospital care treatment in most cases improves the chance of survival for the victim and we must ensure that medical personnel are well versed in these treatments.

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BOOK REVIEW

Coping with Trauma – Theory, Prevention and Treatment
R J Kleber and D Brom (Eds)
Swets & Zeitlinger 1992, ISBN 9–026–51227–9, 317pp, £34.00 (Hardback) (Jessica Kingsley)

There has been tremendous interest in trauma care over the past 10 years, and this is reflected in the focus of papers submitted to this journal. The interest in trauma care has included psychological issues in the field of traumatic stress

This book addresses many of these difficulties for the client and for the emergency worker involved. It covers Post Traumatic Stress Disorder, Disaster, Violence and War as some of the traumatic events to which emergency nurses will have to respond.

Theories about coping and the determinants of trauma are explored in a way that held my interest. The modes of intervention are not only described well but critically appraised, with observations on how the outcomes are measured. Determining success, and what this means or how it was achieved, is not always clear. The authors explore this well

The research which produced this book was conducted at the Dutch Institute for Psycho-social Stress Research, and later supported by the Institute of Psychotrauma and the University of Utrecht. It is a truly academic book but displays insight and sensitivity into the difficulties and needs of the client. The two do not always go together in a book.

I can highly recommend this book to Accident and Emergency (A & E) nurses. It is not often, with this type of book, that one cannot put it down. Even if A & E nurses do not obtain their own copy, it should be available from the college library to nurses on A & E and trauma courses.

BOB WRIGHT