Chemical, biological, radiological and nuclear major incidents

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Abstract

Chemical, biological, radiological and nuclear (CBRN) incidents have the potential to be catastrophic if they occur on a society that is not prepared for them. It is important to know how to make plans to mitigate against such events as well as to manage a scene where CBRN agents are present. CBRN agents are potentially hazardous to responders at both a scene and many miles away in a medical treatment facility. An understanding of the risks and the ways to mitigate these is paramount. Early recognition, treatment with specific antidotes and decontamination can have a profound effect on both morbidity and mortality of those affected.

Keywords Biological; CBRN; chemical; major incident; nuclear; radiological

Introduction

In the UK, major incidents are rare, and those involving chemical, biological, radiological or nuclear (CBRN) components are rarer still. However, it is important to recognize that these incidents could happen without any warning, thus leaving minimal time to co-ordinate an appropriate response. It is therefore paramount that organizations have a specific CBRN major incident plan, that their staff are aware of this plan and that training is undertaken in advance of any potential incident.

The key points underlying the successful management of CBRN major incidents are: prior planning, recognition, early administration of antidotes, decontamination, and movement to specialist care.

In addition, CBRN-related injuries may require additional/non-conventional management.

Although the term 'CBRN' is often used to refer to just deliberate use of hazardous material, in this article it will refer to both deliberate and accidental exposure to CBRN hazardous material.

Types of CBRN agents

There is a long history of CBRN agents being used in warfare and many examples of accidental release of toxic industrial chemicals, hazardous biological agents, and of nuclear material. Increasingly, state-sponsored activists and terrorist organizations are using both simple and more complex CBRN agents in their attacks and these have the potential for not only increased loss of life but significant impact in terms of clean-up operations, damage to infrastructure and hysteria/panic within a population.

Improving medical professionals' understanding of CBRN will increase understanding of the different agents and their pathophysiology and therefore improve management and patient outcomes.

Chemical

The most common causative agent in a CBRN incident is chemical, either due to accidental or deliberate release of a substance. Chemical agents range from household items to chemical weapons and can cause a wide spectrum of presentations from mild symptoms to death. Examples include nerve agents, cyanide, chlorine, or bleach.

Biological

Biological agents can be divided into live agents and toxins. These can cause a wide array of clinical presentations and their management will differ depending on the specific agent. It is important to remember that infected casualties may be contagious and able to spread the biological disease through person-to-person transmission. In hospital, management of casualties suspected of being exposed to a biological agent will require close liaison with the infection control team.

Due to the variation of incubation periods of biological agents, there may be a delay in symptom presentation. This carries a risk of the disease spreading over a large area before recognition has occurred. This can make forensic investigation of natural disease versus deliberate release of a pathogen particularly difficult as it may not be possible to identify the site/scene at which the biological agent was released.

Toxins are more akin to chemical agents in that they are not alive but are produced by biologically active organisms.

Radiological

Ionizing radiation is a type of energy released during the decay of radioactive material as well as from certain equipment, such as X-ray machines. Different types of radiation will cause different effects as the properties of each type varies.

Alpha particles travel only short distances and cannot penetrate through skin due to rapid loss of momentum following release. They are only thought to be hazardous when inhaled, ingested, injected, or absorbed through open wounds but are otherwise stopped by an intact layer of skin.[1]

Beta particles can travel further and may damage the actively dividing deeper layer of the skin although both clothing and PPE would offer some protection against this.[1] Eyes are also susceptible to damage from beta radiation unless eye protection is worn. Like alpha particles, beta particles are hazardous to internal organs on ingestion, inhalation, injection, or absorption through an open wound.[1]

Gamma rays and X-rays travel further than other forms of ionizing radiation and can travel through many meters of air and penetrate internal organs and deep tissues. Although they interact less with tissues, because gamma rays can penetrate

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further into the body, exposure causes more damage than the other forms of ionizing radiation. Dense materials such as concrete or lead shielding will provide protection from gamma and X-rays.

Nuclear

In the early phase of a nuclear incident, such as a nuclear reactor or nuclear weapon detonation, casualties not killed by the initial blast will be exposed to neutrons. These particles are a highly damaging form of radiation that can travel extensively through tissue and material. Neutrons will only be present for a short time at the beginning of a nuclear incident; however, casualties who remain at the scene or are contaminated with materials from the scene will remain at risk of ionizing radiation from the radioactive materials as they emit alpha, beta and gamma radiation.

It is important to note that casualties exposed to radiation but not contaminated with radioactive material do not present any risk to others. In contrast, a contaminated patient will continue to be irradiated by the radioactive material until it is removed and will pose a risk of exposure to those treating/nearby/first responders.

Radiological and nuclear incident management can therefore be grouped together as the damage from both is caused by ionizing radiation and the treatment is similar for both. Exposure to radiation may occur from industrial accidents but may also occur during deliberate release of radiological material.

Characteristics of CBRN agents

General characteristics of CBRN agents to consider include toxicity, latency, and persistency. Understanding these characteristics will allow for earlier recognition, appropriate decontamination, and improve overall management of the incident.

Toxicity

This refers to the severity of effects caused by the agent. The severity of these effects can be expressed as:

- Lethal: the lethality of an agent is expressed as the LD50, which is the lethal dose to kill 50% of the exposed population. The lower the LD50 value, the more toxic the agent will be as less of the agent is required to cause a lethal effect.
- Damaging: these agents have a lower mortality of usually <5%; however, they cause lasting damage to health and can cause significant morbidity.
- Incapacitating: these refer to the reversible incapacitating ability of some agents. For example, an agent causing severe vomiting will cause incapacitation of casualties but is less likely to cause any lasting morbidity or mortality. An incapacitating dose (ID50) can be calculated for these agents.

Latency

This is the time between casualty exposure to the agent and symptoms starting. CBRN agents display different speeds of onset:

- Immediate: the casualty will demonstrate symptoms from the exposure immediately, such as with cyanide gas.
- Acute onset: symptoms develop within 6 hours of exposure, such as with a nerve agent.
- Delayed onset: symptoms may take between 6 hours up to several weeks to develop. This may cause a delay in recognizing the cause, such as with a biological agent.
- Late onset: occurring months to years after exposure, such as cancers which may develop following exposure to radiological material.

Persistency

The persistency determines how long the agent will remain in the environment. It dictates how casualties are decontaminated and the risk of secondary infection to others. Persistency is related to the physical properties of the agent:

- Gas: this will be an inhalational hazard existing at room temperature. It is non-persistent and theoretically does not need decontamination beyond leaving the environment in which the gas is present. In practice, disrobing and decontamination is typically performed due to the difficulty of immediately distinguishing between gas and vapour at a CBRN incident.
- Vapour: an agent that is a liquid at room temperature but will evaporate and diffuse into the air causing inhalational hazard. Vapours can condense onto clothing and so can also be a contact hazard. Theoretically, decontamination would only require disrobing if no skin exposure occurred but in practice dry or wet decontamination is also performed due to partial skin exposure typically occurring.
- Liquid: liquid agents can either be ingested or be contact hazards. They are a persistent hazard, although their persistency depends on the volatility of the agent.
- Solid: these can be of various sizes ranging from fine dust to large blocks of an agent. Radiological agents are the most likely to be present in solid form. Solids represent both an ingestion and contact hazard, and are persistent.
- Aerosols: these can be formed from either liquid or solid agents with small particle sizes. Once aerosolized, they represent a droplet hazard requiring respiratory protection and can be a persistent hazard if deposited on skin or clothes.
- Infectious hazards fall into a separate category and the ability to transmit these depends upon how long they can survive on various surfaces and if the organism is spore/fomite forming.

CBRN incident management

While the potential for a CBRN incident should always be in the back of the mind of a first responder it is neither sensible nor practical for every incident to be approached in full chemical personal protective equipment (PPE) by the first people to arrive on a scene. When the cause of an incident is unknown, a safety trigger used in the UK is the 1, 2, 3+ rule which governs actions when a number of casualties are displaying the same signs/symptoms at the same incident (Table 1).[1]

In the event of a suspected CBRN incident, specialist teams should be called for. In the UK this will include the fire service and the Hazardous Area Response Team (HART) who are trained to wear the specialist PPE as well as in the decontamination and management principles required for CBRN threats.

The 1, 2, 3+ step rule

Step 1	One casualty	Approach using NORMAL procedures CBRN contamination unlikely
Step 2	Two casualties	Approach with CAUTION, consider all options CBRN contamination possible Report on arrival, update control If possible or suspected, follow advice for STEP 3
Step 3+	Three casualties or more	DO NOT APPROACH – CBRN INCIDENT CONTAMINATION LIKELY Identify hazards Control scene Give METHANE report as soon as possible Direct ambulant casualties to place of safety Make risk assessment and provide help to non-ambulant casualties if benefit outweighs risk using minimum personnel & appropriate PPE

Table 1

A CBRN scene

A CBRN scene can be considered in terms of several zones where the risk to the casualty and responder varies and where it is appropriate to do different interventions.

Hot zone: The hot zone refers to the area where there is an ongoing and direct hazard to casualties and to responders. The size of the hot zone depends upon the type and nature of the hazard. For example, a gaseous or vapour hazard can be carried by the wind and therefore the hot zone can extend downwind of the original area of release.

Responders entering the hot zone will need appropriate protective equipment or a limited time in the zone for their own safety.

Management of casualties in the hot zone encompasses a brief assessment and management of immediately life-threatening injuries only. This is typically management of catastrophic haemorrhage, airway, and delivery of antidotes (if the agent is known or suspected) before evacuating the casualty out of the hot zone for decontamination and further treatment.

Warm zone: This area represents a secondary contamination hazard from contaminated equipment, casualties or personnel leaving the hot zone. Decontamination starts in this zone and ideally should be completed before casualties leave it. Responders will also need to decontaminate their PPE and themselves prior to leaving this area. Secondary warm zones may exist if contaminated casualties are removed from the scene to be decontaminated at other sites, e.g. outside the medical treatment facility.

Cold zone: This is the clean area and is where definitive care can be initiated following removal from the hot zone, initial life-saving interventions and decontamination. The area includes a clean area at the scene and the medical treatment facilities to which casualties are taken. In this area it is usually not necessary for responders to wear PPE but this will depend upon the type and nature of the hazard.

Triage

Triage is slightly more complex in a CBRN environment and may be more difficult to perform by a responder wearing PPE. The principle is the same as triage in non-CBRN incidents with the caveat that the triage category can be upgraded by 1 if there are signs of toxicity as illustrated by Figure 1.[2]

Decontamination principles

Rapid and effective decontamination following exposure is paramount to ensure the safety of casualties and responders alike as casualties may pose a risk to responders if they are contaminated and/or contagious.[1] The type and level of decontamination will depend on the agent and its properties, if known. The route of exposure will also determine how decontamination is performed. Ideally, all casualties should be decontaminated at the scene, but it is possible that, in a mass casualty scenario, contaminated casualties may self-present to healthcare facilities.[3] It is therefore prudent hospital point-of-care departments understand CBRN incident decontamination principles.

In the UK, decontamination responsibility lies with the fire and ambulance services, however, 'emergency decontamination' should be commenced immediately whilst specialist input/equipment is arranged. Specialist decontamination facilities will take some time to arrive at the scene and be set up. Decontamination should not be delayed while these resources arrive. All hospitals should undertake the same form of 'emergency decontamination' for self-presenting patients of CBRN incidents.

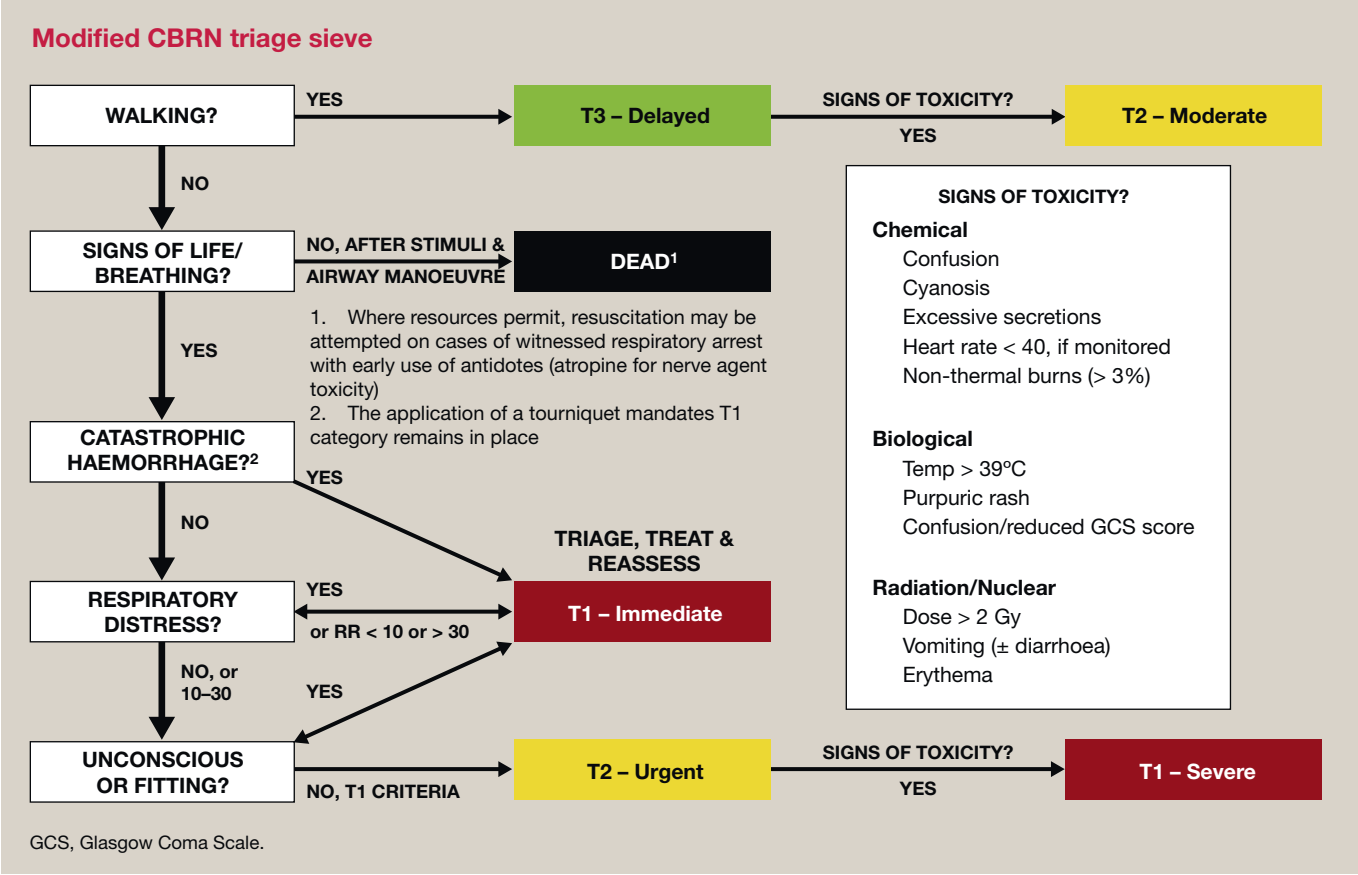

Figure 1

Self-decontamination should be encouraged for all walking casualties who are able to follow directions as this will allow multiple casualties to be decontaminated at the same time. Decontamination of stretcher casualties is time consuming and takes several members of staff to achieve safely and adequately.

It may not be possible to fully decontaminate a casualty at the scene, for example if they have a wound that is deeply contaminated which can only be fully decontaminated by surgical debridement. In these circumstances the wound should be dressed and sealed using 'cling film' wrap. Communication with the receiving medical treatment facility is then paramount to alert them to a contaminated wound so that the staff at this facility can be wearing the appropriate PPE when the patient arrives.

Disrobing: the initial step of gross decontamination involves the removal of clothing and any obvious contaminant from the casualty and is highly effective at reducing exposure to agents.[1] As high as 90% of decontamination can be achieved by removing the casualty's clothing which should be sealed in a double bag and stored in a well-ventilated area.

Dry decontamination: use dry paper tissue or towels to blot and gently rub the skin of the contaminated casualty to remove any liquid contaminant. The material used should be absorbent enough to prevent transfer of contaminant around the patient's skin. As for disrobing, waste from dry decontamination should be sealed and stored in a well-ventilated space.[1]

Wet decontamination: if there is evidence of a caustic substance (indicated by symptoms of skin burning or stinging) then wet decontamination will be required, using water and a sponge to clean the skin of the material. The process should take at least 90 seconds using a rinse-wipe-rinse approach. If there is evidence of eye involvement, then the eyes should be irrigated extensively with 0.9% sodium chloride.

Assessment

It would be difficult and impractical for all front-line staff in a health service to be intimately familiar with all the signs and symptoms of every CBRN agent so a system of 'quick look' exists with some common agents and their symptoms and signs arranged via the acronym CRESS:

- conscious level
- respiratory rate
- eyes
- secretions
- skin.

This allows early identification of the causative agent and, therefore, rapid administration of appropriate antidotes.

The CRESS assessment for various chemical agents is summarized in Table 2.[2]

For biological agents the most common presenting feature is a fever and generic prodromal illness which may include fatigue, myalgia, malaise, and nausea. It can be difficult to

CRESS assessment for chemical agents

	Nerve agent	Methaem	Cyanide	Pulmonary agents	Vesicant/acid/alkali	Atropine	Botulinum	Opiate
Consciousness	Fitting/↓	Agitated	Fitting/↓	Normal	Normal	Confused	Normal	↓
Respiration	↑↑	↑/↑↑	↑↑/Apnoea	↑↑	↑			↓
Eyes	Pinpoint	Normal	N/Dilated	N/Dilated/Painful	N/Red/Painful	Dilated	Dilated	Pinpoint
Secretions	↑↑	Normal	Normal	N/Frothy	N/↑			Normal
Skin	Sweaty	Cyanosed	Pink/Cyanosed	N/Cyanosed	Red/Blisters	Dry	Dry	Normal
Other	Fasciculations	Chocolate blood	Very rapid onset Lactic acidosis	Pink sputum	Mustard (delayed 6–12 hours)		Descending paralysis	

Table 2

differentiate one biological infection from another until other symptoms begin to emerge. It is easiest to consider symptoms as grouped together to form syndromes and then the differential diagnosis for these syndromes. The summary in Table 3 is not an exhaustive list but a starting point when considering biological casualties.

It is also important to note that some biological agents do not have a specific tissue or organ effect as they work at the intracellular level, and as such may present with multi-organ failure and no clear causative agent. Similarly, even biological agents with recognized syndromes can present this way if it is severe or if the person who has been infected is more susceptible, e.g. immunocompromised patient.

Treatment

The treatment given to CBRN casualties will depend upon a number of factors but is best described using the <C>AaBCDdEe approach:

<C>: Catastrophic haemorrhage
A a: Airway and antidotes
B: Breathing, application of oxygen
C: Circulation
D d: Disability and decontamination
E e: Exposure and evacuation

Whilst within the hot zone, the priority is to provide only those interventions which are required immediately to save lives and so will be limited to <C>, A and a where a 'quick look' assessment can be used to identify the potential cause and the antidote required. This gives responders the opportunity to start life-saving interventions prior to decontamination and evacuation out of the hot zone. <C> Catastrophic haemorrhage treatment remains similar to non-CBRN incidents, with the priority given to early application of tourniquets. However, tourniquets applied in the hot zone ideally should be applied higher up the limb than usual and this allows a clean tourniquet to be placed in the conventional position closer to the wound during the decontamination process. The contaminated original tourniquet can then be carefully removed once the lower, clean, tourniquet is controlling the bleeding.

Some agents will have specific treatment available to be used immediately in the form of 'combo-pens'. These are auto-injectors that may be carried by the ambulance service/first responders for quick and easy intramuscular administration of an antidote. One example of such an auto-injector is for the treatment of nerve agent poisoning and is carried in the UK by HART. Further management can be considered in terms of generic management and then specific therapy once the causative agent is identified.

General management principles can be followed for the remaining of the <C>AaBCDdEe approach: ensuring that the airway is managed and protected if required, that the patient is adequately oxygenated and ventilated, and that they have

Differential diagnosis[1]

Syndrome	Differential diagnosis/causative organism
Gastrointestinal	*Salmonella*, *Shigella*, *Campylobacter*, viral haemorrhagic fevers
e.g. diarrhoea, vomiting, blood in stool	
Respiratory	Tuberculosis, pulmonary anthrax, pneumonic plague, tularaemia, influenza
e.g. cough, sputum production, haemoptysis, dyspnoea, chest pain	(seasonal or pandemic), coronavirus, Q fever, viral pneumonitis
Cutaneous	Chickenpox, cutaneous anthrax, radiation, chemical or thermal burn, smallpox
Either localized lesions or widespread rashes	
Neurological	Meningitis or encephalitis
e.g. central – confusion/agitation, meningism,	Botulism, Guillain–Barré syndrome
peripheral – flaccid paralysis	Carbon monoxide poisoning, heavy metal poisoning, nerve agents, toxic alcohols
Haemorrhage	Viral haemorrhagic fevers, severe infection causing DIC, plague, anthrax
e.g. bleeding from mucus membranes, evidence of DIC	

Table 3

appropriate fluid resuscitation and haemodynamic support. This is all likely to take place within a medical treatment facility and in the most severe cases in an intensive care unit familiar with dealing with organ system support. This generic management buys time for specific management to be coordinated and delivered but also prevents or reduces some of the complications of critical illness.

Specific agent management

Nerve agents (e.g. tabun, sarin, soman, VX, Novichok)

Nerve agents are highly toxic substances used in chemical warfare. There are organophosphate pesticides in use around the world that have a similar effect.

These act by inhibiting anticholinesterase, which results in excess acetylcholine binding to receptors throughout the nervous system. This leads to seizures, paralysis and respiratory arrest. Very small doses may be fatal. They can be absorbed through skin – including through clothing – and eyes, by inhalation and by ingestion. The effect will depend on the type and dose of nerve agent used as well as the duration and route of exposure.

Initial management will primarily require an anticholinergic, namely atropine, which blocks the muscarinic receptors the excessive amount of acetylcholine is binding with to cause symptoms. The dose is adjusted to the response and improvement of heart rate, bronchospasm and secretions. Large doses of atropine may be required for this, and it is available in more concentrated, larger volume preparations for this purpose. In addition, an anticholinesterase enzyme reactivating drug e.g. pralidoxime, is used to act directly as an antidote against the nerve agent itself.[1] Benzodiazepines are also used for control of seizures, and severely symptomatic patients are likely to need ventilatory support in ICU for prolonged periods of time – until their acetylcholinesterase has regenerated in sufficient quantities for normal nerve function to occur.

In the UK, any incident thought to involve a nerve agent should be escalated to the National Poisons Information Service (NPIS) and expert advice sought.

Cyanide

Cyanide inhibits aerobic respiration by inhibiting mitochondrial enzymes, preventing them from utilizing oxygen as part of the cellular energy production processes.

It rapidly causes cellular hypoxia, metabolic acidosis and, ultimately, death. Primarily it is absorbed through inhalation, although cyanide salts can be absorbed through the skin or ingested. Inhalational exposure will show rapid symptom manifestation, whereas ingestion or absorption through the skin may present more insidiously.

Treatment of cyanide toxicity depends on the clinical features of the casualty. Oxygen needs to be given to all, but if the casualty is breathing normally and conscious 5 minutes after removal from the source then they should recover spontaneously.

There are several antidotes available for cyanide poisoning. In the case of mild poisoning, sodium thiosulphate is recommended which acts as a sulphur donor and converts cyanide to less toxic thiocyanate.[1,4] This antidote is recommended in mild cases only as it has slow onset of action and short half-life.

In severe poisoning, hydroxocobalamin (only in the form of Cyanokit) is recommended. Cyanide preferentially binds with hydroxocobalamin instead of mitochondrial enzymes and therefore aerobic respiration is no longer inhibited. Hydroxocobalamin is recommended only in severe cases as it has high risk of adverse drug reactions such as anaphylaxis and acute kidney injury due to tubular necrosis.[1,4] Sodium thiosulphate may be used as an adjunct to hydroxocobalamin in severe cases.

A historical treatment is dicobalt edetate – but this is no longer being manufactured.

Chlorine/pulmonary agents

Chlorine is a highly irritant and corrosive gas that is fatal in high concentrations. It has both direct and indirect damaging actions on the respiratory tract:

- Direct actions – forms acids when it reacts with water causing direct physical damage to the cells and allowing leakage between them. Irritates the smooth muscle and causes spasm leading to reduction of airway size.
- Indirect actions – leads to free-radical formation that can cause secondary damage to the respiratory tract. Inflammation causes acute respiratory distress syndrome (ARDS) and a generalized inflammatory response. This also contributes to inflammation and thrombus formation within the lung vasculature.

There is no specific antidote for chlorine or other pulmonary agents aside from advanced intensive care including lung protective ventilation techniques and the consideration of extracorporeal membrane oxygenation (ECMO) to maintain adequate tissue oxygenation while the lung inflammation is reduced.[5] Surviving patients may be left with long-term fibrosis because of chlorine exposure.

Biological management

Several things need to be considered in the management of the biological casualty, as they remain a hazard for longer than chemical casualties who can be decontaminated. Infection control is therefore paramount to prevent ongoing spread between patients, from patients to healthcare workers and from healthcare workers to the rest of the population (including other patients). Strict isolation of infectious patients and rigorous attention to PPE and handwashing practices are required to contain outbreaks of infectious diseases. Isolation can be individual or by cohort depending upon the number of patients and the resources available.

Some important principles include:

- Infectivity refers to the ease with which an agent can cause an infection. For example, anthrax requires many spores to create an infection compared to 10–50 organisms for tularaemia.
- Transmissibility refers to how easily a live agent can spread from person to person. On a population level, this has been referred to as the R number during the COVID-19 pandemic and relates to the number of people an infected person passes the infection on to. An R number <1 means that overall numbers are decreasing and an R number >1 means that they are increasing.

Specific treatment of biological patients is encompassed by the UK Surviving Sepsis Campaign principles of[6]:

- obtaining cultures prior to antibiotic administration
- measurement of serum lactate level
- administration of broad-spectrum antibiotics
- bolus of crystalloid fluid of 30 ml/kg for hypotension or lactate 4 mmol/L
- vasopressor therapy if hypotensive despite fluid resuscitation to achieve a Mean Arterial Pressure (MAP) of 65 mmHg

Antimicrobial therapy can be narrowed or specifically targeted if the organism is known/suspected or based on the results of appropriate investigations, depending upon the syndrome identified.

Radiological management

Radiation exposure is most likely as a result of an industrial incident, but it could be caused by the deliberate release of radioactive material (i.e. a 'dirty bomb') or as a result of a nuclear explosion. Depending upon which of these incidents has occurred determines if the casualty is an ongoing hazard to themselves and others. People who have been exposed to a radioactive source that they have been moved away from have been irradiated but are not contaminated. People who have radioactive material on their clothes or person have been contaminated and are exposing themselves and others to an ongoing radioactive source. To determine which of these is the case is relatively easy by measuring the radiation level coming from a person using a Geiger counter. In the UK, all emergency departments have Geiger counters and advice can be sourced locally, from the hospital's nuclear medicine department, or nationally, from Public Health England.

Radiation causes damage to the DNA of our cells, breaking the double helix. Cells that are rapidly turning over, e.g. mucus membranes and bone marrow, are the most susceptible to damage from ionizing radiation and are where the initial symptoms of radiation sickness become evident.

When DNA is damaged, one of three things occurs:

1. The DNA is repaired and the cell survives.
2. The DNA is not repaired and the cell dies – leading to the deterministic effects and acute radiation syndrome.
3. The DNA is mis-repaired and mutates. This can lead to cell death or transformation, the latter of which causes stochastic effects and the long-term risk of developing cancer.

The acute radiation syndrome consists of a prodromal illness including nausea, vomiting, diarrhoea, and a widespread rash. This is followed by a latent asymptomatic period after which cell death within the GI tract, vasculature and bone marrow cause haemorrhage and significantly increased susceptibility to infections, which are the most common modes of death.

There is no specific antidote to radiation illness, but supportive treatment includes aggressive management of coagulopathy, infection, and multi-organ failure. People who do survive have a large increase in their lifetime cancer risk.[1]

Summary

The potential for CBRN agents to complicate industrial accidents or terrorist events should always be in the back of the mind of both the emergency planner and all responders. The confounding factors that would result from such an event cannot be mitigated against without significant prior thought, planning, procurement of PPE and antidotes or training of front-line staff.

The key principles are advanced planning, consideration, and recognition that a CBRN event has occurred, appropriate triage, decontamination and treatment at scene and then definitive care at an appropriate medical treatment facility. ◆

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Practice points

- The triage sieve used for CBRN incidents is greatly similar of that used for non-CBRN incidents with the caveat that the triage category can be upgraded by 1 if there are signs of toxicity
- The treatment to CBRN casualties is best summarized by a <C>AaBCDdEe approach:
  - <C>: Catastrophic hemorrhage
  - Aa: Airway and antidotes
  - B: Breathing, application of oxygen
  - C: Circulation
  - Dd: Disability and decontamination
  - Ee: Exposure and evacuation
- While in the hot zone of a CBRN scene the priority is to provide immediately lifesaving interventions only, which will be limited to <C> and Aa of the <C>AcBCDdEe approach
- Decontamination of CBRN casualties starts in the warm zone of a CBRN scene and should be completed (as much as feasible) before the patient leaves this zone. 'Emergency decontamination' should be commenced immediately and consists of disrobing and dry decontamination (using paper tissue or towel to blot and rub). Wet decontamination (using clean warm water with detergent and the rinse-wipe-rinse method) is reserved for caustic substances. Self-decontamination of walking casualties should be facilitated as much as possible
- In mass casualty CBRN incidents, contaminated casualties may self-present to healthcare facilities, therefore it is essential for point-of-access healthcare staff to understand and know how to implement 'emergency decontamination' methods