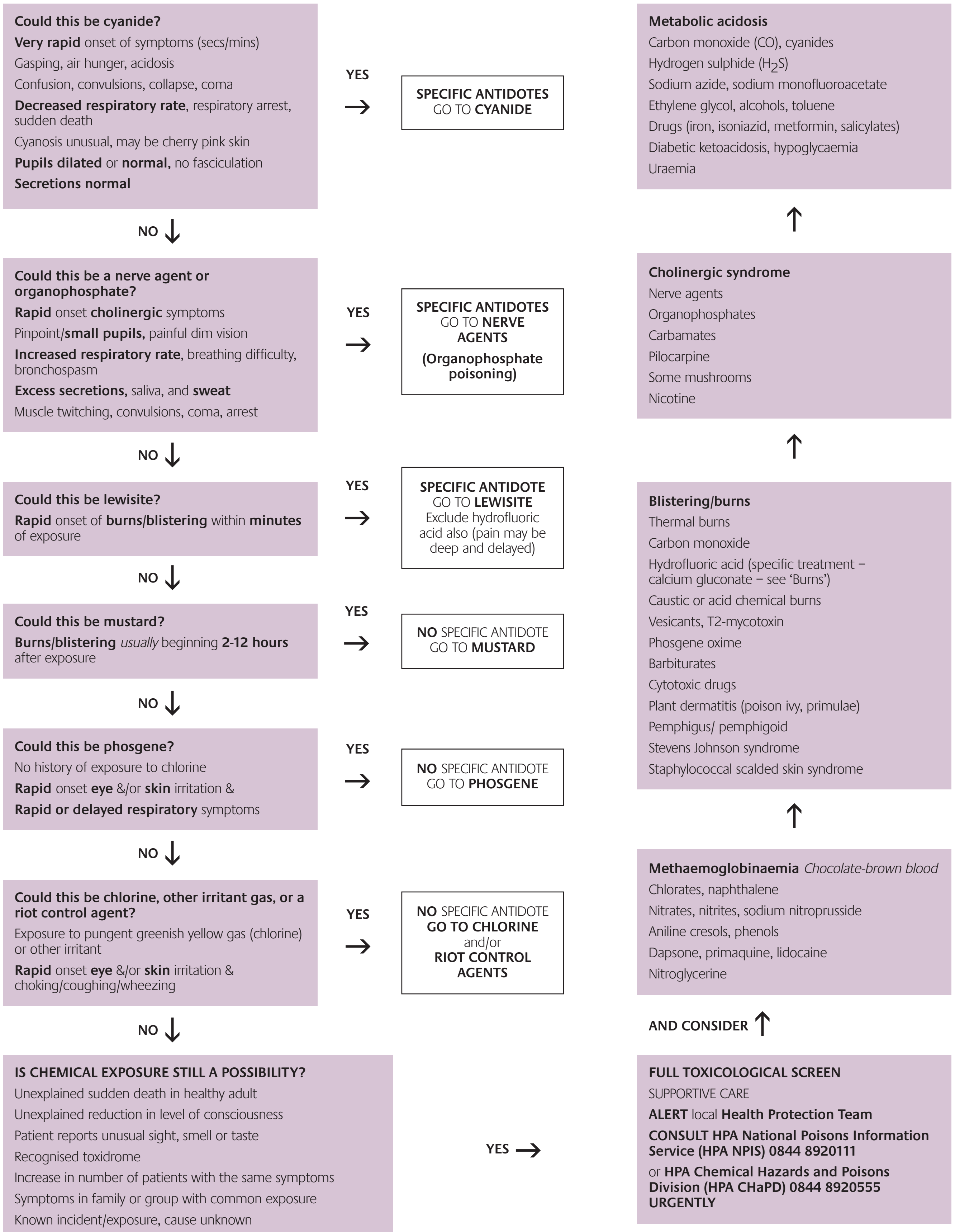
Chemical incidents

Diagnosis and early management in chemical incidents

If you know, or strongly suspect, that your patient has been involved in a chemical incident:

- Ensure either that you are wearing 'chemical' PPE **or** that patient has been decontaminated
- Decontaminate patient (outside the department, in the NHS decontamination unit/decontamination area) if this has not already been done
- Stabilise airway (oxygen by mask, intubate and ventilate if needed), control any haemorrhage, set up IV access if needed
- Assess cause, give antidotes if appropriate, reassess, alert local Health Protection Team (HPT), and seek expert advice if needed from HPT, Toxbase, HPA National Poisons Information Service (HPA NPIS) or HPA Chemical Hazards and Poisons Division (HPA CHaPD)

Diagnostic algorithm



Chemical exposure record form

Overview

- Chemical exposures may have both short term and long term consequences for patients, so it is very important to record, as fully as possible, the details of any exposure at the time that it is recognised
- This form should be photocopied for use in incidents involving fewer than 20 cases. For larger incidents, the toxicology coordinator should contact HPA Chemical Hazards and Poisons Division (HPA CHaPD) 0844 8920555 before completing case records, as a scannable version of this record form may be available from them
- Forward the completed form to HPA Chemical Hazards and Poisons Division (HPA CHaPD), and put a copy of the completed form in the patient's notes

Chemical exposure record form

PATIENT DETAILS This section may be completed by the patient, or a clerk, volunteer, or health professional					
Hospital/Trust			Date of arrival		Time
Hospital number			EMD number		
Surname			First name		
Male	Female	Age (years)	Date of birth		
Home address					
Town					
Country			UK resident?	Yes	No
Postcode	Telephone number (include STD code)				
Name of GP (if patient UK resident)			PCT		
This section completed by	Patient	Clerk	Other (specify)		
EXPOSURE and DECONTAMINATION This section (and the rest of the form) must be completed by a health professional					
Has the patient been chemically contaminated?	Yes		No		Not sure
If yes, date and time of contamination?	Date				Time:
If yes, where was the patient when contaminated?					
Was the contaminant?	Solid	Liquid	Vapour/gas		Not sure
Route of exposure?	Inhaled	Eaten	On skin		Not sure
Name of chemical (or other detail, eg UN number):					Not known
Was the patient decontaminated at the scene?		Yes	No		Not sure
Has the patient been decontaminated in the EMD?		Yes	No	Time:	
EXPOSURE-RELATED SYMPTOMS and MANAGEMENT					
Has the patient developed any symptom/s?		Yes	No		Not sure
If yes, please list the symptom/s:					
Date and time of onset of the first symptom?	Date			Time:	
Triage category at scene?	Not known	Immediate	Urgent	Delayed	
Triage category in EMD?	Not known	Immediate	Urgent	Delayed	
AVPU at scene? Alert	Verbal stimulus response	Painful stimulus response		Unresponsive	Not known
Has any antidote been given?		Yes	No		Not sure
If yes, give name and dose of any drug given as antidote:					
Have specimen/s been taken for toxicology?	Blood		Urine		None
OUTCOME					
Has the patient been admitted to this hospital?	ITU		Ward		No/not sure
Has the patient been discharged?	Yes		No		Not sure
Given a follow up appointment at this hospital?	Yes		No		Not sure
Given instructions to see GP within 24 hours?	Yes		No		Not sure
Given an information leaflet?	Yes		No		Not available
Has the patient been referred to another unit?	No		Name of unit		
Did the patient die?	Date of death		No		
These sections completed by:	Name		Grade		Other

DO NOT WRITE ON THIS FORM – USE IT AS A MASTER TO MAKE PHOTOCOPIES

Toxicological testing

Overview

- Emergency medicine departments have been supplied with **Toxi-Boxes (Toxicological Analytic Sampling Kits)**, and these kits should be used, where possible, for toxicological sampling

Each Toxi-Box contains:

- 1 x 10ml plastic lithium heparin tube
- 1 x 5ml glass lithium heparin tube
- 1 x 4ml EDTA tube
- 1 x 60ml universal container for urine (the top is wide enough for males and females to urinate into directly, thereby minimising the risk of cross contamination)
- Corrugated cardboard for wrapping samples
- 1 x chemical incident analysis request form (this must be filled in for each patient)
- 1 x double plastic bag for form and samples
- 1 x cardboard container

Sampling guidance

- Decontaminate the patient before obtaining any samples
- Collect samples as early as possible, ideally pre-treatment – but do not delay life-saving treatment to obtain them
- Always use STANDARD precautions when obtaining any clinical specimen
- Use additional PPE (face shield/eye protection; mask; double gloves) if the hazard warrants or aetiology is uncertain
- If you are uncertain about what PPE to use, or which specimens to collect, seek expert advice
- Telephone the chemical pathology/biochemistry laboratory in advance to tell them to expect the specimens
- If you cannot locate a Toxi-Box, use routine specimen bottles with plastic or metal lined tops for blood specimens instead (you may need to obtain them from the phlebotomy service), and sterile preservative-free universal containers for urine specimens. In this case, you will also need to send, for every specimen, an empty specimen bottle of the same type and from the same batch to act as a control
- Do NOT use Vacutainer™ tubes, tubes containing gel separators or mucous heparin, soft plastic bottles, re-usable containers or containers with rubber bungs for toxicology specimens – all of these can interfere with assays
- Do NOT pre-clean the venepuncture site with alcohol or proprietary skin wipes or swabs (eg Mediswabs™): these contain solvents that can interfere with some assays. Use sterile water or, if the skin is visibly clean, dry cotton wool
- Fill each of the blood specimen tubes. It is particularly important that the 5ml glass lithium heparin tube is filled to leave the minimum safe air space. If venepuncture is difficult, prioritise according to the table below
- Screw container caps tight. Do not centrifuge
- Avoid contaminating the outer surface of specimen containers during specimen collection
- Label all samples with the patient's name, hospital number, date and time of sample
- Label all samples as 'high risk' (or otherwise identify them as 'high risk' using your locally agreed method)
- Place the samples in the sealable section of the plastic specimen bag
- Complete the chemical incident analysis request form, mark it 'high risk', and place in the other section of the plastic bag
- Wrap the plastic bag tightly in the corrugated cardboard and place in the cardboard container
- Tape the cardboard container shut
- Complete a chain of evidence form if necessary
- Transport container to your local chemical pathology/biochemistry laboratory by hand as soon as possible, using locally agreed procedures for high risk samples

In order of importance, the samples for a blind toxicological screen should consist of:

Adults	Children
• 10ml blood in plastic lithium heparin tube • 5ml blood in glass lithium heparin tube • 4ml blood in EDTA tube • 30ml urine without preservative	• 5ml blood in glass lithium heparin tube • 4ml blood in EDTA tube • 30ml urine without preservative

See also

Emergency contacts, chain of evidence documentation, standard precautions, chemical incident analysis request form and the chemical exposure record form

Chemical incident analysis request form

Overview

- Emergency departments have been supplied with **Toxi-Boxes** (Toxicological Analytic Sampling Kits), and these kits should be used, where possible, for toxicological sampling. Each kit contains a chemical incident analysis request form, which should be completed for each patient on whom toxicological tests are requested. A version of this form is reproduced below, and may be copied freely

Chemical incident analysis request form

Unless you are certain which samples are required and to which analytical toxicology laboratory they should be sent, please check first with HPA Chemical Hazards and Poisons Division (HPA CHaPD) 0844 8920555

READ THE NOTES ON TOXICOLOGICAL TESTING BEFORE YOU TAKE A SAMPLE
PLEASE COMPLETE THIS FORM IN BLOCK CAPITALS

REFERRING LABORATORY:				**ANALYTICAL TOXICOLOGY LABORATORY:**	
PATIENT DETAILS					
Surname:				First name:	Sex:
Hospital number:				Date of birth:	Age:
Hospital/Trust:				Ward/Unit:	
Analysis requested by:				Consultant:	
SAMPLE DETAILS				Name and address for report	
Sample date	Sample time	Sample type	Req Lab No	ATL No (specalist lab use only)	
		Heparinised blood (10ml)			
		Heparinised blood (5ml)			
		EDTA blood (4ml)			
		Urine (30ml)			
EXPOSURE DETAILS					
Place of exposure:			Unknown:		
Date (dd/mm/yy) of exposure:			Unknown:		
Time exposure occurred (24 hr clock):		:	Unknown:		
Exposed to (give name of chemical):			Unknown:		
Length of exposure (estimate duration in minutes):			Unknown:		
Clinical features (please describe these as fully as possible, and give time and date of onset for each symptom or sign):					
				Telephone number:	
				Telephone number for urgent results:	
				Name and address for invoice:	
				Telephone number:	
CHAIN OF EVIDENCE FORM	A form has been completed and accompanies these specimens (Yes/No):				

BEFORE REFERRING THESE SPECIMENS, please NOTIFY the ANALYTICAL TOXICOLOGY LABORATORY
PHOTOCOPY the COMPLETED REQUEST FORM and GIVE THE PHOTOCOPY to the TOXICOLOGY CO-ORDINATOR

DO NOT WRITE ON THIS FORM – USE IT AS A MASTER TO MAKE PHOTOCOPIES

Understanding chemical hazard labels

Vehicles transporting dangerous goods in quantity on **journeys in the UK** carry hazard (**Hazchem**) warnings, often combined into a single label like this:

The three-character **Emergency Action Code** (EAC) provides information that tells the emergency services about immediate actions (whether to use fine spray, coarse spray, foam or a dry agent to fight any fire; the PPE needed, safe spillage management) to take on arrival at an incident. The **UN Substance Identification Number (SIN)** is an internationally agreed four-digit code that identifies the chemical. The diamond-shaped symbol shows to which of the 9 UN Hazard Groups the chemical belongs. Companies also provide a telephone number for emergency advice.

Vehicles in the UK **transporting dangerous goods on international journeys** may use a different warning system, where the three-digit **Kemler code** (or ADR Hazard Identification Number [HIN]) is used to describe chemical hazards. The first digit specifies the primary hazard (eg 2=gas, 6=toxic); additional characters describe secondary hazards (eg X=reacts dangerously with water, 606=infectious substance).

The nine main **UN Hazard Groups** are:

Class 1: Explosive eg fireworks, ammunition, hydrazine: subgroups 1.1-1.6 include 1.1: mass explosion hazard, 1.4: no significant hazard

Class 2: Gases (2.1: flammable; 2.2: non-flammable, non-toxic; 2.3: toxic)

Class 3: Flammable liquids (eg diesel, xylene, methanol, alcohol)

Class 4: Flammable solids eg barium, sodium (4.1: flammable solid; 4.2: spontaneous combustion risk; 4.3: release flammable gas on water contact)

Class 5: Oxidisers (5.1) or organic peroxides (5.2)

Class 6: Toxic (6.1 - includes sarin, nerve agents, mustard, lewisite, pesticides) or Infectious (6.2) substances

Class 7: Radioactive substances and articles (sources in nuclear industry, industrial radiography, military, nuclear medicine, radiotherapy)

Class 8: Corrosive substances (eg chlorine, fluorine, sodium hydroxide, nitric acid)

Class 9: Miscellaneous dangerous substances (eg pepper spray, mace, asbestos)

A **CAS number** (which has the form **XXX-XX-X**) is a unique identification number given to a chemical by the Chemical Abstract Service.

In the UK, **suppliers of chemicals** and other potentially harmful substances are required to classify the hazards of the chemicals, to provide information about the hazards using **package labels** and Material Safety Data Sheets (MSDS), and to package chemicals safely. The symbols used (some are shown below) are standard within the EU. They are similar to those used for hazchem transport labelling, but the criteria used to assess risk are different, so the same substance may have different hazard labels for supply and transport (eg a carcinogen might be categorised as 'toxic' for supply, but not need any transport hazard label). Different formulations of the same chemical may have different warnings – a chemical may be 'Harmful' at a low concentration but 'Toxic' at a higher one. Standardised **safety phrases** (two digits prefixed with an S: eg S29 [which means 'do not empty down drains']) and **risk phrases** (two digits prefixed with an R: eg R20 ['harmful by inhalation']) are used to give extra information about the hazards.

F: Flammable or **F+**: Extremely flammable

T: Toxic or **T+** Extremely toxic

E: Explosive

O: Oxidising

N: Environmentally dangerous

C: Corrosive

Xi: Irritant or **Xn**: Harmful

Useful data on many individual chemicals can be found on the website run by the International Programme on Chemical Safety (IPCS) which is a collaborative venture of the World Health Organization, United Nations Environment Programme and the International Labour Organization; www.inchem.org

The **Fire and Rescue Service** will usually be able to **provide information** on **chemical hazards** from **road accidents and other incidents**

TOXBASE (an on-line database, which requires pre-registration: www.spib.axl.co.uk) is the primary source of information on chemical poisoning for health care professionals in the UK. For further expert advice, contact **HPA National Poisons Information Service (HPA NPIS) 0844 8920111** or **HPA Chemical Hazards and Poisons Division (HPA CHaPD) 0844 8920555**

Chlorine and other irritant gases

Main effects

- Main effects **IRRITANT** and **CORROSIVE**
- Exposure to high concentrations can be **FATAL**
- Can affect **SKIN**, **EYES**, or **RESPIRATORY SYSTEM**
- Those with pre-existing respiratory disease (eg asthma, smokers) are at greater risk
- Severity of effects depends on concentration and duration of exposure
- No specific antidote, treatment is supportive
- **Consider deliberate release if no history of occupational or household exposure and/ or more than one case**

Chemical facts

- Chlorine is a greenish yellow gas (or clear amber liquid) smelling of bleach or swimming pools
- Chlorine gas is heavier than air – accumulates in low lying areas and closed spaces
- Chlorine gas reacts with tissue water to form hydrochloric and hypochlorous acids
- Chlorine is widely used in chemical industry as disinfectant, and in water sterilisation (eg swimming pools)
- Highly reactive – can form explosive mixtures
- Mixing household bleach with acidic cleaning agents can liberate chlorine gas

Acute effects of exposure to chlorine

Inhalation	Eyes	Skin
• Cough, choking • Wheeze/dyspnoea • Tight chest/chest pain • Nausea, vomiting • Metabolic changes – alkalosis, respiratory acidosis, or if massive exposure hyperchloraemic metabolic acidosis • Pneumonitis and non-cardiogenic pulmonary oedema • Sometimes 12-24 hours between exposure and onset of pneumonitis or pulmonary oedema • Hypoxia • Cardiac arrest	• Watering, stinging • Blepharospasm • Frostbite after contact with compressed liquid gas	• Irritation • Erythema or redness • Burns or frostbite possible after contact with compressed liquid gas

Long term effects Rarely, reactive airway dysfunction syndrome: dyspnoea and increased bronchial resistance.
Long term decrease in residual volume has been described; those at greatest risk were older and had marked initial airflow obstruction

Management

- If you suspect that your patient has been exposed to chlorine or other irritant gas, ensure that either they have been decontaminated or that you are wearing PPE
- Maintain airway, give supplemental oxygen if needed
- Remove patient's clothing if not already done (double-bag, seal, label, and store securely); if adherent, ease off using tepid water and gently irrigate underlying skin with copious quantities of tepid water
- Assess any exposed patients with immediate symptoms, admit for 24 hours initial observation if pre-existing respiratory disease or if symptoms persist beyond period of exposure. Complete chemical exposure record form for any not admitted, and give written instructions to return immediately if respiratory symptoms develop
- Eye exposure: remove contact lenses if present and will not cause further trauma; irrigate eyes with lukewarm water or 0.9% NaCl solution; if fluorescein staining +ve, or eye injury, refer to ophthalmology; seek specialist advice urgently if eye tissue frozen or eye contact with liquid (compressed) chlorine
- Respiratory symptoms: check arterial blood gases, CXR, peak expiratory flow rate, repeat if necessary; consider inhaled salbutamol and inhaled steroid for bronchospasm; ventilation (PEEP, CPAP) may be needed
- No evidence that systemic steroids are of benefit
- Monitor for secondary infection and ARDS and treat appropriately
- Treat burns symptomatically, consider surgical referral for frostbite
- If admitted, before discharge: re-check lung function, arrange 3-month follow up, and complete chemical exposure record form

See also

- Emergency contacts, decontamination, personal protective equipment, diagnosis and early management of chemical incidents, chemical exposure record form

Hydrogen cyanide and other cyanogens

Main effects

- **VERY RAPID effects** on CNS within seconds or minutes of exposure; **DEATH from respiratory or cardiac arrest**
- Usually absorbed by inhalation, but liquid can be absorbed through skin or eyes, and ingestion is also possible
- Severity of poisoning depends on concentration and duration of exposure; effects less rapid after ingestion
- Cyanide is rapidly detoxified in the body – recovery is possible if the patient is promptly removed from the source
- DO NOT use mouth to mouth or mouth to nose resuscitation techniques (risk of secondary exposure)
- **SPECIFIC ANTIDOTES available but SPEED CRITICAL**
- **Consider deliberate release if no history of accidental or industrial exposure and/or more than one case**

Chemical facts

- Includes hydrogen cyanide (HCN), cyanogens (eg cyanogen chloride), and cyanide salts (eg potassium cyanide)
- Colourless gas or bluish-white highly volatile liquid (HCN), or colourless gases or white solids (cyanogens, cyanide salts). May smell to some of bitter almonds; ability to detect odour is genetically determined
- Highly flammable and can form explosive mixtures
- Cyanide vapour is lighter than air (so usually disperses quickly); liquid HCN evaporates rapidly
- Cyanides are reversible cytochrome oxidase inhibitors which prevent cells from using oxygen
- Hydrogen cyanide is widely used in industry in the manufacture of plastics and nitrites; other cyanide compounds used in printing, dyeing, photography, metal cleaning and manufacturing

Acute effects of inhalation of hydrogen cyanide

Severe exposure	**Moderate exposure**	**Mild exposure**
Blood cyanide level 3mg-4mg/litre • Almost immediate rapid deep breathing, involuntary gasping • Convulsions 20-30 seconds later • Collapse, coma, respiratory arrest, fixed dilated pupils within minutes • Cyanosis unusual, sometimes cherry pink skin • Death	Blood cyanide level 2mg-3mg/litre • Dizziness, headache • Nausea WITH vomiting • Agitation, excitation • Confusion • Dyspnoea, tight chest • Convulsions and coma if exposure prolonged	Blood cyanide level less than 2mg/litre • Dizziness, headache • Nausea • Dyspnoea, tight chest • Anxiety • Metallic taste in mouth

Effects of ingested hydrogen cyanide are the same as those above, but onset is delayed
Some cyanide compounds (eg cyanogen chloride) also have irritant effects: coughing, choking, non-cardiogenic pulmonary oedema
Other cyanide compounds (eg sodium cyanide) may cause skin and eye damage

Long term effects of acute exposure: confusion, intellectual deficit, unsteady gait, Parkinsonism, deafness, post-traumatic stress disorder

Management

- **CHEMICAL ANTIDOTES NOT REQUIRED** if patient/case **BREATHING NORMALLY** and **FULLY CONSCIOUS 5 minutes after removal from source** – they should recover spontaneously with oxygen therapy and reassurance
- If you suspect that your patient has been exposed to cyanide, ensure that either they have been decontaminated or that you are wearing PPE
- Establish and maintain airway; give high flow oxygen by non-rebreathing mask; intubate and ventilate
- If liquid contamination of patient or clothing, quickly remove clothing if not already done (double-bag, seal, label, and store securely); decontaminate using shower or wash-wipe-rinse with liquid soap and water; remove contact lenses if present and possible without eye damage and gently irrigate eyes with lukewarm water or 0.9% NaCl solution; check triage tags for details of pre-hospital treatment
- Establish IV access with large-bore cannula; monitor ECG; correct acidosis with sodium bicarbonate IV
- If cyanide compound ingested: do NOT induce vomiting; if less than 1 hour since ingestion, consider activated charcoal slurry or gastric lavage
- Take 5-10mls blood into lithium heparin or plastic tube for blood cyanide level before giving chemical antidotes
- If respiratory depression and/or impaired consciousness (Glasgow Coma Scale less than 8) and if not already given, give **ANTIDOTES**

DICOBALT EDETATE (adverse effects include vomiting; facial, laryngeal and pulmonary oedema; anaphylaxis, severe hypotension)

- Adult: Dicobalt edetate 300mg (1 ampoule = 20ml of 15mg/ml) IV over 1 minute followed by 50ml glucose 50% (500mg/litre) IV
- Child: Dicobalt edetate 0.5ml/kg of 15mg/ml solution (= 7.5mg/kg) IV over 1 minute, then 2.5ml glucose 50% IV for each ml of dicobalt edetate

If no response repeat x 1, and reconsider diagnosis

Alternatively,

SODIUM NITRITE with **SODIUM THIOSULPHATE**:

- Adult: 10ml of 3% sodium nitrite IV over 5-20 minutes; followed by 25ml of 50% sodium thiosulphate IV over 10 minutes
- Child: 4mg-10mg/kg body wt max. 300mg (0.13ml - 0.33ml/kg, max 10ml) 3% sodium nitrite IV; then sodium thiosulphate 400mg/kg body wt max. 12.5g (= 0.8ml/kg max. 25ml of 50% solution) over 10 minutes

- Complete chemical exposure record form; if no history of ingestion, mild cases and moderate cases not requiring antidote can be discharged with written information; if history of ingestion observe for 24 hours and treat if deterioration; admit any case given antidote to ITU

See also

- Emergency contacts, decontamination, personal protective equipment, diagnosis and early management of chemical incidents

Lewisite

Main effects

- **VESICANT** (causes blisters) and **IRRITANT**
- Main effects on **SKIN, EYES** and **RESPIRATORY SYSTEM**; can also cause systemic effects of arsenic poisoning
- Rapidly absorbed through skin (penetrates clothing) and eyes, by inhalation and, rarely, by ingestion
- **RAPID** decontamination after liquid exposure CRITICAL
- **Immediate** clinical **effects** (unlike mustard – where effects are usually delayed, unless eye/skin contact with liquid)
- Severity increases with dose and duration of exposure; worsened by hot, humid conditions; liquid more severe than gas
- **SPECIFIC ANTIDOTE** available
- **Consider deliberate release if no history of occupational exposure and/or more than one case**

Chemical facts

- Oily volatile liquid arsenical (colourless, or blue-black). May smell of geraniums
- Vapour heavier than air – accumulates in low lying areas and enclosed spaces
- Fat soluble: absorbed rapidly through skin and mucous membranes; absorption increased by heat and moisture
- Cause tissue damage mainly by alkylation and in severe exposure systemic signs of arsenic poisoning
- Industrial exposure unlikely (NaOH and other caustic agents may produce burns with oedema and tissue fluid loss, but blisters are unusual)

Acute effects of exposure to lewisite

Eyes	Skin	Respiratory system
• Symptoms immediate • Painful blepharospasm • Watering/tearing • Periorbital oedema • Recovery over 1-2 weeks Moderate – severe effects • Blindness (usually temporary) • Corneal ulceration, clouding & necrosis • Perforation of globus	• Immediate burning feeling • Raised erythema ('sunburn') at 15-30 minutes • Blisters on erythematous area by 3-6 hours, gradually expand to cover entire area, maximum by 4 days, filled with clear to yellow fluid. Blisters may rupture, do not contain lewisite, and heal over 1-4 weeks • No pigment changes • Exposure to liquid may cause severe deep necrotic burns • Secondary bacterial infection	• Immediate runny nose, burning pain in throat, cough, hoarseness, voice loss • Cough becomes productive – may cough up necrotic slough • Dyspnoea • Fever • Throat, tonsils, palate, uvula, larynx and trachea: red, painful, swollen and ulcerated. Pseudomembrane formation and oedema may cause laryngeal obstruction • Chemical pneumonitis, ARDS • Secondary bacterial infection • Main cause of mortality
Systemic effects of lewisite include liver toxicity and arsenic poisoning – nausea, vomiting, diarrhoea, generalised weakness, muscle cramps, red or green coloured urine, neuropathy, nephritis, haemolysis, encephalopathy and 'lewisite shock'		
Long term effects: Few available data, but thought likely to include visual impairment and chronic pulmonary disease		

Management

- If you suspect that a patient has been exposed to lewisite, ensure that either they have been decontaminated or that you are wearing PPE
- Maintain airway, give oxygen if necessary, inhaled salbutamol for bronchospasm
- Remove patient's clothing if not already done (double-bag, seal, label, and store securely); shower or wash down or rinse-wipe-rinse with liquid soap and water, or dilute detergent; remove contact lenses if present, irrigate eyes copiously with lukewarm water or 0.9% NaCl solution
- If no eye signs or minimal skin signs, observe for 2 hours: if no progression, complete chemical exposure record form and discharge with written information
- Admit if moderate/severe symptoms, observe for 24 hours. If no progression and only erythema, small blisters, or minor eye irritation/conjunctivitis, complete chemical exposure record form, and discharge with written information and follow-up appointment
- Generous analgesia (may require opiates) for eye pain, erythema, blisters; AVOID topical anaesthetic eye drops
- Eyes: do not patch, but do prevent lids sticking together (sterile petroleum jelly, boric acid ointment 5%); if blepharospasm refer to ophthalmology (cycloplegic eye drops to prevent synechiae – atropine or homatropine tds)
- Skin: hydrocortisone ointment 1% +/- oral antihistamine for itching; debride ruptured blisters, clean with sterile 0.9% saline. Cover small areas with petroleum gauze, larger areas with silver sulphadiazine 1%; early referral to plastic surgeon. Consider transfer of severe cases to burns unit and seek advice on use of BAL ointment and oral chelating agents.
- Do NOT use BAL ointment and silver sulphadiazine ointments together on the same patient as the BAL chelates the silver
- If signs of pulmonary oedema *or* a burn bigger than hand-size not decontaminated within first 15 mins *or* exposure of more than 5% of body surface with signs of skin damage, give: **DIMERCAPROL** (BAL) 3mg-5mg/kg body weight by deep IM injection every 4 hours for 4 doses

See also

- Emergency contacts, decontamination, personal protective equipment, diagnosis and early management of chemical incidents, chemical exposure record form

Mustard and related chemicals (vesicants)

Main effects

- **VESICANT** (cause blisters) and **IRRITANT** with main effects on **SKIN, EYES** and **RESPIRATORY SYSTEM**
- **Rapidly absorbed** through skin (can also penetrate clothing) and eyes, by inhalation, and (rarely) by ingestion
- **RAPID DECONTAMINATION CRITICAL:** secondary cases can follow exposure to inadequately decontaminated primary cases
- Although tissue damage begins immediately on exposure, **clinical effects are usually delayed** (except after eye/skin contact with liquid mustard) and evolve over hours or days after a variable latent period of 1-24 hours
- Severity increases with dose and duration of exposure; worsened by hot, humid conditions; effects of liquid more severe than gas
- The more severe the exposure, the shorter the latent period
- No specific antidote, treatment is supportive
- **Assume deliberate release if the chemical exposure occurred in a public place, or anywhere other than at an industrial site**

Chemical facts

- Chemical warfare agents; fatality rate in World War 1 was 2-3%
- Oily volatile liquids (colourless, or pale yellow, amber or brown). May smell of mustard, horseradish, garlic, onions or leeks
- Vapours heavier than air – accumulate in low lying areas and enclosed spaces
- Cause tissue damage mainly by alkylation
- Industrial exposure unlikely (NaOH and other caustic agents may produce burns with oedema and tissue fluid loss, but blisters unusual)

Acute effects of exposure to mustard gas and related chemicals

Eyes	Skin	Respiratory system
• Eyes most vulnerable • If eye symptoms, expect respiratory effects Mild effects • Latent period 4-12 hours • Watering or tearing • Gritty red painful eyes • Mild periorbital oedema • Recovery over 1-2 weeks Moderate – severe effects • Latent period 1-3 hours • Painful blepharospasm • Blindness (usually temporary) • Corneal ulceration, clouding and necrosis	• Warm, moist areas (groin, genitalia, perineum, neck, axillae) at greatest risk • Raised erythema ('sunburn') at 6-12 hours • Blisters filled with clear to yellow fluid appear at 13-24 hours, maximal at 48-72 hours. They do not contain mustard, rupture easily, and heal slowly over 1-4 weeks • Itching at 42-72 hours • Pigmentation as erythema fades • Secondary bacterial infection	• Hoarseness, voice loss at 2-6 hours • Other symptoms usually develop slowly over 1-3 days • Cough, becomes productive – may cough up necrotic slough • Dyspnoea • Fever • Throat, tonsils, palate, uvula, larynx, and trachea: red, painful, swollen, ulcerated at 1-3 days. Oedema and pseudomembrane may cause laryngeal obstruction • Chemical pneumonitis, ARDS • Secondary bacterial infection • Main cause of mortality
Systemic effects include nausea, vomiting, diarrhoea after moderate-severe exposure After severe exposures, bradycardia, cardiac arrhythmias, CNS depression, and bone marrow depression		
Long term effects PTSD, visual impairment, late-onset keratitis (years post exposure), bone marrow dysplasia, vitiligo, scarring (more common after secondary infection) Chronic exposure associated with increased risk of respiratory tract malignancy, but the risk after a single exposure is unclear		

Management

- If you suspect that a patient has been exposed to mustard, ensure that either they have been decontaminated or that you are wearing PPE
- Maintain airway, give oxygen if necessary, inhaled salbutamol +/- inhaled steroids for bronchospasm
- Remove patient's clothing if not already done (double-bag, seal, label, and store securely); shower or wash down or rinse-wipe-rinse with liquid soap and water, or dilute detergent; remove contact lenses if present, irrigate eyes copiously with lukewarm water or 0.9% NaCl solution
- Observe for 8 hours and take baseline FBC even if asymptomatic: if no eye signs or skin signs develop, complete chemical exposure record form and discharge with written information
- If minor eye/skin signs at 8 hours, observe for further 24 hours, then, if no progression and only minor erythema, small blisters, or minor eye irritation/conjunctivitis, complete chemical exposure record form, discharge with written information and follow-up appointment
- Generous analgesia (may require opiates) for eye pain, erythema, blisters; AVOID topical anaesthetic eye drops
- Eyes: decontaminate eyes rapidy, if blepharospasm seek urgent ophthalmology opinion; do not patch, but do prevent lids sticking together (sterile petroleum jelly, boric acid ointment 5%); use cycloplegic eye drops to prevent synechiae – atropine or homatropine tds
- Skin: hydrocortisone ointment 1% +/- oral antihistamine for itching; debride ruptured blisters, clean with sterile 0.9% NaCl solution, cover small areas with petroleum gauze, larger areas with silver sulphadiazine 1%. Intensive nursing care may be needed, especially if perineum or genitalia affected; seek early referral to plastic surgeon/burns unit
- If symptoms severe, monitor FBC (WCC high initially, leucopaenia at 3-5 days, possible bone marrow depression)
- If bone marrow depression occurs consult a haematologist

See also

- Emergency contacts, decontamination, personal protective equipment, diagnosis and early management of chemical incidents, chemical exposure record form

Nerve agents (organophosphate poisoning)

Main effects

- **HIGHLY TOXIC** chemical warfare agents: small drop on skin can be **FATAL**
- Cause death by **RESPIRATORY ARREST** due to CNS depression and **muscle paralysis** by same mechanism as organophosphates
- Absorbed through skin (through clothing) and eyes, by inhalation, or by ingestion
- **RAPID DECONTAMINATION** is essential following **SKIN EXPOSURE**; secondary cases can follow exposure to inadequately decontaminated primary cases
- Clinical effects depend on dose, duration and route of exposure
- Local effects are immediate; systemic effects can be delayed for up to 18 hours
- **SPECIFIC ANTIDOTES AVAILABLE AND CAN BE LIFE SAVING IF ADMINISTERED PROMPTLY**
- Severe acute organophosphate poisoning occurs in the UK, but is relatively uncommon
- **Consider deliberate release if no history of occupational exposure (eg to sheep dip, pesticide, insecticide), or exposure occurred in a public place, and/or more than one case**

Chemical facts

- Colourless to brown liquids at room temperature; some smell fruity, others are odourless
- Volatile to varying degrees; can therefore be sprayed, aerosolised and inhaled
- Vapours heavier than air – accumulate in low lying areas and enclosed spaces
- Like organosphosphorus pesticides, inhibit acetylcholinesterase; acetylcholine therefore accumulates at nerve synapses and neuromuscular junctions, stimulating muscarinic and nicotinic receptors and central nervous system
- Two deliberate releases of sarin in Japan in 1994 (Matsumoto) and 1995 (Tokyo subway) caused 18 deaths in total; secondary effects occurred in health care workers without PPE, treating un-decontaminated cases in emergency medicine departments

Acute effects of exposure to nerve agents

Severe exposure	Moderate exposure	Mild exposure
• Pinpoint pupils • Confusion, agitation – severe • Convulsions/fitting • Copious excess secretions • Cardiac arrhythmias • Collapse/respiratory depression/arrest • Coma • Death	• Pinpoint pupils, conjunctival injection • Dizziness, disorientation • Coughing, wheezing, sneezing • Drooling++, excess phlegm, bronchorrhoea, bronchospasm • Breathing difficulty • Marked muscle twitching/tremors • Muscle weakness, fatigue • Vomiting, diarrhoea, urination	• Small or pinpoint pupils • Painful, blurred vision • Runny nose and eyes • Excess saliva • Eyes look 'glassy' • Headache, nausea • Mild muscle weakness • Localised muscle twitching • Mild agitation

Muscle twitching and **excess secretions** distinguish **nerve agents** from **cyanide**
Progression of symptoms suggests **continued exposure, inadequate decontamination** or **inadequate treatment**

Late effects 1-4 days post exposure to organophosphates: acute respiratory failure, flaccid paralysis: refractory to pralidoxime, ventilation required
Late effects: EEG changes, poor concentration and memory and post-traumatic stress disorder

Management

- If you suspect that your patient has been exposed to a nerve agent (or organophosphate) ensure that either they have been decontaminated or that you are wearing PPE
- Maintain airway, give supplemental oxygen, suction secretions
- Remove patient's clothing if not already done (double bag, seal, label, and store securely); shower or wash down or rinse-wipe-rinse with liquid soap and water, or dilute detergent; remove contact lenses if present, irrigate eyes with lukewarm water or 0.9% NaCl solution; check triage tags for details of pre-hospital treatment (eg Combipen)
- For severe or moderate symptoms, establish IV access, arrange assessment by anaesthetist and give, as soon as possible:

  ATROPINE 0.6mg-4mg IV (adult) or 20 micrograms/kg IV (child) every 10-20 minutes until secretions dry up and heart rate 80-90bpm – you may need to give as much as 20mg to achieve this; do NOT rely on reversal of pinpoint pupils as a guide to atropinisation

  PRALIDOXIME 2g or 30mg/kg IV (adult) over 4 minutes stat; then 4-6 hourly or infuse IV at 8mg-10mg/kg/hour

  DIAZEPAM 5mg-10mg IV (adult) or 1mg-5mg IV (child) stat; repeat as required
- Intubate and ventilate if apnoeic or severe respiratory distress (avoid succinyl choline); check ABGs, U & Es, glucose; monitor ECG, treat arrhythmias
- Contact HPA National Poisons Information Service (HPA NPIS) or HPA Chemical Hazards and Poisons Division (HPA CHaPD) for advice if no response or slow response to antidotes
- Paralysis may mask seizures – consider EEG monitoring
- Mild symptoms only (eye signs but no bronchospasm or bronchorrhoea or history of fits) observe for 2 hours post exposure, consider atropine or 0.5% tropicamide eye drops for painful/blurred vision, if no progression of symptoms, complete chemical exposure record form, discharge with information sheet

See also

- Emergency contacts, decontamination, personal protective equipment, diagnosis and early management of chemical incidents, chemical exposure record form

Phosgene

Main effects

- **IRRITANT:** can affect **SKIN, EYES** or **RESPIRATORY SYSTEM**
- Absorbed by inhalation, which can be fatal
- Outcome cannot be predicted from severity of exposure or initial symptoms
- **Effects** can be brought on or **made worse by exercise**
- No specific antidote, treatment is supportive
- **Consider deliberate release if no history of occupational exposure, or exposure occurred in a public place and/or more than one case**

Chemical facts

- Colourless gas or white cloud at room temperature
- May smell of musty hay or mown grass (odourless at low concentrations)
- Heavier than air – accumulates in low lying areas
- Degrades slowly, so area exposed can be large – stay upwind
- Reacts with tissue water to form hydrochloric acid
- Widely used in industry in manufacture of isocyanates, polyurethane and polycarbonate resins, pesticides, herbicides and dyes

Acute effects of exposure to phosgene

Initial (irritant phase)	**Latent period**	**Delayed (oedema phase)**
Immediate	*2-72 hours*	*following latent period*
• Watering painful eyes • Blepharospasm • Nausea and vomiting • Tight chest/chest pain • Wheeze, dyspnoea • Low blood pressure • Bradycardia/tachycardia • Contact burns/eye damage if exposed to liquid • Laryngospasm • Haemolysis, rapid death	• No symptoms • Patient appears well • Symptoms can be precipitated by exercise in 72 hours post exposure	• Frothy sputum, wheeze, cough, breathing difficulty • Non cardiogenic pulmonary oedema • Hypotension, hypoxia • Tachycardia • Bronchial necrosis • Secondary pneumonia • ARDS • Death

Chronic effects Reactive airway dysfunction syndrome: dyspnoea and increased bronchial resistance for 3-6 months
Rarely, chronic bronchitis, emphysema, bronchiectasis, pulmonary fibrosis

Management

- If you suspect that a patient has been exposed to phosgene, ensure that either they have been decontaminated or that you are wearing PPE
- Maintain airway, give supplemental oxygen, inhaled salbutamol +/- inhaled steroid for wheeze or bronchospasm
- Remove patient's clothing if not already done (double-bag, seal, label, and store securely); if adherent, ease off using tepid water and gently irrigate underlying skin with copious quantities of tepid water
- Remove contact lenses if present; irrigate eyes with lukewarm water or 0.9% NaCl solution; if fluorescein staining +ve, or eye injury, refer ophthalmology; seek urgent specialist advice if eye contact with liquid phosgene
- Admit for 24 hours initial observation and bed rest as soon as possible after exposure
- Check respiratory rate, pulse oximetry, ABG, CXR, peak expiratory flow rate
- CXR: bilateral 'batwing' shadows, ground glass infiltrates; CXR changes lag behind clinical signs – repeat CXR if clinical deterioration
- Pulmonary oedema: if aetiology uncertain, furosemide/frusemide 10mg–40mg IV, repeat once if no response; intubation and ventilation may be needed
- Deterioration can be sudden and rapid – reassess frequently
- No evidence that systemic steroids are of benefit
- Treat burns from contact with liquid phosgene symptomatically; may need surgical referral for frostbite
- Before discharge (at 24 hours if asymptomatic): recheck lung function, arrange review at 3 months, complete chemical exposure record form

See also

- Emergency contacts, decontamination, personal protective equipment, diagnosis and early management of chemical incidents, chemical exposure record form

Ricin and abrin (toxalbumins)

Main effects

- **Potent toxins** that inhibit protein synthesis causing cell death
- Multi-organ effects, may be **FATAL**
- **Onset** of symptoms often **DELAYED**
- **Fever** is **COMMON**
- Death is usually due to multi-organ failure
- No specific antidote for ricin or abrin exposure: treatment is supportive
- **Ricin and abrin (toxalbumin) poisoning is rare, a single case suggests deliberate release**

Chemical facts

- Ricin is present in, and can be extracted from, beans (seeds) of the castor oil plant, *Ricinus communis* – seed cases each contain 3 shiny red-brown-grey streaked seeds
- Abrin is found in *Abrus precatorius* ('rosary pea', 'jequirity bean') – seeds are red-black or white-black
- 1 million tons of castor oil beans are processed each year: waste is 5% ricin by weight; there is no comparable industrial source of abrin
- Accidental poisoning can occur after chewing castor beans or rosary peas, which are used to make necklaces, bracelets, prayer beads, and to fill maracas (1-3 seeds may be fatal for child, 8 may be fatal for adult, though adults have survived ingestion of 10-30 seeds, and children 4-10)
- Extremist groups in the US and UK are known to have planned to use ricin
- Toxins may be swallowed, inhaled (if aerosolised) or injected
- Although highly toxic after injection, multiple cases unlikely
- Cutaneous and systemic allergic responses to ricin exposure have been reported

Acute effects of exposure to ricin or abrin

Presentation variable, severity of initial symptoms may not be a good indicator of outcome	
more likely after **INGESTION**	more likely after **INHALATION**
• Abdominal pain, cramps • Vomiting (often profuse) • Diarrhoea (may be bloody) • Gastrointestinal bleeding • Dehydration (thirst, headache, postural drop in blood pressure) • Abnormal LFTs • Haematuria, proteinuria, high white cell count • Multiple gastric ulcers on endoscopy • Hypovolaemic shock, DIC, multiple organ failure	• Fever • Cough • Dyspnoea • Tight chest • Arthralgia, myalgia • Non cardiogenic pulmonary oedema • Low blood pressure • Respiratory failure • ARDS
No chronic effects known, but relatively little information	

Management

- If you suspect that a patient has been exposed to aerosolised ricin or abrin, ensure that either they have been decontaminated or that you are wearing PPE
- Maintain airway, prevent aspiration of vomit, give supplemental oxygen if needed; do NOT give antispasmodics
- If patient exposed to aerosolised ricin or abrin: remove patient's clothing if not already done (double-bag, seal, label, and store securely); if contact lenses present, remove if possible, and irrigate eyes with lukewarm water or 0.9% NaCl solution; if not already done decontaminate skin (rinse-wipe-rinse regime using liquid soap and water, or dilute detergent)
- If no symptoms, but thought to have ingested ricin or abrin, admit, observe, complete chemical exposure record form, and discharge with information sheet if still symptom free 8 hours later
- If no symptoms, but thought to have been exposed to aerosolised or injected ricin or abrin, admit, observe, complete chemical exposure record form, and discharge with information sheet if still symptom free 24 hours later
- Admit if symptomatic
- If respiratory symptoms, check: arterial blood gases, CXR, peak expiratory flow rate, and repeat if necessary. Consider inhaled salbutamol and inhaled steroids, ventilation (PEEP); monitor for secondary infection and ARDS and treat appropriately
- Replace gastrointestinal fluid losses IV, and correct and maintain electrolyte balance
- If exposed to ingested ricin or abrin: discuss whole bowel irrigation with HPA National Poisons Information Service (HPA NPIS), HPA Chemical Hazards and Poisons Division (HPA CHaPD) or expert toxicologist

See also

- Emergency contacts, decontamination, personal protective equipment, diagnosis and early management of chemical incidents, chemical exposure record form

Riot control agents (tear gas, CS gas, pepper spray, mace)

Main effects

- Chemicals designed to have **short acting IRRITANT** and **INCAPACITANT** effects
- Main effects on **EYES, RESPIRATORY SYSTEM**, and, sometimes, **SKIN**
- Onset **IMMEDIATE** within seconds-minutes of exposure
- Clinical effects vary from mild to severe, severity increases with dose and duration of exposure
- No specific antidotes, treatment is supportive
- **Fatalities uncommon**; those with pre-existing respiratory disease (eg asthma, smokers) may be at greater risk
- **Consider deliberate release if no history of occupational exposure or use in self defence and/or more than one case**

Chemical facts

- White or coloured, sometimes crystalline, solids; may smell of apple blossom or pepper
- Usual forms of dispersal (as spray or as fine powder) result in inhalation, or skin contamination
- Effects increased by addition of hypochlorite: DO NOT use bleach in decontamination, use soap/detergent and water
- Fine powder may settle on clothes, furniture, floors, and be re-aerosolised by movement, causing secondary cases
- Clinical effects may also be caused by chemicals used in the dispersal system
- Used by law enforcement, security forces and the military for crowd control and other purposes (eg training), and as a constituent in personal protection devices

Acute effects of exposure to riot control agents

Eyes	Skin	Respiratory system
• Symptoms immediate • Stinging, burning • Painful blepharospasm • Watering/tearing/crying • Blurred vision • Corneal ulceration possible after severe prolonged exposure • Usually, recovery within 15-30 minutes after exposure ceases	• Immediate burning feeling • Delayed (more than 2 hours post exposure) redness and blistering or thermal burns possible after severe prolonged exposure • Secondary bacterial infection • Contact dermatitis possible on repeat exposure	• Immediate painful runny nose, burning pain in throat, hoarseness, voice loss • Excess saliva • Chest tightness • Feeling of suffocation • If exposure severe and prolonged (eg in underventilated, confined space) may cause delayed (12- 24 hours) non cardiogenic pulmonary oedema • ARDS, respiratory arrest
Long term effects: Allergic reaction/dermatitis on repeat exposure		

Management

- If you suspect that patient has been exposed to a riot control agent, ensure that either they have been decontaminated or that you are wearing PPE
- Reassure that pain is temporary and will pass (decontamination with soap and water may briefly increase discomfort)
- Maintain airway, give oxygen if necessary, inhaled salbutamol +/- inhaled steroids for bronchospasm
- Remove patient's clothing if not already done (double-bag, seal, label, and store securely); decontaminate skin (rinse-wipe-rinse regime using soap and water or dilute detergent)
- If only minor signs, observe for 2 hours: if no progression of symptoms, complete chemical exposure record form and discharge
- Skin: sodium bicarbonate solution may neutralise effects and soothe skin irritation; calamine lotion (should be applied only after thorough cleansing) +/- hydrocortisone ointment 1% +/- oral antihistamine for persistent itching/erythema
- Eyes: if contact lenses present, remove if possible, and flush eyes gently with tepid water for at least 15 minutes; refer to ophthalmology if persistent pain (more than 2 hours post exposure) or fluorescein +ve
- Admit if initial severe respiratory symptoms or incomplete recovery in the 2 hours after exposure and condition warrants; observe for 24 hours, if no persistent respiratory symptoms and/or only minor eye or skin signs, complete chemical exposure record form, discharge with written information and follow-up appointment

See also

- Emergency contacts, decontamination, personal protective equipment, diagnosis and early management of chemical incidents, chemical exposure record form