

# CBRN incidents: clinical management & health protection

- The following is a list of amendments within the CBRN incidents: clinical management & health protection handbook.
- Note that the revisions below supersede all previous versions of the same page.

Version reference	Location	Description
v4.0 September 2008	About this guide	Alteration to email address and telephone numbers
	Generic incident management: Emergency contacts	Alteration to telephone number
	Generic incident management: Further reading and other resources	Alteration to other useful UK organisations and telephone numbers
	Chemical incidents: Diagnosis and early management in chemical incidents	Alteration to telephones numbers
	Chemical incidents: Chemical exposure record form	Alteration to telephone number
	Chemical incidents: Chemical incident analysis request form	Alteration to telephone number
	Chemical incidents: Understanding chemical hazard labels	Alteration to telephone number

## Overview

- This guide to clinical management and health protection in Chemical, Biological, Radiological and Nuclear (CBRN) incidents has been written primarily for front line health care professionals in emergency departments, but we hope that it will also be useful to health care professionals in other specialties, including primary care and public health, emergency planners, trainers, and emergency service personnel
- The handbooks are arranged in six sections (generic incident management, chemical incidents, biological incidents, radiation incidents, associated injuries and illnesses, and a picture gallery), and together these contain the core information needed to plan for, recognise, and respond safely and effectively to the early stages of a CBRN incident
- This guide is not, and was not intended to be, a complete guide to emergency medicine. We may live in troubled times, but the adage 'common things are common' remains true: the unconscious patient is more likely to have taken an overdose, drugs or alcohol, to be a diabetic, or to have had a stroke than to have been exposed to cyanide. But remember: **you may be the first person to recognise that a CBRN incident has occurred. If you SUSPECT that a patient has been exposed to a chemical, to a biological agent, or to radiation that could have been released deliberately, IMMEDIATELY alert your local Health Protection Team**
- This guide is consistent with current national guidance from the Department of Health and with Health Protection Agency (HPA) guidelines. Full versions of current guidance for health professionals on planning for and responding to a CBRN incident, including action check lists, patient information sheets, and patient group directions can be found at [www.hpa.org.uk](http://www.hpa.org.uk) and [www.dh.gov.uk](http://www.dh.gov.uk)
- At many points in the guide, we urge you to seek further advice when it is needed. The suggested process is shown in the table below. TOXBASE ([www.spib.axl.co.uk](http://www.spib.axl.co.uk)), an on-line database requiring pre-registration, is the primary source of information for health care professionals in the UK on the management of chemical poisoning. HPA National Poisons Information Service (HPA NPIS) provides advice on the clinical management of individual patients. HPA Chemical Hazards and Poisons Division (HPA CHaPD) provides advice on the management of more complex problems and chemical incidents
- Before prescribing a drug, check dosage, contraindications and interactions (eg in the British National Formulary [www.bnf.org](http://www.bnf.org))
- Inclusion of a website elsewhere in this guide does not imply that the content of the site is endorsed by the HPA. All website details were correct when last checked, but sites are constantly moved, changed, or updated. If you have difficulty locating the information you want, searching on the name of the organisation will usually produce the link you need
- The HPA provides training in preparedness for, and management of, CBRN and other major incidents. For details, see: [www.hpa.org.uk](http://www.hpa.org.uk)
- We intend to update individual handbooks in response to changes in national guidance, and to review the entire guide annually. We should welcome your comments, corrections, and suggestions for topics for additional handbooks. These may be sent to: [erd@hpa.org.uk](mailto:erd@hpa.org.uk)
- Additional complete copies of the guide and replacement handbooks may be downloaded in PDF format from: [www.hpa.org.uk](http://www.hpa.org.uk), and the guide can also be found within TOXBASE. You should check regularly (eg every six months and before any planned drill or exercise) for updates, amendments, training opportunities and new handbooks. If you register on the HPA site, we will be able to send updates and amendments to the guide to your department automatically
- The guide was written by Dr Julia Heptonstall and Dr Nick Gent, and the project was led by Professor Nigel Lightfoot, all of the Health Protection Agency.

**Patient with UNUSUAL, UNEXPECTED, OR UNEXPLAINED symptoms or signs?  
DISCUSS the case with a SENIOR EMERGENCY MEDICINE clinician**

**Senior emergency medicine clinician may discuss the case with local Health Protection Team and other LOCAL sources of advice:**

### Chemical

Clinical biochemist/ Toxicologist  
TOXBASE  
HPA National Poisons Information Service  
(HPA NPIS): 0844 8920111  
Health Protection Team

### Biological

Microbiologist  
ID physician  
Infection control team  
Health Protection Team

### Radiation

Radiation Safety/Protection Officer  
Medical physicist  
Radiotherapist/oncologist  
Health Protection Team

**Local Health Protection Team or others may inform, or seek further advice from, NATIONAL experts:**

**HPA Chemical Hazards and Poisons  
Division (HPA CHaPD) 0844 8920555**

**HPA Centre for Infections, Colindale  
020 8200 4400**

**HPA Radiation Protection Division  
Office hours 01235 831600 or  
non office hours 01235 834590**

**CBRN incident response is coordinated by HPA Centre for Emergency Preparedness and Response: 01980 612 100**

# Index and glossary

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Glossary of abbreviations

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Burns	Psychological effects of traumatic events

**Picture gallery**

- **#** fracture
- **AAFB** acid alcohol fast bacilli
- **ABG** arterial blood gases
- **ACDP** Advisory Committee on Dangerous Pathogens
- **ARDS** acute respiratory distress syndrome
- **ARS** acute radiation sickness
- **BD** or **Bd** or **bd** twice a day
- **BNF** British National Formulary
- **bpm** breaths per minute, or beats per minute, depending on context
- **BSA** body surface area
- **CBRN** Chemical, Biological, Radiological, Nuclear
- **CCDC** Consultant in Communicable Disease Control
- **CDC** Centers for Disease Control and Prevention, Atlanta, US
- **CEM** Consultant in Emergency Medicine
- **CERF** chemical exposure record form
- **CHP** Consultant in Health Protection
- **CK** creatine kinase
- **CNS** central nervous system
- **COPD** chronic obstructive pulmonary disease
- **CPAP** continuous positive airways pressure
- **CRP** C-Reactive Protein
- **CRT** capillary return time
- **CSF** cerebrospinal fluid
- **CVS** cardiovascular system
- **CXR** chest X-ray
- **DH** Department of Health
- **DIC** disseminated intravascular coagulation
- **DPH** Director of Public Health
- **Dx** diagnosis
- **EA** Environment Agency
- **ECG** electrocardiogram
- **EEG** electroencephalogram
- **EMD/ED** Emergency (Medicine) Department
- **EMG** electromyograph
- **EPLO** Emergency Planning Liaison Officer
- **FBC** full blood count
- **GI** gastrointestinal
- **HAV** hepatitis A virus
- **HBV** hepatitis B virus
- **HCV** hepatitis C virus
- **HEPA** Health Emergency Planning Advisor
- **HIV** human immunodeficiency virus
- **HLA** human lymphocyte antigen
- **HPA** Health Protection Agency
- **HPA CRCEH** HPA Centre for Radiation and Chemical and Environmental Hazards
- **HPA CEPR** HPA Centre for Emergency Preparedness and Response (HPA Porton Down)
- **HPA CHaPD** HPA Chemical Hazards and Poisons Division (part of HPA CRCEH)
- **HPA CFI** HPA Centre for Infections (includes HPA Colindale, HPA CDSC, CPHL)
- **HPA NPIS** HPA National Poisons Information Service
- **HPA RPD** HPA Radiation Protection Division (part of HPA CRCEH, formerly NRPB)
- **HPT** Health Protection Team
- **HPU** Health Protection Unit
- **HSE** Health and Safety Executive
- **HSV** herpes simplex virus
- **ICD** Infection Control Doctor
- **ICU/ITU** Intensive care/therapy unit
- **ID** infectious disease, or identity, depending on context
- **IM** intramuscular
- **INM** Institute of Naval Medicine
- **IV** intravenous
- **IVI** intravenous infusion
- **Ix** investigation
- **LDH** lactate dehydrogenase
- **LFTs** liver function tests
- **MC&S** microscopy, culture and sensitivity
- **MOD** Ministry of Defence
- **Mx** management
- **NBM** nil by mouth
- **NPA** nasopharyngeal aspirate
- **NPIS** HPA National Poisons Information Service
- **NRPB** National Radiological Protection Board (now the HPA Radiation Protection Division)
- **OD** or **od** once daily
- **OHD** Occupational Health Department
- **PCR** polymerase chain reaction
- **PCT** Primary Care Trust
- **PEEP** positive end expiratory pressure
- **PEP** post exposure prophylaxis
- **PO** orally, or 'by mouth'
- **PPE** personal protective equipment
- **QDS** or **Qds** or **qds** four times a day
- **RMS** Radiation Medicine Specialist
- **RR** respiratory rate
- **RSV** respiratory syncytial virus
- **Rx** treatment
- **SARS** severe acute respiratory syndrome
- **SC** subcutaneous
- **SEPA** Scottish Environmental Protection Agency
- **TDS** or **Tds** or **tds** three times a day
- **U & Es** urea and electrolytes
- **UK** United Kingdom
- **URTI** upper respiratory tract infection
- **VEE** Venezuelan equine encephalitis
- **VHF** viral haemorrhagic fever
- **WHO** World Health Organisation
- **ZN** Ziehl Nielson

# Generic incident management

# Emergency contacts

## Emergency contacts template

- Emergency contact details should be included in your major incident plan, and should be checked and updated regularly (eg every six months and after every drill or exercise, with the task designated to a post – not a person – in the department)
- You may use this list as a template or use it to review and amend your own emergency plans

Useful extension numbers				
Emergency department reception		Chemical pathology laboratory		
Admissions		Microbiology laboratory		
Pharmacy		Haematology laboratory		
Emergency theatres		Blood bank		
Main theatres		Emergency department X-ray		
ITU		Main X-ray		
Coronary care unit		Porters		
PICU		Security		
CSSD/sterile supplies		Mortuary		
		Canteen		
Major incident control room		Ambulance Liaison Officer		
Emergency medicine incident room		Police Documentation Office		
Major incident press office				
Local contacts (Internal and external)				
Contact	Name	Extension	Bleep	Mobile /out of hours
Trust Chief Executive				
Trust Senior Nurse Manager				
Trust Medical Director				
Consultant chemical pathologist				
Consultant microbiologist				
Consultant haematologist				
Consultant infectious disease physician				
Infection control lead				
Occupational Health lead				
Radiation protection/safety officer				
Emergency Planning Liaison Officer				
Head pharmacist				
Emergency admissions/beds manager				
Duty manager				
Chaplains				
Voluntary services organiser				
Switchboard supervisor				
Duty engineer				
Social services emergency duty team				
Senior Security Manager				
Catering Manager				
Contact	Name	Daytime contact	Mobile/out of hours	
HM Coroner				
Consultant CDC/Health Protection				
Health Protection Unit				
DPH, lead Primary Care Trust				
Regional HEPA				
Regional Infectious Disease Unit				
Regional Chemical Provider Unit				
Regional Burns Unit				
Police				
Fire and Rescue Service				
Ambulance control				
Pod activation (via ambulance/BTS)				
NHS Direct	<b>0845 46 47</b>			
HPA Chemical Hazards and Poisons Division: <b>0844 8920555</b>		HPA National Poisons Information Service: <b>0844 8920111</b>		
HPA Centre for Infections: <b>020 8200 4400</b>		NAIR (for incidents involving radioactivity): <b>0800 834 153</b>		

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

# Immediate incident management for first responders

## STEP 1 2 3

When the cause of an incident is unknown, emergency personnel use these safety triggers

<b>STEP 1</b>	<b>ONE CASUALTY</b>	Approach using <b>normal</b> procedures
<b>STEP 2</b>	<b>TWO CASUALTIES</b>	Approach with <b>caution</b> , consider all options Report on arrival, update control
<b>STEP 3</b>	<b>THREE CASUALTIES or MORE</b>	Do <b>NOT</b> approach Withdraw Contain Report Isolate yourself and SEND for SPECIALIST HELP

Do NOT compromise your own safety or that of your colleagues or the public

Provide a CHALETS or METHANE assessment as soon as possible

Remember that the emergency services have staff trained and equipped to deal with CBRN incidents

### Mnemonics for rapid incident assessment

#### 'METHANE'

- M**y call sign/major incident alert
- E**xact location
- T**ype of incident
- H**azards at the scene
- A**ccess
- N**umber of casualties and severity
- E**mergency services present or required

#### 'CHALETS'

- C**asualties, number and severity
- H**azards, present and potential
- A**ccess and egress
- L**ocation – exact
- E**mergency services – present or required
- T**ype of incident
- S**afety

### Medical Emergency Response Incident Teams (MERIT)

- MERIT teams carry out the duties formerly undertaken by Mobile Medical Teams or MMTs. They attend an incident at the request of the Ambulance Service and will normally be transported to the site by the Ambulance Service. On arrival at an incident MERITs should report to the Medical Incident Officer (MIO), or in their absence, the Ambulance Incident Officer (AIO) for briefing. At an incident:
- **Always follow instructions from the MIO, AIO, and other emergency service personnel on site**
- **Channel all requests and queries on site through the MIO**
- **Protect yourself – do not put your own life or health at risk to save others:**
  - Ensure that you are wearing appropriate PPE before entering the inner cordon or approaching any casualty
  - Ensure that you are clearly and appropriately identifiable
  - Enter any inner cordon only through the inner cordon access point, where your entry will be logged and you will be briefed about hazards
  - Leave any inner cordon only through the inner cordon access point, so that you can be debriefed and your departure can be logged
- **Initial triage**  
Remember that triage is a dynamic, continuing process (not a 'one off' decision) that aims to 'do the most for the most'  
React to physiological effects (changes in vital signs) rather than anatomical effects (the easily visible)
 

<b>P1</b>	<b>LIFE THREATENING</b>	Breathe only after airway cleared <i>or</i> RR less than 9 or more than 30bpm <i>or</i> CRT more than 2 secs	<b>IMMEDIATE TREATMENT</b>
<b>P2</b>	<b>URGENT</b>	Unable to walk <i>and</i> RR 10bpm-29bpm <i>and</i> CRT 2 secs or less	<b>URGENT TREATMENT</b>
<b>P3</b>	<b>MINOR</b>	Walking	<b>DELAYED TREATMENT</b>
<b>P4</b>	<b>DEAD</b>	Not breathing even after airway cleared	<b>NO TREATMENT</b>
- **Decontaminate** according to protocols for clinical, emergency or mass decontamination
- Decontamination of the injured and emergency decontamination is led and managed by the Ambulance Service
- Mass decontamination is led and managed by the Fire and Rescue Service
- Radiation incidents: if **life-threatening injury, stabilise first** (transfer to hospital if necessary) and **then decontaminate**; if **no life-threatening injury, decontaminate at scene** and **then treat**
- Chemical incidents: removing the casualty from the source and prompt decontamination may be life-saving; as may prompt administration of the specific antidotes that are available for some chemicals (eg cyanide, organophosphates)
- Remember that in any CBRN incident, clinical signs may be caused by common, pre-existing conditions (eg ischaemic heart disease, asthma, epilepsy, diabetes), which may be exacerbated by the incident
- **Record any treatment given** on the **triage tag** attached to the casualty
- **Feedback relevant information regularly to MIO/Ambulance Control**
- **Ensure that you and your equipment remain in the contaminated area until decontaminated, and that you report to the MIO before you leave the site**

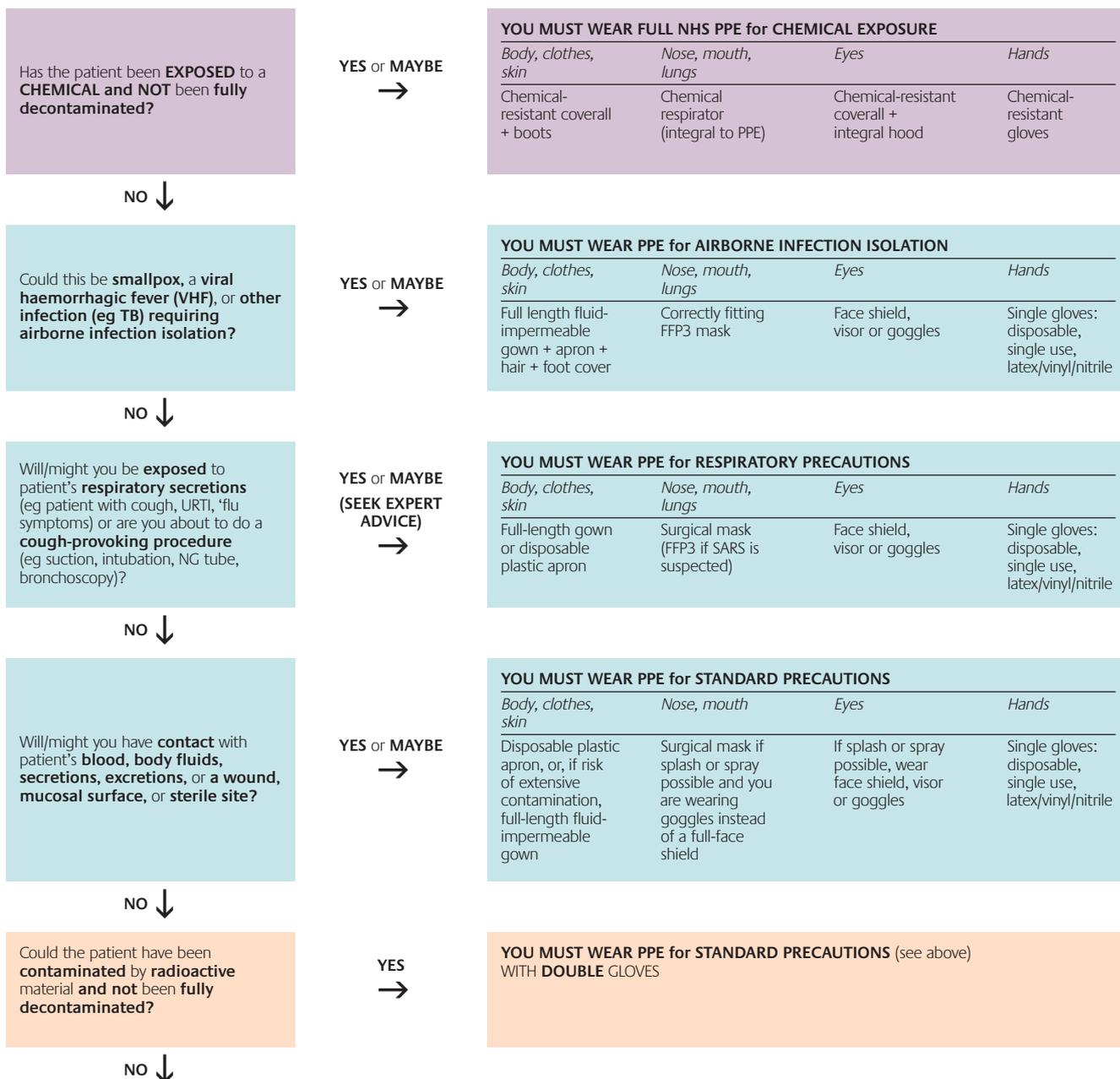
### See also:

- PPE, decontamination, specific agents, diagnosis & immediate management of chemical incidents, radiation facts, emergency contacts

# Personal protective equipment (PPE)

## Overview

- PPE will protect you, the patient, and other patients and colleagues from infection and from other hazards, but only if selected, worn, and discarded correctly. The algorithm below is designed to help you select PPE appropriate to the task
- Don and remove PPE as you have been instructed in training.
- For advice on choosing and using PPE contact your infection control team (infection hazards) or for chemical/ radiation, Health Protection Team (HPT), Health Emergency Planning Advisor (HEPA) or HPA Centre for Radiation and Chemical and Environmental Hazards (CRCEH)



### AT ALL TIMES AND FOR ALL PATIENTS ALWAYS:

- Hand hygiene ('cleanyourhands')
- Safe sharps use and disposal
- Good basic hygiene
- Safe disposal of clinical waste
- Learn how to don and remove PPE in a way that minimises the risk of cross-contamination

### See also

- Decontamination, standard precautions, respiratory precautions, airborne infection isolation, and agent-specific handsheets

# Decontamination of non-ambulant patients at the hospital

## Overview

- Decontamination after exposure to a chemical, biological or radiation hazard is intended to reduce the risk of harm to the patient, to others, or to the wider environment
- If a CBRN/Hazmat incident occurs, casualties should be decontaminated at the scene, but, contaminated casualties may also self present to the emergency department
- The first indication of an incident may be the arrival of contaminated or symptomatic patients at your department
- Casualties of industrial accidents, road accidents, bombs or incendiary devices may be contaminated
- Prompt decontamination after chemical exposure may be life-saving; in a radiation incident, first treat life-threatening injury, then decontaminate
- Be alert to the unusual, the unexpected, and the unexplained – and if in doubt, seek expert advice

## Equipment for decontamination

Scissors	Large plastic bags (for clothing and double bagging)
Buckets (5-10 litres size)	Small clear plastic bags (for jewellery, watches, other valuables)
Sponges/soft brushes/washcloths	ID labels/tags
Liquid soap/washing up liquid/shampoo without conditioner	Sturdy containers for used decontamination equipment
Disposable towels/drying cloths	Warm water source; 0.9% saline; topical anaesthetic drops for eyes

## RINSE – WIPE – RINSE technique

**Step 1: Gently wash affected areas with soapy water (0.9% saline for open wounds and eyes):** this dilutes the contaminant and removes particles and water based chemicals

**Step 2: Wipe affected areas gently but thoroughly with sponge or soft brush or washcloth:** this removes organic chemicals and petrochemicals

**Step 3: Gently rinse affected areas**

## “Remove it from others, keep it off yourself, and don’t spread it around”

- Work in teams of 2-4 people
- **Protect yourself:** ensure that you are wearing appropriate PPE; do NOT perform mouth to mouth/nose resuscitation
- **Protect others:** ensure that contaminated patients are decontaminated outside your department, in the NHS decontamination unit, and that contaminated patients do not enter the department. Ensure that the decontamination area is cordoned off, secured, and that patients (and staff) have privacy. Only personnel wearing appropriate PPE should enter the decontamination area
- Emergency resuscitation, antidote administration, and decontamination may have to be done at the same time
- Avoid or minimise hand – mouth/eye/face/mask contact. NEVER eat, drink or smoke in the decontamination area
- Make up a solution of **liquid soap and water** (5ml soap/litre of water = 3-4 squirts of liquid soap to a 5-10 litre bucket of water)
- **Use warm or tepid water** (hot water may increase absorption of contaminant; cold water increases risk of hypothermia)
- **Do NOT use bleach**
- Establish patient’s name (if possible), and use name and/or hospital number (ideally both) on water-impermeable wrist band for patient and on labels for bags containing patient’s clothing and effects
- **Explain what you are going to do** before you start and as you go along. Remember that, for most, this will be a frightening, unpleasant experience
- **Remove/cut off clothing gently and speedily** (this may reduce contamination by 80%-90%). Do NOT pull clothing off over the head
- If clothing is adherent, do not rip, pull or tear: soak gently and thoroughly with water until clothing can be separated from underlying tissue
- Fold clothing outside to middle to contain contamination. Place clothing in large plastic bag and put ID label in the bag
- Remove jewellery, watches, rings, and other personal effects (eg wallet, passport), place in small clear plastic bag, add ID label
- Place small clear plastic bag inside larger bag, then place both bags inside a further large plastic bag. Seal/tie, ID-label, and store securely
- Glasses/spectacles needed for vision can usually be washed-wiped-rinsed-dried and returned to, or kept with, the patient
- Hearing aids should be removed, but should not be immersed in water. Either wipe thoroughly with saline-moistened gauze, place in clear plastic specimen bag and keep with patient if patient cannot hear without them, or place with other personal effects
- **Decontaminate using RINSE – WIPE – RINSE technique. Do NOT rub hard or abrade skin**, as this may increase absorption
- Airway and face first (protect airway, prevent aspiration); sites needed urgently for IV access and any open wounds next (gently and thoroughly irrigate wounds with copious 0.9% saline, then cover with dressing), then work from hair/head downwards to toes. Pay special attention to skin folds, skin creases (axillae, perineum, back of neck, behind knees), nails, ears, and hair. Roll patient gently onto side (ensure neck stability if cervical spine injury) to reach back, buttocks, back of head, and legs
- **Eyes:** if contact lenses present, remove if possible without harm; use topical anaesthetic if needed; flush eyes copiously with 0.9% saline
- If contaminated with **radioactive material**, survey for residual contamination and if more than 2 x background, repeat decontamination process
- **Dry, and cover** or clothe patient, transfer to clean trolley or backboard, transfer to ‘clean’ area for further assessment and care
- Used sponges, towels, brushes and other contaminated equipment should remain in the decon area for evidential use or safe disposal
- Contain waste water where possible: if not possible, seek advice, and inform EA/SEPA/local sewage and water companies
- Protect yourself and others: rest and rotate staff as needed; make sure all staff self-decontaminate before leaving the decon area

## See also

- For Home Office guidance (The decontamination of people exposed to chemical, biological, radiological or nuclear (CBRN) substances or material. Strategic National Guidance. [2nd edition, revised 2004]), see [www.ukresilience.info/cbrn](http://www.ukresilience.info/cbrn), and PPE, emergency contacts, CERF, radiation facts, specific agents, incident management record form

# Infection control: standard precautions and hand hygiene

## Overview

- 'Infection control' is intended to prevent transmission of infection between patients, from patients to health care workers, and from health care workers to patients. Training in basic infection control and local policies should be provided as part of your orientation or induction. If you are in doubt about any aspect of infection control, or need training, seek help from your infection control team
- Infection control includes adopting safe behaviours and working practices (eg hand hygiene) that reduce transmission of infection; choice and use of personal protective equipment (PPE: gloves, gowns, eye/mouth/face protection, masks); patient placement (eg protective isolation for immunosuppressed patients, isolation rooms, cohort nursing); pre and post exposure prophylaxis (eg HBV immunisation); environmental measures (eg cleaning, laundering, safe disposal of clinical waste); design and engineering controls (eg auto-destruct syringes, laminar air flow), and organisational culture – working in an organisation where patient and worker safety is highly valued.
- '**STANDARD**' precautions are applied by **ALL STAFF** in **ALL HEALTH CARE SETTINGS** to **ALL PATIENTS**, regardless of the patient's diagnosis or presumed infection status, **ALL THE TIME**

## Standard precautions

- Practice good basic hygiene with regular hand cleaning (see below)
- Cover wounds or skin lesions with waterproof dressings
- Never touch your eyes, nose, mouth or face, or adjust PPE, with contaminated hands or gloves: you risk infecting yourself
- Limit your contact with items in the patient's immediate environment to the minimum necessary for patient care
- Select PPE for a task according to the anticipated risks (splash, spray, splatter, touch, infection, chemical, radiation)
- Wear gloves (single use disposable latex, vinyl or nitrile) for: all invasive procedures; contact with sterile sites (including wound care and dressing changes); contact with mucous membranes, and all tasks assessed as carrying a risk of exposure to patients' blood or body fluids
- Don gloves immediately before starting the task, remove and discard them safely on completion, and clean your hands before moving to another patient
- Work from 'clean' to 'dirty'; change gloves during a procedure if you have to move from a 'dirty' body site to a 'clean' one
- If your gloves get torn or become heavily soiled during a procedure, remove them, discard them safely, clean your hands, and don a new pair
- Wear a disposable single use plastic apron for any task where there is a risk that your clothing or uniform may be exposed to the patient's body fluids or become wet; discard the apron safely when you complete the task and clean your hands before moving to another patient
- Wear a full-body, fluid-impermeable, gown for tasks where there is a risk of extensive splashing of body fluids or contamination of your skin
- Wear eye and face protection for tasks where there is a risk of splashes or spray to your face, eyes, nose or mouth
- Avoid using sharps if possible, and know how to use and discard sharps safely
- Do not re-sheath needles; discard used needles and syringes as a single unit into a sharps bin placed at point of use; do not overfill sharps bins
- Know what to do if there is a sharps injury or blood splash incident
- Always clear up blood spillages promptly and safely
- Never re-use single use disposable equipment (including single use ambu bags, laryngoscope blades/handles, suction equipment), and ensure that re-usable equipment is correctly decontaminated (eg by being sent to CSSD) after use and before being used on another patient
- Always dispose of contaminated waste safely, and know how to deal with soiled linen
- Clean, disinfect and sterilise equipment, and decontaminate the environment as appropriate
- If you are in doubt, or unsure about any aspect of infection control, ask your infection control team for advice

## Hand hygiene: cleanyourhands

- If **ALL** health care workers **ALWAYS** cleaned their hands before **ANY** direct patient contact, health care associated infections could be halved
- If your hands are visibly dirty, or contaminated with blood or body fluids, use soap and water to clean your hands
- If your hands are not visibly dirty, use an alcohol-based hand rub, or soap and water
- **Always** cleanyourhands:
  - Before any patient contact (even if you are 'only' going to examine them)
  - Before any clinical procedure
  - Before you eat
  - After any patient contact
  - After completing a clinical procedure
  - After handling or touching any contaminated item or equipment (eg bed pan, suction apparatus, toilet flush-button)
  - After removing your gloves
  - After leaving an isolation room
  - After using the lavatory
- Never try to clean visibly soiled disposable gloves by cleaning your gloved hands: it doesn't work. Remove gloves, clean your hands, and reglove

## See also

- Emergency contacts, personal protective equipment, respiratory precautions, airborne infection isolation, specific agents

# Infection control: respiratory precautions

## Droplet spread

- Droplets are particles (> 5 micrometers) generated when a patient coughs, sneezes or talks, and during cough-provoking procedures (eg bronchoscopy, chest physiotherapy, suctioning, intubation, nasogastric tube insertion, nebuliser therapy, non-invasive ventilation, CPAP)
- Droplets expelled by an infected patient can travel for short distances through the air and, if deposited on the mucosal surfaces of the eyes, nose or mouth (or subsequently transferred there by hand-face contact) can infect anyone nearby (traditionally, within 1 metre, but possibly, at greater distances)
- Diseases that are transmissible by droplet spread include: SARS, influenza, pneumonic plague, monkeypox, smallpox, *Mycoplasma pneumoniae*, adenovirus, RSV, whooping cough, group A streptococcal infections and meningococcal meningitis (*Neisseria meningitidis*)
- Smallpox and SARS may also be transmissible from person to person by airborne spread: airborne isolation infection precautions are required
- Basic hygiene measures, applied as part of standard infection control, will help to prevent transmission of these infections. You should:
  - Encourage all staff, patients and visitors with URTI symptoms (cough, sneezing, runny nose) to cover their nose and mouth when coughing or sneezing, and to use single-use disposable paper tissues, discard them safely into a lidded bin, and clean their hands afterwards
  - Ensure that patients (and others) in waiting areas who have URTI symptoms maintain a distance of at least 1 metre from others in the area, and are offered a surgical mask to wear and/or disposable tissues to use while waiting
  - Make sure that if you have symptoms of an URTI, you avoid patient contact until your symptoms have resolved
  - Practice scrupulous hand hygiene ('clean your hands')
  - Avoid touching your eyes, nose, mouth or face or adjusting your PPE with contaminated, unclean, or gloved hands
  - Ensure that single use disposable equipment (eg peak flow meter mouthpiece) is always safely discarded after a single use
  - Ensure that surfaces and equipment are regularly cleaned and decontaminated, paying particular attention to surfaces and items likely to be touched frequently or likely to be contaminated with blood/body fluids (eg bedrails, doorknobs, bedside tables, equipment near patient, toilet and surrounding area)

## Respiratory precautions

- Use **RESPIRATORY PRECAUTIONS** in **addition** to **STANDARD** precautions when you **know** or **suspect** that a patient has an **infection transmissible by droplet spread** or when the patient has syndromic signs and symptoms of an infection transmissible by droplet spread (eg URTI or flu-like illness; meningitis with petechial or ecchymotic rash; bronchiolitis in children)
  - Examine the patient in a single room or cubicle
  - Wear a surgical mask (in addition to any other necessary PPE) for all close contact with the patient (within 1-2 metres, or when in room)
  - Change your mask if it becomes soiled or wet, or before leaving the room: discard it safely, and immediately clean your hands
  - If the patient needs admission and a single room is not available, discuss patient placement with your infection control team
  - Encourage the patient to wear a surgical mask, provided that they can tolerate this medically
  - Encourage anyone accompanying or visiting the patient to wear a surgical mask
  - Limit patient movement outside the room to what is medically necessary
  - If the patient has to be moved from the room (eg to go to X-ray), they should wear a surgical mask until they return to the room; those transporting or accompanying the patient do not need to wear a mask
  - Maintain respiratory precautions until the suspected diagnosis has been excluded or, for bacterial infections, until 24 hours (meningococcal infection) or 72 hours (pneumonic plague) after the start of antibiotic therapy or, for viral infections, until symptoms resolve – but discuss discontinuation with your infection control team

## Masks

- Wear a mask:
  - As part of PPE for standard precautions, to protect your nose and mouth during tasks that might produce splash/spray of blood or body fluids
  - As part of PPE for respiratory precautions, to protect your nose, mouth and upper respiratory tract from droplet infection
  - During surgical procedures or other 'sterile' procedures, to protect the patient
- Don PPE in this order: gown, mask, face shield or goggles, gloves
- Remove PPE in order determined by local protocol
- When you remove your mask, assume that both the inside and the outside of the facepiece are contaminated: do NOT handle the facepiece. Remove the mask touching only the tapes or ties, discard it safely into a waste container, and then immediately clean your hands
- Surgical masks do not protect against the infection following the inhalation of small (< 5 micrometers) particles. If you know or suspect that the patient has smallpox, a viral haemorrhagic fever, or other serious infection that may be transmissible by airborne infectious particles, you should wear a correctly fitted FFP3 mask. You should also use a FFP3 mask if the patient fulfils the case definition for SARS or for avian influenza until these diagnoses have been excluded.

## See also

- Emergency contacts, personal protective equipment, standard precautions, airborne infection isolation, specific agents

# Infection control: airborne infection isolation

## Airborne spread of infection

- Airborne spread follows the inhalation of small (< 5 micrometers) particles containing an infectious agent
- These small particles may be formed after evaporation of droplets expelled from the respiratory tract (droplet nuclei) of an infected patient, or from dust particles containing microorganisms
- Small particles less than 5 micrometers can remain suspended in air, travel for longer distances in air than larger particles, and may be dispersed widely in air currents and through shared ventilation systems, so close contact (within 1-2 metres) with an infected person is not required for transmission of infection, although close contact may make transmission more likely
- Infections that may be transmissible from person to person by the airborne route include TB, chickenpox, measles, smallpox and, possibly, SARS, and viral haemorrhagic fevers (VHFs)
- Smallpox is most often transmitted by droplet spread or by contact, but airborne transmission from person to person has been documented
- Airborne spread of haemorrhagic fever viruses is thought to be an uncommon route of transmission in humans, but research on VHF infections in non-human primates has suggested that airborne spread in these species may be possible
- Airborne transmission of SARS from person to person has been reported, but not conclusively proven
- Surgical masks protect mucosal surfaces of the upper respiratory tract against contamination by large particles (droplets) and, therefore, protect personnel against infections transmissible by droplet spread, but they do not protect the respiratory tract against inhaled infectious small particles
- Basic hygiene measures, applied as part of standard infection control, also help to prevent transmission of these infections. See the handshets on 'standard infection control precautions', 'respiratory precautions', and 'personal protective equipment' for more information

## Airborne infection isolation

- Use **AIRBORNE INFECTION ISOLATION** (sometimes called 'STRICT RESPIRATORY PRECAUTIONS') in addition to **STANDARD** precautions when you know or suspect that a patient has **smallpox, SARS, a viral haemorrhagic fever, or other infection that may be transmissible by airborne spread** or when the patient has syndromic signs and symptoms of an infection transmissible by airborne spread (eg fever + generalised vesicular rash; fever and repetitive dry cough)
- Develop triage systems that allow early identification and segregation of patients who may have an infection transmissible by airborne spread
- In the emergency department:
  - **Immediately put a surgical mask on the patient** and maintain this until patient has either been admitted to a negative pressure isolation room or assessed and the diagnosis of an infection transmissible by the airborne route excluded
  - **Immediately place patient in single room/side room, close the door, and restrict entry to essential personnel:** admitting doctor (wearing surgical mask or FFP3 mask, gown and gloves) to remain with patient to provide reassurance and any immediately necessary supportive care
  - All persons entering the room to don gown, face shield or goggles, and surgical mask or FFP3 mask before entry, and to remove and safely discard all PPE, and clean their hands immediately before leaving the room
  - Senior EM clinician (wearing surgical mask or FFP3 mask, eye protection, gown, gloves) to assess patient. If the diagnosis cannot be excluded, arrange urgent further assessment and management by Smallpox Diagnostic Expert, or ID physician or consultant microbiologist, as appropriate
- If the patient requires admission:
  - Immediately alert infection control team, occupational health, and local Health Protection Team
  - Admit to 'negative pressure' isolation room with more than 6 air changes/hour (or, for VHFs, as directed by ID physician)
  - If negative pressure isolation room is not available, agree patient placement with infection control doctor and consultant ID physician
  - Restrict entry to essential personnel and visitors; all entering room to wear correctly fitting FFP3 mask, eye protection, and other PPE as appropriate, and to have been instructed in infection control precautions before entry
  - Keep the door closed except to allow entry and exit of essential personnel and visitors
  - Limit patient movement outside the room to what is medically necessary
  - If the patient has to be moved from the room (eg to go to X-ray), they should wear a surgical mask until they return to the room. Those transporting or accompanying the patient should wear a correctly fitting FFP3 mask and other PPE as appropriate
  - Keep aerosol-provoking procedures to the minimum necessary for effective patient care
  - Don PPE in this order: gown, FFP3 mask, face shield and/or goggles, gloves
  - Remove PPE in order determined by local protocol
  - When you remove your FFP3 mask, assume that both the inside and the outside of the facepiece are contaminated: do NOT handle the facepiece. Remove the mask touching only the tapes or ties, discard it safely into a waste container, and then immediately **clean your hands**
  - Maintain airborne infection isolation until the suspected diagnosis has been excluded, or, for smallpox, until the scabs have separated; for VHFs for the duration of illness; for SARS for 10 days after resolution of fever, provided that respiratory symptoms have resolved or are improving – but always discuss discontinuation of airborne infection isolation with the infection control team

## See also

For detailed guidance on the management of smallpox, SARS, and VHFs, see agent specific section. More detailed information available at: [www.hpa.org.uk](http://www.hpa.org.uk)

# Suspect packages and parcels

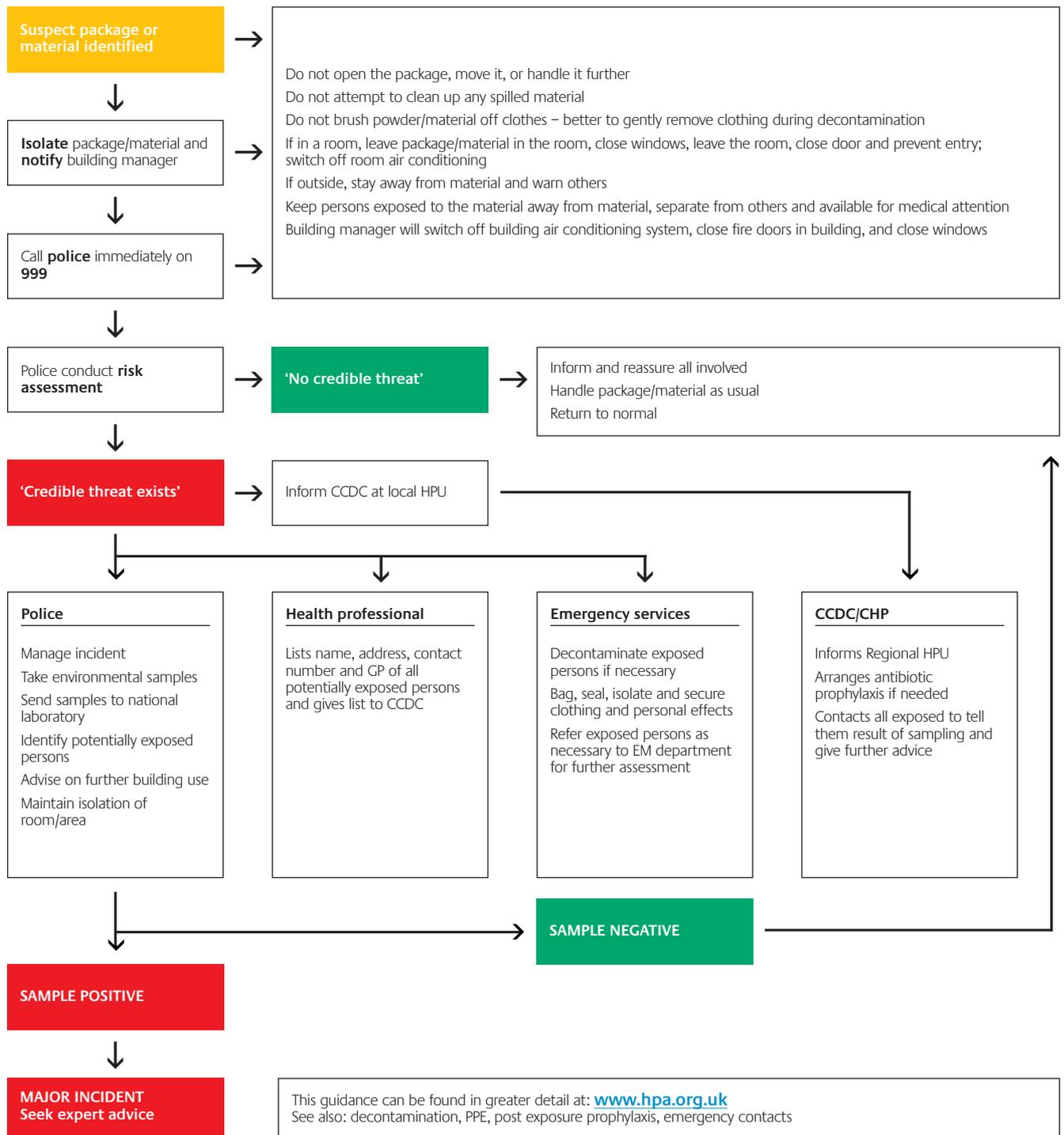
## Remember

If you are **EVER** in ANY doubt about a package, letter or parcel  
**DO NOT OPEN IT, HANDLE IT, OR MOVE IT**  
**CALL THE POLICE ON 999**

## Signs that might trigger suspicion include

- Any envelope or package with a suspicious or threatening message written on it or contained inside
- Oily stains, strange odours
- Envelopes that are lopsided, rigid, bulky, discoloured, or feel as though they contain powder
- Unexpected envelopes or packages from foreign countries
- No postage stamp, no franking, no cancellation of the postage stamp, excessive postage
- Incorrect spelling of common names, places or titles
- Handwritten envelopes/packages from an unknown source particularly if addressed to an individual and marked 'personal' or 'addressee only'
- Symptoms (runny nose, streaming eyes, cough, skin irritation) in exposed persons

## Suspect package management algorithm





# Chain of evidence documentation

## Overview

- If a deliberate release is suspected or there are other forensic considerations, chain of evidence (sometimes called 'chain of custody') documentation will be needed for samples
- Chain of evidence forms are intended to provide a complete record of the 'life' of a sample – from obtaining the sample, through testing (perhaps in two or three different laboratories), to storage
- Any break in the chain of documentation may compromise the evidential value of the sample
- Samples from a single patient to a single destination (eg microbiology, toxicology laboratory) can be grouped together on the same form
- Every transfer of a sample must be documented. If you use the form below, which may be freely copied or used as a template for your own form, you will need to complete a new form for each transfer (eg from the person who took the sample to the porter who will take the sample to the laboratory; from porter to scientist; from laboratory to courier service; from courier service to scientist in reference laboratory). All the forms in this chain must be numbered in sequence
- Keep all the forms for one set of samples together – and keep the originals carefully: photocopies cannot usually be used as evidence.
- The consultant in charge of the case should authorise the transfer of the sample(s) to the laboratory. To prevent delay, particularly for specimens critical to patient care (eg group and save, cross match, ABGs), authorisation may be given verbally – but the consultant must sign the form as soon as practicable thereafter

Chain of evidence form			
<b>HOSPITAL/TRUST</b>			
<b>PATIENT DETAILS</b>	Patient name:		Sex:
	Hospital number:		Date of birth:
Requesting doctor:		Postcode:	Ward:
		Bleep number:	Consultant:
<b>SAMPLE DETAILS</b>			
Sample type/description	Sample date	Sample time	Laboratory/specimen number
<b>HANDOVER DETAILS</b>			
<b>Person handing the sample(s) over</b>		<b>Person receiving the sample(s)</b>	
Name:	Grade:	Name:	Grade:
Signature:	Date & time:	Signature:	Date & time:
<b>Person authorising the transfer</b>			
Name:	Signature:		Date:
Address:			Form number:

Chain of evidence form			
<b>HOSPITAL/TRUST</b>			
<b>PATIENT DETAILS</b>	Patient name:		Sex:
	Hospital number:		Date of birth:
Requesting doctor:		Postcode:	Ward:
		Bleep number:	Consultant:
<b>SAMPLE DETAILS</b>			
Sample type/description	Sample date	Sample time	Laboratory/specimen number
<b>HANDOVER DETAILS</b>			
<b>Person handing the sample(s) over</b>		<b>Person receiving the sample(s)</b>	
Name:	Grade:	Name:	Grade:
Signature:	Date & time:	Signature:	Date & time:
<b>Person authorising the transfer</b>			
Name:	Signature:		Date:
Address:			Form number:

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

## Important UK national sources of advice include:

Health Protection Agency [www.hpa.org.uk](http://www.hpa.org.uk)  
Department of Health [www.dh.gov.uk](http://www.dh.gov.uk)  
Home Office [www.homeoffice.gov.uk/terrorism](http://www.homeoffice.gov.uk/terrorism)  
UK Resilience [www.ukresilience.info](http://www.ukresilience.info)

## UK toxicology & pharmacology resources:

TOXBASE [www.spib.axl.co.uk](http://www.spib.axl.co.uk) (registration required)  
British National Formulary [www.bnf.org](http://www.bnf.org) (registration required)  
Chemical Incident Management Handbook, The Stationery Office, 2000, ISBN 0113222521

## UK professional organisations for emergency and immediate care providers include:

BASICS (British Association for Immediate Care) [www.basics.org.uk](http://www.basics.org.uk)  
British Association for Accident and Emergency Medicine [www.baem.org.uk](http://www.baem.org.uk)  
Faculty of Accident and Emergency Medicine [www.faem.org.uk](http://www.faem.org.uk)  
Advanced Life Support Group [www.alsg.org.uk](http://www.alsg.org.uk)

## Other useful UK organisations include:

PRODIGY [www.prodigy.nhs.uk](http://www.prodigy.nhs.uk)

## Important international sources of advice include:

World Health Organisation [www.who.int/csr/en](http://www.who.int/csr/en) from which 'Public health response to biological and chemical weapons. WHO guidance 2004' may be downloaded  
Centers for Disease Control and Prevention, Atlanta, Emergency Preparedness and Response website [www.bt.cdc.gov](http://www.bt.cdc.gov)  
International Atomic Energy Authority [www.iaea.org](http://www.iaea.org)  
International Programme on Chemical Safety [www.inchem.org](http://www.inchem.org)  
International Commission on Radiological Protection [www.icrp.org](http://www.icrp.org)

## Sources of expert telephone advice

HPA Chemical Hazards and Poisons Division 0844 8920555  
HPA Centre for Emergency Preparedness and Response 01980 612 100  
HPA Centre for Infections 020 8200 4400  
HPA National Poisons Information Service 0844 8920111  
HPA Radiation Protection Division, office hours 01235 831600 or non office hours 01235 834590  
NAIR (National Arrangements for Incidents involving Radioactivity) RADSAFE 0800 834 153  
Institute of Naval Medicine (for advice on the clinical management of radiation injury; ask for duty RMS) 02392 768 020

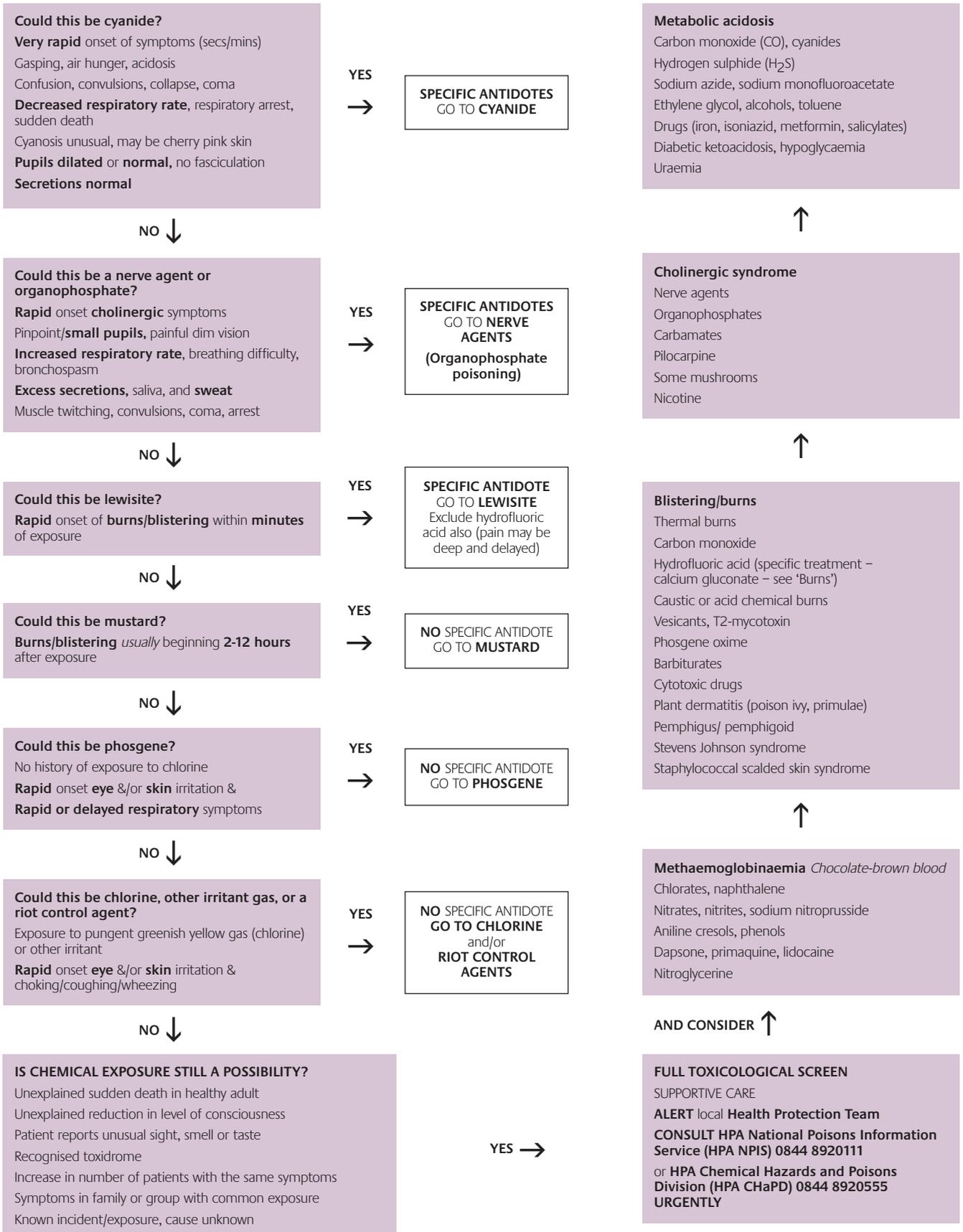
# Chemical incidents

# 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					
<b>PATIENT DETAILS</b> 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)	
<b>EXPOSURE and DECONTAMINATION</b> 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:
<b>EXPOSURE-RELATED SYMPTOMS and MANAGEMENT</b>					
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
<b>OUTCOME</b>					
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

## 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

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

#### Children

- 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 <b>READ THE NOTES ON TOXICOLOGICAL TESTING BEFORE YOU TAKE A SAMPLE</b> <b>PLEASE COMPLETE THIS FORM IN BLOCK CAPITALS</b>				
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 (specialist 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:				
<b>CHAIN OF EVIDENCE FORM</b>	A form has been completed and accompanies these specimens (Yes/No):			
<b>BEFORE REFERRING THESE SPECIMENS, please NOTIFY the ANALYTICAL TOXICOLOGY LABORATORY</b> <b>PHOTOCOPY the COMPLETED REQUEST FORM and GIVE THE PHOTOCOPY to the TOXICOLOGY CO-ORDINATOR</b>				

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](http://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](http://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
<ul style="list-style-type: none"><li>• Cough, choking</li><li>• Wheeze/dyspnoea</li><li>• Tight chest/chest pain</li><li>• Nausea, vomiting</li><li>• Metabolic changes – alkalosis, respiratory acidosis, or if massive exposure hyperchloraemic metabolic acidosis</li><li>• Pneumonitis and non-cardiogenic pulmonary oedema</li><li>• Sometimes 12-24 hours between exposure and onset of pneumonitis or pulmonary oedema</li><li>• Hypoxia</li><li>• Cardiac arrest</li></ul>	<ul style="list-style-type: none"><li>• Watering, stinging</li><li>• Blepharospasm</li><li>• Frostbite after contact with compressed liquid gas</li></ul>	<ul style="list-style-type: none"><li>• Irritation</li><li>• Erythema or redness</li><li>• Burns or frostbite possible after contact with compressed liquid gas</li></ul>

**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 <ul style="list-style-type: none"><li>• Almost immediate rapid deep breathing, involuntary gasping</li><li>• Convulsions 20-30 seconds later</li><li>• Collapse, coma, respiratory arrest, fixed dilated pupils within minutes</li><li>• Cyanosis unusual, sometimes cherry pink skin</li><li>• Death</li></ul>	Blood cyanide level 2mg-3mg/litre <ul style="list-style-type: none"><li>• Dizziness, headache</li><li>• Nausea WITH vomiting</li><li>• Agitation, excitation</li><li>• Confusion</li><li>• Dyspnoea, tight chest</li><li>• Convulsions and coma if exposure prolonged</li></ul>	Blood cyanide level less than 2mg/litre <ul style="list-style-type: none"><li>• Dizziness, headache</li><li>• Nausea</li><li>• Dyspnoea, tight chest</li><li>• Anxiety</li><li>• Metallic taste in mouth</li></ul>
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		
<b>Long term</b> 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

**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
<ul style="list-style-type: none"> <li>• Symptoms immediate</li> <li>• Painful blepharospasm</li> <li>• Watering/tearing</li> <li>• Periorbital oedema</li> <li>• Recovery over 1-2 weeks</li> </ul> <p>Moderate – severe effects</p> <ul style="list-style-type: none"> <li>• Blindness (usually temporary)</li> <li>• Corneal ulceration, clouding &amp; necrosis</li> <li>• Perforation of globus</li> </ul>	<ul style="list-style-type: none"> <li>• Immediate burning feeling</li> <li>• Raised erythema ('sunburn') at 15-30 minutes</li> <li>• 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</li> <li>• No pigment changes</li> <li>• Exposure to liquid may cause severe deep necrotic burns</li> <li>• Secondary bacterial infection</li> </ul>	<ul style="list-style-type: none"> <li>• Immediate runny nose, burning pain in throat, cough, hoarseness, voice loss</li> <li>• Cough becomes productive – may cough up necrotic slough</li> <li>• Dyspnoea</li> <li>• Fever</li> <li>• Throat, tonsils, palate, uvula, larynx and trachea: red, painful, swollen and ulcerated. Pseudomembrane formation and oedema may cause laryngeal obstruction</li> <li>• Chemical pneumonitis, ARDS</li> <li>• Secondary bacterial infection</li> <li>• Main cause of mortality</li> </ul>
<p>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'</p>		
<p><b>Long term effects:</b> Few available data, but thought likely to include visual impairment and chronic pulmonary disease</p>		

**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
<ul style="list-style-type: none"><li>• Eyes most vulnerable</li><li>• If eye symptoms, expect respiratory effects</li></ul> <p>Mild effects</p> <ul style="list-style-type: none"><li>• Latent period 4-12 hours</li><li>• Watery or tearing</li><li>• Gritty red painful eyes</li><li>• Mild periorbital oedema</li><li>• Recovery over 1-2 weeks</li></ul> <p>Moderate – severe effects</p> <ul style="list-style-type: none"><li>• Latent period 1-3 hours</li><li>• Painful blepharospasm</li><li>• Blindness (usually temporary)</li><li>• Corneal ulceration, clouding and necrosis</li></ul>	<ul style="list-style-type: none"><li>• Warm, moist areas (groin, genitalia, perineum, neck, axillae) at greatest risk</li><li>• Raised erythema ('sunburn') at 6-12 hours</li><li>• 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</li><li>• Itching at 42-72 hours</li><li>• Pigmentation as erythema fades</li><li>• Secondary bacterial infection</li></ul>	<ul style="list-style-type: none"><li>• Hoarseness, voice loss at 2-6 hours</li><li>• Other symptoms usually develop slowly over 1-3 days</li><li>• Cough, becomes productive – may cough up necrotic slough</li><li>• Dyspnoea</li><li>• Fever</li><li>• Throat, tonsils, palate, uvula, larynx, and trachea: red, painful, swollen, ulcerated at 1-3 days. Oedema and pseudomembrane may cause laryngeal obstruction</li><li>• Chemical pneumonitis, ARDS</li><li>• Secondary bacterial infection</li><li>• Main cause of mortality</li></ul>
<p><b>Systemic effects</b> include nausea, vomiting, diarrhoea after moderate-severe exposure After severe exposures, bradycardia, cardiac arrhythmias, CNS depression, and bone marrow depression</p>		
<p><b>Long term effects</b> 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</p>		

## 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 rapidly, 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 organophosphorus 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
<ul style="list-style-type: none"> <li>• Pinpoint pupils</li> <li>• Confusion, agitation – severe</li> <li>• Convulsions/fitting</li> <li>• Copious excess secretions</li> <li>• Cardiac arrhythmias</li> <li>• Collapse/respiratory depression/arrest</li> <li>• Coma</li> <li>• Death</li> </ul>	<ul style="list-style-type: none"> <li>• Pinpoint pupils, conjunctival injection</li> <li>• Dizziness, disorientation</li> <li>• Coughing, wheezing, sneezing</li> <li>• Drooling++, excess phlegm, bronchorrhoea, bronchospasm</li> <li>• Breathing difficulty</li> <li>• Marked muscle twitching/tremors</li> <li>• Muscle weakness, fatigue</li> <li>• Vomiting, diarrhoea, urination</li> </ul>	<ul style="list-style-type: none"> <li>• Small or pinpoint pupils</li> <li>• Painful, blurred vision</li> <li>• Runny nose and eyes</li> <li>• Excess saliva</li> <li>• Eyes look ‘glassy’</li> <li>• Headache, nausea</li> <li>• Mild muscle weakness</li> <li>• Localised muscle twitching</li> <li>• Mild agitation</li> </ul>
<p><b>Muscle twitching and excess secretions distinguish nerve agents from cyanide</b>  <b>Progression of symptoms suggests continued exposure, inadequate decontamination or inadequate treatment</b></p>		
<p><b>Late effects</b> 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</p>		

## 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

## 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) <i>Immediate</i>	Latent period <i>2-72 hours</i>	Delayed (oedema phase) <i>following latent period</i>
<ul style="list-style-type: none"> <li>• Watery painful eyes</li> <li>• Blepharospasm</li> <li>• Nausea and vomiting</li> <li>• Tight chest/chest pain</li> <li>• Wheeze, dyspnoea</li> <li>• Low blood pressure</li> <li>• Bradycardia/tachycardia</li> <li>• Contact burns/eye damage if exposed to liquid</li> <li>• Laryngospasm</li> <li>• Haemolysis, rapid death</li> </ul>	<ul style="list-style-type: none"> <li>• No symptoms</li> <li>• Patient appears well</li> <li>• Symptoms can be precipitated by exercise in 72 hours post exposure</li> </ul>	<ul style="list-style-type: none"> <li>• Frothy sputum, wheeze, cough, breathing difficulty</li> <li>• Non cardiogenic pulmonary oedema</li> <li>• Hypotension, hypoxia</li> <li>• Tachycardia</li> <li>• Bronchial necrosis</li> <li>• Secondary pneumonia</li> <li>• ARDS</li> <li>• Death</li> </ul>
<p><b>Chronic effects</b> Reactive airway dysfunction syndrome: dyspnoea and increased bronchial resistance for 3-6 months Rarely, chronic bronchitis, emphysema, bronchiectasis, pulmonary fibrosis</p>		

## 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 <b>INGESTION</b>	more likely after <b>INHALATION</b>
<ul style="list-style-type: none"><li>• Abdominal pain, cramps</li><li>• Vomiting (often profuse)</li><li>• Diarrhoea (may be bloody)</li><li>• Gastrointestinal bleeding</li><li>• Dehydration (thirst, headache, postural drop in blood pressure)</li><li>• Abnormal LFTs</li><li>• Haematuria, proteinuria, high white cell count</li><li>• Multiple gastric ulcers on endoscopy</li><li>• Hypovolaemic shock, DIC, multiple organ failure</li></ul>	<ul style="list-style-type: none"><li>• Fever</li><li>• Cough</li><li>• Dyspnoea</li><li>• Tight chest</li><li>• Arthralgia, myalgia</li><li>• Non cardiogenic pulmonary oedema</li><li>• Low blood pressure</li><li>• Respiratory failure</li><li>• ARDS</li></ul>
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
<ul style="list-style-type: none"><li>• Symptoms immediate</li><li>• Stinging, burning</li><li>• Painful blepharospasm</li><li>• Watering/tearing/crying</li><li>• Blurred vision</li><li>• Corneal ulceration possible after severe prolonged exposure</li><li>• Usually, recovery within 15-30 minutes after exposure ceases</li></ul>	<ul style="list-style-type: none"><li>• Immediate burning feeling</li><li>• Delayed (more than 2 hours post exposure) redness and blistering or thermal burns possible after severe prolonged exposure</li><li>• Secondary bacterial infection</li><li>• Contact dermatitis possible on repeat exposure</li></ul>	<ul style="list-style-type: none"><li>• Immediate painful runny nose, burning pain in throat, hoarseness, voice loss</li><li>• Excess saliva</li><li>• Chest tightness</li><li>• Feeling of suffocation</li><li>• If exposure severe and prolonged (eg in underventilated, confined space) may cause delayed (12- 24 hours) non cardiogenic pulmonary oedema</li><li>• ARDS, respiratory arrest</li></ul>

**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

# Biological incidents

# Biological incident action guide

## Overview

- A deliberate release may be **overt** (announced openly by perpetrators, eg the envelopes containing threatening notes and anthrax spores distributed through US Postal Service in 2001), or **covert** (unannounced, without any warning or indication of the organism involved) eg 1984 *Salmonella typhimurium* contamination of salad bars in restaurants in Dalles, Oregon, by followers of Baghwan Shree Rajneesh, when 751 people developed gastroenteritis
- Many different organisms could, in theory, be used deliberately, and be distributed through food, water, or the air (by an explosive device, aerosol canister, or crop duster); this manual focuses on organisms that could be aerosolised and/or would cause serious or fatal infections
- Intentional and naturally occurring outbreaks may be indistinguishable initially
- Symptoms of some forms of intentional or accidental chemical poisoning may mimic some infections (eg arsenic-contaminated coffee, Maine, 2003, and nicotine-contaminated minced meat, Michigan, 2003, both initially thought to be gastroenteritis; thallium poisoning, Florida, 1988, initially thought to be botulism)
- **Early recognition of a covert release of a biological agent will be achieved only if clinicians remain aware of the possibility, and are willing to alert and consult with their microbiologist, ID physician and Health Protection Team on suspicion, and before a definitive diagnosis has been reached**
- **Be alert to the unusual, the unexpected, and the case that 'just doesn't fit':**
  - an unusual illness (eg sudden unexplained febrile death, critical illness or pneumonia death in a previously healthy young adult)
  - an unusual number of patients with the same symptoms
  - an illness unusual for the time of year (eg 'flu' in summer)
  - an illness unusual for the patient's age group (eg 'chickenpox' in a middle-aged adult)
  - an illness in an unusual patient (eg cutaneous anthrax in a patient with no history of contact with animals, animal hides or products)
  - an illness acquired in an unusual place (eg tularemia acquired in the UK)
  - unusual clinical signs (eg mediastinal widening on CXR; sudden onset of symmetrical flaccid paralysis)
  - unusual progression of an illness (eg lack of response to usually effective antibiotics; 'chickenpox' rash predominant on extremities)
- Any confirmed case of smallpox, plague, pulmonary anthrax, glanders, tularemia, Venezuelan equine encephalitis (VEE) or viral haemorrhagic fever (VHF) in the UK should be assumed to be the result of a deliberate release until proven otherwise
- Use the action list below in conjunction with the handsheets on infection control (standard precautions, respiratory precautions, airborne infection isolation) and PPE in the section on generic incident management, and those on microbiological testing and specific infections in this section

Action list												
Actions	Infections											
	Anthrax	Botulism	Brucella	Glanders	Melioidosis	Plague	Q fever	SARS	Smallpox	Tularemia	VHF	VEE
Important actions to take for health protection when a diagnosis suspected or confirmed ● If smallpox is the suspected diagnosis, Smallpox Diagnostic Expert will take specimens ■ If VHF is the suspected diagnosis, seek expert advice and assessment before taking specimens ▲												
<b>At presentation of a patient in whom the diagnosis is SUSPECTED</b>												
Discuss with senior emergency medicine clinician and on-call medical microbiologist	●	●	●	●	●	●	●	●	●	●	●	●
Immediately ISOLATE patient in SINGLE ROOM and restrict entry to essential personnel only						●			●	●	●	
Doctor, triage nurse and others who had close contact with patient to remain in room with patient									●			
Ask other patients and their relatives/friends to remain until diagnosis confirmed or excluded									●			
Ensure ambulance used by case is not used again until decontaminated or diagnosis excluded									●	●		
Enforce STANDARD and AIRBORNE infection control precautions (including appropriate PPE)								●	●	●		
Enforce STANDARD and RESPIRATORY infection control precautions (including appropriate PPE)						●						
Enforce STANDARD infection control precautions (including appropriate PPE)	●	●	●	●	●	●			●	●		●
Arrange IMMEDIATE clinical assessment by Smallpox Diagnostic Expert (■) or ID physician (●)		●				●		●	■		●	
Arrange URGENT ID consultation/assessment	●		●	●	●	●				●		●
Alert Infection Control Doctor, Trust senior management and nursing staff, & Occupational Health						●		●	●		●	
Immediately alert local Health Protection Team (HPT)	●	●		●	●	●		●	●	●	●	●
Label ALL specimen containers and ALL request forms 'high risk', and warn laboratory in advance	●	●	●	●	●	●	●	●	■	●	▲	●
Transport clinical specimens to the laboratory according to local protocols for high-risk specimens	●	●	●	●	●	●	●	●	■	●	▲	●
With HPT, identify case contacts for follow up (+/- post exposure prophylaxis or vaccination)						●		●	●		●	
See disease-specific fact sheet for history taking, investigation, treatment and further management	●	●	●	●	●	●	●	●	●	●	●	●
This disease is notifiable by law (or maybe depending on presentation ◆)	●	◆				●			●		●	◆
<b>When/if the diagnosis is CONFIRMED</b>												
Inform local Health Protection Team	●	●	●	●	●	●	●	●	●	●	●	●

# Biological agents: syndromes and differential diagnosis

## Overview

- Be alert to the unusual, the unexpected, and the case that 'just doesn't fit'
- Take a thorough clinical history. Remember to ask the patient about:
  - Occupation (what is their job and where do they do it?)
  - Travel abroad (countries and areas visited, with dates; rural or urban; use of antimalarial drugs, bed nets, insect repellents; immunisations; unprotected sex; unusual events eg animal bite)
  - Family and other contacts (has anyone had similar symptoms?)
  - Hobbies, recreations, contact with pets or other animals, insect bites, food
  - What they think might have caused their illness
- Have a low threshold for seeking advice from the senior emergency medicine clinician, and your consultant microbiologist, CCDC, or ID physician
- The tables below show the differential diagnoses for some important syndromic presentations. Those marked\* are covered in this manual

<b>Neurological symptoms/signs (symmetrical descending flaccid paralysis)</b>	→ <b>Differential diagnosis</b> includes: Guillain-Barre syndrome CVA Chemicals & toxins: organophosphates, carbon monoxide, mushrooms, thallium, alcohol CNS viral infection, polio, transverse myelitis Myasthenia gravis Psychiatric illness Botulism*, nerve agents*
<b>Fever and... chest symptoms/signs (cough, and/or sputum, chest pain, dyspnoea)</b>	→ <b>Differential diagnosis</b> includes: Exacerbation COPD (often <i>Haemophilus influenzae</i> ) Lobar pneumonia ( <i>Streptococcus pneumoniae</i> , rusty sputum, cold sore/s) Atypical pneumonia ( <i>Mycoplasma pneumoniae</i> , <i>Chlamydia pneumoniae</i> , <i>Chlamydia psittaci</i> , <i>Legionella pneumophila</i> , influenza, RSV, chickenpox, Q fever* [ <i>Coxiella burnetii</i> ]) Lung abscess, empyema TB SARS*, pulmonary anthrax*, plague*, tularemia*, melioidosis*, glanders*, ricin*, radiation*
<b>Fever and... generalised rash</b>	→ <b>Differential diagnosis</b> includes: <i>Erythematous/maculopapular rash</i> : rubella, measles, parvovirus B19, enteroviral infections, scarlet fever, typhoid (rose spots), dengue and arboviral infections, syphilis, and smallpox* <i>Vesicular/pustular rash</i> : chickenpox, disseminated HSV, disseminated herpes zoster, hand foot and mouth disease, molluscum contagiosum, monkeypox, drug rash, impetigo, contact dermatitis, erythema multiforme, Stevens Johnson syndrome, scabies, acne, complications of smallpox vaccination, smallpox*
<b>Fever and... localised skin signs and/or local lymphadenopathy</b>	→ <b>Differential diagnosis</b> includes: Impetigo, erysipelas Fixed drug eruption, local reaction to vaccine/BCG Orf, cowpox, necrotic recurrent herpes simplex virus (HSV) infection (cold sore) Lymphogranuloma venereum, granuloma inguinale, chancroid, bubonic plague* Tick bite, spider bite, infected insect bite Cutaneous anthrax*, tularemia*, glanders*, melioidosis*
<b>Fever and... shock and/or bleeding tendency or DIC</b>	→ <b>Differential diagnosis</b> includes: Gram negative sepsis Meningococcal infection ( <i>Neisseria meningitidis</i> ) Toxic shock syndrome ( <i>Staphylococcus aureus</i> ) Malaria, typhoid, leptospirosis, rickettsial infection (typhus, spotted fever), dengue, haemolytic uraemic syndrome (enterotoxigenic <i>E coli</i> ); viral haemorrhagic fevers*, anthrax*, plague*, tularemia*, glanders*, melioidosis*, smallpox*, ricin* Other causes of DIC, including leukaemia, solid tumour, intrauterine death, liver failure

## Taking samples

- Always use standard precautions when taking any specimen
- Use additional PPE (eg double gloves, eye and face protection, FFP3 mask) appropriate to the task and infection, or if the aetiology is uncertain
- If you are uncertain about what PPE to use, or which specimens to collect, seek expert advice
- Telephone the microbiology laboratory in advance to tell them to expect the specimens
- Pre-label specimen containers with the patient's name, hospital number, date and time of sample
- Use dry cotton wool balls (rather than alcohol swabs) to apply pressure to stop any bleeding from venepuncture sites
- Label all specimens and forms as **'high risk'** or **'danger of infection'** (or otherwise identify them as **high risk** using locally agreed method)
- If possible, take specimens for bacterial culture before starting antibiotic treatment. If antibiotics have already been given, mention this on the form
- Take at least 4 sets of blood cultures (2 sets from each of two venepunctures at different sites at least 1 hour apart)
- Avoid contaminating the outside of the specimen container during specimen collection. Screw container caps tight
- Put each specimen in a separate plastic specimen bag (ie 3 specimens, 3 specimen bags). Seal specimen bags with tape: do NOT use clips, staples or pins – this endangers the laboratory staff who open the bags
- Fill in all request forms fully and accurately, giving the working diagnosis and as much clinical information about the case as you can ('? tularemia' is helpful, but 'fever, skin nodules, pneumonia, laboratory worker, on ampicillin ? tularemia' much more so). Put each request form in a separate plastic bag. Never put a request form in the same bag as a specimen – use separate bags, then tape the bag containing the specimen and the bag containing the request form together
- Complete a chain of evidence form if necessary
- Transport specimens to the local microbiology laboratory as soon as possible, using locally agreed procedures for **high risk** samples
- Specimens should be transported to the laboratory by hand by a responsible person
- Do NOT use vacuum-tube systems for specimen transport
- Specimen packaging, labelling and transportation must comply with current national and international standards. See: Biological agents: managing the risks in laboratories and healthcare premises, ACDP/HSE 2005 [www.hse.gov.uk](http://www.hse.gov.uk)
- The table below shows the specimens that are important (or that may be helpful, if it is clinically appropriate to obtain them) in the laboratory diagnosis of high consequence pathogens – but it is not all-inclusive, and if you suspect that a patient has any of these illnesses, you should discuss the case with a senior clinician and with the consultant microbiologist

Clinical specimens	Infections												
	Anthrax	Botulism	Brucella	Glanders	Melioidosis	Plague	Q fever	Tularemia	SARS	Smallpox	VEE	VHF	Unusual illness
Important for laboratory confirmation of diagnosis, collect routinely ●													
Helpful for laboratory confirmation of diagnosis, if specimen clinically indicated ■													
Helpful for exclusion of an important differential diagnosis ▲													
Label ALL specimens and ALL request forms 'high risk' or 'danger of infection'													
Hazard Group of organism	3	2	3	3	3	3	3	3	3	4	3	4	3
Blood cultures	●		●	●	●	●	●	●	●	▲	▲		●
Paired sera (10mls clotted blood acutely and at least 14 days post onset)	●	●	●	●	●	●	●	●	●		●		●
Additional 20mls acute serum sample AND further sample at more than 21 days post onset									●				●
EDTA blood sample (5 x 4ml) on admission	●					●		●					●
Swab/aspirate of any skin lesion for microscopy, culture & sensitivity	●			●	●	●		●					■
Nasal swabs (dry swabs, not in transport medium, preferred) for microscopy, culture & sensitivity	●												
Throat and nasal swabs together (or throat washings) in virus transport medium									●	●			●
Nasopharyngeal aspirate or throat washings for rapid tests for influenza and RSV	▲					▲	▲	▲	▲				▲
Sputum for microscopy, culture & sensitivity	●			●	●	●	●	●	▲				■
Sputum for ZN stain and AAFBs	▲		▲	▲	▲	▲	▲	▲	▲				▲
Bronchoalveolar lavage or bronchial washings (in sterile container)	■	■		■	■	■	■	■	■				■
Urine (at least 20mls; 'clean catch' specimen into sterile container) for microscopy, culture & sensitivity	▲		▲	●	●	▲		▲			▲		▲
Urine (in sterile container) for legionella and pneumococcal antigens	▲			▲	▲	▲	▲	▲	▲				▲
Faeces (at least 10g in sterile container)	■	●											
Vomitus or gastric washings or gut contents (at least 10g in sterile container)	■	●											
CSF (in sterile containers)	■		■			■							■
Bone marrow aspirate (in sterile container)			■										
Specimens from other normally sterile sites that may be helpful for laboratory diagnosis include pleural fluid, pus, and tissue from debridement													
If in doubt, seek advice from your consultant microbiologist and/or infectious disease physician													
For detailed guidance on the identification, investigation, and management of 'unusual illness', see: <a href="http://www.hpa.org.uk">www.hpa.org.uk</a>													

# Pre- and post- exposure prophylaxis

## Overview

- The decision to offer post-exposure prophylaxis after a deliberate or accidental release should be taken after a risk assessment of the likelihood and extent of exposure has been made. If a deliberate release occurs, advice about the use of prophylaxis will be provided. Groups likely to need prophylaxis include persons exposed at the incident scene (including first responders and handlers of contaminated clothing) and, for smallpox and pneumonic plague, contacts of cases, laboratory workers and others
- For exposure outside the context of deliberate release (eg accidental exposure during laboratory work; accidental inoculation of the live brucella vaccine that is used in animals), follow local occupational health protocols (including those on exposure to HBV, HCV and HIV) on reporting, care provision, counselling and follow up, and seek expert advice if in doubt
- Before prescribing, check current recommendations via the HPA ([www.hpa.org.uk](http://www.hpa.org.uk)) and DH ([www.dh.gov.uk](http://www.dh.gov.uk)) websites, and check drug dosages, contraindications and interactions in the BNF
- The table shows the **drug/s of first choice** and **second choice** (for use when the drug of first choice cannot be prescribed because it is contraindicated or is not available), and alternatives for use (eg amoxicillin for anthrax) when the organism is known to be sensitive to the drug. Except where specified, antibiotic prophylaxis should begin, if possible, within 24 hours of exposure
- The Department of Health has prepared Patient Group Directions (PGDs) for use when members of the public may have been exposed to a biological agent. These provide for initial (first 3 days) post exposure prophylaxis with ciprofloxacin, and for completion of treatment with either ciprofloxacin or doxycycline
- Ciprofloxacin is not licensed for use in children or in pregnant women. There have been no formal studies of the use of ciprofloxacin in pregnancy, but it is unlikely to be associated with a high risk of abnormalities of foetal development. There is some evidence that the use of fluoroquinolones in children (including via breast feeding) may be associated with tendinitis and arthropathy. The risk of adverse effects of ciprofloxacin must be weighed against the risk of developing an infectious disease with significant morbidity and mortality. Doxycycline has adverse effects in children (deposition in growing bones and teeth, causing staining and, occasionally, dental hypoplasia), and should be used in children less than 12 years and in pregnancy only when no alternative antibacterial can be given, and when the risk of infection outweighs the risk of adverse effects. If given ciprofloxacin or doxycycline, lactating mothers should stop breast feeding
- For patient information sheets, patient group directions, and additional information on ciprofloxacin and doxycycline: [www.dh.gov.uk](http://www.dh.gov.uk)

Protocols				
Disease/ Agent	Pre-exposure vaccine	Post-exposure prophylaxis Adults	Duration	Post-exposure prophylaxis Children
Anthrax	Available for those at occupational risk eg work with animal hides, laboratory work. 5 dose course (0, 3 and 6 weeks, 6 and 12 months)	<b>Ciprofloxacin 500mg orally bd</b> or <b>Doxycycline 100mg orally bd</b> or if organism shown to be sensitive <b>Amoxicillin 500mg orally tds</b>	60 days or 28 days*	<b>Ciprofloxacin 10mg-15mg/kg orally bd (not to exceed 1g per day)</b> or if organism shown to be sensitive <b>Doxycycline 2.5mg/kg orally bd</b> or <b>Amoxicillin 25mg/kg orally tds</b>
		Anthrax vaccine may be available and used post-exposure in combination with antibiotics in selected cases (eg first responders in incident 'hot zone'). * If anthrax vaccine is given, or a full course of vaccine has been completed previously, antibiotic prophylaxis is reduced to 28 days		
Botulism	Toxoid vaccine for research workers	Not indicated		
Brucellosis	No	<b>Doxycycline 100mg orally bd</b> and <b>Rifampicin 600mg-900mg orally daily</b> Pregnancy: use rifampicin alone	21 days (if low risk)- 6 weeks (high risk)	<b>Doxycycline 2.5mg/kg orally bd</b> and <b>Rifampicin 10-15mg/kg orally daily</b>
Glanders and melioidosis	No	<b>Doxycycline 100mg orally bd</b> or <b>Co-trimoxazole 960mg orally bd</b>	7 days	<b>Co-trimoxazole 24mg/kg orally bd</b>
Plague	Sub-unit vaccines in development but not yet evaluated in humans	<b>Ciprofloxacin 500mg orally bd</b> or <b>Doxycycline 100mg orally bd</b>	7 days	<b>Ciprofloxacin 10mg-15mg/kg orally bd (not to exceed 1g per day)</b> or <b>Doxycycline 2.5mg/kg orally bd</b>
		Health care and laboratory workers should continue therapy until 7 days after last known exposure		
Q fever	Not in UK	<b>Doxycycline 100mg orally bd</b> or <b>Co-trimoxazole 960mg orally bd</b> (particularly for pregnant/ breast-feeding women)	7 days	<b>Co-trimoxazole 24mg/kg orally bd</b>
		Begin prophylaxis 8-12 days after exposure (if taken earlier it will merely delay illness onset)		
Smallpox	Vaccinia vaccine – has been given to key workers	Vaccine given immediately or very soon after exposure reduces the severity of infection		
Tularemia	Vaccine has been given to selected laboratory workers	<b>Ciprofloxacin 500mg orally bd</b> or <b>Doxycycline 100mg orally bd</b>	14 days	<b>Ciprofloxacin 10mg-15mg/kg orally bd (not to exceed 1g per day)</b> or <b>Doxycycline 2.5mg/kg orally bd</b>
		Vaccine gives incomplete protection: antibiotics required after known laboratory exposure		
VEE	No	Not indicated		
Viral haemorrhagic fever	No current vaccine available	Ribavirin and active follow up for 21 days for any health care or laboratory worker with a high-risk exposure (eg needlestick injury, or skin, eye or mucous membrane contact with blood or body fluids) to a known source of Lassa fever virus or arenavirus, or to a VHF of uncertain aetiology		

## Think of anthrax

In any **previously health patient** with:

- Rapid onset of severe febrile illness, sepsis or respiratory failure with wide mediastinum on CXR *or*
- Painless black-scabbed ulcer on arm, neck or face with extensive local swelling *or*
- Gram positive rods (or *Bacillus sp*) in blood or CSF assessed not to be contaminants *or*
- Haemorrhagic meningitis *or*
- Unexplained febrile death
- **Inhalational anthrax is very rare indeed: a single confirmed case in the UK suggests deliberate release**

## Key facts

- Caused by *Bacillus anthracis* (Gram positive bacterium with hardy spore form that can survive in soil for decades)
- Zoonosis (disease that affects animals and humans) – mainly of sheep, cattle, and goats
- Human anthrax now rare in UK (< 1 case/year) but still occurs in parts of Europe, the Americas and in the Middle East and Africa
- Naturally acquired human anthrax is the result of contact with an infected animal, carcass or animal product
- Clinical features depend on route of exposure: contact with abraded skin causes cutaneous anthrax; breathing in the spores causes inhalational anthrax; eating under cooked anthrax-contaminated meat causes gastrointestinal anthrax
- Occupational risks: working with animals or animal hides, skins or hair, as in Hawick, Scotland in 2006 where there was one death, or working with the organism in the laboratory. Working in a postal sorting office or as mail handler was a risk in the 2001 outbreak, when deliberate release of letters containing anthrax spores via the US Postal Service caused 22 cases (five deaths)
- Other risks: threatening letters or suspicious packages
- Incubation period usually 1-7 days (range < 24 hours – 60 days post exposure)

## Symptoms and signs

Cutaneous anthrax	Inhalational anthrax	Gastrointestinal anthrax
<ul style="list-style-type: none"> <li>• Initial pimple/papule enlarges, blisters, ulcerates over 2-6 days to form a black scab (eschar)</li> <li>• Painless, not tender (may itch)</li> <li>• Extensive local swelling</li> <li>• Commonest on hands, forearm, neck, or face</li> <li>• Local lymphadenopathy</li> <li>• Systemic malaise: headache, chills</li> <li>• With antibiotics, recovery usual</li> </ul>	<ul style="list-style-type: none"> <li>• Febrile, flu-like prodrome                             <ul style="list-style-type: none"> <li>– Fever, drenching sweats</li> <li>– Malaise, myalgia</li> <li>– Nausea, vomiting</li> <li>– Non-productive cough</li> <li>– Headache, confusion</li> <li>– No coryza (cf URTI, flu)</li> </ul> </li> <li>• 1-2 days later severe sepsis, acute dyspnoea, chest pain, respiratory failure, meningism</li> <li>• 100% mortality if untreated</li> </ul>	<ul style="list-style-type: none"> <li>• Acute abdomen</li> <li>• Severe abdominal pain</li> <li>• Nausea, vomiting</li> <li>• Bloody diarrhoea</li> <li>• Sepsis, shock</li> <li>• High mortality even with treatment</li> </ul>

## Management

- If diagnosis suspected, discuss with senior emergency medicine clinician and consultant microbiologist, arrange urgent ID consultation, and alert local Health Protection Team (HPT)
- NO risk of person to person spread: use STANDARD precautions
- Culture (and Gram stain) of: blood, swab /aspirate of any skin lesion, sputum, other (eg pleural fluid, CSF); 10mls clotted blood for serology (and further sample at least 14 days post onset); 20mls blood in EDTA tubes for PCR; nasopharyngeal aspirate or throat washings for rapid tests for influenza and RSV (positive results may exclude diagnosis); Hazard Group 3 organism, label all samples 'danger of infection'
- If possible take cultures BEFORE starting antibiotics
- CXR +/- or CT scan chest (look for wide mediastinum, pleural effusion/s, pulmonary infiltrates)
- Dermatology/ID referral for biopsy of any skin lesion (histology, PCR)
- Systemic anthrax: ABGs: (low PaO<sub>2</sub>); FBC (high white cell count); U & Es (low sodium); LFTs (high transaminases, low serum albumin)
- Initial treatment for adults with systemic anthrax: ciprofloxacin 400mg IV bd (or doxycycline 100mg IV bd) plus 1 or 2 additional antibiotics (rifampicin/vancomycin/clindamycin/penicillin or amoxicillin/imipenem or meropenem/chloramphenicol)
- Initial treatment for children with systemic anthrax: ciprofloxacin 10mg/kg IV bd, not to exceed 800mg per day (or doxycycline: if at least 8 years old and body weight 45kg: 100mg IV bd; if less than 8 years and body weight less than 45kg, or less than 8 years: 2.2mg/kg IV bd) plus 1 or 2 additional antibiotics as above
- Initial treatment for adults with cutaneous anthrax and no systemic symptoms: ciprofloxacin 500mg orally bd or doxycycline 100mg orally bd for 7 days; change to amoxicillin 500mg orally tds if organism sensitive
- Initial treatment for children with cutaneous anthrax and no systemic symptoms: ciprofloxacin 10mg/kg-15mg/kg orally bd or doxycycline 2.5mg/kg orally bd or, if organism penicillin sensitive, amoxicillin 80mg/kg/day orally in three divided doses
- Anthrax is NOT sensitive to cephalosporins

## See also

- Emergency contacts, personal protective equipment, infection control, post-exposure prophylaxis, biological incident action guide, microbiological testing, picture gallery

## Think of botulism

In any **previously healthy patient** with:

- Symmetrical descending flaccid paralysis, with prominent bilateral cranial nerve signs, without fever and without sensory loss
- **A single suspected case of botulism is a public health emergency, regardless of the circumstances**

## Key facts

- Caused by neurotoxins of *Clostridium botulinum* (spore forming Gram positive anaerobic bacillus)
- *Clostridium botulinum* occurs in soils and marine sediments worldwide; in anaerobic conditions, the spores germinate and the growing bacterial cells then produce toxin
- Botulinum toxin has 7 antigenically distinct forms, A-G (A and B most common in natural human disease)
- Toxin acts by blocking acetylcholine release at the neuromuscular junction
- Toxin is amongst the most lethal known, but is inactivated by normal cooking of food and by chlorination of water
- Botulism follows absorption of toxin into bloodstream after eating toxin-containing food, or following local production of toxin by *C botulinum* in a wound (or, in infant botulism, intestine), or breathing in pure toxin
- Naturally acquired food-borne botulism is rare in the UK, but can occur (27 cases in 1989 outbreak associated with hazelnut yoghurt); more common in Europe where home-canning/preservation of food more widespread; wound botulism has occurred after gun-shot wounds, and in UK drug users who have injected with contaminated heroin; infant botulism usually affects infants aged less than 6 months, and is associated with feeding of honey containing *C botulinum* spores, with subsequent gut colonisation and toxin production
- Inhalation botulism does not occur naturally but could follow the deliberate release of aerosolised toxin
- All forms of botulism have the same neurological symptoms and signs
- Speed of onset and severity of illness are related to dose and route of exposure: 6 hours-8 days after ingestion of toxin: onset might be more rapid after inhalation

## Symptoms and signs

### Early symptoms and signs

- No fever
- Facial weakness
- Ptosis, drooping eyelids
- Difficulty speaking, seeing, or swallowing
- 4 Ds: dysphonia, dysarthria, diplopia, dysphagia
- Dry mouth
- Pupils dilated and sluggishly reacting
- Normal sensation and alertness
- Nausea, vomiting and diarrhoea sometimes accompany food-borne botulism

### Late symptoms and signs

- Neck weakness – loss of head control
- Descending weakness – pharynx, arms, accessory muscles of respiration, diaphragm, lower body
- Respiratory failure may be the first sign if onset is very rapid
- Loss of gag reflex and tendon reflexes
- Autonomic disturbance
- Death from airways obstruction and respiratory muscle paralysis
- Mortality reduced by early administration of antitoxin and good supportive care

**Note** Often diagnosed late: misdiagnoses have included anxiety, Guillain-Barre syndrome (preceding febrile illness, ascending paralysis, paraesthesiae, CSF/EMG findings); myasthenia gravis (recurrent paralysis, sustained response to anticholinesterase test, EMG); intoxication eg carbon monoxide, organophosphates, mushrooms, magnesium, alcohol (history, toxicology); stroke (usually asymmetric, abnormal brain scan); and rarely, polio (fever, asymmetry), tick paralysis (ascending paralysis, tick on skin), CNS viral infections (altered consciousness, CSF, EMG), and psychiatric illness

## Management

- If diagnosis suspected, discuss with senior emergency medicine clinician and consultant microbiologist, arrange immediate assessment by ID physician, and immediately alert local Health Protection Team
- NO risk of person to person spread: use STANDARD precautions
- Take a clear and detailed food history
- Obtain 10mls serum; 10g faeces (in sterile container) and other (gastric washings/lavage; bronchial washings/lavage; pus from abscess/wound; wound swab in transport medium) as appropriate, for urgent toxin detection by reference laboratory
- Obtain samples for toxin detection before giving any antitoxin
- Tests that may help in excluding diagnosis include: brain scan, EMG, CSF examination, Tensilon™ test
- ID physician will provide expert advice about further management, and about giving antitoxin (botulinum antitoxin is held in regional centres and HPA Centre for Infections)
- Decision to give antitoxin is made clinically, and not on laboratory test results
- Antibiotics (penicillin with metronidazole) indicated only for wound botulism; if wound botulism, may also need surgical debridement
- Monitor and support respiratory function: intubate, ventilate (possibly long term); treat secondary infection

## See also

- Emergency contacts, personal protective equipment, post-exposure prophylaxis, infection control, microbiological testing, biological incident action guide, picture gallery

## Think of brucellosis

In any with **previously healthy patient** with:

- Fever of unknown origin, *or*
- Endocarditis (culture negative), *or*
- Hepatitis (negative for HAV, HBV, HCV markers with granulomata on biopsy)
- **A single confirmed case with no history of travel to endemic area or of occupational exposure suggests deliberate release**

## Key facts

- Caused by *Brucella abortus*, *Brucella melitensis*, or *Brucella suis* (tiny Gram negative coccobacilli)
- Zoonosis (disease that affects animals and man), affecting cows (*Brucella abortus*), sheep, goats and camels (*B melitensis*), pigs (*B suis*), and other mammals
- Animal disease is now rare in UK, but still common in some parts of Europe, M East, Africa, Asia, S and C America (including Mexico), and the Caribbean
- Naturally acquired human infection follows drinking unpasteurised milk or eating unpasteurised milk products from infected animals; breathing in the organism or directly contaminating the eyes, nose, mouth or abraded skin during close contact with infected animals, products of conception, or carcasses, or while working with the organism in the laboratory, and the accidental inoculation of live attenuated animal vaccine
- Human disease uncommon in UK (< 20 reported cases each year, usually acquired abroad)
- *B melitensis*, *B abortus* and *B suis* cause similar human illnesses (*B melitensis* causes the most severe disease); clinical features do not depend on route of exposure
- Occupational risks for: animal handlers, vets, meat packers and abattoir workers exposed to infected animals, carcasses, or contaminated dust (eg when washing down buildings); laboratory workers
- Incubation period usually 1-3 weeks, but may be longer (up to 6 months)
- Diagnosis easily missed as symptoms are variable and non-specific

## Symptoms and signs

### Acute brucellosis

- Fever, often undulant/irregular
- Chills, sweats, malaise, fatigue, exhaustion
- Loss of appetite, weight loss
- Headache
- Myalgia, joint pain (sacroiliac and other large joints)
- Low back pain (lumbar tenderness)
- Dry cough, pleuritic chest pain
- Depression, mood change, irritability
- Physical examination usually normal but may have:
  - Hepatosplenomegaly, generalised lymphadenopathy
  - Meningoencephalitis (rare, < 5% of all cases)
  - Endocarditis (rare, 1-2% of all cases)

### Chronic brucellosis (symptoms for at least 1 year)

- Intermittent low grade fever, chills, sweats
- Malaise, fatigue
- Weight loss
- Depression (may be severe, or main symptom)
- Arthritis
- Back pain (vertebral osteomyelitis, paravertebral abscess)
- Hepatosplenomegaly
- Endocarditis
- Mortality low (< 5%) but morbidity considerable

## Management

- Discuss with senior emergency medicine clinician and consultant microbiologist, arrange urgent ID consultation; inform local Health Protection Team if diagnosis confirmed
- NO risk of person to person spread: use STANDARD precautions
- Diagnosis most often made serologically: 10mls clotted blood (and further sample at least 14 days post onset); culture blood (multiple sets, which will need prolonged incubation in laboratory – make sure request forms mention the possible diagnosis), bone marrow aspirate, other (eg joint aspirate, pleural fluid); high risk of laboratory-acquired infection, label all samples 'danger of infection'
- If possible take cultures BEFORE starting antibiotics
- CXR: usually normal, rarely enlarged hilar nodes, pleural effusion; LFTs: often mildly abnormal; FBC: sometimes anaemia, leucopaenia, thrombocytopenia
- If neurological signs consider brain scan, CSF; refer cardiology if signs of endocarditis (surgical treatment may be required)
- Initial treatment for adults:
  - Doxycycline 100mg orally or IV bd
  - and either
  - Rifampicin 600mg-900mg orally *or* streptomycin 1g/day IM [maximum 3 weeks] *or* gentamicin 5mg/kg/day IM or IV
  - Check drug levels of streptomycin or gentamicin if used; monotherapy with rifampicin preferred for pregnant women
  - Duration of treatment depends on disease severity, patient age and response to treatment
- Initial treatment for children: gentamicin 5mg/kg/day IM for 5 days and cotrimoxazole (standard paediatric dose) orally for 3 weeks
- Treatment response indicated by resolution of fever and other symptoms, and weight gain
- Relapses may occur: follow up (check compliance) at 3 weeks and 6 weeks, then every 3 months for 1 year

## See also

- Emergency contacts, personal protective equipment, post-exposure prophylaxis, infection control, biological incident action guide, microbiological testing

## Think of glanders

In any **previously healthy patient** with:

- Cavitating pneumonia unresponsive to standard antibiotic or antituberculous therapy, *or*
- Severe unexplained sepsis, especially if cluster of linked cases, *or*
- Severe febrile illness with bloody nasal discharge or eye infection or visceral abscesses
- **In UK, a single confirmed case with no history of laboratory exposure suggests deliberate release**

## Key facts

- Caused by *Burkholderia mallei* (formerly *Pseudomonas mallei*), a small Gram negative bacillus
- Zoonosis (disease of animals and man); primarily a disease of horses, donkeys, and mules
- Animal disease no longer occurs in the UK, but still occurs in Turkey, M East, parts of Africa, and S and SE Asia
- Naturally acquired human disease is the result of close contact with an infected animal or carcass, or a laboratory exposure; there is no environmental reservoir
- Infection acquired by direct contact of organism with cut or abraded skin, or eyes, nose or mouth, or by inhalation
- Occupational risks: work with organism in laboratory; in endemic areas, risk for stablehands, muleteers, vets and abattoir workers exposed to infected animals or carcasses
- Considered as a bioweapon in both World War I (eg to infect mules on Eastern front) and World War II
- Incubation period for human disease usually 10-14 days
- Human disease rare; very little recent clinical experience on which to base recommendations

## Symptoms and signs

Localised glanders	Pulmonary glanders	Septicaemic glanders
<ul style="list-style-type: none"> <li>• Fever, chills, malaise</li> <li>• Headache, myalgia</li> <li>• Local or generalised pustular ulcers</li> <li>• Local lymphadenopathy</li> <li>• Purulent or bloody nasal discharge</li> </ul>	<ul style="list-style-type: none"> <li>• Fever, chills, malaise</li> <li>• Headache, myalgia</li> <li>• Productive cough</li> <li>• Dyspnoea</li> <li>• Chest pain</li> <li>• CXR: multifocal consolidation, effusion, cavitation, lung abscess</li> </ul>	<ul style="list-style-type: none"> <li>• Fever, chills, malaise</li> <li>• Headache, myalgia</li> <li>• Septic shock</li> <li>• Multiple abscesses – common sites are liver, kidney, spleen</li> <li>• Multi-organ failure</li> <li>• High mortality if untreated</li> </ul>

## Management

- If diagnosis suspected, discuss with senior emergency medicine clinician and consultant microbiologist, arrange urgent ID consultation, and alert local Health Protection Team (HPT)
- Very low risk of person to person spread: use STANDARD precautions and exclude immunocompromised staff (including diabetics) from direct patient care
- Culture blood, urine, sputum, other (eg pus if suppurative lesions present), 10mls clotted blood for serology (and further sample at least 14 days post onset); exclude pulmonary TB if lung lesions (sputum for AAFBs and culture)
- If possible take cultures BEFORE starting antibiotics
- Initial treatment of severe disease: minimum 2 weeks IV therapy with:
  - Ceftazidime 120mg/kg/day (usual adult dose 2g IV tds) *or*
  - Meropenem 50mg/kg/day (usual adult dose 1g IV tds) *or*
  - Imipenem/cilastatin 50mg/kg/day (usual adult dose 1g IV tds) *or*
  - Gentamicin 5mg/kg IV once daily and oral co-trimoxazole 8/40mg/kg/day
  - Ciprofloxacin is NOT recommended
- For initial oral treatment of mild disease or oral eradication treatment of severe disease (20 weeks treatment in total):
  - Doxycycline 4mg/kg/day and co-trimoxazole 40/8mg/kg/day *or*, particularly for children and pregnant women, co-amoxiclav, expressed as amoxicillin, 60mg/kg/day (adult dose, expressed as amoxicillin, 500mg orally tds)
- Consider surgical drainage of abscesses
- Disease may relapse or recur: long term (minimum 5 years) follow up required

## See also

- Emergency contacts, personal protective equipment, infection control, post exposure prophylaxis, microbiological testing, biological incident action guide

## Think of melioidosis

In any **previously healthy patient** with:

- Cavitating pneumonia unresponsive to standard antibiotic or antituberculous therapy, *or*
- Rapid onset of severe unexplained sepsis, especially if cluster of linked cases
- **In UK, a single confirmed case with no history of laboratory work or of travel to endemic area suggests deliberate release**

## Keys facts

- Caused by *Burkholderia pseudomallei* (formerly *Pseudomonas pseudomallei*), a small Gram negative bacillus
- Does not occur naturally in the UK, 1-2 imported cases each year
- Common in South Asia and SE Asia particularly in paddy-rice growing areas, and Northern Australia; cases also reported from Africa and Central and Southern America
- Naturally acquired infection follows contact of contaminated water with cut or abraded skin, swallowing/aspirating contaminated water (eg in near-drowning incidents), or breathing in contaminated dust
- Clinical features of primary disease (skin/soft tissue infection or pneumonia) depend on route of exposure, but presentation is highly variable
- Incubation period extremely variable: for acute infection, 1-21 days (mean 9 days) but disease may occur years after exposure, particularly in the immunocompromised (diabetes, chronic renal failure, steroid treatment, cystic fibrosis)
- Occupational risks for: laboratory workers; in endemic areas, rice farmers and agricultural workers
- *B pseudomallei* is intrinsically resistant to many antibiotics. Think of melioidosis if a Gram negative oxidase positive non-fermenter resistant to gentamicin and colistin but sensitive to co-amoxiclav is grown from blood, pus or sputum

## Symptoms and signs

Skin and soft tissue melioidosis	Pulmonary melioidosis	Septicaemic/disseminated melioidosis
<ul style="list-style-type: none"> <li>• Primary site of infection after trauma/inoculation or result of metastatic spread through bloodstream</li> <li>• Fever, chills, malaise</li> <li>• Local lymphadenopathy</li> <li>• Cellulitis</li> <li>• Subcutaneous nodules</li> <li>• Abscess (parotid gland in children)</li> <li>• Skin pustules</li> </ul>	<ul style="list-style-type: none"> <li>• Primary site of infection after inhalation or result of metastatic spread through bloodstream</li> <li>• Fever, chills, malaise</li> <li>• Productive cough</li> <li>• Dyspnoea</li> <li>• Chest pain</li> <li>• CXR: multifocal consolidation, often of upper lobes with apical sparing, cavitation, lung abscess</li> </ul>	<ul style="list-style-type: none"> <li>• Fever (may be high, swinging)</li> <li>• Chills, malaise, sweats</li> <li>• Multiple abscesses – common sites are liver, spleen, kidney; also bone, prostate, brain</li> <li>• Septic shock</li> <li>• Multiple organ failure</li> <li>• 100% mortality if untreated</li> <li>• 40% mortality with treatment</li> </ul>

## Management

- If diagnosis suspected, discuss with senior emergency medicine clinician and consultant microbiologist, arrange urgent ID consultation, and alert local Health Protection Team (HPT)
- Very low risk of person to person spread: use STANDARD precautions and exclude immunocompromised staff (including diabetics) from direct patient care
- Culture blood, urine, sputum, other (eg pus if suppurative lesions present); 10mls clotted blood for serology (and further sample at least 14 days post onset); exclude pulmonary TB if lung lesions (sputum for AAFBs and culture)
- If possible take cultures BEFORE starting antibiotics
- *B pseudomallei* is NOT sensitive to aminoglycosides (eg gentamicin, amikacin); ciprofloxacin is not recommended as treatment
- Initial treatment of severe disease: minimum 2 weeks IV therapy with:
  - Ceftazidime 120mg/kg/day (usual adult dose 2g IV tds) *or*
  - Meropenem 50mg/kg/day (usual adult dose 1g IV tds) *or*
  - Imipenem/cilastatin 50mg/kg/day (usual adult dose 1g IV tds)
- For initial oral treatment of mild disease, or oral eradication treatment of severe disease (20 weeks treatment in total):
  - Doxycycline 4mg/kg/day + co-trimoxazole 40/8mg/kg/day *or*, particularly for children and pregnant women, co-amoxiclav, expressed as amoxicillin, 60mg/kg/day (adult dose, expressed as amoxicillin, 500mg orally tds)
- Consider surgical drainage of abscesses
- Disease may relapse or recur: long term (minimum 5 years) follow up required

## See also

- Emergency contacts, personal protective equipment, infection control, post exposure prophylaxis, microbiological testing, biological incident action guide

## Think of plague

In any **previously healthy patient** with:

- Rapid onset of severe unexplained febrile respiratory illness, *or*
- Unexplained death following a short febrile or septicaemic illness, *or*
- Pneumonia with haemoptysis, especially if two or more linked cases
- **A single case of plague acquired in the UK suggests deliberate release**

## Key facts

- Caused by *Yersinia pestis* (small Gram negative coccobacillus)
- Zoonosis (disease that affects animals and humans) – spread between fleas and small rodent reservoirs
- Does not occur naturally in UK
- 1500-3000 reported cases worldwide each year from Africa, Asia, and Americas (including US)
- Naturally acquired human disease usually the result of a bite from an infected flea
- Clinical features depend on route of exposure: bite of infected flea causes bubonic plague; breathing in organism causes pneumonic plague; direct inoculation of *Y pestis* into bloodstream, or progression of bubonic or pneumonic plague cause septicaemic plague
- Occupational risks: laboratory work on organism; in endemic areas outside UK, animal trapping, hunting, or skinning
- Deliberate release most likely to be via aerosol, causing pneumonic plague
- **Person to person spread of pneumonic (but not bubonic or septicaemic) plague CAN occur**

## Symptoms and signs

Bubonic plague	Pneumonic plague	Septicaemic plague
<p><i>Incubation period 2-8 days</i></p> <ul style="list-style-type: none"> <li>• Fever</li> <li>• Bubo – a swollen, very painful, tender lymph node draining the site of the flea bite (usually in the groin, axilla or on the neck); overlying skin is red and indurated</li> <li>• Buboes are usually unilateral</li> <li>• Hypotension, confusion</li> <li>• With antibiotics, 95% of cases recover</li> <li>• Untreated can progress to plague pneumonia, septicaemia or meningitis, and death</li> <li>• No person to person spread if no progression to pneumonia</li> </ul>	<p><i>Incubation period 2-4 days</i></p> <ul style="list-style-type: none"> <li>• Fever, chills, sweats</li> <li>• Headache, severe malaise</li> <li>• Vomiting, diarrhoea</li> <li>• Cough, increasing dyspnoea</li> <li>• Watery sputum, may be bloody</li> <li>• Associated chest pain</li> <li>• CXR – multilobar consolidation, bilateral infiltrates, effusions</li> <li>• Rapid progression to shock/ARDS/ respiratory failure</li> <li>• 100% mortality if untreated</li> <li>• Early antibiotic Rx critical</li> <li>• Person to person spread by droplet infection occurs readily</li> </ul>	<p><i>Incubation period 1-8 days</i></p> <ul style="list-style-type: none"> <li>• Most often from progression of untreated bubonic or pneumonic forms, but may occur without signs of infection elsewhere</li> <li>• Fever, chills, sweats</li> <li>• Gram negative shock</li> <li>• Purpura/peripheral gangrene</li> <li>• DIC</li> <li>• High mortality if untreated</li> </ul>
		<p><b>Rare presentations</b></p> <ul style="list-style-type: none"> <li>• Plague meningitis</li> <li>• Pharyngeal plague – cervical nodes + tonsillitis</li> </ul>

## Management

- If diagnosis suspected, discuss with senior emergency medicine clinician and consultant microbiologist, arrange immediate assessment by ID physician, and immediately alert local Health Protection Team (HPT)
- If pneumonic plague suspected (or confirmed) put patient in side room or cubicle, and enforce STANDARD and RESPIRATORY precautions for 72 hours after starting antibiotic treatment; with local HPT arrange post-exposure prophylaxis for close contacts
- Culture blood, sputum, other specimens (eg bubo aspirate, pleural fluid, CSF); 10mls clotted blood for serology (and further sample at least 14 days post onset); 20mls blood in EDTA tubes on admission for PCR
- If possible take cultures BEFORE starting antibiotics
- CXR: multilobar consolidation, bilateral infiltrates, pleural effusion/s
- Initial treatment:
  - Gentamicin at standard doses for severe sepsis according to local protocol, *or*
  - Ciprofloxacin 400mg IV bd (adults) or 15mg/kg IV bd (children)
- For mild adult cases: ciprofloxacin 500-750mg orally bd
- For mild paediatric cases: ciprofloxacin 20mg/kg orally bd
- For plague meningitis: use chloramphenicol 25mg/kg IV qds
- Check levels of gentamicin or streptomycin if used; expect clinical response in 36-48 hours

## See also

- Emergency contacts, personal protective equipment, post-exposure prophylaxis, infection control, microbiological testing, biological incident action guide, picture gallery

## Think of Q fever

In any **previously healthy patient** with:

- Community acquired pneumonia, especially if two or more linked cases, *or*
- Endocarditis (culture negative), *or*
- Hepatitis (negative for HAV, HBV, and HCV markers, with granulomata on biopsy)

## Keys facts

- Caused by *Coxiella burnetii* (small Gram negative pleomorphic coccobacillus – difficult and dangerous to grow)
- Zoonosis (disease that affects animals and man): worldwide distribution, with reservoirs in sheep, cattle, goats, and other mammals – infected animals usually asymptomatic but shed the organism in large numbers in placental tissue, amniotic fluid, milk, urine and faeces
- *C burnetii* is resistant to heat and drying, so survives well in the environment
- Infectious dose is very low (can be just one organism)
- Naturally acquired human infections usually caused by breathing in organism (eg when birthing infected animal, from contaminated dust, from aerosols in laboratory work); rarely, from eating or drinking unpasteurised milk or unpasteurised milk products
- 50% human infections are asymptomatic; symptomatic infection may be more common in smokers
- In UK: 50-100 reported cases of human infection each year; 1% of all cases of community acquired pneumonia; most cases are sporadic, but outbreaks occur
- Incubation period of acute Q fever usually 18-21 days (range 4-40 days), may be shorter if large infective dose; chronic Q fever may occur years after untreated primary infection
- Occupational risks for: farmers, shepherds, vets and abattoir workers exposed to infected animals, their body fluids or carcasses, or contaminated dust (eg when washing down buildings); laboratory workers

## Symptoms and signs

### Acute Q fever

- Fever (often abrupt onset, high)
- Malaise, fatigue, sweats
- Headache, myalgia
- Dry cough (25% of symptomatic infections)
- No rash
- Hepatitis (30% of symptomatic infections)
- Often self-limiting after 1-2 weeks
- Rarely, aseptic meningitis, endocarditis

### Chronic Q fever

- Fever
- Weight loss, malaise, fatigue
- Aseptic meningitis/meningoencephalitis
- Endocarditis (75% aortic valve; usually affects prosthetic valve or damaged native valve)
- Needs prolonged (minimum 2 years) antibiotic treatment, and usually, surgical valve replacement if endocarditis

## Management

- If diagnosis suspected, discuss with senior emergency medicine clinician and consultant microbiologist, arrange urgent ID consultation; if confirmed, alert local Health Protection Team (HPT)
- NO risk of person to person spread: use STANDARD precautions
- Diagnosis is usually serological: 10mls clotted blood for Q fever serology (and convalescent sample at least 28 days post onset); histology/immunocytochemistry (eg of liver biopsy) sometimes also helpful
- CXR: abnormal in 50% of symptomatic infections: patchy infiltrates, lobar consolidation, enlarged hilar nodes
- LFTs: raised (2-3 x normal) transaminases, bilirubin usually normal
- FBC: normal, or raised WCC, sometimes thrombocytopenia
- If neurological signs, consider brain scan, CSF; refer to cardiology if signs of endocarditis (surgical Rx may be required)
- Although untreated infection is usually self-limiting, antibiotic Rx reduces the risk of chronic infection and speeds recovery
- Initial treatment for acute Q fever for adults:
  - Doxycycline 100mg bd orally or IV, *or*
  - Tetracycline 500mg orally qds, *or*, if pregnant or breast-feeding,
  - Co-trimoxazole 960mg orally bd
- Initial treatment for children: Co-trimoxazole 24 mg/kg orally bd
- Treatment response (usually within 2-3 days) indicated by resolution of fever and of other symptoms
- Treatment of chronic Q fever or Q fever endocarditis requires long term combined antibiotic therapy: seek expert advice

## See also

- Emergency contacts, personal protective equipment, post-exposure prophylaxis, infection control, biological incident action guide, microbiological testing

# Severe acute respiratory syndrome (SARS)

## Think of SARS

### Any patient who meets this definition has SARS until proven otherwise:

Fever more than 38°C **AND** cough or dyspnoea or breathing difficulty **AND** in the 10 days before onset of illness, has:

- Travelled to/from a SARS zone of re-emergence (check [www.hpa.org.uk](http://www.hpa.org.uk)), *or*
- Had close contact with other case(s) of severe respiratory illness from a SARS zone of re-emergence, *or*
- Worked in a laboratory with possible exposure to SARS coronavirus, *or*
- Had close contact with a health care worker with a severe unexplained respiratory illness

## Key facts

- Caused by a human coronavirus discovered in 2003, SARS coronavirus does not occur naturally in the UK
- First cases were seen in Southern China in late 2002. Rapid person to person spread of virus caused outbreaks in Hong Kong SAR, Vietnam, Singapore and Canada in 2003, with more than 8000 cases in more than 30 countries
- Further cases in Singapore, Taiwan and China in late 2003 and 2004 were associated with laboratory-acquired infections
- Mortality during outbreaks 15% in hospitalised cases overall, higher in elderly and those with pre-existing illness; SARS in children less than 10 yrs was mild and uncommon
- Infection usually acquired by droplet transmission (breathing in virus particles from respiratory secretions) during close contact with a symptomatic case, or by contamination of eyes, mouth or nose with respiratory secretions, body fluids, or faeces of a case
- No antiviral drug (eg ribavirin) or other drugs, such as steroids, have been proven to be effective; treatment is essentially supportive
- Incubation period (from exposure to onset of fever): 3-7 days (range 2-10 days, average 5 days)
- Asymptomatic contacts are not infectious; cases are non-infectious from 10 days after resolution of fever
- **Health care workers caring for cases are at high risk of becoming infected if infection control is inadequate**
- Rapid detection and early isolation of cases, and early and effective infection control, are central to control of SARS

## Symptoms and signs

### Initial symptoms

- Fever, chills, rigors
- Malaise, myalgia, headache
- Diarrhoea (sometimes)

Followed, after 2-4 days by

- Cough
- Breathing difficulty
- Respiratory failure, ARDS, death
- Rash, lymphadenopathy or CNS signs may make Dx less likely
- Spectrum of disease – many cases will be relatively mild, and will not require hospital admission

## Investigation (treat samples as 'high risk')

- CXR, pulse oximetry, ABG if O<sub>2</sub> saturation on air less than 95%
- FBC & differential, U & Es, LFTs, creatinine, CK, LDH, CRP
- Blood cultures
- Clotted blood for acute serology (mycoplasma, legionella, chlamydiae, influenza A and B, adenovirus, RSV) + 20mls reserve; second sample at 21 days post onset
- Sputum culture +/- Gram stain
- Respiratory sample for rapid tests for influenza A and B, and RSV
- Urine for legionella and pneumococcal antigens
- Specialist investigations for SARS in liaison with local microbiologist and HPA Centre for Infections, Colindale

## Management

- Assess all patients with febrile respiratory illness in a side room: patient to wear surgical mask; staff (including radiographer) to wear surgical mask, gown, gloves, pay scrupulous attention to handwashing and minimise hand-face or glove-face contact; restrict entry to essential staff and relatives
- Determine the date of onset of symptoms and obtain a travel, occupational, and contact history for the 10 days before onset
- If patient does not fit case definition, unlikely to be SARS: manage as condition indicates
- If patient satisfies case definition, and condition warrants hospital admission:
  - Discuss with senior emergency medicine clinician and consultant microbiologist; arrange immediate ID assessment; alert local Health Protection Team (HPT) and Occupational Health
  - Arrange admission to single isolation (ideally negative pressure) room, with AIRBORNE INFECTION ISOLATION precautions (use FFP3 mask)
  - Minimise aerosol-provoking procedures (high risk to health care workers of infection); avoid high flow (6L/min, or more) oxygen
  - Antibiotics according to local treatment protocol for community acquired pneumonia *or*
  - Co-amoxiclav 1.2G IV tds (*or* cefuroxime 1.5g tds) **and** erythromycin 500mg IV qds (*or* clarithromycin 500mg bd)
  - List patient's close contacts (household, face-to-face – within 1 metre, health care workers, others) in 10 days before onset
- Re-assess at 48 hours: if CXR and clinical course consistent with SARS, and no alternative diagnosis, send specialist Ix for SARS in liaison with HPA Centre for Infections, if not, remove from airborne infection isolation if appropriate, continue treatment and inform local HPT
- If patient fits case definition but condition does not warrant hospital admission, arrange follow up at 48 hours by primary care or local HPT to reassess and confirm recovery. Clinical staff should observe appropriate respiratory precautions when in patient's home (including wearing FFP3 mask)

## See also

- Detailed HPA guidance on SARS can be found at: [www.hpa.org.uk](http://www.hpa.org.uk), and guidelines on clinical management can be found at the British Thoracic Society website at: [www.brit-thoracic.org.uk](http://www.brit-thoracic.org.uk)
- Emergency contacts, personal protective equipment, infection control, microbiological testing, biological incident action guide, picture gallery

## Think of smallpox

In any **previously healthy patient** with:

- Abrupt onset of moderate (to 39°C) fever and severe prostration *and*
- A characteristic rash: begins on third day of illness, densest on extremities and face, and with all pocks on any one part of body at the same stage of development
- **A single suspected case of smallpox is a public health emergency**

## Key facts

- Caused by a DNA orthopox virus
- Smallpox eradication was certified in 1980; only remaining smallpox virus is secured in two laboratories in US and Russian Federation; there is no current evidence of illicit stocks of virus
- Only possible sources of infection now are an accidental release from a repository or deliberate release
- Routine vaccination ceased 30 years ago, and the population is no longer immune to smallpox
- May cause severe disease: mortality rate in outbreaks was 25-30%; highest in children less than 1 year, and the elderly
- Usually acquired by airborne route, but infection can follow direct contact of eyes, nose or mouth with vesicle fluid, respiratory secretions, saliva, or scabs
- Incubation period (from exposure to onset of illness) usually 10-16 days (range 7-19 days, median 12 days)
- Person to person spread occurs (secondary attack rate 10-25%); infectious dose low (probably 10-100 virions)
- Cases are infectious to others from onset of fever until all scabs have separated
- Asymptomatic afebrile contacts are not infectious
- Outcome of any release will be determined by speed of diagnosis and management of initial cases and contacts

## Symptoms and signs

Clinical course of smallpox	Clinical course of chickenpox	Differential diagnosis of smallpox
<ul style="list-style-type: none"> <li>• Febrile prodrome (days 1-3): sudden onset fever, malaise, headache, backache, prostration, vomiting, abdominal pain – patients are usually anxious and poorly</li> <li>• Erythematous rash (days 2-3) May become haemorrhagic</li> <li>• Maculopapular rash (days 4-6)</li> <li>• Vesicular rash becomes pustular (days 5-14+) as clear fluid in blisters becomes cloudy and thickens. Pustules are round, tense and deep in dermis, and feel like small hard peas in the skin. Rash may affect palms and soles, and is densest on face and extremities</li> <li>• Complications include haemorrhage, encephalitis, keratitis, multi-organ failure</li> <li>• Scabs form (days 10-14), separate (days 14-28), heal with scarring</li> <li>• Death can occur in first 48 hrs, before the rash develops</li> </ul>	<ul style="list-style-type: none"> <li>• Incubation period 14-21 days</li> <li>• No history of chickenpox</li> <li>• Febrile prodrome usually mild or non-existent, patient usually not severely unwell</li> <li>• Rash is densest on trunk, with relative sparing of face and extremities, not usually present on palms and soles</li> <li>• Rash itches, evolves rapidly, lesions superficial, oval and appear in crops – macules, papules, vesicles and pustules at the same time on any one part of body</li> <li>• Scabs form quickly (day 4-7), separate rapidly (before day 15)</li> <li>• Caused by DNA herpes virus, can be distinguished from pox virus by electron microscopy</li> <li>• Aciclovir effective in treatment</li> </ul>	<ul style="list-style-type: none"> <li>• Febrile prodrome: influenza, malaria, meningitis, typhoid</li> <li>• Erythematous stage: measles, rubella, parvovirus B19</li> <li>• Papular stage: measles, chickenpox</li> <li>• Later rash: chickenpox, monkeypox, disseminated herpes simplex, disseminated herpes zoster, drug rash, contact dermatitis, hand foot and mouth disease, Stevens Johnson syndrome, erythema multiforme, molluscum contagiosum, scabies, impetigo</li> </ul>

## Management

- If you suspect smallpox, **IMMEDIATELY put a surgical mask on the patient and ISOLATE patient** (and any accompanying relatives or friends) **in a SINGLE room**. Close the door, and restrict entry to essential personnel. Admitting doctor to remain with patient, provide reassurance and any immediately necessary supportive care
- Senior emergency medicine clinician to assess patient in the room. If smallpox cannot be excluded, then:
  - If patient arrived by ambulance, ensure that ambulance is taken out of service until smallpox excluded or ambulance decontaminated
  - Alert consultant microbiologist, ICD, Trust Management, and local HPT and **IMMEDIATELY** arrange for URGENT assessment of case by local designated Smallpox Diagnostic Expert (SDE)
  - Enforce STANDARD and AIRBORNE infection control precautions
  - Current advice is to switch off air conditioning – and leave it off until smallpox excluded or system decontaminated
- If Smallpox Diagnostic Expert (SDE) suspects smallpox, SDE will alert Smallpox Management and Response Team (SMART) and assume responsibility for patient care and infection control until SMART arrives, when SMART will take over investigation, diagnosis, treatment planning and arrange any necessary vaccinations
- If SDE excludes smallpox, inform all those notified, stand down all action, arrange further patient management

## See also

- Emergency contacts, personal protective equipment, post-exposure prophylaxis, infection control, biological incident action guide, microbiological testing, picture gallery
- Detailed special plans for investigation and treatment of smallpox can be found on [www.dh.gov.uk](http://www.dh.gov.uk)

## Think of tularemia

In any **previously healthy patient** with:

- Severe unexplained febrile illness or febrile death *or*
- Fever, single painful ulcer, with tender local lymphadenopathy, *or a*
- Cluster of cases of unexplained pneumonic or febrile illness

## Key facts

- Caused by *Francisella tularensis* (tiny Gram negative coccobacillus, several biovars, difficult and dangerous to grow)
- Zoonosis (disease that affects animals and humans) – reservoirs in small mammals eg rabbit, lemming, vole
- Does NOT occur naturally in UK but common in parts of rural Europe, Asia, Americas and Australasia
- Naturally acquired human disease follows exposure by: bite of infected vector (tick, mosquito, deerfly); handling infected animal or carcass; breathing infected aerosol (from infected animal or carcass, contaminated hay, lawn mowing); eating contaminated food or water
- Clinical features depend on route of exposure: breathing in organism causes pneumonia; infection via bite or abraded skin causes ulcero/glandular disease; ingestion causes oropharyngeal disease; eye inoculation (eg by rubbing eyes with contaminated hands) causes oculoglandular disease
- Severity depends on infecting biovar (type A most severe, < 10 organisms can infect), and dose
- Occupational risks: in UK, laboratory work; outside UK, in endemic areas, hunting, trapping, or farming
- Deliberate release most likely to be via aerosol, causing pneumonic tularemia
- Incubation period usually 2-5 days (range 1-14 days)

## Symptoms and signs

<p><b>Ulcero-glandular and glandular tularemia</b></p> <ul style="list-style-type: none"> <li>• Fever, headache, myalgia, chills</li> <li>• Local lymphadenopathy – depends on site of inoculation – glands tender, painful, may be fluctuant</li> <li>• +/- Tender papule or ulcer at site of inoculation</li> </ul>	<p><b>Oculoglandular tularemia</b></p> <ul style="list-style-type: none"> <li>• Fever, headache, myalgia, chills</li> <li>• Unilateral painful red eye</li> <li>• Eye exudate</li> <li>• +/- Corneal ulcer</li> <li>• Tender, swollen periauricular lymph nodes</li> </ul>	<p><b>Oropharyngeal tularemia</b></p> <ul style="list-style-type: none"> <li>• Fever, headache, myalgia, chills</li> <li>• Sore throat</li> <li>• Exudate</li> <li>• Tender swollen cervical lymph nodes</li> <li>• +/- Pharyngeal/tonsillar ulcer/stomatitis</li> </ul>
<p>Without antibiotics, infection will persist for weeks or months (fever, weight loss, malaise, fatigue) or may progress to:</p>		
<p><b>Pneumonic tularemia</b></p> <ul style="list-style-type: none"> <li>• Follows inhalation of organism, or spread through bloodstream from primary site</li> <li>• Fever, chills, headache, myalgia, sore throat</li> <li>• Dry cough, pleuritic chest pain, dyspnoea</li> <li>• Physical signs and CXR variable</li> <li>• Untreated, can progress to respiratory failure, death</li> </ul>	<p><b>Septicaemic tularemia</b></p> <ul style="list-style-type: none"> <li>• Follows primary exposure to organism, or spread through bloodstream from primary site</li> <li>• Fever, chills, headache, myalgia</li> <li>• Nausea, vomiting, diarrhoea, abdominal pain</li> <li>• Confusion, altered consciousness, coma</li> <li>• Septic shock, DIC, haemorrhage, ARDS</li> </ul>	

## Management

- If diagnosis suspected, discuss with senior emergency medicine clinician and consultant microbiologist, arrange urgent ID consultation, and alert local Health Protection Team (HPT)
- Very low risk of person to person spread: use STANDARD precautions
- Culture: blood (organism hard-to-grow, take multiple sets and mention diagnosis on request form), and other specimens as appropriate eg sputum, throat swab/washings, fasting gastric aspirate, swab exudate/aspirate of any ulcer/local lesion; 10mls clotted blood + 20mls blood in EDTA tubes for serology/PCR (and further sample at least 14 days post onset); high risk of laboratory acquired infection: label all samples 'danger of infection'
- If possible take cultures BEFORE starting antibiotics
- Dermatology/ID referral for review and biopsy of any skin lesion (histology, PCR)
- CXR: may be near-normal, or multilobar infiltrates, enlarged hilar nodes, pleural effusions, adhesions
- Initial treatment if tularemia suspected but not confirmed:
  - Add aminoglycoside at standard doses to existing local protocol appropriate to presentation (eg community-acquired pneumonia, Gram negative sepsis)
- If diagnosis of tularemia confirmed by microbiology:
  - Gentamicin (first choice) 7mg/kg once daily IV (adults); 2.5mg/kg IV/IM tds (children) for 10 days, *or*
  - Streptomycin 1g IM bd (adults); 7.5mg/kg IM bd (children) for 10 days, *or*
  - Ciprofloxacin 400mg IV bd (adults); 10mg/kg-15mg/kg IV bd (children) for 14 days; change to oral treatment when appropriate
- Check levels of gentamicin or streptomycin if used

## See also

- Emergency contacts, personal protective equipment, pre and post exposure prophylaxis, infection control, biological incident action guide, microbiological testing, picture gallery

# Venezuelan equine encephalitis (VEE)

## Think of Venezuelan equine encephalitis

In any **previously healthy patient** with:

- Febrile illness and history of travel in endemic area in the two weeks before onset, *and/or*
- Viral meningitis or encephalitis, *or a*
- Cluster of cases of flu-like illness with encephalitis/neurological symptoms in a small proportion of the cases
- **In the UK, a single confirmed case with no history of recent travel or of occupational risk suggests deliberate release**

## Key facts

- Caused by a mosquito-borne alphavirus
- Zoonosis (disease that affects animals and humans) spread by mosquitoes between rodents, bats and birds, and, in outbreaks, horses, mules and donkeys
- Does not occur in UK but common in central and northern parts of S America, also occurs in Mexico and southern USA; natural epidemics in humans are usually preceded by disease in horses
- Naturally acquired human infection usually the result of bite of infected mosquito, but can also follow breathing in the virus in the laboratory
- Occupational risks: outdoor work in an endemic area; work with the organism in a laboratory
- Human-mosquito-human spread has probably occurred in some epidemics, but direct person to person spread is not thought to occur
- Incubation period 1-6 days

## Symptoms and signs

### Mild or moderate VEE infection

- Fever
- Flu-like illness
- Backache, myalgia, malaise
- Headache
- Mild photophobia
- Sore throat
- Nausea, vomiting, diarrhoea
- Normal neurological exam
- Symptoms last 2-5 days, followed by complete recovery over next 1-2 weeks

### Severe VEE infection

- May be more common in children (in natural outbreaks, 4-5% of children but 1-2% of adults)
- Abrupt onset
- High fever (38-40°C), chills, sweats
- Severe backache and myalgia, leg muscles tender
- Severe headache
- Neck stiffness
- Photophobia
- Nausea, vomiting, diarrhoea
- Confusion, sleepiness, altered mental state
- Convulsions, ataxia, paralysis, coma
- 20% fatality rate; neurological sequelae in survivors

## Management

- If diagnosis suspected, discuss with senior emergency medicine clinician and consultant microbiologist/ID physician; if diagnosis confirmed, or cluster of suspect cases, alert local Health Protection Team
- Very low risk of person to person spread: use STANDARD precautions
- Exclude malaria (blood film for malarial parasites)
- Diagnosis clinical, confirmed by virus isolation/serology: 10mls clotted blood for serology (and further sample at least 14 days post onset); throat swab in virus transport medium; CSF if lumbar puncture performed
- CSF: increased pressure, raised lymphocytes, mildly elevated protein
- FBC: low WCC & lymphopaenia, and sometimes thrombocytopaenia early in disease; LFTs: mildly raised AST, LDH; CXR: normal
- If insect vectors (mosquitoes) are present, prevent any biting the patient (insecticides, insecticide-treated bed nets, screening)
- Treatment is supportive:
  - Mild/moderate cases: analgesia and antipyretics; correct/maintain fluid balance as needed
  - Severe cases may need intensive supportive care: fluid balance, nutrition, ventilation, anticonvulsants, treatment of secondary infection, and long term follow up

## See also

- Emergency contacts, personal protective equipment, post-exposure prophylaxis, infection control, biological incident action guide, microbiological testing

# Viral haemorrhagic fevers (VHF)

## Think of viral haemorrhagic fever

In any **previously healthy patient** with:

- Fever of unknown origin and recent travel to endemic area or with flushed swollen face/haemorrhage
- **A single confirmed case in the UK, even if from endemic area, should be investigated to exclude deliberate release**

## Key facts

- Caused by viruses from four different families: arenaviruses, filoviruses, bunyaviruses, and flaviviruses
- VHFs include Lassa fever, Junin (Argentinean haemorrhagic fever), Machupo (Bolivian haemorrhagic fever), Guanarito (Venezuelan haemorrhagic fever), Congo-Crimean haemorrhagic fever (CCHF), Rift Valley fever, Ebola, Marburg, yellow fever and dengue viruses, and others
- All are zoonoses (diseases that affect animals and humans): distribution of natural disease is governed by the geographic distribution and ecology of the animal reservoir
- VHFs do NOT occur naturally in UK; imported cases are rare (< one a year)
- Route of infection varies: mosquito bite (dengue, yellow fever, Rift Valley fever); tick bite (CCHF); inhalation of dust contaminated with infected rodent droppings/urine (Lassa fever, hantaviruses); needlestick or direct contact of infected blood or body fluids with eyes, nose or mouth (Lassa, CCHF, Ebola, Marburg); most are infectious by aerosol in the laboratory, but no evidence of naturally occurring airborne spread
- For Lassa, Ebola, Marburg and CCHF, **HIGH RISK** of person to person spread and nosocomial infection (spread within health care settings to other patients and/or health care workers) by percutaneous or mucocutaneous exposure to blood or body fluids from febrile symptomatic patients; afebrile, asymptomatic contacts are not infectious
- Incubation periods disease-specific, vary from 1 day - 21 days
- Illnesses range from mild to life threatening, but all VHFs have a febrile prodrome (fever, headache, malaise, myalgia, nausea, vomiting, prostration) of up to 7 days, followed by signs of vascular involvement. In the second week of illness, cases tend either to recover or to deteriorate rapidly
- Differential diagnosis includes: malaria, typhoid, shigella, meningococcal sepsis, leptospirosis, other causes of DIC

## Symptoms and signs

Lassa fever	Ebola/Marburg	Congo Crimean HF
<i>Incubation period 3-21 days</i>	<i>Incubation period 2-21 days</i>	<i>Incubation period 1-12 days</i>
<ul style="list-style-type: none"> <li>• West Africa (Nigeria, Sierra Leone, Guinea, Liberia)</li> <li>• Naturally occurring cases may have stayed in rural endemic areas/seen rodents, though direct contact with rodent not necessary for infection</li> <li>• Slow onset of febrile prodrome</li> <li>• Severe prostration</li> <li>• Sore throat, reddened eyes</li> <li>• Facial oedema, retrosternal pain</li> <li>• Vomiting and diarrhoea</li> <li>• Bleeding in severe cases in second week</li> <li>• Pleural effusion, ascites, encephalopathy</li> <li>• Many cases mild – mortality in outbreaks higher in pregnant women; nerve deafness in 1/3 survivors</li> </ul>	<ul style="list-style-type: none"> <li>• Tropical rain forest areas in Africa (cases in Ivory Coast, Gabon, Congo, DRC, Sudan, Angola)</li> <li>• Reservoir unknown, but in some outbreaks initial cases associated with killing and eating primates</li> <li>• Abrupt onset of febrile prodrome</li> <li>• Severe prostration</li> <li>• Diarrhoea (sometimes bloody), vomiting, dehydration, shock</li> <li>• Maculopapular rash days 3-8</li> <li>• Bleeding</li> <li>• Hiccups</li> <li>• Sleepiness, delirium, coma, restlessness, hepatomegaly, multi-organ failure</li> <li>• Mortality in outbreaks 30%-90%</li> </ul>	<ul style="list-style-type: none"> <li>• Crimea, Balkans, Africa, C &amp; S Asia</li> <li>• Tick bite usual source in naturally occurring cases</li> <li>• Abrupt onset of febrile prodrome</li> <li>• Vomiting, diarrhoea, abdominal pain</li> <li>• Sore throat, reddened eyes</li> <li>• Sleepiness, lethargy</li> <li>• Facial oedema</li> <li>• Petechial rash, palatal petechiae</li> <li>• Bleeding in 75% cases, begins on day 4 or 5</li> <li>• Hepatomegaly; CNS signs (neck stiffness, agitation, coma) in 20%</li> <li>• Mortality in outbreaks 30%-50%</li> </ul>

## Management

- If you suspect VHF, discuss with senior emergency medicine clinician, and **IMMEDIATELY ISOLATE** patient in single room, close the door, and restrict entry to essential personnel. Admitting doctor to remain with patient, provide reassurance and any immediately necessary supportive care
- Enforce STANDARD and AIRBORNE infection control precautions
- **IMMEDIATELY** arrange URGENT assessment by ID physician and consultant microbiologist/ICD who will categorise case according to risk and arrange admission to High Security Infectious Disease Unit if needed; for further details of risk categorisation and case investigation and management, see ACDP guidance (can be found via [www.hpa.org.uk](http://www.hpa.org.uk)); alert local Health Protection Team
- Minimise investigation until VHF confirmed or excluded. Diagnosis of VHF is made by antigen detection/serology: 10ml clotted blood (obtained by staff experienced in phlebotomy), further sample at least 14 days post onset, but seek advice from ID physician and await risk categorisation before obtaining any samples from the patient. Blood film +ve for malaria parasites may not exclude diagnosis of VHF; do NOT take fingerprick sample or make direct blood smear for malaria parasites – laboratory will do this using blood from EDTA sample)
- Treatment mainly supportive: analgesia, sedation, oxygen, minimise invasive procedures, avoid antiplatelet drugs (including aspirin) and IM injections, correct and maintain fluid balance, correct coagulopathy, treat secondary infection
- Ribavirin effective in Lassa fever and Congo-Crimean haemorrhagic fever but not for Marburg, Ebola, or flaviviruses:
  - For adults, initial dose ribavirin 30mg/kg IV, then 15mg/kg IV tds for 4 days, then 7.5mg/kg IV tds for 6 days; or
  - Oral treatment: ribavirin 2g orally (loading dose), then 1g orally qds for 4 days, then 0.5g orally tds for 6 days; total treatment 10 days

## See also

- Emergency contacts, personal protective equipment, post-exposure prophylaxis, infection control, microbiological testing, biological incident action guide, picture gallery

# Radiation incidents

## Ionising radiation

- Ionising radiation (invisible, odourless and tasteless) is a form of energy emitted spontaneously by radioactive materials
- Natural radiation is all around us: in air, from cosmic rays; in the earth and building materials; and in food and water – and all of this makes up the **background radiation** to which we are all exposed all the time, from conception to death
- Man-made sources of radiation and radioactive materials are used in medicine (diagnostic imaging, radiotherapy), research, widely in industry (nuclear power stations, mining, food irradiation), industrial radiography (eg of pipes, buildings, baggage), and for many other uses including nuclear fuel and nuclear weapons
- Alpha particles, beta particles, gamma rays, X-rays and neutrons are all forms of ionising radiation
- Alpha and beta particles and gamma rays are produced as radioactive materials decay; X-rays are generally man-made
- **Alpha** particles are heavy and highly charged, and interact strongly with atoms. As a result, they lose momentum rapidly, can travel only very short distances and cannot penetrate human skin. Alpha emitters are hazardous only when inhaled, ingested, injected or absorbed (eg through a wound)
- **Beta** particles are also charged, but interact less strongly than alpha particles, so travel further and penetrate more: they can penetrate the dermis. Clothing, including standard PPE, provides some protection against them. They can cause radiation skin injury on prolonged exposure but are hazardous to internal organs only when inhaled, ingested, injected or absorbed (eg through a wound)
- **Gamma** rays and **X-rays** are uncharged, so do not interact directly with atoms, and travel many metres in air. They easily penetrate the human body, causing organ damage. Their effects can be attenuated by concrete or lead shielding
- **Neutrons** are uncharged, travel far and penetrate everything (except thick layers of concrete and water), and are highly damaging, but only likely to be present in the very early stages of a nuclear detonation or accident

## Exposure and contamination

- An **exposure** occurs when all or part of the body is irradiated
- Three key factors affect exposure: **duration, distance** and **shielding**. If the exposure time is halved, the dose is halved. The inverse square law applies to distance: doubling the distance between the source and the body reduces the dose by a factor of 4; trebling the distance between the source and the body reduces the dose by a factor of 9, and so on
- A person is **contaminated** when radioactive material is deposited on skin and/or clothing (**external contamination**), or into the body (**internal contamination**) by inhalation, ingestion (hand-to-mouth, food, drink), or absorption via a wound
- In the same way that a patient who has had a CT scan or X-ray presents no risk to others, radiation safety precautions are **NOT** needed for patients who have been exposed to radiation but not contaminated
- External contamination – usually dust or particulate matter – is readily removed by **decontamination**
- Even if a patient is contaminated, the risk of long term health effects for a health professional who uses standard precautions is likely to be tiny, if not trivial
- **Radiation is readily detectable with equipment, and contamination is easily measurable. Medical physics, nuclear medicine departments, and front line services have equipment for detecting beta and gamma radiation, and people trained to use it**
- **In a radiation incident:**
  - Triage and treat life-threatening injury before decontamination; if the patient's clinical condition permits, decontaminate first, and then treat
  - If trauma cases require surgery, perform as soon as possible (and certainly within 48 hours) if dose more than 1 Sievert, or await marrow recovery

## Measuring radioactivity and radiation

- Radioactivity (and contamination by radioactive material) is measured in becquerels (1Bq = 1 disintegration per second)
- The **absorbed dose** of radiation (the amount of energy absorbed by per unit mass of tissue) is measured in gray (Gy); 1Gy = 1 joule/kg of tissue
- Different types of radiation have different effects on human tissue (gray for gray, alpha particles and neutrons are more damaging than beta particles, gamma rays or X rays in terms of the risks of cancer or of heritable genetic defects), so the absorbed dosage is multiplied by a radiation weighting factor to account for this. This gives the **equivalent dose** (of an organ or tissue), measured in Sievert (Sv). For X-rays and gamma rays, and beta particles, the weighting factor = 1, so: 1 gray = 1 sievert = 1000 milli sievert
- Some organs are more radiosensitive than others (eg bone marrow is more sensitive than thyroid), and exposures are rarely uniform. Weighting the equivalent doses received by different organs and tissues during an exposure to allow for each organ's radiosensitivity, and then summing the results, gives the **effective dose**
- An estimate of the **whole body dose** is helpful in estimating long term cancer risk

## Radiation doses and dose limits

- Chest X-ray: 20 micro sievert
- Average annual background radiation in UK: 2.2 milli sievert (2,200 micro sievert)
- Annual effective dose limit for member of the public: 1 milli sievert (1,000 micro sievert)
- Annual effective dose limit for radiation worker: 20 milli sievert (20,000 micro sievert)
- Acute radiation sickness (whole body single dose): 1 sievert and above
- LD50/60 (dose killing 50% of those exposed within 60 days if whole body dose): ~4.5 sievert

# Acute radiation syndrome (ARS)

## Think of radiation exposure

- In any newly diagnosed bone marrow depression (leucopenia: infection; thrombocytopenia: bleeding gums, nosebleeds, bruising), *or*
- ‘Burns’, erythema, or bullae with no history of heat or chemical exposure, *or*
- Sudden, rapid, hair loss **especially** if there is a relevant occupational history or unexplained nausea / vomiting +/- diarrhoea 2-4 weeks before onset, *and*
- When dealing with **ANY** incident involving a bomb or other intentionally placed explosive device

## Overview

- All nuclear and other major sites in the UK have emergency plans and exercise and update them regularly
- On average, there is one serious radiation incident – resulting in death or major radiation injury – in the world each year
- Incidents at major sites will be recognised and managed according to existing plans. However, in the last 50 years there have been more than 200 incidents involving lost, stolen or misused (‘orphan’) sources (eg Lilo, Georgia, 1996-97, 11 trainee border guards exposed to 12 hidden, abandoned, sources had signs and symptoms of radiation injury, but the cause remained unrecognised by doctors for months). The first sign of a problem may be the presentation of a case to an emergency department
- Other concerns include the possibility of exposure from a ‘dirty bomb’ (conventional explosive used to disperse radioactive material), a low yield improvised nuclear device (IND), or a deliberately hidden source of radiation

## Acute radiation syndrome

- Many radiation accidents cause partial body injury (early erythema followed by bullae, and, if severe, ulceration and necrosis, often of the hands) and may not be associated with ARS
- ARS follows a **large, usually** external exposure of **all** (or most) of the body to **penetrating** radiation (gamma rays, high-energy X-rays, neutrons) in a **short** time (seconds)
- Symptoms of ARS occur in a four-phase sequence: prodromal phase → latent period → illness → recovery/death
- As the radiation dose increases, the prodromal and latent periods shorten, and the severity of illness, and mortality, increase. Major trauma and radiation exposure interact synergistically on mortality
- Initial symptoms of ARS are non-specific, and rarely immediately life-threatening; treatment of other injuries takes priority
- If, in the first 6 hours after a suspected exposure, there are no symptoms of exposure (eg nausea, vomiting), serious ARS is unlikely

## Symptoms and signs

Dose: less than 1 sievert	Dose: 1 sievert – 8 sievert	Dose: more than 6 sievert – 20 sievert	Dose: more than 20 sievert
<p><i>Usually asymptomatic</i></p> <ul style="list-style-type: none"> <li>• Symptoms mild (or absent)</li> <li>• Episodic nausea, vomiting in first 48 hours in 1%-10%</li> <li>• Mildly depressed WBC at 2-4 weeks</li> <li>• No foetal effects if effective dose less than 100 milli sievert (100,000 micro sievert)</li> <li>• Counselling needed if pregnant and effective dose more than 100 milli sievert (100,000 micro sievert)</li> </ul>	<p><i>Haematopoietic syndrome</i></p> <ul style="list-style-type: none"> <li>• Anorexia, nausea, vomiting, fatigue: 1-4 hours after exposure, timing and severity dose-related</li> <li>• Latent period: 2 days-4 weeks</li> <li>• Bone marrow depression: leucopenia – infection; low platelets – bleeding, bruising</li> <li>• Serial lymphocyte counts in first 48 hours predict severity</li> <li>• 3-4 sievert: hair loss at 2-3 weeks</li> <li>• LD 50/60 is ~4.5 sievert without treatment</li> </ul>	<p><i>Gastrointestinal syndrome</i></p> <ul style="list-style-type: none"> <li>• Early nausea, vomiting, diarrhoea, anorexia, fatigue</li> <li>• Latent period: hours-1 week</li> <li>• Severe gastrointestinal symptoms (fever, abdominal pain, cramps, watery diarrhoea, haemorrhage, electrolyte imbalance, dehydration) coupled with bone marrow depression</li> <li>• LD100 is about 10 sievert, death usually within 2 weeks</li> </ul>	<p><i>CNS/CVS syndrome</i></p> <ul style="list-style-type: none"> <li>• Almost immediate projectile vomiting, explosive bloody diarrhoea, headache, collapse, confusion, loss of consciousness, agitation, burning sensation on skin</li> <li>• May be lucid interval (hours)</li> <li>• Neurological and cardiovascular symptoms predominate: convulsions, coma, hypotension, shock</li> <li>• Death within 2-3 days</li> </ul>

## Management

- Stabilise airway, breathing, circulation, and initiate Rx of any life-threatening conditions (trauma, thermal burns, lung injury)
- Assume all patients are contaminated until you know that they are not: make sure that you, and the area you work in, are protected from possible contamination (see PPE, and radiation facts); reassign pregnant staff; do not handle unfamiliar objects or embedded fragments (eg shrapnel) directly: use tongs or forceps and place in lead-lined container; remember distance & inverse square law
- Assess contamination using contamination meter. If present, decontaminate, and presume patient may also be internally contaminated
- Removing patient’s clothing (bag, label and store it securely) can reduce external contamination by as much as 90%
- Symptomatic treatment for nausea, vomiting (cyclizine, ondansetron), diarrhoea, pain (opiates), and erythema; monitor and replace fluid loss
- To help assess the dose of radiation received: obtain and record as much information as possible about type and extent of exposure (what? where? when? for how long?); record date, time of onset, and severity of all symptoms and signs; record (body-map, or photograph) sites of any erythema or local injury
- Samples: baseline FBC with serial absolute lymphocyte counts 3-4 hourly for first 12 hours after acute exposure, then 6 hourly for 48 hours; HLA typing (BEFORE transfusing – use irradiated blood products if ARS possible); pregnancy test; nasal swabs or nose blows x 2; chromosome analysis (7ml venous blood taken 24 hours post exposure into lithium heparin tube); if contamination confirmed, 24 hour urine and faeces
- Seek expert advice early on formal dose assessment and management of internal contamination (medical physics, nuclear medicine, HPA RPD, MoD); infection-prevention regimes, G-CSF and GM-CSF, stem cell/platelet transfusions (haematology, oncology, INM)
- If dose more than 1 sievert and surgery required, do as early as possible (and certainly within 48 hours of exposure) or wait for marrow recovery

## See also

- Radiation facts, decontamination, personal protective equipment, emergency contacts

# Associated injuries and illnesses

## Explosives

- Explosions can occur in many settings: industry (coal mine, chemical plant); military (missile, hand grenade, bomb, land mine), criminal (terrorism, revenge, suicide bombing, illicit drug manufacture – methamphetamine ‘factories’), and in the home (gas leak, fireworks)
- Low order explosives (LE) make a subsonic explosion without an overpressure wave. LE include gunpowder/black powder (fireworks, pipe-bombs), smokeless powder, and petroleum-based bombs (Molotov cocktail, fuel tanks of aircraft in WTC attack New York 2001)
- High order explosives (HE) make a supersonic blast or ‘overpressure’ wave on detonation that causes primary blast injury. HE include Semtex, TNT, nitroglycerine, dynamite, C-4, and ANFO (ammonium nitrate fuel oil, as used in Oklahoma City truck bomb 1998)
- Both HE and LE can create a ‘blast wind’ (forced superheated air flow) that accelerates people and objects through space
- Explosive devices may be ‘manufactured’ (mass produced for military use and subject to quality control; always HE based) or ‘improvised’ (using HE or LE or both)

## Blast injuries

- Blast injuries are categorised as ‘primary’, ‘secondary’, ‘tertiary’ or ‘miscellaneous’/‘other’/‘quaternary’, depending on the mechanism
- Primary (type 1) blast injury is caused by the blast wave itself – and therefore associated only with HE-based explosions
- Primary blast injury affects gas/air filled organs (ear, lung, gut – particularly large bowel, eye, CNS)
- Primary blast injury (blast lung) is the commonest cause of death in immediate survivors of HE explosions
- Secondary (type 2) blast injuries (usually the most common) are penetrating or blunt trauma injuries caused by flying debris
- Tertiary (type 3) blast injuries are caused when people are displaced by the blast wind (eg thrown against a wall) – often skull # or long bone #
- ‘Miscellaneous’ includes all other explosion-related injuries eg smoke inhalation, burn, crush injury, exacerbation of existing condition, PTSD
- Patients may have injuries caused by more than one, or all four, mechanisms

## Primary blast injury

Ear	Lung	Abdomen	Brain
<i>Symptoms &amp; signs</i>	<i>Symptoms &amp; signs</i>	<i>Symptoms &amp; signs</i>	<i>Symptoms &amp; signs</i>
Deafness	Breathlessness	May be none initially	Headache, fatigue, lethargy
Earache	Cough (+/- blood-stained fluid)	Abdominal pain, nausea, vomiting	Anxiety, depression, memory loss
Tinnitus or ringing in the ears	Chest pain	Haematemesis, rectal bleeding	May be no physical sign of injury
Bleeding or discharge from ear	Apnoea, hypotension, bradycardia	Hypovolaemia, shock, sepsis	
<i>from</i>	<i>from</i>	<i>from</i>	<i>from</i>
Tympanic membrane rupture	Blast lung	Perforated bowel (may be silent)	Concussion from blast wave (can mimic post-traumatic stress)
Haemotympanum	Pneumothorax (simple or tension)	GI haemorrhage	
Ossicular disruption	Haemothorax	Mesenteric ischaemia (air embolus)	
Perilymphatic fistula	AV fistula causing air embolism	Testicular rupture	<b>Eye</b>
			Ruptured globe

## Key facts

- Injuries are more severe after an explosion in an enclosed space (in a building, down a mine, on a bus) or under water
- Injury severity increases with proximity to the explosion, to solid objects (eg walls), and any structural collapse
- Structural collapse +/- prolonged extrication increase the likelihood of crush injury, compartment syndrome and acute renal failure
- Some explosive devices cause specific injury patterns: eg fireworks – eye, face and hand injury; land mines – traumatic limb amputation
- Eye injuries: usually caused by penetrating debris, occur in up to 1 in 10 bomb survivors, are easily overlooked, and may present late
- Traumatic amputation is often associated with multi-system injury
- Blast lung usually presents early (within 4 hours); blast abdomen is rarer but presents late, often not until complications have developed
- Tympanic membrane rupture may indicate multi-system blast injury, but blast lung can occur in the absence of tympanic membrane rupture
- Air embolism can affect CNS (stroke), heart (myocardial infarct), spinal cord, gut mesentery, and extremities; hyperbaric oxygen treatment may help

## Management

- Check with the Incident Command Team at the site for information about associated radiation/chemical/toxic hazards: if in doubt, wear PPE and check cases for radioactivity with survey meter, decontaminating them (and yourself) if necessary. In a radiation incident, treat life-threatening injury first, then decontaminate; if no life-threatening injury, decontaminate first, then treat
- Standard triage and treatment for penetrating and blunt trauma, shrapnel (treat as low velocity gun shot), burns, fractures, and smoke inhalation
- All cases: urinalysis, examine lungs, abdomen and ears (otoscopy and, if possible, audiometry), check tetanus status
- If chest signs or wheeze: CXR (repeat if needed), ABG, DIC screen, consider inserting chest tubes prior to anaesthesia or air transport
- Abdominal pain +/- vomiting: erect and supine abdominal X-rays or abdominal CT scan; admit, observe, NBM, group & save or cross match
- If TM rupture or ear signs but no other injury: check CXR (for characteristic butterfly pattern of blast lung) and observe for at least 4 hours. If CXR normal and case asymptomatic, discharge with urgent ENT appointment, ear care advice (keep dry, no neomycin) and written instructions to return if dyspnoea or vomiting or abdominal pain
- If no apparent significant injury, normal vital signs and examination: observe for 4 hours, discharge with instruction to return if dyspnoea/pain

## See also

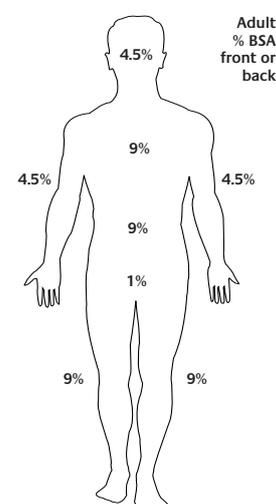
- Personal protective equipment, decontamination, emergency contacts, radiation facts, acute radiation syndrome

## Overview

- Can be caused by heat (most common: thermal burns, flash burns, scalds, steam burns); electricity, chemicals or ionising radiation
- Severity of effects depends on burn depth and the proportion of total body surface area (BSA) burned
- Burns are categorised by depth as: erythema, superficial (first degree); partial thickness (second degree); or full thickness (third degree)
  - **Erythema** inflammatory response only, tender, minimal swelling, no blisters, resolves quickly
  - **Superficial** (epidermis only) burn: erythema, painful to touch, minimal swelling, no blisters
  - **Partial thickness** burn (epidermis + patchy involvement of dermis): very painful erythema, blistering, swelling, and, if deep, sluggish capillary return and dry or white surface
  - **Full thickness** burn (epidermis and all the dermis): charred, brown or white skin (can see coagulated blood vessels underneath), painless and hard to touch – though the patient may feel pain because of gradation in burn depth towards the edge of the burn. Devastating burns extending beyond the dermis into underlying tissues (bone and muscle visible) are sometimes called ‘fourth degree’ burns.
- Burn depth tends to be underestimated on parts of the body where the skin is thinner (eg eyelids, anterior wrist)
- Oedema, ischaemia, or infection can convert a partial thickness burn to a full thickness burn
- Morbidity and mortality are increased in children, the elderly, and patients with major trauma, smoke damage, or a pre-existing medical condition
- High voltage electrical burns can cause much more extensive deep tissue injury than is apparent from the extent of skin injury
- Chemical burns will continue to progress until the chemical is removed by decontamination
- Think of radiation if patient with a burn has no history of exposure to heat or chemicals – especially if history of nausea/vomiting 2-3 weeks earlier

## Estimating the % BSA affected

- In adults, the ‘**rule of nines**’ is a useful guide for estimating the size of large burns
  - Head and neck: front: 4.5% BSA; back: 4.5% BSA
  - Arm: front: 4.5% BSA; back: 4.5% BSA
  - Perineum: 1% BSA
  - Upper torso: front 4.5% BSA; back: 4.5% BSA
  - Lower torso: front 4.5% BSA; back 4.5% BSA
  - Leg: front 9% BSA; back: 9% BSA
  - Include superficial, partial and full thickness burns but not erythema when calculating fluid replacement
- The patient’s **palm ~1% BSA** – useful for estimating the size of smaller burns (< 10% BSA)
- Children have relatively larger heads and smaller legs than adults: use a **Lund and Browder chart** to estimate burn area. If no chart is available, then, for children less than 1 year, head and neck = 18% BSA (9% front, 9% back) and each leg = 14% BSA (7% front, 7% back). For each year over the age of 1, add 0.5% to each leg and decrease estimate for head by 1% up to the age of 10 years
- ‘Critical’ burns include burns to face, hands, feet, perineum, genitals, circumferential burns of thorax or extremities



## Management

- If a patient has been burned as the result of an explosion, ensure that there is no risk of chemical or radioactive contamination and that either the patient has been decontaminated or that you are wearing PPE appropriate to the risk
- **Stabilise airway, give supplemental OXYGEN** (keep O<sub>2</sub> saturation > 90%, pulse oximetry unreliable in carbon monoxide poisoning)
- Suspect inhalation injury if: patient found unconscious at scene, or in a confined or smoke-laden environment; burns to face/neck; singed facial or nasal hair; sooty sputum; intraoral blisters or erythema or oedema; hoarse voice/voice loss, stridor or wheeze: CXR and fiberoptic assessment
- Have a very **low threshold for early intubation** as oedema may later make intubation very difficult
- Thermal burns: prevent further damage by removing constricting clothing/jewellery; if clothing smouldering or hot to touch, gently cool burned tissue with saline or water-soaked towels (do not use ice or gel packs), then wrap in clean dry sheets (high risk of hypothermia – do not prolong cooling, or wrap in wet sheets or space blankets). Household chemical burns: irrigate with 0.9% saline or clean water until agent removed
- Hydrofluoric acid burns: monitor ECG; check for, and correct, hypocalcaemia (tetany, fitting, cardiac arrest) with calcium gluconate IV or calcium chloride IV; treat burns with calcium gluconate gel (2.5%) rubbed gently into affected area for at least 30 minutes; if gel not available use 10% calcium gluconate solution or 25% magnesium sulphate solution
- **Establish large-bore IV access**, away from burned area where possible (hard to secure line safely if sited on burn; oedema may dislodge line)
- Assess extent and depth of all burns and estimate % BSA involved; estimate body weight
- **Early accurate fluid replacement and monitoring of urine output critical**, particularly if % BSA burn more than 15%
 

Use local protocol, or, for adults, Parkland formula:

  - 4 mL x kg body wt x % BSA burn = fluid (Ringers lactate) in first 24 hrs post burn, half given over first 8 hours, half given over next 16 hours
  - Adjust to maintain urine output of 30-50 mL/hour (adult or child > 50kg) or 1mL/kg body weight/hour (child < 50kg)
  - May need more fluid if: inhalation injury, delayed resuscitation, child, or glycosuria. If hypovolaemic, check for hidden trauma
- Ix severe burns: urinalysis, FBC, DIC screen, full biochemistry, ABG and carboxyhaemoglobin, group & save; if electrical burns, CPK and urine myoglobin
- Adequate **analgesia** (IV opiate if needed); assess tetanus status; assess and monitor peripheral pulses (Doppler): escharotomy or fasciotomy may be needed for developing compartment syndrome, especially if deep circumferential burns on extremities or thorax
- Refer to burn centre if: inhalation injury; child more than 10% BSA burn; adult more than 15%-20% BSA burn; ‘critical’ burns, electrical or chemical burns

## See also

- Decontamination, radiation facts, acute radiation syndrome, mustard, lewisite

## Overview

- Throughout history large groups of people have presented to professionals (not necessarily doctors) complaining of symptoms of exposure when there is no documented evidence of that exposure. In recent decades many of these 'outbreaks' have involved beliefs about mass poisoning, usually by alleged chemical agents. As anxieties about bioterrorism, 'dirty' bombs and weapons of mass destruction continue to rise, it is likely that more of these incidents will occur
- No satisfactory label exists for these group symptoms. 'Mass hysteria' is a common label, but implies (totally erroneously) that those affected do not have 'real' symptoms but are imagining them or indulging in histrionics. Mass sociogenic illness (MSI) is probably the best label
- One definition of MSI is: 'symptoms which, although suggestive of organic illness, have no plausible environmental cause and produce minimal (or no) clinical or laboratory evidence of disease, and which occur in a cohesive group with shared beliefs about the symptoms'
- It is known that:
  - MSI typically affects groups under physical or emotional stress
  - MSI reflects prevailing social concerns and fears: witchcraft and demonic possession in enclosed religious communities in mediaeval Europe; toxic gases, environmental pollutants, and chemical weapons in communities today
  - MSI affects normal, otherwise healthy, people who do not have major psychological or personality disorders
  - Triggers can include: seeing the index case become ill; smelling an odd odour or peculiar smell, which may be real (eg incense, diesel fumes) or perceived; hearing a rumour
  - The commonest settings for MSI are schools and workplaces (factories, offices, military barracks)
  - Although most MSI incidents are short lived, some can extend over a month or more, or recur on return of the group to the site (schoolroom, office building)
  - Prompt identification is needed to limit and manage cases
  - MSI can be misdiagnosed:
    - In a school in London in 1990, children had symptoms typical of MSI; however, children who had symptoms were more likely to have eaten cucumber for lunch than those who had not; the cucumber was contaminated with pesticide
    - Symptoms in workers in a garment factory in Puerto Rico were assumed, after a short investigation, to be due to MSI. More thorough investigation showed the symptoms to be caused by toxic gases

## Diagnosis, investigation and management

- MSI is essentially a diagnosis of exclusion
- Symptoms of MSI are variable and wide ranging (eg headache, dizziness, nausea, abdominal pain, burning throat) but tend to:
  - Be transient and benign
  - Be of rapid onset and recovery
  - Be accompanied by marked anxiety
  - Occur within a segregated group
  - Spread rapidly by sight ('visual' or 'line-of-sight' transmission), sound or oral communication, and through awareness of illness in others
  - Spread from those of a high status to those of a lesser status (eg older schoolchildren followed by younger ones)
  - Predominantly affect females
  - Be exacerbated by prominent emergency and media responses
  - Mimic those of the perceived threat
- **If you suspect MSI, report the incident and cases promptly to the local Health Protection Team, who will investigate**
- Recommended management of MSI includes:
  - Separating those who are ill from those who are not, and from the environment in which the outbreak began
  - Remembering that the cause of illness in the 'index' case may be different from that in the rest of the group, and that the group may contain individuals who have an illness with a physical cause: physical examination and investigation should be thorough enough to exclude serious illness from other causes
  - Providing gentle, honest, truthful and non-patronising reassurance about the likely cause of the outbreak and the likelihood of sequelae

## See also

- Detailed guidance for health professionals on the recognition, investigation and management of outbreaks and incidents of unusual illnesses can be found at: [www.hpa.org.uk](http://www.hpa.org.uk)

# Psychological effects of traumatic events

## Overview

- Any traumatic incident or disaster, whether natural or man-made, has a psychological impact on those involved – survivors, the bereaved, witnesses, rescuers, responders and health professionals, and their families, relatives, friends and workmates
- Traumatic events provoke strong reactions. These can include pride and professional satisfaction in responding well to a difficult task, a sense of purpose and solidarity, but also profound sadness, anger, rage and grief
- Most of those affected will adjust gradually, over time – some will need more support than others
- Any incident that causes fear and uncertainty may be accompanied by an increase in health concerns, anxiety and somatic symptoms in the public. Somatic symptoms are caused by the physiological response to anxiety – they are not ‘imaginary’ or ‘all in the mind’ – and can be easily confused, by the persons themselves and by health professionals, with symptoms of exposure. Estimates suggest that the numbers of persons presenting with health concerns and anxiety may outnumber the directly exposed by 5-20 to 1. Providing reassurance and allaying anxiety are important both in preventing long term symptoms in this group, and in preventing collective behavioural disturbance and mass panic
- Risk factors for more sustained responses and for the development of post-traumatic stress disorder, depression, anxiety disorder, or substance abuse include: proximity to the event, multiple stressors, a history of trauma, unresolved anxieties, and pre-existing chronic illness

## Common responses to a traumatic event

Emotions	Cognition	Physical	Other effects
Numbness, feeling nothing Sadness, grief Fearfulness for self Fearfulness for others Feeling overwhelmed Blaming others/self Feeling depressed Volatile emotions, anger Irritability, jumpiness	Difficulty in concentrating Shortened attention span Poor memory Disorientation Intrusive/unwanted memories Heightened alertness Difficulty in making decisions Difficulty in sleeping, poor sleep Bad dreams, nightmares	Tiredness, exhaustion Headache, other aches and pains Dizziness Nausea, gastrointestinal upset Rapid heart rate Profuse sweating Tremor, shaking Jaw clenching, teeth grinding <b>Breathing difficulty, chest pain*</b>	Emotional outbursts Increased argumentativeness Withdrawal, silence Temporary loss/increase in appetite Changed interest in sex Increased smoking/restarting smoking Overuse of alcohol, substance abuse Inability to rest Unnecessary risk-taking

\*Require immediate medical attention

## Caring for health care professionals

- Few of us perform better – either physically or mentally – after prolonged sleep deprivation: ensure that professionals have adequate rest
- Whatever the emergency, try to limit time on duty to no more than 12 hours a day; rotate staff from highly taxing to less taxing functions, and, if practicable, from tasks requiring direct involvement to more routine tasks
- Encourage staff to take brief, frequent breaks from the scene; provide somewhere quiet, safe and private ‘off scene’ for staff to eat, drink and rest without interruption, and try to ensure that staff are able to stay in touch with friends and family
- Support staff in taking steps that will help to maintain their well-being – there is nothing unprofessional about being responsibly self-caring
- Make sure that staff are aware of the availability of other sources of support (eg their own GP; chaplains and other religious or spiritual advisors) and provide telephone numbers for access to confidential listening or counselling services

## Helping patients to cope with trauma

- Listen – and be ready to help patients and relatives to talk about their responses when they feel ready to do this
- Try to communicate clearly, openly, and with compassion: use ordinary language free from medical jargon, check to see that anything you have explained has been understood, paraphrase what the patient has said to make sure that you have understood them
- Validate emotions – intense reactions and painful emotions are a common, understandable and expected response to a traumatic event: things may never be the same, and recovery may be an uneven process, but life will feel better with time
- Keep your own experiences to yourself: remember, you do not know ‘just how’ someone feels, though you may sometimes think that you do
- Help patients to identify concrete needs, and then try to see that these are met – foster communication with or about family, friends and colleagues – it is quite usual for traumatised patients to be more worried about others than themselves
- Keep families together and provide assistance in locating loved ones
- Encourage those affected to rest, keep to their usual routines, and help them to identify ways to relax
- Encourage those affected to identify and use other sources of support to talk through their experiences and responses – family and friends, spiritual, religious, community or cultural networks

## Indications for referral to a mental health professional

- The initial management (4-8 weeks) should be supportive social care from family and friends. Early counselling or mental health intervention has been shown to have a negative effect
- Persistent non-resolving symptoms that interfere with daily living
- Symptoms severe enough to prevent self-care: not eating, not washing/bathing, not changing clothes
- Problematic use of alcohol or drugs
- Those with suicidal or homicidal thoughts, feelings or plans
- Domestic violence, child abuse or elder abuse
- Those with symptoms of mental illness – either pre-existing, or newly developed

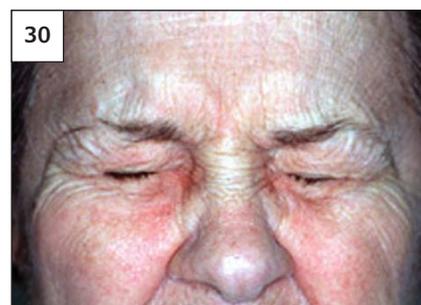
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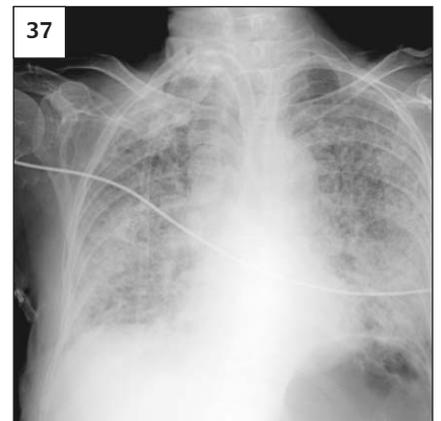
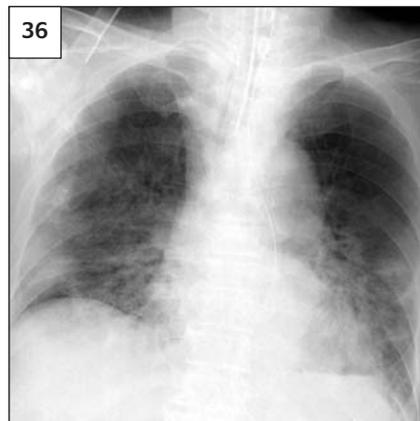
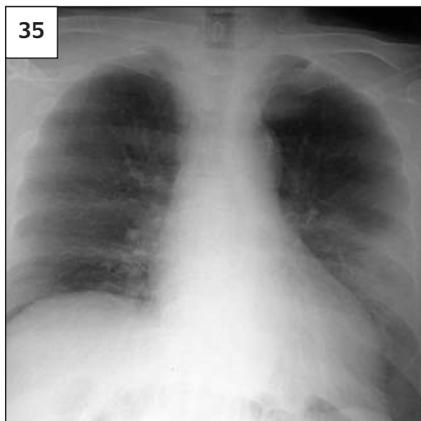
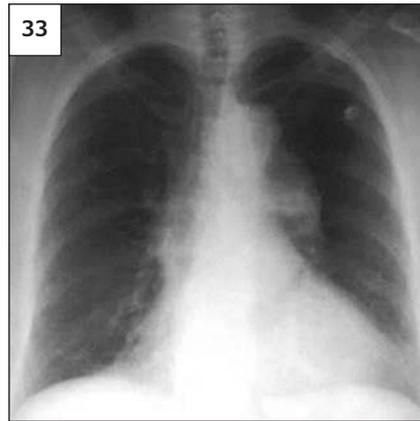
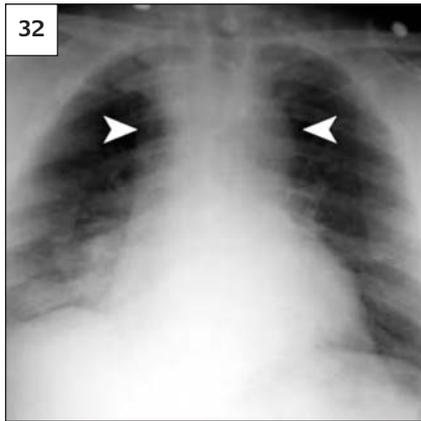
- 1 *Cutaneous anthrax*: late (painless) lesion on an infant's arm, with central black eschar and marked oedema
- 2 *Tularemia*: ulcerated nodule at site of inoculation, likely to be painful, with fever and local lymphadenopathy
- 3 *Cutaneous leishmaniasis*: indolent, slowly healing lesion at site of inoculation, with surgical tape allergy
- 4 *Brown recluse spider bite*: necrotic ulcer with punched out edge, and little oedema
- 5 *Tick bite eschar (rickettsial infection)*: small ulcer with central scab bite site, likely also to have fever and rash
- 6 *Sporotrichosis*: inoculation of soil fungus, *Sporothrix schenckii*, causes indolent skin nodules that may ulcerate
- 7 *Ringworm*: caused by dermatophyte fungi, gradually spreading raised patch, often circular, itchy, red, and scaly
- 8 *Plague*: in the septicæmic form, peripheral gangrene may occur; also seen in meningococcal sepsis
- 9 *Plague*: bubo (painful, tender, swollen lymph node in area draining flea bite) – here, the axilla, but often inguinal



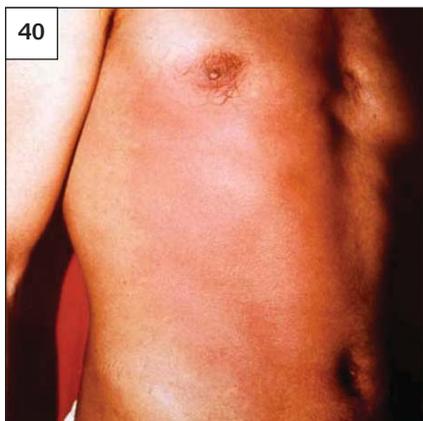
- 10 *Chancroid*: inguinal buboes with ulceration, caused by infection with *Haemophilus ducreyi*
- 11 *Granuloma inguinale*: swollen, ulcerated inguinal nodes, caused by infection with *C granulomatis*
- 12 *Molluscum contagiosum*: firm smooth pinkish, white or pearly papules caused by a DNA poxvirus
- 13 *Impetigo*: superficial skin infection caused by streptococcal or staphylococcal bacteria
- 14 *Scabies*: intensely itchy (note scratch marks), may be localised to hands, or more widespread, as here
- 15 *Smallpox* vaccination site, on day 7
- 16 *Meningococcal septicaemia*: petechial rash
- 17 *Meningococcal septicaemia*: petechial rash
- 18 *Viral haemorrhagic fever*: subconjunctival haemorrhage
- 19 *Viral haemorrhagic fever*: gingival haemorrhage (CCHF)
- 20 *Viral haemorrhagic fever*: extensive bruising (CCHF)
- 21 *VHFs*: faint, generalised macular erythematous rash seen in some arenavirus infections



- 22 *Chickenpox*: rash often dense on the chest, with relative sparing of the peripheries
- 23 *Chickenpox*: pleomorphic rash, with macules, papules, pustules and vesicles present at the same time
- 24 *Smallpox*: rash most pronounced on face and peripheries, with relative sparing of chest
- 25 *Smallpox*: vesicles and pustules on the hands, deeply embedded in the dermis
- 26 *Typhoid fever*: rose spots – pink papules – appear on abdomen and chest in the second week of illness
- 27 *Eczema herpeticum*: widespread cutaneous HSV infection in patient with pre-existing skin disease
- 28 *Pinpoint pupils*: if comatose, think of opioid drugs, stroke (pontine haemorrhage), organophosphates
- 29 *Botulism*: bilateral mild ptosis, facial symmetry, dilated pupils and dysconjugate gaze
- 30 *Blepharospasm*: after chemical exposure, has an acute onset, with tearing, pain +/- ocular signs
- 31 *Mustard gas*: extensive blistering, worst on warm moist areas



- 32 CXR pulmonary anthrax with mediastinal widening
- 33 CXR thoracic aortic aneurysm
- 34 CXR community acquired pneumonia, with consolidation in posterior basal segment of right lower lobe
- 35 CXR: SARS pneumonia, 14 days post onset
- 36 CXR: SARS, same patient as image 34, 1 week later, intubated, diffuse reticular shadows, pleural effusion
- 37 CXR: intubated patient with ARDS (*acute respiratory distress syndrome*)



38 *Gamma radiation*: early effects of localised accidental exposure

39 *Gamma radiation*: late effects of localised accidental exposure

40 *Cutaneous radiation damage*: localised early erythema 5 days post exposure to an Ir 192 source

41 *Cutaneous radiation damage*: same patient as image 40, late ulceration, necrosis and desquamation

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### Picture gallery

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- 1 © 2002 American Medical Association. All Rights reserved. In: Inglesby TV, O'Tool, T. Henderson DA, et al. Anthrax as a biological weapons, 2002. Updated recommendations for management. JAMA 287; 17:2236–2252
- 2 Dr Brachman, Centres for Disease Control & Prevention, Atlanta
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