CBRN for the FRCA

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CBRN

- Initial Operational Response – video
- NARU / HART basic response STEP 1-2-3
- History, Hazard Spectrum, Classification
- Medical implications, management
- CBRN triage sieve
- Types of agent
- CRESS – How to recognise Toxidromes
- Nerve agent and countermeasures
Initial Operational Approach Video
The way the NHS responds to HAZMAT/CBRN events is changing

The new focus is on early evacuation and disrobing within 15 minutes of exposure to the contamination, followed by immediate decontamination.

EVACUATION  DISROBING  DECONTAMINATION

The Initial Operational Response (IOR) programme has been introduced following extensive research and an NHS-wide review of clinical decontamination processes. It is being rolled out across all NHS ambulance trusts and all NHS hospital trusts.

Why is IOR important to you?
What do I need to know?

Casualties should be directed to:
- Evacuate to a place of safety (away from the source, ideally uphill / upwind).
- Disrobe – by removing their outer clothing casualties will remove 80% of contaminating substances.
- Self decontaminate using absorbent materials such as paper towels, thus protecting healthcare staff.

Remember

Communicating clearly with patients and the public, and providing positive reassurance, are essential for a successful response to HAZMAT/CBRN incidents.

What happens next?

The new protocols are being introduced across the NHS in stages, with training packages soon available in the form of JESIP IOR guidance, a multi-agency e-learning package, a DVD outlining the key elements of IOR and an aide memoire for staff.
The way the NHS responds to HAZMAT/CBRN events is changing

**STEP 1-2-3 PLUS**

**STEP 1**
One person incapacitated with no obvious reason
- Approach using standard protocols

**STEP 2**
Two people incapacitated with no obvious reason
- Approach with caution using standard protocols

**STEP 3**
Three or more people in close proximity, incapacitated with no obvious reason
- Use caution and follow PLUS

Coventry and Warwickshire NHS Trust
PLUS means follow the CBRN First Responder Flow Chart to consider what actions can be undertaken to save life, using the following principles:

- **Evacuate** – Get people away from the scene of contamination.
- **Communicate and Advise** – Give immediate medical advice and reassurance that help is on its way.
- **Disrobe** – Remove clothing.
- **Decontamination** – Dry decontamination should always be the default process.

These new protocols should be implemented upon receipt of advice from your Trust.

**So what happens next?**

The new protocols are being introduced across the NHS with training packages soon available in the form of guidance, a multi-agency e-learning package, a Department of Health elements of IOR and an aide memoire for staff.

**The Initial Operational Response (IOR) programme** is being introduced following extensive research and an NHSE-led review of clinical decontamination processes. It is being rolled out to NHS ambulance trusts and all NHS hospital trusts.
Historical perspectives

- Ancient Greeks used ‘poisoned’ arrows
- Plague corpses catapulted into the siege city of Kaffa (14th Century)
- Mass casualties due to chemical weapon use during WW1 (1915-18)
- More people died of pandemic flu (1918-19) then during the whole of WW1
- Japanese trial of biological weapons against the Chinese (late 1930s)
- First use of a nuclear weapon on the Japanese city of Hiroshima (1945)
- The Cold War (1940s-1990)
- Georgi Markov assassinated by umbrella delivered ricin pellet (1978)
- Iraqi forces use chemical weapons against Iranian forces (1980s)
- Iraqi forces use chemical weapons against the Kurdish minority (1988)
- Sarin attack on Tokyo underground transportation system (1995)
- Anthrax letters delivered in the US (2001)
- Alexander Litvinenko killed by the radioisotope Polonium 210 (2006)
- Chlorine tankers blown up in Iraq by insurgents (2007)
- Schools targeted with possible chemical agents in Afghanistan (2009)
- North Korea threatens first use of nuclear weapons (2013)
- Ricin letters sent to US politicians (2013)
- Claims of chemical weapon use in the Syrian uprising (2013 onwards)
- Assassination of Kim Jong Nam with VX in Kuala Lumpur airport (2017)
- Russian Use of ‘Novichok’ in Salisbury (2018)
## Threats CBRN sits alongside

<table>
<thead>
<tr>
<th>C</th>
<th>Chemical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chemical threats, such as conventional chemical agent threats plus toxic industrial chemicals, riot control agents and chemical hazards derived from pharmaceuticals.</td>
</tr>
<tr>
<td>B</td>
<td>Biological</td>
</tr>
<tr>
<td></td>
<td>Biological threats, such as live organisms, toxins and biological hazards deliberately employed to harm the PAR.</td>
</tr>
<tr>
<td>R</td>
<td>Radiological</td>
</tr>
<tr>
<td></td>
<td>Radiological threats, such as material or events that release ionizing (alpha, beta, gamma radiation and neutrons) and non-ionizing radiation (including directed energy).</td>
</tr>
<tr>
<td>N</td>
<td>Nuclear</td>
</tr>
<tr>
<td></td>
<td>Nuclear threats, such as weapons or events that result in nuclear fission/fusion reactions.</td>
</tr>
<tr>
<td>E</td>
<td>Explosive</td>
</tr>
<tr>
<td></td>
<td>Explosive (and ballistic) threats cover all consequences of explosive activity on human bodies including gunshot wounds, indirect fire, improvised explosive devices, shells and bombs.</td>
</tr>
<tr>
<td>E</td>
<td>Endemic</td>
</tr>
<tr>
<td></td>
<td>Endemic threats, such as infectious diseases and Biological Agents of Operational Significance that are not deliberately released but pose a hazard to the health of the population at risk (PAR).</td>
</tr>
<tr>
<td>E</td>
<td>Environmental</td>
</tr>
<tr>
<td></td>
<td>Environmental threats, such as environmental conditions likely to cause harm such as heat, cold, and altitude.</td>
</tr>
<tr>
<td>E</td>
<td>Trauma</td>
</tr>
<tr>
<td></td>
<td>Traumatic threats cover the trauma element of non-battle injuries (NBI) to complement the explosive (and ballistic) threats causing battle-injuries.</td>
</tr>
</tbody>
</table>
# Classification of CBRN agents

<table>
<thead>
<tr>
<th>C</th>
<th>Chemical</th>
<th>Nerve agents</th>
<th>Pharmaceutical based agents (PBAs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Blistering agents (vesicants)</td>
<td>Riot control agents (RCAs)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pulmonary agents</td>
<td><em>(Methaemoglobinaemia-formers)</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chemical asphyxiants</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Biological</td>
<td>Live biological agents (bacteria, viruses, fungi)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Toxins (origin: bacterial, plant, animal, fungal)</td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>Radiological</td>
<td>Radiological exposure device (e.g. point source)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Overt radiological dispersal device (e.g. ‘dirty bomb’)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Covert radiological dispersal device (e.g. food, water)</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>Nuclear</td>
<td>Nuclear power reactors</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nuclear weapons / detonation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fissile material / Spent nuclear fuel</td>
<td></td>
</tr>
</tbody>
</table>
Medical implications of CBRN incident

- Immediate and long term health effects
- Managing trauma patients in CBRN environment
- Secondary exposure – contamination / contagion
- Hazard management – decon / isolation / quarantine / cohorting / fatality management
- Physical psychological degradation of PPE
- Combined CBRN & E3T
- Effect of Counter-measures
Properties of CBRN agents

• Severity of toxic effects – lethality LD50, damaging, incapacitating

• Onset (latency) immediate, acute <6 hours, delayed >6 hours, late >month

• Physical properties: gas/vapour/liquid/solid; delivery system; route of exposure; persistence e.g. Mustard / VX
Hazards and Casualty Indicators

- Contaminated e.g. Mustard (external, internal, wounds)
- Contagious e.g. Covid-19!
- Intoxication
- Infection
- Irradiation
- Injured (trauma / psychological)
- Iatrogenic (countermeasures)
How are CBRN incidents recognised?

- Industrial accident / environmental disaster
- Delivery devices – overt / covert
- Multi patient incidents - consider
- Toxicity Symptoms in responders
- Clustering of unusual signs / symptoms
- CBRN surveillance devices
- Medical intelligence
Conceptual Incident overview

- IOR
- Hot zone
- Warm zone
- Life saving interventions
- Decontamination
- CCS
- Transfer to hospital
- Rehabilitation
CSCAT$^3$ vs CSC$^3$AT$^3$ER Major incident management organisation
## Communication

### Shared Situational Awareness

<table>
<thead>
<tr>
<th>M</th>
<th>MAJOR INCIDENT</th>
<th>Has a major incident or standby been declared? (Yes / No - if no, then complete ETHANE message)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>EXACT LOCATION</td>
<td>What is the exact location or geographical area of the incident?</td>
</tr>
<tr>
<td>T</td>
<td>TYPE OF INCIDENT</td>
<td>What kind of incident is it?</td>
</tr>
<tr>
<td>H</td>
<td>HAZARDS</td>
<td>What hazards or potential hazards can be identified?</td>
</tr>
<tr>
<td>A</td>
<td>ACCESS</td>
<td>What are the best routes for access and egress?</td>
</tr>
<tr>
<td>N</td>
<td>NUMBER OF CASUALTIES</td>
<td>How many casualties are there, and what condition are they in?</td>
</tr>
<tr>
<td>E</td>
<td>EMERGENCY SERVICES</td>
<td>Which and how many, emergency responder assets/personnel are required or are already on-scene?</td>
</tr>
</tbody>
</table>
Warm zone / CCS assessment

Casualty assessment in a CBRN-threat environment 'Quick Look'

Type of casualty (incident)?

Trauma
- Catastrophic Haemorrhage?
  - Treat

Chemical
- Casualty wearing respirator?
  - Yes
    - Respiration problem?
      - If permissible, briefly remove respirator
        - Airway/respirator problem?
          - Treat
        - Breathing problem?
          - Treat
    - Reassess
  - No
    - C-AB assessment
      - Airway problem?
        - Treat
      - Breathing problem?
        - Treat

If persistent agent & not wearing respirator, then decontaminate face & apply respirator

Conscious?
- Respiration problem?
  - Eyes?
    - Secretions?
      - Skin?
        - Treat

CRESS assessment
CBRN triage sieve

TRIAGE IN A CBRN ENVIRONMENT

HOT ZONE / FWD CCP

WALKING?
YES → T3 – Delayed
NO →-

SIGNS OF LIFE / BREATHING?
NO → DEAD
YES →-

CATASTROPHIC HAEMORRHAGE?
NO →-
YES →-

RESPIRATORY DISTRESS?
NO, or 10 - 30 →-
YES, or RR < 8 or > 30 →-

UNCONSCIOUS OR FITTING?
NO → T2 – Urgent
YES →-

WARM ZONE / CCP

SIGNS OF TOXICITY?
YES → T2 – Moderate
NO → T1 – Immediate

SIGNS OF TOXICITY

1. Where resources permit, resuscitation maybe attempted on cases of witnessed respiratory arrest with early use of antidotes (atropine for nerve agent toxicity)

2. The application of a tourniquet mandates T1 category remains in place
# Toxidrome Assessment - CRESS

<table>
<thead>
<tr>
<th>CRESS</th>
<th>Nerve agent</th>
<th>Cyanide</th>
<th>Opiate (Morphine)</th>
<th>Atropine</th>
<th>Sepsis</th>
<th>Heat stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Consciousness</td>
<td>Convulsions</td>
<td>Unconscious / Convulsions</td>
<td>Reduced → unconscious</td>
<td>Agitated / Confused</td>
<td>Normal, reduced or altered</td>
</tr>
<tr>
<td>R</td>
<td>Respiration</td>
<td>Increased or reduced → stopped</td>
<td>Increased or stopped</td>
<td>Reduced → stopped</td>
<td>Increased</td>
<td>Increased</td>
</tr>
<tr>
<td>E</td>
<td>Eyes</td>
<td>Pinpoint pupils*</td>
<td>Normal / Large pupils</td>
<td>Pinpoint pupils</td>
<td>Large pupils / Blurred vision</td>
<td>Normal</td>
</tr>
<tr>
<td>S</td>
<td>Secretions</td>
<td>Increased*</td>
<td>Normal</td>
<td>Normal</td>
<td>Dry mouth / Thirsty</td>
<td>Normal / Sputum</td>
</tr>
<tr>
<td>S</td>
<td>Skin</td>
<td>Sweaty</td>
<td>Pink → blue</td>
<td>Normal / Blue</td>
<td>Flushed / Dry</td>
<td>Warm → pale Non-blanching rash</td>
</tr>
<tr>
<td></td>
<td>Other features</td>
<td>Vomiting Incontinence</td>
<td>Sudden onset</td>
<td>Fast pulse</td>
<td>Fast pulse Fever (&gt;38.3°C) Bio-syndrome* No radial pulse</td>
<td>High temperature (&gt;38°C)</td>
</tr>
</tbody>
</table>

* Pinpoint pupils (and/or increased secretions) may be delayed if skin absorption or eye protection worn.

† ‘Bio-syndromes’ include: respiratory, cutaneous (skin), lymphadenopathy, haemorrhagic, gastrointestinal, and neurological (central & peripheral).
# Nerve Agent Treatment - reverse 3Bs

## Nerve Agents

<table>
<thead>
<tr>
<th>Nerve Agent</th>
<th>Tabun (GA)</th>
<th>Sarin (GB)</th>
<th>Soman (GD)</th>
<th>Cyclosarin (GF)</th>
<th>V-agents incl. VX</th>
</tr>
</thead>
<tbody>
<tr>
<td>LC₅₀</td>
<td>L₅₀ 400mg/min/m³</td>
<td>LC₅₀ 100mg/min/m³</td>
<td>LC₅₀ 50mg/min/m³</td>
<td>LC₅₀ unknown</td>
<td>LC₅₀ 10mg/min/m³</td>
</tr>
<tr>
<td>LD₅₀</td>
<td>1.0g (skin)</td>
<td>1.7g (skin)</td>
<td>350mg (skin)</td>
<td>30mg (skin)</td>
<td>10mg (skin)</td>
</tr>
</tbody>
</table>

## Mechanism of Action

Inhibition of the enzyme acetylcholinesterase in over stimulation of the following parts of the body:

- **Parasympathetic**: Miosis, secretions (towards mucous membranes).
- **Central nervous system**: Confusion, convulsions, fits.
- **Sympathetic ganglia**: Sweating.
- **Neuromuscular junction**: Fasciculations.

**Hazard**: GB (vapour); GA, GD, GF (liquids)

## Triage Categories

- **T1 (Immediate / Severe)**
  - Unconscious, convulsions, respiratory distress or arrest, profound bradycardia, cyanosis.
- **T2 (Urgent / Moderate)**
  - Non-ambulatory.
  - Excessive secretions, confusion, not obeying commands.
- **T3 (Delayed / Mild)**
  - Walking.
  - Pinpoint pupils only.

## Supportive Management

- **Airway**: Airway manoeuvres, suction.
- **Breathing**: Ventilatory support, oxygen, reverse secretions and bronchosospasm.
- **Circulation**: Reverse bradycardia.
- **Disability**: Treat convulsions.

## Emergency Medical Treatment

- **MedCM / Antidotes**:
  - (Pre-treatment): Pyridostigmine
  - Antimuscarinic: Atropine
  - Atropine 2mg autoinjector every 5-15 minutes

## Nerve Agents

### (tabun, sarin, soman and VX)

**Mechanism**: Inhibition of the enzyme acetylcholinesterase that breaks down the nerve transmitter acetylcholine. This results in over stimulation of the parasympathetic system, motor neurons (leading to paralysis) and CNS.

**Quick Look**

<table>
<thead>
<tr>
<th>Conscious</th>
<th>Resp Rate</th>
<th>Eyes</th>
<th>Secretions</th>
<th>Skin</th>
<th>Other factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fitting</td>
<td>↑↑</td>
<td>Pinpoint (miosis)</td>
<td>+++</td>
<td>Sweaty</td>
<td>For skin exposure – local fasciculation, delayed pinpoint pupils</td>
</tr>
</tbody>
</table>

**Mild**

- Miosis, eye pain, red eyes

**Moderate**

- Secretions, wheezing, nausea, vomiting, diarrhoea, difficulty in breathing

**Severe**

- Muscle weakness, respiratory fatigue, respiratory arrest, seizures, death

**Other factors**

- Other factors: For skin exposure – local fasciculation, delayed pinpoint pupils

**Antidotes**

- Anticholinergics (atropine), oximes (pralidoxime), benzodiazepines (diazepam)

**Other agents**

- Organophosphate pesticides, main route of exposure is ingestion, but possible air borne dissemination with varying effect. Treat as above although pharmacokinetics may vary due to dose and route of exposure.

## SELF / FIRST AID

- Remove from scene
- Immediate decontamination
- Clear secretions and vomitus
- Move into recovery position
- Give MedCM (Nerve agent antidote autoinjector)

## Clinical Investigations

- Red blood cell count

## Treatment

- High doses of atropine and the oxime do not show efficacy due to the 3B's (bradycardia, bronchosospasm, br...
Nerve Agent Antidote - video
Duodote IM injector – Atropine 2.1mg in 0.7ml / Pralidoxime 600mg in 2ml

• Available from WMAS central stockpiles:
  • Nerve agent ‘antidote pod’
  • Obidoxime
  • Dicobalt edetate
  • Botulinum antitoxin

• Telephone number in UHCW CBRN plan
CBRN

- Initial Operational Response – video
- NARU / HART basic response STEP 1-2-3
- History, Hazard Spectrum, Classification
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- Types of agent
- CRESS – How to recognise Toxidromes
- Nerve agent and countermeasures
Questions?

• Where do I find the MIP?
• What kit do we have?
• What antidotes? Where do I go? Action card?

CBRN

This SOP forms part of the Major Incident Plan suite of documents and therefore should be used in conjunction with this plan.

If the **CBRN Plan has been activated** and you have not read this SOP DO NOT READ IT NOW.

Find your action card and follow the instructions provided in this document

OR

Go to your normal place of work and follow instructions from your manager
References

- Sen et al 2021 BJA Education
- CBRN incidents
- Geoghegan et al. 2006 BJA Education
- Pharmacology of Chemical Warefare Agents
- Johnston et al 2015 BJA Education
- Hospital Response to Major Incident
- Hulse et al 2019 BJA
- Medical management of organophosphorus nerve agent poisoning
### ATROPINE OVERDOSE / BZ (ANTI-MUSCARINICS)

**Mechanism:** Both atropine and BZ are peripherally and centrally acting anti-cholinergic (anti-muscarinic) antagonists. They cause:
- **Parasympathetic:** Blurred vision, dilated pupils, dry mucosa, urinary retention, tachycardia.
- **Central nervous system:** Confusion, delirium & coma.
- **Sympathetic ganglia:** Dry skin and risk of heat illness.
- **Hazard:** Atropine (ingestion, injectable), BZ (solid aerosol).

**Quick Look (CRESS)**

<table>
<thead>
<tr>
<th>Conscious</th>
<th>Respiration</th>
<th>Eyes</th>
<th>Secretions</th>
<th>Skin</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confusion, unconscious</td>
<td>Normal or increased</td>
<td>Dilated pupils</td>
<td>Dry</td>
<td>Dry</td>
<td>Tachycardia, risk of heat illness</td>
</tr>
</tbody>
</table>

**Differential diagnosis:** Heat stroke, acute stress reaction, mass psychogenic illness.

### CASUALTY MANAGEMENT

**SELF / FIRST AID**
- Remove from scene
- Immediate decontamination
- Remove any weapons or harmful objects.
- Reassure and avoid physical restraint. Keep casualty cool.

**DETECT METHODS**
- Gas chromatography & mass spectrometry

**TRIAGE CATEGORIES**
- **T1 (Immediate / Severe)**: Unconscious. Extreme agitation or violent behaviour. Fitting. Chest pain. Temp >40°C.
- **T2 (Urgent / Moderate)**: Non-ambulatory. Confused, not obeying command. Temp >38°C.
- **T3 (Delayed / Mild)**: Walking.

**EMERGENCY MEDICAL TREATMENT**
- **Supportive management:** MedCM / Antidotes:
  - Consider sedation – benzodiazepines.
  - Prevent and treat heat illness.
  - Manage any urinary retention.
- **Physostigmine injection (5-10mg intravenous injection).**

**Clinical Investigations:** Urinalysis.

**ADDITIONAL INFORMATION**
- Symptoms may continue for several hours.

### VESICANTS (sulphur mustard, lewisite)

**Mechanism:** Sulphur mustard - Damage to DNA resulting in cell death of exposure tissue including skin and airway mucosa.
- **Lewisite:** Arsenic (lethal) poisoning causing acid type burns and systemic toxicity.

**Mild:** Erythema (red skin), eye pain
**Secretions:** Normal /
**Skin:** Red / blisters
**Other factors:** Note mustard has delayed onset (12-24 hrs), Lewisite is immediate

**Antidotes:** Sulphur mustard: None; Lewisite: Chelating agents such as British Anti-Lewisite (BAL)
**Other agents:** Hydrofluoric acid (HF): Causes chemical burn with immediate symptoms and hypocalcaemia. (Antidote: Calcium gluconate and calcium chloride)

### PULMONARY (LUNG DAMAGING) AGENTS (chlorine, phosgene, ammonia, nitrous oxides)

**Mechanism:** Direct irritation of airways. Damage to cell membranes of the respiratory tract and lungs either directly or by the formation of free radicals.

**Mild:** Eye pain
**Secretions:** pink tinged
**Skin:** Cyanosed
**Other factors:** Phosgene effects may be delayed or worsen with exercise.

**Antidotes:** None, possible role for inhaled steroids.

### CYANIDES (hydrogen cyanide, cyanogen chloride)

**Mechanism:** Cyanide inhibits the mitochondrial enzymes in cells. This stops cells using oxygen and metabolising glucose completely (aerobic respiration). This leads rapidly to a metabolic (lactic) acidosis.

**Mild:** Nausea, dizziness, agitation
**Secretions:** Normal
**Skin:** Pink then blue
**Other factors:** RAPID ONSET

**Antidotes:** Oxygen, dicyclobal edetate (where available), sodium / amyl nitrite & sodium thiosulphate, hydroxocobalamin (Vit B12a).
**Other agents:** Hydrogen sulphide (HS): Bad egg gas that causes aerobic respiration failure.
**Phosphine gas:** Produced by contact of aluminium phosphide and moisture, used widely as a rodenticide (not to be mistaken with phosphine gas) and similar effects to cyanide.
# OPIATES
(morphine, heroin, fentanyl)

<table>
<thead>
<tr>
<th>Mechanism:</th>
<th>Direct CNS depression causing reduced conscious level and respiratory depression.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mild:</strong></td>
<td>No obvious effect, euphoria</td>
</tr>
<tr>
<td><strong>Moderate:</strong></td>
<td>Reduced level of consciousness</td>
</tr>
<tr>
<td><strong>Severe:</strong></td>
<td>Respiratory depression or arrest, cyanosis, unconscious, coma, death</td>
</tr>
<tr>
<td><strong>Antidotes:</strong></td>
<td>Naloxone (consider high doses)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Quick Look</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Conscious:</td>
</tr>
<tr>
<td>Resp Rate:</td>
</tr>
<tr>
<td>Eyes:</td>
</tr>
<tr>
<td>Secretions:</td>
</tr>
<tr>
<td>Skin:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Other factors:</strong></th>
</tr>
</thead>
</table>

# METHAEMOGLOBIN FORMERS
(nitrites, other TICs)

<table>
<thead>
<tr>
<th>Mechanism:</th>
<th>Turns Fe$^{2+}$ Hb into Fe$^{3+}$ (Met) Hb. This prevents the red blood cells carrying oxygen from the lungs to the tissues.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mild:</strong></td>
<td>No obvious effect</td>
</tr>
<tr>
<td><strong>Moderate:</strong></td>
<td>Cyanosis and shortness of breath</td>
</tr>
<tr>
<td><strong>Severe:</strong></td>
<td>Severe cyanosis and shortness of breath, confusion, death</td>
</tr>
<tr>
<td><strong>Antidotes:</strong></td>
<td>Methylene blue</td>
</tr>
</tbody>
</table>

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</tr>
<tr>
<td>Secretions:</td>
</tr>
<tr>
<td>Skin:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Other factors:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyanosis not improved with $O_2$. Chocolate coloured blood.</td>
</tr>
</tbody>
</table>