

Dr Christina Baxter, of EmergencyResponseTIPS.com and Hazard3.com, offers helpful advice for first responders

Keeping you safe!

This column aims to provide the hazmat/ CBRNE community with operational guidance on the selection and performance of equipment and tactics. In this issue we focus on the medical management of hazmat/ CBRNE casualties focusing on agents with rapid onset of lethal or incapacitating effects.

Medical Triage Tools

Most mass casualty incident (MCI) triage tools classify victims with conventional injuries according to the severity of their injuries. These tools include the UK's NHS Ten Second Triage, Major Incident Triage Tool, and the US's Simple Triage and Rapid Treatment. MCI triage tools provide a fast, simple and accurate means for emergency response personnel to prioritise patients, however they primarily focus on conventional injuries and become less useful during incidents involving weaponised chemical or biological materials.



Toxidromes, or toxic syndromes, are often used as the first 'detection' of a potential chemical or biological exposure or attack by recognising symptom clusters representative of the chemical agent or biological agent group in question. Common toxidromes include acute exposure to solvents, aesthetics, or sedatives; anticholinergics (or antimuscarinics); anticoagulants; cholinergics (also called pesticides or nerve agents); covalents; irritants/corrosives; knockdowns; opioids; or stress-responses (or sympathomimetics). Recognising toxidromes is critical for successful medical triage and the treatment of chemical and biological casualties, in conjunction with other incident indicators.

Operationalising toxidromes into simplified triage tools helps streamline mass casualty events in CBRN contaminated environments. Examples include the Nato CRESS tool, which refers to consciousness, respirations, eyes, secretions, and skin. There's also MARCHE2, meaning massive haemorrhage, mask/air check, airway, administer antidotes, respirations, rapid spot decontamination, circulation, administer countermeasures, hypothermia/head wound, extraction/evacuation, along with Ciottone's rapid triage system for chemical warfare agents.



Ciottono's system divides CBRN threats into those requiring the immediate administration of antidotes and treatment first due to their rapid lethality, and then those requiring immediate decontamination and supportive care. Nerve agents, asphyxiants, and opioids are among the agents requiring treatment prior to decontamination.

Those requiring immediate decontamination followed by treatment include anaesthetic agents; vesicants, caustics, riot control agents, or T-2 toxin; central compartment (large-airway) pulmonary agents; peripheral compartment (small-airway) pulmonary agents; botulinum agent; or anticholinergic agents.



Pre-hospital care

The level of pre-hospital care available will vary depending upon whether the Franco-German or Anglo-American model is used. The Franco-German model brings the hospital to the patient, with heavy emphasis on 'stay and stabilise' using emergency physicians in field operations. In contrast, the Anglo-American model emphasises 'scoop and run' techniques using paramedics. Regardless of which care model is chosen, some chemical agent exposures require rapid field intervention either through the administration of antidotes or supportive care en route to hospital.

Organophosphate and carbamate pesticides or nerve agents are a class of material that acts fast and is highly lethal. The specific antidote for organophosphates includes a combination of atropine and oxime therapy with supportive care using albuterol, ipratropium bromide, methylprednisolone, and benzodiazepines. Specific antidotes are often administered using autoinjectors, such as the Meridian DuoDote for simultaneous delivery of atropine and pralidoxime chloride. Supportive care for anticonvulsants (eg midazolam and diazepam) is also available in autoinjector format. Much of the supportive care needed for nerve agent response is also used for asthma and chronic obstructive pulmonary disease (COPD), therefore it is widely available.



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There are several field support options when dealing with asphyxiants such as cyanide, however they require intravenous administration over five to 15 minutes which makes them less suitable for MCI applications. The two most common are the Cyanokit which utilises hydroxocobalamin to chelate the cyanide and the Nithiodote kit which uses a combination of sodium nitrite and sodium thiosulfate to convert cyanide to thiocyanate. Historically, amyl nitrite and dicobalt edetate were used but have been replaced with the Cyanokit and Nithiodote kits. Some agencies are now using 4-dimethylaminophenol or nitrocobinamide in place of sodium nitrite as they are fast acting. New treatments not yet approved, such as Sulfanegen and nitrocobinamide with thiosulfate autoinjectors, are under development. Many of the antidotes for cyanide have also been used successfully for hydrogen sulphide toxicity, however, hydroxocobalamin and sodium thiosulphate are not supported.

Methylene blue is used as an antidote for chlorates, nitrates, nitrites, aniline dyes, chlorobenzene, naphthalene, nitrophenol and nitrous gases, but this is rarely done in pre-hospital settings due to potential adverse effects. It is also currently being investigated to assist with hydrogen sulphide toxicity. N-Acetylcysteine is used for patients exposed to asphyxiants such as acrylonitrile, chloroform and paraquat. It may also be used to treat delayed effects from other pulmonary agents such as chlorine and phosgene. Supportive care will be required for most asphyxiant exposures in field settings.

The final class of threat agents that requires immediate intervention is the pharmaceutical based agents, specifically the fast acting and long-lasting opioids. Naloxone quickly reverses opioid binding. It is available in multiple forms including intranasal, intravenous and injection. For field applications, intranasal sprays (eg Narcan, OPVEE, Kloxxado, RiVive and Rezenopy) and autoinjectors (eg Rapid Opioid Countermeasure System) are available.

Research on medical countermeasures (MCM) for CBRN agent exposures continues. The US Biomedical Advanced Research and Development Authority (BARDA) CBRN programme aims to ensure that "at least one countermeasure is available for all CBRN threat materials" with strategic priorities on chemical, burn/blast, radiological/nuclear, antimicrobials, antitoxins, antivirals and vaccine development. Similar far-reaching programmes such as the UK Advanced Research and Invention Agency (ARIA) and the EU Health Emergency Preparedness and Response Authority (HERA) highlight international efforts. Their budgets are significant. BARDA's investment in CBRN MCMs alone was \$1.5bn in FY2024.



Planning

Understanding the level of pre-hospital and in-hospital care available for CBRNE casualties is critical. Where one hospital might be best suited for traumatic injuries, another may be best for delivery of antidotes and management of symptoms due to chemical or biological exposure. Prior coordination among all the response partners will be key to optimising outcomes to protect our communities.

Medical management of CBRNE casualties will vary across jurisdictions due to local needs, available resources, financial constraints and medical directors' preferences. The information provided here is meant to guide discussion and may be outside the standard of care set by your jurisdiction; always revert to the protocols approved by your medical director.

Images are courtesy of Phil Buckenham <https://philbuckenhamart.wixsite.com/philbuckenham>