

# **NSHA Chemical Exposure Tool Kit**

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## Read this First:

This document is designed to provide assistance for physicians, nurses, and other allied health professionals in the management of a *mass casualty event* with a chemical or radiological exposure.

When you first receive warning of a pre-hospital mass chemical exposure, or if you or your staff recognize an influx of patients with evidence of exposure, please immediately inform the Atlantic Canada Poison Center (ACPC) for toxicological events. The poison center will be able to help coordinate acquisition of Provincial antidote kits as required and indicated, and provide online medical expertise for poison and toxicological management.

**Atlantic Canada Poison Center: 1-800-565-8161**

If there is concern of a non-mass-casualty radiation event (industry/laboratory) immediately contact the Radiation Health Officer:

**Radiation Health Office: 902-473-2767**

*or*

**1-902-473-2222** and ask for the **on-call Radiation Officer**

For a single or small number of stable patients, contact the FNEP DO with Health Canada. They may refer you to a Nuclear Safety Officer depending on the clinical exposure.

**Federal Nuclear Emergency Program Duty Officer (FNEP DO) 1-613-954-6651**

In the case of a mass-casualty radiological event (Reactor event [Point Lepreau, NB; Nuclear Propulsion Naval vessels]) or radiological dirty bomb or nuclear weapon, contact the Emergency Preparedness Manager on-call via locating. They will contact the FNEP DO via the Provincial EMO.

In all radiological crises- such as a transportation spill, accidental industrial exposure, or power-plant mishap, do not hesitate to alert the Radiation Emergency Assistance Center/Training Site (REAC/TS) in Tennessee, USA for clinical assistance.

**REAC/TS Emergency Contact : 1-865-576-1005 (ask for REAC/TS)**

This document provides *single page* references for a variety of common exposures or potential threats that may present in the case of industrial disaster or terror related events. These guides are based on evidence and best-practice, but do not represent, necessarily, the state of the art. They are designed to help you and your team manage a mass-casualty presentation immediately, and give you time to access additional resources as the situation evolves.

The scope of this guide is limited to common industrial chemicals that high a higher likelihood of mass exposure, or specific agents that may be utilized by terrorist organizations during an intentional attack. This document does not seek to provide instruction for all possible chemical agents, be prepared to access other resources as required by your clinical situation.



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## Reception of Contaminated Casualties and PPE:

**Safety for Providers:**

There are several reasons that it is generally safe for Emergency Department staff to manage casualties from a chemical exposure.

1. The concentrations of chemical at the scene of the incident (ie the hot zone) are always much higher than even a short distance from the incident
2. The casualties with the highest (ie: lethal) exposure doses may not survive to be transported. Those who are able to be transported have not received the highest doses
3. Casualties have often had at least basic decontamination prior to arrival at the ED. Even simple removal of the patient's clothes removes approximately 90% of the contamination for dust and liquid spills. In fact, EHS generally will not transport patients who have not been decontaminated on scene.
4. With volatile chemicals, there is "offgassing" of residual contamination during the process of transporting the casualty that results in reduced threat to staff at the ED when the patient finally arrives.
5. Patients exposed to a true gas (ie: chlorine gas, as opposed to a vapor or mist) do not require decontamination in most cases. Any symptoms they have are caused by the effect of the gas on their mucus membranes and respiratory epithelium, and generally do not pose a threat to ED staff (although they may smell bad.)
6. EHS paramedics will generally refuse to transport contaminated casualties until after they have been decontaminated on scene. For patients presenting by private vehicle instead of EHS, decontamination may not have been performed on scene. Although secondary contamination remains low risk, consider immediate surface decontamination of affected casualties.

## PPE for First Receivers:

Personal Protective Equipment for Hazardous materials can be rated as levels A to D. Levels A and B both use delivered air- either as a self-contained breathing apparatus (SCBA) or via an umbilical duct system. Levels A and B PPE are reserved for specialized HAZMAT teams in the pre-hospital setting, or for lab workers in laboratories with particularly dangerous chemicals or biological samples.



Within the hospital context, the levels of PPE are generally limited to LEVEL D and LEVEL C.

When faced with a potential HAZMAT contaminated mass casualty incident, we recommend a MINIMUM of level D should be used prior to patient decontamination. This refers to using splash resistant surgical gown, double gloves, boot covers, face-mask, and eye-shield.

Following patient decontamination, health care providers should maintain universal precautions (eg. Gown, nitrile gloves, and surgical mask) as per standard patient safety guidelines for *additional contact, droplet, or airborne requirements*.

For particular agents, additional protection (LEVEL C) is indicated, and noted in the toolkit under the agent's "PPE NEEDED" section. LEVEL C PPE refers to a chemically resistant (Tyvek) suit, boots, double gloves, and Air-purifying respirator (passive [APR] or powered [PAPR]).



Air Purifying Respirator (APR)



Powered APR (PAPR)

## Identifying Chemicals, their Health Effects, and required PPE:

### Identifying the Agent:

Sometimes the agent is known. It could be provided by first receivers of others on scene with technical knowledge. If that information is provided, you should find out the key facts about that agent. There are several good sources of key health-related information on known toxins. These include:

- MSDS (Material Safety Data Sheets) are required to be kept on the premises of any site using hazardous chemicals. For example, the hospital has MSDS pages for chemicals used by housekeeping. The relevant sheets are often sent with the patient from the scene of occupational and industrial incidents. There are, however, NO comprehensive binders of MSDS available in the ED.
- WISER (smartphone app and/or web-based app: [wiser.nlm.nih.gov](http://wiser.nlm.nih.gov))

## Toxicological Symbols

Sometimes the agent is not known precisely during a transport-related incident. In those cases having a picture of the transportation placard can be used to identify it precisely. The following resource has a complete library of placards the symbols they use to code the different types of agents. Each agent is given a unique CAS number, which can be used to look up additional safety data. Similarly, each agent has been denoted with universal toxicological symbols for quick hazard references.

Please see the symbols below for reference.

Harmful



Toxic



Oxidizing Agent



Health Hazard – General



Flammable



Corrosive



Explosive



Environmental hazard



Compressed Gas



**Unknown Agents:**

Finally, some casualties arrive with no information about the specific chemical to which they have been exposed. You should approach those cases the same way that you approach poisoning or overdoses with unknown drugs: by assessing the patient for a *toxidrome*. Each class of chemical or radioactive agent presents with somewhat unique signs and symptoms. The broad classes of agents involved include:

- Irritant Gases (chlorine, ammonia)
- Chemical asphyxiants / blood agents (carbon monoxide, cyanide, hydrogen sulfide)
- Cholinergics / nerve agents (organophosphate pesticides and carbamate insecticides)
- Corrosives (acids and bases)
- Hydrocarbons and Substituted Hydrocarbons
- Oxidizers and Reducing Agents
- Radiological Agents

A guide for unknown chemical exposure is on page 35-36.

**A special note on Radiation:**

Managing a mass radiation incident requires significant resources and support. In the case of a “dirty bomb”, the vast majority of contamination is anxiety-provoking but harmless: patients who are otherwise uninjured should be told to go home and shower at home. Several helpful online and downloadable resources that are freely available and completely reliable to assist you:

- REMM: <https://www.remm.nlm.gov/>; available as a smartphone app or web-based app
- REAC/TS online guide to managing radiation emergencies:  
<https://orise.orau.gov/resources/reacts/guide/index.html>

## AMMONIA (gas or liquid)

### What is it?

Ammonia (NH<sub>3</sub>) is a colourless gas with a very pungent odour. It rapidly forms Ammonium hydroxide upon contact with water, mucous membranes, sclera etc. which is a basic corrosive agent (pH 11.6). It can cause mucosal and pulmonary irritation and chemical burns.

### PPE NEEDED:

LEVEL D PPE (surgical gown, gloves, facemask and eye shield): Recommended for majority of cases following decontamination.

Level C PPE (Tyvek suit, Air purifying respirator, gloves, boots): May be necessary with visible ammonia contamination (liquid) or strong smell of ammonia undergoing decontamination.

### Common Sources:

Coolant units / Ice Rink Freezers  
Industrial fertilizer production  
Petrochemical Industry  
Industrial Cleaning  
Home cleaners  
Methamphetamine production

### CAS / Chemical Information:

CAS # 7664-41-7



### Presenting Symptoms:

- Highly irritated sclera and conjunctiva
- Upper airway mucosal irritation- mouth, nose, throat
- Cough, respiratory compromise and larygospasm
- Chemical skin burns
- Can cause frost bite if released as cooled liquid

### Decontamination Suggestions:

Exposure to vapor only: Remove outer layers of clothing and wash exposed skin with soap and water minimum 5 minutes.

Exposure to liquid: Remove ALL clothes And wash all skin and hair with soap and water for minimum 5 minutes.

### Emergency Treatment / Antidotes:

No antidote.

Supportive care for skin burns or frostbite injury.

Consider early intubation for patients with any signs of upper airway compromise, especially stridor. Anticipate challenging airway if oral and pharyngeal mucosa is edematous.

If ARDS occurs, supportive management is indicated.

For ocular irritation, provide analgesia (topical and/or systemic) and irrigate with water or NS using a morgan lens for 2L volume or at least 15 minutes of irrigation, then check for neutral pH level

## **AMMONIA (gas or liquid)**

### **Workup and Special Tests:**

Consider plain chest radiography initially and/or at 6 hours post exposure of respiratory symptoms continue to assess for chemical pneumonitis or ARDS.

No specific blood testing is indicated for ammonia exposure.

### **Follow up / Disposition:**

As edema resolves with supportive care, there are generally no long term consequences to ammonia exposure.

Severe exposure can result in chronic Pulmonary disease from inhalation, or significant ocular injury.

Corneal ulceration and perforation can occur in a delayed fashion- and ophthalmological follow up is recommended for patients with eye exposure.

Once asymptomatic for 6 hours, patients may be discharged home.

### **Ammonia References:**

Muskat, P. C. (2008). Mass Casualty Chemical Exposure and Implications for Respiratory Failure. *Respiratory Care*, 53(1), 58-63.

Center for Disease Control - Agency for Toxic Substances and Disease Registry. (2020, 01 16). *ATSDR - Toxic Substances Portal - Ammonia*. Retrieved 2020, from CDC:  
<https://www.atsdr.cdc.gov/mmg/mmg.asp?id=7&tid=2>

Kerstein M, S. D. (2001). Acute management of exposure to liquid ammonia. *Military Medicine*, 166(10), 913-914.

Sigma-Aldrich; Safety Data Sheet for Ammonia (7664041-7). Product number: 294993, Version 3.10 (Revision date 02/23/2016). Available from, as of May 2 2016:  
<http://www.sigmaaldrich.com/safety-center.html/>.

## CHLORINE (gas) and HYDROCHLORIC ACID (aerosol, gas)

### What is it?

Chlorine (Cl<sub>2</sub>) is a heavy, lightly green-yellow gas. Hydrochloric acid (HCl) is a colourless gas. Both smell strongly pungent.

### PPE NEEDED:

UNIVERSAL PRECAUTIONS: For first receivers (in hospital) attending to patients with only chlorine gas exposure only.

LEVEL C PPE: (Tyvek suit, Air purifying respirator, gloves, boots) for patients with visible chlorine liquid contamination.

### Common Sources:

Chemical laboratories  
Industrial Cleaner  
Home cleaner  
Steel production facilities  
Chemical warfare agent  
Paper/pulp production and processing

### Presenting Symptoms:

Ocular and mucosal irritation.  
Cough, respiratory failure.  
ARDS.

### CAS / Chemical Information:

Cl<sub>2</sub> / HCl

CAS # 7782 -50- 5 / 7647-01-0



### Decontamination Suggestions:

For Cl<sub>2</sub> gas exposure only with NO skin Or eye irritation, no decontamination is Required.

Patients with ocular or skin irritation, or Exposure to liquid HCl or liquid chlorine Should have clothing removed and Wash with soap and water for minimum of 5 minutes.

### Emergency Treatment / Antidotes:

Supportive therapy is indicated.

For patients with pulmonary irritation, consider NaCO<sub>3</sub> via nebulizer. 4 mL of a 4.2% sodium bicarbonate solution by nebulizer. One dose is often adequate; repeat doses may be necessary in more severe cases.

For patients with pulmonary irritation and wheeze, consider bronchodilators (salbutamol) via nebulizer; 5mg nebulized. Start with 3 back-to-back nebulizers and re-assess.

Role for steroids is equivocal- contact Poison Control for guidance.

## **CHLORINE (gas) and HYDROCHLORIC ACID (aerosol, gas)**

### **Workup and Special Tests:**

Consider plain chest radiography initially and/or at 2-4 hours post exposure of respiratory symptoms continue to assess for chemical pneumonitis or ARDS.

No specific blood testing is indicated for chlorine exposure.

### **Follow up / Disposition:**

Patients with respiratory symptoms are at risk for developing secondary pneumonia within 3-5 days of the initial exposure.

They should return to hospital if they experience fever, or increasing difficulty breathing.

Prophylactic antibiotics are NOT indicated.

In a mass casualty situation, asymptomatic patients who are reliable historians and those who experienced only minor sensations of burning to the nose, throat, eyes, and respiratory tract (with mild cough) may be released without further observation.

Otherwise, once patients are symptom free for 4-6 hours they may be discharged home.

### **Chlorine References:**

Muskat, P. C. (2008). Mass Casualty Chemical Exposure and Implications for Respiratory Failure. *Respiratory Care*, 53(1), 58-63.

IWK Regional Poison Centre. (2020, 01 16). *Antidote - Sodium Bicarbonate*. (D. N. Murphy, Editor) Retrieved from <https://iwkpoisoncentre.ca/sodium-bicarbonate-adult.html>

Aslan S, K. H. (2006). The effect of Nebulized NaHCO<sub>3</sub> treatment on "RADS" due to chlorine gas inhalation. *Inhaled Toxicology*, 18(11), 895-900.

CHEMM. (2019). Chlorine – Emergency Department / Hospital Management. U.S. Department of Health and Human Services. Retrieved from [https://chemm.nlm.nih.gov/chlorine\\_hospital\\_mmg.htm](https://chemm.nlm.nih.gov/chlorine_hospital_mmg.htm).

## CS (gas)/Tear Gas (aerosol), CN (aerosol) and Pepper Spray

### What is it?

CS, CN, and Capcaisin (pepper) spray are all riot control agents. They are generally sprayed out of a highly pressurized canister- often by law enforcement officers. They are immediately irritating, though designed to not be toxic unless applied at extremely high doses.

### PPE NEEDED:

LEVEL D PPE: While assisting decontamination of patients exposed to riot control agents.  
Universal Precautions: Once decontamination has occurred.

### Common Sources:

Riot control / crowd control agent  
Law enforcement use  
Chemical warfare agent  
Personal defense weapon

### Presenting Symptoms:

- Blepharospasm, tearing.
- Cough, rhinorrhea, pharyngitis, and bronchitis
- Skin blistering
- Salivation
- Nausea, vomiting
- Anxiety

### Emergency Treatment / Antidotes:

No antidote.

Rinse eyes with morgan lens for 15 minutes, then reassess.  
Apply topical analgesia to eyes.

Provide respiratory supportive care.

Salbutamol nebulized (5mg via nebulizer) may be helpful for symptoms of bronchospasm, especially in patients with known asthma and/or COPD.

Nausea and vomiting can be controlled with usual anti-nausea medication.

### CAS / Chemical Information:

Multiple chemical formulas



### Decontamination Suggestions:

Contaminated clothing should be cut away, not lifted overhead.

Gross liquid contamination should be washed with soap and water for at least 5 minutes.

Eyes should be irrigated for 15 minutes with normal saline, RL, or tap water.

## **CS (gas)/Tear Gas (aerosol), CN (aerosol) and Pepper Spray**

### **Workup and Special Tests:**

No additional testing is generally required.

If ocular symptoms persist > 30-60 minutes following irrigation, consider fluorescein exam to rule out abrasions.

### **Follow up / Disposition:**

Generally once patients have symptoms Controlled, they will not require follow up.

There are case reports of delayed pulmonary manifestations following riot control agent exposure- and patients should be instructed to return to the hospital should their breathing worsen over the 24h following exposure.

### **CS/CN/Pepper Spray References:**

Carron, P.-N. &. (2009). Management of the effects of exposure to tear gas. *British Medical Journal*(338), b2283.

## PHOSGENE (Gas)

### What is it?

A colorless gas with a smell reminiscent of freshly cut hay. It is heavier than air, and remains in a gaseous state above 8.3°C, below which it condenses to a liquid. Importantly, the odor-detection threshold is significantly lower than the toxic exposure limit. If you can smell it, you have been exposed to a *potentially* toxic dose.

### PPE NEEDED:

LEVEL C PPE: If there is suspicion or concern that liquid contamination has occurred, then off-gassing is likely and staff should wear LEVEL C PPE during the decontamination process.

LEVEL D PPE: Suitable for receiving patients exposure to gas only.

UNIVERSAL PRECAUTIONS: Following decontamination.

### Common Sources:

Chemical Warfare agent  
Dye production  
Pesticide production  
Pharmaceutical production  
Methamphetamine production – *hydrophosphorous acid*

### CAS / Chemical Information:

COCl<sub>2</sub>

CAS # - 75-44-5



### Presenting Symptoms:

- Burning to nares, eyes, mouth
- Onset of pulmonary difficulty within 8-10 hours.
- Pulmonary injury <4h post exposure has negative prognosis.

### Decontamination Suggestions:

Patient with only gas exposure do not require decontamination.

Patients with liquid phosgene contamination should be washed with soap and water for at least 5 minutes.

### Emergency Treatment / Antidotes:

No antidote.

Consider early intubation for patients exposed to phosgene with respiratory symptoms and oxygen requirement <4h post-exposure, as they may decline markedly and have likely been exposed at an LD50 level or higher.

Bronchodilators and corticosteroids are indicated for severe phosgene exposure.

Volume support and positive pressure ventilation is supportive care.

## **PHOSGENE (Gas)**

### **Workup and Special Tests:**

No specific blood tests are indicated.

A CXR done at 8 hours post exposure is indicated.

### **Follow up / Disposition:**

For patients requiring positive pressure Ventilation, it is expected that all symptoms will resolve within 3-5 days.

Once pulmonary edema resolves, there are minimal long term adverse effects.

No specific follow up is required.

If there are no changes on the CXR at 8 hours post exposure, and no pulmonary symptoms at this time, the patient can be discharged.

If no radiography is available, patients should be observed 24 hours to ensure no delayed onset pulmonary edema occurs.

### **Substance References:**

Muskat, P. C. (2008). Mass Casualty Chemical Exposure and Implications for Respiratory Failure. *Respiratory Care*, 53(1), 58-63.

CHEMM. (2019). Phosgene – Emergency Department / Hospital Management. U.S. Department of Health and Human Services. Retrieved from [https://chemm.nlm.nih.gov/phosgene\\_hospital\\_mmg.htm](https://chemm.nlm.nih.gov/phosgene_hospital_mmg.htm).

## CYANIDE (Gas, liquid)

### What is it?

Cyanide (CN) is a gas with a classic bitter almond smell, though 20-40% of the population is unable to detect this scent. As a gas, Hydrogen Cyanide can cause effects within minutes, while liquid absorption through the skin can have delayed effects up to an hour post-exposure. *Generally*, a person exposed to a lethal amount of cyanide will be dead within 10 minutes of exposure.

### PPE NEEDED:

LEVEL C PPE: During decontamination if patients are contaminated with liquid cyanide.  
UNIVERSAL PRECAUTIONS: Following decontamination.

### Common Sources:

Product of combustion of plastics  
Home or industrial fires

Laboratory usage  
Industrial metal working  
Paper and plastic industrial production

### CAS / Chemical Information:

CN / HCN  
CAS # - 57-12-5



### Presenting Symptoms:

Altered level of consciousness  
Headache  
Nausea / Vomiting  
Tachycardia, Bradycardia  
Seizures  
Shock  
Cherry red skin

### Decontamination Suggestions:

Patients exposed to CN gas require the outer layer of clothing to be removed, and have their hair washed.

Patients with liquid cyanide contamination should have all clothing removed and be washed with soap and water for a minimum of 5 minutes.

### Emergency Treatment / Antidotes:

**Antidote is AVAILABLE** – Check your Nova Scotia Antidote kit. Additional product can be accessed from other emergency departments in the province. Call the Poison Centre for more information.

First line – Hydroxycobalamin 5 g (2 x 2.5 g vials successively or 1 x 5 g vial) IV over 15 minutes

- Doses up to 20 g have been used in severe poisoning.
- For a final concentration of 25 mg/mL: reconstitute each 2.5 g vial with 100 mL sodium chloride 0.9% or reconstitute each 5 g vial with 200 mL sodium chloride 0.9%. Use the transfer spike provided. Rock or invert the vial for at least 1 minute to mix. Do not shake.

Treat with 100% FiO<sub>2</sub> and, if needed, positive pressure ventilation.

## **CYANIDE (Gas, liquid)**

### **Workup and Special Tests:**

Be aware that in case of combustion, CO toxicity may be concomitant. Consider hyperbaric treatment if CO toxicity is significant.

A high-anion-gap metabolic acidosis is a hallmark of significant cyanide toxicity- similarly, hypotension, cardiovascular collapse, or decreased level of consciousness are all indications for hydroxycobalamin in patients with concern for CN toxicity.

Follow patient progress with serial Arterial Blood Gases. Cyanide toxicity is characterized by a normal arterial oxygen tension and an abnormally high venous oxygen tension, resulting in a decreased arteriovenous oxygen difference (< 10%).

### **Cyanide References:**

Baskin SI, B. T. (1997). Cyanide Poisoning. *Medical Aspects of Chemical and Biological Warfare*, 271-286.

Baud FJ, V. E. (2002). Value of Lactic Acidosis in the assessment of the severity of acute cyanide poisoning. *Critical Care Medicine*, 30(9), 2044-50.

IWK Regional Poison Centre. (2020, 01 16). *Antidote Kit - Adult*. Retrieved from <https://iwkpoisoncentre.ca/manual.html>

### **Follow up / Disposition:**

There is limited data to generalize follow up for CN exposed patients.

Significant cardiac and neurological sequelae have been documented in survivors of exposures.

No clear follow up guidelines can be provided.

## Hydrogen Sulfide - Gas

### What is it?

Hydrogen sulfide (H<sub>2</sub>S) is a colorless gas which has a strong smell of rotten eggs or “sewer gas”. It is produced naturally by the decomposition of organic matter, but can produced rapidly during chemical synthesis processes. At high concentrations it is an irritant gas, and also acts as a cytochrome inhibitor, resulting in a mitochondrial shock state similar to cyanide exposure. H<sub>2</sub>S is one of the few true “knock down” gases, which can present as a sudden loss of consciousness similar to cardiac syncope. Be advised, the odor threshold is *orders of magnitude lower* than the toxic threshold (0.5 parts per *billion* vs 50 parts per *million* for 10 minutes or 100 ppm instantly). You cannot use smell as a gage of concentration in an environment.

### PPE NEEDED:

LEVEL A or B PPE: For first responders entering a area with elevated H<sub>2</sub>S gas.

UNIVERSAL PRECAUTIONS: For first receivers treating patients exposed to H<sub>2</sub>S gas only.

### Common Sources:

Paper mills and paper production plants  
Analytical chemistry application  
Purification of metal ores.  
Volcanism

### Presenting Symptoms:

- Ocular irritation and conjunctival injection
- Mucus membrane irritation
- Stridor, bronchitis
- ARDS
- Lactic acidosis
- Shock

### CAS / Chemical Information:

H<sub>2</sub>S  
CAS 7783-060-4



### Decontamination Suggestions:

- For patients contaminated with liquid H<sub>2</sub>S, removal of clothing and washing of exposed hair and skin is indicated with soap and water for at least 5 minutes.

For patients with pure exposure to Gaseous H<sub>2</sub>S, removal of clothing and rinsing of hair is helpful only to reduce smell—they pose ***no risk*** of secondary contamination.

### Emergency Treatment / Antidotes:

ANTIDOTE AVAILABLE

For high concentration exposure and patients with systemic symptoms, early dosing with SODIUM NITRITE has been shown to provide benefit in certain studies. This is only available at the Halifax Infirmary Pharmacy, and in limited quantities. Contact the Atlantic Canada Poison Center for expertise. **1-800-565-8161.**

Intravenous sodium nitrite (300 mg over absolutely no less than 5 minutes) may aid recovery by forming sulfmethemoglobin, thus removing sulfide from the tissue. That said, the usefulness of nitrite therapy given beyond the first few minutes after exposure is questionable.

Priority should be oxygenation and ventilation. Bronchodilators and supportive care as needed.

## **Hydrogen Sulfide - Gas**

### **Workup and Special Tests:**

Supportive care is indicated.  
There are no clear prognosticating tests.

### **Follow up / Disposition:**

Patients who remain symptom free with no pulmonary, ocular, or neurological symptoms for 6 hours may be released.

### **Substance References:**

CDC. (2014). Toxic Substances – Hydrogen Sulfide. Agency for Toxic Substances and Disease Registry. <https://www.atsdr.cdc.gov/MHMI/mmg114.pdf> (accessed 29 January 2020).

Malone E, and King A. A fatal exposure to hydrogen sulfide. J Med Toxicol 2018; 14(1):48.

## DIRTY BOMB, RADIATION EXPOSURE/CONTAMINATION

### What is it?

Radiation comes from high energy material called radionuclides. Since they are essentially energetic forms of otherwise stable atoms, they are too small to be seen, and can be solid or liquid. Radiation **exposure** results from proximity to a source of radioactive decay. Radiation, in the form of neutrons, electrons (beta particles), helium nuclei (alpha particles), and photons (X rays and gamma rays), can cause adverse health effects in an acute, dose dependent (deterministic) manner, or as a long term (stochastic) risk of malignancy. **Exposure** refers to radiative particles hitting the patient, while **contamination** refers to the soiling of clothes, skin, or internal organs by radioactive material itself.

### PPE NEEDED:

*Level of PPE is indicated by Geiger Counter readings. If the Geiger Counter detects levels of activity significantly above background levels then PPE should be worn (since there is either external or internal contamination).*

LEVEL D PPE: If patients have been contaminated, then PPE should be minimum of LEVEL D (which can effectively stop alpha and most beta particles). X-Ray radiation can be stopped by lead aprons and thyroid covers, but Gamma and neutron radiation are avoided best by source control, distance, and limiting time near sources. If available, responders should wear personal DOSIMETERS to track exposure. **Generally, residual contamination on patients is not dangerous** following dry or wet decontamination.

UNIVERSAL PRECAUTIONS: If patients have been exposed but not contaminated, then no PPE is required above universal precautions.

**SEE THE FLOW SHEET ON THE NEXT PAGE FOR GUIDANCE**

### Common Sources:

Industrial Sources: Cesium-137, Cobalt-60,

Americium-241, Strontium-90

Medical/Laboratory Sources:

Iodine-131, Cesium-131, Technetium-99

Military/Power Sources:

Uranium-235, Plutonium-239

Uranium-238, Tritium H<sub>3</sub>

### CAS / Chemical Information:

No CAS #. All are elements.



### Presenting Symptoms:

- Most common symptom is anxiety
- Often there are no or few immediate symptoms of radiation exposure- though symptoms can be in as little as 30 minutes if there has been very high exposure Levels. If patients have the gastrointestinal symptoms within hours of exposure, they have a poor prognosis.
- Watch for vomiting, diarrhea, skin burns

### Decontamination Suggestions:

If *contamination* is a concern, have patients remove their clothing and wash clothes and hair with soap and water.

Be mindful of wet decon runoff- as radioactive fallout should be collected and not allowed in to the ground water or municipal waste water if there is an alternative.

## DIRTY BOMB, RADIATION EXPOSURE/CONTAMINATION

### Emergency Treatment / Antidotes:

There is no global antidote. *Internal contamination* may have chelation therapy. Consult REMM for details at < [https://www.remm.nlm.gov/int\\_contamination.htm#blockingagents](https://www.remm.nlm.gov/int_contamination.htm#blockingagents)>.

Provide a single dose of Potassium Iodine 130mg to adults and 65mg to children *if* radioiodine is a known exposure *or* in the event of a nuclear plant meltdown event.

See page 4 for full detailed contact information. Alert the Federal Nuclear Emergency Liaison Officer **1-613-954-6651** or **via the NS EMO (if mass casualty incident)**. They will advise if dosimetry kits are indicated. For additional assistance, call the Radiation Emergency Assistance Center/Training Site (REAC/TS) at 1-(865)-576-3131 (M-F, 8 am to 4:30 pm EST) or 1-(865)-576-1005 (after hours).

Treat burns as per thermal injury. Palliate as necessary.

### Workup and Special Tests:

Serial complete blood counts q2-3 hours during the first 8-12 hours after exposure and q6h for the subsequent 72 hours is indicated. Absolute lymphocyte count depletion is associated with negative prognosis.

See the lymphocyte nomogram to the bottom right.

Dosimetry should be conducted on patients following Decontamination.

### Radiation References:

Andrews GA, A. J. (1965). The Importance of Dosimetry to the Medical Management of Persons Exposed to High Levels of Radiation. In I. A. Agency, *Personal Dosimetry for Radiation Accidents*.

REMM. (2019). Managing Internal Contamination. US Department of Health and Human Services. [https://www.remm.nlm.gov/int\\_contamination.htm#blockingagents](https://www.remm.nlm.gov/int_contamination.htm#blockingagents).

Gusev IA, Guskova AK, Mettler FA Jr, editors. *Medical Management of Radiation Accidents*, 2 nd ed. New York : CRC Press, Inc.; 2001.

Jarrett DG. *Medical Management of Radiological Casualties Handbook*, 1 st ed. Bethesda, Maryland : Armed Forces Radiobiology Research Institute (AFRRI); 1999.

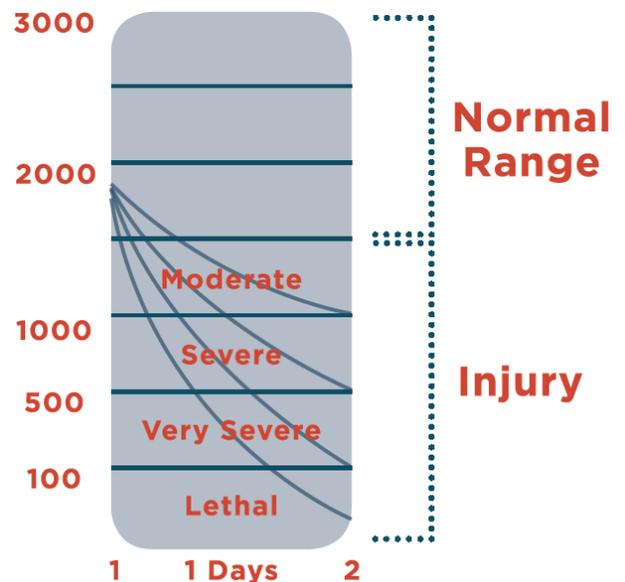
REAC/TS Guidance for Radiation Accident Management. Online reference guide to answer specific questions related to the care and management of patients who have been involved in radiation incidents. <https://orise.orau.gov/resources/reacts/guide/index.html>

### Follow up / Disposition:

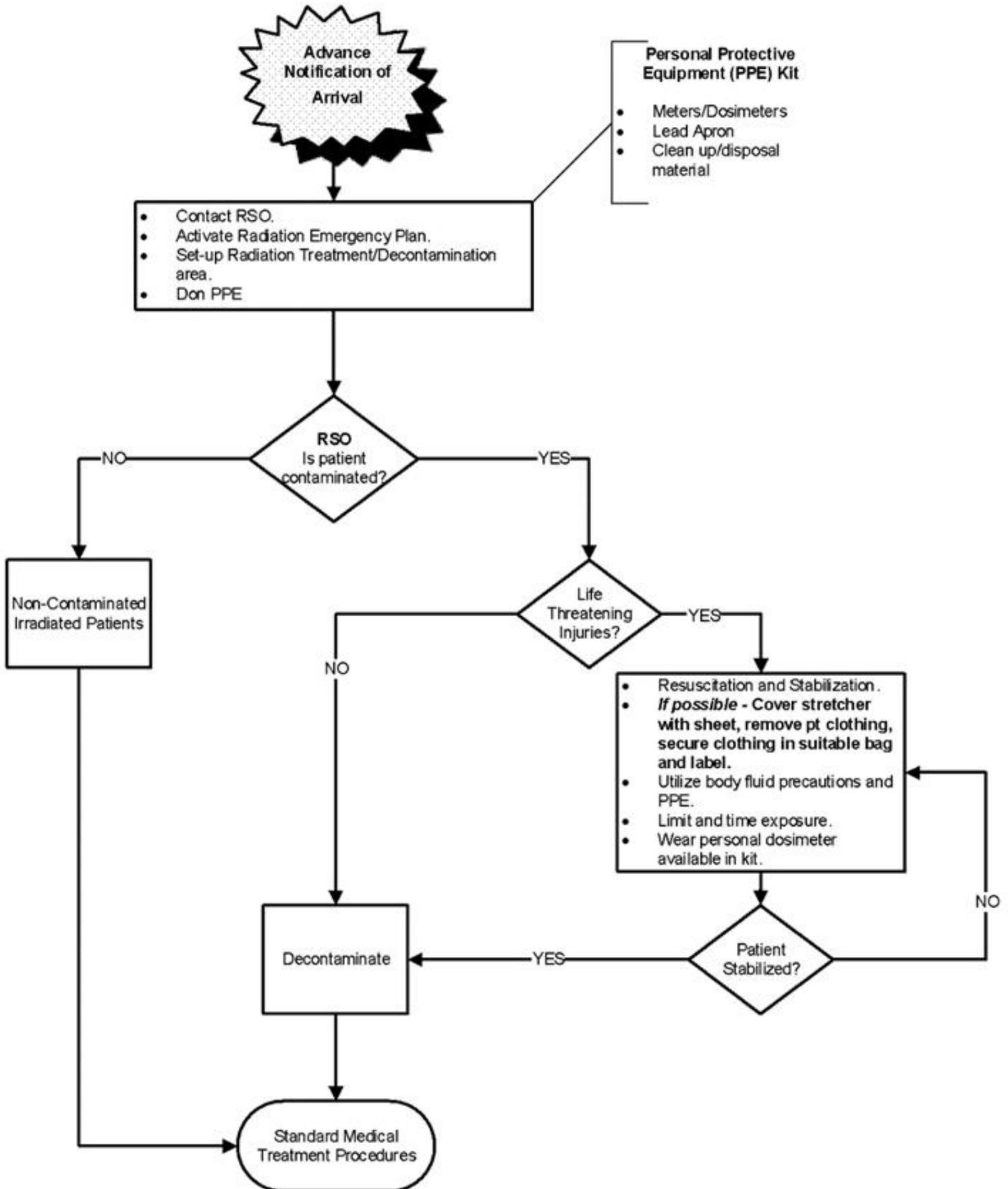
Patients with 0.7 - ~10 GY of exposure are at risk for Bone Marrow failure. If their ALC drops below 1.5 within 24h, admission for supportive care is recommended.

Patients with GI symptoms, suggestive of exposure > 6 GY will need admission.

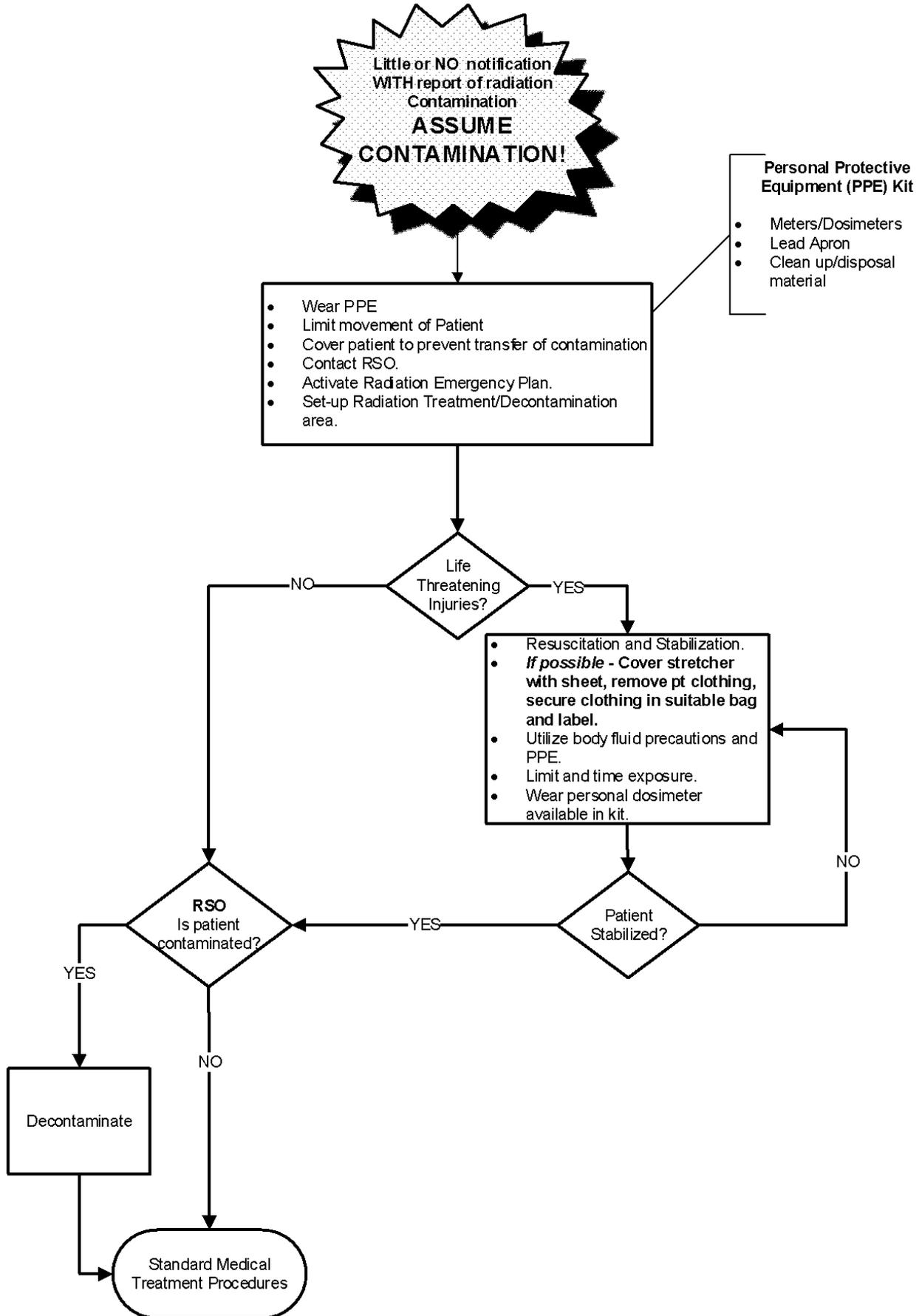
Patients with neurological symptoms, Suggestive of exposure > 10 GY, will likely need palliation. In a mass casualty event, consider these patients as expectant.



## DIRTY BOMB, RADIATION EXPOSURE/CONTAMINATION



## DIRTY BOMB, RADIATION EXPOSURE/CONTAMINATION



## GASOLINE, DIESEL FUEL, KEROSENE, & HYDROCARBONS

### What is it?

Hydrocarbon fuels are clear to light yellow fluids with an aromatic smell. They have variable viscosity but trend towards low viscosity and low surface tension. They are highly flammable and their vapors can be explosive. Their primary toxicity relates to the fact that they are non-polar solvents: they dissolve fats (ie: skin, cell membranes, and blood-brain-barrier). They are also frequently loaded with heavy metals (ie: lead).

### PPE NEEDED:

LEVEL D PPE: Adequate ventilation is necessary when decontaminating patients with hydrocarbon gross contamination to avoid off-gassing of volatile compounds. Note that rubber gloves are indicated, as nitrile and latex gloves can be dissolved by hydrocarbons.

### Common Sources:

Motor vehicles  
Fuel trucks  
Petrol stations

### CAS / Chemical Information:

Multiple chemicals.



### Presenting Symptoms:

- Aspiration, cough
- Skin irritation
- Nausea and Vomiting
- Altered level of consciousness

### Decontamination Suggestions:

Patients with gross contamination should have their clothing removed and wash with soap/detergent and water for a minimum of 5 minutes.

### Emergency Treatment / Antidotes:

There is no specific antidote.

Primary concern following decontamination should be to ascertain if any hydrocarbon has been aspirated or ingested.

Aspiration of hydrocarbons can lead to a pneumonitis. Patients with pneumonitis will require supportive therapy, possible positive pressure ventilation.

Symptoms of ingestion of hydrocarbons is generally limited to GI upset. However, in cases of ingestion of CAMPHOR, HALOGENATED hydrocarbons, AROMATIC hydrocarbons, Heavy-METAL containing hydrocarbons, and PESTICIDE containing hydrocarbons should prompt a call to the poison control center to discuss decontamination methods.

**ATLANTIC CANADA POISON CENTER - 1-800-565-8161**

## **GASOLINE, DIESEL FUEL, KEROSENE, & HYDROCARBONS**

### **Workup and Special Tests:**

No specific tests are required.

For patients with a history of aspiration, Chest radiography is indicated, and these patients should be observed for 12 hours to ensure no pneumonitis occurs.

### **Follow up / Disposition:**

Once symptom free, no follow up is required.

If patients have history of aspiration, they should be monitored for 12 hours and, if symptom free at that time, may be discharged.

### **Substance References:**

Tormoehlen LM, Tekulve KJ, Nañagas KA. Hydrocarbon toxicity: A review. Clin Toxicol (Phila). 2014 Jun. 52 (5):479-89.

Arena JM. Hydrocarbon poisoning--current management. Pediatr Ann. 1987 Nov. 16(11):879-83.

Lee DC. Hydrocarbons. Emergency Medicine, Concepts and Clinical Practice. 1998. 4th ed: 1362-6.

Shis RD. Hydrocarbons. Goldfrank's Toxicologic Emergencies. 1998. 6th ed: 1383-95.

## CHOLINERGICS – ORGANOPHOSPHATES AND CARBAMATES

### What is it?

Cholinergic substances, such as organophosphate pesticides and military gases such as Sarin, Soman, Tabun, Soman, and VX, are easily absorbed as gas via the respiratory tract and through skin and mucous membranes as liquid or aerosols.

### PPE NEEDED:

LEVEL C PPE: Required for all providers decontaminating patients exposed to aerosolized or liquid cholinergic substances.

LEVEL D PPE: For patients exposed only to gas.

### Common Sources:

- Commercial Pesticides
- Pesticide manufacturing
- Farm storage
- Military
- Terrorism

### Presenting Symptoms:

The presenting symptoms of the cholinergic toxidrome is dependent on the nicotinic and muscarinic properties of the particular agent. Muscarinic symptoms can be remembered by the acronym DUMBELS, while nicotinic symptoms can be remembered by the acronym MTWHF.

MTWHF	DUMB <sub>3</sub> ELS <sub>2</sub>
- Mydriasis	- Diarrhea
- Tachycardia	- Urination
- Weakness	- <b>Miosis</b>
- Hypertension	- Bradycardia
- Fasciculations	- Bronchoconstriction
	- Emesis
	- Lacrimation
	- Lethargy
	- Salivation, Seizure

*An MCI with multiple patients presenting with miosis and any of the above symptoms should be concerning for possible Organophosphate toxicity.*

### Emergency Treatment / Antidotes:

ANTIDOTES ARE AVAILABLE. Additional antidote supply can be obtained from Antidote Kits in other emergency departments in the province. If you have confirmed organophosphate toxicity in your ED, you may need to mobilize your local supplies of atropine from your perioperative/anesthesia colleagues. Reach out early and contact the ATLANTIC CANADA POISON CENTER- **1-800-565-8161**.

### CAS / Chemical Information:

C<sub>4</sub>H<sub>10</sub>FO<sub>2</sub>P (Sarin) -- # 107-44-8

C<sub>11</sub>H<sub>26</sub>NO<sub>2</sub>PS (VX) -- # 50782-69-9

OP(OR<sub>3</sub>) (OP group) – 56-38-2 (Parathion)



### Decontamination Suggestions:

Patients exposed to liquid pesticide or liquid formulations of Sarin/Tabun/VX should have their clothing cut away, and be thoroughly washed with soap + warm water for at least 5 minutes.

People exposed to vapor organo-phosphates should be decontaminated as above, as the aerosol can remain on skin and clothing.

## **CHOLINERGICS – ORGANOPHOSPHATES AND CARBAMATES**

### **Emergency Treatment / Antidotes (continued):**

#### **ATROPINE**

- 1 - 2 mg IV initially. If no response, the dose is doubled every 5 - 10 minutes until tracheobronchial secretions are dry and patient can be oxygenated.
- Administration by infusion in severe cases may be considered. Initial infusion rates of 0.02 - 0.08 mg/kg/hour have been recommended (up to 2.4 mg/kg/hour has been required).
- Consult with Atlantic Canada Poison Center for assistance with tapering dose once patient has been stabilized.

#### Atropine administration:

IV Direct: Administer undiluted over 15 - 30 seconds. Cardiac monitoring is required.

Infusion: Add 20 mg (34 mL of a 0.6 mg/mL solution) to 66 mL (remove 34 mL from 100 mL minibag) of sodium chloride 0.9% or dextrose 5% in water to provide a final concentration of 0.2 mg/mL. Cardiac monitoring and an infusion device are required

#### **PRALIDOXIME (2-PAM):**

*Use in conjunction with Atropine- never as a sole agent.*

Initial Dose: 1 - 2 g IV over 30 minutes followed by:

Infusion: 8 - 10 mg/kg/hour (maximum rate 650 mg/hour). Duration of treatment depends on symptoms and the chemical in question – consult with ACPC (1-800-565-8161)

To administer: For initial dose, reconstitute 1 g vial with 20 mL sterile water for injection to provide a concentration of 50 mg/mL.

For following infusions, dilute 1 g in 50 mL or 2 g in 100 mL sodium chloride 0.9% and administer over 15 - 30 minutes.

#### **Workup and Special Tests:**

No specific special testing must be done for immediate treatment.

If possible, a *plasma pseudocholinesterase* and RBC acetylcholinesterase levels can be drawn prior to treatment and subsequently during a patient's course in hospital to measure response to treatment. But this will not alter outcome and should not delay clinical diagnosis and treatment.

#### **Follow up / Disposition:**

Once a patient is no longer requiring Atropine or Pralidoxime, and have been observed for 6 hours without SLUDGE symptoms they may be discharged.

Warn patients that 24-96 hours after exposure, and intermediate syndrome of weakness and extrapyramidal symptoms can occur and should prompt return to ED.

#### **Substance References:**

CDC. (2011) Sarin (GB) : Nerve Agent. National Institute of Occupational health and safety. [https://www.cdc.gov/niosh/ersbdb/emergencyresponsecard\\_29750001.html](https://www.cdc.gov/niosh/ersbdb/emergencyresponsecard_29750001.html). Accessed on 2020/1/29.

IWK Regional Poison Centre. (2020, 01 16). *Antidote Kit - Adult*. Retrieved from <https://iwkpoisoncentre.ca/manual.html>

Volans, AP. (1996). Sarin: guidelines on the management of victims of a nerve gas attack. *Journal of Accident and Emergency Medicine*. 13: 202-206.

Sarkar S, Madhumita N, et. al. (2014). Organophosphorus-induced extrapyramidal intermediate syndrome in an adolescent suicide attempt survivor. *J Neurosci Rural Pract*. 2014 Jul-Sep; 5(3): 276–278.

Moretto A. (1998). Experimental and clinical toxicology of anticholinesterase agents. *Toxicol Lett*. 102-103:509-13.

## Hydrofluoric Acid and Fluorosilicates

### What is it?

A colorless, odorless liquid which can vaporize at room temperature (19.5°C). While it is, chemically, a weak acid- clinically it is very corrosive, and can cause significant liquefactive chemical burns to skin and eyes. Systemically, the fluoride ions bind rapidly to calcium and can cause severe systemic hypocalcemia, which can cause lethal arrhythmias.

### PPE NEEDED:

LEVEL D PPE: HF exposures managed in the ED are usually skin exposure by the patient to liquid HF. For any residual HF on the patients skin or clothing, basic decontamination (removal of contaminated clothing, and rinsing/showering skin contamination) is adequate.

### Common Sources:

Glass manufacturing and etching  
Aluminum Mining and lead refining  
Oil refining processes  
Porcelain manufacturing

### CAS / Chemical Information:

HF / F<sub>6</sub>H<sub>2</sub>Si  
CAS # - 7664-39-3 / 16961-83-4



### Presenting Symptoms:

- Skin burns
- Ocular injury
- Symptoms of hypocalcemia
  - Tetany, muscle spasm
  - Paresthesia
  - Seizures
  - Hypotension
  - QT prolongations
  - Arrhythmias

### Decontamination Suggestions:

All soiled clothing must be removed. Patient should be washed with water for 15-30 minutes. All skin blisters must be broken, as they can harbor more HF.

### Emergency Treatment / Antidotes:

The antidote to HF acid is CALCIUM.

Surface burns should be treated with:

- (1) Local subcutaneous Calcium Gluconate (10%, 0.5mL/cm<sup>2</sup> of burn)
- (2) Topical Calcium gel (20 mL of 10% calcium gluconate injection with 56 g of K-Y Jelly or Muko lubricating jelly.)
- (3) Intravenous infusion - Infuse 1 g (10 mL of 10% calcium gluconate injection) diluted with 40 mL sodium chloride 0.9% IV in affected limb using a Bier block technique.
  - Maintain ischemia for 20 - 25 minutes; release cuff sequentially over 3 - 5 minutes.
- (4) Intra-arterial Infusion - This is for severe burns or failure of regional IV infusion. Experienced physician to place intra-arterial catheter in appropriate vascular supply close to site of dermal exposure (e.g., Radial, ulnar, or brachial artery).
  - Infuse 1 g (10 mL of 10% calcium gluconate injection) diluted with 40 mL sodium chloride 0.9% over 4 hours.
  - May repeat every 4 hours until pain subsides.

## Hydrofluoric Acid and Fluorosilicates

### Emergency Treatment / Antidotes (continued):

For patients with Inhalational Exposure, provide nebulized calcium gluconate.

- Add 150 mg (1.5 mL of a 10% calcium gluconate injection) to 6 mL of sterile water in nebulizer.
- Adjust oxygen flow to provide sufficient fog (6 - 8 L/minute).

### Workup and Special Tests:

- Send Calcium, magnesium, and phosphorous levels.
- Patients should be placed on cardiovascular monitors.

### Follow up / Disposition:

Patients with normal electrolytes and Adequate analgesia can be discharged after a 6h period of observation.

Long term follow up is as per thermal burns.

### Substance References:

Levine MD & Zane R. (2014). Chapter 64: Chemical Injuries. in Marx, J. A., & Rosen, P. Rosen's emergency medicine: Concepts and clinical practice (8th ed.). Philadelphia, PA: Elsevier/Saunders.

IWK Regional Poison Centre. (2020, 01 16). *Antidote Kit - Adult*. Retrieved from <https://iwkpoisoncentre.ca/manual.html>

Peter, J., Maksan, S. M., Eichler, K., Schmandra, T. C., & Schmitz-Rixen, T. (2012). Hydroflouric acid burn of the hand-A rare emergency. *European Journal of Vascular & Endovascular Surgery*, 44(5), 527.

Han HH, Kwon BY, Jung SN, Moon SH. Importance of initial management and surgical treatment after hydrofluoric acid burn of the finger. *Burns*. 2017 Feb. 43 (1):e1-e6.

Wilkes GJ. Intravenous regional calcium gluconate for hydrofluoric acid burns of the digits. *Emerg Med (Aust)*. 1993. 5:155-8

## Mustards, Dimethyl Sulfate, and Lewisite

### What is it?

Mustard gas, of Sulphur mustard, is a blistering agent used in chemical warfare. It is seen as a vapor, a liquid, or a tarry solid. Certain formulations can be odorless, but a strong smell of garlic, mustard, and/or onions can be noted. It acts as an irritant of skin and mucus membranes- but also can cause long term DNA damage.

### PPE NEEDED:

LEVEL : Mustard vapor may not be filtered by industrial or medical APR/PAPR respirators. SCBA breathing apparatuses are recommended for decontamination. Negative pressure rooms are also advised for decontamination.

*This is unavailable at NSHA hospitals.* The best possible decontamination would be casualty self-washing in an aerated/outdoor location (such as an ambulance bay) with water collection. Staff should spend minimal time, in LEVEL C PPE, near patients who are washing.

### Common Sources:

- Chemical warfare agent

### Presenting Symptoms:

- Often delayed 2-12 hours post exposure
- Skin irritation, blistering
- ocular pain and tearing
- shortness of breath, ARDS
- Abdominal pain, diarrhea, vomiting
- Bone marrow failure, pancytopenia

### Emergency Treatment / Antidotes:

- **There is no antidote for mustard contamination.**
- For patients with mild symptoms onset after 12 hours from exposure, no treatment is necessary. These patients may be sent home and urged to return if symptoms worsen.
- For patients with symptom onset before 12h, they should be monitored for 24 hours and treated according to their condition.
- Severe ocular lesions should be treated with a topical mydriatic (e.g., atropine), topical antibiotics, and petroleum jelly or similar substance applied to the lid edges several times a day.
- Skin burns should be treated as per thermal burns. Blisters DO NOT contain mustard.
- Respiratory injury should be treated with supportive measures. Pseudomembranes can form in the respiratory tract and bronchoscopy may be required following admission.

### CAS / Chemical Information:

Bis(2-chloroethyl) sulfide –  $C_4H_8Cl_2S$   
CAS # - 505-60-2



### Decontamination Suggestions:

Ideally, decontamination should be done within **2 minutes** of exposure. Regardless of time post-exposure, Clothing should be removed, and patients washed with soap and water for at least 5 minutes. Eyes should be washed for 10 minutes.

## Mustards, Dimethyl Sulfate, and Lewisite

### Workup and Special Tests:

- Supportive measures.
- A test for urine thiodiglycol can be sent to specialized laboratories to confirm mustard exposure- but is not required during immediate treatment.

### Follow up / Disposition:

- Long term follow up is recommended.
- Ophthalmology should be consulted as Exposure can lead to permanent blindness.
- If persistent respiratory symptoms Continue, respiratory follow up should be considered for PFTs.
- Follow up with a CBC in 96 hours is recommended to assess for bone marrow suppression. Treatment is supportive.

### Substance References:

Muskat, P. C. (2008). Mass Casualty Chemical Exposure and Implications for Respiratory Failure. *Respiratory Care*, 53(1), 58-63.

Center for Disease Control - Agency for Toxic Substances and Disease Registry. (2020, 01 16). ATSDR – Toxic Substances Portal - Medical Management Guidelines for Blister Agents: Sulfur Mustard Agent H or HD (C<sub>4</sub>H<sub>8</sub>Cl<sub>2</sub>S) Sulfur Mustard Agent HT. Retrieved 2020, from CDC: <https://www.atsdr.cdc.gov/mmg/mmg.asp?id=924&tid=191>

Saladi RN, Smith E, Persaud AN. Mustard: a potential agent of chemical warfare and terrorism. *Clin Exp Dermatol* 2006;31(1):1–5.

Emad A, Rezaian GR. The diversity of the effects of sulfur mustard gas inhalation on respiratory system 10 years after a single heavy exposure: analysis of 197 cases. *Chest* 1997;112(3):734–738.

McManus J, Huebner K. Vesicants. *Crit Care Clin* 2005;21(4):707–718.

## Carbon Monoxide (gas)

### What is it?

Carbon monoxide is a colorless, odorless, non-irritant gas which is, primarily, a product of combustion. It can come from car exhaust, as well as home heating devices. It binds to hemoglobin 200x more strongly than O<sub>2</sub>, and results in cellular hypoxia systemically.

### PPE NEEDED:

LEVEL A or B PPE: First responders *entering an area with high CO concentrations.*

UNIVERSAL PRECAUTIONS: Patients that have been exposed but that there is no active CO leak near the hospital.

### Common Sources:

- Internal combustion engines
- Home heating
- Gas stoves
- Industrial smelting operations

### Presenting Symptoms:

- Headache
- Nausea
- Blurred vision
- Impaired dexterity
- Chest pain, shortness of breath
- Somnolence
- Coma
- Shock

### Emergency Treatment / Antidotes:

The antidote for CO toxicity is high concentrations of oxygen.

This should be provided immediately on suspicion of CO toxicity at 100% by non-rebreather mask.

*Mass numbers of patients who are ambulatory should be seated and provided immediate oxygen.*

The half-life of CO at sea-level 21% oxygen is 320 minutes.

At 1.0 FiO<sub>2</sub>, the half-life decreased to 50-100 minutes (75 minutes +/- 25 minutes)

At 2.8 to 3ATM, hyperbaric treatment with 1.0 FiO<sub>2</sub>, this further decreases to 23-58 minutes, depending on comorbidities.

Hyperbaric treatment has been shown to reduce development of delayed neurological symptoms, and is recommended to be initiated in indicated patients within 22.5 hours, and ideally within 6 hours.

***Always consider Cyanide toxicity if patients are presenting from a structural fire.***

### CAS / Chemical Information:

CO - CAS# 630-08-0



### Decontamination Suggestions:

As CO is a gas, there is no need to decontaminate patients. That said, guidelines do recommend removing clothing and sequestering that clothing to off-gas in an open air environment.

## Carbon Monoxide (gas)

### Workup and Special Tests:

Arterial blood gas to monitor COHb (carboxyhemoglobin) levels is recommended.

That said, the correlation between symptoms and COHb levels is poorly supported by evidence.

Lactate level and troponin assays may be helpful in determining overall perfusion and cardiac injury in patients with known or suspected coronary disease.

### INDICATIONS FOR HYPERBARIC O<sub>2</sub>

- COHb > 25%
- COHb > 15%, pregnant or pediatric
- Altered Mental Status
- Evidence of Myocardial ischemia
- New neurological findings
- Arrhythmia
- Prolonged exposure (CO "soaking")

**CALL 1-902-473-2222 and page the Hyperbaric Physician on-call to discuss all concerning cases.**

### Follow up / Disposition:

Following reduction of COHb levels and Resolution of symptoms, patients may develop delayed Neurological symptoms (DNS) 1-6 weeks after their Initial CO poisoning.

The majority (~75%) of patients with DNS will resolve within 1 year.

Follow up with primary care if patients Experience DNS is indicated, and referral to Neurology is ideal.

### Substance References:

Weaver LK et al. (2000). Carboxyhemoglobin half-life in carbon monoxide-poisoned patients treated with 100% oxygen at atmospheric pressure. *Chest*. 117(3):801-8.

Bleecker ML. (2015). Carbon monoxide intoxication. *Handbook of Clinical Neurology*. 131:191-203.

Hampson NB, Dunn SL et al. Symptoms of carbon monoxide poisoning do not correlate with the initial carboxyhemoglobin level. *Undersea Hyperbaric Medicine*. 39(2): 657-65.

Weaver LK & Deru K. (2017). Carboxyhemoglobin half-life during hyperbaric oxygen in a patient with lung dysfunction: a case report. *Undersea Hyperbaric Medicine*. 44(2):173-177

Liao SC, Mao YC, Yang KJ et al. (2019). Targeting optimal time for hyperbaric oxygen therapy following carbon monoxide poisoning for prevention of delayed neuropsychiatric sequelae: A retrospective study. *Journal of Neurological Science*. 396:187-192.

Nelson, LS & Hoffman, RS. (2014). Chapter 159: Inhaled Toxins. *Rosen's Emergency Medicine - Concepts and Clinical Practice* 8th edition, eds. Marx JA et al.

## METHAMPHETAMINE LABS

### What is it?

The clandestine synthesis of methamphetamines in “labs” can create both an explosive and hazardous material concern for exposed persons. Chemicals that are required to make methamphetamines can include pseudoephedrine, ammonia, freon, hydriodic acid, elemental lithium, red phosphorous, and several other organic alcohols and benzene products.

### PPE NEEDED:

LEVEL C PPE: Recommended to decontaminate the patient.

LEVEL D PPE: Recommended following decontamination.

### Common Sources:

- Clandestine pharmaceutical production.

### CAS / Chemical Information:



### Presenting Symptoms:

The chemicals used to produce methamphetamine can be, toxic if ingested or inhaled. Presenting symptoms often include (1) respiratory distress and chest pain, (2) ocular irritation and lacrimation, (3) dizziness or presyncope, (4) headache, (5) chemical burns, and (6) rash.

Please assess the patient for exposure to AMMONIA (pg 9), FREON (pg 37), HYDROPHOSPHOROUS ACID (pg 15).

If the patient has gastrointestinal symptoms, treat as per (1) *potential* corrosive ingestion, (2) *potential* alcohol Ingestions, and (3) *potential* hydrocarbon ingestion. (pg 25.)

### Decontamination Suggestions:

Patient exposed to chemicals in a “lab” should have their clothing removed and all particulate matter brushed away. Once dust has been brushed off, then wash with tepid water for at least 5 minutes. It is important to remove as much lithium powder as possible prior to wet decon, as lithium will erupt if Exposed to water.

Once decontaminated, universal precautions are indicated for healthcare personnel.

### Emergency Treatment / Antidotes:

Reach out early to the Atlantic Canada Poison Center. **1-800-565-8161.**

There is no antidote for methamphetamine, though sympathomimetic toxidromes can be treated with benzodiazepines.

People exposed within the lab itself should receive standard resuscitation as required. Clinical consideration should include assessment for caustic ingestion, toxic ingestion, respiratory exposure, and ocular or skin burns. People who are adjacent to labs, or have reported only noticing “smells” may not require significant treatment.

## METHAMPHETAMINE LABS

### Emergency Treatment / Antidotes - continued:

If skin shows signs of blistering or burns, gently dress them with non-stick and/or petroleum jelly coated gauze, and loosely wrap.

Ocular exposure with unknown contaminant should be considered at risk for Red Phosphorous, acid, or lithium exposure. In all cases, morgan lens flushing for 20 minutes *minimum* should be initiated, and ophthalmology consulted for any scleral or corneal burns.

Exposure to significant red phosphorous plumes general require the victim to be trapped within a “lab.” Intolerable concentrations are reported at 100mg/m<sup>3</sup>, and lethal concentrations (secondary to pulmonary edema) are roughly 2000mg/m<sup>3</sup> for >15 minutes. This suggests that only victims trapped would allow prolonged exposure. Ocular and reversible respiratory irritation was present from 100-700mg/m<sup>3</sup>. Consider review of phosgene gas exposure management (pg. 15)

### Workup and Special Tests:

For patients with respiratory symptoms, a chest x-ray at 8 hours post exposure is recommended. If this is normal and shows no pulmonary edema, and the patient has no oxygen requirements, they may be discharged.

For patients with ocular burns, ophthalmology consultation is recommended.

For patients with sympathomimetic symptoms, benzodiazepine Treatment and consultation with the Atlantic Canada Poison Center is recommended.

For patients with alcohol or hydrocarbon ingestion, consult the ACPC and review hydrocarbon ingestion (pg. 25).

### Substance References:

Environmental Protection Agency. “Acute Exposure Guidelines – Red Phosphorous – CAS Reg. No. 7723-14-0).

Mitchell, W.R. and Burrows, E.P. 1990. Assessment of red phosphorus in the environment. U.S. Army Medical Research and Development Command, Fort Detrick, Frederick, MD. NTIS/AD-A221704

Uhrmacher, J.C., Werschulz, P.P., Schultz, D.O., Weber, D.O. 1985. Red Phosphorus. A health and environmental effects data base assessment of U.S. Army waste material. Final Report. Pp. 49-1 – 49-9. U.S. Army Medical Research and Development command, Fort Detrick, Frederick, MD. AD-A175274.

U.S. Department of Health and Human Services. 1976. Occupational Guideline for Lithium Hydride. US Department of Labor Occupational safety and health administration, September 1976.

Melnikova, N., Welles, W. L., Wilburn, R. E., Rice, N., Wu, J., & Stanbury, M. (2011). Hazards of illicit methamphetamine production and efforts at reduction: data from the hazardous substances emergency events surveillance system. Public health reports (Washington, D.C. : 1974), 126 Suppl 1(Suppl 1), 116–123. <https://doi.org/10.1177/003335491112605115>

### Follow up / Disposition:

Outpatient Ophthalmology for patients with minor ocular abrasions.

No follow up needed for asymptomatic patients 8 hours post exposure and normal chest radiography.

## **FREON (Gas)**

### **What is it?**

Freon-22, alternatively known as  $\text{CHClF}_2$  or dichlorodifluoromethane, is a more common derivative of the original Freon gas,  $\text{Cl}_2\text{F}_2$ . It is a colorless, odorless gas which is highly volatile and evaporates rapidly at room temperature. It is not a contaminant, and does not require true decontamination.

### **PPE NEEDED:**

LEVEL D PPE

### **Common Sources:**

- Refrigeration Units.
  - Gas propellants.
  - Methamphetamine production.
- Largely being phased out; will not be in use by 2030.

### **CAS / Chemical Information:**

CAS # 75-45-6



### **Presenting Symptoms:**

Patients exposed to Freon leaks may present with acute Skin frost burns, or ocular frost burns. Exposure to Freon Has also been shown to cause palpitations, dizziness, and- In rare cases of enclosed area, high concentration exposure- Ventricular arrhythmias and cardiac death.

Patient suffering from ventricular arrhythmias will present With decreased level of consciousness and, often, preceding Hypoxia from  $\text{CHClF}_2$  simple asphyxiation.

### **Decontamination Suggestions:**

As Freon is a non-contaminating gas, there is no decontamination required.

If a patient has liquid freon on them, clothing should be removed to reduce frost burn and stop off gassing within the receiving facility.

### **Emergency Treatment / Antidotes:**

Reach out early to the Atlantic Canada Poison Center. **1-800-565-8161.**

There is no antidote to Freon exposure. Hypoxia should be treated with high flow oxygen, and arrhythmias treated as per ACLS. Frost bite and frost burns should be treated with dressings and appropriate referral to plastic/reconstructive surgery and/or burn center.

Be highly cautious with using beta-adrenergic medications during the 24h post exposure (salbutamol, epinephrine, norepinephrine etc.) as fluorocarbons may predispose the cardiac myocytes to arrhythmias, as in "Sudden sniffing death" syndrome.

## **FREON - Gas**

### **Workup and Special Tests:**

Electrocardiogram and serum electrolyte testing is recommended for patients with palpitations.

### **Follow up / Disposition:**

Patients with documented ventricular Arrhythmias should be consulted to the cardiology service.

If cardiology consultation is not available, patients with documented ventricular arrhythmias should be monitored for 12h post exposure to ensure resolution.

Avoid catecholamine medication or drugs of abuse for 24h post exposure to Freon.

### **Substance References:**

Sabik, Laila M E et al. "Cardiotoxicity of Freon among refrigeration services workers: comparative cross-sectional study." Environmental health : a global access science source vol. 8 31. 13 Jul. 2009, doi:10.1186/1476-069X-8-31

DuPont. 2012. Material Safety Data Sheet - DuPont™ Chlorodifluoromethane.  
<http://www.dupont.com/content/dam/assets/corporate-functions/our-approach/sustainability/commitments/product-stewardship-regulator/articles/product-stewardship/documents/Chlorodifluoromethane%20R22%20Product%20Safety%20Summary.pdf>

Dal Grande M, Zanderigo C, Coato F, Menegolli S, Cipriani E, Pancheri V, Malesani F, Perbellini L. Morte improvvisa da freon 22? [Sudden death caused by freon 22?]. Med Lav. 1992 Jul-Aug;83(4):361-4. Italian. PMID: 1461194.

Tormoehlen LM, Tekulve KJ, Nañagas KA. Hydrocarbon toxicity: A review. Clin Toxicol (Phila). 2014 Jun;52(5):479-89. doi: 10.3109/15563650.2014.923904. PMID: 24911841.

## UNKOWN AGENT – UNWELL PATIENT

### What is it?

When faced with an unknown chemical exposure that is causing clear illness in a patient, it is recommended to treat *as if* the agent is the most potentially dangerous, so as to avoid exposure to healthcare professionals and provide the most thorough decontamination to the patient.

### PPE NEEDED:

LEVEL C PPE: Recommended to decontaminate the patient.

LEVEL D PPE: Recommended following decontamination.

### Common Sources:

- Not applicable.

### CAS / Chemical Information:



### Presenting Symptoms:

Patient presenting with altered level of consciousness, cardiovascular instability, seizures, significant gastro-intestinal symptoms AND a chemical exposure should be considered significantly ill due to contamination.

### Decontamination Suggestions:

Patients exposed to unknown agents causing significant illness should have their clothing cut away, and be thoroughly washed with soap + warm water for at least 5 minutes.

If the chemical is thick, tarry, or oil based, mineral oil or petroleum jelly can be used to loosen the oil based chemical prior to using soap and water.

Use copious volumes of warm, but not steam producing water.

### Emergency Treatment / Antidotes:

Reach out early to the Atlantic Canada Poison Center. **1-800-565-8161**.

Advise them that the contaminant is unknown- but advise them of symptoms.

WISER-CHEMM (app and website: <https://chemm.nlm.nih.gov/chemmist.htm>) can also be helpful in trying to identify a chemical based on its properties and patient symptoms.

Treatment should focus on hemodynamic stability and supportive care. Treatment of seizures with benzodiazepines- as opposed to specialized antiepileptic drugs or sodium-channel blockers- is advised. Treat cardiovascular instability and arrhythmias as per ACLS protocols.

## **UNKNOWN AGENT – UNWELL PATIENT**

### **Emergency Treatment / Antidotes - continued:**

If skin shows signs of blistering or burns, gently dress them with non-stick and/or petroleum jelly coated gauze, and loosely wrap.

Ocular exposure with unknown contaminant should be treated with copious irrigation via Morgan lens for at least 2L of RL per eye, and until pH is neutral (between 7 and 8).

If the patient is coming from a nuclear work site, or terrorism is suspected, consider using a geiger counter and refer to page 21 (DIRTY BOMB, RADIATION EXPOSURE/CONTAMINATION).

### **Workup and Special Tests:**

None.

### **Follow up / Disposition:**

As per standard of care.

### **Substance References:**

n/a