

FOREWORD:

INFANT AND YOUNG CHILD FEEDING IN THE CONTEXT OF A CHEMICAL ATTACK

This guidance note is a document developed by the IFE Core Group Sub-Working Group on Infant and Young Child Feeding in Emergencies (IYCF-E) in the context of chemical agent threats. There is limited information in the literature about the impact of chemical agents on breastfeeding. In situations of a chemical attack, often medical measures must be administered rapidly, and patients may not be conscious. Therefore, medical professionals may not be aware of the breastfeeding status of a patient. The following guidance note serves to outline key facts on IYCF in the context of a chemical attack including management and treatment, and recommendations for breastfeeding and infant feeding. We will outline the latest information available on the safety of the treatments used for each agent and current literature on whether the chemical agent in question can be excreted in breast milk.

The guidance note is intended for policymakers and for people who will provide guidance for health facilities and healthcare workers in the case of a chemical attack. There are a wide variety of possible agents that can be used in a chemical attack and therefore this guidance note will prioritize those most likely to be used, describing how IYCF could be impacted. Chemical agents that are most likely to be used in warfare or a terrorist attack could come in the following forms: nerve agents, pulmonary/choking agents, blood/systemic agents, and blistering agents.¹ Within each category, there is a different mechanism of action, different medical management and fatality rates, and therefore different impact on IYCF.

This guidance note is considered a living document. Currently, the guidance presented is based on the most recent research and evidence. As more information and research become available regarding the treatment of breastfeeding women who are exposed to chemical agents, we will continue to update as needed. **For more information, please contact ife@enonline.net**

The guidance note is part of a larger body of work called Chemical, Biological, Radiological and Nuclear (CBRN) Threats In War Time Situations: The Impact on Breastfeeding Safety and Infant/Young Child Feeding Practices. It can be accessed at: <https://www.enonline.net/cbrn-iycfe>

The development and writing of the chemical guidance was led by Sharon Leslie, co-written by Mija Ververs and Jodine Chase with support from the members of the IFE Core Group Sub-Working Group on IYCF-E in the context of CBRN threats.

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¹ Madsen, JM. UpToDate 2020. Chemical terrorism: Rapid recognition and initial medical management. [Accessed 24th of May 2022]. Available from: <https://www.uptodate.com/contents/chemical-terrorism-rapid-recognition-and-initial-medical-management>.

GUIDANCE NOTE:

INFANT AND YOUNG CHILD FEEDING IN THE CONTEXT OF A CHEMICAL ATTACK



This guidance note is a document developed by the IFE Core Group Sub-working Group on Infant and Young Child Feeding in Emergencies (IYCF-E) in the context of chemical, biological, radiological and nuclear threats. Its purpose is to outline key facts on IYCF in the context of a biological weapon emergency to inform emergency plans and responses. The guidance note is intended for policymakers and for people who will provide guidance for health facilities in the case of a chemical agent attack. **There are a wide variety of possible agents that can be used in a chemical attack and therefore this guidance note will prioritise those most likely to be used, describing how IYCF could be impacted. For more information, please contact ife@enonline.net.**

What are the most likely forms of chemical attack?

The chemical agents that are most likely to be used in warfare or a terrorist attack could come in the following forms: nerve agents, pulmonary/choking agents, blood/systemic agents, and blistering agents.¹ Within each category, there is a different mechanism of action, different medical management and fatality rates, and therefore a different impact on IYCF.

Table 1: Category of Chemical Agents

Category of Chemical Agents	Examples
Nerve agents – Cause toxic effects by disrupting the transmission of nerve impulses in the brain, skeletal muscles, smooth muscles, and exocrine glands (glands with ducts)	Sarin, tabun, VX
Pulmonary/choking agents – Damage the large airways, small airways and air sacs, or both, leading to breathing problems	Chlorine
Blood/systemic agents – Prevent the normal use of oxygen by the body tissues	Hydrogen cyanide
Blister agents – Cause local damage (damage on contact) to eyes, skin, lungs, and damage to other tissues through distribution via the bloodstream	Sulfur mustard, lewisite

Agents that could be used as mass-casualty weapons include military chemical warfare agents and toxic industrial chemicals; some chemicals are dual use in that they have been used in both war and in industry. The most important things to know about any such agent are:

1. The actual **agent** or agents used
2. The **states or forms** (e.g., solid, liquid, vapour, gas, aerosol or combinations) of the chemical in the environment
3. The **routes of exposure** (how the chemical contacts and enters the body, e.g., via inhalation, the skin, the eyes, ingestion or wounds)
4. The **dose** (the amount that contacts the body – the *exposed* dose – and the amount that crosses a protective lining of cells to get truly inside the body – the *absorbed* dose)
5. The **duration** of exposure (which contributes both to the exposed dose and the absorbed doses)

What information do we have on breastfeeding safety following a chemical attack?

This document will outline the agents most likely to be used in a chemical attack and the characteristics, management, and treatment associated with each agent.

Breastfeeding provides infants with hydration, comfort, connection, and high-quality nutrition. It protects them against disease and provides food security. This protection and security are critical during emergencies when there is often a lack of access to clean water, electricity, food supplies, and health care. Breastfeeding also has important consequences for maternal health and caregiving capacity. It is critically important to provide caregivers with clear and accurate information, reassurance, and guidance to protect, promote, and support appropriate IYCF in the event of a chemical attack and to ensure that women do not stop breastfeeding unnecessarily.

There is limited information in the literature about the impact of chemical agents on breastfeeding. In situations of a chemical attack, often medical measures must be administered rapidly and patients may not be conscious. Therefore, medical professionals may not be aware of the breastfeeding status of a patient. We will outline the latest information available on the safety of the treatments used for each agent and the current literature on whether the chemical agent in question can be excreted in breast milk. Given the lack of data on the subject, decisions about whether to continue to breastfeed following a chemical attack should be made on a case-by-case basis.

A note on food safety for breastfeeding mothers or young children in case of a chemical attack: There is a chance of contamination of food and water for many of the chemical agents listed below. It is recommended not to use unpackaged or packaged food until deemed safe by local authorities. There is a possibility of a residue of agents on packaged food and therefore touching the surfaces of packaging can create a hazard. This applies to all materials including tinfoil, glass, cans, and hard plastic alike.

Table 2 serves as a summary of the information contained in this guidance note. A detailed explanation of key facts, symptoms, management, medical treatment and breastfeeding safety is included under each specific agent.

Table 2: Summary of breastfeeding safety and treatment by agent. Note: If there are clear guidelines on when breastfeeding can be resumed, the guidance states, “temporarily interrupt” and will give recommendations regarding when it is safe to resume. If there are no evidence-based guidelines on when to resume, the guidance uses the word “halt”.

Agent	Treatment for breastfeeding women	Treatment for infants and children	Is breastfeeding safe after exposure?	Is breastfeeding safe during treatment?
Chlorine gas	Decontamination, supportive care, and treatment of pulmonary injury. Treatment: Albuterol, Sodium bicarbonate, prednisone, prednisolone.	Decontamination, supportive care, and treatment of pulmonary injury. Treatment: Nebulized sodium bicarbonate, inhalation of albuterol via metered-dose aerosol.	Yes. Breastfeeding can continue if the mother is physically able to do so.	Yes. Breastfeeding can continue if the mother is physically able to do so. Albuterol and sodium bicarbonate are considered safe for breastfeeding women. Prednisone and prednisolone are considered safe with breastfeeding.
Hydrogen cyanide	Decontamination, supportive care. Antidotes: IV hydroxocobalamin, Nithiodote (sodium nitrite with sodium thiosulfate; amyl nitrite).	Decontamination, supportive care. Antidotes: IV hydroxocobalamin, Nithiodote (sodium nitrite with sodium thiosulfate) (not for infants under 6 months of age). Dosing available for paediatric population.	No. Temporarily interrupt for 15 days post exposure.	No. Temporarily interrupt for 15 days post exposure. If a breastfeeding mother is treated with Nithiodote (sodium nitrite with sodium thiosulfate), breastfeeding should be temporarily interrupted. IV hydroxocobalamin (Vitamin B ₁₂) is considered safe for breastfeeding women.
Lewisite	Decontamination, supportive care. Antidote: Intramuscular injection of British Anti-Lewisite (BAL or dimercaprol). Due to its significant side effects, it is recommended only for people who have signs of shock or significant pulmonary injury. Contraindicated in anyone with a peanut allergy.	Decontamination, supportive care. Antidote: Intramuscular injection of British Anti-Lewisite (BAL or dimercaprol). Due to its significant side effects, it is recommended only for people who have signs of shock or significant pulmonary injury. Dosing available for the paediatric population but not for the infant population.	No. Breastfeeding should be temporarily interrupted. Arsenic can be excreted into milk and can be toxic to a nursing infant. Can resume after 15 days if the mother is physically able.	No. Can resume after 15 days if the mother is physically able to do so with or without treatment. (See full recommendation for Lewisite for information on half-life of both Lewisite and BAL). BAL is considered contraindicated by some sources for breastfeeding women given its possible excretion into breast milk.

Table 2 continued...

Sarin	<p>Decontamination, supportive care.</p> <p>Antidote: Atropine and pralidoxime chloride (2-PAM).</p> <p>Diazepam or Midazolam – when there is evidence of seizures.</p> <p>See Appendix 2 for dosage recommendations for nerve agents.</p>	<p>Decontamination, supportive care.</p> <p>Antidote: Atropine and pralidoxime chloride (2-PAM) if over 1 year of age, only atropine if under 1 year of age.</p> <p>Diazepam – when there is evidence of seizures.</p> <p>See Appendix 2 for dosage recommendations for nerve agents.</p>	<p>No. Breastfeeding should be halted.</p> <p>In the absence of knowledge and data, if a safe breastmilk substitute (BMS) alternative is available, halt breastfeeding.</p>	<p>No. Breastfeeding should be halted.</p> <p>In the absence of knowledge and data, if a safe BMS alternative is available, halt breastfeeding.</p>
Sulfur Mustard	<p>Decontamination, supportive care.</p> <p>Pain medication for eye pain, blisters, and skin burns. Oral antihistamines for skin itching and irritation.</p>	<p>Decontamination, supportive care.</p> <p>Pain medication and oral antihistamines.</p>	<p>No. Breastfeeding should be halted.</p> <p>Halt breastfeeding due to high fat solubility of sulfur mustard.</p>	<p>No. Breastfeeding should be halted.</p> <p>Halt breastfeeding due to high fat solubility of sulfur mustard.</p>
Tabun	<p>Decontamination, supportive care.</p> <p>Antidote: Atropine and pralidoxime chloride (2-PAM).</p> <p>Diazepam – when there is evidence of seizures.</p> <p>See Appendix 2 for dosage recommendations for nerve agents.</p>	<p>Decontamination, supportive care.</p> <p>Antidote: Atropine and pralidoxime chloride (2-PAM) if over 1 year of age, only atropine if under 1 year of age.</p> <p>Diazepam – when there is evidence of seizures.</p> <p>See Appendix 2 for dosage recommendations for nerve agents.</p>	<p>No. Breastfeeding should be halted.</p> <p>In the absence of knowledge and data, if a safe BMS alternative is available, halt breastfeeding.</p>	<p>No. Breastfeeding should be halted.</p> <p>In the absence of knowledge and data, if a safe BMS alternative is available, halt breastfeeding.</p>
VX	<p>Decontamination, supportive care.</p> <p>Antidote: Atropine and pralidoxime chloride (2-PAM).</p> <p>Diazepam – when there is evidence of seizures .</p> <p>See Appendix 2 for dosage recommendations for nerve agents.</p>	<p>Decontamination, supportive care.</p> <p>Antidote: Atropine and pralidoxime chloride (2-PAM) if over 1 year of age, only atropine if under 1 year of age.</p> <p>Diazepam-when there is evidence of seizures.</p> <p>See Appendix 2 for dosage recommendations for nerve agents.</p>	<p>No. Breastfeeding should be halted.</p> <p>In the absence of knowledge and data, if a safe BMS alternative is available, halt breastfeeding.</p>	<p>No. Breastfeeding should be halted.</p> <p>In the absence of knowledge and data, if a safe BMS alternative is available, halt breastfeeding.</p>

Nerve Agents

There are three common nerve agents that are discussed here in detail: sarin, tabun and VX. **Please refer to Appendix 1 for detailed information on how nerve agents impact the body.**

SARIN

Key facts

- Sarin (GB)ⁱ is a colourless, tasteless nerve agent that often has a faint fruity odour.¹ It is one of the so-called G-series agents, or G agents, that were developed by Germany before and during World War II.
- All G agents are volatile, meaning that they can quickly and easily evaporate from a liquid to a vapour that can spread rapidly through the air. Sarin is the most volatile of the G agents; it evaporates at almost the exact rate as water.²
- Sarin vapour is heavier than air so it will usually sink to lower ground or low-lying areas.²
- People can be exposed by breathing air that contains sarin or through skin or eye contact.² Sarin mixes easily with water and therefore people can be exposed by touching or drinking water that contains sarin.²
- Although exposure can also happen by eating food contaminated with sarin, ingestion is an uncommon route of exposure.
- A person's clothing can harbour sarin vapour and therefore can lead to exposure of others by releasing the sarin vapour.³
- Sarin has low persistence in the environment meaning, in vapour form, it will last minutes to hours and in liquid form, 2 to 24 hours. The level of persistence will depend on the amount of agent released, the method of release, the environment conditions, and the types of surfaces impacted.³

Symptoms

- Symptoms can appear within a few seconds of a high-dose exposure to sarin vapour and within minutes of a high dose of the liquid form. Fatal liquid exposures to the skin usually create symptoms within half an hour or less.³
- Exposure to a large dose of sarin by any route may cause loss of consciousness, convulsions, paralysis, respiratory failure, and death.⁴
- People exposed to a low or moderate dose of either sarin vapour or liquid sarin may experience the following symptoms within seconds to hours: runny nose, watery eyes, excessive sweating, chest tightness, rapid breathing, diarrhoea, nausea, vomiting, confusion, weakness, headache, slow or fast heart rate, and low or high blood pressure.⁴
- There is ample evidence showing that some individuals exhibit long-term effects from even mild to moderate sarin exposure. These effects include visual effects, changes to the central nervous system, and impairments of learning, memory, and intelligence and concentration.⁵
- Severely exposed people are less likely to survive.³
- Although sarin is metabolised and excreted relatively quickly from the body, it is so toxic that it can cause death before metabolism and elimination can occur.^{3,4}

TABUN

Key facts

- Tabun (GA)ⁱ is a colourless and tasteless liquid with a slightly fruity odour.¹ The liquid slowly evaporates to form a vapour.⁶
- Tabun vapour is heavier than air and so will sink to low-lying areas.
- People can be exposed to tabun primarily through skin contact, eye contact, or inhalation.⁷
- In a trauma situation, any nerve agent can also enter the body through wounds.
- Water and food supply can also be contaminated with tabun.

ⁱ In addition to their chemical names, some chemical agents have a 1-3 letter North Atlantic Treaty Organization (NATO) code.

- A person's clothing can harbour tabun after contact with vapour and lead to exposure of other people through "off-gassing".⁷
- Tabun evaporates more slowly than sarin does but is still considered a volatile and non-persistent agent and therefore a relative short-term threat.⁷
- Tabun breaks down slowly in the body so repeated exposures can have cumulative effects.⁷

Symptoms

- Symptoms can appear within a few seconds after exposure to tabun vapour and within a few minutes to hours after exposure to liquid tabun.¹
- Exposure to a large dose of tabun by any route may cause loss of consciousness, convulsions, paralysis, respiratory failure, and death.⁷
- The clinical presentation of tabun is essentially the same as that of sarin; people exposed to a low or moderate dose of either tabun vapour or tabun liquid may experience the following symptoms within seconds to hours: runny nose, watery eyes, excessive sweating, chest tightness, rapid breathing, diarrhoea, nausea, vomiting, confusion, weakness, headache, slow or fast heart rate, and low or high blood pressure.^{6,7}
- As with sarin, there are differences in the onset of symptoms depending upon the state of the agent (liquid vs. vapour) and the routes of exposure.

VX

Key facts

- VX is among the most potent of nerve agents.⁸
- It is an odourless, tasteless liquid that is amber in colour and has very low volatility, meaning that it is quite slow to evaporate.¹
- VX is primarily a liquid exposure hazard but, if it is heated to high temperatures, it can turn to vapour.⁸
- VX vapour is heavier than air so will sink to low-lying areas.
- Once VX is released into the air, people can be exposed through skin contact, eye contact, or inhalation of VX vapour or aerosol.⁸
- VX can pose a risk of food or water contamination.
- VX breaks down slowly in the body so repeated exposures can have cumulative effects.⁸
- Compared to sarin, VX is much more toxic, especially through skin contact.⁸ Any visible VX liquid contact on the skin would be lethal if not washed off immediately.
- VX is persistent in the environment, capable of lasting for days on objects under average weather conditions and for months under very cold conditions.⁸ Because of this slow evaporation, it is considered both a long-term and short-term threat due to its potential contamination of surfaces.⁸

Symptoms

- Symptoms can appear within a few seconds if exposed to the vapour form and within a few minutes to 18 hours if exposed to the liquid form.⁸
- Exposure to a large dose of VX by any route may cause loss of consciousness, convulsions, paralysis, and respiratory failure possibly leading to death.⁸
- People exposed to a low or moderate dose of VX by any of the above methods may experience the following symptoms within seconds to hours: runny nose, watery eyes, excessive sweating, chest tightness, rapid breathing, diarrhoea, nausea, vomiting, confusion, weakness, headache, slow or fast heart rate, and low or high blood pressure.⁸

Management of nerve agent exposure

- Treatment consists of removing the agent from the body as soon as possible and providing supportive care in a medical setting.
- If people think they have been exposed, they should leave the area where the agents were released and get to fresh air. Since all three nerve agents are heavier than air, people should go to the highest ground possible.
- If a nerve agent was released indoors, people should be advised to quickly get out of the building.³
- If people think they have been exposed, they should remove their clothing and any clothing that must be pulled over the head should be cut off the body instead of being pulled over the head.^{3,7,8} People should seal clothing in a plastic bag and then seal that bag in a second plastic bag.^{3,7,8} Local or state health departments or emergency personnel should be informed upon their arrival that there is contaminated clothing and no one should handle the plastic bags. Those exposed should quickly wash the entire body with large amounts of soap and water and rinse the eyes with plain water for 10 to 15 minutes if there is eye pain or if vision is blurred.^{3,7,8}
- All people who think they have been exposed should seek medical care as soon as possible.^{3,7,8}
- As with all chemical agents, people should not touch or use unpackaged or packaged food until deemed safe by local authorities.¹ There is a possibility of a residue of agents on packaged food and therefore touching the surfaces of packaging creates a hazard. This applies to all materials including tinfoil, glass, cans, and hard plastic alike.

Medical treatment

- Atropine and pralidoxime chloride (2-PAM) are antidotes for nerve agent toxicity and they are most useful if given as soon as possible.^{3,7,8}
- 2-PAM must be given within minutes or a few hours following exposure to be effective.^{3,7,8} Atropine should be given every 5-10 minutes as needed.^{3,7,8}
- Diazepam or midazolam should be given initially and when there is evidence of seizures.^{3,7,8} See Appendix 2 for dosage recommendations for nerve agent treatments.
- There are infant doses documented for atropine and doses for diazepam in infants over the age of one month.

Breastfeeding safety

- Breastfeeding should be halted.
- It is not known whether nerve agents are absorbed and secreted into breast milk. It is known that nerve agents are both water- and fat-soluble and recent research indicates that the elimination of nerve agents from the body may continue over time.^{9,10}
- In the absence of knowledge and data, if there are safe breastmilk substitute (BMS) alternatives and the required resources to safely prepare BMS, it is recommended that breastfeeding be halted following exposure to nerve agents and BMS be used.
- See Appendix 4 for further guidance on BMS.
- If breastfeeding cannot be halted, please see Appendix 2 for information on the safety and dosage of treatment for nerve agents for breastfeeding women and for infants.

Pulmonary/Choking Agents

Chlorine is the sole representative of this class that this guidance note will examine although others, such as phosgene, may be added at a later date. **Please refer to Appendix 1 for detailed information on how pulmonary/choking agents impact the body.**

CHLORINE

Key facts

- Chlorine exists in the environment as a yellow-green gas with a characteristic chlorine smell.¹
- It is heavier than air so it tends to settle near the ground.¹¹
- Most effects tend to be pulmonary but chlorine exposure can also cause skin and eye injuries.^{11,12}
- Children may be more sensitive to exposure to high concentrations of chlorine gas than adults because they have a greater lung-surface-area-to-body-weight ratio and smaller-diameter airways.¹¹

Symptoms

- It typically causes nearly immediate eye and mucous membrane irritation and pain as well as sneezing and hoarseness.
- Signs and symptoms from contact with the eyes and mouth include irritation, pain, and swelling of the eyes, mouth, and throat as well as sneezing and hoarseness; effects from damage to the large airways can include immediate airway irritation, pain, coughing, hoarseness, wheezing, and inspiratory stridor (a high-pitched noise while breathing in).¹¹⁻¹⁴ The shortness of breath or chest tightness from damage to the alveoli is usually delayed, often for hours. Later, with increasing fluid in the alveoli and airways, oxygen saturation drops, and cyanosis (bluish discoloration of the skin) is seen and may be followed by death.^{11,15,16}
- As with most agent exposures, a shorter than expected latent period indicates a higher dose and the onset of shortness of breath within 4 hours of exposure suggests a potentially fatal exposure.
- Most patients who have mild to moderate exposure will see acute symptoms resolve in 3-5 days and will have normal pulmonary function tests after several months.^{11,13} Some patients will develop chronic respiratory problems such as reactive airway disease as well as an elevated risk for congestive heart failure.¹³
- The actual signs and symptoms, their onset, and their severity depend on the state of the agent, the routes of exposure, the dose, and the region or regions of the respiratory tract targeted by the inhaled compound.

Management of exposure to chlorine

- The management of chlorine exposure involves decontamination, supportive care, and the treatment of pulmonary injuries.¹²
- If people think they have been exposed, they should remove their clothing and any clothing that must be pulled over the head should be cut off the body instead of pulled over the head.¹² People should seal clothing in a plastic bag and then seal that bag in a second plastic bag.¹² Local or state health department or emergency personnel should be informed upon their arrival that there is contaminated clothing and no one should handle the plastic bags. Those exposed should quickly wash the entire body with large amounts of soap and water and rinse the eyes with plain water for 10 to 15 minutes if they are burning or if vision is blurred.¹²
- All people who think they have been exposed should be kept at rest as much as possible and seek medical care as soon as possible.¹²

Medical treatment

- No antidotes are available.
- Beta-agonists such as albuterol can be useful for bronchospasm.¹¹
- Nebulized sodium bicarbonate can also be used to decrease symptoms and decrease lung injury.^{13,17}
- There is evidence that early corticosteroid use may help with lung inflammation and might prevent post-injury scarring.¹³
- While albuterol and nebulized sodium bicarbonate can safely be used in children over the age of 2 years, the safety and effectiveness of albuterol sulfate inhalation solution in children below the age of 2 years have not been established, nor is there any data on nebulized sodium bicarbonate in infants.¹⁸

Breastfeeding safety

- Breastfeeding can continue after exposure to chlorine gas and during/after treatment if the mother is physically able to do so.
- Chlorine gas almost exclusively affects exposed eyes, mucous membranes, and both compartments of the respiratory tract.
- Although high concentrations can reach the bloodstream, inhaled chlorine is rapidly metabolised and eliminated from the body.¹¹
- It is highly unlikely to be present in breast milk in appreciable quantities to impact breastfeeding.
- Albuterol and sodium bicarbonate are considered safe for breastfeeding women.^{17,19,20}
- Corticosteroids such as prednisone and prednisolone are also considered safe to use with breastfeeding.¹⁹⁻²¹

Blood/Systemic Agents

At this time, hydrogen cyanide is the sole representative of this class that this guidance note will examine although others may be added later. **Please refer to Appendix 1 for detailed information on how blood/systemic agents impact the body.**

HYDROGEN CYANIDE

Key facts

- Hydrogen cyanide (AC)ⁱ is the simplest cyanide-containing compound.
- It is a colourless or pale blue volatile liquid or colourless vapour or gas with a distinct odour of bitter almonds although a large proportion of people cannot detect the odour.²²
- Cyanide vapour and gas are lighter than air and so will rise.
- Cyanide has whole-body (systemic) effects by preventing the normal use of oxygen by nearly every organ in the body.²²
- It has the most impact on the brain, heart, and lungs because these organ systems are the most sensitive to low oxygen levels.²²
- Effects occur rapidly following inhalation exposure, with symptoms beginning within seconds to minutes.^{22,23} Death may occur within minutes.
- After skin exposure, symptoms may be immediate or delayed for 30 to 60 minutes.²⁴
- The time of the onset of the effects depends on the amount of cyanide a person is exposed to, the state of the agent, and the routes and duration of exposure.²⁴
- People can be exposed to cyanide by breathing air, drinking water, eating food, or touching soil that has been contaminated with cyanide.¹²
- Breathing cyanide vapour or gas causes the most harm of all methods of poisoning, but swallowing cyanide can also be toxic.^{22,24}
- Cyanide vapour or gas is most dangerous in enclosed spaces; it evaporates quickly in open spaces making it less dangerous (but not necessarily harmless) outdoors.²²

Symptoms

- Symptoms of mild inhalation exposure include headache, weakness, confusion, and loss of consciousness as well as heart palpitations, difficulty breathing, shortness of breath and nausea, and vomiting.^{22,24,25}
- Eye contact may result in eye inflammation and temporary blindness.²⁴
- The first evidence of inhalation of a high dose may be brief gasping.
- Symptoms of severe inhalation exposure include shock, disordered heart rhythms, cardiac arrest, pulmonary oedema, coma, seizures, and fatal respiratory arrest.²⁴
- Children exposed to hydrogen cyanide may receive larger doses than adults because they have a larger surface-area-to-body-weight ratio as well as higher metabolic rates and are therefore more vulnerable to toxicants.²⁴
- Usually, death occurs rapidly or there is prompt recovery.
- Survivors of serious exposures may suffer brain damage and examples of long-term effects include memory loss, movement disturbances, and personality changes.²⁴

Management of exposure to hydrogen cyanide

- If hydrogen cyanide gas was released indoors, advise people to get out of the building.²⁴
- If the cyanide gas was released outdoors, people should move away from the area where it was released.²²
- If people cannot get out of the area where the cyanide gas was released, they should stay as low to the ground as possible.²²
- If people think they have been exposed, they should remove their clothing and any clothing that must be pulled over the head should be cut off the body instead of pulled over the head.²² Clothing should be sealed in a plastic bag and then that bag should be sealed in a second plastic bag.²² Local or state health department or emergency personnel should be informed upon their arrival that there is contaminated clothing and no one should handle the plastic bags. Those exposed should quickly wash the entire body with large amounts of soap and water and rinse the eyes with plain water for 10 to 15 minutes if they are burning or if vision is blurred.²²

Medical treatment

- Speed is critical in the management of cyanide poisoning.
- Initial treatment consists of the administration of antidotes, oxygen, and IV fluids, the correction of chemical imbalances in the blood, seizure control, and especially airway management and ventilation as indicated.²⁴
- Antidotes for cyanide toxicity include IV hydroxocobalamin, amyl nitrite, sodium nitrite, and sodium thiosulfate^{1,26} (the latter mostly given in combination under the label Nithiodote²⁶).
- IV Hydroxocobalamin is considered a first-line treatment option, and amyl nitrite with sodium nitrite and sodium thiosulfate can be used if IV hydroxocobalamin is not available.
- Hydroxocobalamin, sodium nitrite, and sodium thiosulfate are all available in IV paediatric and infant doses.
- Sodium nitrite should be used with caution in patients under 6 months of age because of the higher risk of developing severe methemoglobinemia compared to older children and adults.²⁶

Breastfeeding safety

- Breastfeeding should be temporarily interrupted.
- Animal studies show that cyanide can be transferred into milk and passed to nursing goats.²⁵ However, there are no studies looking at cyanide and excretion into human breast milk.²⁵
- The half-life for hydrogen cyanide elimination is one hour and it has limited fat solubility.²⁷ However, cyanide rapidly metabolises to thiocyanate which can be excreted into breast milk and can be toxic to the infant.
- Given the half-life of thiocyanate is 2.7 days, it would be advisable to temporarily interrupt breastfeeding for 15 days (5 half-lives) after cyanide poisoning for thiocyanate to be fully eliminated from the mother's body.²⁷
- IV hydroxocobalamin (Vitamin B₁₂) is considered safe for breastfeeding women.^{19,20}
- Breastfeeding is not recommended during treatment with Nithiodote because of the potential for serious adverse reactions in breastfed infants.²⁶

Blistering Agents

The two blistering agents covered in this guidance note are sulfur mustard and lewisite. **Please refer to Appendix 1 for information on how blistering agents impact the body.**

SULFUR MUSTARD

Key facts

- Sulfur mustard is also known, inaccurately, as mustard gas.
- It can smell like mustard, garlic, onions, or even asphalt and is sometimes odourless.²⁸
- Sulfur mustard can exist as a solid (below 58 degrees Fahrenheit, 14 degrees Celsius), an oily liquid in association with a vapour or a gas (but only above 423 degrees Fahrenheit, 217 degrees Celsius).^{28,29}
- Sulfur mustard is heavier than air so it will settle in low-lying areas.
- Sulfur mustard can last for up to 1-2 days in a typical ambient environment and for weeks or months in very cold conditions.²⁸
- Exposure to sulfur mustard can kill although most cases are not fatal.²⁸
- Both skin and inhalational exposures are associated with significant latent periods (the times between exposure and the onset of signs and symptoms) and people typically may not know immediately that they have been exposed.²⁸
- Depending on the severity of the exposure, symptoms may not appear for up to 24 hours but extremely high doses may be obvious within an hour or two or even (for massive and usually fatal doses) even less.²⁸
- If sulfur mustard is released into the air as a vapour, people can be exposed through eye contact, skin contact, inhalation, or any combination of these. It can also be released into water thus contaminating water for drinking, bathing, and other uses.
- Sulfur mustard breaks down slowly in the body and can have cumulative effects if people have repeated exposures.²⁸

Symptoms

- The agent, both as a liquid and a vapour, can cause eye pain and injury, skin burns and blisters, and damage, especially to the large airways. It is more dangerous to warm, moist, and oily skin and in hot and humid conditions and climates.²⁸
- Respiratory effects are predominantly on the larger airways at low to moderate doses but can involve the entire respiratory tract at high doses.
- Systemic effects include nausea, vomiting, and diarrhoea as well as bone-marrow depletion.^{28,29}
- Cancer is another systemic effect but arises only years after exposure.
- Sulfur mustard exposure in children causes similar local damage (to eyes, skin, and the respiratory tract) and similar systemic damage as in adults. However, the effects tend to be more severe and begin earlier in children.²⁹
- Long-term health effects include permanent eye injury, chronic respiratory disease, skin burns with scarring, and skin and respiratory cancer.^{28,29}

Management of exposure to sulfur mustard

- The most important factor is the prompt removal of sulfur mustard from the body.
- If a sulfur mustard release is suspected, people should be advised to find higher ground.
- If avoiding exposure is not feasible, removing the sulfur mustard as soon as possible after exposure is the only effective way to prevent or decrease damage to the body.²⁸
- The removal of sulfur mustard from the skin within two minutes if possible is ideal, but even late decontamination can minimise not only the contamination of others by the patient but also, and just as importantly, the continued absorption of sulfur mustard (especially thickened mustard) from the surface of the skin.²⁸
- Those exposed to sulfur mustard should remove their clothing and any clothing that would normally be pulled over the head should be cut off the body instead of pulled over the head.²⁸ People should seal clothing in a plastic bag and then seal that bag in a second plastic bag.²⁸ Local or state health department or emergency personnel should be informed upon their arrival that there is contaminated clothing and no one should handle the plastic bags. Those exposed should quickly wash the entire body with large amounts of

soap and water and rinse the eyes with plain water for 10 to 15 minutes if eye contact with either vapour or liquid is suspected or confirmed. Do not wait until eye irritation or the blurring of vision occurs.²⁸ If contacts lenses are worn, these should be removed and placed with contaminated clothing.²⁸

Medical treatment

- There is no antidote to sulfur mustard and the treatment is similar to that of burn injuries.
- Pain medication may be given for eye pain, blisters, and skin burns and oral antihistamines may be given for skin itching and irritation.

Breastfeeding safety

- Breastfeeding should be halted.
- It is not known if sulfur mustard can be passed to infants in breast milk.^{29,30} However, due to the high fat solubility of sulfur mustard and persistence in the body, there is a higher risk that sulfur mustard could appear in the breast milk of exposed mothers.³⁰ Therefore, halting breastfeeding is recommended.

LEWISITE

Key facts

- Lewisite is an oily, pale amber to brown liquid that can evaporate to form a colourless vapour said to have the odour of geraniums or fruit.³¹
- Lewisite vapour is heavier than air so it will settle in low-lying areas.
- If lewisite is released into the air, people can be exposed through eye contact, inhalation, and skin contact with lewisite vapour.³¹
- People can also be exposed to lewisite through water or food contamination as well as by coming into direct contact with liquid lewisite.³¹
- It remains a liquid under a variety of environmental conditions and therefore can last in the environment for a long time.³²
- Lewisite contains arsenic and is a powerful irritant and blistering agent. It immediately damages the skin, eyes, and respiratory tract.³¹
- Because it contains arsenic, lewisite can also cause abdominal distress, the leakage of fluid from capillaries throughout the body (most notably in the capillaries surrounding the alveoli in the lungs), and low blood pressure.^{31,32}

Symptoms

- Unlike sulfur mustard, lewisite has a very short latent period with initial pain occurring within a couple of minutes of exposure; blisters form within several hours.³²
- Victims can experience eye irritation, a bloody nose, coughing, and other large-airway signs and symptoms and, at lower doses than for sulfur mustard, pulmonary oedema with low blood pressure, a condition caused by capillary leakage in the lungs and called lewisite shock.
- Digestive tract symptoms include nausea, vomiting, and diarrhoea.^{31,32}
- For the same reasons that children are more likely to have greater susceptibility than adults to sulfur mustard, children might be expected to be at a similarly heightened risk of severe effects from lewisite.
- The possible long-term effects of extensive exposure to lewisite include permanent eye damage (including blindness), skin burning and scarring, and chronic respiratory disease.³²
- Lewisite is not known to suppress the immune system.^{31,32}

Management of exposure to lewisite

- Immediate decontamination is the only way to limit injury.
- People should quickly move to an area with fresh air and go to the highest possible ground.³¹ Those exposed should quickly remove clothing and any clothing that would normally be pulled over the head should be cut off the body instead of pulled over the head.³¹ Clothing should be sealed in a plastic bag and then that bag should be sealed in a second plastic bag. Local or state health department or emergency

personnel should be informed upon their arrival that there is contaminated clothing and no one should handle the plastic bags.³¹ Those exposed should quickly wash the entire body with large amounts of soap and water and rinse the eyes with plain water for 10 to 15 minutes if eye contact with either vapour or liquid is suspected or confirmed. They should not wait until eye irritation or the blurring of vision occurs.³¹ If a person wears contact lenses, these should be removed and placed with contaminating clothing.³¹

Medical treatment

- The antidote for lewisite is British Anti-Lewisite (BAL, or dimercaprol).^{32,33}
- This is given via intramuscular injection and binds to arsenic to prevent systemic toxicity but it will not prevent injury to skin, eyes, or mucous membranes.^{32,33}
- Due to its significant side effects, it is recommended only for people who have signs of shock or significant pulmonary injury.³³
- It is contraindicated in anyone with a peanut allergy.³²
- Paediatric dosing is available for dimercaprol although not for the infant population.³⁴
- Safer alternatives to BAL are under investigation.

Breastfeeding safety

- Given that both the agent and the treatment can be excreted in breast milk, breastfeeding should be temporarily interrupted.
- BAL is considered contraindicated by some sources for breastfeeding women given its possible excretion into breast milk.^{19,20}
- Arsenic can be excreted into breast milk and can be toxic to a nursing infant.³⁵
- The half-life of lewisite ranges from 55 to 75 hours and the half-life of BAL is 4 hours.^{34,36}
- In the absence of other alternatives, it would be safe to resume breastfeeding 15 days (5 half-lives) after exposure and treatment completion upon clearance from a physician and if the mother is physically able to do so.

CONCLUSION

This guidance note is considered a living document. Currently, the guidance presented is based on the most recent research and evidence. As more information and research become available regarding the treatment of breastfeeding women who are exposed to chemical agents, we will continue to update as needed. Appendix 3 outlines BMS and relactation guidance for use in cases where breastfeeding must be halted or temporarily interrupted.

Appendix

Appendix 1: How chemical agents impact the body

Nerve agents

In the body, a small molecule called acetylcholine (ACh) acts as a neurotransmitter (signal transmitter) in the brain, skeletal muscles, smooth muscles, and exocrine glands (glands that secrete through ducts).³⁷ Electrical impulses sent along neurons cause the release of ACh at target organs and the ACh causes the target muscle, neuron, or gland to respond. Once ACh has transmitted its message, it is normally broken down by an enzyme called acetylcholinesterase (AChE). Nerve agents bind to and inactivate AChE, leading ACh to build up and cause overstimulation and eventually fatigue and the failure of its target organs.

Effects in the brain can include seizures, loss of consciousness, and cessation of breathing. Breathing can also stop from the direct effects on the diaphragm and other breathing muscles. Twitching and paralysis can affect other skeletal muscles as well, and smooth-muscle effects can include miosis (pinpoint pupils), vomiting and diarrhoea, and bronchoconstriction (asthma-like tightness in the chest).³⁸ The effects on exocrine glands lead to increased secretions including tearing, runny nose, drooling, and excessive sweating.¹ This constellation of signs and symptoms is similar for all nerve agents and is called the cholinergic toxidrome.³⁹ The extent of poisoning from any nerve agent depends on whether the agent is encountered as a liquid or a vapour, the routes of exposure, the dose, and the amount to which a person is exposed. While it is difficult to measure actual doses of nerve agents during a terrorist attack, doses can often be inferred based on the length of the latent period which is the time between exposure and the onset of symptoms; a shorter latent period implies a higher dose.³⁹ Very low exposures may cause detectable decreases in AChE activity without any symptoms. Mild exposures may result in only local effects such as tearing, a runny nose, a decrease in pupil size from vapour exposure, or localised sweating and twitching from liquid contact with the skin; symptoms from vapour exposure predictably occur much sooner than symptoms after mild to moderate skin exposures to liquid. Severe symptoms can lead to convulsions, apnoea, and death.³⁹

Children are not simply small adults and differ from adults in several ways other than size. Because of their smaller body mass, less agent is needed to poison them. In addition, children have immature respiratory tracts, higher respiratory rates, immature blood-brain barriers, greater susceptibility to seizures, and a less mature metabolism.⁴⁰ Their susceptibility to nerve agents is likely to be increased and the signs and symptoms in children exposed to nerve agents are known to differ in important ways from the clinical presentation of adults.^{23,40}

Pulmonary/chocking agents

Pulmonary agents are primarily gases that can contact the eyes, nose, and throat and that can be inhaled to cause damage to the large airways (trachea, bronchi, and larger bronchioles), the small airways (smaller bronchioles), air sacs, and the alveoli or both. The damage, clinical presentation, and treatment are different depending upon the part of the respiratory tract affected. Large-airway (central-compartment) agents cause irritation and the shedding of the delicate lining of the airways and eventually partial or total airway obstruction. Small-airway (peripheral-compartment) compounds damage the cells enclosing the alveoli and lead to a gradually progressive fluid leakage into the alveoli and, eventually, even the large airways. This pathological process is called pulmonary oedema and can cause the clinical syndromes of acute lung injury or acute respiratory distress syndrome.^{1,15}

Blood/systemic agents

Systemic agents are a group of chemicals that impact the body by preventing the normal use of oxygen by the body tissues. Introduced into warfare after the pulmonary agents, systemic asphyxiants were called blood agents because they were systemically (widely) distributed to all body tissues through the blood.³⁹ Their site of action is not the blood however, since their predominant mode of action is in the tissues throughout the body.³⁹ They exert their toxic effects by inhibiting certain enzymes in the electron transport chain in mitochondria throughout the body.³⁹ The extent of poisoning from any blood/systemic agent depends on the state of the agent, the routes and duration of exposure, and the delivered dose.

Blistering agents

Blistering agents produce skin injuries that resemble those caused by burns.¹ Blistering agents include mustards (comprising sulfur mustard and three kinds of nitrogen mustards) and arsenicals. Sulfur mustard is the blistering agent considered to be the most likely of these compounds to be used as a mass-casualty agent. Sulfur mustard has local effects on the skin, eyes, and respiratory tract, primarily the large airways (although high doses can also cause pulmonary oedema), and can also be distributed systemically to damage DNA, especially in the bone marrow.²⁸ This causes decreased formation of blood cells and can cause decreased formation of platelets, leading to bleeding, infections, and weakness.^{28,29} Lewisite, an arsenical, is absorbed rapidly via inhalation and through the skin.²⁸ It has local effects on the skin, eyes, and large airways similar to those of sulfur mustard. It also acts as a systemic poison and through its arsenic component can cause leakage of fluid from capillaries, especially in the lungs.³² Children are probably at higher risk of severe poisoning than are adults because they are more likely to be closer to the low-lying areas of higher vapour concentration. The extent of poisoning from any blister agent depends on the state of the agent, the routes of exposure, the dose, and the duration of exposure.

Appendix 2: Safety information and doses for atropine and 2-PAM³

The following data on the safety of treatment for nerve agents in breastfeeding women is for information purposes only since breastfeeding should be halted when a woman is exposed to nerve agents. Atropine is considered safe to take while breastfeeding.^{19-21,41} There is no information on whether pralidoxime chloride (2-PAM) is excreted into breast milk. Breastfeeding should be held for at least 6 to 7 hours after a dose is given.²⁰ Diazepam may be excreted in breast milk.^{19,20} Monitor an infant breastfed by a mother receiving diazepam for drowsiness, decreased feeding, lethargy, and failure to thrive. Halt breastfeeding in cases with high doses of diazepam or when repeated administration is needed.⁴²

Infant (0 – 2 yrs.) for mild to moderate physical findings, including localised sweating, muscular twitching (fasciculations), nausea, vomiting, weakness, and shortness of breath (dyspnoea), administer atropine at 0.05 mg/kg IM; 2-PAM at 15 mg/kg IM (over 1 year).

Infant (0 – 2 yrs.) for severe physical findings, including unconsciousness, convulsions, cessation of breathing (apnoea), and floppy (flaccid) paralysis, administer atropine at 0.1 mg/kg IM; 2-PAM at 25 mg/kg IM (over 1 year).

Child (2 – 10 yrs.) for mild to moderate physical findings, including localised sweating, muscular twitching (fasciculations), nausea, vomiting, weakness, and shortness of breath (dyspnoea), administer atropine at 1 mg/kg IM; 2-PAM at 15 mg/kg IM.

Child (2 – 10 yrs.) for severe physical findings, including unconsciousness, convulsions, cessation of breathing (apnoea), and floppy (flaccid) paralysis, administer atropine at 2 mg/kg IM; 2-PAM at 25 mg/kg IM.

Adult, for mild to moderate physical findings, including localised sweating, muscular twitching (fasciculations), nausea, vomiting, weakness, and shortness of breath (dyspnoea); administer atropine at 2 to 4 mg IM; 2-PAM at 600 mg IM.

Adult, for severe physical findings, including unconsciousness, convulsions, cessation of breathing (apnoea), and floppy (flaccid) paralysis, administer atropine at 6 mg IM; 2-PAM at 1800 mg IM.

Appendix 3: Supporting breastfeeding mothers and infants if breastfeeding needs to be temporarily interrupted⁴³

The vast majority of mothers can and should breastfeed, just as the vast majority of infants can and should be breastfed. Only under exceptional circumstances can a mother's milk be considered unsuitable for her infant. For those few health situations where infants cannot, or should not, be breastfed, the choice of the best alternative – expressed breast milk from an infant's own mother, breast milk from a healthy wet-nurse or a human-milk bank, or a BMS fed with a cup which is a safer method than a feeding bottle and teat – depends on individual circumstances.

Relation

If breastfeeding is temporarily interrupted, mothers and infants need support to protect their breast milk supply and relactate once they are ready to resume breastfeeding.

During any temporary interruption of breastfeeding, women should be supported to maintain their breast milk supply through frequent breast milk expression (either through hand expression or pump).ⁱⁱ Expressing breast milk is also important to avoid discomfort and breast infections. Women should be supported to increase their breast milk supply and relactate once they are ready to resume breastfeeding. If mothers have breast milk that was expressed and stored before the exposure, this can be used to feed the infant. If breast milk is frozen, thaw the sealed bag/contained of milk in a bowl of warm water from a safe source (tap or bottled depending on emergency). An easily cleaned cup (i.e., open, without a teat or spout) should be used to feed the infant expressed breast milk (see below). If breast milk expressed before the chemical attack is not an option, infants should be fed with an appropriate BMS if available.

Important links:

<https://www.llli.org/breastfeeding-info/relactation/>

<https://www.llli.org/increasing-breastmilk-supply/>

<https://www.unicef.org.uk/babyfriendly/maximising-breastmilk-and-re-lactation-guidance/>

<https://abm.me.uk/breastfeeding-information/relactation/>

Artificially fed or non-breastfed infants

For infants being fed BMS, ready-to-use infant formula and powdered infant formula already in the home or manufactured before the chemical attack are suitable for consumption.

If infants under 6 months of age are being fed BMS, mothers and caregivers should be advised to use ready-to-use infant formula (RUIF) if this is available. RUIF carries the least risk for formula-fed infants during a chemical attack. If RUIF is not available, then powdered infant formula (PIF) should be used. PIF should be made using bottled water. If this is not possible, tap water can be used if the local authorities say it is safe. For infants over 6 months of age, alternative milks (such as ultra-high temperature milk, fermented milk or yogurt, pasteurised or boiled full-cream animal milks or reconstituted evaporated milk) may be used instead of RUIF and PIF.

An easily cleaned cup (i.e., open, without a teat or spout) should be used to feed the infant BMS and expressed breast milk. Bottles, teats or cups with a lid are hard to clean in an emergency. Using bottles, teats or cups with a spout may also limit the successful restarting of breastfeeding as they reduce suckling.

Important links:

UNICEF BMS Procurement 2021: <https://www.unicef.org/media/100911/file/BMS-Procurement-Guidance-Final-June-2021.pdf>

Safe preparation, storage, and handling of powdered infant formula – guidelines:

<https://apps.who.int/iris/handle/10665/43659>

<https://www.ennonline.net/attachments/93/pif.pdf>

<https://www.ennonline.net/attachments/545/poster-preparing-formula-in-care-settings.pdf>

How to prepare for cup feeding at home:

<https://www.ennonline.net/attachments/543/safe-prep-cup-feeding-leaflet.pdf>

If bottle feeding is necessary careful preparation and use is critical:

<https://www.ennonline.net/attachments/542/safe-prep-bottle-feeding-leaflet.pdf>

For more information on the supporting infants dependent on breastmilk substitutes and the resources needed, please see: <https://www.ennonline.net/ifecoregroupinfographicseries>

ⁱⁱ The parts of the breast pump in contact with breast milk need to be carefully cleaned after each use with water from a safe source. Where this cannot be done, hand expression is recommended. Please see standard breast pump guidelines: <https://www.cdc.gov/healthywater/hygiene/healthychildcare/infantfeeding/breastpump.html>

Appendix 4: Medications commonly used in the treatment of chemical agents and for use in breastfeeding women

	LactMed ¹⁹	Briggs ²⁰	Hales ²¹	EmbryoTox – Germany ⁴¹
Albuterol	Acceptable during breastfeeding	Compatible	L1: No data – compatible	Safe during breastfeeding
Amyl nitrite	No data		L4: Limited data – possibly hazardous	No data
Atropine	Limited data – safe for short term use	Limited human data – probably compatible	L3: No data – probably compatible	Limited data – safe for short term use
Diazepam	Use cautiously during breastfeeding	Limited human data – potential toxicity	L3: Limited data – probably compatible	Safe during breastfeeding as single dose. Use caution with long term use
Dimercaprol (BAL)	No data	Contraindicated	No data	No data
Hydroxocobalamin	Acceptable during breastfeeding	Compatible	No data	No data
Pralidoxime chloride (2-PAM C1)	No data	Breastfeeding should be held for at least 6 to 7 hours after a dose is given.	No data	No data
Prednisone	Acceptable during breastfeeding	Compatible	L2: Limited data – probably compatible	Safe during breastfeeding
Prednisolone	Acceptable during breastfeeding	Compatible	L2: Limited data – probably compatible	Safe during breastfeeding
Sodium bicarbonate	No data	Compatible	L2: No data – probably compatible	No data
Nithiodote – sodium nitrite/sodium thiosulfate	No data	No data	No data	No data

Appendix 5: Important guidance

Infant Feeding in Emergencies Core Group, Infant Feeding in Emergencies Operational Guidance for emergency relief staff and programme managers Version 3.0 – October 2017, Emergency Nutrition Network, 2017. <http://www.enonline.net/operationalguidance-v3-2017>

Sphere Association. The Sphere Handbook: Humanitarian Charter and Minimum Standards in Humanitarian Response, fourth edition, Geneva, Switzerland, 2018. www.spherestandards.org/handbook

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