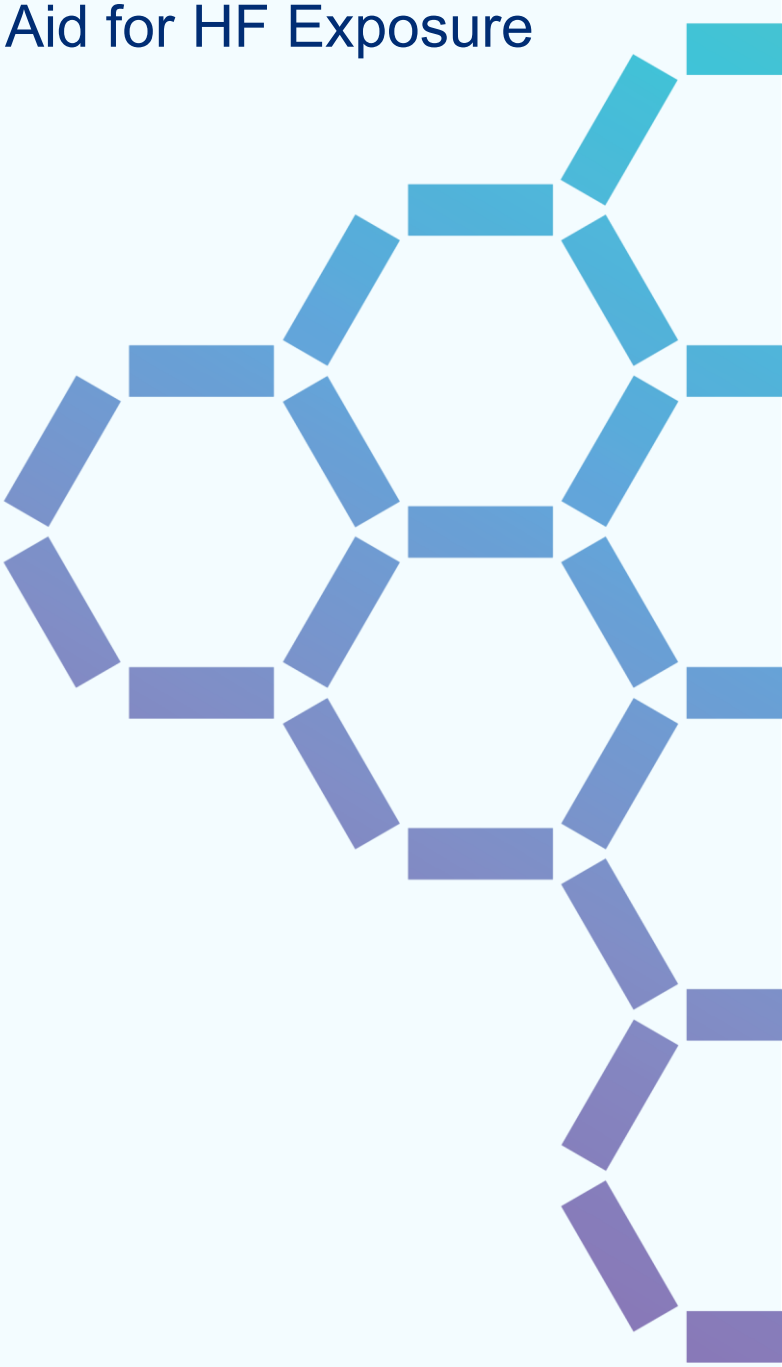
Hydrofluoric Acid Guidance – Section I
Emergency First Aid for HF Exposure



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Chemical Industries Association

Introduction

This Guidance has been developed by the Hydrofluoric Acid Sector Network Group of the Chemical Industries Association (CIA). It is part of a suite of Guidance Sections maintained by the Network on a wide range of aspects of working with HF.

Guidance from the HF Network reflects the 'current best practice' (at the time of publication) and is recommended for use in conjunction with information from the supplier(s) of HF. It is intended as a recommendation and not as a mandate to which manufacturers and users of HF must adhere; it is not intended as a substitute for any applicable legislative requirement. Whilst all reasonable efforts have been made to ensure the accuracy of the contents and applicability to regulations at the time of publication, readers must refer to these themselves to ensure their compliance with current legislative requirements.

Guidance on the First Aid treatment of HF burns is intended to provide a common standard to be used when planning for or undertaking response to HF incidents and the management of HF casualties. It reflects recommendations on emergency First Aid for HF burns and injury, developed by the Medical Group of the HF Network, which includes expert medical practitioners. It is important to understand that the Guidance is limited to recommended First Aid procedures and transfer to hospital, not any subsequent professional medical treatment of HF burn casualties. The advice is based upon reviews of medical research literature, and many years of practical experience. As with all Guidance produced by the HF Network, this First Aid Guidance is not intended as a substitute for legislative requirements. However, the content of the current Guidance was endorsed by the Health and Safety Executive (HSE) and the National Poisons Information Service (NPIS) as well as CIA. NPIS and HSE were part of the Medical Group that have developed it.

Hydrofluoric Acid Sector Network Group review the HF Guidance on an ongoing basis and the content will be reviewed when changes are identified to ensure it remains current,

Acronyms / Glossary

ABC	Airway, Breathing, Circulation
COSHH	Control of Substances Hazardous to Health Regulations (2002)
HF	Hydrogen Fluoride / Hydrofluoric Acid
HSE	Health and Safety Executive
Hypo	Low, e.g. hypokalaemia (potassium), hypocalcaemia (calcium), hypomagnesaemia (magnesium)
MSDS	Manufacturer's Safety Data Sheet
NPIS	National Poisons Information Service
O_2	Oxygen
PPE	Personal Protective Equipment
TOXBASE	The clinical toxicology database of the UK NPIS

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I1 Emergency First Aid for Burns & Injuries

The following Guidance has been agreed and endorsed by the Medical Group of the CIA HF Sector Network, the Health & Safety Executive, and the National Poisons Information Service. It is intended that the Guidance in this Section can be copied and distributed widely in the interests of sharing best practice, advice and Guidance on the emergency First Aid treatment of HF burns. CIA copyright has been waived for this purpose. This part of the Guidance is also freely available from CIA.

Note: For companies that manufacture or use HF, it is recommended that the First Aid treatment Guidance below is used in conjunction with incident response planning, drafting procedures, training and awareness-raising about what to do in the event of HF burns. Further information relevant to these aspects is included elsewhere in this Guidance.

I1.1 Occupational Health and Safety

These guidelines should form part of a site-specific approach to the prevention and treatment of HF burns.

- All personnel using HF should have appropriate PPE.
- There should be immediate access to high flow water for decontamination and easy access to calcium gel in areas where HF exposures may occur.
- All persons working on a HF plant should receive education on the spectrum of HF burns from life threatening to delayed burns. Workers should be provided with calcium gluconate gel to take home in the event of delayed symptoms from low concentration burns. They should present themselves to hospital if they are concerned or have used the gel at home.

I2 Emergency Treatment Prior to Transfer to Hospital

I2.1 Primary Response

- **AVOIDING DANGER:** For the safety of the rescuers, it is essential to prevent inhalation of HF and contact with HF during any rescue operation. First aiders involved in rescue or decontamination must use appropriate Personal Protective Equipment (PPE).
- **RESPONSE:** Assess for a response and breathing. If the casualty is unresponsive or breathing abnormally commence Advanced Life Support. Call for an ambulance immediately as high concentration HF exposure can be rapidly fatal.
- **ABC (Airway, Breathing, Circulation):** Follow Basic Life Support and Advanced Life Support Guidance. Administer 100% oxygen if patient is breathing.

I2.2 Decontamination

Decontamination is the immediate priority if the patient is responsive. This takes precedence over transfer to medical facilities, though an ambulance should be requested while decontamination is being undertaken.

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I2.3 Exposure Route-Specific Actions

Skin Contact

- **DO NOT DELAY decontamination if the patient is responsive.**
- **Immediately decontaminate** with high flow water for a maximum of one minute.
- Ask others to ensure ample supplies of calcium gluconate gel are obtained. ***Note: If calcium gluconate gel is not available continue to flush with water until it is.***
- **Rapidly remove contaminated clothing, shoes and jewellery.**
- **Apply calcium gluconate gel** and massage into the burn area wearing gloves appropriate to prevent cross-contamination. Continue to massage while repeatedly applying gel until 15 minutes after the pain in the burnt area is relieved, if necessary, continue during the ambulance transfer to hospital.
- If skin contamination is extensive and clothing is affected, be aware of the possibility of inhalation injury.
- All potentially contaminated equipment and clothing should be disposed of in line with the COSHH risk assessment.

Eye Exposure

- **DO NOT DELAY decontamination if the patient is responsive.**
- Flush the eyes with copious amounts of water or eye wash solution (sterile isotonic saline solution) until the ambulance arrives. Do not attempt to remove contact lenses. Irrigation should be continued while on route to hospital.
- Remove any exposed clothes, jewellery and shoes as these may carry HF contamination.
- Do not apply calcium gluconate eye drops as effectiveness has not been proven and the drops may increase ocular damage.
- There is some evidence from a single experimental study that if Hexafluorine® is applied to the eye within 25 seconds of exposure, and continued for 15 minutes, ocular damage is lessened. (Spöler et al. Analysis of HF penetration and decontamination of the eye by means of time-resolved optical coherence tomography. Burns 2008; 34: 549-555). However, at the time of publication of this Guidance this is by no means conclusive evidence.

Inhalation

- **Remove to fresh air** and remove any exposed clothes, jewellery and shoes.
- If inhalation is suspected administer 100% oxygen.
- **Immediately arrange hospital admission.**
- Keep casualty at rest in a comfortable position and administer oxygen until transfer to hospital.

Ingestion

- **DO NOT DELAY decontamination: remove clothes, jewellery and shoes.**
- **Seek urgent hospital transfer as ingestion can be rapidly fatal.**
- Do not induce vomiting. Mouth and lips may be rinsed with water, only if casualty is conscious.

Transfer to Hospital

Arrange for transfer to hospital for further assessment and treatment by an appropriately qualified and experienced medical practitioner ensuring that the nature of the incident has been explained and, where possible, all chemicals involved in the contamination have been identified. Ideally send the MSDS with the patient.

Decontamination with high flow water and removal of clothes, jewellery and shoes should be done prior to loading rather than inside the confines of an ambulance. The administration and massage of calcium gluconate gel can be done on route to hospital.

It is good practice to provide a treatment pack to accompany the patient to hospital. The pack should contain several tubes of calcium gluconate gel, as well as a copy of these medical treatment guidelines, to alert the receiving doctor or nurse to the potential severity and recommended treatment of an HF burn – see below.

Hospital medical staff should consult TOXBASE (https://www.toxbase.org/login/?ReturnUrl=/) via the login and telephone NPIS for specific advice (UK NPIS 0344 892 0111).

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Additional Information

The basic First Aid treatment described above is derived from available scientific peer-reviewed evidence. It takes account of the rapidity with which HF burns progress, proven effective decontamination with water, and treatment with calcium gluconate gel.

For skin burns, the Guidance is clear – without delay, maximum 1-minute water-wash with high flow water to decontaminate, before commencing calcium gluconate treatment application.

However, in many situations there is the potential that the presence of workwear, or personal protective equipment which may have been damaged or compromised, worn by someone exposed to HF may mean it is not possible to effectively and immediately apply water directly to skin until these are removed. In such circumstances, casualties with suspected HF exposure should make use of a safety shower as quickly as possible (where one is available), remove clothing / PPE as quickly as possible, apply water for a maximum one minute to the exposed skin, followed by the application of calcium gluconate gel. Where safety showers are not available, nearby other water supplies should be used to decontaminate as quickly as possible, though these are unlikely to be as effective in flooding the skin as an emergency shower.

Note: It cannot be stressed enough that time is of the essence to minimise the consequences of HF exposure, in ensuring rapid, effective decontamination followed by calcium gluconate gel treatment.

I3 Medical Effects of HF Exposure

HF is corrosive to the skin, eyes and the mucous membranes of the respiratory and digestive tracts. It penetrates rapidly through the skin and into the underlying tissues causing necrosis. It is therefore essential that decontamination and primary First Aid is given immediately and must not be delayed for any reason including transfer to hospital or specialist unit.

HF is also readily absorbed in the body causing acute and severe systemic effects, mainly attributable to a rapidly developing **serum hypocalcaemia** caused by the systemic circulation of calcium fluoride. **Serum hypomagnesaemia** and **serum hyperkalaemia** also occur.

The extent and intensity of these systemic complications are directly related to the amount of circulating fluoride, which in turn relates to the severity of exposure. There are also indications that subcutaneous HF under the burnt areas may be responsible for a slow supply of fluoride ions to the circulation.

Symptoms of serious intoxication include hypotension, hypocalcaemic tetany and/or laryngospasm, often respiratory failure, ventricular tachycardia and cardiac arrest. Renal function may be impaired, and muscular damage may be secondary to tetany. At lower concentrations HF can result in delayed symptoms causing later onset of effects.

Industrial experience indicates that prompt management, as described, will prevent the development of serious injury. In the majority of cases caused by industrial accidents, little more than skin **hyperaemia** results after management. **Appropriate First Aid is vital and must be carried out quickly and effectively** – see above. However, even minor burns may be associated with absorption of fluoride ions from skin, respiratory tract and alimentary tract, leading to systemic effects. Referral to a hospital or to medical staff with appropriate experience must always occur.

I4 Equipment for HF Injuries

It is recommended that a specific HF First Aid Kit be kept in or near workplaces where hydrogen fluoride injuries can be anticipated, including vehicles transporting significant quantities of acid. Emergency showers and other decontamination equipment should be appropriately sited. The minimum content of a HF First Aid Kit should be:

- 12 tubes of 25g of calcium gluconate gel 2.5%
- Two pairs of gloves, appropriate to HF burns
- Scissors (one large and one small) for cutting clothing
- 500 ml of sterile saline or water for eye irrigation
- Copy of Emergency First Aid Guidance.

These are minimum quantities and may need adjustment depending on the number of potential casualties and specific site.

The HF First Aid Kit should be inspected by an authorised, competent person on a regular basis. Inspection dates and details should be recorded. Used and out-of-date contents should be replaced immediately. ***Care must be taken to ensure that any item subject to a "use by (date)" requirement is duly changed on expiry.*** Calcium gluconate gel should be protected from heat and light and stored between 8 to 20ºC. Periodic (such as annual) liaison visits between the site medical advisor and local A&E department are recommended to maintain awareness about the possibility of and special attention to HF burn injuries.

Emergency Kit for Hospital Transfer

It is good practice to maintain a box or kit available to accompany casualties to hospital. It is recommended that the box:

- Is prominently marked as 'P1' – this information alerts paramedic and hospital A&E staff that this is a Priority 1 situation.
- Inside the lid – an emergency notice (see suggested draft at Appendix 1)
- Contents of the box should reflect the advice given above.
- Information should also be included about contact numbers for site specialist advice, including out-of-hours contact details.

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I5 HF Acid Treatment & Outcome Record

Copies of this page should be made and kept available for completion in the event of an accident involving HF (copyright waived for this purpose). A completed form must accompany each casualty to hospital.

Name of patient: :	Name of company:	Name of person completing record:
Date of incident:	Time of incident:	Time of start of initial decontamination:
Brief description of incident leading to exposure:		
Note affected body part(s):		
Strength of HF:	Note Other Chemical Exposure (if any):	

First Aid Management Record

	Skin	Eye
Method of decontamination:		
Delay to start of decontamination:		
Length of initial decontamination:		
Number of decontamination cycles:		
Application of neutralising substance(s), e.g. calcium gluconate:		
Number of application cycles:		

	Inhalation	Ingestion
Symptoms:		
Management:		

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Appendix 1 Recommended Alert Note Text

Recommended text of Alert Note for emergency box to accompany patient to hospital:

FAO: THE ATTENDING HEALTH PRACTITIONER.

THIS PATIENT HAS SUSTAINED A BURN FROM HYDROFLUORIC ACID (HF)

THESE BURNS, EVEN INVOLVING A SMALL AREA OF SKIN OR A BRIEF INHALATION, CAN CAUSE SEVERE OR FATAL SYSTEMIC EFFECTS.

PLEASE TREAT AS HIGH PRIORITY AND REFER TO THE ENCLOSED DOCUMENTS.

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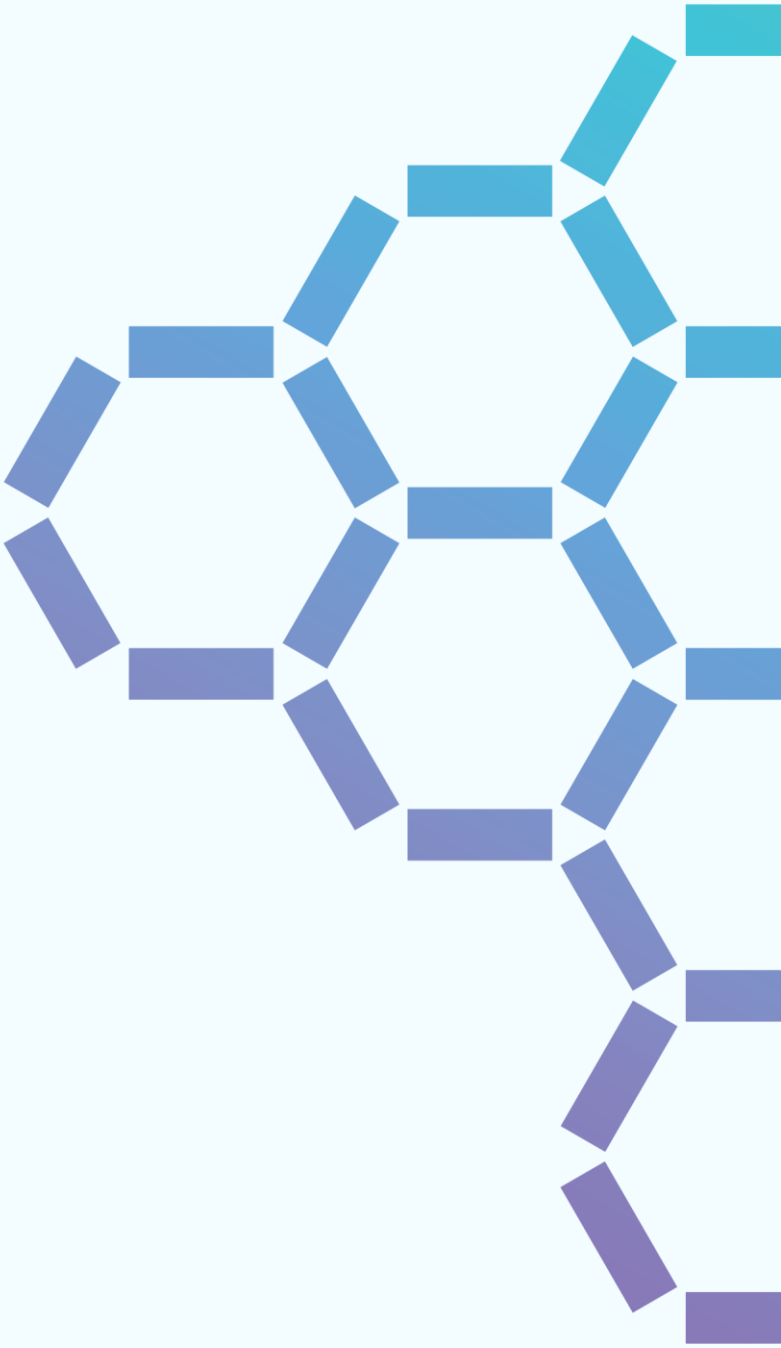
Appendix 2 Hydrogen Fluoride & Hydrofluoric Acid Physician Notes

Although damaging to living tissue HF is a weak acid. The fluoride ion is highly electronegative and does not readily disassociate from the hydrogen ion. The acid moves across lipid barriers and can penetrate to deep tissue posing a greater hazard than from most chemical burns. The injury process has two stages. Firstly, rapid dehydration and coagulative necrosis followed by reactivity of dissociating fluoride ions with calcium. Depletion of tissue calcium probably results in release of potassium from nerve endings causing the characteristic severe pain of skin burns. Hypocalcaemic and hyperkalaemia is also the cause of systemic side effects and a number of cases of refractory cardiac arrest have been reported.

Symptoms of serious intoxication include hypotension, hypocalcaemic tetany and / or laryngospasm, often respiratory failure, ventricular tachycardia and cardiac arrest. Renal function may be impaired, and muscular damage may be secondary to tetany. At lower concentrations HF can result in delayed symptoms (pain and hyperaemia, etc) of up to 48 hours.

Systemic	Skin	Inhalation	Eyes	Ingestion
The degree of systemic complications relates to levels of circulating fluoride and hence severity of exposure. They should be considered in all cases of significant inhalation or ingestion and where full thickness skin burns occur to > 1% of the body(palm of hand)	Exposure to weak solutions (below 20%) usually does not cause long-term morbidity but may cause considerable pain which (for solutions up to 50%) may be delayed for 2-24 hours. High concentrations (50%+) rapidly induce pain, and cause blister, initial erythema which may turn white, followed by liquefaction and eschar formation. Tenosynovitis and osteolysis may occur.	In addition to acute respiratory symptoms, HF inhalation can cause delayed pulmonary oedema, up to 48 hours after exposure.	Eye contact, like skin can be the cause of intense pain.	Rarely occurs.
First Aid – Adequate initial decontamination (see skin). Do not transfer to hospital until decontamination complete.	**First Aid –** Remove contaminated clothing. Wash with copious cold water (1 minute). Apply calcium gluconate gel (2.5%) and massage in. Repeat until 15 minutes after pain has subsided (may take many hours).	**First Aid –** Remove to fresh air – keep warm/rest. Emergency resuscitation if indicated with bag valve mask use. 100% 0_2 if breathing is laboured.	**First Aid –** Irrigate with eyewash or N saline. Continue in ambulance. DO NOT USE GEL.	**First Aid –** No emetics. Lips and mouth may be rinsed with water (up to 200 ml) if patient is conscious.
Follow On – Seek immediate expert advice. General support and monitor (ECGQ-T interval). Serum calcium and potassium half hourly. Maintain ECG and calcium levels with slow IV 10% calcium gluconate (oral too slow to be of value). Avoid leaking from vein as this will result in necrosis.	**Follow On –** Debridement and excision of necrotic coagulum should be considered especially since may act as a barrier to the gel. Severe subungual burns usually require nail removal. If no response, consider intra-arterial injection of 5% calcium gluconate after taking expert advice. Relief of pain indicates sufficient treatment; therefore do not use local anaesthetic. Intra-arterial 5% calcium gluconate following angiography has been used (seek expert advice).	**Follow On –** Monitor, treat pulmonary oedema if it occurs. If inhalation has occurred assume systemic effects.	**Follow On –** Seek expert advice.	**Follow On –** Seek expert advice. Assume systemic effects

CHEMICAL INDUSTRIES ASSOCIATION



WWW.CIA.ORG.UK

@SEE_CHEM_BUS

RESPONSIBLE CARE

Kings Buildings, Smith Square, London, SW1P 3JJ
Telephone: 020 7834 3399 | Email: enquiries@cia.org.uk | www.cia.org.uk