STS 94/96

Comité Technique Européen du Fluor

Working group Storage, Transportation and Safety

Guidelines in case of a Hydrogen Fluoride Exposure

2nd Edition

June 2007

This document can be obtained from: CTEF - Avenue E. Van Nieuwenhuyse 4,
Box 2 - B 1160 Bruxelles, Belgium.

PREFACE

Hydrogen fluoride (HF) is essential for chemical industry and therefore, there is a need for HF to be produced, transported, stored and used.
HF is primarily an industrial raw material. It is used in stainless steel manufacturing, iron and steel foundries, metal finishing, aluminum production, inorganic and organic chemical manufacturing, petroleum refining, mineral processing, glassmaking, electronic components, refrigerant gases, and in the production of several medications and anesthetic gases[1].

The HF industry has a very good safety record; nevertheless, the European HF producers, acting within CTEF have drawn up this document to promote continuous improvement in the standards of safety associated with HF handling.

These recommendations are based on the various measures taken by member companies of the CTEF.

In no way is it intended as a substitute for the various national or international regulations, which should be respected and complied with in an integral manner.

These guidelines are a result of many years of experience of the HF producers in their respective countries at the date of issue of this document.

Established in good faith, these guidelines should not be used as standard or a comprehensive specification, but rather as a guide which should, in each particular case, be adapted and utilized in consultation with an HF manufacturer, supplier, user, or any other expert in the field.

It has been assumed in the preparation of this publication that the user will ensure that the contents are relevant to the application selected and are correctly applied by appropriately qualified and experienced people for whose guidance it has been prepared.

The CTEF does not and indeed cannot, make any representation or give any warranty of guarantee in connection with material published in CTEF publications and expressly disclaims any legal liability or responsibility for damage or loss resulting from the use, misuse, of information contained in this document.

The content of these recommendations are based on the most authoritative information available at the time of writing and on good engineering and medical practice, but it is essential to take account of appropriate subsequent technical developments or legislative changes. It is the intent of the CTEF that this guideline be periodically reviewed and updated to reflect developments in industrial practices and evolution of technology. Users of these guidelines are urged to use the most recent edition of it, and to consult with an HF manufacturer before implementing it in detail.

The edition of this document has been drawn up by “The Storage, Transportation and Safety Work Group” together with “The Medical Work Group” to whom all suggestions concerning possible revision should be addressed through the offices of CTEF. It may not be reproduced in whole or in part without the written authorization of CTEF or of its member companies.

Exposures to HF are usually very serious, HF will penetrate any tissue it comes in contact with and has the potential for significant complications due to the injury produced in the contact area and the systemic toxic effects basically due to fluoride toxicity. Concentrated HF, liquid or

---

[1] Information obtained from: CTEF.- Comité Technique Européen du Fluor, ACC.- American Chemistry Council, and ANIQ.- Asociación Nacional de la Industria Química.

vapor, may cause severe burns, metabolic imbalances, pulmonary edema, blindness and life threatening cardiac arrhythmias. Even moderate exposures to concentrated HF may rapidly progress to a fatality if left untreated[2].

Every effort must be made to prevent exposure to hydrofluoric acid or hydrogen fluoride[3]. If exposure does occur, the specialized procedures which follow are recommended to avoid the very serious consequences that might otherwise occur.

---

[2] From ATSDR´s Toxicology Profile for Fluorides, Agency for Toxic Substances and Disease Registry, of the Health and Human Services USA.

[3] Basic Principle of Occupational Health "If your goal is zero occupational accidents and illnesses, you must strive for zero over-exposure to physical, chemical, biological and psycho-social risk agents.

Guidelines for first aid and medical treatment.

General Information:

Hydrofluoric Acid exposures are different from other acid exposures because:

- HF penetrates all tissue it comes in contact with and does not remain on their surface[4].
- Once absorbed HF rapidly dissociates into ionic Hydrogen and Fluoride[4].
- Hydrogen is in this context of little importance, Fluoride migrates and continues to destroy deep tissue layers as it migrates and will create soluble and insoluble compounds that are the basis for the systemic toxic effects[4].
- And unlike other acids that are rapidly removed or neutralized, the corrosive and toxic effects may continue for days if left untreated.

Hydrogen Fluoride is corrosive to the skin, eyes, and the mucous membranes of the respiratory and digestive tracts. And is readily absorbed into the body causing acute and severe toxic systemic effects, mainly attributable to a rapidly developing serum hypocalcemia caused by the formation of calcium fluoride or fluoroapatite, serum hypomagnesemia and serum hyperkaliemia[4].

HF skin burns are usually accompanied by severe pain which is thought to be due to irritation of nerve endings by increased level of potassium ions entering the extra-cellular space to compensate for the reduced levels of calcium ions which have been bound to the fluoride. Relief of pain is an important guide to the success of the treatment; therefore local anesthesia should be avoided[5].

The extent and the intensity of these systemic complications are directly related to the amount of HF absorbed, and the concentration of the HF when in solution. There are also indications that subcutaneous deposits of HF under the burnt area may be responsible for a slow supply of fluoride ions to the circulation[6].

Symptoms of serious intoxications include hypotension, hypoclacemic tetany, and/or laryngospasm, often respiratory failure (possibly due to pulmonary hypertension), ventricular tachycardia, ventricular fibrillation and cardiac arrest. Renal and hepatic functions may be impaired and muscular damage may be secondary to tetany[7].

Speed is essential. Delays in first aid care or medical treatment or improper medical treatment will likely result in grater damage or may, in some cases, result in a fatal outcome.

---

[4] ATSDR´s *Toxicology Profile for Fluorides*, Agency for Toxic Substances and Disease Registry, Department of Health and Human Services USA.

[5] T. D. Brown.- *The Treatment of Hydrofluoric Acid Burns*.
The Journal of the Society of Occupational Medicine, Vol. 24, No. 3, July 1974, pp 80-89.

[6] Buckingham F.M. Surgery: *A Radical Approach to Severe Hydrofluoric Acid Burns*. Journal of Occupational Medicine, Vol. 30, No. 11, pp 873-874 1988

[7] Upfal, Doyle, Medical Management of Hydrofluoric Acid Exposure.- Journal of Occupational Medicine, Vol. 32, No. 8 August 1990. Plus all references to this article.

List of Appendices:

Appendix 1: First Aid and medical treatment for HF exposure

These are useful for training of medical staff, first aid teams and as a fast reminder for those that have no experience and normally do not see HF exposures regularly. They can also be sent with the patient to the medical facility where definitive treatment will be provided. Attending physicians will greatly benefit from the information provided in the algorithms avoiding loss of time and improving patient prognosis.

Appendix 2: First Aid Form on Patient to Hospital

A first aid form that should be filled out by the person who has given first aid and that should be sent with the patient to the hospital or clinic to inform the attending physician on the actions already taken.

Appendix 3: First Aid Kit Contents

A list of contents for a first aid kit for hydrofluoric acid exposures. It is recommended that this kit be kept available as close as possible to the place where accidental exposures may occur.

Appendix 4: List of addresses where gel can be obtained.

Appendix 5: Recipes for preparation of gels and solutions

The recipes of calcium gluconate gel, and the solutions of calcium gluconate for nebulization, injection, and eye irrigation that are intended for those situations where the gel or the solutions are not available and you have to make them. However, notice that the preparations are difficult and should be preferably carried out by a qualified pharmacist.

Appendix 6: List of obsolete treatment methods

In this appendix are methods listed which have been used in the past or are still used.
All of the listed treatment modalities have limitations that do not permit them to be the elective treatment for HF exposures. Calcium gluconate is the treatment of choice because:

- It is an excellent outside source of calcium.
- It is easy to prepare and use in the field, in route, or in hospital settings.
- Helps to minimize both the corrosive and the toxic systemic effects.
- It can be used in first aid procedures as well as in medical procedures.
- There are no known negative side effects of the gel or the solutions at the calcium concentrations suggested.

There is a large volume of clinical experience to support the use of this modality of treatment

Appendix 7: References

APPENDIX 1.

ALGORITHMS OR FLOW CHARTS FOR THE MANAGEMENT OF HYDROFLUORIC ACID EXPOSURES

Author:
Miguel Treviño MD Occupational and Environmental Medicine
With the invaluable cooperation of:
Michael A. Mackinnon MD and
Carol Butler RN
June 2005.

GENERAL PROCEDURE TO BE FOLLOWED:

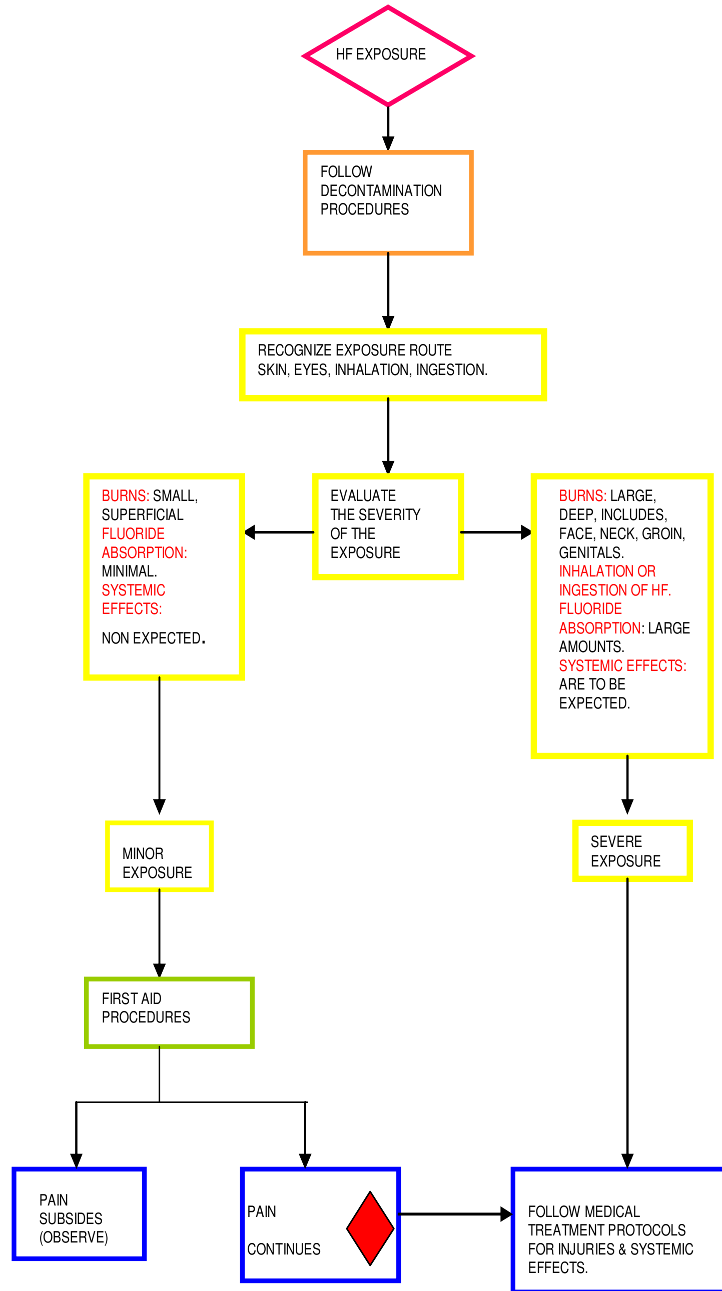
EXPOSURE

DECONTAMINATION

SIGNS AND SYMPTOMS
&
SEVERITY EVALUATION

FIRST
AID

MEDICAL
TREATMENT



SKIN EXPOSURE

DECONTAMINATION

EXPOSURE

DECONTAMINATION PROCEDURE FOR AHF & HF AQUEOUS SOLUTIONS.

- GO TO THE NEAREST SOURCE OF WATER OR SAFETY SHOWER.
- OPEN THE WATER VALVE.
- REMOVE ALL YOUR CLOTHING, SHOES AND JEWELRY.
- FINALLY, WHILE CLOSING YOUR EYES AND FACING THE WATER FLOW, REMOVE YOUR GOGGLES OR RESPIRATOR FACE MASK.
- REMEMBER WASH FOR 5 MINUTES MAXIMUM.

DECONTAMINATION PROCEDURE FOR HF CONTAINING TARS & OILS.

PROTECTING YOUR HANDS WITH PVC, NITRILE OR NEOPRENE GLOVES PROCEED TO:

- MECHANICALLY REMOVE THE TAR OR OIL USING GAUZE, TONGUE DEPRESSOR, PAPER TOWELS ETC.

CONSIDER ALL DISCARDED MATERIALS HAZARDOUS WASTE AND HANDLE THEM APPROPRIATELY.

- USE “BABY-OIL” TO REMOVE LEFTOVER TAR OR OIL.
- REMOVE “BABY- OIL” RESIDUE THOROUGHLY BY WASHING WITH SOAP & WATER.
- OR USE A CITRUS OIL SOLVENT AND WATER AND THEN
- WASH WITH COPIOUS AMOUNTS OF WATER FOR 5 minutes MAXIMUM.

SIGNS, SYMPTOMS & SEVERITY CLASSIFICATION

- EXPOSURE TO CONCENTRATED SOLUTIONS OF HF <30%.
- EXPOSED BODY SURFACE TO AHF* LESS THEN 3 SQUARE INCHES.
- INJURY AND/OR PAIN APPEARS SEVERAL HOURS AFTER EXPOSURE.
- SUPERFICIAL INJURIES.
- TISSUE NECROSIS- BLANCHING, BLISTERING, SWELLING, PAIN.
- PATIENT IS CONSCIOUS, STABLE, COOPERATIVE.
- NO SYSTEMIC TOXIC EFFECTS.

→ MINOR EXPOSURE

- EXPOSURE TO HIGH CONCENTRATIONS OF HF >30% OR AHF.*
- EXPOSURE BODY SURFACE IS MORE THAN 3 SQUARE INCHES.
- INJURY APPEARS IMMEDIATELY AFTER EXPOSURE, WITH SEVERE PAIN, REDNESS BLANCHING.
- EXPOSURE OF THE FACE, GROIN, GENITALS OR NECK.
- PATIENT IS UNCONSCIOUS AND UNSTABLE.
- CARDIAC ARRHYTHMIA (IRREGULAR HEART BEATS).
- SYSTEMIC TOXIC EFFECTS PRESENT.

→ SEVERE EXPOSURE

FIRST AID

FIRST AID PROCEDURES (MINOR EXPOSURE):

- USING ACID RESISTANT GLOVES, CONTINUOUSLY RUB CALCIUM GLUCONATE 2.5% GEL ON THE EXPOSED AREA.
- NOTE THE TIME OF INITIATION.
- IF PAIN SIGNIFICANTLY DECREASES OR DISAPPEARS WITHIN 20 TO 30 MINS, STOP AND OBSERVE.
- NEVER USE LOCAL ANESTHETICS.

FIRST AID PROCEDURES (SEVERE EXPOSURE):

- USING ACID RESISTANT GLOVES, CONTINUOUSLY RUB CALCIUM GLUCONATE 2.5% GEL ON THE EXPOSED AREA UNTIL YOU REACH MEDICAL ASSISTANCE.
- FOLLOW MEDICAL PROCEDURES.

MEDICAL TREATMENT

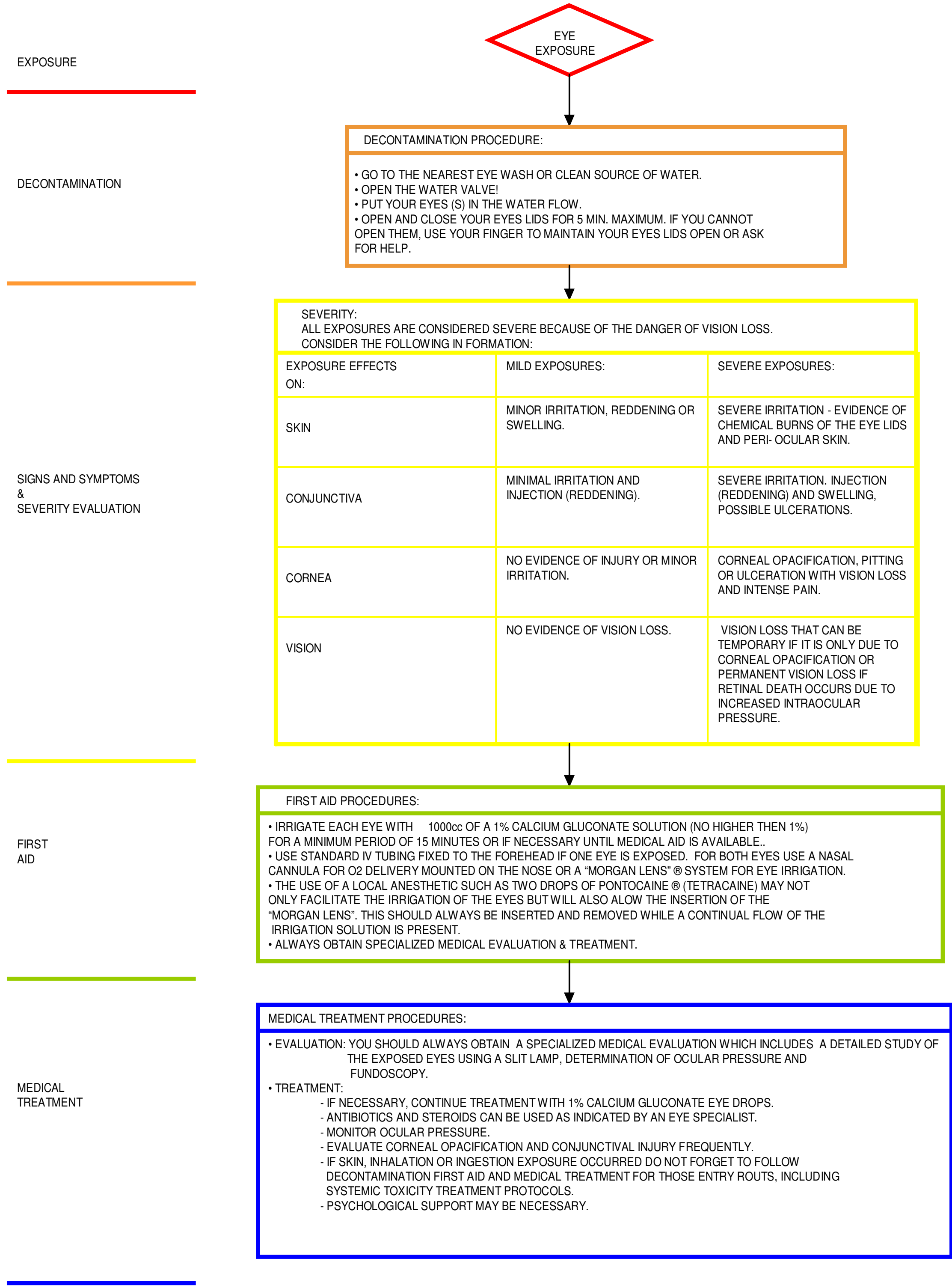
MEDICAL TREATMENT PROCEDURES:

MEDICAL MANAGEMENT OF THE CHEMICAL INJURIES AFTER DECON & FIRST AID:

- INJECT CALCIUM GLUCONATE 2.5% IN NORMAL SALINE SOLUTION INTO, AROUND AND UNDER THE INJURY.
- NEVER USE LOCAL ANESTHETICS. PAIN PERCEPTION IS IMPORTANT TO DETERMINE THE AMOUNT OF CALCIUM GLUCONATE TO BE INJECTED.
- TREAT THE INJURY AFTER THE INJECTIONS AS YOU WOULD ANY OTHER OPEN WOUND.
- DO NOT OVERINJECT DIGITS, NOSE FLAPS OR EAR LOBES SO AS TO AVOID ISCHEMIC NECROSIS.
- IN CASE OF LIMB AND FACE EXPOSURES SLOW INTRA-ARTERIAL INFUSION OF 2.5% CALCIUMGLUCONATE

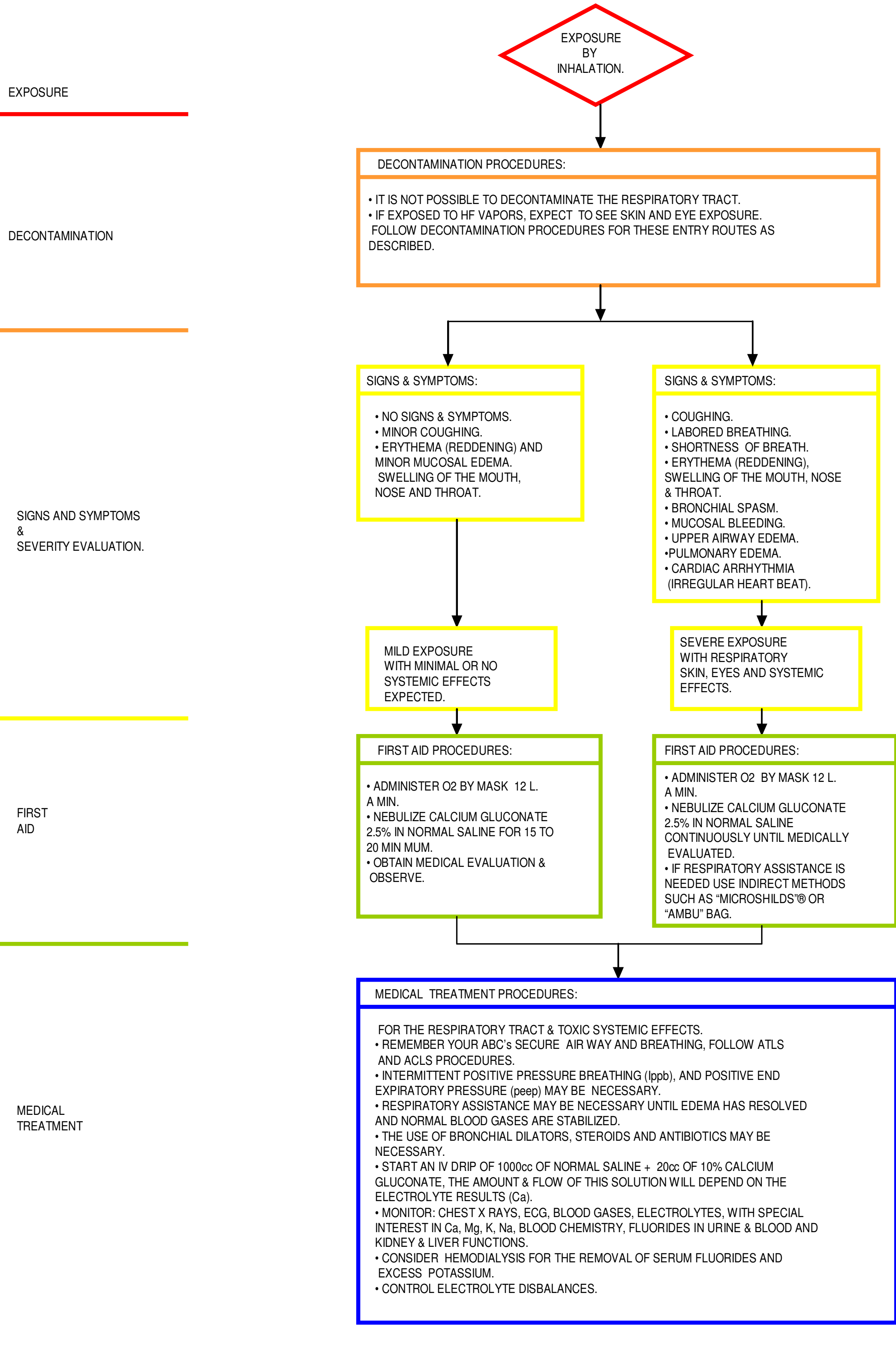
MEDICAL MANAGEMENT OF THE TOXIC SYSTEMIC EFFECTS.

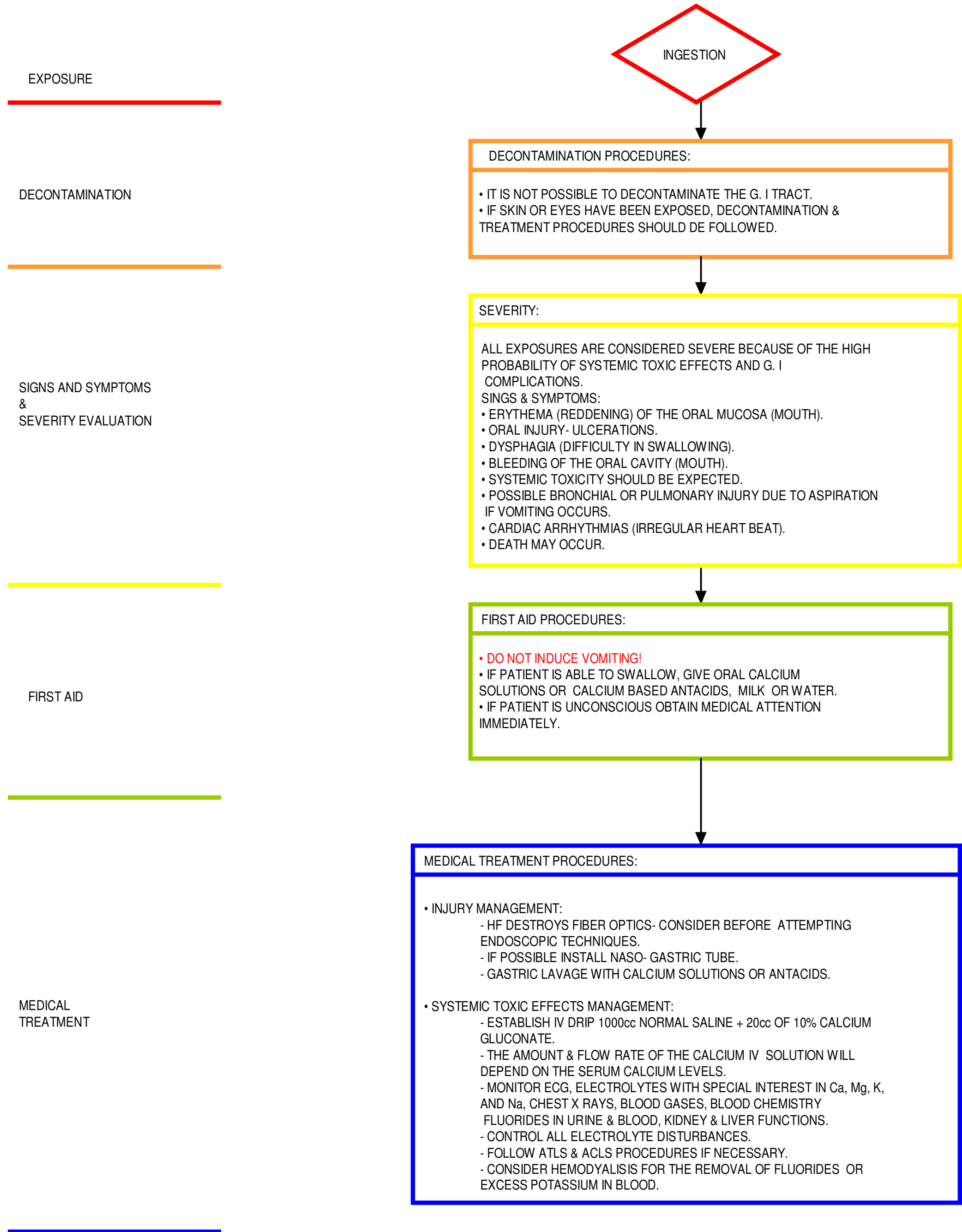
- START A DRIP OF 1000cc + 2 AMPOULES OF 10% CALCIUM GLUCONATE SOLUTION.
- THE AMOUNT OF SOLUTION AND RATE OF ADMINISTRATION WILL DEPEND ON THE PATIENT'S SERUM CALCIUM (ELECTROLYTE TITRATION TECHNIC).
- MONITOR CONTINUOUSLY EKG, ELECTROLYTES (WITH SPECIAL INTEREST IN CALCIUM, MAGNESIUM, SODIUM, AND POTASSIUM), CHEST X RAYS, Ph, BLOOD CHEMISTRY, FLUORIDES IN URINE AND BLOOD, LIVER & KIDNEY FUNCTIONS.
- CONSIDER HEMODIALYSIS FOR THE REMOVAL OF FLUORIDES.


EXPOSURE
EYE EXPOSURE
DECONTAMINATION
DECONTAMINATION PROCEDURE:
• GO TO THE NEAREST EYE WASH OR CLEAN SOURCE OF WATER.
• OPEN THE WATER VALVE!
• PUT YOUR EYES (S) IN THE WATER FLOW.
• OPEN AND CLOSE YOUR EYES LIDS FOR 5 MIN. MAXIMUM. IF YOU CANNOT OPEN THEM, USE YOUR FINGER TO MAINTAIN YOUR EYES LIDS OPEN OR ASK FOR HELP.
SIGNS AND SYMPTOMS & SEVERITY EVALUATION
SEVERITY:
ALL EXPOSURES ARE CONSIDERED SEVERE BECAUSE OF THE DANGER OF VISION LOSS.
CONSIDER THE FOLLOWING IN FORMATION:
EXPOSURE EFFECTS ON:
MILD EXPOSURES:
SEVERE EXPOSURES:
SKIN
MINOR IRRITATION, REDDENING OR SWELLING.
SEVERE IRRITATION - EVIDENCE OF CHEMICAL BURNS OF THE EYE LIDS AND PERI- OCULAR SKIN.
CONJUNCTIVA
MINIMAL IRRITATION AND INJECTION (REDDENING).
SEVERE IRRITATION. INJECTION (REDDENING) AND SWELLING, POSSIBLE ULCERATIONS.
CORNEA
NO EVIDENCE OF INJURY OR MINOR IRRITATION.
CORNEAL OPACIFICATION, PITTING OR ULCERATION WITH VISION LOSS AND INTENSE PAIN.
VISION
NO EVIDENCE OF VISION LOSS.
VISION LOSS THAT CAN BE TEMPORARY IF IT IS ONLY DUE TO CORNEAL OPACIFICATION OR PERMANENT VISION LOSS IF RETINAL DEATH OCCURS DUE TO INCREASED INTRAOCULAR PRESSURE.
FIRST AID
FIRST AID PROCEDURES:
• IRRIGATE EACH EYE WITH 1000cc OF A 1% CALCIUM GLUCONATE SOLUTION (NO HIGHER THEN 1%) FOR A MINIMUM PERIOD OF 15 MINUTES OR IF NECESSARY UNTIL MEDICAL AID IS AVAILABLE..
• USE STANDARD IV TUBING FIXED TO THE FOREHEAD IF ONE EYE IS EXPOSED. FOR BOTH EYES USE A NASAL CANNULA FOR O2 DELIVERY MOUNTED ON THE NOSE OR A "MORGAN LENS" ® SYSTEM FOR EYE IRRIGATION.
• THE USE OF A LOCAL ANESTHETIC SUCH AS TWO DROPS OF PONTOCAINE ® (TETRACAINE) MAY NOT ONLY FACILITATE THE IRRIGATION OF THE EYES BUT WILL ALSO ALOW THE INSERTION OF THE "MORGAN LENS". THIS SHOULD ALWAYS BE INSERTED AND REMOVED WHILE A CONTINUAL FLOW OF THE IRRIGATION SOLUTION IS PRESENT.
• ALWAYS OBTAIN SPECIALIZED MEDICAL EVALUATION & TREATMENT.
MEDICAL TREATMENT
MEDICAL TREATMENT PROCEDURES:
• EVALUATION: YOU SHOULD ALWAYS OBTAIN A SPECIALIZED MEDICAL EVALUATION WHICH INCLUDES A DETAILED STUDY OF THE EXPOSED EYES USING A SLIT LAMP, DETERMINATION OF OCULAR PRESSURE AND FUNDOSCOPY.
• TREATMENT:
- IF NECESSARY, CONTINUE TREATMENT WITH 1% CALCIUM GLUCONATE EYE DROPS.
- ANTIBIOTICS AND STEROIDS CAN BE USED AS INDICATED BY AN EYE SPECIALIST.
- MONITOR OCULAR PRESSURE.
- EVALUATE CORNEAL OPACIFICATION AND CONJUNCTIVAL INJURY FREQUENTLY.
- IF SKIN, INHALATION OR INGESTION EXPOSURE OCCURRED DO NOT FORGET TO FOLLOW DECONTAMINATION FIRST AID AND MEDICAL TREATMENT FOR THOSE ENTRY ROUTS, INCLUDING SYSTEMIC TOXICITY TREATMENT PROTOCOLS.
- PSYCHOLOGICAL SUPPORT MAY BE NECESSARY.

OTHER EYE TREATMENTS FOR HF EXPOSURE.

A.-Subconjunctival injection of a 1% calcium gluconate solution.


EXPOSURE
DECONTAMINATION
SIGNS AND SYMPTOMS
&
SEVERITY EVALUATION.
FIRST
AID
MEDICAL
TREATMENT
EXPOSURE
BY
INHALATION.
DECONTAMINATION PROCEDURES:
• IT IS NOT POSSIBLE TO DECONTAMINATE THE RESPIRATORY TRACT.
• IF EXPOSED TO HF VAPORS, EXPECT TO SEE SKIN AND EYE EXPOSURE.
FOLLOW DECONTAMINATION PROCEDURES FOR THESE ENTRY ROUTES AS
DESCRIBED.
SIGNS & SYMPTOMS:
• NO SIGNS & SYMPTOMS.
• MINOR COUGHING.
• ERYTHEMA (REDDENING) AND
MINOR MUCOSAL EDEMA.
SWELLING OF THE MOUTH,
NOSE AND THROAT.
SIGNS & SYMPTOMS:
• COUGHING.
• LABORED BREATHING.
• SHORTNESS OF BREATH.
• ERYTHEMA (REDDENING),
SWELLING OF THE MOUTH, NOSE
& THROAT.
• BRONCHIAL SPASM.
• MUCOSAL BLEEDING.
• UPPER AIRWAY EDEMA.
•PULMONARY EDEMA.
• CARDIAC ARRHYTHMIA
(IRREGULAR HEART BEAT).
MILD EXPOSURE
WITH MINIMAL OR NO
SYSTEMIC EFFECTS
EXPECTED.
SEVERE EXPOSURE
WITH RESPIRATORY
SKIN, EYES AND SYSTEMIC
EFFECTS.
FIRST AID PROCEDURES:
• ADMINISTER O2 BY MASK 12 L.
A MIN.
• NEBULIZE CALCIUM GLUCONATE
2.5% IN NORMAL SALINE FOR 15 TO
20 MIN MUM.
• OBTAIN MEDICAL EVALUATION &
OBSERVE.
FIRST AID PROCEDURES:
• ADMINISTER O2 BY MASK 12 L.
A MIN.
• NEBULIZE CALCIUM GLUCONATE
2.5% IN NORMAL SALINE
CONTINUOUSLY UNTIL MEDICALLY
EVALUATED.
• IF RESPIRATORY ASSISTANCE IS
NEEDED USE INDIRECT METHODS
SUCH AS "MICROSHIELDS"® OR
"AMBU" BAG.
MEDICAL TREATMENT PROCEDURES:
FOR THE RESPIRATORY TRACT & TOXIC SYSTEMIC EFFECTS.
• REMEMBER YOUR ABC's SECURE AIR WAY AND BREATHING, FOLLOW ATLS
AND ACLS PROCEDURES.
• INTERMITTENT POSITIVE PRESSURE BREATHING (Ippb), AND POSITIVE END
EXPIRATORY PRESSURE (peep) MAY BE NECESSARY.
• RESPIRATORY ASSISTANCE MAY BE NECESSARY UNTIL EDEMA HAS RESOLVED
AND NORMAL BLOOD GASES ARE STABILIZED.
• THE USE OF BRONCHIAL DILATORS, STEROIDS AND ANTIBIOTICS MAY BE
NECESSARY.
• START AN IV DRIP OF 1000cc OF NORMAL SALINE + 20cc OF 10% CALCIUM
GLUCONATE, THE AMOUNT & FLOW OF THIS SOLUTION WILL DEPEND ON THE
ELECTROLYTE RESULTS (Ca).
• MONITOR: CHEST X RAYS, ECG, BLOOD GASES, ELECTROLYTES, WITH SPECIAL
INTEREST IN Ca, Mg, K, Na, BLOOD CHEMISTRY, FLUORIDES IN URINE & BLOOD AND
KIDNEY & LIVER FUNCTIONS.
• CONSIDER HEMODIALYSIS FOR THE REMOVAL OF SERUM FLUORIDES AND
EXCESS POTASSIUM.
• CONTROL ELECTROLYTE DISBALANCES.


EXPOSURE
INGESTION
DECONTAMINATION
DECONTAMINATION PROCEDURES:
• IT IS NOT POSSIBLE TO DECONTAMINATE THE G. I TRACT.
• IF SKIN OR EYES HAVE BEEN EXPOSED, DECONTAMINATION & TREATMENT PROCEDURES SHOULD DE FOLLOWED.
SIGNS AND SYMPTOMS & SEVERITY EVALUATION
SEVERITY:
ALL EXPOSURES ARE CONSIDERED SEVERE BECAUSE OF THE HIGH PROBABILITY OF SYSTEMIC TOXIC EFFECTS AND G. I COMPLICATIONS.
SINGS & SYMPTOMS:
• ERYTHEMA (REDDENING) OF THE ORAL MUCOSA (MOUTH).
• ORAL INJURY- ULCERATIONS.
• DYSPHAGIA (DIFFICULTY IN SWALLOWING).
• BLEEDING OF THE ORAL CAVITY (MOUTH).
• SYSTEMIC TOXICITY SHOULD BE EXPECTED.
• POSSIBLE BRONCHIAL OR PULMONARY INJURY DUE TO ASPIRATION IF VOMITING OCCURS.
• CARDIAC ARRHYTHMIAS (IRREGULAR HEART BEAT).
• DEATH MAY OCCUR.
FIRST AID
FIRST AID PROCEDURES:
• DO NOT INDUCE VOMITING!
• IF PATIENT IS ABLE TO SWALLOW, GIVE ORAL CALCIUM SOLUTIONS OR CALCIUM BASED ANTACIDS, MILK OR WATER.
• IF PATIENT IS UNCONSCIOUS OBTAIN MEDICAL ATTENTION IMMEDIATELY.
MEDICAL TREATMENT
MEDICAL TREATMENT PROCEDURES:
• INJURY MANAGEMENT:
- HF DESTROYS FIBER OPTICS- CONSIDER BEFORE ATTEMPTING ENDOSCOPIC TECHNIQUES.
- IF POSSIBLE INSTALL NASO- GASTRIC TUBE.
- GASTRIC LAVAGE WITH CALCIUM SOLUTIONS OR ANTACIDS.
• SYSTEMIC TOXIC EFFECTS MANAGEMENT:
- ESTABLISH IV DRIP 1000cc NORMAL SALINE + 20cc OF 10% CALCIUM GLUCONATE.
- THE AMOUNT & FLOW RATE OF THE CALCIUM IV SOLUTION WILL DEPEND ON THE SERUM CALCIUM LEVELS.
- MONITOR ECG, ELECTROLYTES WITH SPECIAL INTEREST IN Ca, Mg, K, AND Na, CHEST X RAYS, BLOOD GASES, BLOOD CHEMISTRY FLUORIDES IN URINE & BLOOD, KIDNEY & LIVER FUNCTIONS.
- CONTROL ALL ELECTROLYTE DISTURBANCES.
- FOLLOW ATLS & ACLS PROCEDURES IF NECESSARY.
- CONSIDER HEMODYALISIS FOR THE REMOVAL OF FLUORIDES OR EXCESS POTASSIUM IN BLOOD.

APPENDIX 2.

FIRST AID MANAGEMENT OF HYDROFLUORIC ACID EXPOSURE.

INSTRUCTIONS: Fill out the form and send with the patient to the hospital

Name____Age___Sex_______

Diagnostic.

The patient was exposed to:

( ) Anhydrous Hydrogen Fluoride, ( ) HF 70% solution, ( ) HF 49% solution
( ) Other fluoride, specify____
Time & Date of exposure ____
Nature of Exposure:

( ) Skin, ( ) Eyes, ( ) Inhalation, ( ) Ingestion.
Degree of Exposure:
( ) Slight, ( ) Severe.
Treatment given:

( ) Lavage, decontamination of the skin. Duration_________min.
( ) Lavage, decontamination ot the eyes. Duration_________min.
( ) Calcium Gluconate gel Duration_________min.
( ) Eye Irrigation with a 1% calcium gluconate solution. Duration__________min.
( ) Nebulization of a 2.5% solution of calcium gluconate.Duration__________min.
( ) Basic life support.
HF is corrosive and toxic and may cause:

1. **Severe and painful burns of the skin.**
2. **Irritation of air ways that can lead to bronchitis or even pulmonary edema.**
3. **Asphyxia.**
4. **Severe and painful burns of the eyes.**
5. **Blindness.**
6. **Severe and painful burns of the digestive track and,**
7. **Serious Toxic Systemic Effects, that will require specialized metabolic, surgical, thoracic, ophthalmic intervention (Intensive Care).**

NOTE.- All or any of the above effects may be delayed in onset, and or be accompanied by Toxic Systemic Effects.
PLEASE MAKE SURE THAT HOSPITAL STAFF IS AWARE OF THE UNIQUE CARACTERISTICS OF INJURIES CAUSED BY HF EXPOSURES AND THE FACT THAT THE SYSTEMIC TOXIC EFFECTS OF THE EXPOSURE WILL REQUIERE PROMPT SERUM MONITORING OF FLUORIDES, CALCIUM, MAGNESIUM AND SODIUM AND CALCIUM REPLACEMNT BY INFUSION.

Name and Signature____
Of the Dr., Nurse, or attending first aid person
Date____________Time__________Place___________________________________

APPENDIX 3.
FIRST AID KIT FOR HYDROFLUORIC ACID EXPOSURES (HF KIT).

Instructions: This HF KIT should be placed in a controlled area near workplaces where the possibility of an exposure exists, such as production areas, storage areas, and in transportation vehicles. The KIT should be sealed and only opened for emergency use or for periodical inspection.

CONTENTS OF THE HF KIT.

In a portable container place the following items:
A.- A full set of updated decontamination and first aid procedures.
B.- For skin exposures.
1. **4 pairs of gloves (PVC, Nitrile, or Neoprane).**
2. **8 tubes of HF gel (A calcium gluconate gel at a 2.5% concent.).**
3. **4 aluminized plastic sheets.**

C.- For eye exposures.
1. **1 liter of a 1% calcium gluconate irrigation solution.**
2. **1 IV tubing set.**
3. **1 nasal canula for O_2 administration.**

D.- For inhalation exposures.
1. **1 O_2 portable cylinder with nebulizer, ¾ in. Corrugated tubing and mask.**
2. **500 cc. of a 2.5% calcium gluconate nebulizing solution.**

E.- For ingestion exposures.
1. **1 bottle of calcium solution or of effervescent calcium tablets.**
2. **1 large bottle of a calcium or magnesium based antacid.**

F.- For general use.
1. **2 pairs of scissors for clothing removal and general use.**
2. **1 flashlight.**
3. **20 pacs of sterile gauze.**
4. **2 tourniquets.**
5. **2 coldpacks**
6. **1 IV infuser.**

G.- FOR MEDICAL USE ONLY.
1. **5 amp. of a 10% calcium gluconate solution.**
2. **5, 25 caliber, 1 and ½ in. long stainless steel needles.**
3. **1 bottle of a local eye anesthetic.**
4. **5, 10 cc. Sterile syringes.**
5. **4 Morgan lenses.**
6. **1 tube of water soluble lubricating gel.**
7. **2 sterile containers.**
8. **1 set of airway canulas.**
9. **2 ventilation masks, or microshields.**

NOTE. These are minimum quantities and may need adjustment depending on the number of potential exposure victims. Kits should be inspected once every 3 months. Used or outdated materials should be replaced immediately. The calcium gel and solutions should be protected from light extreme heat or cold.

THE FOLLOWING LABEL SHOULD BE WRITTEN ON THE OUTSIDE OF THE HF KIT.

CAUTION
TO BE OPENED ONLY IF AN HF EXPOSURE OCCURS.
IF THE SEAL ON THIS KIT IS BROKEN AN IMMEDIATE INSPECTION SHOULD BE MADE BY AN AUTHORIZED, COMPETENT PERSON.

APPENDIX 4.

CALCIUM GLUCONATE GEL PRODUCERS.
GEL CAN BE OBTAINED IN THE FOLLOWING ADDRESSES:

FRANCE. **Pharmacie Centrale des Hopitaux de Paris.***
13, Rue Lavoisier.
92033 NANTERRE CEDEX.
France.
Tel. 01 46 69 13 13.

GERMANY. **Krebs Walter Import-Export GmbH & Co.**
Pharmazeutische Erzeunginisse
Dieselstr. 29.
D 63071 Offenbach.
Germany.
Tel. (049 69) 80 90 99-3

ITALY. **Stabilimento Ausimont SpA**
Via della Chimica 5.
Porto Marghera (Venezia).
Italy.
Tel. 041 2912805.

THE NEDERLANDS.
Van der Laan´s Handelsonderneming.
Nieuwe Maas Apotheek.
Haantje de Jongstraat 6.
3067 AB Rotterdam.
The Nederlands.
Tel. 010-4209155.

UNITED KINGDOM.
Industrial Pharmaceutical Service Limited.
Bridgwater Road.
Broadheath.
Altricham
Cheshire WA14INA
England.
Tel. 061-928 3672.

CANADA. **Pharma Science.**
8400 Darnly Road,
Montreal Quebec H4T 1M4,
Tel. (514) 340 1114.

***Supplies a modified version of the gel, containing dexamethasone and preserving agents with a highly allergenic potential. Allergic dermatoses may develop immediately or after repeated use.**

APPENDIX 5.

HOW TO MAKE THE CALCIUM GLUCONATE GEL AND SOLUTIONS.

CALCIUM GLUCONATE 2.5% GEL (HF GEL).

1. **Mix one 10cc´s of a 10% calcium gluconate solution with 30cc´s of a water soluble lubricant to obtain 40cc´s of calcium gluconate 2.5% gel by weight.**

CALCIUM GLUCONATE 1% EYE IRRIGATION SOLUTION.

1. **To obtain 100cc´s of a 1% calcium gluconate solution, mix 90cc´s of normal saline solution with 10cc´s of a 10% calcium gluconate solution.**
2. **To obtain 1000cc´s of a 1% calcium gluconate solution mix 900cc´s of a normal saline solution with 100cc´s of a 10% calcium gluconate solution.**

CALCIUM GLUCONATE 2.5% SOLUTION FOR NEBULIZATION OR FOR INJECTION.

1. **To obtain 100cc´s of a 2.5% calcium gluconate solution, mix 75cc´s of a normal saline solution with 25cc´s of a 10% solution of calcium gluconate.**
2. **To obtain 1000cc´s of a 2.5% calcium gluconate solution, mix 750cc´s of a normal saline solution with 250cc´s of a 10% solution of calcium gluconate.**

APPENDIX 6.

List of obsolete treatment methods

In this appendix are methods listed which have been used in the past or are still used.
All of the listed treatment modalities have limitations that do not permit them to be the elective treatment for HF exposures.

A.- BENZLAKONIUM CHLORIDE. (Benzal, Zephiran or Hyamine, rtm).
This method consists of immersing or soaking the exposed area for 3 to as much as 12 hrs. in a 0.13 % benzalkonium chloride iced solution in water or alcohol, followed by careful debridement and conventional treatment of the injury.

B.- BIER BLOCK AND INTRAVENOUS CALCIUM GLUCONATE INFUSION.
The technique consists of simultaneously using a proximal tourniquet and the intra-venous administration of calcium gluconate in the exposed limb to elevate local calcium levels.

C.- HEXAFLUORINE
Current information did not demonstrate the compound to be effective in the treatment of skin or eye exposures as was initially reported, it proved to be as efficient as simple water rinsing of the area.

D.- BICARBONATE OF SODA
The treatment consisted of soaking the area exposed or immersion of the exposed person into a large container containing saturated solution of bicarbonate of soda.

E.- MAGNESIUM OXIDE AND SULPHATE PASTE.
These pastes were used on the surface of the exposed area.

F.- AMMONIA INHALATION
The treatments described when to permit the patient to do a single inhalation of anhydrous ammonia for inhalations of Hydrogen Fluoride.

APPENDIX 7.

References on skin exposure:

Brown T.D., *The Treatment of Hydrofluoric Acid Burns*.
Journal of the Society of Occupational Medicine, vol. 24, no. 3, July 1974. And all references of the article.

Dowback, Rose, Rohrich. *A Biochemical and Histological Rational for Treatment of Hydrofluoric Acid Burns with Calcium Gluconate*. UT Dallas, JUL-AUG, 14 (4) ; 324-7, 1994.

EPA´s, (Environmental Protection Agency of the United States of America) *Fluoride Study, Report to Congress*, Section 301(N)(6), Clean Air Act Amendments of 1990-1992, Section 2, Properties, and all references of the document.

Harris, Rumack. *Comparative Efficacy of Injectable Calcium and Magnesium Salts in the Therapy of Hydrogen Fluoride Acid Burns*. Clinical Toxicology, 18 (a), pp 1027-1032.1981.

Kono, Kashida, Watanabe, Tanioka, Dote, Orita, Bessho,Yoshida, Sumi, Omebyshi. *An Experimental Study on the Treatment of Hydrofluoric Acid Burns*. Archives of Environmental Contamination and Toxicology Vol.22, No. 4, pp 414-418, 1992.

NIOSH, *Profile on Hydrogen Fluoride*, (National Institute for Occupational Safety and Health) US Department of Health, Education & Welfare. Public Health Service and Center for Disease Control. 1976. and all references of the document.

Sheridan, Ryan, Quimby, Blair, Tompkins, Burke. *Emergency Management of Major Hydrofluoric Acid Exposures*. Burns, Vol. 21, No. 1, pp 62-64, 1995, and all references of the article.

Treviño, Herrmann, Sprout. *Treatment of Severe Hydrofluoric Acid Exposures*. Journal of Occupational Medicine, Vol. 25, No. 12, Dic. 1983. and all references of the article.

Treviño, Herrmann. *Nueva Modalidad en el Tratamiento* de *Quemaduras con Acido Fluorhidrico*. Presented to the Dupont Medical Group Mexico City 1984.

Upfal, Doyle. *Medical Management of Hydrofluoric Acid Exposures*, Journal of Occupational and Environmental Medicine, Vol. 32, No. 8, August 1990. And all references of the article.

Williams, Bracken, Cuppage, Mclaury, Kirwin & Klaussen. *Comparative Effectiveness of Topical Treatments* for *Hydrofluoric Acid Burns*. Journal of Occupational Medicine, vol. 27, no. 10, pp 733-739. And references of the article.

***The Material Safety Data Sheets for HF* of Mexichem Fluor, Dupont, Honeywell, Solvay, etc.**

Comercial Information on *De-Solv-It* brand name of a citrus based solvent for oils, glues and tar.

References on obsolete techniques for skin exposure treatment.

Cox, Osgood. ***Intravenous Magnesium Sulfate for the Treatment of Hydrogen Fluoride Acid Burns*****. Journal of Toxicology, Clinical Toxicology. 01-1994, 23(2): 123-36. And all referenced in the article.**

Henry, Hla. ***Intravenuos Regional Calcium Gluconate Perfusion for Hydrofluoric Acid Burns*****. Journal of Toxicology, Clinical Toxicology, Vol. 30, No. 2, pp 203-207.**

Heron. ***Tratamiento con Acetato de Calcio de las Exposiciones al Acido Fluorhidrico*****. Inedito.**

Lan, Mohr, Arenhiltz, Solem. ***Treatment of Hydrofluoric Acid Burns to the Face by Carotid Artery Infusion of Calcium Gluconate*****. Journal of Burn Care & Rehabilitation. Vol. 25, (5) Sept. Oct. 2004 pp 421-424. And all referenced in the article.**

Mackinnon. ***Hydrofluoric Acid Burns*****. Occupational Dermatoses, Dermatologic Clinics, Vol. 6, No. 1, Jan. 1988.**

Michelson, Martin, Cabaugh, Scheider. ***Wave form Monitored Intraarterial Calcium Infusion for Hydrofluoric Acid Burns*****. Vet. Hum. Toxicology; 34 (4), 1992, p 337.**

Shultz. ***Hydrofluoric Acid Burns*****. The Western Journal of Medicine, July 1989, p 71. And all referenced in the article.**

Vance, Curry, Kunkel, Ryan, Ruggeri. ***Digital Acid Burns Treatment With Intraarterial Calcium Infusion*****. Annals of Emergency Medicine 15:8, August 1988. And all referenced in the article.**

Williams, Hammad, Cotting, Herchelroad. ***Intravenous Magnesium in the Treatment of Hydrofluoric Acid Burns in Rats*****. Annals of Emergency Medicine 1994, March, 23(3): pp464-469.**

References on eye exposure

Bentur, Tennenbaum, Yaffe, Helpert. ***The Role of Calcium Gluconate in the Traetment of Hydrofluoric Acid Eye Burns*****. Israel Poison Information Center. Rambam Medical Center, Jerusalem, Israel. Annals of Emergency Medicine 1993, Sep; 22(9); 1488-99, and the references of the article.**

Grant. ***Hydrofluoric Acid, Toxicology of the Eye, 2nd Edition*****. Charles C. Thomas, Springfield, Ill, 1974, p 557.**

McCully, Whyting, Peritt. ***Treatment for Exposed Eyes to Hydrogen Fluoride*****. LOM, 10, Vol. 25, No. 6, Jun. 1983.**

Rubenfield, Sivert, Aentsen, Laibson. ***Ocular Hydrofluoric Acid Burns*****. American Journal of Ophthalmology, 1145(4), pp 420-423, 1992**

Shewmake, Anderson. ***Hydrofluoric Acid Burns*****. Archives of Dermatology, 115: 593-596, 1979.**

Trevino, Herrmann, Sprout, ***Treatment of Severe Hydrofluoric Acid Exposures*****. Journal of Occupational Medicine, Vol. 25, No. 12, Dic. 1983**

The MSDS's for Hydrogen Fluoride **from.- Mexochem Fluor, Dupont, Honeywell, Solvay, etc.**

References on inhalation exposure

Lee, David C. *Treatment of Hydrogen Fluoride Exposure with Nebulized Calcium Gluconate*. Medical College of Pennsylvania, Delaware, Valley Regional Poison Control Center. Presented at the American Chemistry Council, HF Panel Meeting in Hilton Head SC. USA. 1993.

Lee, Wiley, Snyder. *Treatment of Inhalation Exposure to Hydrogen Fluoride Acid with Nebulized Calcium Gluconate*. Journal of Occupational Medicine, Vol. 35, No. 5, p 470, 1993.

Mackinnon. *Hydrofluoric Acid Burns*. Dermatologic Clinics, Vol. 6, No. 1, pp 67-74, January 1988.

Russi, EW, Ahmed. *Calcium and Calcium Antagonist in Airway Disease*. Chest 1984; 86 (3): 475-482

Treviño, Herrmann, Sprout. Treatment of Severe *Hydrofluoric Acid Exposures*. Journal of Occupational Medicine, Vol. 25, No. 12, Dic. 1983.

Upfal, Doyle. *Medical Management of Hydrofluoric Acid Exposures*. Journal of Occupational and Environmental Medicine, Vol. 32, No. 8. August 1990.

***The MSDS´s for Hydrogen Fluoride* from Mexichem Fluor, Dupont, Honeywell, etc.**

Caravati 1988.- unable to obtain the article.

References on ingestion exposure

Monoguerra, Neuman. *Fatal Poisoning From Acute Hydrofluoric Acid Ingestion*. Journal of Emergency Medicine 1986, 4: pp 362-363 and al references for the article.

Stemski, Grande, Ling. *Survival Following Hydrofluoric Acid Ingestion*. Annals of Emergency Medicine 1992, Nov; 21(11): 1396-9, 1992.

***The MSDS´s for Hydrogen Fluoride* from Mexichem Fluor, Dupont, Honeywell, Solvay**