

# HF BURNS: HOW TO AVOID THEM?

## HEXAFLUORINE<sup>®</sup> decontamination

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### PURPOSE

HF is a weak acid but a strong corrosive and toxic chemical with a potentially lethal risk. It is commonly used in the workplace with specific prevention and safety rules. The first aid protocol in case of splashes with HF is detailed here. Water is usually recommended as the protocol of reference, sometimes in association with calcium gluconate. We have decided to compare these commonly recommended interventions with Hexafluorine<sup>®</sup>, a specific active rinsing solution of HF splashes and its derivatives.



FIGURE 1-Photograph of a 70% HF splash of a worker. Immediate washing with water at the accident site.

### METHODS

The aim of this study is to review the literature for available data concerning HF burns and their decontamination, and to emphasize how new substitute studies can be linked to clinical results.



### RESULTS

#### 1. CASE REPORTS WITH WATER

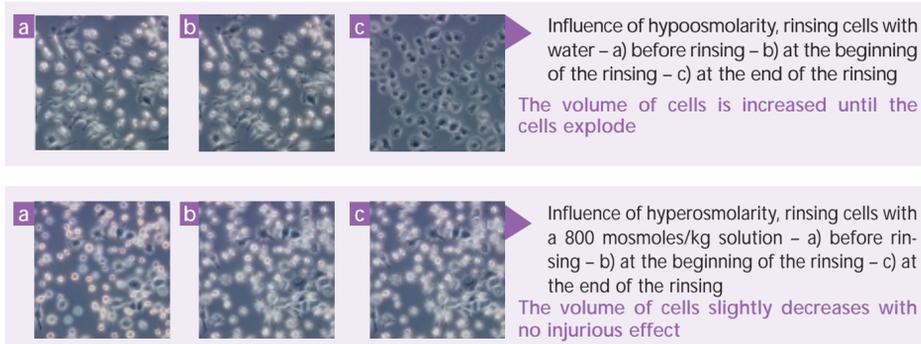
Initial tap water decontamination has usually been recommended in cases of chemical splashes. Even though immediate water decontamination can decrease the severity of the burns, often it cannot prevent severe burns and sometimes ends in death (clinical and animal data). Improvements are obtained with calcium gluconate, which binds fluoride ions. Diluted HF has been successfully decontaminated with water followed by topical applications of calcium gluconate gel. Improved management of HF burns can prevent fatalities as a result of some major HF burns, but severe burns and sequelae remain.

- Mayer (in 1985) 70% HF (water)  
> 10% of body surface affected - death
- Mullet (in 1996) 70% HF (water + GluCa)  
> 8% of body surface affected - death
- Tepperman (in 1980) 100% HF (water + GluCa)  
> 2.5% of body surface affected - death
- Camarasa (in 1983) 100% HF (water + GluCa)  
> Partial permanent incapacity, on sick leave for 1 year  
> After effects = wearing of mittens, sensitiveness to the cold
- Dunser (in 2004) 70% HF (water + GluCa)  
> 30% of body surface, improvement of the handling of the situation  
> no death, 25 day hospital stay

#### 2. IN VITRO EXPERIMENTS

Studies were conducted to analyse the impact of an effective replacement decontamination solution to replace water during as first aid washing. *In vitro* experiments performed at the Augenklinik, Aachen, Germany, show the benefits of slightly hyperosmolar washing (fibroblast culture experiments)

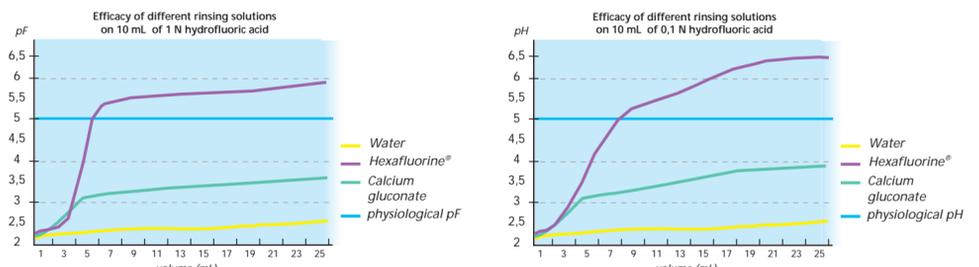
FIGURE 2 - FIBROBLAST CULTURES



The comparison between different washing solution to obtain the most rapid return to a physiological pH and pF (*in vitro* simulation of penetration through a semi-permeable membrane) is shown in Figure 3.

### RESULTS (CONTINUED...)

FIGURE 3 - IN VITRO EXPERIMENTS



#### RESULTS:

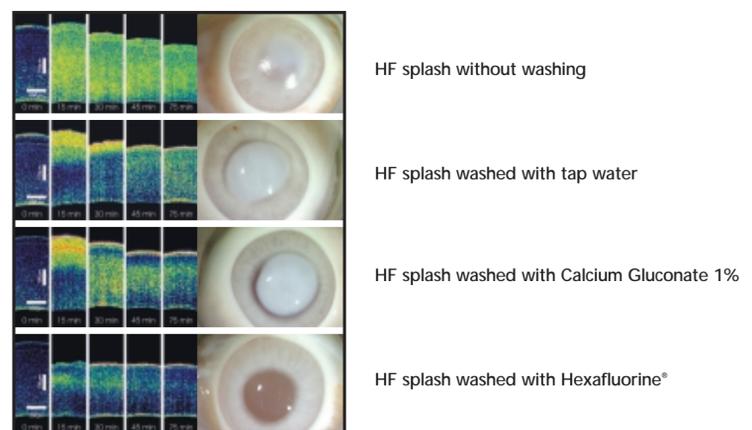
These measurements show the better efficacy of Hexafluorine<sup>®</sup> versus water to allow a quick return to physiological values of pH and pF without the effect of mechanical rinsing.

#### 3. EX VIVO EXPERIMENTS

Experiments were performed with the acute EVEIT model using rabbit cornea (model has been proven to react very similarly to living eye tissue concerning the behaviour during chemical eye burns) and an OCT HR (Optical Coherence Tomography).

If we follow the penetration velocity of 2.5% HF inside the cornea, we can see that it is decreasing with time due to dilution. Full corneal penetration is observed 240 s after topical application.

FIGURE 4 - Comparison between no rinsing and different washing solutions (washing during 15 minutes), 20s after topical application of 25 µl of 2.5% HF.



This study shows a clear cornea even one hour after the end of the washing only with Hexafluorine<sup>®</sup>.

#### 4. CASE REPORTS

##### 32 case studies of emergency decontamination with Hexafluorine<sup>®</sup>

| No of cases | Splashed by  | Affected body surface                   | Type of washing   |
|-------------|--|---|---|
| 1           | HF/HCl Bath  | Total immersion                         | Hexafluorine <sup>®</sup> on the body, Ocular washing with water <sup>1</sup> |
| 1           | 70% HF vapour  | Right cheek                             | Hexafluorine <sup>®</sup> <sup>2</sup>  |
| 1           | 38% HF   | One eye                                 | Hexafluorine <sup>®</sup>   |
| 2           | 5% HF  | body                                    | Hexafluorine <sup>®</sup>   |
| 1           | 40% HF   | One eye <sup>3</sup>                    | Hexafluorine <sup>®</sup> on the site and at the infirmary                    |
| 1           | 6% HF /15% HNO <sub>3</sub>                              | One eye                                 | Hexafluorine <sup>®</sup> on the site and at the infirmary                    |
| 5           | 40% HF   | 0.2 - 1 - 4.5 - 4.5 - 16.5 <sup>1</sup> | Hexafluorine <sup>®</sup> on the site and at the infirmary                    |
| 5           | 6% HF / HNO <sub>3</sub> 15%                             | 0.2 - 2.25 - 4 - 4.5 - 10.5             | Hexafluorine <sup>®</sup> on the site and at the infirmary                    |
| 2           | 70% HF   | Left forearm - oral cavity              | Hexafluorine <sup>®</sup>   |
| 1           | HF (concentration unknown)                               | One eye                                 | Hexafluorine <sup>®</sup>   |
| 1           | HF/HNO <sub>3</sub> pH=1                                 | One eye                                 | Hexafluorine <sup>®</sup>   |
| 1           | HF/HNO <sub>3</sub> pH=1                                 | Two eyes                                | Hexafluorine <sup>®</sup>   |
| 1           | HF/HNO <sub>3</sub> pH=1                                 | One thigh                               | Hexafluorine <sup>®</sup>   |
| 2           | HF/HNO <sub>3</sub> pH=1                                 | Two thighs                              | Hexafluorine <sup>®</sup> after 1h / 1h30                                     |
| 2           | HF/HNO <sub>3</sub> /H <sub>2</sub> SO <sub>4</sub> pH=1 | One eye - Face                          | Hexafluorine <sup>®</sup> after 3-5 min                                       |
| 2           | HF/HNO <sub>3</sub> pH=1                                 | Face + oral cavity - Forehead           | Hexafluorine <sup>®</sup>   |
| 3           | HF/HNO <sub>3</sub> pH=1                                 | Forearm-arm - arm + hand - Two elbows   | Hexafluorine <sup>®</sup>   |
| 1           | HF/HNO <sub>3</sub> pH=1                                 | Wrists                                  | Hexafluorine <sup>®</sup> after 2 hours                                       |

#### RESULTS: Immediate analgesic effect with the washing with Hexafluorine<sup>®</sup> and no sequelae.

Among these 32 case reports, using Dunser's table (cf. references), 5 accidents could have presented lethal risk but no sign of systemic effect was observed when decontamination with Hexafluorine<sup>®</sup> was performed and treatment with calcium gluconate was applied with calcium gluconate if needed.

1: Slight burns on the abdomen and the back and serious burn on the left eye  
2: Slight painless erythema: Application the next day with calcium gluconate gel, no lost work time  
3: ocular and cutaneous splash with 40% HF

**CONCLUSION** New substitute experimental studies open the fields of understanding burn mechanisms and improvement of first aid, and maybe in the future, delayed management of chemical burns. Convergent data, *in vitro* data and *ex vivo* data confirm the clinical observations that an active decontamination solution for HF splashes, such as Hexafluorine<sup>®</sup>, is effective, as it is used as first aid and immediately.

### REFERENCES

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