# Huishoudproducten en chemische brandwonden: een aanvaardbaar risico?

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Belgisch Antigifcentrum
Symposium 50 jaar AGC

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# Chemische brandwonden & huishoudproducten

- Veel chemische producten, ook in het huishouden
- Niet:
  - oorlogsgassen (yperiet), witte fosfor, en andere exoten
  - Oxiderende agentia (permanganaat….)
  - Etc.
- Wel:
  - huis- tuin- en keukenproducten waar dagelijks ongelukken mee gebeuren.

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# Incidentie

- Relatief ‘weinig frequent’ in vgl. met thermische brandwonden (3 à 10%)
- Weinig gegevens, geen systematische data-collectie
- Statistiek 6 maanden, feb 2010 tot juli 2010 (enkel huishoudelijk ongevallen)
  - 166 blootstellingen ( ~332/jaar)
  - 36 kinderen
  - 57 per os – 55 cutaan – 54 oculair
  - Detectie van slechts een fractie van werkelijke casussen
  - Hoeveel onderrapportering?
- CREDOC-studie 1993
  - Extrapolatie tot 12.000/jaar voor België

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# Belangrijk?

- Ernst:
  - Initiële onderschatting
  - Diepe wondes – zware chirurgische interventies.
  - Tot 30% van alle mortaliteit verbonden aan brandwonden ~ chemische brandwonden

    Luterman et al. Chemical burn injury. In: Jurkiewcz et al.
    Plastic Surgery: Principles and Practice. Mosby: 1990.

| | |
|---|---|
| Eye irritation/conjunctivitis | 41 |
| Skin burns, unspecified | 32 |
| 2nd degree skin burns | 20 |
| Burns in the mouth | 9 |
| Mouth irritation | 6 |
| Ocular pains | 6 |
| Local erythema / irritation | 4 |
| Lip burns | 4 |
| vomiting | 3 |
| Crying | 3 |
| Lip swelling | 2 |
| Epigastric pain | 2 |
| 3rd degree skin burns | 2 |
| Throat pain | 1 |
| Hemoptysis | 1 |
| Anorexia | 1 |
| Local pain | 1 |
| Oesophagitis | 1 |
| Ear pain | 1 |
| Cough | 1 |

# Caustisch product

- Goldfrank's Toxicologic Emergencies:
  - « A caustic is a xenobiotic that causes both functional and histological damage on contact with tissue surfaces »
- Classificatie soms complex. Meest relevant:
  - Zuur
  - Base
- Herkennen:

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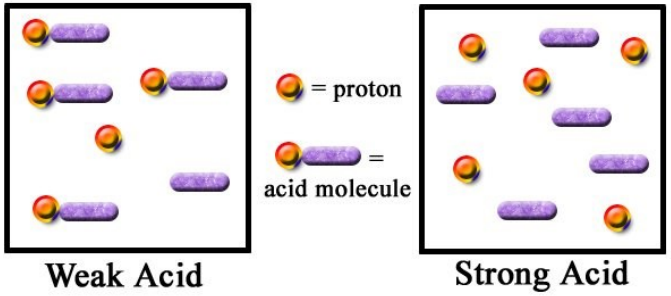
# Zuur? Base?

- Zuur:
  - « proton-donor »
  - $H^+Cl^-$ → $H^+$ en $Cl^-$
- Base:
  - « proton-acceptor »
  - $Na^+OH^-$ → $Na^+$ en $OH^-$
- Soms moeilijker herkenbaar:
  - NH3
  - $NH4^+OH^-$ → $NH4^+$ en $OH^-$

# Sterke/zwakke base/zuur

- Volledig gedissocieerd in waterige oplossing = « sterk »
- Onvolledig gedissocieerd = « zwak »
  - vb HCl in $H_2O$ ---> enkel $H_3O^+$, $OH^-$ en $Cl^-$ geen HCl
- Sterke zuren/basen:
  - Zwavelzuur (H2SO4), Zoutzuur (HCl)
- Zwakke zuren:
  - Azijnzuur, citroenzuur, mierenzuur, etc.
- Sterke basen:
  - NaOH, KOH
- Zwakke basen:
  - NH3, acetaat$^-$



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# Waar in het huishouden?

- Zuren
  - Ontstoppers
  - Ontkalkers
  - Toiletreinigers
  - Batterijzuur
  - Antiroestmiddelen
  - Azijn
- Basen
  - Ontstoppers
  - Ovenreinigers
  - Ammoniak
  - Sodakristallen
  - Schuurmiddelen
  - Javel
  - Cement
  - Kalk

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# Ernst van blootstelling

- pH
- Concentratie
- Duur van contact
- Andere
  - Neutraliserende substanties (vb voedsel in de maag)
  - Mogelijkheid om in weefsels door te dringen (molecuulgrootte, graad van dissociatie,…)

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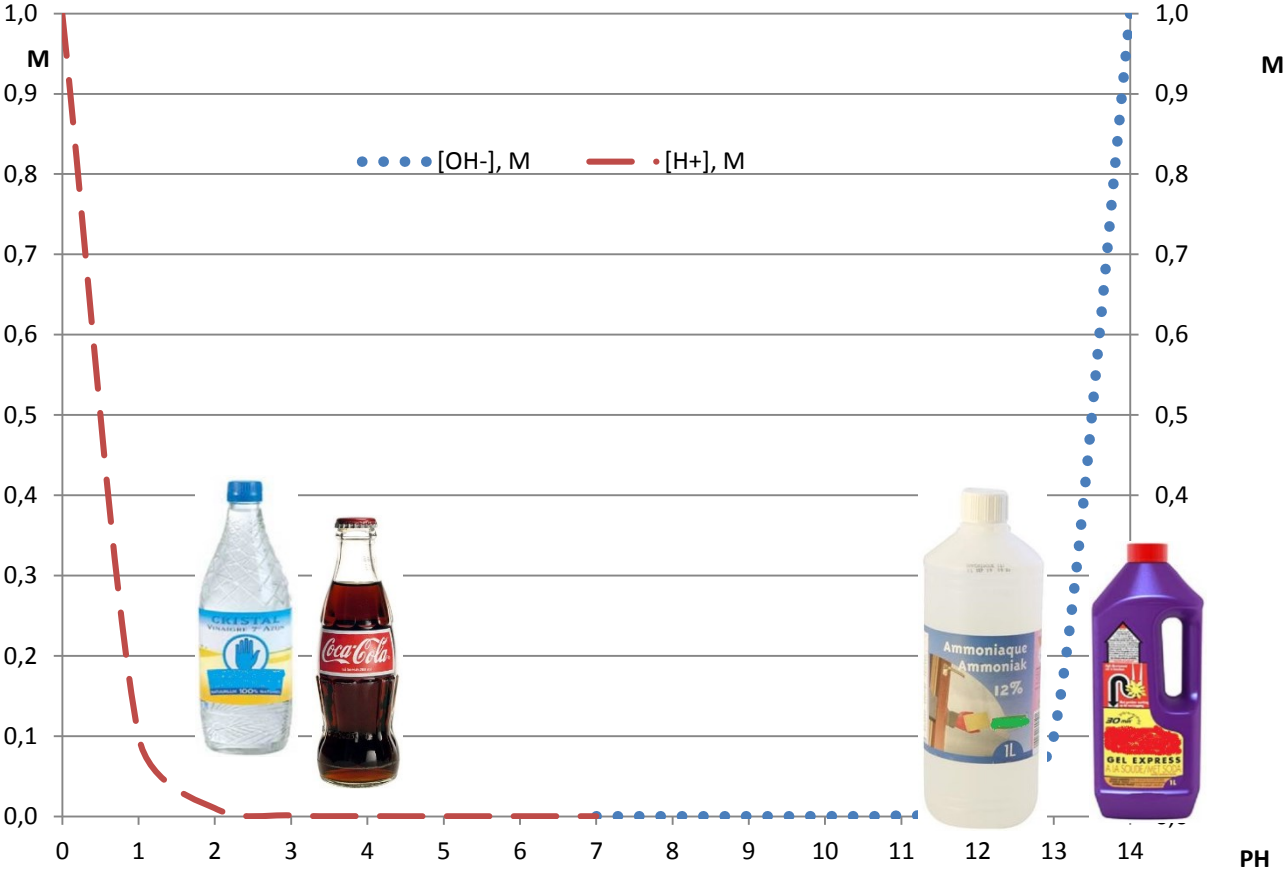
# Wat is een pH, pOH?



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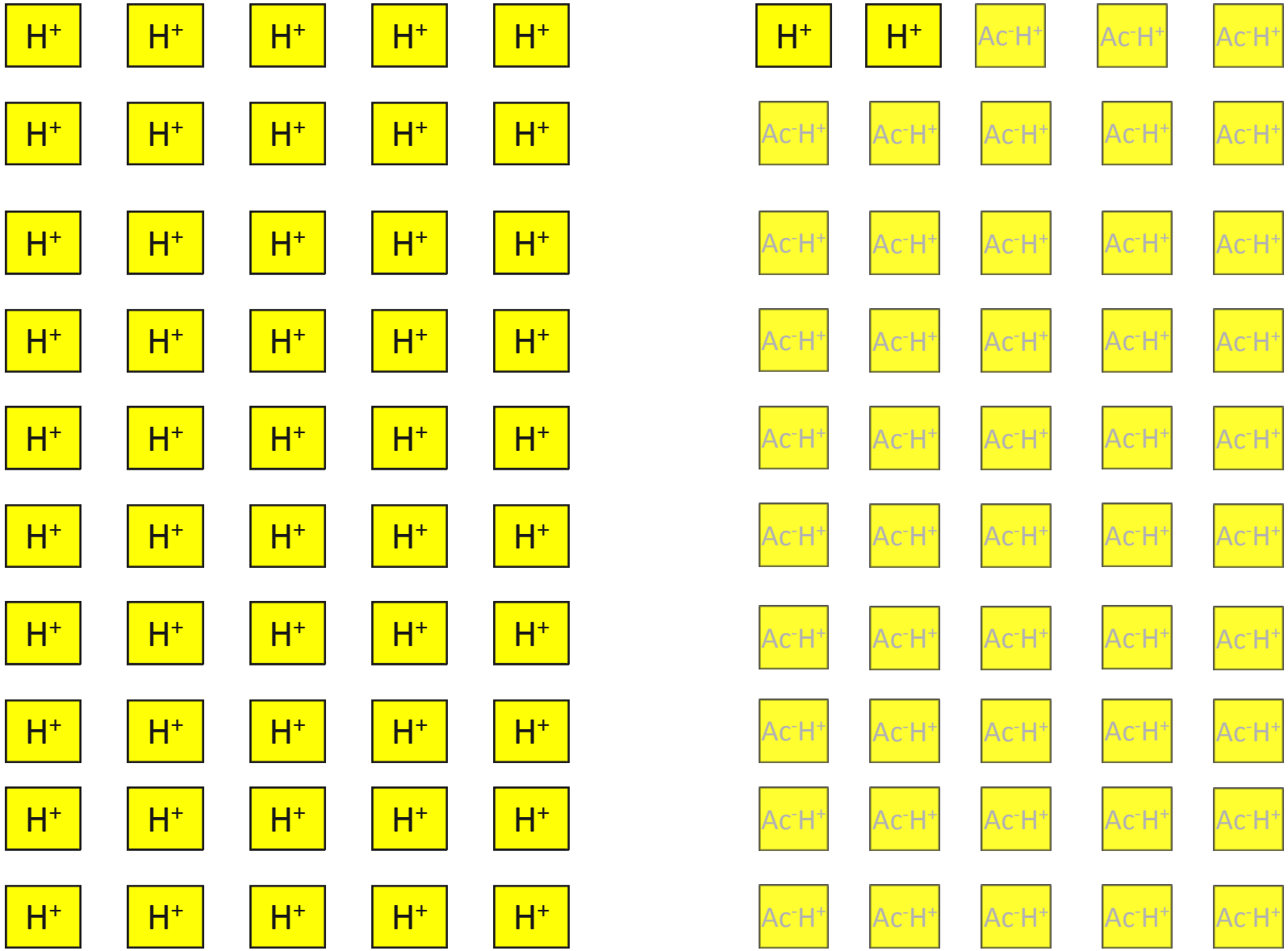
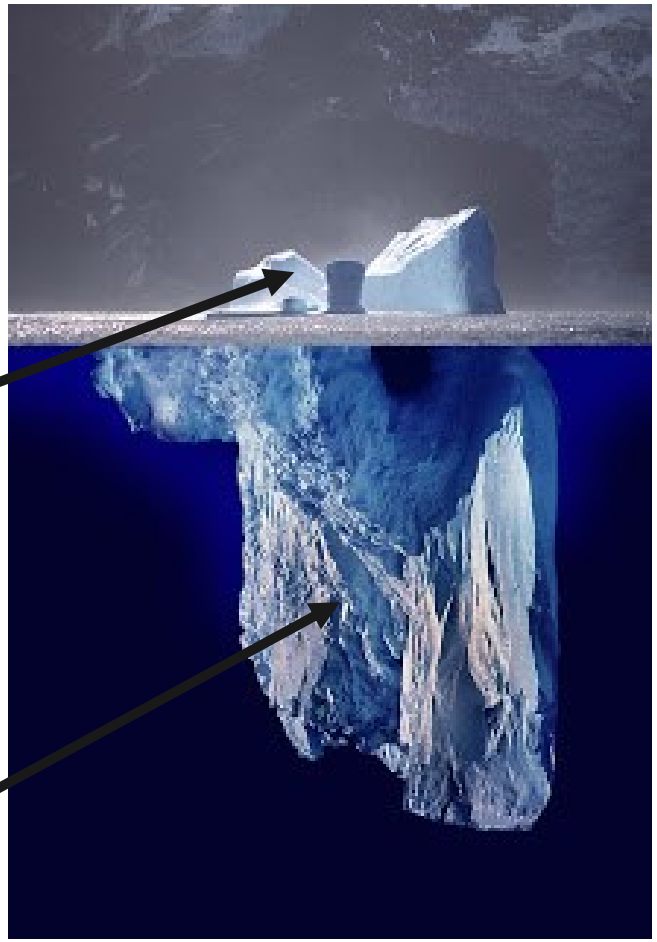
# Wat is buffer?

- pH is ± stabiel (‘mild ’)
- Grote reserve aan « agressoren » $OH^-$ en $H^+$
- Soms gekwantificeerd in de termen
  - « alkali-reserve »
  - « zuur-reserve »


H+
Ac-H+

# Alkalijne reserve / zuurreserve



**p(O)H**

pH zegt niet alles: let ook op de concentratie!!

**p(O)H-reserve**

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# Toepassing: azijn

## CHEMICAL SKIN BURNS CAUSED BY A BIPHASIC NAIL POLISH REMOVER CONTAINING ETHYL ACETATE

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*Belgian Poison Centre, Brussels, Belgium*

### Introduction

Ethyl acetate and butyl acetate are widely used in nail polish removers. In contact with water they may decompose with formation of acetic acid(1,2). Our aim is to describe a case of skin injury caused by a decomposed biphasic nail polish remover.

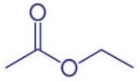
### Case report

Three hours after using a nail polish remover, a 74-year-old woman felt a burning sensation in her fingers. The following hours, she complained of increasing burning pain. She was examined by a general practitioner one day later. There was erythema with blisters at the top of the fingers, suggestive of a second degree burn. The lesions were treated with a silver sulfadiazine ointment. She recovered without sequellae. The original product presented in two phases: a solvent phase containing 59.4 % of ethyl acetate, 20.0 % of butyl acetate and 20.0 % of dimethoxymethane and an aqueous phase consisting of 99.2% of water with trace amounts of other ingredients. At the time of the accident, one month after opening of the bottle, there was only an aqueous phase left with a pH of 2.47. Analysis by HPLC-UV revealed 40% of acetic acid.

### Chemical identity

IUPAC name:
Ethyl ethanoate

CAS number:
141-78-6



### Discussion

Ethyl acetate and butyl acetate are widely used in nail polish removers, usually in one phase formulations. Some products are sold in a biphasic presentation, with an apolar solvent phase and a polar aqueous phase, to be shaken before use. Ethyl acetate (1) and butyl acetate (2) in biphasic solvent systems may slowly decompose into acetic acid and ethanol. In the literature we found no cases of skin burns caused by nail polish removers containing ethyl acetate or butyl acetate. We believe that the polar phase promoted decomposition of ethyl acetate by trapping acetic acid. This resulted in a solution with 40% of acetic acid and a pH of 2.47. Acetic acid is known to cause skin burns in concentrations as low as 5% (3).

### Conclusions

Decomposition of ethyl acetate or butyl acetate in biphasic nail polish removers can lead to the formation of a highly concentrated acetic acid solution, causing second degree skin burns.

*Fig. 1.* Deep ulcer on the dorsum of the left foot.

Tafelazijn:
6% ~ 1 M
pH 2,88

Contact Dermatitis. 1997 Mar;36(3):169-70.
Chemical burn from acetic acid with deep ulceration.
Kuniyuki S, Oonishi H.

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# Toepassing: vaatwastabletten

**Table 1** Patient and injury characteristics

| Case | Age (months) | Sex | Substance pH† | Detergent brand, form, source | GI ‡ | G | ETT | Hospital LOS (days) | PICU LOS (days) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 17 | M | 13.3 | MF powder | III | + | – | 65 | 0 |
| 2 | 19 | M | 13.3 | MF powder (wnb) | III | + | + ¶ | 50 | 9 |
| 3 | 15 | M | 13.3 | MF powder (wnb) | III | – § | + ¶ | 39 | 10 |
| 4 | 12 | F | 13.3 | MF powder | IIb | – | + | 14 | 3 |
| 5 | 19 | F | 10.9 | Fn powder | II | – | + | 12 | 4 |
| 6 | 15 | M | 13.3 | MF powder | I | – | + | 2 | 2 |
| 7 | 17 | M | 13.3 | MF powder | 0 | – | – | 2 | 0 |
| 8 | 11 | M | ns | Dishwasher tray | 0 | – | – | 2 | 0 |
| 9 | 30 | M | ns | Tablet | 0 | – | – | 2 | 0 |
| 10 | 22 | M | 13.4 | Atv granules | 0 | – | – | 1 | 0 |
| 11 | 16 | M | 13.4 | Atv granules | 0 | – | – | 1 | 0 |

†pH based on product testing at a 20% dilution rate; ‡gastrointestinal injury (endoscopic grade); §nasojejunal tube placement; ¶tracheostomy.
Atv, *Active* brand; ETT, endotracheal tube; Fn, *Finish* brand; G, gastrostomy; LOS, length of stay; MF, *Morning Fresh* brand; PICU, paediatric intensive care unit; wnb, wide-mouthed nozzle bottle.

Serious injuries from dishwasher powder ingestions in small children Amy Bertinelli et al.
Journal of Paediatrics and Child Health 42 (2006) 129–133

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# Ernst van blootstelling?

- pH
- Concentratie
- **Duur van contact**
- Andere
  - Neutraliserende substanties (vb voedsel in de maag)
  - Mogelijkheid om in weefsels door te dringen (molecuulgrootte, graad van dissociatie,…)

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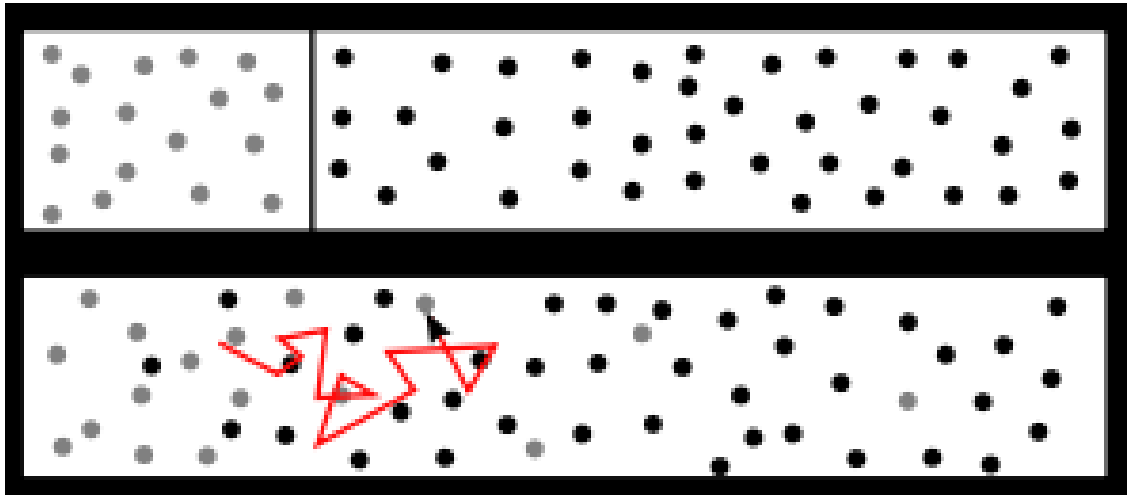
# Indringen /uitspoelen = diffusie = TRAAG



Volledigheid van uitspoelen wordt bepaald door:

1° Gradiënt (Sneller naar binnen dan naar buiten!)

2° Tijd

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# Hoe en waarom spoelen? Diffusie!

- Diffusie vraagt tijd!
  - SNELHEID:
    - Spoelen voor er penetratie is voorkomt schade.

      Vb ontstopper op de hand en binnen enkele seconden spoelen → vaak geen schade ondanks afgrijselijk agressieve producten
    - Hoe sneller, hoe beter
    - Ter plaatse spoelen!
    - Geen tijd verliezen: dichtsbijzijnde kraan!
  - DUUR:
    - Eens ingedrongen, kan men het alleen terughalen door LANGDURIG spoelen, essentieel in het voorkomen van verdere schade
    - In principe zeker 15 minuten voor zuren, 30 minuten voor basen.
    - Uurwerk in de hand!

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# Waarmee spoelen? Water!

- Water-based solutions are the best decontaminating fluids for dermal corrosive exposures: a mini review.
  Brent J. Clin Toxicol (Phila). 2013 Sep-Oct;51(8):731-6.
- Neutraliserende oplossingen (Diphoterin®):
  - Geen onafhankelijke prospectieve klinische studies
  - methodologische problemen
    - Vb beperkte debieten
    - Vb zwakke eindpunten
  - Risico van tijdsverlies en te beperkt debiet.

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# Topical Treatment of Experimental Hydrofluoric Acid Skin Burns by 2.5% Calcium Gluconate

Isabelle Roblin, PharmD,* Martine Urban, PharmD,* Domitille Flicoteau, PharmD,* Chantel Martin,† Dominique Pradeau, PhD*

Topical therapy with 2.5% calcium gluconate gel is considered as the "first-aid" treatment of accidental hydrofluoric acid skin burns. The efficacy of three different gel formulations varying in the amount and/or nature of their gelling and moisturizing agents was experimentally evaluated. Thirty male Wistar-Han rats (250 g) were exposed to 60 μl of 40% hydrofluoric acid for 2 minutes on two spots (4 $cm^2$) of skin under pentobarbital anesthesia. One lesion was massaged with 1 g of gel (10 rats/type of gel) at 3 minutes; 30 minutes; 1 hour; 1 hour, 30 minutes; 2 hours; 3 hours; and 4 hours after injury. During the next 3 days, rats received a single daily application of gel. The other lesion for each rat remained untreated (control). From day 1 after injury to the end of the study (day 17), gel therapy reduced the number of extensive (−66%), severe (−44%), and moderate (−34%) lesions ($P < .0001$). It reduced ($P < .001$) the median Area Under the Curve $day_{0-17}$ of burn injury from 34.0 (25th to 75th percentile: 18.2–44.5; untreated lesions) to 17.7 (7.0–26.7); overall, there was three cases of treatment failure. At day 17, full wound recovery was obtained in 14 cases by gel therapy compared with 6 in the absence of treatment. The efficacy of the three gel formulations was comparable for all evaluated parameters. Repeated applications of a 2.5% calcium gluconate gel is an efficient treatment of experimental 40% hydrofluoric acid skin burn; few differences were observed between evaluated gel formulations. (J Burn Care Res 2006;27:889–894)

with the wounded area. We here demonstrated the efficacy of repeated topical applications of three different 2.5% calcium gluconate gels in a rat model of HF skin burn. The influence of gel formulation was

tion), produced a lesion typical of HF exposure characterized by a central necrotic blister surrounded by a well-delimited edema.[2] The development, stabilization, and recovery (although often incomplete)

"Burn injury was induced using a protocol derived from other experimental studies in rats [cites]. **The washing of the exposed area with water after topical treatment was, however, discarded because it abolished the development of a burn lesion in our model.**"

burn injury

| Injury Phase | AUC Untreated | AUC Treated |
|---|---|---|
| Days 0–3 | 6.5 (4.2–10.5) | 3.0 (1.5–4.5)* |
| Days 3–14 | 19.5 (10.7–25.0) | 8.7 (5.5–17.0)* |
| Days 14–17 | 7.5 (2.0–13.0) | 2.0 (0.0–7.5)* |
| Total | 34.0 (18.2–44.5) | 17.7 (7.0–26.7)* |

*AUC*, area under the curve.
* Significantly different, $P < .001$, repeated measures analysis of variance on ranks and Student Newman Keuls test.

(25th and 75th percentiles). Not surprisingly, rats with a spontaneous full recovery at day 17 after burn were those with less severe burns (absence of lesion at day 1, no severe or extensive burns throughout the study). Exact causes of this variability are unknown but might include differences in shaving quality, in the HF exposure procedure, absence of individual housing, as well as interindividual variability.

The treatment protocol was adapted from therapeutic recommendations in humans with prompt and repeated calcium gluconate gel applications as often as

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# Zuren versus basen?

## Zuren:

- Coagulatie-necrose met een korst → minder diep
- Na grondige spoeling breiden deze letsel vaak niet meer uit
- pH 2 à 3
- Ongeveer 1/3 van alle chemische brandwonden
- Onmiddellijk symptomen

## Basen:

- Liquefactie-necrose: makkelijk doordringbaar voor OH → diepe letsels
- Letsel kunnen verder uitbreiden
- pOH 2 à 3 = pH 11 à 12
- Ongeveer 2/3 van alle chemische brandwonden.
- Laattijdige symptomen!

**Brandwonden door basen worden onderschat!!!!!**

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# Brandwonden

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# Waterstoffluoride (HF)

- Gevelreiniger of roestverwijderaar
- Zeer penetrant
- Zeer pijnlijk – niet initieel
- Calciumtherapie:
  - Gel
  - Infiltratie
  - Intra-arterieel

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# Waterstofperoxide

- Waterstofperoxide (casus)

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# Hair straightener

- Cosmetic FF
  - < 10,00 % $Ca(OH)_2$
  - pH value of Part 1 and 2 mixed prior to use : 11 – 13

http://www.radiosandwell.co.uk/afro.php?post_id=30#sthash.24WxTMHV.dpuf

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# Aanvaardbaar risico?

- Producten zullen niet verdwijnen
- Preventie:
  - Wetgeving: labelling, veiligheidsdoppen,…
  - Educatie
- Impact preventie:
  - Daling incidentie na invoeren veiligheidsdoppen
  - Groot verschil ontwikkelingslanden versus het Westen