Base (Sodium Hydroxide; NaOH) Skin Injury and Decontamination: In vitro, Experimental Animal, and Human Skin Explant Ex Vivo Studies

Mathieu L[1], Wang H-f[2], Zhang F[3], Fosse C[1], Coudouel H[1], Lati E[4], Peno-Mazzarino L[4], Bouzard D[4], Hall AH[5,6]

[1]Prevor Laboratory, Valmondois, France; [2]Department of Fire Engineering, The Chinese People's Armed Forces Police Academy, Langfang, Heibei Province, China; [3]Tianjin No. 1 Special Firefighting and Rescue Detachment, Tianjin, China; [4]BIO-EC Laboratory, Clamart, France; [5]Toxicology Consulting and Medical Translating Services, Inc., Laramie, Wyoming, USA; [6]Colorado School of Public Health, Denver, Colorado, USA

Objective

Sodium hydroxide (NaOH) is one of the most common corrosive substances, responsible of very painful and severe burns. An efficient skin model will allow a better understanding of burn mechanisms. These results were also approximated with in vitro experiments.

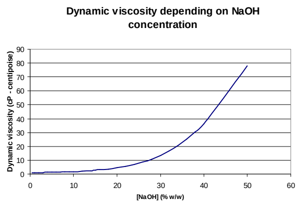
Methods

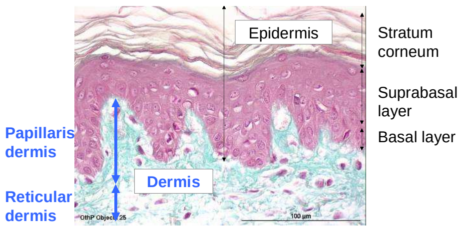
In vivo method

40% $NaOH_{aq}$ exposure during 5s in 18 rabbits (1.5+/-0.2kg) on the back of each rabbits, with paper filter of 1cm² diameter on depilatoried skin (Na2S). The skin are then decontaminated with Diphoterine®, boric acid or tap water (6 rabbits in each group) after 30s. Total amount of washing solution and temperature are followed. pH value is the indicator of the washing end. After the rinsing, spontaneous healing is followed. Only desinfecting liquid is applied once each day to prevent the wound from being infected.

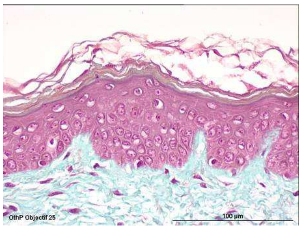
Ex vivo method

41 human skin explants from abdominoplasty preserved at 37°C in a moist atmosphere with 5% CO_2 were exposed to 50% NaOH by topical route. Control group: no exposition. Histological sampling at different times, from 1 minute up to 24 hours. Observation was performed by optical microscopy X40.

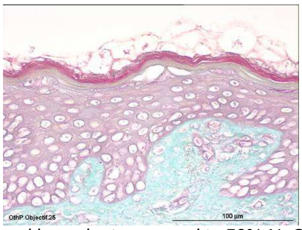




Non exposed human skin explants.



Human skin explants exposed to 50% NaOH during 30 minutes.
Destructuration of the stratum corneum.
Possible limit of the model due to the viscosity of 50% NaOH.

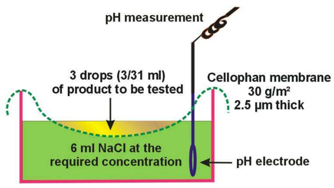


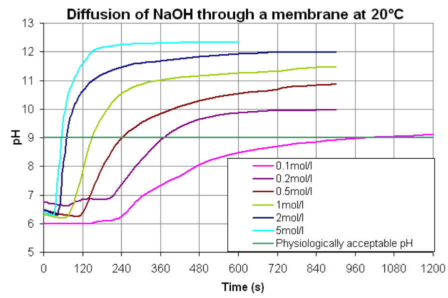
Human skin explants exposed to 50% NaOH during 2 hours.
No viability in epidermis and dermis.

This study on 50% NaOH is limited by the viscosity of the tested chemical and the way to apply it on explants. Further studies are requested on both less viscous concentrations and other application methods in order to be closer to real observations.

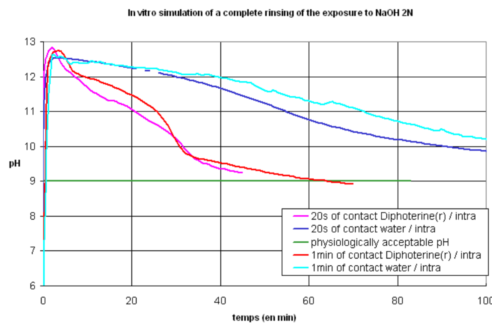
In vitro assays

The NaOH diffusion is simulated through a semipermeable membrane of cellophane (30g/cm², 2.5 micrometers). A volume of NaOH (3 drops) is put at the surface of the membrane and the evolution of the pH is measured in a compartment simulating the anterior chamber, containing sodium chloride (6ml, 420mosmoles/kg). Different NaOH concentrations were compared. NaOH decontamination: evaluating pH and temperature changes following washing with water or Diphoterine® were studied.





Diffusion depends on the concentration.

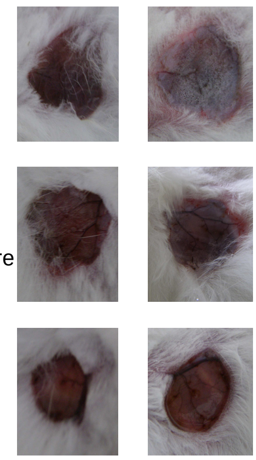


The physiologically acceptable pH is reached more rapidly with Diphoterine® washing than with tap water washing, thanks to its chemical activity.

Results

Solution	Consumption (ml)
Diphoterine®	51.8
Boric acid 3%	60.8
Tap Water	110.3

No significant temperature changes were founded in any group. Less Diphoterine® was needed to reach a physiologically acceptable pH of 6.7. NaOH burn healing was best following Diphoterine® washing, without significant heat release.



After NaOH exposure

After Diphoterine® washing

After 3% boric acid washing

After tap water washing

Conclusion

This study confirms the need for an urgent and effective decontamination to prevent or minimize the severity of chemical burns due to concentrated sodium hydroxide. These results support further studies and clinical use of Diphoterine® as a skin decontamination solution in case of sodium hydroxide cutaneous splashes.

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