Decontaminations for Emergent Concentrated Sulfuric Acid Skin Splash Research

Wang Hui-fei lecturer

(Department of Fire Engineering, The Chinese People armed Police forces Academy, Langfang, Hebei Province, China, 065000)

Abstract: The appropriate decontamination way and use as early as possible play very important role in the improvement of treatment and rehabilitation of skin burning. The different decontamination ways were tested for this purpose. Three decontaminants, Diphoterine, water and sodium bicarbonate were tested in vitro and rabbit skin to evaluate the after effects of decontamination of concentrated sulfuric acid. Firstly, the temperature of damaged skin surface increased no matter what kind of decontaminants was used. Secondly, both sodium bicarbonate solution and water rinsing could cause thermo burns easily; the amount of sodium bicarbonate use was least, but the trauma recovered slowly. The amount of water use was largest and water had less efficiency in balancing pH and easily caused the falling off of the damaged skin, which did not favor healing. Thirdly, the amount of Diphoterine use was two times as the sodium bicarbonate use. The increased temperature of damaged skin surface decreased auickh' (je ne sais pas pourquoi il a mis ce mot..) soon and trauma recovered month fast when Diphoterine was used (the total consumption of Dipho is doubled than that of solution of sodium bicarbonate, with a relatively low temperature of wound surface and rapid cooling, which well protects the skin tissues with quick and effective healing ability). It showed effective protection of damaged skin though the cost is high. The burn is more serious with delaying of washing time. The washing time is primarily important factor. Diphoterine is better choice than sodium bicarbonate, while water does not favor treatment and rehabilitation of trauma.

Keywords: Chemical burns, Sulfuric acid, Skin, Decontamination, Diphoterine

0 Introduction

In the production and processing, transportation, storage, as well as the people's daily lives, as a result of improper use, It is common that acidic chemical liquid splashed on bodies caused chemical burning accidents. In particular strong acid, sulfuric acid, nitric acid, hydrochloric acid, aqua regia (王水, nitrosyl chloride, NOCl, CAS No.: 2696-92-6, Oxydant tres fort $HNO_3 + 3HCl ==== 2H_2O + Cl_2 + NOCl$) and so on, resulting in skin burns, can cause local pain and tissue coagulation necrosis, moreover, it can cause permanent disability, if not treated in time, even threatening people lives. [1,2]. The research indicated that the burn appropriate handles early time is directly related to the patients' condition and wound healing. It is the more common viewpoint that a large number of water washing can effectively reduce the wounds burn depth after sulfuric acid burns early time, but the heat from concentrated acid dilution by massive water cause more harm [3,4]. There should be more experimental studies to pay great attention to the sulfuric acid burned early water flushing and neutralizer application [5]. It appears particularly important to select a rapid and effective approach to reduce acid to organism damage, to create more favorable conditions for burn treatment and rehabilitation. Through three decontaminations washing concentrated sulfuric acid burns skin effects have been studied, analyzed the dilution, the neutral and the chelated three kind of different decontamination principle decontaminant characteristic, so as to provide a good handling method to rapidly retreat acid burns at the scene of the accident.

1 Materials and Methods

1.1 Materials

Sodium bicarbonate solution, concentration: 50g / L, laboratory preparation;

Diphoterine, France PREVOR production company, pH value of 6.69;

Concentrated Sulfuric acid, Tianjin Chemical Reagent Factory;

Healthy rabbits, regardless of male and female, Weight (1.5 ± 0.2) kg, on the market.

1.2 **Methods**

1.2.1 **The decontamination of concentrated sulfuric acid in vitro**

Three groups of 1ml 95% sulfuric acid were accurate volume and put into different beakers; three different decontamination solutions with Diphoterine, water and sodium rinse the corresponding beaker's sulfuric acid separately by the identical speed, recording pH value changes, at the same time monitoring temperature changes in the system with infrared thermometer.

1.2.2 **The decontamination of concentrated sulfuric acid burns skin**

Before test, rabbit back hair is removed to about 2 cm × 2cm with 8% Na2S hair removal agent, back-up. The size of 1 cm × 1cm soaked 95% sulfuric acid solution of parachment (parchment) paper with the tweezers are pasted onto the rabbit back bare skin 5s, cause burns, after a period of time for waiting, different decontamination solution at the same speed wash the skin of burn, until the surface of the skin pH value is normal (normal skin pH value of 6 to 6.5), the amount of decontamination are measured, the temperature changes are recorded with infrared thermometer. After washing, the wound heals naturally. The raising environment is disinfected with 84 disinfection fluids one time every day to prevent the occurrence of burn infection. The wound healing is observed every day after the burn, and skin changes are recorded in decontamination washing before and after different periods with digital cameras.

2. Results and Discussion

2.1 The results and analysis of concentrated sulfuric acid decontamination in vitro

2.1.1 The amount of decontamination and pH changes

At room temperature, water, Diphoterine and sodium bicarbonate solution washed 1 ml 95% sulfuric acid to pH 6.5. The results shown in Figure 1.

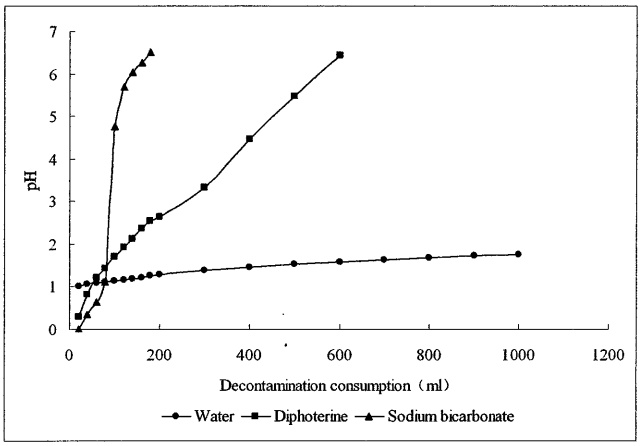


Fig.1 Curve of different decontaminations washing 95% sulfuric acid pH changes

The results show that sodium bicarbonate solution and sulfuric acid neutral reaction is fastest, pH value quickly rose to 6 ~ 6.5. Water reduces the H^+ concentration, increases pH with a simple dilution effect, then it is clear that the process is slow and requires a large amount of water, Therefore, when water used 1000 ml, system's pH still about 1.75. Diphoterine is a gender of the chelating molecules which can be combined with H^+ and HO^-, not through the chemistry significance response to complete this process [6,7]. Diphoterine chelates H^+ in the system, and plays a neutral role, the amount of 500ml is more than twice the amount of sodium bicarbonate solution, which concentrated sulfuric acid is diluted.

2.1.2 **The system temperature changes as decontamination rinsing**

A large number of H_2SO_4 is molecule state in concentrated sulfuric acid, diluting with water, on the one hand, it happens ionization reaction to produce H^+ ion, on the other hand, combinates water to hydration sulfuric acid, which is a chemical change with releasing a lot of heat (88 KJ / mol) [8]. In experiment, the system temperature reaches the highest in 3s, when decontamination rinses the 1ml 95% sulfuric acid, afterward the temperature drops. As can be seen from Fig.2, the sodium bicarbonate solution rinsing highest temperature reached 113.8°c, the water rinsing highest temperature reached 102.8°c, Diphoterine washing, although its temperature lower than the previous two, but also arrives at 88.3°c. Thus temperature will cause skin burning. With washing constantly, the temperature drops, Diphoterine makes the system temperature drops fastest. When consumping 10ml, the system's temperature dropped to 43°c, however dropping to the same temperature, sodium bicarbonate solution and water need 4 times Diphoterine capacity. In theory, so long as the skin temperature is more than valve value 43°c, the skin is possibly damaged [2]. Therefore, considered thermodynamics burns, in the sulfuric acid decontamination's process, washing should be based way to take the heat away as soon as possible.

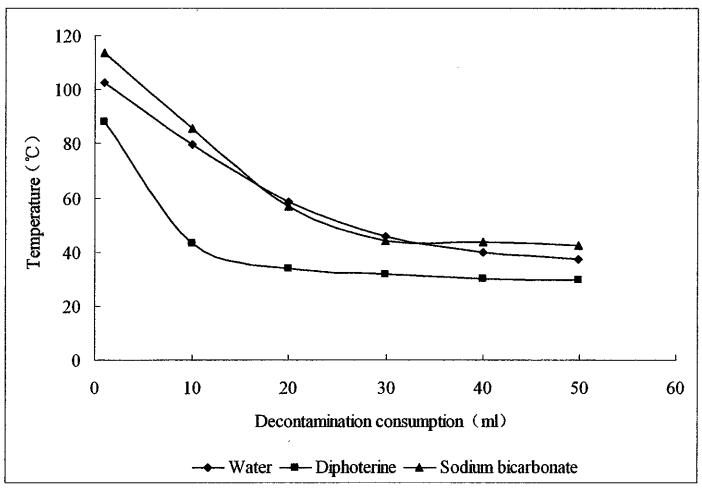


Fig. 2 Curve of different decontamination rinsing 95% sulfuric acid the temperature changes

2.2**The effect of concentrated sulfuric acid burn skin decontamination and analysis**

From the effects of three decontaminations rinsing concentrated sulfuric acid, sodium bicarbonate solution reaction is the fastest, and Diphoterine is advantageous to lower the system temperature. But the skin contains protein, water and a small amount of fat and so on organic ingredients, it is and greater difference than simulation tests (Skin contains several organic tissues like protein, water and a little fat etc., which is distinctly different from the simulation test.). When concentrated sulfuric acid splashed on the skin, its acidity and the oxidability may corrode and oxidize skin organization, the dehydration cause in the skin organization's hydrogen and the oxygen by ratio of 2:1 removing, then skin organization carbonizes, the removing hydrogen and the oxygen make the sulfuric acid hydration, which it is an exothermic process mentioned above. The account of skin collagen is about 70% of the total skin weight, at lower than the neutral pH environment, the collagen denatured temperature is 40 ~ 41°c, however, under the acidic pH environment; it is 38 to 39°c. As a result, the temperature reached 47°c, the skin feels pain, at 55°c, more than 3 seconds the skin is damaged. With the skin temperature increasing, the protein makes denatured, and the organization is necrosis [2]. Therefore, as splashing sulfuric acid on it, the skin is caused not only the chemical burns, but also thermodynamics burns. It is vital essential that timely and efficient rinsing to reduce acid damage to the skin, protect skin organizations and functions, in order to create conditions for the latter treatment.

2.2.1 **The comparative analysis of three decontamination results**

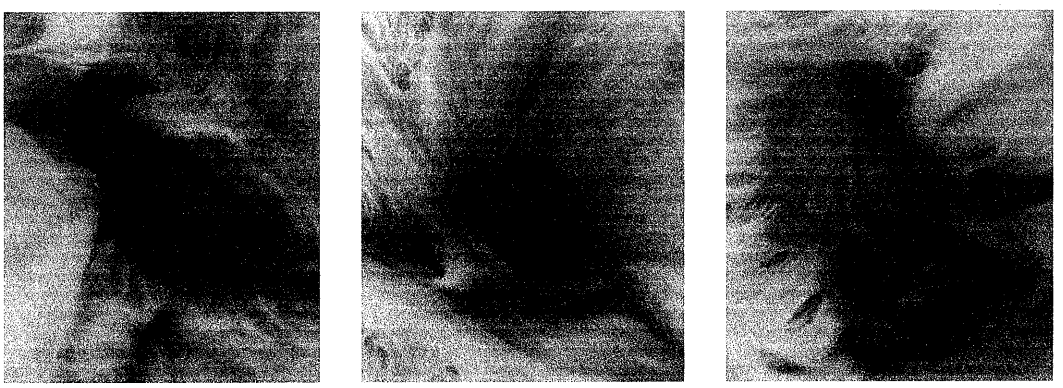
Rabbit burns skin temperature rapidly increase when concentrated sulfuric acid burns it, before rinsing, the

highest temperature reached 44.5°c. After 30s, the burn is washed with three decontaminations. Table 1 shows that the skin temperature rises to 68.3°c, when sodium bicarbonate solution rinse it, and the skin temperature arrives at 51.2°c, the water washing, thus temperature causes the skind thermodynamic burn easily.

The skin temperature drops, Diphoterine washing, even though still high, it has positive significance to skin protection and acid burn treatment. In the decontamination consumption, the consumption ratio of the sodium bicarbonate solution and the Diphoterine is same as model experiment consumption proportion; amount of water is the biggest.

Tab.1 The decontamination consumption and the wound highest temperature

Decontamination	Consumption / ml	The maximum temperature of the skin wound / °c
Sodium bicarbonate solution	34.5	68.3
Diphoterine	57.5	40.4
Water	150	51.2



(a) (b) (c)

Fig.3 The decontaminated rabbit skin of waiting until the 30s, after sulfuric acid burns

(a) the sodium bicarbonate washing skin, (b) the Diphoterine washing skin, (c) the water washing skin

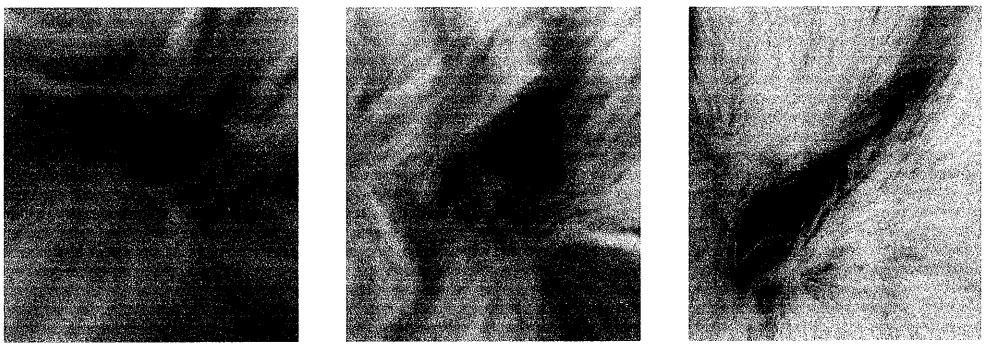
Rabbit skin burns by sulfuric acid, wounds surface is pale and obvious trace of carbonation. From Fig.3, after sodium bicarbonate solution washing the skin, the burn phenomenon is alleviated, but the burn marks still evident. After Diphoterine washing wounds, the carbonation almost eliminates and the wound is no further damage. Although some signs of carbonation reduces, water washing the wound directly, the some skin falls off.

(a) (b) (c)

Fig.4 The rabbit skin after decontamination one day

(a) the sodium bicarbonate washing skin, (b) the Diphoterine washing skin, (c) the water washing skin

After decontamination, the burns skin natural healing without treatment. Figure 4 is skin wound photos after decontamination a day, the sodium bicarbonate washing wound is scarlet, it may be a sake that high temperature further damage the wound tissue when water washing the burn. The Diphoterine rinsing trauma is dry and blood red, which may be due to lower temperature when Diphoterine washing the wound and its hyperosmolar [7] better neutralize not only sulfuric acid on the trauma surface, but also in the skin deep tissue, then maintain the structure and function better. There is a white crust attached on the trauma surface after water washing wounds, moreover, skin organization has been more traumatic.



(a) (b) (c)

Fig.5 The rabbit skin after decontamination a week

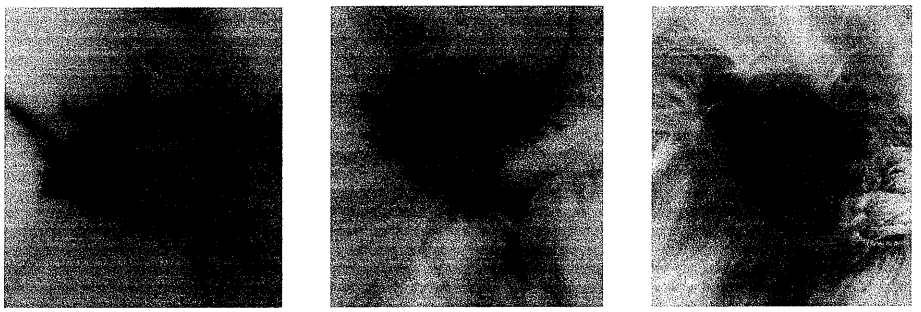
(a) the sodium bicarbonate washing skin, (b) the Diphoterine washing skin, (c) the water washing skin

Fig.5 is the skin condition after the decontamination a week, the sodium bicarbonate solution rinsing trauma gets a small amount of hair. Thus shows that sodium bicarbonate neutralization has certain effect. The Diphoterine rinsing trauma all grows new hair, it shows that Diphoterine is an advantage to protect the organization and restore its function rapidly. There is a bigger crust on the wound water washing and no new hair, so that water rinsing sulfuric acid burns effect is limited and bad for the skin wound healing latter.

2.2.2 **The influence of waiting time to skin burns decontamination effect**

In two hours, the burn is more serious, Along with concentrated sulfuric acid burning the skin time extension [9]. The residue sulfuric acid has sustained damage to the skin, the burn is further serious, so the sulfuric acid is cleaned away in the wound as soon as possible [10]. Compared with (a) and (b), the waiting 2 min trauma is more serious than the waiting 30s trauma, carbonation is more obvious, the crust is thicke. Also they show that the acid burns make more serious, skin is dehydrated and carbonized; moreover, the organization is destructed along with time extension. The acid anhydride constantly infiltrates into the skin inner, which the skin depths is further corrupted and the trauma is heavier [7].

Therefore, it is very necessary to decontamination as soon as possible after acid burns, it is advantage to reduce acid damage to the skin and favor for the wound further treatment and restoration latter.



(a) (b) (c)

Fig.6 the skin of rabbits wating different times decontamination before and after

(a) the skin before the decontamination wating 30s, (b) the skin before the decontamination waiting 2min, (c) the skin after decontamination wating 2min

Sulfuric acid burn at an early stage within a very short time to form, which emphasized the importance of early treatment, can in the shortest possible time to remove sulfuric acid burn early treatment is the key to the problem. From contrast between fig.3 (b) and Fig.6 (c), Diphoterine decontamination is affected which there is still a traces of carbonation and a thicker crust, because after burn 2min, the acid make protein coagulation and denaturation, the organization structure is destroyed, forms the crust, the decontamination can only wash the surface of trauma and it is difficult to enter the trauma inner. So when sulfuric acid splashed on the skin, time is more important than to find a suitable decontamination [11]. No matter decontamination, if decontamination is not timely, the effect of decontamination will reduce greatly; it does not favor the burns healing and function recovery.

3 Conclusion

Concentrated sulfuric acid on the skin longer, more serious burns. No matter what type of decontamination, it should race against time, washing the burns, as soon as possible, which the decontamination is more prompt, the effect is more remarkable. The injured feels the burns spot temperature rising as decontaminating. The sodium bicarbonate solution and water rinsing cause the skin thermodynamic burn easily because of its too high temperature. Diphoterine affects obviously to protect the burn skin, with burn wounds lower-temperature as decontaminating and healed faster and better, besides, more expensive price and the bigger amount of use, moreover, it is difficult to the large scale application. The amount of sodium bicarbonate solution decontamination is leas, and its neutral pH ability is strongest, with cheap price and obtain easily, besides, slow wound healing after decontamination. Water can only wash the skin's surface sulfuric acid, pH balance capacity is the least, moreover, cause skin off which is very disadvantageous to the washed wound healing. As a result, in conditions as much as possible, it is important that the better decontamination and methods is chosen for rapid decontamination.

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