American Red Cross
Scientific Advisory Council

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Answers
First Aid for Caustic Attacks

Questions to be addressed:
What is the appropriate first aid for victims of attacks with caustic substances?

Answer:

January 2023 Updated Answer:
Caustic attacks are a cause of morbidity throughout the world. Studies document the importance of early removal of clothing and immediate irrigation with water in decreasing burn severity and the need for surgical intervention. While certain chemicals may have specific antidotes, the abundance of water makes it a more reliable first aid treatment. Following exposure, emergency medical services (e.g. 911) should immediately be called, life threatening problems should be quickly addressed, and victims should remove contaminated clothing (by themselves if able), and irrigate exposed areas, such as the skin and eyes, with copious amounts of any clean water available (i.e. from any available faucet, hose, eyewash station, or shower) as quickly as possible. This should continue for at least 15 minutes and preferably until neutral pH is obtained, which may take up to 2 hours. Special care should be taken by first aid providers to use personal protective equipment and avoid inadvertent contamination of themselves by the caustic substance. Following initial decontamination, victims should also seek medical attention due to potential complications; ideally transport should be performed with ongoing decontamination, if still indicated

Previous Answer:
Caustic attacks are a cause of morbidity throughout the world. Studies document the importance of early removal of clothing and immediate irrigation with water in decreasing burn severity and the need for surgical intervention. While certain chemicals may have specific antidotes, the abundance of water makes it a more reliable first aid treatment. Following exposure, emergency medical services (e.g. 911) should immediately be called, life threatening problems should be quickly addressed, and victims should remove contaminated clothing (by themselves if able), and irrigate exposed areas, such as the skin and eyes, with copious amounts of any clean water available (i.e. from any available faucet, hose, eyewash station, or shower) as quickly as possible. This should continue for at least 15 minutes and preferably until neutral pH is obtained. Special care should be taken by first aid providers to use personal protective equipment and avoid inadvertent contamination of themselves by the caustic substance. Following initial decontamination, victims should also seek medical attention due to potential complications; ideally transport should be performed with ongoing decontamination, if still indicated. There are an estimated 1500 caustic attacks per year throughout the world ("Acid Survivors Trust International," 2018). These attacks generally do not kill the victim but are perpetrated with the intent to permanently scar and disfigure. They are also often accompanied by a significant amount of psychological and socioeconomic morbidity (Burd & Ahmed, 2010; Grundlingh,

Payne, & Hassan, 2017; Ashim Mannan, Ghani, Clarke, & Butler, 2007). Nitric and sulphuric acids along with sodium hydroxide are commonly used in the developing world, and hydrofluoric acid is also readily available in the form of cleaning supplies (Atley & Ridyard, 2015; A. Mannan et al., 2006; Milton, Mathieu, Hall, & Maibach, 2010). A literature search revealed limited articles about the treatment of patients intentionally exposed to caustics in the developed world. Most of the evidence regarding first aid for exposure to caustic chemicals comes from treatment of industrial accidents or experiences in the developing world.

One study looking at 185 patients in the United Kingdom over an 8 year period found that chemical burns account for about 10% of all burns but account for a disproportionate amount of burn mortality. Additionally they found that, while chemical industrial accidents decreased over a 25 year time period, domestic burns were increasing and in their more recent study accounted for 42% of the exposures (Hardwicke, Hunter, Staruch, & Moiemen, 2012). This puts further emphasis on an increasing push to limit the ready accessibility of chemicals in the home (Olaitan & Jiburum, 2008).

During an attack, caustic substances are often thrown into the victim's face, causing permanent scarring and blindness. The goal of treatment is to limit exposure and, therefore, long term impairment (Grundlingh et al., 2017; Milton et al., 2010). The extent of the burn damage is related to the mechanism and concentration of the chemical, its depth of penetration, the volume of chemical that the victim is exposed to, and how long the exposure lasts (Fitzpatrick & Moylan, 1985; Olaitan & Jiburum, 2008). While most authors acknowledge there is limited data about first aid for these burns, completely removing contaminated clothing should be the first step, and most agree that in limited studies aggressive water decontamination has been associated with better patient outcomes (Brent, 2013; Fitzpatrick & Moylan, 1985). A small study performed by Leonard and colleagues in the 1970s demonstrated that patients who received immediate water irrigation had smaller areas of full-thickness burn and shorter length of stay. They classified immediate decontamination as within 10 minutes of exposure and with a large volume of water for at least 15 minutes. They note that water works in multiple ways by removing surface chemical, diluting the chemical that is injuring the tissue, and also by restoring tissue water loss (Leonard, Scheulen, & Munster, 1982). More recent data suggests that irrigation with copious amounts of water should continue until a neutral pH is reached (Grundlingh et al., 2017). This may require multiple hours of decontamination and should continue at least until arrival at a higher level of care or until pH paper is available. Contact lenses should be removed and eyes should also be irrigated for at least 30 minutes or to a neutral pH and checked again 15-30 minutes after cessation of irrigation to ensure that no chemical has been retained underneath the eyelids. Patients should be referred for specialized ophthalmologic care and to tertiary burn centers as appropriate. Additional therapy is similar to that provided for thermal burns with special attention paid to airway protection, intravenous fluid resuscitation, appropriate pain control, and tetanus prophylaxis (Atley & Ridyard, 2015; Grundlingh et al., 2017; Hall & Maibach, 2006). Surgical debridement may also be necessary (Burd & Ahmed, 2010). It is noted in the literature that it can often be difficult to determine the depth of injury initially so the need for specialty referral should be frequently revisited (Fitzpatrick & Moylan, 1985).

Several caustics deserve special consideration. Hydrofluoric acid is readily available in many industrial and household cleaning products and is especially damaging as fluoride ions can

penetrate tissue and cause deeper damage through liquefaction necrosis (Atley & Ridyard, 2015). It can lead to severe hypocalcemia and hypomagnesemia causing deep cellular injury and decalcification of bone (Fitzpatrick & Moylan, 1985). These electrolyte disturbances can also lead to hyperkalemia and elongate the QT interval leading to arrythmias (Kaushik & Bird, 2019). First aid treatment should consist of irrigation of the skin and eyes with copious water or normal saline (Atley & Ridyard, 2015). Calcium gluconate gel can be massaged into small areas that are affected and can be very successful for pain control (Kaushik & Bird, 2019). Similarly, oxalic acid will bind calcium and is treated with extensive water irrigation and calcium gluconate (Fitzpatrick & Moylan, 1985).

Phenols pose a particularly difficult problem because they often cause an initial local anesthetic effect which will delay the development of pain. This type of burn should be treated with an oil based dressing after irrigation with water (Fitzpatrick & Moylan, 1985; Leonard et al., 1982).

Sodium hydroxide is an alkali that is readily available in the form of cleaning supplies and is commonly used in chemical assaults (Milton et al., 2010; Olaitan & Jiburum, 2008). It penetrates deeply and continues to cause damage long after the initial exposure. Large exposures can also lead to systemic effects. Eye exposures cause quick corneal penetration leading to perforation and scarring. Sodium hydroxide releases heat on contact with the skin, causes destruction of the skin's lipid barrier, and leads to cell death due to osmotic shifts. Additionally, the formation of hydroxyl ions leads to liquefaction necrosis of the deep tissues. Again, early and copious irrigation with water has been shown to decrease the amount of damage by diluting the heat release, slowing chemical reactions, and returning skin pH to normal levels. For this type of exposure, experts have recommended up to 2 hours of continuous irrigation, noting the importance of maintaining normal body temperature during irrigation (Palao, Monge, Ruiz, & Barret, 2010). Studies in Bangladesh have shown that educating the public about the importance of early removal of clothing and immediate irrigation with water have decreased the time that skin and eyes are exposed to chemicals and has decreased burn severity and the need for surgical intervention. Prior to educational initiatives, very few victims received early water decontamination; after public education, approximately 50% of victims are immediately rinsed (Milton et al., 2010). Immediate responders and hospital workers should also be educated to protect themselves from inadvertent exposure while treating victims (Kaushik & Bird, 2019).

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