

TECHNICAL NOTE

The Continued Utility and Viability of Dakin's Solution in Both High- and Low-resource Settings

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Abstract

Healthcare is expensive and often inaccessible to many. As a result, surgeons must consider simple, less expensive interventions when possible. For wound care, an older but quite effective cleaning agent is Dakin's solution (0.5% sodium hypochlorite), an easily made mixture of 100 milliliters (ml) bleach with 8 teaspoons (tsp) baking soda into a gallon of clean water or 25 ml bleach and 2 tsp baking soda into a liter of water. Gauze is then wet with this solution, placed on the wound, and replaced every 24 hours as needed. Our team of surgeons in Haiti and the United States is currently using Dakin's solution for wound care following orthopedic surgery and finds it to be a low-cost, safe, and effective treatment for post-surgical wound care for both resource-limited and non-resource strained environments. This report aims to update the current literature and encourage the consideration of Dakin's solution for modern wound care.

Level of evidence: III

Keywords: Cost-reduction, Dakin's solution, Haiti, Low-resource settings, Wound care

Introduction

Costs of healthcare are rising worldwide, and access to effective care is often limited. As of 2015, 5 billion people did not have access to safe and affordable surgical care and nine out of ten people could not access basic surgical care in low and low-middle income countries (1). Efforts to decrease costs in wound care have encouraged surgeons in both high- and low-resource settings to consider simpler, less expensive interventions. Affordable care is especially important for those in low and lower-middle income countries, where the burden of catastrophic expenditure for surgery is greatest (1).

One such intervention is Dakin's hypochlorite solution for wound care. First studied as an antiseptic in the beginning of the 20th century, it was widely used in World War I with the discovery that aseptic techniques were imperative

to wound healing (2). Organisms that Dakin's solution has bactericidal activity against includes: *Enterococcus*, *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Escherichia coli*, *Pseudomonas aeruginosa*, and other anaerobes. It has also been efficacious against methicillin-resistant *Staphylococcus aureus* and vancomycin resistant *Enterococcus* (3). However, its popularity has declined with the advent of wound treatment options such as vacuum assisted therapy and newer topical agents such as chlorhexidine, benzalkonium, chloride, and iodine-containing agents (4).

Additionally, with the discovery of antibiotics, the use of antiseptics for wound care has declined; however, recent research suggests that there is a renewed role for antiseptics in wound healing (5, 6). In addition to highly contaminated wounds, a recent randomized control trial also found that

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use of Dakin's solution in drain care following mastectomy and/or lymph node dissection resulted in decreased bacterial colonization of drains and subsequent potential decrease in surgical site infections (7).

We routinely use this solution in our academic, tertiary referral center in the United States, as well as in collaboration with our orthopaedic colleagues in Haiti for both acute and chronic wounds of the extremities. Given the lack of consensus on the best methods for wound care and rising healthcare costs, this article aims to provide a technique guide and refresh the literature on Dakin's solution and its continued relevance in the treatment of highly contaminated and difficult to treat wounds (6, 8-10).

Technical Note

Dakin's solution can easily be made by healthcare workers and patients alike by mixing 100 ml bleach with 8 tsp baking soda into a gallon of water. Smaller mixtures can also be made using 25 ml of bleach with 2 tsp baking soda in a liter of water. Bleach and baking soda can be found at most general stores, and water should be clean but does not have to be sterilized, though many providers in developing countries do prefer to use boiled water as a precaution (11).

Gauze or sponges should be soaked in Dakin's solution until they are saturated. Gauze is then wrung out such that it remains damp but no excess solution flows out of the gauze when compressed. The damp gauze can then be placed into the wound, and replaced every 24 hours, often called a "wet-to-dry" technique. This technique expands the antimicrobial properties that Dakin's was originally noted for, as its use also improves the mechanical debridement due to the desiccative nature of Dakin's solution and adhesion of tissue to each gauze used. As the gauze dehydrates, it draws fluid from the wound and encompasses the damaged tissue. During

daily replacement of the gauze, bacteria and devitalized tissues are removed with the gauze, further debriding the wound. If the wound dressing must be more secured, one can wrap the packed wound with clean gauze or a standard bandage wrap. If necessary, Dakin's solution and gauze can be applied daily for multiple weeks until the wound can be closed by secondary intention, skin graft, or surgical closure.

Case Examples: depicting progression of wound care following utilization of Dakin's solution

1. 19-year-old Haitian female after sustaining a polytrauma including open fracture and Gustilo-Anderson Type 3A wound with exposed tendon. No initial soft-tissue coverage. Local physicians selected advanced trauma life support (ATLS) and damage control protocol with external fixation and stabilization. Dakin's was applied with wet-to-dry technique for 3 weeks [see figures 1A-D].

2. 47-year-old American male with osteomyelitis of left forearm complicated by deep post-surgical infection underwent incision and drainage of the left forearm with extensive exploration and scar release. Following wound irrigation and closure, Dakin's wet-to-dry dressing was applied. Over the next 7 weeks, the patient continued caring for his wound at home with Dakin's solution provided by the hospital. His wound was completely healed by the 7-week follow-up [see figures 2A-C].

3. 36-year-old Haitian male with infected wound following open reduction internal fixation of a Schatzker Type IV tibial plateau fracture. Dakin's solution was applied to the wound with dressing for 3 weeks after which the patient received a gastrocnemius flap for coverage of the implant [see figures 3A-D].

4. 54-year-old Haitian male with diabetic foot ulcer. Ulcer was untreated for multiple months before presenting to



Figure 1A. Before Dakin's



Figure 1B. During Dakin's

Figure 1. Case examples depicting progression of wound care following utilization of Dakin's solution.

19-year-old Haitian female after sustaining a polytrauma including open fracture and Gustilo-Anderson Type 3A wound with exposed tendon. No initial soft-tissue coverage. Local physicians selected advanced trauma life support (ATLS) and damage control protocol with external fixation and stabilization. Dakin's was applied with wet-to-dry technique for 3 weeks.



Figure 1C After Dakin's



Figure 1D. Final Result after Skin Graft



Figure 2A. Post operation/Start Dakin's



Figure 2B. During Dakin's



Figure 2C. Final result

Figure 2. 50-year-old American male with osteomyelitis of left forearm complicated by deep post-surgical infection underwent incision and drainage of the left forearm with extensive exploration and scar release. Following wound irrigation and closure, Dakin's wet-to-dry dressing was applied. Over the next 7 weeks, the patient continued caring for his wound at home with Dakin's solution provided by the hospital. His wound was completely healed at 7-week follow-up.

hospital. Patient was treated with Dakin's Solution and vacuum-assisted closure (VAC) with negative pressure wound therapy/vacuum-assisted closure (V.A.C.) for three weeks before discharge [see figures 4A-D].

Discussion

As cost becomes an increasing concern in both high- and low-income nations, low-cost but effective solutions should be sought after. The averaged cost in Haiti of a gallon of Dakin's solution is a nominal 0.19 U.S. cents. In fact, Dakin's can be cheaper, and many times more accessible, than regular saline and is made from common ingredients, making it easily accessible in low-resource settings. In Haiti, Dakin's solution is routinely used in

wound care following a variety of surgeries including upper extremity surgeries, lower extremity surgeries, appendectomies, diabetic foot ulcers and amputations. It is also used as an irrigant for open fractures, debridement, chronic wound care, after trauma, and in the care of burns. It should be noted that ideal storage length and conditions have not been fully established, however, studies have shown Dakin's to be viable for up to 2-years with degradation rates not affected by temperature changes (12). Additionally, patients can be taught to make the solution and continue treatment outside of a healthcare facility.

We have experienced empirical success with the utilization of Dakin's solution following various



Figure 3A. Before Dakin's



Figure 3B. During Dakin's



Figure 3C. Gastroc Flap



Figure 3D. Final Result

Figure 3. 36-year-old Haitian male with infected wound following open reduction internal fixation of a Schatzker Type IV tibial plateau fracture. Dakin's solution was applied to the wound with dressing for 3 weeks after which the patient received a gastrocnemius flap for coverage of the implant.

orthopedic procedures both at our tertiary care academic medical center in the northeastern United States, and our collaborators in public hospitals in Port-Au-Prince at *Hôpital de l'Université d'État d'Haïti*, and *Hospital l'Universite de La Paix*. As shown in the cases and figures, use of Dakin's solution resulted in the formation of granulation tissue in wounds, and wounds either spontaneously closed or were closed by secondary intention without infection. Thus, Dakin's offers a sustainable, quality wound care that can lead to decreased numbers of amputations and deaths as a result of poor wound care. Although critics raise concerns of cytotoxicity of antiseptics, we do not know of any of our patients who have suffered soft tissue or other complications specifically attributed to the Dakin's solution.

Although the use of Dakin's may seem to have increased utility in low-resource settings, the utilization of low-cost

and effective treatments for patients in high-resource settings is also warranted. With the advent of new agents for wound care, the question remains whether these costly interventions truly merit such an increased cost, some costing more than several hundred U.S. dollars per day. The United States currently spends an estimated 20 billion USD on chronic wound care and thus warrants increased scrutiny of the necessity of new agents that may have minimal or no advantages over simpler agents (13). From our observed success of Dakin's, we recommend physicians in high-resource settings consider Dakin's as a viable alternative for select patient populations.

Given the empiric success of Dakin's solution in our academic centers in the United States and Haiti for wound healing in orthopaedics, Dakin's solution remains a viable and low-cost option for wound care following surgery. Future investigation to establish its utilization in wound



Figure 4A. Initial Presentation



Figure 4B. Day 10



Figure 4C. Day 20



Figure 4D. Day 33

Figure 4. 54-year-old Haitian male with diabetic foot ulcer. Ulcer was untreated for multiple months before presenting to hospital. Patient was treated with Dakin's Solution and VAC with negative pressure wound therapy/vacuum-assisted closure (V.A.C.) for three weeks before discharge.

care on a global scale, with comparative effectiveness research, is recommended. This method for wound care can be advantageous in both the developed and developing world given its low cost, high accessibility, and ease of production.

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