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SHORT REPORT

Cost Analysis of Pure Hypochlorous Acid Preserved Wound Cleanser versus Mafenide for the Irrigation of Burn Wounds

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Abstract: Over 40,000 patients in the United States (US) require hospitalization for burns annually. The treatment regimen can cost more than $6,000 a day and requires the use of numerous supplies to ensure the graft takes for successful wound healing. Irrigation of the wound is a critical step for burn treatment, yet little is known about the cost-effectiveness of different irrigation modalities. In a recent study, pure hypochlorous acid preserved wound cleanser (pHA) was shown to be safe and effective compared to mafenide. This study estimated the associated costs of two common wound irrigation modalities, pHA and mafenide solution, for the treatment of patients with burns. In this study, a patient-level Monte Carlo simulation model using data from a randomized control trial (RCT) was used to conduct the cost analysis from the US Hospital perspective. Based upon 100,000 simulated patients, pHA was expected to save $133 ($123 to $144, 10th to 90th percentile) for the hospital compared to using a mafenide solution over 14 days. Adoption of pHA should be considered a cost-saving strategy when treating patients with burns.

Keywords: wound care, burn irrigation, economic evaluation

Introduction

In the United States (US), nearly 40,000 people require hospitalization for burn injuries annually.[1] These hospitals are faced with a multitude of care challenges, ranging from acute and critical care to long-term care and rehabilitation.[2] Burn treatment is complicated by the patient's inability to fight infection, which emphasizes the importance of antimicrobial treatment options. Furthermore, multidrug-resistant (MDR) bacteria provide a major obstacle in bettering our current approach to burn treatment.[3] Inflammation can be triggered by the presence of microorganisms, thus delaying the healing process.[4] Commonly used topical antimicrobial treatments include Chlorhexidine, Povidone-Iodine, Sodium Hypochlorite, and Dakin's Solution.[5] Many of these treatments have adverse effects on the health of the patient. For example, mafenide acetate's cytotoxicity will delay wound healing and reduce the strength of healed wounds.[6]

Pure hypochlorous acid wound cleanser (pHA) (Vashe, Puricore, Malvern, PA) shows promise in the efficacy of its therapy. Hypochlorous acid, is naturally produced as a product of the oxidative burst pathway, in which an enzyme known as NADPH catalyzes a cascading reaction of free radicals.[7] NADPH, a cofactor, works as a reduction agent to provide necessary biochemical reactions.[8] So far, no antimicrobial resistance has been detected against pHA. Unlike other common antimicrobial treatments, pHA has been proven to not show cytotoxic properties in mammalian cells, as the human body provides its own antioxidant defense system, producing scavenger molecules such as taurine and nitrates to neutralize free radical molecules like pHA.[9] Topical stabilized pHA provides an optimal environment for wound healing, and may be ideal for reducing scarring when combined with silicone.[10] Prior studies have found the use of pHA in patients with burns was associated with reductions in pain scores reported by patients.[11–13]

Unfortunately for both patient and provider, burn-care management is expensive. A survey conducted in three burn centers found the average cost per day for patients with burns was $6,795 (USD 2017).[14] The total cost of care for

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a patient hospitalized with burns has been estimated at around $92,208 (USD 2017).[15] Having a better understanding of supply costs to treat wounds is critical to understanding how to achieve the Triple-Aim of improving outcomes, improving quality of care, and reducing costs for patients suffering burns. However, there is little published evidence to rely upon. The objective of this study was to assess the costs of two common wound irrigation modalities, pHA and mafenide solution, for the treatment of patients with burns.

Methods

Study Population

The current study uses publicly available data[16] and was deemed exempt from review. The original published study was approved by hospital institutional review board and the data were obtained from the published RCT conducted at a single center.[16] The trial enrolled male and female patients older than 18 years who were hospitalized with a severe burn that did not exceed 20% of the total body surface area (TBSA). Patients were excluded if they were pregnant, had a chlorine sensitivity, or the burn was a result of a chemical, electrical, or frostbite injury. Patients were randomized 1:1 to pHA or mafenide cohorts and followed for 14 days.

The clinician performed excision and grafting using the same standard protocols for each cohort. Specifically, a Weck knife was used for excision and hemostasis achieved electrocautery and epinephrine/thrombin solution. The autografts were obtained with a dermatome set and secured into price with fibrin sealant and staples. An 8-ply dressing was moistened with pHA or mafenide solution during the procedure and post-operatively to maintain the desired level of moisture by the clinician. The necessary volume of pHA or mafenide solution was determined by the clinician performing the procedure.[16] A total of 19 patients who had received excision and grafting were randomized to pHA (n=11) or mafenide (n=8). There were no statistically significant differences in age, sex, %TBSA burned, or baseline pain score. The %TBSA burned (pHA, 10.0% and mafenide, 6.5%) and pain score (pHA, 5.4% and mafenide, 4.5%) were not statistically different between the two cohorts. The pHA included bilateral lower leg and abdomen burns that were not present in the mafenide cohort. There were no statistically significant differences in graft take between pHA (97.4%) and mafenide (96.0%) cohorts.

Modeling Strategy

A patient-level Monte-Carlo simulation model was developed to assess the costs of using pHA versus mafenide for the irrigation of burn wounds. The perspective of the model was the US hospital. The cost parameters included the cost of the irrigation solution and the volume of irrigation used. All other care, including adverse events and graft take percentage, were similar for both cohorts; thus, the costs canceled each other out. Table 1 lists the model parameters and their values used in the model. The modeling strategy followed recommended practices by the International Society of Pharmacoeconomics and Outcomes Research and the Society of Medical Decision Making.[17,18] All cost data were

Table 1 Model Parameters

	Base	Low	High	Reference
Utilization, per patient				
pHA, mL	6,234.50	5,844.84	6,625.16	Foster
Mafenide	4,136.88	3,878.33	4,395.44	Foster
Cost, per mL of irrigation				
pHA, $	0.043	0.041	0.045	Foster
Mafenide, $	0.097	0.093	0.102	Foster

Abbreviation: pHA, Pure hypochlorous acid wound cleanser.

Table 2 Model Results

	pHA	Mafenide	Difference (Mafenide–pHA)
Mean	$270	$403	$133
Standard Deviation	$18	$26	Not Applicable
10th Percentile	$247	$370	$123
50th Percentile	$269	$402	$133
90th Percentile	$293	$437	$144

Abbreviation: pHA, Pure hypochlorous acid wound cleanser.

reported in 2022 United States Dollars using the Medical Care Consumer Price Index published by the US Bureau of Labor Statistics.[19]

The model used a probabilistic Monte-Carlo approach to simulate 100,000 patients over a 14-days receiving either pHA or mafenide irrigation for their graft dressings. The use of 100,000 simulated patients was necessary to address the small sample size of the clinical study relied on for this analysis. The primary result was the difference between the expected mean cost for each cohort. In addition, the 10th, 50th, and 90th percentiles were reported to describe the variation in costs. One-way deterministic sensitivity analysis was performed to gauge the reliability and robustness of the results to changes in model input parameters. The one-way sensitivity analysis varied key model parameters one-by-one and recalculated the expected cost.

Results

The use of pHA was expected to cost the hospital $270 compared to $403 for mafenide – a $133 savings per patient for the irrigation of burn wounds over a 14-day period. The expected savings per day was $9.50. Table 2 shows the distribution of the results by percentile. At the 10th percentile, pHA was expected to save a hospital $123 and at the 90th percentile, pHA was expected to save $144 per patient. Figure 1 provides the probability distribution of simulating 100,000 patients. In 98% of the simulated patients, pHA was the cost-saving strategy. The one-way deterministic sensitivity analysis revealed the utilization of mafenide to be the most influential variable (Figure 2). When the lowest

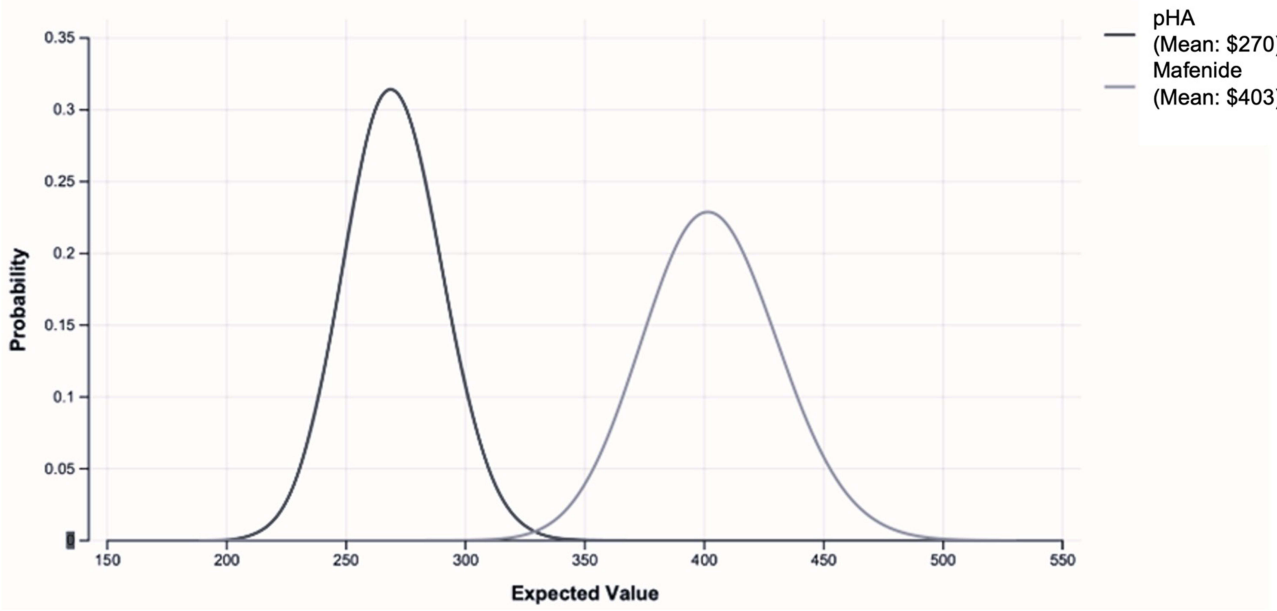

Figure 1 Irrigation Costs using pHA or Mafenide Acetate. pHA: Pure hypochlorous acid wound cleanser. pHA (black) was expected to cost $270 on average compared to mafenide acetate's (grey) expected cost of $403. At the pHA highest cost scenarios and mafenide acetate lowest cost scenarios, there was an overlap in the expected cost to irrigate. pHA was expected to be the cost-saving strategy 98% of the time.

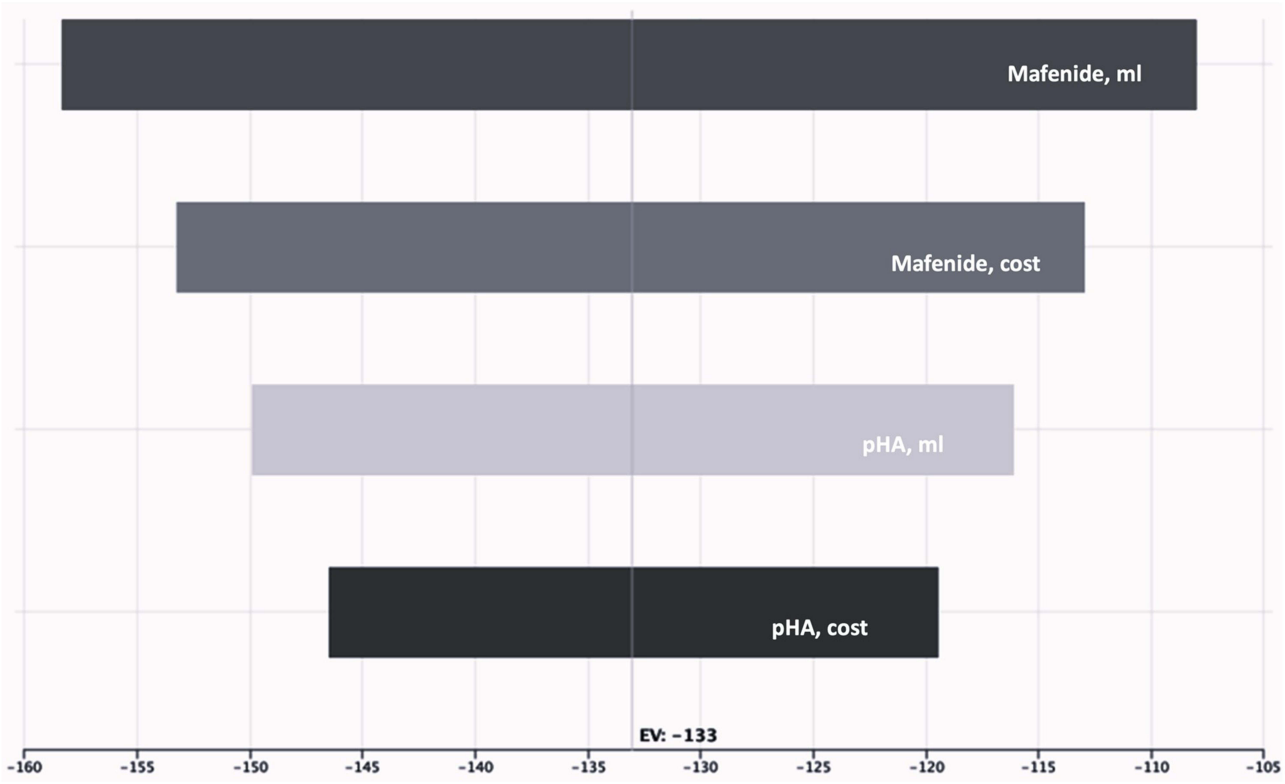

Figure 2 One-Way Sensitivity Analysis. The figure shows the expected cost savings of using pHA compared to mafenide acetate for the irrigation of burns by varying the individual variables one at a time. In all cases, pHA was expected to save money compared to mafenide acetate.

and highest amount of mafenide was used, pHA was expected to save $107 and $159, respectively. Conversely, when the highest and lowest amount of pHA was used, pHA was expected to save $116 and $150, respectively.

Discussion

The purpose of this study was to compare the economic outcomes of using two marketed irrigation modalities, pHA and mafenide, for the treatment of burn wounds following excision and grafting. The economic simulation relied on data from an RCT which showed no clinical differences in safety and efficacy outcomes as well as healing time between the cohorts following skin grafts.[16] What the study did reveal was potential cost savings to the care provider when using pHA instead of mafenide.

In the patient-level Monte-Carlo simulation model, a hospital was expected to spend $270 with pHA compared to $403 with mafenide irrigation, a $133 savings over 14 days despite more volume of pHA used for irrigation. These findings are a useful contribution to the wound care literature, as there is little evidence of the economics of irrigation for burns. Prior studies have focused on the treatment costs per day, expensive grafts, or in totality for an episode of care.[14,15,20,21] These data produced by this model add to the small body of economic knowledge tied to the irrigation of burn wounds of patients who are hospitalized.

The initial reaction to the use of increased healthcare resources is often negative as the cost of treatment is expected to rise. However, in our study, we found savings associated with the use of pHA despite an increase in the volume of product used. In a capitated payment model, these savings are received by the hospital where the service occurs rather than by another care provider or the payer as is often the case. Thus, the use of pHA is expected to lower the overall visit costs while the reimbursement to the hospital remains the same and ultimately lead to increases in the hospital margin. This cost comparison points to a positive impact on hospitals' overhead without compromising the care or outcomes of patients with burns.

Limitations

This study has several limitations that must be noted. First, the results are based on a single-center, small, RCT of 19 patients and care should be given to generalizing the results to populations not included in the trial. Second, the clinical study effect measure, graft take percentage, was the same for each cohort. This prevented a full cost-effectiveness analysis from being completed and limited us to a cost comparison analysis. A conservative approach to assessing the cost was used to focus on the incremental costs of irrigation rather than the total cost of care. The RCT did not provide sufficient clinical data to assess the total cost of care for patients with burns. Third, the RCT used only assessed the patient for the first fourteen days of treatment. We did not have data on outcomes or irrigation usage beyond the scope of the clinical study. Finally, the wound size of these patients was small, and the cost savings may not be applicable to larger wounds. Despite these limitations, these results provide insight into the cost-effectiveness of the irrigation modality used to treat burn patients.

Conclusion

While the overall costs of treating patients hospitalized with burns are substantial relative to the irrigation costs, the use of pHA is a less costly option compared to mafenide based upon the small clinical study leveraged for this analysis. Combined with the non-cytotoxic properties, pHA should be considered as a possible cost-saving irrigation modality in the treatment of burns.

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Disclosure

Evelyn J. Rizzo and Peter Mallow are paid consultants for Urgo Medical. Peter Mallow also reports personal fees from Abiomed, Health Clarity Solutions, Zoll Medical, and One Tall Tree, LLC, outside the submitted work. The authors report no other conflicts of interest in this work.

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