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Original Article

Evaluation of pain associated with the application of burn dressings

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Abstract: Introduction: Topical wound care after burn injury has revolutionized burn care. Dressings and topical solutions provide broad-spectrum antimicrobial coverage to prevent wound infection, be easy to apply and remove, and promote wound healing. A wide variety of dressings are available for providers to choose from based on wound characteristics. An additional factor to consider when making that decision is any pain associated with applying the dressing and frequency of dressing changes. Methodology: This retrospective study aimed to examine the daily and maximum pain reported by patients and daily opioid consumption to determine if there are any differences among commonly used dressings including 5% sulfamylon solution (SMS), manuka honey, negative-pressure wound therapy (NPWT), silver sulfadiazine, and silver nylon. Results: This study demonstrated that silver sulfadiazine had lower mean daily pain scores compared only to manuka honey as well as lower maximum scores when compared to all other dressings except silver nylon. Furthermore, the choice of dressing did not have an overwhelming effect on the amount of opioids consumed by patients during their hospital stay with manuka honey having less opioid consumption when compared to only 5% SMS and NPWT only. Conculsion: Further studies are needed with additional validated pain assessment tools and clinically relevant endpoints to fully elucidate the impact of burn dressings and other topical wound care options on pain.

Keywords: Burn pain, burn dressing, topical wound care

Introduction

Advancements in burn wound care, including the development of a variety of topical therapies, to include salves and creams, topical antimicrobials, bydrocolloids, and negative-pressure wounds pads, have significantly contributed to increased survival after burn injury. Burn wound dressings have multiple purposes, including the prevention of infection and the promotion of wound healing [1, 2]. Higher levels of pain have been associated with delayed re-epithelization after burn injury, suggesting a need for mitigating pain and accelerating healing with topical therapies after burn injury [3, 4].

Several topical therapies for burn injury have been evaluated for pain severity and potential reduction after application. Traditionally, pain associated with dressings is related to pain with application and removal. A Cochrane review examined 30 published randomized controlled trials investigating dressings for superficial and partial thickness burns and overall, there was no consensus on a single dressing associated with the lowest amount of pain, however it is noted that the data was poorly reported leading to poor quality evidence. Additionally, pain was often a secondary outcome and not thoroughly investigated [5]. Post-burn pain is multifactorial, with immediate activation of nociceptors at the surface of the wound by noxious burn stimuli [6]. In the acute phase after injury, exposure to air is postulated to contribute to increased pain, evidenced by studies that demonstrate that occlusive dressings decrease pain [2, 7]. Providing a wound environment of optimal moisture and protection

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from outside contamination has also been theorized as a mechanism behind effective burn dressings that reduce pain [2].

The purpose of this study was to examine pain levels associated with burn dressings in patients with smaller (<20% total body surface area [TBSA]) burns using a validated pain assessment tool in addition to daily consumption of opioids by patients.

Methods

Study design

This study consisted of a single-center, retrospective review with approval from the Institutional Review Board.

Setting and participants

Inclusion criteria consisted of patients admitted to the Burn Progressive Care Unit from 2014 to 2019 age ≥16 years with a burn <20% TBSA and who presented within 48 hours of their injury. Patients with pre-existing conditions that would impact pain sensation or reporting were excluded, such as diabetic neuropathy, diagnosis of chronic pain, or severe psychiatric illness (e.g., schizophrenia, uncontrolled bipolar disorder, major depressive disorder, etc.). Patients with chronic outpatient opioid use or recent illicit drug or alcohol use on admission were also excluded. This study also excluded any wound that had concern for infection.

Variable and data source

Data collected from the electronic medical record included patient demographics (age, sex, body mass index [BMI]) and burn characteristics (TBSA, % full-thickness, and etiology). Dressings evaluated included manuka honey, 5% sulfamylon solution (SMS), silver sulfadiazine, silver nylon, and negative-pressure wound therapy (NPWT), which are commonly used dressings at our institution. Initial dressing choice was determined based on the admitting provider's evaluation of the wound. Dressing data was collected for patients who had the dressing applied and in place for ≥24 hours and had >2 pain scores recorded. If multiple dressings were utilized in the patient's care, data on the predominant dressing was recorded for each specific day, which was defined as the dressing covering the largest area of burn on the patient. Data collected consisted of pain scores, both daily median and maximum, and daily pain medication used, which included oral and intravenous medications (fentanyl, hydrocodone, hydromorphone, morphine, oxycodone, percocet), recorded in total morphine milligram equivalents (MME). Pain scores reported by the patient were assessed using the Numeric Rating Scale (NRS) at a minimum of every 4 hours, using a scale of 0-10, where 0 is no pain and 10 is the worst pain imaginable. The NRS and MME utilization have been validated for use in burn patients [8-10].

Statistical methods

Outcomes between the groups were analyzed and significance was established when *p*-values were less than 0.05. Categorical data were summarized using percentages and analyzed using Chi-Squared or Fisher's Exact tests, where appropriate. Given a larger sample size in this study, we chose to present data more representatively as means ± standard deviation (SD) or medians (inter-quartile range [IQR]) as appropriate and analyzed using Wilcoxon's Kruskal Wallis to test for differences in continuous measures with a Steel-Dwass adjustment.

Results

Participants

A total of 1348 patients met inclusion criteria and were available for review with a total of 5043 dressing applications over the study period.

Descriptive data

Table 1 presents the overall demographic data and relevant burn characteristics. Dressings evaluated consisted of manuka honey (n=191), 5% SMS (n=1610), silver sulfadiazine (n=506), silver nylon (n=1602), and NPWT (n=1134). The choice of dressing was not influenced by age or burn etiology.

Outcomes data

The average daily pain score across all cohorts was 4.2 ± 2.1 with each dressing's associated daily pain score found in **Table 2**. Comparing

Table 1. Patient demographics

Demographic/Burn Characteristic	Results
Age	45.1 ± 17.0
Male gender	997 (74.0%)
BMI	29.6 ± 7.5
TBSA	3.5 (1.5, 6.5)
% Full-thickness burn	0.0 (0.0, 1.0)
Burn Etiology	
Fire/Flame	650 (48.2%)
Scald	410 (30.4%)
Contact	214 (15.9%)
Chemical	59 (4.4%)
Electrical	15 (1.1%)
Length of stay (days)	9 (5, 14)

BMI = body mass index, TBSA = total body surface area. Data is presented as mean + SD, median (IQR) or n (%).

between cohorts found manuka honey to have higher average daily pain compared to silver sulfadiazine (P=0.04) with no other differences noted.

The average maximum daily pain score across all cohorts was 7.0 ± 2.6 with each dressing's associated maximum daily pain score found in **Table 3**. Comparing between cohorts found silver sulfadiazine to have lower maximum daily pain compared to 5% SMS, manuka honey, and NPWT (P=0.02, P=0.03, and P<0.01, respectively), silver nylon to have lower maximum daily pain compared to NPWT (P<0.01), with no other differences between cohorts.

The median MME consumed across all cohorts was 38.0 (15.0, 76.0) with each dressing's associated median MME consumed found in **Table 4**. Comparing between cohorts found manuka honey to have a lower median MME consumed compared to 5% SMS and NPWT (P=0.03 and P=0.02, respectively) with no other differences between cohorts.

Discussion

This study demonstrated that silver sulfadiazine had lower mean daily pain scores compared to manuka honey with no other significant differences between the other commonly used dressings. When examining maximum reported pain scores, silver sulfadiazine was associated with lower maximum scores when compared to all other dressings except silver nylon. The only other significant finding with maximum pain scores was that silver nylon was associated with a lower maximum score when compared to NPWT. When looking at MME consumed, conversely, manuka honey was found to result in lower median MME consumption in comparison to 5% SMS and NPWT with no other significant differences between the other commonly used dressings. Thus, while silver sulfadiazine had lower mean daily pain scores compared to manuka honey, there was no difference in opioid consumption between the two groups. There was no single dressing resulting in lower mean and maximum daily pain with a reduction in MME consumed.

Previous reports demonstrate that burn injury is considered one of the most painful forms of trauma [6]. Additionally, pain after burn injury is multifaceted and changes over time. This study revealed a mean pain score of approximately 4/10 utilizing the NRS for the cohort. This finding correlates with prior literature that demonstrates that the burn injury itself is a major source of pain in the acute phase after burn injury, commonly described as background pain [6, 11-13]. Since nearly half of the NRS scale is consumed by the intrinsic pain after burn injury, it becomes difficult to delineate how much additional pain is attributable to the specific dressing. Other scales have been examined to determine their utility in pain assessment in burn patients. Current American Burn Association guidelines recommend that future burn studies and clinical practice should utilize the Burn Specific Pain Anxiety Scale as an addition to the standard NRS patients reported pain scale for pain assessment during acute hospitalization, as it is a validated tool in burn patients and includes assessment of anxiety, which is intimately associated with perception of pain after burn injury [6, 14, 15]. Additionally, incorporating the Defense and Veterans Pain Rating Scale (DVPRS), a tool demonstrated to incorporate psychometric components into pain might be a beneficial adjunct to burn patients, both civilian and military [15]. This study reinforces the need to examine pain in greater depth than just the NRS to elucidate the factors that contribute to pain after burn injury. While the NRS lends itself to ease of use from a documentation standpoint, it is limited, and moving forward additional validated tools for the evaluation of pain should be studied to establish the

Table 2. Comparison of average daily pain between dressings

Dressing	n	Average daily pain score	Comparison (*p*-value)				
			5% SMS	Mauka Honey	NPWT	Silver Sulfadiazine	Silver Nylon
5% SMS	1610	4.2 ± 2.1	-	0.10	0.26	0.37	0.69
Manuka Honey	191	4.5 ± 2.2	-	-	0.26	0.04*	0.06
NPWT	1134	4.3 ± 2.0	-	-	-	0.07	0.12
Silver Sulfadiazine	506	4.1 ± 2.1	-	-	-	-	0.48
Silver Nylon	1602	4.2 ± 2.0	-	-	-	-	-

SMS = sulfamylon solution, NPWT = negative pressure wound therapy. Data is presented as mean + SD. * Represents a significant *p*-value <0.05.

Table 3. Comparison of maximum daily pain between dressings

Dressing	n	Maximum daily pain score	Comparison (*p*-value)				
			5% SMS	Mauka Honey	NPWT	Silver Sulfadiazine	Silver Nylon
5% SMS	1610	7.0 ± 2.7	-	0.37	0.13	0.02*	0.16
Manuka Honey	191	7.2 ± 2.6	-	-	0.91	0.03*	0.11
NPWT	1134	7.2 ± 2.6	-	-	-	<0.01*	<0.01*
Silver Sulfadiazine	506	6.8 ± 2.6	-	-	-	-	0.17
Silver Nylon	1602	7.0 ± 2.5	-	-	-	-	-

SMS = sulfamylon solution, NPWT = negative pressure wound therapy. Data is presented as mean + SD. * Represents a significant *p*-value <0.05.

Table 4. Comparison of median MME consumed between dressings

Dressing	Median MME	Comparison (*p*-value)				
		5% SMS	Mauka Honey	NPWT	Silver Sulfadiazine	Silver Nylon
5% SMS	39.0 (15.0, 79.6)	-	0.03*	0.95	0.39	0.28
Manuka Honey	34.0 (15.0, 59.8)	-	-	0.02*	0.15	0.09
NPWT	39.0 (17.6, 76.0)	-	-	-	0.36	0.25
Silver Sulfadiazine	37.8 (15.0, 77.0)	-	-	-	-	0.91
Silver Nylon	38.0 (15.0, 69.0)	-	-	-	-	-

SMS = sulfamylon solution, NPWT = negative pressure wound therapy, MME = morphine milligram equivalents. Data is presented as median (IQR). * Represents a significant *p*-value <0.05.

best method for evaluating and documenting pain in burn patients.

This study revealed that the choice of dressing did not significantly impact the mean daily pain score. This finding is in line with the large Cochrane review that examined multiple dressings utilized on partial thickness burns to determine if any dressing was superior in terms of healing time and pain severity. Although some randomized controlled trials in the review favored a particular dressing with lower average pain scores, overall, there was no consensus for a superior dressing as it relates to pain, and the evidence supporting these dressings was considered low quality and the patient population too heterogeneous to make clinically significant conclusions [5].

Pain changes over time after a burn injury and multiple events contribute to increased pain, such as procedural pain, which includes dressing changes and rehabilitation sessions. There is also the aspect of breakthrough pain that occurs at sporadic times after burn injury. This study aimed to elucidate the pain associated with these events by capturing the maximum daily pain score. Silver sulfadiazine exhibited lower maximum pain scores compared to other dressings except silver nylon, and silver nylon was associated with lower maximum pain scores when compared to NPWT. Silver sulfadi-

azine has been a mainstay for burn injuries for many years and therefore the benchmark for comparison for many other dressings and patients have anecdotally described silver sulfadiazine as soothing after application.

Opioids are the primary modality of pain control in the acute phase after burn injury. Opioids carry an extensive adverse effect profile and have been associated with opioid-induced hyperalgesia and tolerance with prolonged use [16]. In the current era of both an opioid shortage and abuse crisis, studying morphine milligram equivalents (MME) is a clinically relevant outcome measure. Manuka honey dressing application was associated with a reduction in median opioid consumption when compared to 5% SMS and NPWT. However, we cannot conclude if this is secondary to a reduction in pain associated with the dressing as the pain scores (both daily and maximum) do not correlate with lower MME consumed, highlighting the limitation in MME as a surrogate for pain levels and that we must consider that these patients could have been undermedicated. For the remainder of the dressings, the lack of significant differences in MME is likely in part due to uniform prescribing practices and the use of standard order sets, such that patients receive a set amount of narcotics in response to a range of NRS pain scores [11]. Additionally, narcotics are frequently given in anticipation of pain, such as before a dressing change or rehabilitation session so further studies with emphasis on timing of medication and pain score assessment will provide additional information on evaluating dressings and their associated pain.

Limitations

There are several limitations to this study, aside from its retrospective nature. As previously stated, a mean or maximum daily pain score fails to capture the many facets and pain-related events a burn patient experiences including dressing changes, physical and occupational therapy, or procedural pain. Additionally, this study was unable to detect any difference in pain associated with dressings that are changed daily versus longer application duration. The NRS is limited in its scale and patients' report of pain is unique for the individual, as pain affects everyone differently. Future studies should evaluate patients to see the impact that a history of substance abuse, mental health diagnosis, or socio-economic factors all play on the perception of pain. Furthermore, MME consumed, which was designed as more of an objective measurement, needs further analysis. It is common practice to administer pain medication before a dressing change or rehabilitation session to prevent or decrease pain during these events. When studying MME consumed, these practices can negatively influence the interpretation that the patient was being treated for increased pain. This study did not capture the use of non-opioid adjuncts, which our facility routinely utilizes as part of a multimodal therapy regimen tailored to each patient. This study looked at pain and opioid consumption only, future studies would benefit from including a review of wound conversion/progression and need for operative intervention as well as graft failure to evaluate to see if there are any associations between these and pain. Additionally, some patients had several dressings throughout their hospital stay, but this study chose to capture the dressing covering the largest %TBSA as the most impactful on daily pain scores. Further studies should aim to elicit pain scores for each burn site as well as donor sites and any association in the reduction of pain with the size of the wound.

Conclusion

This study demonstrated that dressing type does not significantly affect the patient's experience of pain in the case of a small burn injury. Silver sulfadiazine dressings were associated with lower maximum pain scores when compared to 5% SMS, manuka honey, and NPWT; silver nylon was associated with less maximal pain than NPWT. However, manuka honey dressings were associated with reduced median MME consumption when compared to 5% SMS and NPWT. This study highlighted a weakness in the currently validated Numeric Rating Scale to accurately describe the complex experience of pain following a burn injury. Future studies need to be well-designed with a homogenous population examining clinically relevant endpoints between dressings with similar application times such as opioid use or a validated pain assessment tool with a greater range to capture more aspects of burn pain.

Disclosure of conflict of interest

The views expressed herein are those of the author(s) and do not necessarily reflect the official policy or position of the Defense Health Agency, Brooke Army Medical Center, the Department of Defense, nor any agencies under the U.S. Government. Individual authors have nothing to disclose.

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