AQUACEL® Ag BURN glove and silver sulfadiazine for the treatment of partial thickness hand burns: A retrospective review

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Abstract

Background: Loss of hand function has a detrimental impact on the physical and psychosocial functioning of those with hand burns. Of prime importance is the maintenance of range of movement (ROM). Subsequently, an ideal hand dressing needs to allow for full ROM, be comfortable, and facilitate healing. However, hand burns present complex challenges for burn clinicians with the dressing of choice remaining controversial. Patients and Methods: This retrospective review was undertaken to determine the effectiveness of the AQUACEL® Ag BURN glove as compared to silver sulfadiazine (SSD; standard care) in patients with partial thickness hand burns. The average total body surface area % was 14.6% with an average age of 37 years. Eight hands were dressed with an AQUACEL® Ag BURN glove and eight were dressed with SSD. Results: Pain scores were reduced in those with the glove compared to those who were treated with SSD dressing. Mobility of the hand with the glove was reduced compared to the patients treated with SSD. The glove cost including outer dressings was $330 US, this is compared to $432 US for the SSD dressing based on the average reepithelization rate of 15 days, and translates into a financial saving of approximately $100 US per patient and further reduces workload and resources. Conclusion: The use of a hydrofiber silver impregnated glove for partial thickness hand burns, has clinical significance in the outpatient setting reducing the need for hospitalization, and the amount of dressing changes required.

Key words: AQUACEL® Ag, carboxymethylcellulose, hands, hydrofiber, partial thickness burns, retrospective review, silver sulfadiazine
INTRODUCTION

The hand is the most commonly burned part of the body, accounting for more than 80% of all burn injuries. Loss of hand function has a detrimental impact on the physical and psychosocial functioning. Hand burns although small in total burn surface area (TBSA), required treatment at a burns facility to ensure restoration of function and minimize potential scarring. Of prime importance is the maintenance of range of movement (ROM). However, hand burns present complex challenges for burn clinicians with the dressing of choice remaining controversial. For near on 50 years, silver sulfadiazine (SSD) has been the gold standard for partial thickness burns. It is easily applied to the burn wound and notably affordable to treat large burn surface areas. However, SSD requires dressings to be changed at least once a day, and this is a traumatic and painful experience for patients and resource intensive. Furthermore, the continued use of SSD has been reported to retard wound healing and contribute to the development of hypertrophic scarring.

Within the last decade, there has been a notable shift toward alternative dressings that deliver silver over a sustained period and are less resource intensive reducing the amount of dressing changes. AQUACEL® Ag (ConvaTec, Skillman, NJ, USA) is a soft nonwoven sodium carboxymethylcellulose fiber that forms a gel and has the capacity to absorb exudate and contour to the wound bed. Currently, there are only a few clinical studies within the peer-reviewed literature that investigate the use of the AQUACEL® Ag BURN glove.

PATIENTS AND METHODS

This study was a retrospective review designed to determine the effectiveness of the AQUACEL® Ag BURN glove as compared to SSD (standard dressing). We performed a chart review of patients with partial thickness hand burns between February 2013 and February 2014. The study was approved by the Hospital Ethics Committee, and all patient data were de-identified and kept confidential to ensure the anonymity of the patient. The study cohort consisted of 15 patients (16 hands) with partial thickness hand burns according to the guidelines of the American Burn Association. Exclusion criteria included pediatric, superficial, and full thickness burns and those with active bleeding or infected wounds.

Data extracted from the medical charts included patient’s demographic data [Table 1] that encompassed age, gender, TBSA%, ventilation, and mechanism of injury. Data collected included time to epithelization, visual analog scale (VAS) pain scores on admission and postdressing, the comfort and overall satisfaction of the dressing, and ROM while dressing in situ [Table 2]. Averages provided for VAS pain scores and levels of comfort and satisfaction of dressing were the mean scores across the patient’s treatment until reepithelization. Digital images provided [Figures 1-3].

All patients enrolled in the study received usual care involving assessment of the burn wound including burn depth and TBSA%. Burn wounds were cleansed and debrided of blisters and digital images were taken. Eight hands were enrolled into the AQUACEL® Ag BURN glove cohort and eight were enrolled into the SSD cohort. One patient with bilateral hand burns was enrolled in both cohorts of the study. Those treated with the standard burn care received daily SSD dressing changes with Gauze and Kerlix Bandages. All wounds were assessed at the time of the dressing change. The AQUACEL® Ag BURN glove cohort was fixed with conform and Kerlix with only one glove applied (the initial dressing) with the Kerlix dressing changed on a weekly basis or earlier if indicated. Six patients in the AQUACEL® Ag BURN glove cohort were discharged 24 h after the glove was applied and returned to the outpatient setting for review. The glove detached spontaneously and required no further dressing changes [Figure 1c]. In cases of the glove partially detaching from the hand in reepithelialized areas, the glove was trimmed. In cases of restricted mobility with those unable to respond

<table>
<thead>
<tr>
<th>Variable</th>
<th>AQUACEL® Ag BURN glove</th>
<th>SSD</th>
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</thead>
<tbody>
<tr>
<td>Epithelization average (days)</td>
<td>15.13</td>
<td>15.75</td>
</tr>
<tr>
<td>Monetary cost (US)</td>
<td>$330</td>
<td>$432</td>
</tr>
<tr>
<td>Pain on admission (average VAS)</td>
<td>4/10</td>
<td>5/10</td>
</tr>
<tr>
<td>Pain postdressing (average VAS)</td>
<td>&lt;1/10</td>
<td>2/10</td>
</tr>
<tr>
<td>Comfort (average)</td>
<td>9.1</td>
<td>7.7</td>
</tr>
<tr>
<td>Range of motion (average)</td>
<td>6.8</td>
<td>8.6</td>
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<tr>
<td>Overall dressing satisfaction (average)</td>
<td>8.5</td>
<td>6.9</td>
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</table>

SSD: Silver sulfadiazine, VAS: Visual analog scale
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treated with the AQUACEL® Ag BURN glove, a few drops of normal saline 0.9% were used over the joints in the fingers to moisten the dressing followed by immediate mobilization of the fingers [Figure 2b].

While the patients were hospitalized, pain scores were evaluated on initial assessment of the burn wound then on a daily basis using the VAS. Postdischarge, pain scores were obtained in the outpatient setting on a weekly basis. As part of the ongoing assessment of burn care, pain management was performed as per the burn center’s protocol. Furthermore, the level of comfort and satisfaction of the dressing, the ROM, and time to epithelization was assessed.

**Outcome measures**

The outcomes evaluated included time to epithelialization, signs of infection, pain on admission, pain postdressing, comfort and overall satisfaction of dressing, and ROM of the hand. The individual cost and any complications that resulted from the use of the dressing were also noted. Furthermore, costs were estimated for the AQUACEL® Ag BURN glove cohort that included the glove and Kerlix and the SSD cohort included the SSD and dressing materials. However, time, labor, and the cost of the outpatient clinic were not included in the cost factor. Data were analyzed using descriptive statistics.

**RESULTS**

**Study participants**

During the study period, 16 hands (15 patients) with partial thickness hand burns were enrolled in this retrospective review. The patient demographics for each cohort are presented in Table 1. Two patients in the AQUACEL® Ag and one patient from the SSD cohort were ventilated and unable to respond to assessments of pain and comfort. The average age of the patient was 37 years, of which 13 were men and two were women. The average TBSA% was 14.6%. The mechanism of injury was primarily scalds and flame burns. One patient from the SSD cohort had sepsis.

Pain scores on admission were very similar for both the AQUACEL® Ag BURN glove and SSD cohort reporting 4/10 and 5/10, respectively, using the VAS. Postburn dressing, the pain score dropped for the AQUACEL® Ag BURN glove cohort, reporting <1/10 as opposed to the SSD cohort reporting 2/10. Comfort wise, those with the AQUACEL® Ag BURN glove experience greater comfort and overall satisfaction scoring 9.1/10 for comfort and 8.5/10 for overall satisfaction compared to the SSD cohort reporting 7.7/10 for comfort and 6.9/10 for overall satisfaction. The ROM between the two cohorts was assessed with the AQUACEL® Ag BURN glove cohort reporting a ROM capacity of 6.8/10 as opposed to the SSD cohort reporting a greater ability in the ROM at 8.6/10.
The mean epithelization time for the AQUACEL® Ag BURN glove and SSD cohort was very similar 15.13 and 15.75, respectively. The cost of the AQUACEL® Ag BURN glove at the time of this study was $323 US per glove coupled with the use of Kerlix was estimated at $330 based on the average reepithelization rate of 15 days. This is opposed to the standard treatment using SSD on a daily basis with the added cost of gauze and Kerlix estimated at $432 US based on the average reepithelization rate of 15 days. This translates into a monetary saving of approximately $100. However, this does not account for the time and human resources required to change the dressing and manage the wound.

**DISCUSSION**

The aim of this retrospective review was to determine the effectiveness of the nylon-reinforced silver sodium carboxymethylcellulose (AQUACEL® Ag BURN) glove as compared to SSD (standard care) in patients with partial thickness hand burns. Our findings concur with both Duteille and Jeffery[3] and Ridel et al.[10] demonstrating a cost-effective alternative to the conventional care protocol that reduces the number of dressings, length of hospitalization, and the trauma and pain experienced.

**Pain**

Our findings suggest that there was a reduction in pain experienced utilizing the AQUACEL® Ag BURN glove compared to the daily SSD dressing change. This concurs with Duteille and Jeffery[3] with the VAS pain scores at rest decreasing from 1.57 at day 1 to no pain at day 21. Furthermore, pain on movement decreased from initially 2.66 to 0.75 at day 21 postburn using the AQUACEL® Ag BURN glove.[3] Caruso et al.’s[6] study comparing AQUACEL® Ag with SSD in the treatment of partial thickness burns, reported significantly lower VAS pain scores in those dressed with AQUACEL® Ag compared to those treated with SSD (3.63 vs. 4.77, P = 0.003) during change of dressings as did Yarbora[5] reporting a VAS of 2.92 in the AQUACEL® Ag cohort versus 4.70 in the SSD cohort with the number of dressing changes reported to be less in the AQUACEL® Ag cohort.[3] Saba et al.[12] who assessed pain levels of pediatric patients comparing AQUACEL® Ag and Xerofo, found lower Wong-Baker FACES pain scores among the AQUACEL® Ag cohort 6.4 and 8.2, respectively (P = 0.01), requiring less intravenous narcotics (2.3 vs. 9.6, P ≤ 0.0005). This is echoed by Caruso et al.[8] reporting less administration of pain relief in the AQUACEL® Ag cohort compared to SSD. Furthermore, Lohana and Potokar[13] also demonstrated a reduction in pain medication from morphine to paracetamol and ibuprofen to none during subsequent dressings using AQUACEL® Ag in a pediatric population.

**Comfort and satisfaction**

Our study found the AQUACEL® Ag BURN glove was rated greater for comfort and level of overall satisfaction than those with the SSD dressing. Duteille and Jeffery[3] study recorded variables including comfort at rest and upon movement, during initial application and reapplication, and overall satisfaction and performance. At final evaluation, most patients gave ratings of excellent/good for conformability at 91% and overall glove performance at 74%.

**Flexibility and range of movement**

The flexibility and ROM of the hand or joint remain an important aspect of any burn dressing. Despite the pain experienced, added nursing care, and resources to perform a daily SSD dressing, a greater ROM was maintained in the SSD cohort. This was reflected in other studies that demonstrated difficulty in joint mobility with the hardening of dressing over the joints.[6,9] In particular, the use of SSD achieved greater flexibility and ROM when compared to AQUACEL® Ag for burn wounds.[9] Caruso et al.[14] found the flexibility excellent to very good in the 82% of patients with 19% reporting average to poor flexibility. Duteille and Jeffery[3] reported that on initial application of the AQUACEL® Ag glove, flexibility was either good or excellent reporting 83% at 24 h; however, this reduced to 56% at the final evaluation. The main issues experienced are shrinkage/hardening of the hydrofiber with pulling and taut/restricting sensations of the hand.

**Ease of use**

Ease of use for the AQUACEL® Ag BURN glove was demonstrated to have clinical significance to time and resources used to manage the complexities of hand burns. Duteille and Jeffery[3] reported the initial application of the glove to be very easy/easy in 87% of cases with reapplication of the glove very easy/easy in 95% of cases. Caruso et al.[14] also reported ease of application using AQUACEL® Ag in the management of partial thickness burns, with 82% reporting very easy to apply and 18% easy to apply.

**Reepithelization**

AQUACEL® Ag BURN glove can remain in place for a period of up to 21 days[3] as opposed to the SSD that requires a daily dressing. Subsequently, SSD is relatively short acting and therefore requires daily reapplication to the burn wound.[15] Furthermore, Wasiak et al.[16] demonstrated that SSD not only increases the number of dressings required but also makes a notable delay in wound healing.

The mean reepithelization time for the patients in our study was 15.13 in the AQUACEL® Ag BURN glove cohort and 15.75 in the SSD cohort. Although not statistically significant, those with the glove received only one glove at the time of the initial dressing until reepithelization. Duteille and Jeffery[3] reported 70% of all hand burns using the AQUACEL® Ag BURN glove achieved reepithelization with a mean time to full reepithelization 15.6 days. Caruso et al.[6] who’s study compared AQUACEL® Ag
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to SSD favored AQUACEL® Ag over SSD (74% vs. 60%) with reepithelization reported to be 16 versus 17 days; however, this was not statistically significant and concurs with our finding. Furthermore, Muangman et al.[7] who also compared AQUACEL® Ag to SSD reported the time to close the wound was significantly shorter in the AQUACEL® Ag cohort (10 vs. 13.7 days, P < 0.02) with the number of dressing changes noted to be fewer using AQUACEL® Ag (3.5 vs. 13.7, P < 0.001). Caruso et al.[14] reported 95% reepithelization or complete healing to be 11.6 days for partial thickness burns treated with AQUACEL® Ag. In particular, Yarboro[5] reported 4.10 treatments with AQUACEL® Ag and 10.27 treatments for SSD in order to achieve 100% reepithelization. Saba et al.[12] found that those treated with AQUACEL® Ag had a significantly shorter reepithelization time compared to the comparator (10.3 vs. 16.3 days, P < 0.005). Furthermore, in a recent systematic review of SSD in partial thickness burns,[17] it was concluded that the use of SSD can no longer be supported in the treatment of burns where rapid wound closure is a necessity to regain optimal function.

Cost benefit and resources
The total cost benefit of using the AQUACEL® Ag BURN glove compared to SSD can be viewed in several different domains: The frequency of dressing changes and resources used, the cost of the dressing materials, and the length of stay (LOS). Patients treated with the AQUACEL® Ag BURN glove used only one glove to the point of wound healing with only the Kerlix changed weekly or when required as opposed to the daily dressing with SSD. Duteille and Jeffery[3] trialled the AQUACEL® Ag BURN glove also used only one glove for 11 out of the 23 patients, with 12 patients having more than one glove applied during the 21 day study period. Caruso et al.[6] found to have used significantly fewer AQUACEL® Ag dressings with the total number of dressings reported to be 7.7 in the AQUACEL® Ag cohort compared to the SSD cohort of 19.1 dressings (P ≤ 0.001). Lau et al.[18] also reported the efficacy of the AQUACEL® Ag experiencing an average of 5.67 dressing with AQUACEL® Ag compared to the standard dressing of paraffin-based gauze with an average of 20.59 dressing changes. In addition, the use of a Tulle Gras (nonadherent petrolatum gauge) is a viable option for the treatment of the hands as presented in this retrospective review. However, Tulle Gras does not allow for the absorption of exudate, lacks any antimicrobial activity, and is reported to contribute to skin maceration.[19]

The time it takes to change the dressing needs to be taken into account when reviewing the cost benefit of a dressing. Duteille and Jeffery[3] calculated the mean time required to initially apply the glove was 5.4 and 5.1 min to re-apply the glove. Importantly, Caruso et al.[6] found that the in-clinic change of dressing for the AQUACEL® Ag compared to the SSD was 28.2 versus 45.6 min. Furthermore, nursing time required was significantly shorter with the AQUACEL® Ag cohort than the SSD cohort reporting 35 verses 53 min (P ≤ 0.001). Saba et al.[12] reported significantly less time required for the AQUACEL® Ag cohort at 25 min compared to the comparator of paraffin gauze at 42 min (P ≤ 0.001). Subsequently, Saba et al.[12] reported less nursing time for those using the AQUACEL® Ag estimating 1.9 versus 3.5 min.

The LOS needs to be considered when assessing the cost factor. Of the 15 patients (16 hands) reviewed in this study, six in the AQUACEL® Ag were discharged after 24 h postapplication of the glove. Saba et al.[12] stated that the LOS for the AQUACEL® Ag cohort to be 2.4 days with an average of 9.6 days for the comparator of paraffin gauze (P ≤ 0.0005). Lau et al.[18] also demonstrated a reduced LOS using AQUACEL® Ag compared to paraffin gauze reporting an average of 14.26 days compared to 23.45 days. The total cost of care for our study could not be established per se; however, those treated with the AQUACEL® Ag BURN glove including the Kerlix was estimated at the time of the study at $330.00 US based on a period of 15 days compared to the SSD cohort at a daily cost of $432 US. Muangman et al.[7] concurred with the cost-effective nature of AQUACEL® Ag compared to SSD taking into consideration the hospital, travel, and total treatment cost of burn care of $52 US for the AQUACEL® Ag cohort versus $93 US for the SSD cohort (P ≤ 0.01). Caruso et al.[6] who also compared AQUACEL® Ag and SSD calculated the total cost of care over a 21-day period to be $1,040.00 US in the AQUACEL® Ag cohort and $1180.80 US in the SSD cohort including primary dressings, cost of labor, gauze and retention dressings, and pain medications.

Limitations
When considering the results of this study, a few limitations should be noted. The small sample size of 16 partial thickness hand burns was included in this retrospective review with only one other comparator (8 AQUACEL® Ag BURN glove and 8 SSD); therefore, care should be taken when considering these findings. In addition, three patients were ventilated, therefore, limit the pool of qualitative data collected. The subjective nature of the data collected has implications for the strength of this study. Furthermore, the use of a retrospective study design further limits the strength of these findings with no randomization or blinding and therefore vulnerable to selection bias. However, due to the complexity of hand burns, the AQUACEL® Ag BURN glove showed promising outcomes in the reduction of pain and trauma experienced as well as the added cost benefit.
CONCLUSION

This retrospective review demonstrated that the AQUACEL® Ag BURN glove was well tolerated for the treatment of partial thickness hand burns with no safety concerns identified. Average pain and comfort scores were lower compared to the SSD standard care with the use of only one glove without any further dressing changes required. Subsequently, the frequency of dressings has significance for the reduction of pain and psychological trauma experienced during dressing and burn procedures as well as implications for cost and resources. Epithelization occurred within the maximum of 21 days that the glove can remain in situ. As such, these results have clinical implications for the use in the outpatient setting for those who sustain partial-thickness hand burns avoiding, undue pain and trauma, an extended length of hospital stay with the potential to improve the capacity to return to work sooner and resume activities of daily living.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

REFERENCES