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Reduction in skin grafting after the introduction of hydrofiber dressings in partial thickness burns: A comparison between a hydrofiber and silversulphadiazine

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ABSTRACT

**Aim/purpose:** The aim of this study was to compare clinical outcome of children with scald burns treated with a hydrofiber dressing (Aquacel®, Convatec Inc.) with the former standard of care with silver sulfadiazine (Flammazine®, Solvay Pharmaceuticals), considering surgical intervention and length of stay (LOS).

**Methods:** A retrospective study of all consecutive children from zero to four years with primary scald burns up to 10% admitted to the Burn Centre of the Maasstad Hospital Rotterdam between January 1987 and January 2010 were reviewed. For data collection a prospective computerized database was used. For comparison the study period was divided into two periods representing the period before and after the introduction of the hydrofiber dressing (HFD), respectively 1987–1999 (period 1) and 1999–2010 (period 2).

**Results:** Over the whole study period 27.3% of 502 patients treated with silver sulfadiazine (Ag-SD) underwent surgery, while before the introduction of HFD 30.5% of 338 Ag-SD treated patients were operated upon. After the introduction of the HFD 20.7% of 164 patients treated with Ag-SD eventually underwent skin grafting, a significant difference with the 11.6% of 302 patients whose wounds were dressed with HFD (p < 0.01).

**Conclusions:** Compared to silver sulfadiazine treatment a reduced number of surgical interventions was observed in mixed partial thickness scald burns up to 10% TBSA burned in children aged 0–4 years after the introduction of hydrofiber dressings. The mode of treatment with this wound dressing also limited hospital length of stay.
1. INTRODUCTION

Silver sulfadiazine (Ag-SD) was introduced in the late sixties and early seventies and is currently worldwide used for the topical treatment of burns. Due to its broad antibacterial spectrum leading to lesser wound infection and sepsis more patients with severe burns could survive [1,2]. In full thickness burns these benefits have been proven and Ag-SD is implemented in many treatment protocols. Different from the treatment of full-thickness burns or burns over a large surface area, where the main goal is to diminish bacterial counts awaiting eventual operative interventions, in fresh non-infected partial thickness burns the focus is directed to the preservation of remaining viable epithelial elements. Especially in scald burns areas of superficial, deep dermal and to a lesser extent subdermal burns are present. In these mixed partial-thickness burn wounds the policy is to wait and see to distinguish between parts that will heal spontaneously and demarcation of larger and deeper areas that require excision and grafting. Meanwhile an environment has to be created where wound healing can emerge from epithelium still present in the wound bed. In the late eighties it became evident that the best suitable environment for wound healing was moist instead of dry [3]. In several studies it was shown that Ag-SD has cytotoxic effects that impair healing of partial thickness burn wounds by inhibition of basal keratinocytes growth [4]. Therefore modern wound dressings that create a moist yet stable environment are used more and more. These include amongst others hydrofiber dressings, for example Aquacel® (Aquacel®, Convatec Inc.), achieve this moist and stable environment.

Aquacel® is a primary wound dressing made from sodium carboxymethylcellulose and is produced as a textile fibre presented in the form of a fleece held together by a needle bonding process. The dressing has a large fluid-absorption capacity and interacts with wound exudates to form a soft, hydrophilic, gas-permeable gel providing a micro-environment that facilitates healing. The vertical absorption properties help to maintain the moist area over the wound and reduce the risk of maceration.

In the Burn Centre of the Maasstad Hospital Rotterdam the hydrofiber dressing (HFD) Aquacel® was introduced in 1999, primarily used for scalds of limited surface area. Before that time also in our centre scalds were mainly treated with Ag-SD (Flammazine®, Solvay Pharmaceuticals).

The aim of this study was to compare clinical outcome between children with scald burns treated with HFD (Aquacel®) and the former standard of care with silver sulphadiazine (Flammazine®), considering the surgical intervention, length of stay (LOS) and re-admission in the hospital for treatment of the same burns.
2. METHODS

2.1 Data collection

In order to obtain a homogeneous population all consecutive children from zero to four years with primary scald burns up to 10% admitted to the Burn Centre of the Maasstad Hospital Rotterdam between January 1987 and January 2010 were reviewed. For data collection a prospective computerized database was used.

2.2 Study period and treatment protocols

For comparison the study period was divided into two periods representing the period before and after the introduction of HFD, respectively 1987–1999 (period 1) and 1999–2010 (period 2). In period 1 most scald burns under 10% Total Body Surface Area (TBSA) burned were treated with daily hydrotherapy and change of bandages with Ag-SD. In period 2 HFD was predominantly applied, as seen in Fig. 1. Depending on the amount of exudate and/or in case of sliding of the dressing an additional layer was applied. After about ten to twelve days HFD were removed to assess the wound and to decide whether skin grafting was necessary. In period 2 Ag-SD was also applied in a minority of cases, especially in localizations where HFD was less applicable (joints, hand, face).

![Fig. 1 – Inclusion of patients treated with Ag-SD and HFD.](image)
2.3. Study endpoints
The primary outcome was the incidence of surgical treatment before and after the introduction of HFD. Surgical treatment was defined as tangential excision and split skin grafting. Secondary endpoints were length of stay and re-admission for treatment of the same burns. The total length of stay was calculated, based on the length of stay during first admission and re-admission(s).

2.4. Statistics
Differences in patient demographics and outcome between the three groups (Ag-SD period 1, HFD period 2 and Ag-SD period 2) were tested. Differences in genders, surgical interventions, and re-admissions were analyzed using Chi-square test. Differences in age, TBSA burned and length of stay were analyzed using analysis of variance (ANOVA).
For patients in all groups who underwent surgery Independent Samples Median Test was to determine significance of differences in time between injury and operation.
Statistical significance was declared at the 0.05 level. All statistical analyses were performed using SPSS for Windows, version 15.0.1 (SPSS, Inc., Chicago, IL).

3. RESULTS

3.1. Demographics
During the study period 5122 patients were admitted to the Burn Centre of Rotterdam, The Netherlands. Of these 401 were hospitalized for secondary reconstructive surgery and 240 were re-admissions, leaving 4481 eligible first admissions: 3314 of them were older than 4 years, 196 children had another etiology than scalds and 167 children with scald burns had a TBSA burned >10%.
Therefore 804 children from 0 to 4 years with primary scald burns up to 10%TBSA were eligible for analysis, 502 were treated with Ag-SD and 302 treated with hydrofiber. The flowchart of the inclusion of patients is shown in Fig. 2.
Chapter 4

In period 1, before the introduction of HFD, 338 patients were treated with Ag-SD (Table 1): 202 were boys and 136 girls (ratio of 59.8% vs. 40.2%). In the period after the introduction of HFD 164 patients were treated with Ag-SD. The male–female ratio in this group (55.5% vs. 44.5%) did not differ significantly from the male–female ratio in the first period (p = 0.21). Also there were no differences in male–female ratio between all treated with Ag-SD and HFD treated patients (p = 0.43). Although the difference in mean age of 1.3 years in Ag-SD treated patients vs. 1.1 years in the HFD group is statistically different (p < 0.01), this minor age difference is clinically irrelevant. The mean TBSA burned was also comparable in AgSD and HFD treated patients (p = 0.50).

**Table 1 – Demographics of the three study groups.**

<table>
<thead>
<tr>
<th></th>
<th>Ag-SD before introduction of HFD</th>
<th>Ag-SD after introduction of HFD</th>
<th>AgSD total</th>
<th>HFD</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td>338</td>
<td>164</td>
<td>502</td>
<td>302</td>
<td></td>
</tr>
<tr>
<td>Male/female</td>
<td>202/136</td>
<td>91/73</td>
<td>293/209</td>
<td>179/123</td>
<td>0.21*</td>
</tr>
<tr>
<td>Mean age (±SD)</td>
<td>1.3 (±1.04)</td>
<td>1.3 (±1.09)</td>
<td>13 (±1.06)</td>
<td>1.1</td>
<td>&lt;0.01*</td>
</tr>
<tr>
<td>Mean TBSA (±SD)</td>
<td>5.3 (±2.45)</td>
<td>4.9 (±2.51)</td>
<td>5.2 (±2.47)</td>
<td>5.1</td>
<td>0.50*</td>
</tr>
</tbody>
</table>

SD, standard deviation.  
*p-Values using Chi-square.*
3.2. Primary outcome: need for surgical treatment

Before the introduction of HFD 30.5% of 338 Ag-SD treated patients were operated upon (Table 2). After the introduction of HFD 20.7% of 164 patients treated with Ag-SD eventually underwent skin grafting, a significant reduction over time (p=0.01). Compared to 20.7% operative procedures in the AgSD group after introduction of HFD, a further drop in surgical interventions to 11.6% was observed in patients dressed with HFD (p< 0.01).

<table>
<thead>
<tr>
<th></th>
<th>Ag-SD before introduction of HFD</th>
<th>Ag-SD after introduction of HFD</th>
<th>HFD</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td>338</td>
<td>164</td>
<td>302</td>
<td></td>
</tr>
<tr>
<td>Operations</td>
<td>103 (30.5%)</td>
<td>34 (20.7%)</td>
<td>33</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

Further analysis of data reveals that the median interval between time of injury and operation was different in the two Ag-SD groups; 14.0 days for Ag-SD treated patients before the introduction of HFD (range 1–181 days) and 20.5 days (range 10–47 days) for 34 Ag-SD treated patients after the introduction of HFD (p = 0.02 Independent Samples Median Test). Because of a non-normal distribution of the interval between injury and operation in the 103 operated patients in the Ag-SD group before the introduction of HFD, Independent Samples Median Test was used to determine significance (p=0.02).

3.3. Secondary outcome: length of stay and re-admission

Considering length of stay it is relevant to include patients who had to be re-admitted for treatment of the same burn. There was no significant difference in re-admissions of Ag-SD treated patient before and after the introduction of HFD (p=0.43).

In the Ag-SD group 13 children (2.6%) were re-admitted over the total period (Table 3). Eighteen children (6.0%) who were treated with HFD had to be re-admitted to the Burn Centre because further treatment in the outpatient clinic turned out to be impossible after all. Before the introduction of HFD 338 patients treated with Ag-SD had to stay in hospital for 12.4 days (Table 3). In those patients who were treated with Ag-SD in the second period (n = 164), where predominantly HFD was used, length of hospital stay significantly decreased to a mean of 9.7 days (p<0.01). Patients with burns treated with HFD (n = 302) were admitted to hospital for 7.5 days, a further significant decrease in length of stay when compared to Ag-SD treated patients in the same time period (p<0.01).
In this study we compared the clinical outcome of the treatment of scald burns up to 10% TBSA in children under 5 years using HFD or Ag-SD between 1987 and 2010. Children treated with HFD had a favourable outcome considering treatment with surgery and length of stay. The prevalence of re-admissions in the HFD group was slightly elevated.

As stated before, wound dressings are indicated in noninfected partial thickness burns to create an optimal environment for outgrowth of remnant epithelium, therefore at the time being the first choice of treatment of this type of injury in our clinic.

However, in some places wound dressings are difficult to apply, for example around fingers in little children, or in localizations like the perineum. In those localizations for example Ag-SD is used for practical reasons and also after the introduction of HFD the use of Ag-SD was not completely abandoned.

Over time a decrease in operative procedures in Ag-SD treated patients before and after the introduction of HFD was observed (30.5 vs. 20.7%; p=0.01).

The question arises if this difference in primary outcome of Ag-SD treated patients in this retrospective study could be based on a selection bias for operative intervention. However, before and after the introduction of HFD operated patients turned out to have the same age (mean 1.6 years) and the same TBSA burned (5.4 vs. 5.7%, Table 4). The decrease of operations in Ag-SD treated patients after the introduction of HFD also refutes a potential bias in terms of selection of deeper scald burns in localizations like hands or perineum, in which case more skin grafting would have been observed.

Further analysis of data reveals that the median interval between time of injury and operation was different in the two Ag-SD groups; 14.0 days for Ag-SD treated patients before the introduction of HFD (range 1–181 days) and 20.5 days (range 10–47 days) for 34 Ag-SD treated patients after the introduction of HFD (p=0.02 Independent Samples Median Test). Before the introduction of HFD therefore Ag-SD treated patients were operated more frequently and at earlier stage, which could be explained by a more conservative approach.

### Table 3 – Re-admissions of Ag-SD and HFD treated patients and length of stay.

<table>
<thead>
<tr>
<th></th>
<th>Ag-SD before introduction of HFD</th>
<th>Ag-SD after introduction of HFD</th>
<th>AgSD total</th>
<th>HFD</th>
<th>p-Val</th>
</tr>
</thead>
<tbody>
<tr>
<td>Re-admissions</td>
<td>338 (2.4%)</td>
<td>164 (3.0%)</td>
<td>502</td>
<td>302</td>
<td>0.62</td>
</tr>
<tr>
<td>Mean LOS (days)</td>
<td>12.4 (±8.55)</td>
<td>9.7 (±7.60)</td>
<td>18 (±6.0%)</td>
<td>&lt;0.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>9.7 (±7.60)</td>
<td>7.5 (±6.46)</td>
<td>&lt;0.01</td>
<td></td>
</tr>
</tbody>
</table>

SD, standard deviation.

*p* Values using Chi-Square.

*p* Values using ANOVA.
in the period that coincides with the introduction of HFD. Indeed, since the introduction of HFD hospital stay was shortened by earlier discharge to outpatient care. In this outpatient care setting, using HFD, wound inspection is not possible during the time that the adherent wound dressing is in place, i.e. about 10 days and therefore the decision for surgery might be delayed. Observing extensive re-epithelialisation in these partial thickness scald burns after that period we also became more conservative as to (delayed) primary surgery in our Ag-SD treated patients.

With the use of HFD only 11.6% of patients underwent skin grafting, a further significant reduction compared to the 20.7% of Ag-SD treated patients who had to be operated in the same period (p < 0.01). The interval between injury and operation for these patient (median 20.5 days) did not differ from the AgSD treated patients after introduction of HFD (median 17.0 days). In conclusion HFD treated patients were operated less frequently but at the same time after injury compared to the Ag-SD group in period 2.

The same trend in time in reducing the number of surgical interventions is also reflected in the length of stay. Before the use of HFD Ag-SD treated patients were admitted to hospital 12.4 days on average; after the introduction of HFD admission time of these patients was reduced significantly to 9.7 days (p<0.01). Ag SD requires daily wound care, reason for clinical treatment of these patients. Explanation for a shorter admission time is a change in policy where Ag-SD in advanced wound healing at some point is replaced by paraffin impregnated gauzes, which need to be changed less frequently, allowing for outpatient treatment.

A further significant reduction in hospital stay to 7.5 days was obtained with the use of HFD (p < 0.01). In the first days of hospital stay daily inspection is performed to see if the HFD is saturated or shifted, in which cases new or extra HFD is applied. The clinical or social circumstances permitting, the patients then continued outpatient treatment. Compared to data in the literature this length of stay is longer than the 3.8 days published by Paddock, who in his study of partial thickness burns in children comparing HFD-Ag with Ag-SD also

<table>
<thead>
<tr>
<th></th>
<th>Ag-SD before introduction of HFD</th>
<th>Ag-SD after introduction of HFD</th>
<th>HFD</th>
<th>p-Val</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median interval injury-operation (days)</td>
<td>14.0 (±2.71)</td>
<td>20.5 (±1.56)</td>
<td>17.0 (±0.82)</td>
<td>0.07*</td>
</tr>
<tr>
<td>Mean age (±SD)</td>
<td>5.4 (±2.71)</td>
<td>6.2 (±1.30)</td>
<td>6.2 (±1.30)</td>
<td>0.33*</td>
</tr>
<tr>
<td>Mean TRSA</td>
<td>5.4 (±2.71)</td>
<td>5.7 (±2.08)</td>
<td>6.2 (±1.30)</td>
<td>0.66*</td>
</tr>
</tbody>
</table>

SD, standard deviation. *p-Values using Independent Samples Median Test. **p-Values using ANOVA.
found a reduction in hospital length of stay in favour of the HFD-Ag treated patients [7]. At present, obtaining more experience with HFD applications, also in our Burn Centre admission times decrease to a few days, sending home those children who eat and drink well and have no fever.

Although there are relatively more re-admissions in the HFD treated patients HFD 6.0% vs. 2.6% for Ag-SD: p = 0.02), we found no difference in the percentage of patients re-admitted for skin grafting (HFD 12/18 = 66.7%, Ag-SD 9/13 = 69.2%; p = 0.60). This leaves 6 HFD treated patients and 4 Ag-SD treated patients to be re-admitted for other reasons, e.g. because of clinical conditions like fever or social circumstances.

In the studies by Caruso et al. it was shown that the use of silver impregnated hydrofibers (HFD-Ag) was associated with less pain and anxiety during dressing changes, less burning and stinging during wear, fewer dressing changes, less nursing time, and fewer procedural medications compared with Ag-SD [5,6]. In this prospective randomized study HFD Ag was used with less patients (42 in each group) compared to our study; it was also shown that a greater rate of reepithelialisation was achieved with the use of HFD-Ag in comparison with Ag-SD. In the Cochrane review by Wasiak et al. [8] it is stated that the use of Ag-SD as a comparator on burn wounds for the full duration of treatment needs to be reconsidered, as a number of studies showed delays in time to wound healing and increased number of dressing applications in patients treated with Ag-SD dressings.

5. CONCLUSIONS

Compared to silver sulphadiazine treatment a reduced need for surgical interventions was observed in mixed partial thickness scald burns up to 10% TBSA burned in children aged 0–4 years after the introduction of hydrofiber dressings. The mode of treatment with this wound dressing also limited hospital length of stay.

Conflict of interest statement

We declare that there is no conflict of interest including any financial, personal or other relationship.
Reduction in skin grafting after the introduction of hydrofiber dressings in partial thickness burns

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