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A retrospective analysis of ambulatory burn patients: focus on wound dressings and healing times

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ABSTRACT

INTRODUCTION In this study, we retrospectively analysed healing times of ambulatory burn patients after silver-based dressings were introduced in late December 2005, and compared the results with those obtained before.

PATIENTS AND METHODS Data were collected in November–December 2005 and in January–February 2006. We excluded from the study: (i) admitted patients; (ii) patients with mixed superficial partial thickness and deep partial thickness burns; (iii) patients with full-thickness burns; and (iv) operated patients that came for follow-up. We recorded the age, sex, cause (flame vs scald), burn depth, dressings used and healing times.

RESULTS We selected 347 patients corresponding to 455 burned areas (64.4% superficial and 35.6% deep; 47.7% treated in 2005 and 52.3% in 2006). During the years 2005 and 2006, there was an increase in the use of silver-based dressings (2005, 9.7%; 2006, 38.7%; chi-squared test, $P < 0.001$) and a decrease in the use of paraffin gauzes (2005, 66.4%; 2006, 40.3%; chi-squared test, $P < 0.001$). The healing time of overall burns and of superficial burns showed no significant differences between 2005 and 2006. However, in deep partial thickness burns, a significant reduction was present (2006, 19; 2005, 29 days; Student's t-test, $P < 0.01$). Among all dressings, paraffin gauzes had the shortest healing times in superficial burns (5 days); with silver-based dressings in deep burns, the healing times were nanocrystalline silver (16 days) and silver carboxymethylcellulose (21 days).

CONCLUSIONS Results of our retrospective study would suggest that paraffin gauzes are a valuable option in superficial burns, while silver-based dressings are preferable in deep burns.

KEYWORDS
Burn dressings – Ambulatory burns – Healing times

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Dressings have always been an important issue in reconstructive surgery to obtain better aesthetic and functional outcomes. This is particularly true in burns, where infections and contractures are more frequent than in other fields. Over latter years, pharmacological research has produced several products with different purposes: avoidance of infection (*i.e.* silver-containing products), promotion of re-epithelialisation (alginates, hyaluronic acid-derived products), or both.

In the ambulatory facility of our burn centre, we use different products for different purposes. Although we try to use them according to burn thickness and local status, no clear guideline exists and much of the decision is often left to the surgeon's personal experience. During the last days of 2005, new silver-based products (nanocrystalline silver – Acticoat, Smith and Nephew, and silver carboxymethylcellulose – Aquacel Ag, Convatec) were introduced in our clinical practice. In the present study, we analysed burn outcomes, in terms of healing times, during the last 2 months of 2005 and the first 2 months of 2006, to see if changes in wound care corresponded to an amelioration of healing times. We also tried to correlate eventual differences with those obtained from other products already in use.

Patients and Methods

After local Institutional Review Board approval was obtained, we gathered data from patients treated in the ambulatory facility of our burn centre during the last 2 months of 2005 and the first 2 months of 2006. We excluded from the study: (i) admitted patients; (ii) patients with mixed superficial partial thickness and deep partial thickness burns; (iii) patients with full-thickness burns; and (iv) operated

patients that came to the ambulatory facility for postoperative follow-up.

Patients were initially seen in the hospital's emergency department. Here, they were selected for ambulatory treatment when they presented with minor burns, according to the American Burn Association classification: second-degree burns with total burn surface area less than 15% in adults (10% in children), burns not involving eyes, ears, face, hands, feet or perineum, burns not derived from electrical injuries, not associated with inhalation injuries or fractures, not in a poor-risk patient.[1]

Burn depth was clinically assessed by the senior author (AM, consultant burn surgeon). Superficial and deep partial thickness burns were defined on clinical characteristics (rose or white-pearly lesion appearance, change of the colour after pressing of the skin). No systemic antibiotics were used (intravenously or orally).

Dressing protocols

All patients could have more than one type of product simultaneously applied to different regions of their body, but every single burned area was always medicated with the same dressing until complete healing. The choice of the product depended on the surgeon's clinical experience and personal preference. Dressings used are shown in Table 1. Nanocrystalline silver was 're-activated' at home, after a careful instruction of patients and parents, with bi-distilled water every 8 h according to the manufacturer's recommendation.

The senior author also followed patients during subsequent visits. Although dressing required different changing times, we tried to see patients twice weekly (every 3 days) in the clinic to follow the healing progress. Wounds were diagnosed as completely healed when the normal re-epithelisation process was complete and covered all affected areas. The same author, working in the ambulatory facility and examining patients, expressed this clinical judgement.

For every patient, we recorded the age, sex, cause of burn (flame or scald), type of dressing used, and the number of days required to complete the healing (healing time).

Statistical analysis

The database was constructed with Excel (Microsoft Corporation, Redmond, WA, USA) and the statistical analysis performed using the Statistical Package for the Social Sciences Windows v.13.0 (SPSS, Chicago, IL, USA). Descriptive statistics were expressed as mean and SD, after confirmation of normal distribution, for continuous parametric variables and frequencies for qualitative ordinal variables. Normality assumptions were demonstrated with histograms, Q–Q plots, Skewness and Kurtosis, Kolmogorov–Smirnov and Shapiro Wilk testings.

To compare patient groups (2005 vs 2006), parametric continuous variables were analysed with the Student's *t*-test and categorical variables with the chi-squared test (Fisher's exact test if occurrences in cells were less than 5). All results were considered significant if inferior to 0.05 ($P < 0.05$).

Results

Data were collected in November–December 2005 and in January–February 2006. We recorded data from 347 patients, 167 in 2005 and 180 in 2006 (Table 2). A total of 455 burned

Table 1 Dressings used and manufacturers

Name	Content	Manufacturer	Address
Promogram	Animal collagen (55%) oxidised regenerated cellulose (45%)	Johnson & Johnson	Skipton, UK
Betadine	10% Povidone-iodine	Purdue Frederick Company	Norwalk, CT, USA
Gentalyn beta	Gentamycin 0166 g, betamethasone 0122 g	Schering Plough Corporation	Kenilworth, NJ, USA
Acticoat	Nanocrystalline silver	Smith and Nephew	Hull, UK
Aquacel Ag	Sodium carboxymethylcellulose containing 1.2% silver (ionic form)	Convatec (Bristol-Myers Squibb Company)	New York,NY, USA
Sofargen	1% Silver sulphadiazine	Sofar	Trezzano Rosa, Italy
Jaloskin	Hyaluronic acid ester (HYAFF)	Fidia Advanced Polymers	Abano Terme, Italy
Jelonet	Paraffin gauzes	Smith and Nephew	Hull, UK
Noruxol	Collagenase	Smith and Nephew	Hull, UK

Table 2 Patient demographics and clinical characteristics by year

	Overall	2005	2006	Significance (2005 vs 2006)
Patients (*n*)	347	167	180	–
Sex (male)	213 (61.4%)	101 (60.5%)	112 (62.2%)	NS
Age (years)	48 ± 20.5	42 ± 24.8	52 ± 18.6	NS
Total burn surface area (%)	4 ± 2	4 ± 3	4 ± 2	NS
Scald	221 (63.7%)	108 (64.7%)	113 (62.8%)	NS
Flame	126 (36.3%)	59 (35.3%)	67 (37.2%)	NS
Total areas treated	455	217 (47.7%)	238 (52.3%)	–
Areas of superficial partial thickness	293 (64.4%)	184 (84.8%)	169 (71.0%)	< 0.001
Areas of deep partial thickness	162 (35.6%)	33 (15.2%)	69 (29.0%)	< 0.001

NS, not significant.

areas were treated, 293 (64.4%) superficial and 162 (35.6%) deep partial thickness, 217 (47.7%) in 2005 and 238 (52.3%) in 2006. There was a significant decrease of superficial partial thickness burns between 2005 and 2006, and a significant increase of deep partial thickness burns (Table 2).

Dressings most frequently used in superficial partial thickness burns were paraffin gauzes and silver carboxymethylcellulose, and in deep partial thickness burns, nanocrystalline silver and paraffin gauzes (Table 3). All medications were selected differently according to the burn type (superficial or deep) except for the animal collagen oxidised regenerated cellulose, silver carboxymethylcellulose, silver sulphadiazine and hyaluronic acid ester, in which no significant differences between groups were found (Table 3).

In 2005, dressings most frequently used in superficial partial thickness areas were paraffin gauzes (85.9%) and collagenase (12.0%); in 2006, paraffin gauzes (60.1%) and silver carboxymethylcellulose (25.8%). Considering deep partial thickness areas, in 2005 dressings most frequently used were paraffin gauzes (88.0%) and collagenase (56.0%); in 2006, nanocrystalline silver (72.1%) and paraffin gauzes (39.3%).

The analysis of healing times for overall burns showed no significant differences between 2005 and 2006 (Table 4). Healing times of deep partial thickness burns were longer

Table 3 Dressings used on burns: a subgroup analysis according to the type of burn and the year (2005 vs 2006)

	Areas of superficial partial thickness burns (*n* = 293)	Deep partial thickness burns (*n* = 162)	Significance (superficial vs deep)	2005 (*n* = 217)	2006 (*n* = 238)	Significance (2005 vs 2006)
Animal collagen oxidized regenerated cellulose	0	1 (0.6%)	NS	1 (0.5%)	0	NS
Povidone-iodine	4 (1.4%)	8 (4.9%)	< 0.05	8 (3.7%)	4 (1.7%)	NS
Gentamycin/betamethasone	5 (1.7%)	8 (4.9%)	< 0.05	5 (2.3%)	8 (3.4%)	NS
Nanocrystalline silver	6 (2.0%)	50 (30.9%)	< 0.001	7 (3.2%)	49 (20.6%)	< 0.001
Silver carboxymethylcellulose	41 (14.0%)	16 (9.9%)	NS	14 (6.5%)	43 (18.0%)	< 0.001
Silver sulphadiazine	16 (5.4%)	4 (2.5%)	NS	7 (3.2%)	13 (5.5%)	NS
Hyaluronic acid ester	2 (0.7%)	1 (0.6%)	NS	0	3 (1.3%)	NS
Paraffin gauzes	194 (66.2%)	46 (28.4%)	< 0.001	144 (66.4%)	96 (40.3%)	< 0.001
Collagenase	25 (8.5%)	28 (17.3%)	< 0.01	31 (14.3%)	22 (9.2%)	NS

NS, not significant.

Table 4 Number of days required for healing burns: a subgroup analysis according to the year (2005 vs 2006)

	Overall	2005	2006	Significance (2005 vs 2006)
Healing time (days)				
• All burns	10.2 ± 11.5	9.5 ± 11.7	10.9 ± 11.2	NS
• Superficial partial thickness	6.4 ± 6.6	6.0 ± 5.2	6.9 ± 7.9	NS
• Deep partial thickness	21.7 ± 15.0	29.4 ± 17.5	18.5 ± 12.8	< 0.01

than superficial partial thickness burns, as expected (22 days vs 6 days). Surprisingly, subgroup analysis showed, for deep partial thickness burns, a significant decrease of the healing times between 2005 and 2006 (2005, 29 days; 2006, 19 days; Student's *t*-test, $P < 0.01$), not present in superficial partial thickness burns (Table 4).

When the analysis was restricted to the different types of dressings used, and to groups with more than 15 patients (to avoid any possible bias derived from low numbers), the shortest healing times were achieved in superficial thickness burns with paraffin gauzes (5 days) and in deep partial thickness burns with nanocrystalline silver (16 days; Table 5).

Discussion

Dressings represent one of the most controversial and discussed topics in wound healing. Several products have been developed with different characteristics; however, no clear indications have been reached on their use. This is particularly true in burns, where the high prevalence of wound infections and contractures render the choice more important than in other fields of surgery.

Although there are many studies in the literature about burn dressings, there are few randomised controlled trials. In superficial partial thickness burns, some authors suggest the use of paraffin gauzes for the low prevalence of infections.[2] Even though these dressings are easily bridled with the burn's exudate when it dries, tending to cause pain and difficulty in movement, the use of up to four overlapped layers of paraffin gauze to obviate this drawback is advocated.[5] In deep partial thickness burns, the incidence of infection is higher than in superficial partial thickness burns, and dressings preventing them are needed, favouring the use of silver-based products.[4,5] Furthermore, particular formulations that release silver continuously over 5–7 days reduced both pain and costs, because they require changing only once weekly.[6–9] However, different authors demonstrated that silver is cytotoxic in re-epitheliasing wounds by inhibiting cell proliferation and stimulating apoptosis.[10,11] Its use in superficial partial thickness burns seems excessive (low infection time) and dangerous (cytotoxic); in deep partial thickness burns, the outcome results from a balance between infection prevention and cell cytotoxicity.

Table 5 Healing times for the different dressings used according to the type of burn

	Healing time (days)	
	Superficial partial thickness burns	Deep partial thickness burns
Animal collagen oxidised regenerated cellulose	–	35*
Povidone-iodine	8 (1–14)*	34.5 (24–73)*
Gentamycin/betamethasone	10 (1–69)*	51.5 (20–68)*
Nanocrystalline silver	2.5 (1–7)*	16 (7–73)
Silver carboxymethylcellulose	12 (1–19)	21 (9–68)
Silver sulphadiazine	8 (1–14)	26 (21–29)*
Hyaluronic acid ester	7 (1–13)*	1*
Paraffin gauzes	5 (1–69)	26.5 (1–73)
Collagenase	9 (1–69)	29 (1–73)

*Less than 15 patients.

Specific studies regarding the use of dressings in ambulatory patients have been conducted; even in these cases, no definitive results were obtained. Ambulatory burns are those that, according to the American Burn Association, are defined as 'minor'.[1] Moisture-vapour permeable films were compared with silver sulphadiazine in ambulatory superficial partial thickness burns. The study recorded a significant reduction of pain for semipermeable films as well as less difficulty in wound care and patient's daily functions. However, infection and healing times were similar for both groups.[12] Paraffin gauzes were compared with water vapour-semipermeable polyurethane film: the former gave shorter healing times and better residual scars.[13] When paraffin gauzes were compared with topical antibacterial agents, they proved similarly efficacious for infection times.[14] Furthermore, when compared with povidone-iodine impregnated dressings, no differences in terms of comfort, ease of removal, infections or healing times were found.[15]

There are fewer studies on the out-patient management of deep partial thickness burns. Furthermore, new products have been recently introduced into clinical practice with positive results. Hydrocolloids showed better wound healing, repigmentation, less pain, fewer changes of dressing and less cost than silver sulphadiazine cream. Patients treated with hydrocolloids had less limitation of activity, better patient compliance, greater patient comfort, better overall acceptance and felt results more aesthetically pleasing.[16] Collagenase cream proved better in removing necrotic debris than silver sulphadiazine; however, it showed almost similar healing times (19 days for collagenase vs 22 days for silver sulphadiazine).[17] When collagenase was added with polymyxin B sulphate/bacitracin spray, the healing time was reduced to 10 days (compared to 15 days for silver sulphadiazine alone).[18] Finally, biosynthetic dressings favoured wound regeneration processes when compared in controlled, randomised trials to silver-containing products: they significantly decreased pain and total healing time (10 days vs 15 days) without increasing the cost of out-patient burn care.[19] When added with low-concentration silver, they favoured re-epithelisation and prevented infections.[20–22]

Data gathered from our ambulatory facility partially confirmed the literature. In our clinical practice, although much was left to the surgeon's clinical experience, dressings were chosen according to the burn depth and the likelihood of infection. In superficial partial thickness burns, where the microvascular flow is preserved and the risk of infection is low, healing proceeds without difficulty. We mainly used 'gentle' dressings (*i.e.* paraffin gauzes), that do not remove the newly formed cells during changes, and obtained healing times of 6 days, similar to those already published.[13] When results were analysed according to specific dressings, healing times of patients that received paraffin gauzes were lower than those of silver carboxymethylcellulose (the second most used product in superficial burns), silver sulphadiazine or collagenase. For all these reasons, and after a careful analysis of cost benefit from the literature, we believe that paraffin gauzes are an affordable way to treat superficial partial thickness burns.

Deep partial thickness burns are more prone than superficial to develop infection (because of their impaired microvasculature and oxygen supply), and they require antiseptic dressings more frequently than other burn types. Basic research in wound healing has shown that silver-based dressings are cytotoxic to the regenerating keratinocytes, and this is directly related to the silver concentration.[5,10] However, as the antibacterial power is inversely related to the silver concentration, the nanocrystalline silver concentration is intermediate between silver carboxymethylcellulose (lowest) and silver sulphadiazine (highest).[5,10]

In 2006, we mainly used silver-based dressings for the treatment of deep burns, although paraffin gauzes and collagenase cream were still present. This was probably due to the lack of clear guidelines or a specific protocol in our unit at that time. We found a significant reduction in paraffin gauze use and an increase in nanocrystalline silver and silver carboxymethylcellulose applications between 2005 and 2006. In this type of burn, our healing time (22 days) was similar to those published in literature (15–22 days),[17–19] and subgroup analysis showed a surprising difference of 11 days between 2005 and 2006.

Nanocrystalline silver is well-known for its antimicrobial properties.[7,23] The high interval of time between dressing changes (5–7 days) reduced the number of medications, patient suffering, overall cost and human resources.[24] In our study, it completely healed deep partial thickness burns in 16 days, well below the average 22 days, and was the dressing with the shortest healing times used in deep partial thickness burns. Silver carboxymethylcellulose is another silver-based dressing with antimicrobial properties. In our patients, it increased the ease of dressing management because it eliminated the need for moistening every 8 h required by the nanocrystalline silver application. Its healing times were longer than those of nanocrystalline silver (21 days), but shorter than paraffin gauzes and collagenase cream. We conclude that silver-based dressings are useful in deep partial thickness burns and, among them, nanocrystalline silver is an affordable choice.

Study limitations

The main weaknesses of our study consist in its retrospective nature and the lack of randomisation. Obvious consequences are the fact that several different types of dressing were used on our patients and that a particular wound care was selected not according to a specific protocol but at the

discretion of the surgeon. However, although many studies have analysed the healing properties of a variety of wound-care dressings and treatments, our study looks at healing as a function of changes in wound-care protocols over different periods, following significant changes in our local wound management procedure. Even with its limitations, we believe that this study gives important suggestions for future randomised trials.

Conclusions

The results of our retrospective study formed the basis for the personal guidelines that we use in our ambulatory burns unit. We use paraffin gauzes for superficial partial thickness burns and avoid them in deeper burns where the risk of infection is high. In these cases, antimicrobial dressings are favoured; in our series, silver-based dressings produced good results. These simple guidelines are easy to use and remember, but need to be confirmed by future, larger, prospective studies.

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