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Treatment of children with scalds by xenografts: report from a Swedish burn centre

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Conflict of interest

We have no conflict of interest.

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Treatment of children with scalds by xenografts: report from a Swedish burn centre

Abstract

Scalds are the most common type of burn in children, and one way to treat them is with xenografts with no topical antimicrobials in line with the recommendations of a recent review. However, this treatment has not been examined in detail. Our aim was to describe the treatment of such children when biological dressings (xenografts) were used without local antimicrobials.

Methods: We reviewed the medical records of all children admitted to a Swedish national burn centre during the period 2010-2012 with scalds who were treated with xenografts. Percentage total body surface area injured (TBSA %), age, length of hospital stay, number of operations, antibiotics given, duration of antibiotic treatment, and pain score during the first three days, application of xenografts, and clinical notes of wound infection, were recorded.

Results: We studied 67 children, (43 of whom were boys), with a median (IQR) age of 1 (1-2) years and median (IQR) TBSA % 6.2 (4-11). Twenty children (30%) required operation. Twelve (18%) developed a wound infection, 29 (43%) had other infections, and 26 (39%) were free from infection. The median (IQR) duration of systemic antibiotics was 10 (6-13) days. On the day that the xenografts were applied 10 of the children had a Face, Legs, Activity, Cry, and Consolability (FLACC) score between 3 and 7, and during the following two days only four children scored in this range. The remaining 57 children had scores < 3 on the day that xenografts were applied and on the following two days. Median (IQR) length of stay (LOS)/TBSA% was 0.7 (0.4-1.0).

Conclusion: Treatment with xenografts was associated with median LOS/TBSA% <1 and low pain scores. Despite a high rate of prescription of systemic antibiotics most were for reasons other than wound infection.

Key words: Burns, scald injuries, paediatrics, xenografts.

Introduction

Scalds are the most common burns in children all over the world.^{1, 2} In Sweden they are one of the most common causes of accidents in children under the age of 3, are associated with a hospital stay of about 6 days,³ and are responsible for considerable health care costs. Boys are more likely to be scalded than girls, and similar figures have been reported worldwide.⁴⁻¹¹ The main causes are containers pulled from tables and benches, and saucepans of hot water overturned. Accidents are most common in the kitchen (with at least one parent present) or in the bathroom (from hot tap water).^{12, 13}

A recent review recommended the use of biological dressings such as xenografts for the treatment of superficial partial-thickness burns,¹⁴ a method used in our centre for many years. Xenografts reduce pain and the need for dressing changes, and are a cost effective aid to healing.¹⁵

The policy for prescription of antibiotics in Sweden is more restrictive than in many countries, and the resistance profile against well-known strains of bacteria such as *Staphylococcus aureus* is still good.¹⁶ No prophylactic antibiotics were therefore used in this study despite the recommendations in a recently published meta-analysis,¹⁷ nor were antimicrobials used in dressings.¹⁴

The aim of this study was to describe the group of children whose scalds were treated with xenografts and without local antimicrobials.

Methods

We studied all scalded patients under the age of 18 years who presented to the Burn Centre, Linköping University Hospital, Linköping, Sweden, and were treated with xenograft dressings during the 3-year period 2010-2012 after the unit had been designated a National Burn Centre. The unit has adhered to the guidelines of the American Burn Association (ABA) on referral criteria.¹⁸ Patients are either local residents or people referred from elsewhere, and the severity of the scalds varies accordingly.

Children were admitted if they had deep dermal and full thickness burns regardless of the TBSA%; superficial burns of more than 10% TBSA%; burns of more than 5% TBSA% in children under 3 years old; if they had burns that involved the face, the genitalia, and the perineum; burns of the hands or feet; or burns that involved main joints. They were also admitted if they had co-existing chronic diseases, and associated injuries or inhalational injury together with the scald.

They were considered ready for discharge if their vital signs were stable, pain was under control, they did not need intravenous fluids or antibiotics, and if no surgical intervention was planned within 24 hours. According to our protocol, children who fit these criteria are suitable for outpatient treatment.

Data were collected retrospectively from the medical records and from the burn unit database where data are recorded prospectively. This is a computerised burn registry previously described in detail¹⁹ that regularly sends data to the ABA National Registry. Data retrieved included age, sex, cause of scald, day of injury, TBSA%, depth of burn, length of

stay in hospital (LOS), details of diagnosis and clinical management, and whether antibiotics were given and if so, which ones. Surface cultures were taken from the scald regularly throughout treatment.

All children were admitted on the first or second day after the burn, depending on the distance from the referring hospital. On admission the severity of the wound was assessed by an experienced surgeon who recorded the appearance of the wound, capillary refill, and the sensory functions of the injured areas in detail on a Lund & Browder chart, and these were entered into the registry. Pain was assessed using the Face, Legs, Activity, Cry, Consolability (FLACC) scale, and this was recorded as a value between 0-10 where 0 is no pain and 10 is severe pain, this score is the routine method for assessment of pain in the paediatric medicine department in our hospital.²⁰ A special team is responsible for providing anaesthesia for children during procedures, and is also responsible for assessment of pain and its treatment, which helps to record pain scores accurately and to provide analgesia when it is needed.

On admission, patients with second and third degree burns had them covered with a xenograft as our standard of care procedure (Ezderm®, Mölnlycke Health Care, Sweden) after thorough cleaning of the surface under general anaesthesia or sedation in the operating theatre. The xenografts were kept in place using biological glue (DERMABOND ADVANCED® Topical Skin Adhesive, Ethicon or Artiss® Baxter). The wounds were then covered with a nylon mesh and wrapped with normal sterile gauze followed by elastic stockings or elastic bandages. The xenograft application is a surgical intervention according to the ICD-10 system but only surgical excisions and skin grafts of burn wounds were counted in the analysis. The outer dressings were changed every other day and the xenografts were

monitored to detect any suspected collection of fluids or pus under them. Dried edges were removed until full healing of the wound was recorded or the full thickness was demarcated.

The wounds were examined up to 2 weeks and, if demarcated, any persisting deep wounds were excised and covered with autologous split thickness skin grafts (Figure 1). In cases where xenografts were no longer adherent to a wound bed that had been showing signs of infection, or delayed healing, or both, a silicone foam dressing containing ionic silver was applied before excision (Mepilex Border® Mepilex Ag, Mölnlycke Health Care, Sweden). Swabs were taken for culture when the patient was admitted, and at regular intervals as decided by the attending surgeon. An experienced plastic surgeon was responsible for the management of the wound throughout the treatment, and a paediatrician took care of the child's general condition and nutritional state during admission.

Like Peck et al.²¹ we diagnosed wound infection on three criteria: clinical (local and systemic signs of infection), together with a rise in the concentrations of inflammatory markers (C-reactive protein and procalcitonin) and white blood cell count, and a bacterial surface culture that grew a pathogen. The presence of bacteria on culture (surface culture) was defined as qualitative identification of bacterial strains from swabs of wounds. Antibiotics were given if a wound infection or other infection was diagnosed by the treating physician, and were selected according to the results of the culture and sensitivity testing.

Conservative treatment was defined as treating the patient's wounds without any intervention (excision of burnt skin and graft). Surgical treatment was defined as management of patients' wounds with techniques including excision or revision, with or without skin

grafting. The application of xenografts was considered to be a dressing procedure, which did not count as a surgical intervention.

The study was approved by Linköping Regional Ethics Review Board (No. 2013\341-31).

Data and statistical analysis

Data are presented as median (IQR). Differences between groups were assessed using the Mann-Whitney *U* test, the Kruskal Wallis ANOVA, and the chi square test, as appropriate.

Data were analysed with the help of STATISTICA 10, (StatSoft Inc., USA). Probabilities of less than 0.05 were accepted as significant.

Results

Sixty-seven children, median age 1 (1-12) years were included. Table I shows their personal and clinical details. Twenty children (30%) required excision and grafting within 3 to 17 days after the burn.

Thirty-nine children were given a systemic antibiotic for a median period of 10 days (Table II). Twelve children (18 %) were diagnosed with wound infections (Table I). Twenty-nine children had other causes of infection (Table III) with infections of the upper airway being the most common. TBSA% was greater in the groups with wound infections and other infections, and LOS was longer compared with the group with no wound infection, although adjusted LOS (LOS/TBSA%) did not differ between groups.

Ten children scored between 3 and 7 on the FLAAC scale before the xenografts were applied, and during the two days after application only four children scored in this range (Figure 2).

Discussion

The group studied seems to be comparable with those studied by others, as the reported mean TBSA% in scalded toddlers is usually less than 10%, and we found a similar number who required interventions and grafting (30 %). This confirms that our group is comparable with those studied by others.^{22, 23} Timing of excision also seems consistent with what is internationally accepted.²⁴

We found that the adjusted LOS (LOS/TBSA%) was 0.7 for the whole group which was similar to the results from a recently published work by Trop et al.²⁵, and less than the suggested figure presented by Johnson et.al.²⁶ What is new is that this outcome was achieved without the use of prophylactic antibiotics, systemic or local, and with the use of only xenografts as dressings.

First-line antibiotic treatment in our centre is usually a cephalosporin, followed by penicillin., which recommend penicillin. We think, however, that results of historical cultures that showed increased numbers of opportunistic bacteria with more complicated resistance patterns has led to the present antibacterial strategy. We are, as a result of the outcome of this study, inclined to start using penicillin in the future as the first-line antibiotic for scalds in children.

The use of prophylactic systemic antibiotics in patients with burns is still debatable, although many authors do not recommend it. Topical antibiotics in dressings are, however, still recommended.^{27 28} The systemic antibiotic treatment at our centre adheres to the Swedish national policy, and the guidelines advocate restricted prophylactic use.^{16, 29}

Xenografts in children with scalds

Xenografts are not commonly used for children in Europe, but our results have shown that the LOS/TBSA% was kept below 1, which is the suggested reference measure for standard advanced burn care.^{26, 28} This suggests that temporary coverage of scalds with xenografts in children is a good option that helps us continue treating our patients as far as possible as outpatients. The LOS adjusted for TBSA% was the same in the group diagnosed with wound infections as in the group that had other infections, and even with the group with no infections, which contradicts previous reports.^{30, 31}

Xenografts were used as a temporary cover for these specific injuries, particularly to avoid the use of dressings containing silver, because of the risk of the possible toxicity induced in keratinocytes by silver compounds.³² It may also be that silver pollutes the environment.^{33, 34} This approach differs from that recommended by others.^{14, 17, 35} Xenografts require fewer changes of dressing if not infected, and increase the chance for outpatient treatment of children, with as little time as possible in hospital.

Less pain has been claimed as one of the main arguments for biological dressings such as xenografts.¹⁴ We found little pain associated with the use of xenografts, and pain scores decreased during the 48 hours after the xenografts had been applied.

Wound infection

The definition of infection in burn wounds is debatable,²¹ particularly as it may be considered unethical to biopsy the skin of smaller burns in children to confirm invasive infection.³⁰ The definition of wound infection in this study was based on clinical signs, a rise in the inflammatory markers and a surface culture that grew pathogens. This is a possible explanation for the relatively high incidence of wound infection. The outcome measured in TBSA% adjusted LOS did not differ between the group with wound infection and the group that was free of infection.

Another important aspect in the study is the microbiological profiles shown by the bacterial cultures, with a more favourable bacterial flora than noted in other reports.^{31, 35, 36} The most commonly detected micro-organism from the cultures was *S aureus*. These data confirm other recent Swedish data that indicate that *S aureus* is the most common cause of infections in both skin and blood stream in children.³⁷ Few cultures grew methicillin-resistant *S aureus*, which confirms another study³⁶ that reported that few burn wounds grew MRSA, but we recorded even fewer cultures.

Limitations of the study

An important limitation is that it was a single-centre study based on a restricted number of observations, most of which were scalds with limited TBSA%. However, adherence to Swedish recommendations about the use of antibiotics that differ from the international guidelines, the presence of favourable patterns of bacterial resistance, and the favourable outcome with a low LOS/TBSA% (despite not using prophylactic antibiotics even in patients who needed excision) makes the study interesting, and some aspects are therefore new.

Lastly, an important shortcoming that needs to be stressed is the lack of long term follow-up, as we were not able to report on cosmesis, or any scar-related issues. This issue may be minor as we use a traditional compression garment as part of treatment, and few patients are referred back for further evaluation and treatment of a scar.³⁸ However, this also needs to be addressed in future studies.

Conclusion

Treatment with xenografts led to median LOS/TBSA% <1 and low pain scores. Despite a high rate of prescription of systemic antibiotics most were for reasons other than wound infection.

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Tables

Table I. Description of groups studied.

	ALL	Wound infection	No infection	Other infection	p value
Patients, n	67	12 (18)	26 (39)	29 (43)	
TBSA%	6.2 (4.0-11.0)	12.0 (9.0-25.5)	4.8 (2.0-6.0)	8.0 (5.5-11.5)	<0.001
Superficial second degree burns	5.0 (2.0-9.5)	9.0 (1.3-12.6)	4.0 (1.8-6.0)	6.0 (3.5-9.0)	0.16
Deep second degree burns	0.0 (0.0-1.0)	0.5 (0.0-15.6)	0.0 (0.0-0.0)	0.0 (0.0-2.5)	0.02
Deep third degree burns	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.22
Age (years)	1.0 (1.0-2.0)	1.3 (1.0-2.0)	1.0 (1.0-2.0)	1.0 (1.0-1.5)	0.54
LOS (days)	5.0 (1.0-9.0)	8.0 (4.5-14.0)	3.0 (1.0-5.0)	5.0 (2.0-11.0)	0.003
LOS/TBSA%	0.7 (0.4-1.0)	0.7 (0.3-1.3)	0.7 (0.4-1.0)	0.7 (0.5-1.0)	0.86
Surgery patients, n	20 (30)	6 (50)	5 (19)	9 (31)	0.15
Sex:					
Male	43 (64)	8 (67)	17 (65)	18 (62)	0.95
Female	24 (36)	4 (33)	9 (35)	11 (38)	
Patients with antibiotics, n	39 (58)	11 (92)	-	28 (97)	<0.001
Antibiotic treatment duration, days	10.0 (6.0-13.0)	13.0 (5.0-15.0)		9.0 (6.0-13.0)	0.47

TBSA = Total burn body surface area injured. LOS = length of hospital stay. Data are presented as median (IQR) or number (%). Kruskal Wallis ANOVA and chi square, as appropriate. p values are for differences among the three groups.

Table II. Antibiotic usage in the studied population.

First antibiotic	N	Second antibiotic	N	Third antibiotic	N
Cephalosporin	30	Cephalosporin	13	Cephalosporin	1
Penicillin	6	Penicillin	10	Penicillin	3
Erythromycin	1			Erythromycin	2
Imipinem\cilastin	2	Imipinem\cilastin	2		
Total	39		25		6

Table III. Other causes of infection

Cause	n
Upper airway infection	9
Colonised wounds plus fever	7
Unspecified infection* (not wound)	5
Lower airway infection (pneumonia)	3
Blood infection	3
Donor site infection	1
Impetigo	1
Total	29

*Unspecified infection = not wound infection

Figures Legends

Figure 1: first take down of the outer dressing (day 2) after application of xenografts.

Figure 2. Number of patients who scored 0-2 (grey bars) and 3-7 (black bars) on pain score (FLACC scale 0-10) on the application day of xenograft, and day one and two after application. (N.B: The figure included all the recorded score values some measures were not done at all time points.)

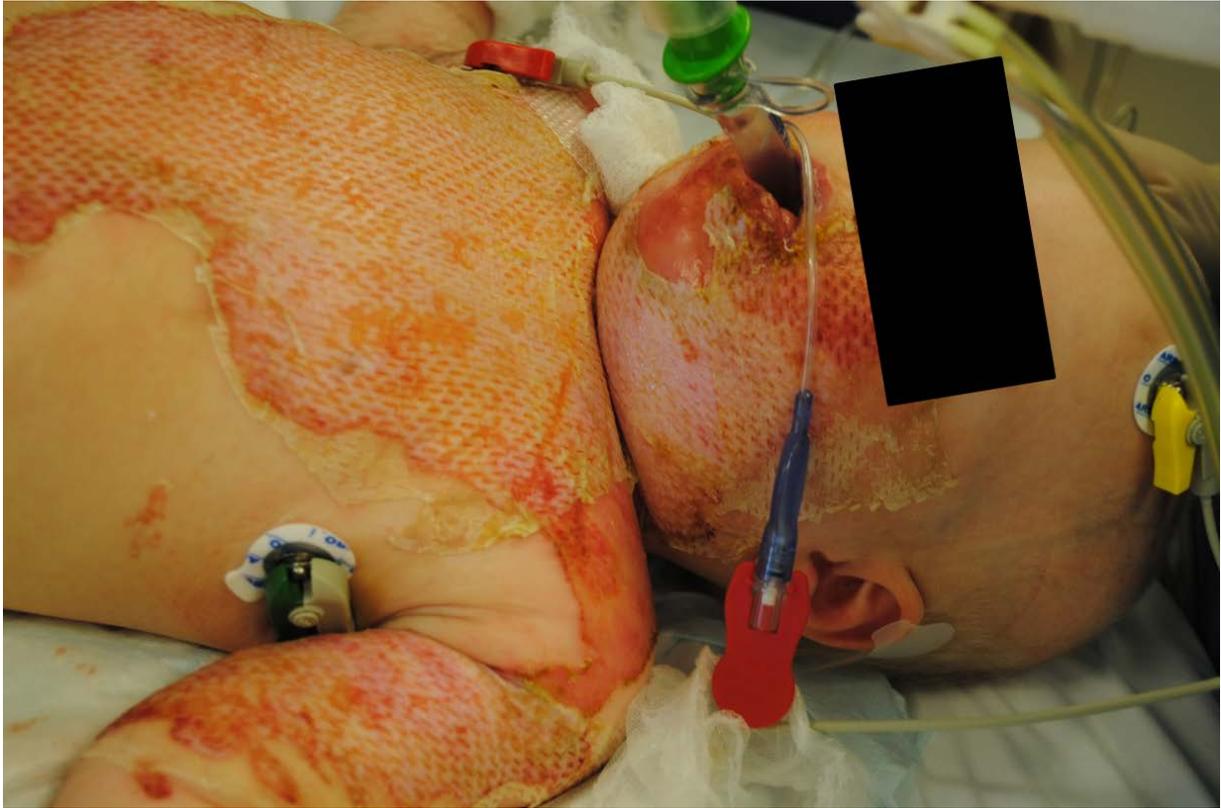


Figure 1

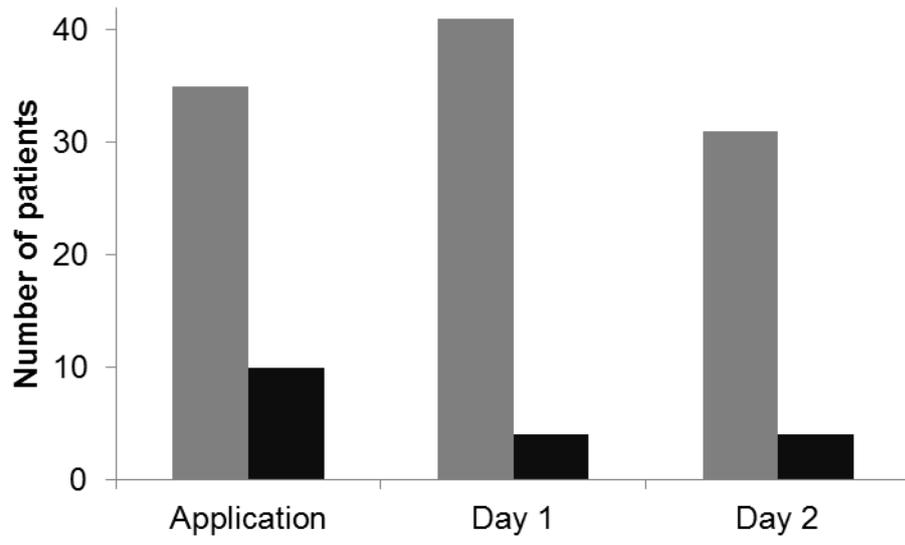


Figure 2