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Epidemiology and treatment of paediatric burns in a large children's hospital in Morocco: Analysis of 394 cases

Épidémiologie et traitement des brûlures pédiatriques dans un grand hôpital pour enfants au Maroc: l'analyse de 394 cas

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Keywords
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Abstract *Introduction:* Injury from burns represents 2% of emergency admissions in university hospitals in Morocco. Burn injuries can lead to substantial morbidity in the paediatric population including an impact on later life.

Methods: A retrospective study of 394 paediatric burn patients was performed. Subjects were identified by review of the emergency centre logs and data were extracted from patient records. Data included demographic information, mechanism of burn, treatment prior to arrival at the hospital, hospital management and follow up condition.

Results: The majority (65.7%, $n = 259$) of patients were between 1 and 4 years old with an average age of 4.26 years and male predominance (male:female = 2:1). Scalding was the main mechanism of injury (83.5%, $N = 329$). The trunk and upper limbs were the most commonly affected areas of the body (59% and 50%, respectively) with the face affected in 9.6% of cases. The total body surface area burned ranged from 1% to 10% in 86% of patients. Seventy-five patients (19%) required hospitalisation, 57 patients (14%) required skin grafting and 27 (6.9%) had major sequelae.

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Discussion: This large case series highlights the current epidemiology, management and outcome of paediatric burn victims in Morocco. Current burn management in low resources settings can be challenging and several additional measures should be taken to reduce morbidity among paediatric burn victims.

Abstract *Introduction:* les blessures associées aux brûlures représentent 2 % des admissions aux urgences dans les hôpitaux universitaires du Maroc. Les blessures par brûlure peuvent entrainer une morbidité importante au sein de la population pédiatrique, et affecter l'avenir de la personne.
Méthodes: Une étude rétrospective a été réalisée auprès de 394 patients pédiatriques brûlés. Les sujets ont été identifiés en consultant les fichiers du service des urgences et les données ont été extraites des dossiers des patients. Les données extraites incluaient les informations démographiques, le mécanisme de brûlure, le traitement avant l'arrivée à l'hôpital, la gestion hospitalière et les conditions du suivi.
Résultats: La majorité des patients (65,7%, $n = 259$) étaient âgés de un à quatre ans, l'âge moyen étant de 4,26 ans, avec une prédominance de garçons (rapport garçon/fille = 2/1). La forme d'accident la plus courante était l'échaudage (83,5%, $N = 329$). Le tronc et les membres supérieurs étaient les zones du corps les plus souvent affectées (59% et 50% respectivement), le visage étant affecté dans 9,6% des cas. La surface corporelle brûlée totale était comprise entre 1 et 10% chez 86% des patients. Soixante-quinze patients (19%) avaient dû être hospitalisés, 57 patients (14%) avaient eu besoin de greffes de peau et 27 (6,9%) souffraient de séquelles majeures.
Discussion: Cette importante série de cas permet de mettre en avant l'épidémiologie, la prise en charge et les conséquences actuelles associées aux victimes de brûlures pédiatriques au Maroc. Actuellement, la prise en charge des brûlures dans des environnements caractérisés par la paucité des ressources peut s'avérer difficile, et des mesures supplémentaires devraient être prises afin de réduire la morbidité chez les victimes de brûlures pédiatriques.

African relevance

- This paper represents a relatively large series of paediatric burns from an African country.
- Paediatric burns are a frequent occurrence in the African setting with significant resultant morbidity.
- Highlights the lack of available resources to deal with paediatric burn injury.

What's new?

- A simplified, Moroccan specific, paediatric burns treatment protocol is proposed.
- Delivers insight into paediatric burn epidemiology in a developing country.
- Key points include a low overall mortality rate, but a high rate of significant burn sequelae due to limited resources.

Introduction

Burn injuries in children, unfortunately, are still relatively common in many areas and in many cases can cause significant lifelong morbidity. Thermal burns, especially scald burns, are the most common type of burn injury in paediatric populations.[1,2] Given the potential for mortality and long-term morbidity, most, if not all burn injuries in children should be considered serious and should be managed by providers with experience caring for burn victims. Early, effective treatment ensures the best chance for survival, as well as a good functional prognosis. Management starts with pre-hospital treatment, followed by treatment in a clinic or hospital. Ideally, the child will ultimately receive functional rehabilitation to treat sequelae resulting from the injury. This article, a large retrospective review of paediatric burns at a children's hospital in Morocco, discusses epidemiologic and treatment characteristics of paediatric burn victims in an African country.

Methods

This is a retrospective study of 394 patients with burn injuries who were treated at the the Children's Hospital of Mohammed VI University Hospital of Marrakech, Morocco. All patients less than 15 years old seen in the emergency room between September 2008 and September 2010 were identified from paediatric emergency and intensive care unit registries. The collected data included: age, medical history, circumstances of accident, causal agent, mechanisms, location and total area of burn wound, treatment and evolution since wound healing. These data were reviewed and recorded by the same investigator (H.D.) in a datasheet and subsequently analysed using SPSS software (v:17). Missing information was abstracted from individual charts of hospitalised patients. In the absence of a local ethics committee, institutional approval was sought and received. Patient confidentiality and privacy were respected throughout this study.

Results

A total of 394 patients were included in the study. The patients ranged in age from one month to 15 years. However, the

majority (65.8%, $n = 259$) were between one and four years old and the average age was 4.26 years (Table 1).

The majority of the patients were male (male:female = 2:1), just over half (56%) were from rural areas and 76 (19.2%) were from lower socioeconomic classes. The average time interval between the occurrence of the burn injury and admission to the emergency department was three hours. The trunk and upper limbs were the body areas most commonly affected (59% and 50% of patients, respectively). The face was affected in 9.6% of the cases (38 patients) (Table 2). 272 patients were affected by burn injuries to more than one area of their body.

In 86% of the patients, the total body surface area burned (TBSA) was less than 10% (Table 3).

The highest concentration of patients was observed during the summer and the holy month of Ramadan. Most accidents occurred in the kitchen (54%) followed by the bathroom (27%). The burns were predominantly caused by scald injury (83.5%) with 79% of the scald burns occurring in children under 4 years. Burns due to flames were encountered in almost 9% of the cases and were mainly due to the explosion of small gas bottles (3 L). The rest of the data are shown in Table 4.

Ultimately, 75 patients (19%) required hospitalisation. Among these, thirty-three patients required admission to the paediatric intensive care unit (PICU). A few patients had multiple indications for admission to the PICU. Twenty-eight of the thirty-three children (85%) who were admitted to the PICU were under 4 years. Indications for PICU admission are detailed in Table 5.

Cool water application to burned areas was performed in only 37% ($n = 147$) of children. No child had a dressing applied before arrival to the emergency department. We were unable to reliably determine if providers took steps to prevent hypothermia in more severely burned children.

All burns were cleaned and dressed with silver sulfadiazine daily and then covered by Vaseline gauze made at the service. The Carvajal formula was used for the 54 children needing fluid resuscitation (burned area greater than 10% TBSA). Antibiotics were used for 59 children who had clinical signs of infection: high temperature, tachypnoea, abnormal wound appearance, and unexplained new elevation in white blood cell count. All second and third degree burns were routinely debrided daily before applying the new dressing.

Two arm level amputations and one thigh level amputation were performed for high electrical voltage. All wounds were left to heal by secondary intention and skin-grafted after 3 weeks. About 14% of patients ($n = 55$) needed autologous split thickness skin grafts for complete healing. For two patients who had more than 50% burns, homographs taken from the child's mother were used for grafting. The mean period between the incident and grafting was 32 days. No early excision grafting was performed. No skin substitutes were used to augment healing. Only 13 of 63 patients for whom our protocols recommended compressive therapy (used for deeply burned areas) were treated with this modality.

A total of 87 children (22%) were lost to follow-up after initial management. Four children died during the study period. Three of the patients had greater than 50% burns and the cause of death was attributed to septic shock. The fourth child experienced an electrical burn and a severe head injury after falling from a high voltage electric pole. Additionally, 27 children experienced significant morbidity from their burn injuries (Table 6).

Table 1 Distribution of patients according to age groups.

Age	Number	Percentage (%)
Less than 1 year	22 (14 M; 8F)	5.6
Between 1 and 4 years	259 (198 M; 61 F)	65.8
Between 5 and 15 years	113 (55 M; 58 F)	28.6
Total	394 (267 M; 127 F)	100

Table 2 The distribution of burns.

Body area	Number of patients	Percentage
Head/neck	46	11.6
Torso	232	59
Upper limbs	197	50
Lower limbs	65	16.5
Total	540[a]	

[a] Many patients had multiple areas of burn injury, hence the total being greater than the number of patients in the study.

Table 3 Distribution according to TBSA of the burn.

Burned body surface area (%)	Number of patients	Percentage
1–10	340	86.3
11–20	30	7.6
21–30	14	3.6
31–40	6	1.5
More than 40	4	1
Total	394	100

Table 4 Distribution according to the causal agent.

Causal agent	Number of patients	Percentage
Scalding	329	83.5
Flames	35	8.9
Contact/touch	20	5.1
Electrical	6	1.5
Others	4	1
Total	394	100

Table 5 Indications for PICU admission.

Indication for PICU admission	Number of patients
>25% Body surface area burned	24
Smoke inhalation	5
Associated trauma	2
High voltage electrical Burns	2

Table 6 Burn sequelae.

Affected body part	Area	Complication/number
Upper limb	Amputations	2
	Axilla	Contractures/3
	Elbow	Contractures/2
	Hand	Palmar contractures/3
		Digital contractures/6
		Dorsal contractures/2
Lower limb	Amputations	1
	Popliteal region	Contractures/4
	Anterior Ankle	Contractures/1
Face	Mouth	Microstomia/2
	Ear	Partial destruction of ear cartilage/1

Discussion

WHO data indicate that burns and fire account for over 300,000 deaths each year throughout the world.[3] There are limited data available in European countries describing the epidemiology of burns on a national scale.[4–6] The incidence data on burn injuries in developed nations are relatively out of date, but are approximately 220/100,000 inhabitants.[7] Of these, only 14/100,000 inhabitants have severe enough burns to require admission.[8] In 2008, there were 410,149 non-fatal burns in the US, with an incidence of 136 per 100,000 each year.[9]

In developing countries, data regarding burn injuries are inadequate. For example, in Morocco, the National Burns Centre (NBC) in Casablanca has conducted a few studies but these have only been presented locally and not published in peer-reviewed journals. The largest and most recent study was conducted by Boukind,[1] which identified 775 children hospitalised between 1983 and 1993. Therefore, updated information of the epidemiology of paediatric burn injuries is needed. Our data represent a relatively large series of paediatric burns cared for at a major children's hospital in Morocco, as well as current information on the management of burns in an African country.

As in previous studies, we found scald burns represent the major mechanism of injury in paediatric burn patients.[1,2,10–15] This is in contrast to adult burn injury patients where open flame is the major mechanism of injury.[1,5,6] Our data also support previous studies which indicate the vast majority of burn injuries occur at home.[1,13,14] Additionally, as in other studies, we found the peak incidence for burn injuries occurred in the summer months (June, July and August) and during the holy month of Ramadan (which also occurred in the summer during the years of the study).[1] The traditional soup prepared in this sacred month could explain this. However, unlike in other studies, a minority of our patients were of a low socioeconomic class. This can be explained by the geographic location of the hospital, which serves a population of largely middle socioeconomic class patients.

As in other studies, we found that children between birth and 4 years constituted the majority of burn victims.[13,14] The incidence of burns in this group may be as high as seven times that of the general population, yet this age group constitutes only 5% of the Moroccan population and represents 15% of all burns.[1] Like Boukind, we found that burns to the hand were the most common site of injury in children.[1] This is probably due to the child attempting to touch a hot vessel and eventually spilling the boiling liquid on the extremity.

Fortunately, most burns are superficial and not extremely substantial in size. Burn characteristics that indicate a need for hospitalisation are depth (need for a skin graft), extent (more than 10%) or localisation (hands, face, and perineum). However, social factors, including the ability of the parents to care for the burns adequately and their ability to return for appropriate follow-up must also be taken into account when considering whether or not a child with a burn requires admission.

Local treatment

Optimally, the treatment of significant burn injuries in children involves a multidisciplinary collaboration between emergency physicians, plastic surgeons (or another surgeon who specialises in burn care), intensivists, child psychiatrists, nutritionists, physical therapists, and rehabilitation specialists. Unfortunately, in low and middle-income countries, such as Morocco, resources are limited making the optimal care for burns a target very difficult to achieve. In well-resourced settings, guidelines recommend the management of paediatric burn victims with $>5\%$ TBSA burns or involvement of the hands, feet, or genitalia in specialised centres by a trained team of specialists. Currently, there are wide ranges of acceptable treatment algorithms with significant regional and institutional variation in resuscitation and wound management of burn victims. This variation indicates the need for further research to identify optimal treatment algorithms for these patients. Our treatment algorithm is shown in Fig. 1.

There are some basic principles of burn care that are agreed upon. First, cool water should be applied to burned areas as soon as possible. This allows for reduction in the size of lesions by more effectively dissipating heat from burned clothing that has adhered to the skin while improving microcirculation.[6] We recommend this be carried out for at least 15 min. Providers should be aware though, that patients with large burns are at risk for hypothermia. As a result, these patients should be covered immediately after cool water treatment. Our data indicate that more effort must be directed towards enhancing the awareness of this procedure, given it is easily available and inexpensive, but never used on the patients in our series.

Burns can then be cleaned gently with normal saline soaked gauze. Antiseptic type solutions should not be applied to wounds because of the risk of systemic absorption and toxicity in infants. Additionally, dyes (gentian violet) should be avoided as well since they cause drying of wounds and impair the assessment of the extent of injury. No attempts should be made to remove burnt clothing adherent to the skin as this may cause additional trauma and damage to tissues. After cleaning, burns can be dressed with sterile gauze and antiseptic creams (i.e., silver sulfadiazine). These dressings may be changed every other day for clean lesions, but daily or even twice daily for burns that are infected. As long as the patient's pain is controlled, changing the bandage is not difficult if it is not sticky, and is therefore painless and safe for the reepithelialisation islands coming from intact skin appendages. This treatment usually allows the healing of superficial lesions within

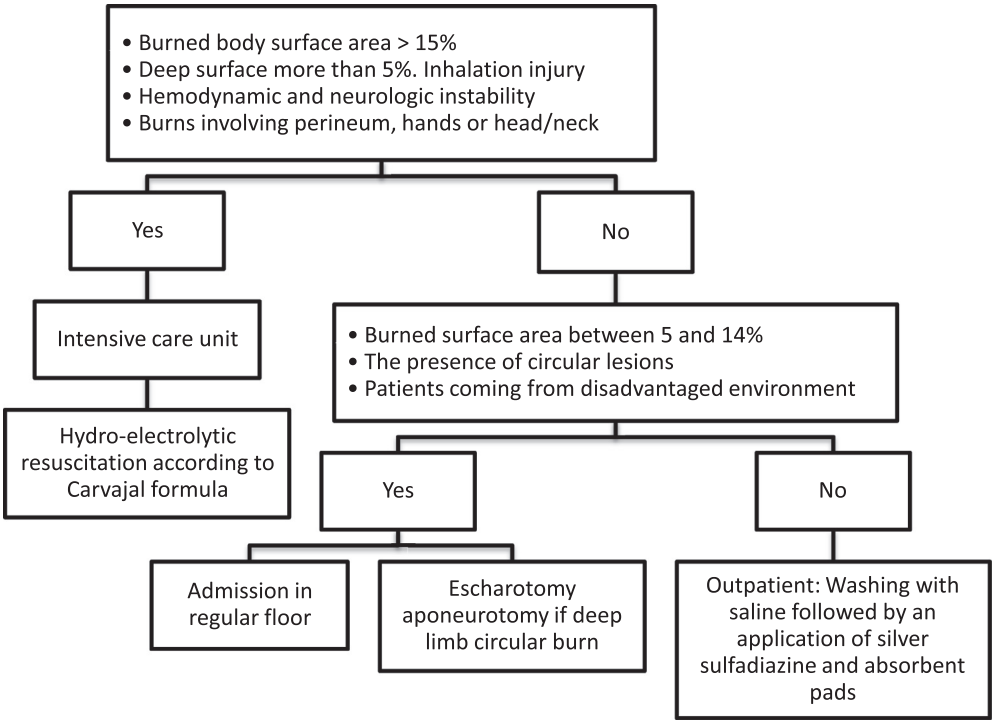

Figure 1 Simplified treatment algorithm for paediatric burn patients.

two weeks. For more severely burned patients we recommend the use of ketamine for sedation during the application of burn dressings.

For burns to extremities, any circular objects, such as rings or bracelets should be removed to prevent them from limiting blood flow distal to the injury as oedema develops. The deep and circumferential burns to the limbs can cause a compartment syndrome. This should be suspected clinically, and if possible, confirmed by measuring the tissue pressure in muscle compartments. In settings such as ours, there is no practical way to measure compartment pressure therefore we have a low threshold to perform escharotomies and fasciotomies for suspected compartment syndrome.

Children, especially infants, have a higher relative body surface area and extracellular fluid volume compared to adults. Additionally, their renal concentrating capabilities are lower. These factors combined lead to elevated fluid loss and may require more aggressive fluid resuscitation. Therefore, adequate intravenous access for resuscitation is essential. In general, intravenous site choice should follow the guidelines advocated by Demling:[16] peripheral line in unburned area > central line in unburned area > peripheral line in burned area > central line in burned area. This algorithm aims to minimise the risk of infection.

While there are many formulas to guide fluid resuscitation, we advocate the use of the modified Carvajal formula:[5000 mL × burned body surface area (m^2)] + [2000 mL × total body surface area (m^2)].

The volume obtained should be given in the first 24 h, with half given in the first 8 h. After the initial 24 h, fluid requirements can be calculated by using the formula:[3750 × burned body surface area (m^2)] + [1500 × total body surface area (m^2)].[17]

In general, patients should be given crystalloids for fluid resuscitation. We use colloids only in cases where there is concomitant hypovolemic shock. Additionally, we choose to administer albumin in cases of low protein (< 30 g/L).

Acute burn victims, especially children, are prone to hypothermia even in relatively warm climates. Measures should be taken to prevent this throughout all phases of treatment by covering the wounds and providing blankets for the patient. Later in the course of care, patients may experience hyperthermia, secondary to inflammation even in the absence of infection. This generally does not require treatment as it very rarely causes febrile seizures or other complications. However, if treatment is required, paracetamol is the best option.

Pain control is an important part of treatment of burned patients as it reduces stress and allows early mobilisation required for effective rehabilitation. Additionally, by reducing discomfort and anxiety, it leads to better patient compliance with the treatment plan. In our experience, the location of the burn, more so than the extent, determines the level of pain the patient experiences. Our preference for the management of ongoing pain of moderate intensity is morphine by slow IV at a rate of 0.1 mg/kg, every 6 h. For pain due to dressing changes or wound care, we recommend ketamine doses of 0.5–1.0 mg/kg. Typical local admission criteria are:

- Extent exceeds 10% of total body surface area.
- Injury to the face, hands or perineum.
- Suspicion of respiratory burns or smoke inhalation.
- Family is of low socioeconomic standing, with parents unable to cooperate or participate in care.
- Associated lesions: head trauma, abdominal injury, fractures, and other trauma.

Unhealed lesions that persist beyond the third week will be grafted according to their location and extent by a full or split

thickness skin graft. In general, we opt for full thickness skin grafts for lesions involving the face, hands and feet and use semi-full thickness skin grafts for joint areas (elbows, knees). Other lesions are grafted if necessary by a split thickness skin graft according to the extent of the unhealed area.

The unhealed areas should be grafted within 21 days for optimal results, because the risk of scarring and hypertrophy is higher beyond this date. The delay of 32 days between the onset of the burn and grafting in our series is due to the absence of facilities dedicated to the care of burn victims and the reduced number of specialised staff to care for these children. Increasingly aggressive surgical approaches with early tangential excision and wound closure are becoming standard practice in burn units. However, limited availability of continuing medical education in developing countries can hinder acceptance of this procedure, as can the lack of well-trained and motivated burn surgeons.

In our centre, we also employ adjunctive measures, including massaging of scars in all children whose burn depths exceed superficial second degree. This treatment is continued for 6–8 months until inflammation subsides (resolution of itching and redness). For burns involving functional areas, we prescribe posture splints or orifice conformers as necessary. However, we realise compliance with these treatments is generally poor, leading to unnecessary morbidity. Long-term outcomes after paediatric burns are poorly documented, and the occurrence of sequelae in our study is certainly underestimated because of the large proportion of patients that were lost to follow-up .[18] Another study concerning burn sequelae is being conducted at this time.

Paediatric burns are still a frequent occurrence in our setting with significant resultant morbidity, but overall a low mortality rate. Prevention campaigns are needed to raise awareness of the frequency of burns in children and measures that can be taken to make the home safer for children. Additionally, more research is needed on how to increase compliance with treatment protocols and rehabilitation. Finally, allocating more resources, including geographically well distributed facilities with capacity to care for burn patients, as well as health workers with additional training in burn care, could help to optimise the care of burn injury victims in low resource settings.

Appendix A. Short answer questions

Test your understanding of the contents of this original paper (answers can be found at the end of the regular features section)

1. What is the main mechanism of injury in paediatric burn patients seen in Morocco?
   a. Flame
   b. Contact
   c. Scald
   d. Electrical
   e. Chemical

2. Which age group is mainly affected?
   a. Less than 1 year
   b. 1–4 years
   c. 4–10 years
   d. 11–15 years
   e. 0–6 months

3. Which of the following is correct for the Carvajal formula?
   a. 5000 mL × burned body surface area (m^2)] + [2000 mL × total body surface area (m^2)
   b. 2000 mL × burned body surface area (m^2)] + [5000 mL × total body surface area (m^2)
   c. 2000 mL + (weight × burned surface area (%) × 2)
   d. 2000 mL + (weight × burned surface area (%) × 4)
   e. None of these propositions.

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