
Pediatric Burn Injuries From Day-Old Campfires: A Highly Morbid and Preventable Problem

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The purpose of this study was to review the authors' experience with pediatric burns from day-old campfires. The authors sought to characterize the operative courses, hospitalizations, and complications arising from burn injuries in this patient population. After Institutional Review Board approval, charts were retrospectively reviewed of pediatric patients seeking care for burn injuries at a regional burn center over 6 years. From June 2002 to September 2008, 30 pediatric patients sought care for burn injuries sustained in campfires; 25 (83.3%) of these occurred in fire pits with previously extinguished fires; 68% were male, with median age of 2.0 years (range, 14 months to 17 years). The median TBSA burned was 2% (range, 1–40%). The most common burn locations were hand (68%), forearm (28%), and foot (24%). Additional locations included back, arm, abdomen, and thigh. Eighteen patients (72%) required hospital admission; among these patients, mean number of hospitalizations was 1.3 (range, 1–2) and mean length of stay was 5 days (range, 1–22 days). This group accounted for 23 admissions, 96 hospital days, 3 intensive care unit days, 16 operations under general anesthesia, and 30 procedural sedations/dressing changes under anesthesia. Operative procedures included 9 full-thickness skin grafts, 13 split-thickness skin grafts, 2 escharotomies, and 1 amputation. Complications included one death (4%), one graft loss (4%), two cellulitis (8%), and four scar hypertrophies (16%). Day-old campfires may cause significant burns in the pediatric population, resulting in considerable short- and long-term morbidities and utilization of health care resources. Our experience with this patient population lends justification for campaigns aimed to prevent such injuries. (*J Burn Care Res* 2011;32:633–637)

Burns from outdoor campfires and fire pits are preventable sources of morbidity and mortality. In the adult population, these types of injuries are usually linked to intoxication or misuse of flame propellants and have been documented to result in significant consequences, with a frequent need for excision and grafting.^{1–3} However, the majority of campfire injuries occur in children younger than 7 years.⁴ The limited available information pertaining to pediatric campfire injuries suggests that nearly 70% of these burn injuries are caused by contact with embers rather than from flames.^{5,6} Although the danger of these burn injuries has been noted, there are minimal published data specifically per-

taining to pediatric injury from day-old campfires and fire pits. In our experiences as well as those of others, such burns are becoming more frequent, further prompting the need to characterize these devastating injuries. We hypothesized that burns from previously extinguished campfires result in substantial medical and surgical consequences for the pediatric population.

The purpose of this study was to review our experience with pediatric burns from day-old campfires. We sought to quantify the proportion of patients needing hospital admission and operative intervention as well as to describe features of their hospitalizations and operative care. In addition, we aimed to characterize complications arising from burn injuries in this patient population.

METHODS

After obtaining Institutional Review Board approval, charts of patients seeking care for burn injuries at a regional burn center over 6 years, from June 2002 to September 2008, were retrospectively reviewed. We

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searched our clinical database—including outpatient logs, emergency room visits, and inpatient hospitalizations—for patients whose injuries took place outdoors, and then reviewed hospital charts to identify those patients whose mechanism of injury was a previously extinguished campfire. Patients aged 18 years or older were excluded from this study.

Data collected from the patients' charts included the need for and total number of hospitalizations, length of stay, the need for and duration of critical care, the number and types of operative procedures performed, the types of anesthetic used for those procedures, the need for procedural sedation, and any complications arising as a result of the burn injury.

Continuous variables are reported as medians and range, while categorical variables are reported as percentages.

RESULTS

During our study period, 30 pediatric patients sought care for burn injuries sustained in outdoor campfires; 25 (83%) of these injuries occurred as a result of thermal contact injury from embers in fire pits with previously extinguished fires. As per our inclusion criteria, the five children who sustained injuries from active fires were excluded from this study. Among the 25 patients who were injured from exposure to previously extinguished fires, 68% were male, with a median age of 2 years (range, 14 months to 17 years). While there were two teenage outliers, the majority of the patients fell into the categories of toddlers (56%) or preschoolers (24%).

The typical patient sustained burns to 2% of TBSA (range, 1–40%). Due to the mechanism of injury for these small children, which typically involved falling onto an outstretched hand, the most common burn locations involved the distal upper extremity, with more than two-thirds of the patients sustaining injuries to the hand and almost one-third burning the forearm (Figure 1). Among those patients with hand injuries, 7 (41%) required operative intervention. While hand injuries were most frequently on the palmar surface, grafting was additionally required on the dorsum as well as the digits in this group of patients. About one-quarter of the patients suffered burns to the feet as a result of stepping into the hot embers (Figure 2A). Among patients with burns to the feet, one (17%) received operative intervention. All burns to the feet involved the solar aspect. For both hand and foot grafts, we used full-thickness grafts for palmar/solar burns and split-thickness grafts for the dorsal aspect and digits. Nine (53%) hand injuries were bilateral, and five (83%) of the patients with burns to the foot had injuries bilaterally. Additional in-



Figure 1. Typical injury distribution. The most frequent location for burn injuries among these children was the distal upper extremity, with more than two-thirds of patients suffering burns to the hand and nearly one-third with burns to the forearm.

juries were sustained to the back, arm, abdomen, and thigh (Table 1).

Eighteen of these patients (72%) ultimately required hospital admission. Among those hospitalized, the

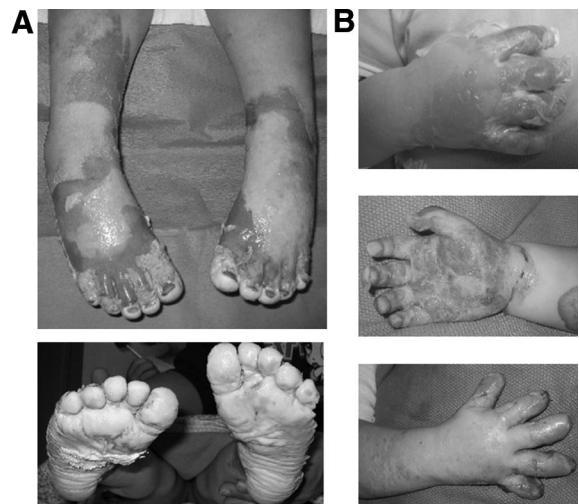


Figure 2. Additional injury patterns. A, In addition to the distal upper extremity, the foot was also a common burn location, seen in nearly one-quarter of these patients. B, One child submerged her hands deep into the embers, causing significant burn injuries and digital vessel thrombosis. She ultimately required several operative procedures, including extensive grafting and partial amputations, and was hospitalized for 22 days, the longest in our series.

Table 1. Burn locations

	N	%
Hand	17	68.0
Forearm	7	28.0
Foot	6	24.0
Back	3	12.0
Arm	3	12.0
Thigh	2	8.0
Abdomen	2	8.0
Leg	1	4.0

mean number of hospitalizations was 1.3 (range, 1–2) and mean length of stay was 5 days (range, 1–22 days). The subgroup of patients who underwent operative procedures had a mean length of stay of nearly 8 days, while those who did not undergo operative intervention still required an average hospitalization duration of almost 3 days for the purposes of symptoms management, wound care, and social work needs. In all, this group of patients consumed an enormous volume of hospital resources, accounting for 23 admissions, 96 hospital days, and 3 days of critical care.

Operative intervention was required for eight (32%) of the patients. This included one patient who underwent four procedures, two patients who underwent three procedures each, one patient who underwent two procedures, and four patients who each had one operative intervention. In total, this group underwent 16 operations under general anesthesia, including 9 full-thickness skin grafts, 13 split-thickness skin grafts, 2 escharotomies, and 1 operation involving multiple partial amputations (Figure 2B). These patients additionally underwent 15 dressing changes under general anesthesia and another 15 via conscious sedation in the Burn Unit (Table 2).

The morbidities resulting from these children’s burn injuries were not insignificant, as they developed a number of complications. There were no cases of pneumonia, urinary tract infection, or line sepsis.

Table 2. Operative data

	Total
Major operative procedures	
Split-thickness skin grafts	13
Full-thickness skin grafts	9
Escharotomies	2
Amputation procedure	1
Sedations for dressing changes	
General anesthetic in OR	15
Conscious sedation in burn unit	15

Table 3. Complications

	N	%
Pneumonia	0	0.0
Line infections	0	0.0
Urinary tract infections	0	0.0
Acute renal failure	1	4.0
Disseminated intravascular coagulation	1	4.0
Respiratory failure	1	4.0
Death	1	4.0
Graft loss	1	4.0
Cellulitis	2	8.0
Scar hypertrophy	4	16.0

However, these patients did develop four cases of mild scar hypertrophy (16%), two diagnoses of cellulitis (8%), one graft loss (4%), and one death (4%) (Table 3). Mild hypertrophic scarring was defined as those individuals who underwent treatment with intradermal steroid injections. One-half of these patients (8%) had undergone previous skin grafting, and all four of them received standard compression garments. The death occurred in a 2-year-old child with extensive extremity and truncal burns who had a long delay before seeking medical treatment. The patient developed multisystem organ failure, marked by respiratory failure, acute renal failure, and disseminated intravascular coagulation. This patient’s condition rapidly declined, and the child ultimately succumbed to overwhelming *Haemophilus influenzae* sepsis with splenic involvement.

DISCUSSION

Injuries to adults resulting from outdoor campfires and fire pits have been well characterized in the literature. The etiology, risk factors, and sequelae of such burns have been described in detail.^{2,3} However, only a minority of these day-old campfire injuries occur in adults.⁴ Despite the prevalence of these types of injuries in children, minimal data have been previously published regarding the outcomes for pediatric patients sustaining such injuries. Previous literature has suggested that more than two-thirds of these burn injuries result from a contact mechanism rather than from flames.^{5,6} In our patient population, we found that >80% of pediatric campfire injuries resulted from previously extinguished fires, while only a small proportion were from active fires. We feel that this phenomenon is a consequence of the failure of both parents and small children to recognize the dangers of previously extinguished fires, whereas active flames represent a more obvious risk from which children

tend to be warned and protected. Most children sustaining these burn injuries required admission, and one-third required an operation. Based on our experiences, we believe that burns from previously extinguished, day-old campfires represent a significant public health issue, causing substantial pain and complications for individual patients and their families, as well as stressing the healthcare system through resource utilization.

Our data have shown that day-old campfires have the potential to cause significant burns in the pediatric population. These injuries result in considerable short- and long-term morbidities and utilization of health care resources. Our experience with this patient population lends justification for campaigns aimed to prevent such injuries.

This work represents the first reported American series of pediatric burn injuries specifically caused by previously extinguished, day-old campfires. While this particular clinical cohort has not previously been well described, the topic of thermal contact burns from hot coals, embers, and ashes has been explored by other authors.^{1,5-7} In Moritz's classic experiments in thermal injury, it was shown that a contact temperature of 70°C for 1-second duration is sufficient to cause a full-thickness burn.⁸ More contemporary studies have demonstrated that fire pits retain heat at this temperature for as many as 12 hours, with the rate of temperature decline dependent on the means of extinguishing the fire (water vs sand).^{1,9} Consequently, while much greater attention has been given to the danger of actively burning flames, it is clear that the embers from day-old fires have the capacity to cause substantial injury. Moreover, this type of injury is perhaps an even greater risk for small children, as the potentially detrimental consequences are not outwardly apparent to toddlers nor to their caregivers.^{1,5}

Among our patients, burns to the distal upper extremities and feet comprised the most common body distributions of the injuries. This is consistent with previous reports of campfire injuries in children, and the functional and aesthetic manifestations of burns to these areas are substantial.^{1,5,10-12} Furthermore, as the majority of these injuries involve the hands, hypertrophic scarring (seen in 16% of our patients) can lead to contractures, affecting function and potentially requiring future intervention as the children grow.^{12,13}

In our series, >80% of pediatric campfire injuries were sustained in previously extinguished fires, and 72% required hospital admissions. These patients utilized significant hospital resources, required numerous operative procedures, and developed severe complications including death. For these reasons, we feel that the important next step is to embark upon a

public awareness campaign. To carry out our message, we plan to take advantage of our current partnerships with local firefighters, rural and regional healthcare providers, and industry leaders in burn care. Our burn unit is also involved at the community level through our schools and neighborhood outreach programming, relationships that will be vital to the execution of this campaign.

Some areas of previously successful public awareness efforts have included tobacco cessation, decreasing drunk driving, preventing HIV transmission, and encouraging automobile restraint use. These campaigns have employed discouragement of negative behaviors through policy advocacy and lawmaking and endorsement of positive behaviors through health promotion programming. Burn outreach professionals have also made substantial community contributions through utilization of these educational techniques.¹⁴⁻¹⁶ For example, with regard to actively burning campfires, one described objective of educational outreach efforts has been the establishment of a widely accepted, well-defined distance to be maintained between children and active fire pits.¹ Another described tactic has included the distribution of injury prevention flyers through regional camping facilities.⁷ The goal of our campaign is to improve public awareness of the danger of previously extinguished campfires. The challenge, however, lies in the difficulty of applying laws and policies to this realm. Our approach will involve the distribution of flyers and pamphlets, public service announcements, at our local schools, parks, and campgrounds, and through incorporation into our current community outreach programs. Support from local and national park services may be of particular help in the success of this campaign.

In addition to carrying out our own local and regional educational efforts, we see a potential opportunity to collaborate with other institutions in developing and adopting safety campaigns on a larger scale. The importance of developing effective prevention strategies has been identified by other authors in this arena.^{1,7,13} While other groups have attempted prevention programming to decrease campfire injuries in children, this devastating type of injury remains an ongoing problem, documented by some to even be increasing in frequency.⁵ A collaborative effort may be the best approach to reduce the incidence of such devastating and highly preventable burns. As we put forth such collaborative efforts, it will be useful to prospectively measure the impact of our interventions. This may be accomplished through the surveillance of campgrounds regarding current fire practices and prevention/educational tools, followed by the

implementation of local educational endeavors, with subsequent data collection and analysis to determine the efficacy of such interventions.

This study is subject to a few limitations, some of which are inherent to the fact that it is a retrospective chart review. It is difficult to avoid some selection bias, in that patients whose injuries were not severe enough to merit transfer to a regional burn center were not treated nor identified, indicating that there may be an even greater prevalence of these types of injuries, including patients with potentially less severe burns. In addition, patients with burns and significant social or economic obstacles that prevented them from seeking care were also not accounted in this study. These factors would suggest that this article may actually be underreporting the pervasiveness of this public health problem.

Our findings demonstrate the significant morbidity and mortality associated with burn injuries from day-old campfires in the pediatric population as well as the enormous consumption of healthcare resources required to care for these patients. Our experience with this population justifies the important necessity of public service campaigns aimed to prevent such injuries.

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