Patient and Injury Characteristics, Mortality Risk, and Length of Stay Related to Child Abuse by Burning: Evidence from a National Sample of 15,802 Pediatric Admissions

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INTRODUCTION

Child abuse is defined as a willful and deliberate act by a caregiver resulting in physical injury of a child.[1] Estimates of the percentage of admissions to burn centers related to child abuse range from 1% to 25%[2-6] with infants and toddlers constituting the majority of cases[5] and scalds more frequent than in accidental injuries.[4, 7]

The wide variation in reported proportion of burn injuries that result from child abuse may be due to different definitions of abuse or non-accidental injury, variations in reporting practices and the availability of trained investigative personnel, or socioeconomic differences in patient samples.[4] Another likely reason relates to the small samples from single burn centers that have been used in existing studies. Only one study has included a sample of at least 100 children with suspected abuse, and that study found that 16% of admissions were abuse-related.[2]

Sampling issues have also limited the ability of researchers to assess mortality risk and burn center resource use related to child abuse. Few studies have compared mortality risk between children with accidental and non-accidental burns. Purdue et al.[8] reported a mortality rate of 5.6% among children who were burned intentionally compared to 2.6% in accidental burns; Hummel et al.[3] reported rates of 9.6% and 6.0% for abused and non-abused admissions; and Andronicus et al.[4] found a 2% mortality rate among burns related to abuse or neglect compared to 1% among children admitted with accidental burns. These three studies, however, included only 4, 5, and 2 patients, respectively, with fatal abuse-related burns – too few for conclusions to be drawn. No studies have compared the length of hospital stay for children admitted with accidental versus abuse-related burn injuries. In addition, the characteristics of abuse-related burns by body parts have been reported in

several studies,[1, 5] but the accuracy of these reports is unknown due to similarly small sample sizes in these studies.

The objective of this study was to use data from a large national registry, the American Burn Association National Burn Repository (ABA-NBR) in order to provide a summary of demographic and burn-injury characteristics of children admitted to burn centers due to suspected child abuse and to assess mortality risk and length of total hospital stays compared to children whose injuries were accidental.

METHODS

Data were extracted from the ABA-NBR database for all pediatric patients 12 years of age or younger who were admitted to 70 burn centers across the United States with thermal injuries (flame, contact, or scald) from 1995 through 2005. Only children aged 12 or younger were included in the analysis since 98.3% (909/925) of all suspected child abuse cases were in this age group. In addition to the circumstances of the injury (e.g., suspected abuse, accident), patient data in the ABA-NBR include age, sex, race, year of injury, the etiology of the burn injury (e.g., flame, scald), mortality status, percent total body surface area (TBSA) burned, percent TBSA burned 2nd degree, percent TBSA burned 3rd degree, and the presence or absence of an inhalation injury.

Data are reported in the text as means $\pm$ standard deviation or as odds ratios (OR). Demographic and clinical variables were compared between children admitted with injuries that resulted from suspected child abuse and children whose burns were not believed to have resulted from abuse on an unadjusted basis using the chi-square test for categorical variables and the Wilcoxon rank-sum test for continuous variables.

Multivariable logistic regression was used to test whether suspected abuse predicted mortality prior to discharge controlling for age category (0 – 1.99 years, 2 – 3.99 years, 4+), sex, race (white versus non-white), total TBSA burned, 3rd degree TBSA burned, burn etiology (flame versus scald or contact), and inhalation injury. A multivariable Cox proportional hazards model was developed to test the association between suspected abuse and lengths of intensive care treatment and total hospital stay, also controlling for age category, sex, race, total TBSA burned, 3rd degree TBSA burned, burn etiology, and inhalation injury. The accuracy of the proportional hazards assumption was tested graphically and using Schoenfeld residuals. All analyses were performed with SPSS version 15.0 (Chicago, Illinois) and all tests of significance were two-sided with a $P < .05$ significance level.

RESULTS

A total of 15,802 children aged 12 or younger were included in the analysis. The mean age was 3.8 ± 3.5 years, 62.2% of patients were male, and 46.4% were white. The mean percent TBSA burned was 9.9% ± 12.5% (range, 0.1% to 100%), the mean percent of 3rd degree TBSA was 3.4% ± 10.8% (range, 0.1% to 100%), and 4.5% of the sample incurred an inhalation injury. A total of 909 (5.8%) admitted children aged 0-12 from all burn centers were classified as having suspected child abuse-related injuries.

Table 1 shows demographic and burn injury characteristics of children with suspected child abuse compared to children for whom abuse was not suspected. Compared to children without suspected abuse-related injuries, children admitted with suspected abuse-related injuries were significantly ($P < .05$) more likely to be younger, female, to have larger total and 3rd degree TBSA burned, to have been admitted with a scald burn, and

to have required intensive care. They were less likely to have incurred an inhalation injury. Only 2.7% of children aged 4-12 years were admitted due to suspected abuse-related injuries, compared to 6.9% of children under 2 years and 8.3% of children aged 2.0 to 3.9 years.

Table 2 shows the distribution of burns by body parts. Given the large total sample size, differences in the distribution were statistically significant ($P < .05$) for all body part classifications except "Both Upper Extremities." Children with suspected abuse-related injuries were 4-5 times more likely to have a burn on their buttocks and 3-4 times as likely to have a perineum burn. They were significantly less likely to have a burn to the head/neck or anterior trunk, but significantly more likely to have a posterior trunk burn. Children with suspected abuse were over 2 times as likely to have any lower extremity burn. They were significantly less likely, however, to have a burn to only one of their lower extremities, but almost 3 times as likely to have both lower extremities burned. On the other hand, children with accidental burns were significantly more likely to have an upper extremity burn, but this was due to differences in injuries to one, but not both, extremities.

Among children with suspected abuse, 23 of 909 (2.5%) died in the hospital compared to 165 of 14,893 (1.1%) among children whose injuries were not suspected to be abuse-related (unadjusted OR = 2.32, 95% confidence interval [CI] = 1.49 – 3.60, $P < .001$). Results from the multivariable logistic regression analysis are shown in Table 3. After adjustment for covariates, children with suspected abuse were more than 4 times as likely to die from their injuries as children whose burns were not suspected to be related to abuse (adjusted OR = 4.67, CI = 2.60 – 8.39, $P < .001$). In addition to suspected abuse,

significant predictors of mortality among children included age, % TBSA burned, flame injury, and inhalation injury, but not sex and race.

Among children who survived to discharge, unadjusted mean lengths of intensive care and total hospital stay were longer for children with suspected abuse (3.4 and 14.4 days, respectively) compared to children whose injuries were not suspected to be abuse-related (2.5 and 9.4 days, respectively). Suspected abuse was significantly related to longer intensive care in both unadjusted (hazard ratio [HR] = 0.90, CI = 0.85 – 0.97, P = .016) and adjusted Cox regression models (HR = 0.93, CI = 0.87 – 1.00, P = .044;) models (Table 4) and to longer total hospital stay in unadjusted (HR = 0.67, CI = 0.63 – 0. 72, P < .001) and adjusted (HR = 0.60, CI = 0.56 – 0.64, P < .001) models (Table 5). Hazard ratios are less than 1 because higher risk in survival models (HR > 1) is associated with faster times to the outcome event (discharge from intensive care or the hospital). Suspected abuse, however, was related to longer times to the outcomes of interest, discharge from intensive care and from the hospital.

DISCUSSION

This study found that almost 6% of injuries to children aged 12 or younger admitted to burn units in the U.S. were suspected to be abuse-related. Children with suspected abuse were 2-3 times as likely to die and required significantly longer hospital stays compared to children whose burn injuries were not related to abuse on an unadjusted basis. After controlling for age, sex, race, burn etiology, % TBSA burned, and inhalation injury, the odds of in-hospital mortality among children whose burns were suspected to be related to abuse were between 4 and 5 times that of children whose injuries were labeled as accidental. Length of intensive care and total hospital stay were also significantly longer

after adjusting for covariates, although there was a much more robust effect for total hospital stay than for time in intensive care.

The reasons why children with abuse may be at risk for mortality after controlling for known risk factors may include factors related to poor overall health, malnutrition, and neglect; additional injuries besides the burn; or delays in obtaining medical care, since all of these are related to child abuse in burn injury.[1, 4] The finding that there were more substantial differences in total length of hospital stays between children with suspected abuse than for children with accidental injuries is likely related to the involvement of child protective services in cases where abuse is suspected, including the time required to investigate suspected abuse and to find appropriate placement for children who are not able to return home.

Demographically, children admitted with suspected abuse were younger than non-abuse related admission, which is consistent with previous findings that infants and toddlers are at greatest risk.[1, 2, 4, 7-10] Children with suspected abuse were more likely to be male than female, although the proportion of males was only slightly higher than among children with accidental burns. There were more non-white children among those with suspected child abuse compared to children with accidental injuries, and this most likely reflected socioeconomic status, which is a known risk factor for child abuse.[2-4, 7, 9, 10] As in other studies,[1, 4, 5] most children with suspected abuse injuries were admitted with scalds. Total TBSA and 3rd degree TBSA were significantly, albeit not substantially, higher with abuse.

Classic patterns of child abuse by burning include deep glove- or stocking-like burns to the feet or hands, particularly when they are symmetrical, and scald burns to the buttocks and lower extremities.[1, 5] Consistent with this, we found that bilateral lower

extremity burns were much more common in cases of suspected abuse, and that burns to the buttocks and perineum were much more frequent with abuse. On the other hand, facial burns and anterior trunk burns were much less prevalent among children whose injuries were suspected to be due to abuse. None of these characteristic patterns are diagnostic per se, however, since no individual burn location was specific to abuse-related injuries.

There are limitations that should be taken into consideration in interpreting the results from this study. The data are from a large registry, and are to some degree less accurate than data gathered using other methods. There was no common definition or method of determining "suspected child abuse" across burn centers, and this would be expected to decrease accuracy. Thus, rather than abuse as determined by a team of specialists, this definition reflected the perceptions of burn personnel as recorded in a registry database and may have introduced biases. It is possible, for instance, that children with larger abuse-related injuries may have been more likely to be listed as "suspected child abuse" than children whose abuse resulted in smaller injuries. In terms of the association between abuse and mortality and length of stay outcomes, decreased accuracy would result in less statistical power, which could have reduced the magnitude of reported outcomes. Similarly, patient comorbidity and injury variables, such as TBSA burned or the presence or absence of inhalation injury, were extracted by chart review, rather than by more precise methods.

An additional limitation is that differences in mortality across burn care centers related to differences in standard burn management or differences in patient characteristics were not explicitly incorporated into the analysis. The ABA-NBR does not include data on important factors that may differ across centers, such as time from burn to admission or

fluid resuscitation. To the extent that a large number of burn centers were included in the current study, however, it is not unreasonable to think that the results of this study are representative of typical patterns across burn centers in the United States.

Given the large number of burn injuries among children that result from abuse, all burn centers that treat children must manage this complex problem. The adverse psychological sequelae of a burn injury are well known. Many children are faced with recovering from a serious burn injury that resulted from the intentional behavior of a caregiver. Physicians and other burn center professions are charged with the task of identifying cases of suspected abuse and involving trained investigative and treatment personnel to provide support and minimize the long-term effects of the event. This is important because as many as 50% of children are likely to suffer from recurrent severe abuse if they return to the abusive home.[1] The results of this study suggest that they are also at greater risk for mortality and require greater resources during the acute phase of recovery.

In summary, children with burn injuries that result from suspected child abuse were younger and had somewhat more extensive injuries than children admitted with accidental injuries. They were more likely to die and required significantly longer time in intensive care and total hospital stays than patients whose injuries were not abuse-related in both unadjusted and adjusted analyses. Burn injuries related to abuse most frequently occurred to the buttocks and perineum, the lower versus upper extremities, and to bilateral lower extremities.

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