

Referral Patterns in Pediatric Burn Patients

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Though multiple studies have demonstrated superior outcomes amongst adult burn patients at verified burn centers (VBCs) relative to nondedicated burn centers (NBCs), roughly half of such patients meeting American Burn Association (ABA) referral guidelines are not sent to these centers. We sought to examine referral patterns amongst pediatric burn patients. Retrospective review of a statewide patient database identified pediatric burn patients from 2000 to 2007 using International Classification of Disease (ICD-9) discharge codes. These injuries were cross-referenced with ABA referral criteria to determine compliance with the ABA guidelines. 1831 children sustained burns requiring hospitalization during the study period, of which 1274 (70%) met ABA referral criteria. Of 557 treated at NBCs, 306 (55%) met criteria for transfer. Neither age, gender, nor payer status demonstrated significant association with treatment center. VBCs treated more severely injured patients, but there was no difference in survival or rate of discharge home from NBCs *versus* VBCs. Studies to evaluate differences in functional outcomes between pediatric burn patients treated at VBCs versus NBCs would be beneficial to ensure optimization of outcomes in this population.

BURN INJURIES IN children result in over 120,000 emergency department visits, 10,000 hospitalizations, and 66 deaths in the United States annually.^{1, 2} However, only 55 per cent of all pediatric burn patients requiring hospitalization in the United States receive care at verified burn centers (VBCs) that have met standards set by the American Burn Association (ABA). Those patients treated at nonburn centers (NBCs) are not captured in the ABA National Burn Repository and thus have not been extensively studied.

Just as treatment at Verified Trauma Centers, as designated by the American College of Surgeons, imparts improved mortality and functional outcomes upon severely-injured trauma patients, there has been a growing interest in describing similar associations amongst burn patients treated at VBCs.^{3, 4} This interest has resulted in a mounting body of evidence indicating that VBCs achieve superior outcomes and provide more cost-effective care than NBCs.^{5–11}

Despite ABA criteria for burn center referral nearly two decades old (Table 1), half of adult burn patients in North Carolina (48%) and south Florida (54%) who meet ABA referral criteria are not treated at VBCs.^{9, 12} Given these data, we sought to examine the referral patterns of pediatric burn patients. Specifically, we aimed to determine how closely the ABA referral guidelines were followed in North Carolina and to analyze whether ethnic differences or socioeconomic disparities were associated with variances in referral to VBCs. A secondary aim was to utilize mortality and available discharge data for preliminary assessment of outcomes at VBCs versus NBCs in children.

Methods

The North Carolina Hospitals Association Patient Data System (NCHAPDS) provided hospital record data for pediatric burn patients in a 7-year period from October 1, 2000, to September 30, 2007. The NCHAPDS is a third-party vendor that collects information from 109 hospitals in North Carolina, including two VBCs, Wake Forest Baptist Medical Center Burn Center in Winston-Salem, and the University of North Carolina Jaycee Burn Center in Chapel Hill. NCHAPDS contains demographic and in-hospital treatment information on all patients admitted to participating hospitals within the state. This database does not include outpatient information. Discharge codes

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TABLE 1. ABA Burn Treatment Center Referral Criteria

Partial-thickness burns greater than 10% TBSA
Burns that involve the face, hands, feet, genitalia, perineum, or major joints
Third-degree burns in any age group
Electrical burns, including lightning injury
Chemical burns
Inhalation injury
Pre-existing medical disorders that could complicate management, prolong recovery, or affect mortality
Concomitant trauma (such as fractures) in which the burn injury poses the greatest risk of morbidity or mortality
Children in hospitals without qualified personnel or equipment for the care of children
Special social, emotional, or long-term rehabilitative intervention

ABA, American Burn Association; TBSA, total body surface area.

TABLE 2. Patient Demographics

	Burn Center (n = 1274)	Nonburn Center (n = 557)	P Value
Patients meeting > 1 referral criteria, no. (%)	970 (76)	306 (55)	<0.0001
Male, no. (%)	796 (63)	333 (60)	0.28
Age, mean \pm SD (years)	5.5 \pm 5.5	5.5 \pm 5.7	0.35
Race of patients meeting criteria, no. (%) (n = 1276)			
Black	147 (15)	48 (16)	0.82
White	280 (29)	130 (43)	<0.0001
Other	137 (14)	38 (12)	0.45
Unknown	406 (42)	90 (29)	<0.0001
Race of patients not meeting referral criteria, no. (%) (n = 555)			
Black	61 (20)	50 (20)	0.97
White	77 (25)	71 (28)	0.43
Other	48 (16)	36 (14)	0.64
Unknown	118 (39)	94 (38)	0.74

SD, standard deviation.

between 940.00 and 948.99 from the *International Classification of Disease, 9th Revision* identified patients with thermal injuries. Patients aged 17 years or younger were included for analysis. Variables extracted included percent and pattern of burn injury, discharging hospital, length of stay (LOS), burn-specific procedures performed, payer status, race, and gender.

The number of ABA referral criteria met was determined by cross-referencing the ICD-9 codes with the referral guidelines. For the purpose of this study, burns involving greater than or equal to 10 per cent total body surface area (TBSA) and burns involving the face, neck, wrist, hand, or genitals met criteria. NCHAPDS did not have sufficient detail to identify other referral criteria, including mechanism of injury, depth of burn, presence of inhalation injuries, pre-existing medical conditions, concomitant trauma, social concerns, and adequacy of hospital resources. All statistical analyses were performed using JMP software (SAS Institute Inc., Cary, NC). Continuous variables were evaluated using either the Student's *t* test, when variables were normally distributed, or the Wilcoxon signed rank sum test, when variables were not normally distributed. Categorical data were compared using Pearson's χ^2 . Significance was at $P < 0.05$.

Results

Over the 7-year study period, 1831 patients aged 0 to 17 years were hospitalized for burn injuries in the state of North Carolina (Table 2). Of those, 1274 (70%) met at least one of the ABA referral criteria, but VBCs treated only 970 (76%) of such patients. Of the 557 patients treated at NBCs, 306 (55%) met at least one ABA referral criteria. Amongst patients meeting at least one criterion, on average, those treated at VBCs met 2.1 criteria (standard deviation [SD] = 1.3) and those treated at NBCs met 1.5 criteria (SD = 0.9).

Analysis of demographic and socioeconomic variables revealed that neither age ($P = 0.97$) nor gender ($P = 0.30$) appeared to be significantly associated with treatment center (Table 2). VBCs were statistically more likely to treat nonwhite children, but information on ethnicity was incomplete in 39 per cent of records. There were no significant differences in payer status between VBCs and NBCs. More than half of patients were covered by the state Medicaid system in both VBCs (692 of 1274 [54%]) and NBCs (319 of 557 [57%]). Fewer had managed care coverage (VBC, 414 [32%]; NBC: 165 [30%]).

The types of injuries treated at VBCs and NBCs were variable. Taken as a whole, VBCs treated more

TABLE 3. *Burn Admissions by International Classification of Diseases, 9th Revision Code*

	Burn Centers, No. (%) (n = 1274)	Nonburn Centers, No. (%) (n = 557)	P Value
940: burn confined to eye and adnexa	53 (4)	5 (1)	0.0002
941: burn of face, head, and neck	501 (39)	117 (21)	<0.0001
942: burn of trunk	103 (8)	15 (3)	<0.0001
943: Burn of upper limb, except wrist and hand	93 (7)	13 (2)	<0.0001
944: burn of upper limb, except wrist and hand	351 (28)	114 (21)	0.0014
945: burn of the lower limb	168 (13)	46 (8)	0.0025
946: burns of multiple specified sites	38 (3)	0 (0)	<0.0001
948.1: burns > 10% TBSA	414 (33)	91 (16)	<0.0001

TBSA, total body surface area.

TABLE 4. *Patients' Lengths of Stay (LOS) and Discharge Status*

	Burn Centers (n = 1274)	Nonburn Centers (n = 557)	P Value
Patients meeting referral criteria, no. (%)			
LOS, Median (IQR) (days)	4 (2–10)	2 (1–5)	<0.0001*
Discharge status, no. (%)			
Home/self-care	737 (76)	236 (77)	0.68
Home health services	201 (21)	31 (10)	<0.0001
Other short-term hospital	16 (2)	36 (12)	<0.0001
Died	9 (1)	0 (0)	0.09
Other	7 (1)	3 (1)	0.65
Patients not meeting referral criteria, no. (%)			
LOS, median (IQR) (days)	3 (2–6)	2 (1–5)	0.0015*
Discharge status, no. (%)			
Home/self-care	244 (80)	207 (83)	0.51
Home health services	53 (17)	30 (12)	0.07
Other short-term hospital	3 (1)	10 (4)	0.02
Died	1 (0.3)	1 (0.4)	0.89
Other	3 (1)	3 (1)	0.81

* Wilcoxon test used because data were not normally distributed.
IQR, Interquartile range.

seriously injured patients with more extensive thermal injuries (Table 3). Accordingly, VBCs performed 1042 (84%) of all burn-related procedures undertaken during the study period. Of the burn specific procedures performed at NBCs, 150 (78%) were done on patients meeting criteria for transfer.

Length of stay (LOS) was significantly longer for patients who met criteria and were treated at VBCs compared with those who met criteria but were not referred (8.4 vs 3.8 days, respectively, $P < 0.0001$; Table 4). The LOS of patients not meeting criteria was significantly shorter at VBCs compared with NBCs (5.4 vs 6.9 days, $P = 0.0015$). Rates of discharge to home or self-care were no different between the two treatment center types. However, patients meeting criteria and treated at a VBC were more likely to be discharged with home health services than their NBC counterparts (21 vs 10%, $P < 0.0001$). In both patients who met and did not meet criteria, those treated at a NBC were more likely to be discharged to another short-term hospital.

Eleven patients in this study died as a result of their injuries: nine who met criteria and were treated at a VBC, one who did not meet criteria and was treated at a VBC, and one who did not meet criteria and was

treated at an NBC. There was no statistically significant difference in patient mortality between treatment centers.

Discussion

The results of this study suggest that pediatric referral patterns are similar to the patterns reported in the adult burn population, with “under-referral” of 55 per cent of the pediatric burn patients treated at NBCs. Yet, unlike the trends described in adults, the present study revealed no significant role of gender, age, or socioeconomic status in referral patterns. The bias toward “under-referral” amongst white children is difficult to interpret given that 39 per cent of the ethnicity data was missing. Secondary outcome data such as LOS and discharge to home (as opposed to another facility) suggests that treatment outcomes of severely burned children may be improved at VBCs versus NBCs.

Despite evidence that VBCs provide superior care in burn care in adult patients, some literature in pediatric burn care suggest that “underreferral”—not transferring eligible patients—is not as large a problem as “over-referral”—sending patients to VBCs who may be

appropriately treated at a local NBC. Strict observance of ABA criteria without regard for clinician judgment may cause overreferral and overcrowding of regional burn centers. In a review by Vercruyse and coworkers, 70 per cent of pediatric patients treated at their VBC had burns comprising less than 10 per cent TBSA. Amongst those transferred from an NBC, 87 per cent had burns less than 10 per cent TBSA. Only 27 per cent of all patients treated at their institution over the study period required skin grafting. Survival, but not functional outcomes were assessed.

Voicing similar concerns regarding the consequences of strict adherence to ABA referral criteria, Rose and colleagues reported that half (49%) of the pediatric burn patients evaluated in their emergency department (ED) met one or more ABA referral criteria.¹⁴ They found that their burns were adequately addressed in their facility without subsequent referral to a burn center. The most common ABA guideline met in this group was age younger than 5 years old (47%). The majority of these patients were sent home from the ED with outpatient follow-up in the ED or a primary care physician. Only 7.5 per cent had complications, including delayed healing, suspected infections, concerning scars, and multiple ED visits.

Based upon the reports from Rose and Vercruyse, experienced burn clinicians and specialists in pediatric emergency care address burns in children as outpatients and in local facilities without transfer and may account for the large proportion of underreferral in our study. Though concerns regarding strict adherence to ABA referral guidelines are valid, VBCs and NBCs in the present study exhibited equal rates of death and discharge to home, despite VBCs treating more severely injured patients. This finding may indicate that VBCs provide better care than NBCs for severely injured pediatric patients. This notion is further supported through the higher rate of discharge with home health services from VBCs. This finding may be attributed to the availability of ABA-mandated resources at VBCs as well as their greater experience with home burn care of more severely injured patients.

Limitations of this study were those inherent to any retrospective query of a large administrative database. First, data were incomplete, most notably surrounding ethnicity for which 39 per cent of patients had missing data. Second, NCHAPDS did not account for all ABA referral criteria, including such important items as mechanism of injury, degree of burn, inhalation injuries, pre-existing medical conditions, concomitant trauma, social concerns, and hospital resources. Third, there was no assurance that TBSA reporting was accurate and uniform. Finally, lack of assessment of functional outcomes in the database precluded a more thorough

analysis of differences in outcomes between children meeting ABA referral criteria treated at VBCs versus NBCs.

There is a clear need for studies critically assessing differences in cosmesis, range of motion, presence of pain or paresthesia, ability to perform activities of daily living, and psychological consequences of pediatric burn patients treated at VBCs and NBCs. If functional outcomes are superior at VBCs, the rates of “under-referral” may truly be problematic. If the opposite is found to be true, then perhaps such “under-referral” may actually represent ABA referral criteria that are too stringent. In the meantime, increased burn center outreach and education should be provided to referring hospitals so that physicians can make informed decisions regarding such referrals. Additionally, comprehensive studies are needed to evaluate outcomes of such referrals to either validate or refine current criteria.

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