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Influence of Injury Characteristics and Payer Status on Burn Treatment Location in Washington State

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Abstract

The provision of optimal burn care is a resource-intensive endeavor. The American Burn Association has developed criteria to help guide the decision to refer a patient to a burn center for definitive injury care. The purpose of this study was to compare the patient and injury characteristics of patients admitted to the single verified burn center in Washington State with those treated at other facilities in the state. We performed a retrospective review of all patients admitted to a hospital with a burn injury in Washington State from 1987 to 2005 using the state's discharge database (Comprehensive Hospital Abstract Reporting System). Patient and injury factors of patients admitted to the state's single verified burn center or at other hospitals were compared. Multivariate poisson regression was used to calculate the relative risk of injury and patient factors that were significantly associated with admission to the verified burn center. From 1987 to 2005, a total of 16,531 patients were admitted to a Washington State hospital after burn injury. Of these patients, 8624 (52.2%) were treated definitively at the University of Washington Burn Center. Patients treated at this verified center had larger overall burn size (7.4% vs 4.5% TBSA, $P < .001$), higher percent full-thickness burn (4.3% vs 1.2%, $P < .001$), and higher rates of inhalation injury (2.3% vs 1.5%, $P = .005$). Uninsured status (relative risk = 1.46, 95% confidence interval = 1.4–1.5) was also significantly associated with treatment at the verified burn center. Injury severity and payer status were both found to be independent predictors of treatment at the single verified burn center in Washington.

The provision of optimal burn care is a resource-intensive endeavor, requiring specialized staff, equipment, and other resources. Burn centers were developed to provide facilities with the available resources and expertise needed to achieve optimal outcomes following burn injury.¹ Accordingly, the American Burn Association (ABA) has developed criteria to help guide the decision to refer a patient to a burn center for definitive injury care.²

Currently in the United States, there are over 120 self-designated burn centers. Of these, 46 are currently verified by the American College of Surgeons and the ABA. These verified centers are located in 24 states and the District of Columbia. Therefore, patients are often initially evaluated at hospitals without burn care facilities where early management and

triage decisions occur. The decision to transfer a patient to a burn center may be guided by patient characteristics, injury characteristics, and the hospital's overall comfort level in managing a burn injury. Studies in the trauma literature have demonstrated that payer status may also motivate decisions to transfer a patient to a specialized center.³ Nathens et al³ demonstrated that noncommercial payer status, when adjusted for injury severity, significantly increased the odds of transfer to a level I trauma center in the state of Washington.

The University of Washington Burn Center is the single verified burn center for Washington State and provides burn care for the states of Alaska, Montana, and Idaho.⁴ Nearly half of the patients admitted to the UW Burn Center are transferred following initial evaluation at another facility.^{5,6} The number and injury characteristics of those patients with burn injuries treated definitively at other facilities (ie, not transferred to the burn center) are unknown. The purpose of this study was to review the location of definitive care for patients treated for burn injury in Washington State during a 19-year period and to examine the factors associated with treatment at the verified burn center using the state's discharge database. We hypothesized that injury severity and payer status would both be significant predictors of treatment location.

METHODS

Study Overview

This is a retrospective cohort study of patients who were hospitalized for burn injury in Washington State from 1987 to 2005. Baseline patient and injury characteristics of those patients treated at the University of Washington Burn Center at Harborview Medical Center—the single verified burn center in the state (hereinafter referred to as the “burn center”)—were compared with those patients admitted to other hospitals following burn injury (hereinafter referred to as “other hospitals”). This study was conducted following approval from our institutional Human Subjects Division.

Data Source and Collection

Data for this study were obtained from the Washington State Comprehensive Hospital Abstract Reporting System (CHARS). This database includes patient information from all public and private hospitals in Washington State (except for military and Veterans Administration hospitals). CHARS provides detailed patient demographic information, admission and discharge details, payer status, and diagnosis and procedure based on International Classification of Diseases (ICD) Ninth Revision codes. This database includes only patients who were admitted and subsequently discharged from a hospital; patients treated only in the emergency department were not captured. In addition, the database includes patients injured in other states but admitted to a hospital in Washington State.

Subjects

Patient records from 1987 to 2005 were searched for all patients with any diagnosis code for burn injury (ICD-9 codes of 940–949). For those patients identified with a burn injury, we obtained information regarding age, gender, total body surface area (TBSA) burned (both total surface area and total surface area of full-thickness burn), anatomic location of burns, inhalation injury status, other injuries, payer status, hospital where treated, and discharge disposition. In addition, we calculated each patient's injury severity score from individual ICD-9 codes using the ICDMAP-90 software developed by the Johns Hopkins University School of Public Health and Tri-Analytics, Inc (Forest Hill, MD). To examine the potential impact of baseline medical comorbidities on outcome, we examined the presence or absence of the following ICD-9 codes: diabetes (250), cardiovascular disease (414), and

cerebrovascular disease (433 or 437). Patients were then classified according to treatment at the burn center or other hospital based on the hospital from which they were discharged.

The medical records of 6950 patients were missing data on TBSA burn. Given the likely primary importance of this variable in predicting treatment location, we performed multiple multivariate imputations to calculate missing values using the multiple imputation by chained equations method.⁷ The imputations were combined during analysis using the Li-Ragunathan-Rubin robust estimate of the variance-covariance matrix of the regression coefficients.⁸ These calculations were conducted using Stata (StataCorp, College Station, TX).

Data Analysis

Patient and injury characteristics of patients treated at the UW Burn Center were compared with those treated at other hospitals, using pooled estimates from linear regression models.⁹ Case counts, where given, were calculated from unimputed data. We performed two separate multivariate modified poisson regression analyses¹⁰ to calculate the relative risk (RR) of injury and patient factors that were significantly associated with treatment at a verified burn center. In the first analysis, we focused on the patient and injury factors we hypothesized a priori would be most likely to influence treatment location. Next, to examine the effect of payer status on the likelihood of treatment at the burn center, an additional model was constructed to determine the RR of transfer based on payer status, adjusting for injury severity, age, and county of residence. We included county of residence as a covariate because the verified burn center is at Harborview Medical Center—the county hospital for King County. Clearly, patients burned in King County would be expected to be treated at Harborview Medical Center regardless of injury severity or other factors. In addition, for both analyses, we include a covariate for treatment year—before or after 2000. In 2000, our burn center began regularly using a toll-free referral line for triage of burn patients to our center. It was our impression that this facilitated patient transfer to our center and we wanted to adjust for these potential effects in our analyses.

RESULTS

From 1987 to 2005, a total of 16,531 patients were admitted to a Washington State hospital following burn injury. Of these patients, 8624 (52.2%) were treated definitively at the University of Washington Burn Center. The baseline and injury characteristics of patients treated at the burn center and at other hospitals are shown in Table 1. Overall, patients treated at the burn center were slightly younger (30.1 vs 38.3 years, $P < .001$), had larger overall burn size (7.4% vs 4.5% TBSA, $P < .001$), higher percent full-thickness burn (4.3% vs 1.2%, $P < .001$), higher rates of inhalation injury (2.3% vs 1.7%, $P = .005$), and higher overall injury severity scores (5.4 vs 3.2, $P < .001$). Forty-four patients (0.005%) admitted to the burn center had been previously admitted to another facility.

The payer status of patients admitted to the burn center and other hospitals is shown in Table 2. Information on primary payer status was available on 97% of patients in this study. A higher proportion of patients admitted to the burn center were uninsured (20.7% vs 6.9%) or were covered under Labor and Industries—Washington's workers compensation program (14.5% vs 9.8%), whereas a higher proportion of patients admitted to other centers were covered by Medicare or commercial insurance.

When examining outcome following burn injury, patients treated at UW Burn Center had higher overall mean and median lengths of stay (Table 3), even after adjustment for overall burn size and total full-thickness burn size. The overall mortality rate was higher at the burn center (4.6% vs 1.3%, $P < .001$). The majority of patients treated at both the burn center and

other hospitals were discharged home following discharge (Table 4). Patients treated at other hospitals were more likely to be discharged to skilled nursing facilities (6.1% vs 1.4%, $P < .001$).

To more precisely identify the baseline patient and injury factors associated with treatment location, we performed two poisson regressions with the outcome of interest being treatment at the burn center. In the first analysis (Table 5), children aged 0 to 5 years and 6 to 15 years were more likely to be treated at the burn center (RR = 1.18, 95% confidence interval [CI] = 1.1–1.2; and RR = 1.09, 95% CI = 1.0–1.2, respectively). However, older adults were more likely to be treated at other hospitals. Both TBSA burned and TBSA of full-thickness burn were significant predictors of treatment at the burn center. We also found that the presence of hand burns and head and neck burns (two ABA referral criteria for transfer) are both significantly predictive of treatment at the burn center (RR = 1.21, 95% CI = 1.16–1.25; RR = 1.09 95% CI = 1.04–1.14).

Finally, we examined the influence of payer status on treatment location in a multivariate model (Table 6). Uninsured status (RR = 1.47, 95% CI = 1.4–1.5) and labor and industries payer status (RR = 1.36, 95% CI = 1.3–1.4) were both significantly associated with treatment at the burn center and patients with Medicare were less likely to be treated at the burn center (RR = 0.87, 95% CI = 0.79–0.91).

DISCUSSION

Triage decisions for patients with burn injuries are often complicated, even with the availability of guidelines for burn center transfer. Ultimately the multi-factorial determination about where patients with burn injuries receive definitive care includes patient age, injury severity, and the initial provider's ability and desire to care for a particular patient. In this study, we sought to examine patient and injury characteristics of those burn patients treated at the single verified burn center in Washington State and those patients receiving definitive care at other hospitals in the state.

As expected, patients treated at the burn center tended to have larger burns, were more likely to have sustained an inhalation injury and were more likely to have other associated injuries. In addition, patients with head and neck burns and hand burns were more likely to be treated at the burn center which is consistent with ABA criteria for burn center treatment. Children, particularly those under 5 years old, were significantly more likely to be treated at the burn center, when adjusting for injury severity and county of residence. However, older adults, particularly those more than age 65, were more likely to be treated at other hospitals. This finding is consistent with other studies of trauma patients. Nathens et al³ found that likelihood of transfer to a level I trauma center decreased with increasing age and MacKenzie et al¹¹ similarly found that older adults were less likely to be transferred to level I centers in the recently published National Survey on Cost and Outcomes of Trauma. The reasons why older patients were less likely to be transferred to the verified center are unclear and may reflect a desire on the part of the patient to remain close to primary care physicians (given potential medical comorbidities), other family members or care givers. Whether this transfer decision impacts outcome requires further exploration, however, in the National Study on Costs and Outcomes of Trauma study it did not affect mortality in the elderly.¹¹

ABA transfer criteria are based on the assumption that certain injuries require the specialized care provided by the burn team—including medical care, physical and occupational therapy, psychological support, and nutrition. Conversely, patients with smaller burns—typically those that do not require surgery and are at low risk for subsequent complications—need not be managed exclusively at burn centers. It appears, for the most

part, that provision of burn care in Washington is consistent with these guidelines. Patients with more severe injuries, patients at the extreme young spectrum of age, and patients with hand or head and neck burns tended to be treated at the burn center. Given the inconsistency with which “E” codes are recorded in the CHARS database, we were not able to determine the influence of etiology (eg, chemical and electrical burns) on treatment location.

Payer status did appear to be an independent predictor of treatment location. Patients with noncommercial insurance were more likely to be treated at the burn center independent of burn size, inhalation injury status, age, and county of residence. Lower socioeconomic status has been associated with worse baseline health status and increased risk for adverse outcome following burn injury.^{12,13} Although these associated factors may have motivated transfer to the burn center, other studies of nonburn trauma patients have identified a similar trend of payer status as a triage criteria. Nathens et al³ examined the predictors of transfer to a level I trauma center in the state of Washington and found injury severity to be the greatest predictor of transfer. However, he also reported that patients without commercial insurance were over twice as likely to be transferred to level I centers when compared with those with commercial insurance.³ The payer status-based triage effect did not appear to be any more significant in larger vs smaller injuries (data not shown).

Finally, the effect of year of injury on location of treatment was examined. The UW Burn Center began regularly coordinating patient triage and transfer through the hospital’s transfer center in 2000. By calling the transfer center’s toll-free number, referring physicians can review the details of the burn injury with a burn center attending physician who can help estimate the extent and depth of burn and make recommendations for transfer and initiation of fluid resuscitation.^{5,6} In addition, the transfer center nurse coordinates patient transport if needed. In the multivariate poisson analysis, treatment after the implementation of the transfer center was associated with an increased likelihood of treatment at the burn center, when controlling for other patient and injury characteristics. Clearly, this may also represent other factors such as those related to reimbursement or liability that may have also changed over time.

There are several potential limitations to this study. First, we used data from a statewide database that was not designed to collect data on burn patients specifically. It is also well known that estimates of burn size and depth by nonburn specialists tend to be inaccurate; in particular, they tend to overestimate actual burn size.^{5,14–17} This may account for some of the differences seen in length of stay when adjusted for TBSA. In a retrospective database review such as this one, it is difficult to differentiate comorbidities from adverse outcome. For example, a patient with a diagnosis code for diabetes could have had diabetes before injury or could have developed high blood sugars as a result of treatment. In particular, complete documentation of comorbidities particularly of those seen as unrelated to the injury and those in deceased patients may be incomplete. Finally, it is very difficult, if not impossible, to ascertain outcome from large administrative databases that are not designed to track outcome. Disposition status and mortality are both available but functional and psychosocial outcome variables are not.

In conclusion, the majority of patients with burn injuries in Washington have been treated at the state’s single verified burn center since 1987. Burn severity—in terms of size and depth, burn location, and payer status were significant predictors of treatment at the verified burn center. Further studies are required to better define factors underlying burn center referral patterns and the outcomes of those patients with severe burn injury treated at other hospitals.

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Table 1

Patient and injury characteristics of burn patients in Washington state

	UW Burn Center N (%)or Mean (SD)	Other N (%)or Mean (SD)	P
Age			
Total (mean)	30.1	38.3	<.001
0–5	1624 (20.3)	1110 (14)	
6–15	680 (8.5)	609 (8.0)	
16–54	4615 (58)	3814 (50)	
55–75	785 (9.8)	1312 (17)	
≥75	294 (3.7)	809 (11)	
TBSA			
Total (mean)	7.4 (0.4)	4.5 (0.4)	<.001
<10%	67.1	71.5	
10–19%	17.3	19.5	
20–29%	6.1	5.4	
30–39%	3.6	2.0	
40–49%	2.0	0.7	
≥50%	3.9	1.0	
Gender (% male)	6154 (71.4)	4873 (61.6)	<.001
Inhalation injury (%)	2.3	1.7	.005
ISS score	5.4 (8.6)	3.4 (4.2)	<.001

Table 2

Payer status

	UW Burn Center (%)	Other (%)
Commercial	12.4	15.5
Medicare	10.1	23.3
Medicaid	23.9	24.5
Uninsured	20.7	6.9
HMO	18.4	20.0
Labor and industries (workers compensation)	14.5	9.8

 $P < 0.001$.

Table 3

Outcomes following injury

	UW Burn Center	Other	<i>P</i>
LOS			
Mean	12.1 (17.2)	6.3 (8.2)	<.001
Median	5.0	4.0	<.001
LOS/TBSA	0.67 (0.75)	0.49 (0.56)	<.001
LOS/full-thickness TBSA	0.83 (0.96)	0.60 (0.66)	<.001
Overall mortality (%)	4.6	1.3	<.001

LOS, length of stay.

Table 4

Disposition status following injury

	UW Burn Center (%)	Other (%)
Home	88.6	78.5
Other acute care	3.4	2.4
Skilled nursing facility	1.4	6.1
Other (shelter, prison)	1.7	3.0
Unknown	4.9	10.0

 $P < 0.001$.

Table 5

Predictors of treatment at verified burn center: patient and injury factors

	Relative Risk	95% CI	P
Age			
0–5	1.18	1.1–1.2	<.001
6–15	1.09	1.0–1.2	.012
16–40	Reference		
41–65	0.88	0.81–0.95	.001
>65	0.69	0.60–0.800	<.001
Sex (female)	0.86	0.82–0.90	<.001
TBSA	1.03	1.01–1.06	<.001
Full-thickness TBSA	1.08	1.05–1.12	<.001
Inhalation injury	1.12	0.98–1.28	.11
Treatment year*	1.03	1.03–1.04	.001
Maximum nonskin AIS	1.03	1.02–1.05	<.001
Burn location			
Hand burn	1.21	1.16–1.25	<.001
Head and neck burn	1.09	1.04–1.14	<.01
Noncounty resident	0.67	0.65–0.68	<.001
Medical comorbidities			
One	0.67	0.60–0.75	<.001
Two or more	0.44	0.24–0.82	.009

* Reference: pre-2000.

CI, confidence interval.

Table 6

Effect of payer status on location of treatment

Payer Status [*]	Relative Risk [†]	95% CI	P
Medicare	0.87	0.79–0.95	.003
Medicaid	1.03	0.98–1.1	.21
Labor and industries	1.36	1.3–1.4	<.001
Uninsured	1.47	1.4–1.5	<.001

* Adjusted for age, burn size, inhalation injury, residence.

[†] Reference: commercial.