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Burn injury outcome differences in Native Americans☆

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ABSTRACT

Objective: Native Americans (NAs) have worse healthcare outcomes over some measures than non-Native Americans (non-NAs) (i.e., lower life expectancy, higher heart disease and psychiatric disease rates). Little data exists to show if there are differences in the hospital course of burned NAs versus non-NA patients. The purpose of this study is to analyze the epidemiology, clinical course, and outcomes of NA burn injury in Arizona.

Methods: We conducted a retrospective database review of all burn center burn admissions from 2000 to 2015. This initial dataset of 12,724 patients included all initial presentations for burns, non-burns, and readmissions. From this database, we extracted all patients who were new admissions for burn injuries only. This resulted in 10,521 patients of which 9555 patients were non-NA patients and 966 were NA patients. The burn center collects sixty-eight data points to populate our burn database; of these data points, we reviewed twenty-nine to assess if differences existed.

Results: Statistically significant differences exist between the two groups with regard to age, geographic locality at time of burn, circumstances surrounding the injury, etiology of the injury, method of transport to the regional burn center, total length of stay, Injury Severity Score on admission, total percent total body surface area burned, month of year of burn injury, hospital charges, payor source for medical costs, and the final disposition. NA burn patients were more often burned at recreational than occupational sites and while participating in non-work related activities. Burn etiologies in NA patients were more frequently due to contact and flame. NA burn patients tended to have greater hospital length of stays and greater charges, and were less likely to be discharged home.

Conclusions: Our data demonstrate that NAs have a different experience with the healthcare system than non-NAs after a burn injury. The majority of these issues revolve around socioeconomic differences between the two groups.

☆ The views expressed in this article are those of the authors and do not reflect the official policy of the Department of Army, Department of Defense, or U.S. Government.

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1. Introduction

Native Americans (NAs) have a lower life expectancy than non-Native Americans (non-NAs) in the United States: 73.7 years versus 78.2 years respectively. Heart disease, malignant cancer, and chronic lower respiratory diseases are common causes of death in both Native and non-Native populations. However, NAs die at higher rates than non-NAs due to other causes such as liver disease and cirrhosis, diabetes mellitus and metabolic syndrome, unintentional injuries, assault/homicide, and intentional self-harm [1]. Burn injury, a subset of unintentional injuries, may also be seen in greater frequency in NAs compared to non-NAs [2–4]. While there are some data on the epidemiology of NA burn injury, there is a paucity of data regarding details of hospital care and outcomes. Pertinent studies are reviewed below.

Schmitt, et al., reporting on accidental deaths among native Canadians in British Columbia from 1961 to 1963, found a death rate of 42.6 per 100,000 compared to a rate of 3.9 per 100,000 for non-native Canadians. Over 905 of these deaths occurred at home and over 70% involved children less than 4 years of age. Important causative factors reported included using an accelerant to light a fire, faulty stoves or chimneys, and children playing with matches [5].

An analysis of the Centers for Disease Control and Prevention's Web-Based Injury Statistics Query and Reporting System (WISQARS™) from 1999 to 2004 showed that Native Americans aged 55 and older had twice the risk of dying from fire related injury than non-Native Americans in the same age group. There was no obvious reason for this disparity, but the authors suggested it might be due to differing living arrangements [6].

Thompson et al., in study of the genetic risk factors for hypertrophic scar development, found that Native American or Alaskan Native race were independent risk factors for the development of hypertrophic scars [7].

Indigenous people living in what is now the state of Arizona can be traced back for thousands of years. Currently, Arizona has the second or third (depending upon source) largest NA population by absolute number and the sixth largest NA population by percentage [8]. Over one-quarter of the state's land area is reservation land. Arizona is home to many NA peoples including the majority of the Navajo Nation, the nation's largest reservation, and the entire Tohono O'odham Nation, the nation's second largest reservation. Fig. 1 demonstrates the location and distribution of NA lands in Arizona [9].

The purpose of this study is to analyze the epidemiology, clinical course, and outcomes of Native American burn injury in Arizona.

2. Methods

This study was approved by the hospital Institutional Review Board.

The Arizona Burn Center (AZBC) at Maricopa Integrated Health System, a public hospital in Phoenix, AZ, is the only tertiary burn center for Arizona and many surrounding locales including parts of New Mexico, Utah, western Texas, eastern California, and northern Mexico. A significant number of Native Americans live in this geographic region providing a unique opportunity to assess this population.

We conducted a retrospective data base and chart review of all burn center burn admissions from 2000 to 2015. This initial dataset of 12,724 patients included all initial presentations for burns, initial presentations for non-burn related diseases (such as necrotizing soft tissue infections and exfoliating skin diseases), and readmissions. From this database, we extracted all patients who were new admissions for burn injuries only; thus, we excluded all non-burn related pathologies and all readmissions. This left us with a database of 10,521 patients of which 9555 patients were non-Native American patients and 966 were Native American patients.

We then analyzed selected outcomes, comparing non-NA patients to NA patients. The burn center collects sixty-eight data points to populate our burn database. Of these data points, we elected to review twenty-nine data sets to assess if statistically significant differences existed between our Native American patients and non-Native American patients. Specifically, we elected to review the following: gender, age, age distribution, month of admission, admission time, admission transport method, hospital transfer status, injury date by month, injury time, location where the burn occurred, presence of inhalation injury, circumstances surrounding the burn event, blood alcohol levels, second degree percent total body surface area (%TBSA) burns, third degree %TBSA burns, total %TBSA burns, total operating room (OR) visits, the total number of operative procedures, length of stay (LOS) in the hospital, length of stay in the ICU, ventilator days, discharge status, hospital charges, injury severity score, payor source, discharge disposition, etiology of the burn, and toxicology screening status. Individual patient charts in both electronic and paper format were also examined for clarification of and or verification of details.

These data were then analyzed to assess trends and the statistical significance of differences between groups. Counts (percentages) were used to describe categorical data, and means (standard deviations), or medians (interquartile ranges), as appropriate, were used for continuous data. Differences in categorical data were evaluated using chi-square tests. Categories were collapsed, in cases of sparse cells, to meet distributional assumptions for the analyses. Z-tests for difference in proportions were used to evaluate differences in categories within constructs. Independent-samples t-tests or Mann–Whitney tests were used to test differences across groups in continuous data. Alpha = 0.05 was selected to determine statistical significance. All tests were two-tailed. SPSS, version 23 (IBM Corp. Armonk, NY) was used for the analysis.

3. Results

Our dataset revealed several notable demographic differences between the NA cohort and the non-NA cohort in our study group (Table 1). Specifically, NAs were more likely to be younger than members of the non-NA cohort, but there were no significant differences in gender between the two groups.

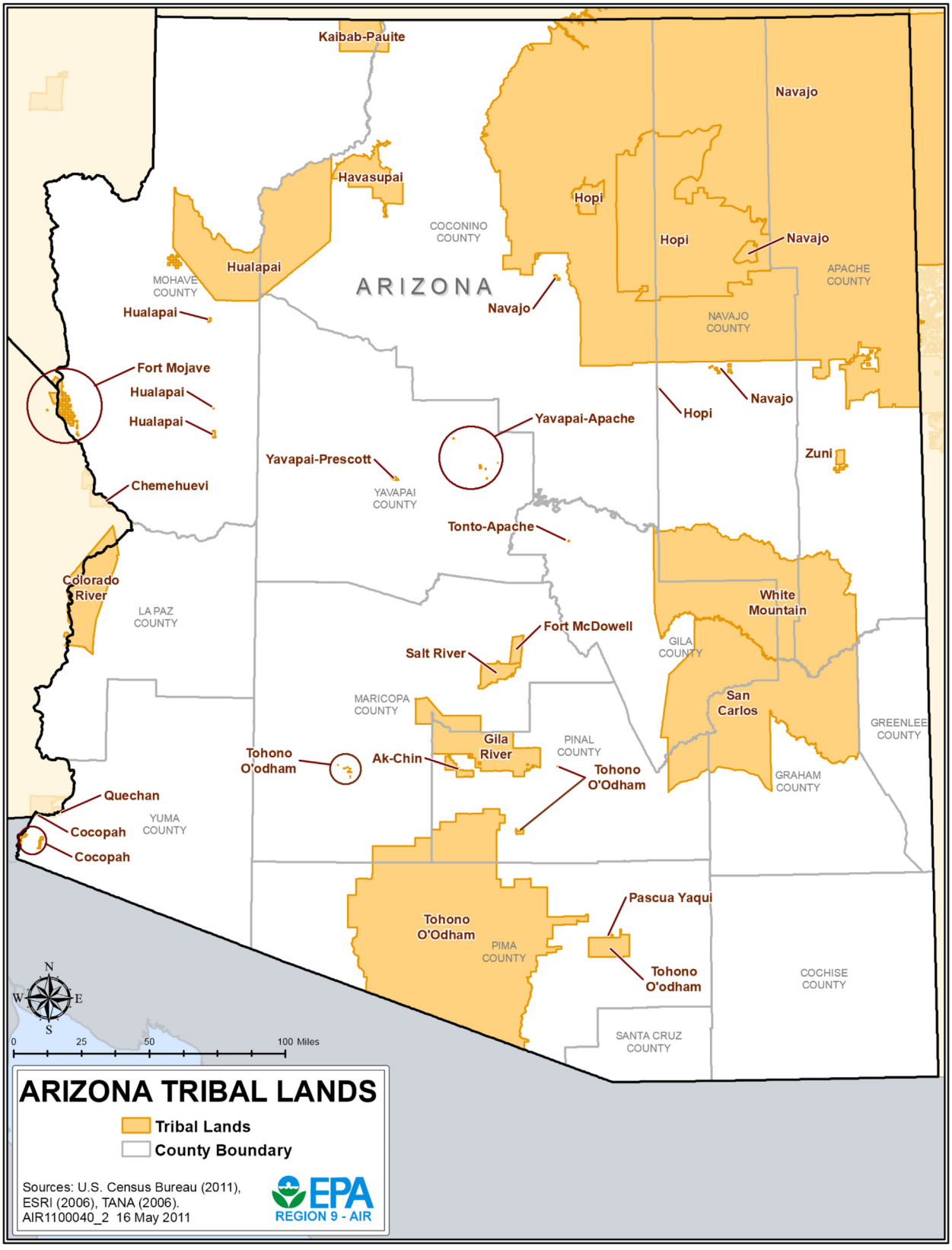

Fig. 1 – Arizona tribal lands.

Table 1 – Demographics of dataset.

Demographics	Native American	Non-Native American	p-Value
Gender			
Male	647 (68.0%)	6169 (70.7%)	0.091
Female	304 (32.0%)	2561 (29.3%)	
±Age, y	27.95 (21.86)	32.62 (22.66)	<0.05
Length of stay (mean days ±SD)			
ICU LOS	1.87 (9.15)	1.92 (9.50)	0.263
Total LOS	11.94 (14.83)	10.78 (16.10)	<0.05
% TBSA (mean days ±SD)			
% TBSA (2nd)	5.91 (7.61)	7.10 (8.93)	<0.05
% TBSA (3rd)	5.38 (10.18)	8.34 (17.52)	0.722
% TBSA (total)	6.67 (9.14)	8.36 (12.21)	<0.05
Inhalational injury	92 (9.7%)	797 (9.1%)	0.581
Injury severity score	2.48 (4.25)	3.57 (7.43)	0.003
Ventilator days, d	1.66 (8.88)	1.62 (9.26)	0.143
EtOH			
Total tested	256 (26.9%)	1761 (21.0%)	<0.05
Positive test on arrival	117 (45.7%)	321 (18.2%)	<0.05
Serum concentration among Positive, mg/dL	173.78 (96.49)	128.56 (91.07)	<0.05
Mortality	20 (2.1%)	228 (2.6%)	0.547
Total	951	8730	

Legend: y=year; d=day; ICU=intensive care unit; LOS=length of stay; % TBSA=percent total body surface area burned; EtOH=ethanol.

Additionally, several clinical data points revealed noteworthy results. NA patients were less severely burned, on average, than non-NA patients. They presented with smaller total TBSA percentages, and—when analyzing subgroups of 2nd and 3rd degree burns only—they had smaller 2nd degree TBSAs on admission. While absolute differences existed between the groups in 3rd degree TBSA, this failed to reach statistical significance. Additional admission injury demographics revealed that NAs had lower ISSs on admission, a greater likelihood of presenting with a positive ethanol screen, and—if a patient was ethanol screen positive—a higher serum concentration of ethanol on presentation than the non-NA cohort. There was no difference between the groups with the rate of inhalational injury. Regarding the entirety of their hospital course, NA patients had longer total hospital LOS. There was no difference between the groups in ICU LOS, ventilator days, or mortality.

Means of transport to the hospital also varied between the groups (Table 2). In the non-NA cohort, ground evacuation via ground ambulance, police department vehicles, fire department vehicles, privately owned, or public transportation vehicles was much more common. However, it is noteworthy that air ambulance provided almost half of the transfers to the burn center for NA patients, reaching statistical significance for both fixed-wing and helicopter ambulance evacuations. Differences also existed in hospital transfer status between the cohorts (Table 2). Non-NA patients tended to present to the burn center initially; however, NA patients typically underwent transfer from another medical facility prior to arrival at the burn center as demonstrated in data base and medical records.

The location where the burn occurred demonstrated further differences between the groups (Table 3). Specifically, non-NA patients were more likely to be burned at an occupational location—such as a mine, quarry, or industrial location—then the NA cohort. NA patients, however, were more likely to be burned at recreational locations, such as campgrounds and parks. While a trend was present showing that NA patients were more likely to be burned at a residential location, this did not reach statistical significance.

On review of when burns occurred during the calendar year, some differences were noted (Table 3). NA patients were more likely to be burned in the winter months of December, January, and February than the non-NA group. Of note, non-NA patients were more likely to be burned during August; otherwise, no months showed a difference in the risk of being burned.

The activities in which a patient was engaged at the time of the burn also were a source of significant difference between the two cohorts (Table 3). Specifically, NA patients were more likely to be burned in non-work related incidents, less likely to be burned on the job, were more likely to be burned during recreational activities, and were more likely to be burned while conducting suspected criminal activities.

The etiology of the burn also shed light on differences between the groups (Table 4). NA patients were more likely to be burned by having direct contact with a hot object. There was

Table 2 – Hospital transport & transfer.

Transport & transfer	Native American	Non-Native American	p-Value
Mode of transport	N=951	N=8730	
Air ambulance			
Fixed-wing ambulance	10 (1.1%)	36 (0.4%)	<0.05
Helicopter ambulance	435 (45.7%)	1359 (15.6%)	<0.05
Ground evacuation	304 (32.0%)	3883 (44.5%)	<0.05
Private/public vehicle	107 (11.3%)	2527 (28.9%)	<0.05
Other	95 (10.0%)	925 (10.6%)	0.56
Transfer status	n=951	n=8730	
Initially presented to ABC	321 (33.8%)	5291 (60.6%)	<0.05
Transferred in state	618 (65.0%)	3350 (38.4%)	<0.05
Other	12 (1.3%)	89 (1.0%)	0.48

Table 3 – Burn event details.

Burn event details	Native American	Non-Native American	p-Value
Number	951	8730	
Site of burn			
Residential	638 (67.1%)	5670 (65.0%)	0.1887
Occupational	34 (3.6%)	757 (7.8%)	<0.05
Recreational	107 (11.3%)	565 (6.5%)	<0.05
Other	172 (18.1%)	1738 (19.9%)	0.1800
Month of burn			
January	116 (12.2%)	752 (8.6%)	<0.05
February	89 (9.4%)	632 (7.2%)	<0.05
March	79 (8.3%)	790 (9.0%)	0.4470
April	70 (7.4%)	720 (8.2%)	0.3428
May	76 (8.0%)	756 (8.7%)	0.485
June	77 (8.1%)	746 (8.5%)	0.6377
July	69 (7.3%)	806 (9.2%)	<0.05
August	56 (5.9%)	791 (9.1%)	<0.05
September	70 (7.4%)	687 (7.9%)	0.5790
October	64 (8.1%)	680 (7.8%)	0.2441
November	77 (8.1%)	715 (8.2%)	0.1321
December	108 (11.4%)	655 (7.5%)	<0.05
Burn event			
Non-work related	459 (48.3%)	3586 (41.1%)	<0.05
Work related	39 (4.1%)	886 (10.1%)	<0.05
Recreation	52 (5.5%)	271 (3.1%)	<0.05
? criminal activity	47 (4.9%)	280 (3.2%)	<0.05
Other	354 (37.2%)	3707 (42.5%)	<0.05

Table 4 – Etiology of burn.

Etiology	Native American	Non-Native American	p-Value
Contact with hot object	160 (16.8%)	1087 (12.5%)	<0.001
Chemical	21 (2.2%)	323 (3.7%)	0.0183
Electrical	21 (2.2%)	507 (5.8%)	<0.001
Flame	429 (45.1%)	3686 (42.2%)	0.0871
Scald	271 (28.5%)	2646 (30.3%)	0.2472
Other	49 (5.2%)	481 (5.5%)	0.6456

also a trend toward a greater percentage of patients suffering a burn from an open flame compared to the non-NA cohort, but this failed to reach statistical significance. Non-NA patients were more likely to suffer chemical burns and electrical burns. Non-NA also had a trend toward suffering scald injuries at a higher rate than NA patients, but this did not reach statistical significance.

Discharge dispositions were also different between the two patient groups (Table 5). NA patients were less likely to be discharged home and are more likely to be discharged to another medical facility (such as acute rehabilitation facilities, skilled nursing facilities, or other hospitals). However, there was no difference between the groups regarding mortality or transfer to other environments—such as inpatient psychiatric facilities, prison, or foster care.

As demonstrated above, statistically significant differences existed between the two groups with regard to total LOS, ISS on admission, and total percent TBSA with NA patients having a lower ISS on presentation, being less severely burned with a lower average percent TBSA on admission, and receiving a longer LOS (Table 1). Despite having—what appears to be—less severe injuries and less significant total physiologic derangements, NA patients tended to undergo more OR visits and have more expensive hospital stays (Table 5). Hospital charges per day of LOS, the hospital charges per percent TBSA burned, cost per admission ISS point, and average total charges for the entirety of the stay were greater in NA patients than in non-NA patients. In addition, while NAs were more likely to undergo a trip to the OR, they underwent fewer OR procedures relative to the non-NA patients in our cohort.

In addition to analyzing the quantitative hospital charge data, we assessed the payor source of the two groups to ascertain if differences in payment methods existed (Table 5). We found that NA patients were more likely to have their hospital stay paid by Medicaid than the non-NA cohort. Conversely, non-NA patients were more likely to possess private insurance, utilize Workers Compensation, or have Medicare cover their hospital costs. It is noteworthy that non-NA patients were also more likely to be uninsured than the NA cohort.

4. Discussion

We questioned before initiating our investigation whether NA patients would experience a greater medical burden from their burn injuries than non-NA patients. We based this assumption on the expectation that socioeconomic factors including the higher poverty rate in the NA population would be associated with more severe burns and advanced illness at time of presentation due to unequal access to medical care, and worse outcomes (e.g. higher mortality) relative to non-NA patients. With this in mind, our data have many interesting outcomes that are both concordant and non-concordant with our assumptions and the current medical literature for NA patients.

The first step in lowering burn rates is prevention. We assumed that NA patients would be less likely to have safe, modern sources of heat in their homes. Moreover, we anticipated that the use of space heaters and open flames would be more common in the winter months. Our data demonstrated that NAs are at a higher risk of suffering burns in the winter months which, we believe, is due to their relative lack of access to safe heat sources for warmth. In regards to the higher average number of burns in August in the non-NA cohort, we feel this is likely due to typical summer time activities—such as camping and backpacking—occurring in higher numbers in the summer months in this cohort putting them at a higher seasonal risk than they are otherwise throughout the year.

Current literature suggests that burn rates are more common in men and in patients age 20 or younger [13]. Our data set supports this with our demographic data showing

Table 5 – Discharge status and hospital charge information.

Discharge & cost data	Native American	Non-Native American	p-Value
Discharge status			
Home	924 (10.6%)	7362 (84.3%)	<0.05
Other facility	924 (10.6%)	924 (10.6%)	<0.05
Death in hospital	924 (10.6%)	244 (2.8%)	0.3883
Other	924 (10.6%)	200 (2.3%)	0.1561
Charge data			
Total OR visits	0.68 (1.49)	0.54 (1.63)	<0.05
Total OR procedures	0.92 (3.06)	1.11 (3.02)	<0.05
Hospital Charges			
Average total charges	$59567 (19134, 155383)	$42706 (13844, 124505)	<0.05
Cost per day of LOS	$8949 (4972, 13418)	$8191 (4150, 12960)	<0.05
Cost per total % TBSA	$16986 (6626, 39037)	$12326 (3925, 30449)	<0.05
Cost per admission ISS	$62146 (19690, 133703)	$50275 (18527, 117592)	<0.05

All charges are reported as the median of the data with the interquartile range in quotes.
OR=operating room; LOS=length of stay; % TBSA=percentage total body surface area burned; ISS=injury severity score.

both groups were more likely to be male and both groups had an average age comparable to national databases. However, it was interesting to note that NAs were more likely to be younger than non-NA patients. No statistically significant differences were noted with regards to gender.

The etiology, location of injury, and mechanism of injury of burn injuries also lend credence to the idea that poverty is a significant issue in burn etiology for NA patients. Both the location and circumstances of the burn indicate that NA patients are much less likely to be burned while involved in occupational activities.

Etiology of the burns, evidenced by the lower chemical and electric burns rates, also points to the possible poverty differences between these groups. If open heat sources and open flames are needed to meet basic living needs in this community also may explain why NA patients are more likely to be burned by having contact with hot objects (such as space heaters and hot plates). This should undergo further study.

In a review of fire fatalities in New Mexico children over 10 years (1981–1991), Parker et al., reported that children living in substandard housing had a much higher mortality than those who were not. Of the children in substandard housing, two-thirds were Native Americans. Only 11% of the children who died reached a burn center [10].

In an examination of demographic and geographic risk factors for a single state, Edelman, et al., found that seven counties with high burn risk also had relatively high populations of Native Americans. However, these same counties also had other confounding risk factors, which made interpretation of the data difficult [11].

While the locality where burns occur lowered the risk of industrial electrical and chemical burns in the NA cohort, recreational activities were more common in burn injuries in NA patients than non-NA patients. This may be due, in part, to cultural differences, wherein tribal and traditional events require open flames as part of ceremonial activities. Or, the NA population may be exposed more frequently to open flames because these are more common in rural than urban living.

Our data demonstrated that the NA population underwent aeromedical evacuation at a much higher rate than ground medical evacuation. In light of this, we assumed that this would lead to patients presenting with more significant physiologic derangements, primarily due to having less access to medical care and longer evacuation times to definitive care at the regional tertiary burn referral center. Higher baseline rates of diabetes, liver disease, cirrhosis, and metabolic syndrome may also have played a role. However, we found a lower average ISS on presentation among the NA group along with lower average total TBSA on presentation and no mortality difference. We hypothesize that the greater rate of aeromedical transportation may be due to the fact that many NA communities only have one available ambulance and using this for transport would leave that community without ambulance support for many hours or even days. Moreover, most NA communities are geographically remote from the regional burn center. These two factors combine to make aeromedical transportation the only logical method of transport for many NA burn patients.

Callegari, et al., analyzed burn injuries in native Canadians admitted to a single burn unit over a 10-year period from 1977 to 1986. Natives demonstrated a higher incidence of burn injury, larger burns, longer hospital stays, and more operations than non-native Canadians. Natives also were less likely to be discharged to home following acute care. There was no difference in mortality between the two groups [12].

A similar study from 1978 to 1983 found that Native Americans in New Mexico during this time period experienced a sex and age adjusted annual mortality from burn injury that was twice that of non-Native Americans [2].

Two additional studies reported that Native Americans were at greater risk for suffering fatal and nonfatal burn injuries when compared to non-Native Americans [3,4].

NA patients have a longer LOS, more OR visits, and a more expensive hospital stay than their more severely injured (as evidenced by TBSA), more ill (as evidence by the presentation ISS), and older non-NA patients. Similarly, it was surprising to note that NA patients are less likely to go home following a burn when compared to the non-NA patients in light of the fact that NAs suffer less severe burns. They are much more likely to undergo transfer to a rehabilitation facility for some length of time prior to going home. We hypothesize this is due to two main reasons; one, that the medical facilities local to the average NAs domicile cannot provide the adequate multidisciplinary care that burn patients receive and two, that—due to the degree of poverty many patients find themselves in—the residence where the average NA lives is not up to standards such that a patient can rehabilitate effectively at home. Because of this demonstrated higher transfer utilisation in NAs, it is possible that the longer LOS—as evidenced by a more expensive hospital stay and more OR visits—may be indicated to more fully optimize a patient prior to transfer to an outside medical facility. Additionally, placement issues—such as limited access to only a few skilled nursing facilities or acute rehabilitation facilities by the NA healthcare payor source, unique NA cultural needs that undergo placement at a select facility, and location near to family and friends for psychosocial support which may benefit from lengthy evacuation to a more rural setting—may also lengthen a NA patient's burn center stay that other patients may not have to overcome.

Many NAs are insured by the Indian Health Service, and the vast majority of their healthcare costs are covered by Medicaid. While this ameliorates the risk of burn injuries causing financial destitution, burns suffered by NAs do cause a significant societal burden as NA burns cost more—on average—than injuries to non-NA patients. Compounded with more expensive evacuation methods (e.g., much higher rates of aeromedical evacuation) and the higher likelihood of transfer to an expensive extended care facility—such as a skilled nursing home or acute rehabilitation facility—rather than undergoing rehabilitation at home, the societal burden of these injuries suffered by NAs, in cost alone, is certainly much higher than is demonstrated by this paper. This cost does not account for the additional, intangible differences in increased mental distress caused by lengthier transfers by uncommon transportation methods, longer hospital stays at a burn center, more operating room visits, and further time away from home and social supports that a lengthy, post-hospitalization rehabilitation facility visit requires.

Our data demonstrates that NAs clearly have a different experience with the healthcare system than non-NAs after

suffering a burn. These differences exist in terms of demographics, mechanism of injury, mode of transportation, and their hospital course. We hypothesize that the majority of these issues likely revolve around socioeconomic differences between the two groups, primarily poverty rates and geographic location. Further research should be directed at addressing these outcome disparities, and multiple opportunities exist for research toward multiple endpoints.

In terms of burn prevention, improving access to more modern living accommodations in the NA community may lower the incidence of injury for NAs. Similarly, ethanol seems to be associated more commonly with burns in the NA population; further interventions to ameliorate ethanol intake in this population may lower the rate of burns in the community. Further development of ancillary, post-hospitalization resources for burn patients in the Indian Health Service (by broadening access to physical therapy and occupational therapy with emphasis on burn care in an outpatient, embedded clinic on a reservation, for example) may allow for more NA patients to return home rather than a lengthy and more expensive transfer to a skilled nursing facility or acute rehabilitation facility. Moreover, if funding can be appropriated to make a NA burn patient's domicile more conducive for rehabilitation, then this may decrease the rate of transfer from a burn center to an allied care facility. To identify differences between the two cohorts to better identify differences that occur during the hospital stay, a more granular analysis of presenting injuries, complications during hospitalization, and investigating why NA patients underwent transfer to an outside medical facility at time of discharge from MIHS are all fields for further, retrospective research into this interesting cohort.

This study has limitations. This is a largely a database study from a single institution and it may not thus be representative of the population studied. Additionally, not all burn patients necessarily came to this institution. Also, patients were self-identified and this may represent a source of error.

Further areas of research include analysis of causes for disparate outcomes and possible interventions to modify or improve these outcomes.

In conclusion, this review of NA burn injuries demonstrated that NA burn patients were more often burned at recreational than occupational sites and while participating in non-work related activities. Burn etiologies in NA patients were more frequently due to contact and flame. NA burn patients tended to have greater hospital length of stays and greater charges, and were less likely to be discharged home.

Sources of support

None.

Conflicts of interest

No conflicts of interest to report.

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