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Interhospital variation of inpatient versus outpatient pediatric burn treatment after emergency department evaluation☆

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ABSTRACT

Background: Approaches to burn care in the pediatric population are highly variable and can be targeted as a potential measure in cost-reduction. We hypothesized that institutions vary significantly in treatment allocation of nonsevere burns to either inpatient or outpatient care.
Methods: We queried the PHIS database for fiscal year 2017 to quantify small pediatric burn admissions and Emergency Department visits (ED). The ICD-10 code T31.0 was used to identify burns involving <10% of total body surface area (TBSA). Centers were categorized by burn center status and length of stay, readmissions, and charges were compared.
Results: Inpatient versus outpatient management distribution was significantly different across the included pediatric children's hospitals ($n = 34$, $p < 0.00001$). When data were analyzed with respect to outpatient care, a bimodal distribution distinguished two groups: high hospital utilizers with an average of 30% outpatient burn care and low-utilizers averaging 87%. Median inpatient charge per patient was greater than 31-fold compared to ED burn management ($p < 0.0001$).
Conclusions: Variability of inpatient versus outpatient pediatric burn management in small burns was significant. Compared to outpatient burn care, inpatient care is significantly more costly. Implementing protocols and personnel to provide adequate attention to small burns in the ED could be an important cost-saving measure.
Type of study: Retrospective analysis.
Level of evidence: Level III.

Burn injury remains a major threat to public health, affecting nearly half a million Americans each year annually [1,2]. Children and adolescents account for approximately 120,000 (24%) of these burns, with a disproportionate majority occurring in those less than 6 years of age [3].

Guidelines for referral of pediatric burn patients to a burn center for admission have been established that recommend referral of all burns that are: >10% TBSA, full thickness, cross joints, chemical, electric, associated with inhalational injury, or include burns on hands, face, and/or genitalia. This criterion also recommends transfer of children with burns if the hospital does not have qualified personnel or supplies to treat the burn [4]. If no regional pediatric burn center is available guidelines recommend that an adult burn center may serve as an alternative [5]. While guidelines suggest referral of pediatric burns from adult centers or children's hospitals without burn centers, this does not suggest that these patients should be admitted. In fact, literature suggests that up to 90% of pediatric burns can be treated with outpatient management based on the above stated criteria. This has been successful provided patients have adequate home support, minimal comorbidities, adequate pain control, and reliable access to ambulatory care facilities [6].

Despite these guidelines, high referral and admission rates continue to be observed throughout the literature. In a recent single-center retrospective study performed at a tertiary care children's hospital, Anderson etal. revealed 80% of low acuity (<5% TBSA) burns were admitted to observation [7]. As our health system continues to evolve from one that is mostly fee-for-service based to one that is predicated on optimizing quality and value for the patient, we sought to better understand the national trends in admission rates for nonsevere pediatric burn patients using the Pediatric Health Information System (PHIS) database.

The Pediatric Health Information System (PHIS) database is a national database that focuses on deidentified data collection of clinical

Abbreviations: TBSA, total body surface area; ED, Emergency Department; PHIS, Pediatric Health Information System; HH, High Hospital-utilizers; LH, Low Hospital-utilizers; VBC, Verified Burn Center; LOS, Length of Stay; FS, Free-standing; CC, combined pediatric and adult hospital.

☆ Conflicts of interest: None.

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and resource information for the purposes of comparative analysis and quality improvement. Patient populations reported in the database include inpatient, emergency department and observation.

We hypothesized that admission rates for nonsevere pediatric burn patients remain variable across national centers. This area of study could provide a potential opportunity for improving institutional cost-efficacy, and also for developing patient-centered care for burns managed primarily in the home.

1. Methods

1.1. Pediatric Health Information System (PHIS) database query

We performed a query of the PHIS database for fiscal year 2017 to quantify small pediatric burn admissions and Emergency Department visits and analyze associated charges. The PHIS database is a robust national administrative comparative database containing deidentified information which includes demographic and payor information, primary and secondary diagnoses, procedure codes, and billing data for clinical services from hospitals associated with the Children's Hospital Association. Standardized algorithms based on temporal data are used to determine admission status of patients and captures parameters, including length of stay (LOS), complications, and readmissions pertaining to the inpatient, observation, or ED encounters. This retrospective analysis of information from the deidentified PHIS records was classified as "exempt" by the Medical University of South Carolina Institutional Review Board (IRB). The ICD-10 code T31.0 was selected to identify nonsevere partial thickness burns involving less than 10% TBSA. Inclusion criteria for this study included all patients <18 years old with small nonsevere burns of less than 10% total body surface area (TBSA) at any center that accepts and treated pediatric patients in the fiscal year of 2017.

Key performance indicator reports were generated within this date to include patient numbers, length of stay, charges for Emergency Department (ED) visits, inpatient admissions and observation admissions. Length of stay (LOS) was measured by ratio of expected versus actual length of stay. We included centers with medium to high-volume of burns, which we defined as ≥15 pediatric burn patient visits per year based on a recent study on burn center volume [8]. These institutions were required to have data for inpatient, observation and emergency department management of pediatric burns, but were not required to be burn centers or free-standing children's hospitals. Readmission data were available only for patients previously admitted as either inpatient or observation. For this reason, patients treated as outpatients in the ED were not included in this analysis as they were not captured as a readmission if admitted following an ED visit.

1.2. Classification of institutions by unique characteristics and hospital utilization

Although hospitals have been deidentified for this study, we also analyzed each of the above performance indicators for significance between free-standing children's hospitals (FS) and combined adult and pediatric centers (CC). The designation of FS or CC was determined within the PHIS database. We also classified centers as either high hospital-utilizers (HH) which we defined as <30% outpatient burn care or low hospital-utilizers (LH) defined as >70% outpatient burn care. Included in this study were verified burn centers (VBC) that had gone through formal accreditation process through the ABA,self-identified burn centers (SIBC) which are recognized on the ABA directory, as well as nonburn centers. The ABA burn center listing was utilized to identify centers as either verified burn centers (VBC), self-identified burn centers (SIBC), or having no official burn status.

1.3. Analysis by insurance payor type

To analyze differential admission practices associated with insurance type, we obtained payor status information from the PHIS database as well as associated LOS. In order to remove confounders, we then removed any encounters that extended beyond three days as these were likely complicated by other factors not captured owing to the administrative nature of this dataset. We then used this subset to calculate charge per day within ED, inpatient and observation admissions. We also used this same subset to analyze payor status which was categorized as either government (Medicare/Medicaid), commercial, self-pay or unknown.

1.4. Statistical analysis

Parameters of the data analyzed were median and mean charge data for all inpatient, observation and Emergency Department visits. A breakdown of ED, versus observational, versus inpatient management strategies within each institution was depicted in graph form for comparison purposes. A Student's t-test or Analysis of Variance (ANOVA) test was used for statistical analysis of data sets as appropriate, to determine significant differences in length of stay and readmissions between the groups. Significance defined as $p < 0.05$. A histogram was generated to show patterns in burn management admission across 34 centers with medium to high-volume of burn patients.

2. Results

2.1. Burn patient admission patterns across institutions

A total of 34 centers treating at least 15 burns per year from the PHIS database were studied. The included institutions consisted of 22 free-standing children's hospitals (FS) and 12 combined pediatric and adult centers (CC). Four of the included institutions were verified burn centers (VBC) and five were self-identified burn centers (SIBC) according to ABA registry. The remaining 25 did not have any official burn status.

Overall, included centers performed a mean of 86 ± 14 ED burn evaluations per hospital (range: 15–371) (Table1). The total collective number of burns treated in all hospitals was 3797 with a mean number of 111 patients per hospital. While the majority of total burns were treated in the ED on an outpatient basis (72.3%), the proportion of ED-only burns was not evenly distributed across institutions (Fig.1). We found a statistically significant difference in management strategy among 34 hospitals between inpatient, observation, and ED encounter admission rate of nonsevere burns per institution ($n = 34$; $p < 0.00001$). Hospital utilization rates across institutions were also compared and found to be highly variable. The mean inpatient admission rate was 10.4% of patients with a median of 1.9% and ranged from 0% to 100% inpatient. The mean observation admission rate was 8.5%,

Table1
Interhospital burn management.

Interhospital burn management				
	Total	Mean # encounters	Median # encounters	Range
Burns treated across institutions	3797	86 ± 14	68	15–371
Inpatient admissions	624 (16.4%)	19 ± 4.5	3	0–112
Observation admissions	429 (11.3%)	13 ± 4.5	4	0–177
Outpatient (ED only)	2744 (72.3%)	83 ± 6.3	60	0–371

Distribution of mean and median numbers of burn encounters treated with inpatient, observation, or outpatient management across 34 institutions.

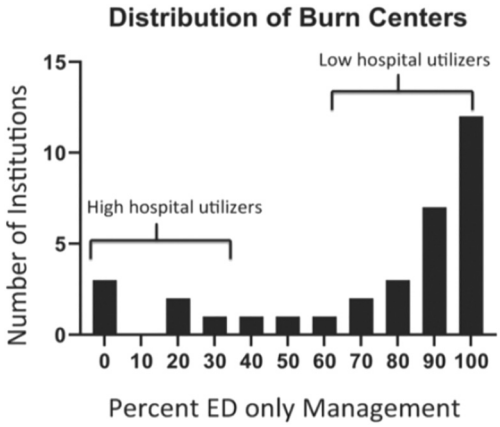

Fig. 1. Histogram demonstrating bimodal distribution of institutions as high hospital utilizers with <30% ED only management and admission of 70%–100% of small burns versus >70% of ED management and only 0%–30% of patients admitted.

median 2.4% (range: 0%–70%). Finally mean outpatient management was 81.1% with a mean of 94.9 and a range of 0% to 100% outpatient management.

When analyzed with respect to emergency department care, a bimodal distribution was observed distinguishing two groups: high hospital-utilizers (HH) with an average of 8% ED burn care and low-utilizers (LH) averaging 87% ED care (Fig.1). The HH group was distinguished as having <30% ED management of small burns, whereas the LH group was defined as having >70% of burn care through the ED. When management of nonsevere burns was further broken down into three categories: ED only, observation and inpatient, distribution was highly variable (Fig.2).

2.2. Comparative charge analysis of nonsevere pediatric burns

Analysis of charges revealed significant variation in resource utilization with just 28% of the patients who were either admitted or observed accounting for 79% ($37 million) of the total charges for burn care in the PHIS database over this time period. The mean of the average ED charges of all institutions with ED burn management ($n = 31$) was $1714 (range: $780–$3316), with median charges per patient of $1420 (Table2). This was lower than the mean observation admission charge ($n = 22$) of $14,604 (range: $4184–$24,211). Inpatient management was, not surprisingly, more expensive with a mean charge of $64,323 (range: $9475–$273,839), almost five times more than observation mean charge. Median inpatient charge per patient was $47,766 and almost 5-fold more than observational management and 31 times that of the emergency department treatment (Table2). Even when analyzed by mean charge per day excluding encounters longer than 3 days, Emergency Department management charges ($1837.70 ±110) were significantly less than the charge/day for both inpatient ($10,886.70 ±942) and observation management ($9729.80 ±1059) ($n = 34$; $p < 0.0001$).

Table2
Median charges compared between inpatient admission burn management and observational and Emergency Department (ED) management.*

Management charges	Median charge ($)	Range ($)
ED charges	1420 ± 20.5*	471–2540
Observation charges	10,455 ± 235*	3090– 23,276
Inpatient charges	47,766 ± 2743*	8235 – 273,839

ED and observation p values are compared to inpatient charges.
* $p<0.001$.

Analysis comparing the three different types of management strategies with ANOVA demonstrated inpatient charges were significantly increased compared to observation and outpatient (ED only) management ($p < 0.0001$) (Table2). Analysis of hospital utilization revealed that the ED charges of the HH group (>30% inpatient care, $n = 10$) were significantly increased compared to LH groups (<30% in patient, $n = 24$) ($p < 0.05$). There was, however, no statistical difference in inpatient or observation charges between high and low hospital utilizers. Additionally, no statistical difference was observed between institutions with regard to burn center status or between free-standing children's hospitals compared to combined pediatric and adult centers (Table3).

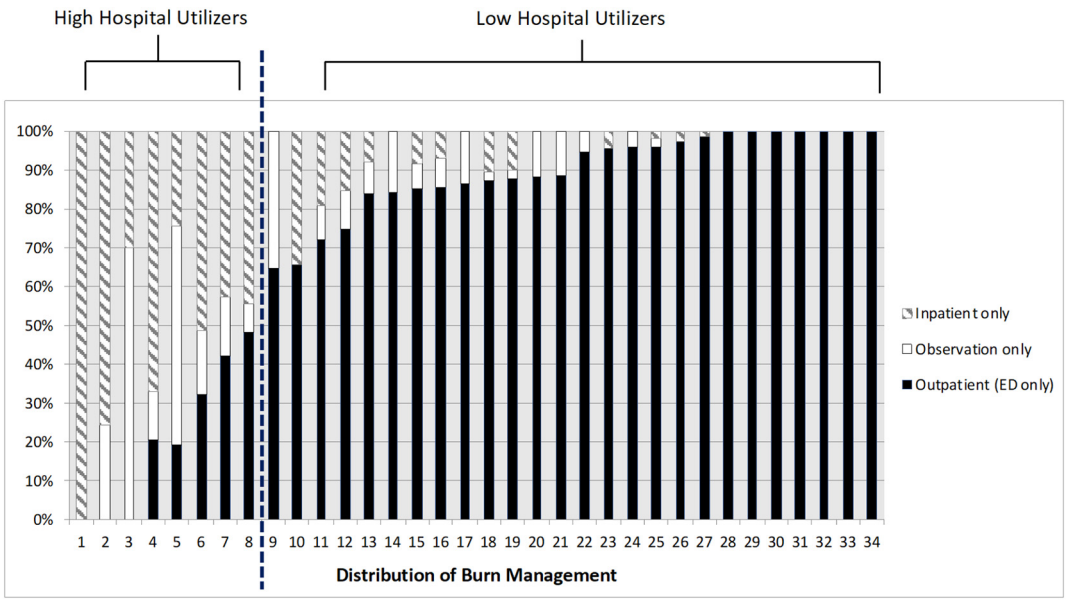

Fig. 2. Bar graph showing distribution of burn management allocation: inpatient (gray lines), observation (white), or outpatient (black), within each hospital ($n=34$) ranging from 0 to 100% outpatient. High hospital utilizers (>70% admission rate) and low hospital utilizers (<30% admission rate).

Table3
Comparison of ED charges between different groups of hospitals.

Institution type	Median ED charge ($)	Mean ED charge ($)	P-value
Hospital utilization	- HH: 2316	- HH: 2202 ± 314	
	- LH: 1454	- LH: 1587 ± 99	$p < 0.05$
Children's hospital status	- FS: 1677	- FS: 1750 ± 126	
	- CC: 1520	- CC: 1712 ± 226	$p = 0.88$
Burn center status	- VBC: 1708	- VBC: 2146 ± 726	
	- SIBC: 1567	- SIBC: 1576 ± 214	$p = 0.48$
	- Neither: 1586	- Neither: 1724 ± 119	

VBC = verified burn center, SIBC = self-identified burn center, neither = no official burn status, FS = Free-standing children's hospital, CC = combined pediatric and adult center, HH = high hospital-utilizers, LH = low hospital-utilizers.

2.3. Admission practices between institutions based on hospital utilization, burn center status and children's hospital status

Percent admission was calculated for all institutions by adding total number of observation and inpatient admissions and dividing by total treated patients. We observed a significant difference in percent admission between our HH and LH group ($p < 0.000001$) confirming that our cutoff dividing these two groups was relevant. Although the median percent admission for VBCs (74.4) was high compared to SIBCs (14.9) or nonburn centers (8.25), there was no significant difference in regard to burn center status: verified, self-identified, or neither ($p = 0.09$). When compared to combined pediatric and adult centers ($n = 12$), free-standing children's centers ($n = 22$) had significantly decreased admissions ($p < 0.05$) (Table4).

2.4. Analysis of readmission and length of stay with respect to ED, observation, or inpatient management

33 of the 34 included centers had readmission data and all 34 centers had length of stay data. Readmission rates between the 22 FS hospitals (mean: 6.7; median: 2.73) and 12 combined pediatric and adult centers (CC) (mean: 6.7; median: 2.72) revealed no significant difference ($p = 0.99$). No significant difference was observed in 30-day readmission rates when analyzed by burn center status although there was significant variation across groups. VBC mean readmission rate was 3.24% (range: 1.2–5.1%), while SIBC mean was 4.34% (range: 0–15.4%), and nonburn centers mean readmission rate was 7.8% (range: 0–33.3%) ($p = 0.6$).

Analysis of length of stay was measured by ratio of expected to observed length of stay. Between FS($n = 22$) and CC($n = 12$) there was no difference in LOS in any type of burn management. However, when we compared LOS between the highest (HH) (<30% outpatient) and lowest hospital utilizers (LH) (>70% outpatient), there was a significant difference in the inpatient and observation admission groups. Observation HH mean LOS was 0.61 days compared to the LH($n = 5$) LOS which was almost twice that at 1.2 days ($n = 8$, $p < 0.05$). The inpatient analysis was similar with the HH group ($n = 8$) mean LOS at 0.67 days and the LH mean LOS at 1.22 days ($n = 6$, $p < 0.05$). There was no statistical difference in LOS in the ED management setting in this analysis with each mean LOS for respective HH($n = 7$) and LH($n = 12$) groups at 0.41 and 0.39 day ($p = .14$). The data revealed no significant difference in inpatient LOS when analyzed with respect to burn center status ($p = 0.53$) and the data were insufficient across all groups to compare ED or observations LOS in this subset analysis.

2.5. Analysis of patterns in payor status and admission practices

In this study, we identified that 29% of these encounters were under commercial insurance, 63.5% were covered by government insurance, 5.7% were categorized as self-pay or uninsured, and 1.7% had unknown status. The payor status statistics were similar across all three groups: outpatient (30.3% commercial, 62.5% government, 5.7% self-pay, 1.6% unknown), observation (30.3% commercial, 62.54% government, 5.5% self-pay, 1.65% unknown), and inpatient (28.4% commercial, 63.2% government, 6.1% self-pay, 2.28% unknown) with no statistically significant differences observed. When HH utilizers were compared to LH utilizers within each category, there was also no statistical significance in inpatient or outpatient management. Interestingly, within the observation group, there were significantly more patients identified as self-pay in the HH($n = 10$) group compared to the LH group ($n = 5$, $p < 0.05$). When we analyzed all inpatient encounters across all institutions including encounters with a LOS >4 days we found that the mean LOS for patients with commercial insurance was 3.92 days ranging from 1 day to 19 days with a median of 2 days. Government insured patients' mean LOS was 5.22 days ranging from 1 day to 139 days with a median of 3 days, and finally self-pay mean LOS was 3.16 days with a range of 1 day to 15 days with a median of 2 days. The difference in LOS between commercial and government insurances reached statistical significance ($p < 0.05$). Although self-pay or uninsured patients' LOS was more than 60% that of government -insured patients, this difference did not reach statistical significance ($p = 0.15$). Combining commercial and government insured encounters together to compare insured to uninsured also did not reach statistical significance ($p = 0.18$).

3. Discussion

In this multicenter analysis of 34 children's burn centers, we found significant variation in the utilization of inpatient services for pediatric patients who suffered minor (<10% BSA) burns. This higher rate of inpatient utilization, not surprisingly, was associated with increased mean charges, and as a consequence, a small cohort of patients accounted for a disproportionate share of the total cost of care for this homogenous

Table4
Percent admission was calculated by division of the sum of inpatient and observation encounters by the total number of nonsevere burns treated at a center and multiplied by 100.

Institution type	Median percent admission	Mean percent admission	P-value
ospital utilization	- HH: 80	- HH: 78.6 ± 5.5	
	- LH: 1454	- LH: 8.2 ± 1.7	$p < 0.000001$
Children's hospital status	- FS: 11.6	- FS: 18.5 ± 5.9	
	- CC: 30.9	- CC: 41.3 ± 10.6	$p < 0.05$
	- VBC: 74.4	- VBC: 70.7 ± 12	
Burn center status	- SIBC: 14.9	- SIBC: 31.4 ± 15.8	$p = 0.09$
	- Neither: 8.25	- Neither: 18.6 ± 5.7	

population. Health systems that successfully managed these patients in the ED only did so at a mean charge of $1586, which is 6 times less than observation and 31 times fewer inpatient admissions. When extended LOS encounters greater than 4 days were excluded, the cost per day remained significantly different between outpatient management and both inpatient and observational management. These figures do not include the opportunity costs (travel costs, parental missed work, childcare for other children, etc.) incurred by a family for a child's potentially avoidable hospital admission which are hard to quantify. Given that healthcare management is transitioning from fee for service to bundled accountable care reimbursement, evaluation of appropriateness of burn admission is a potential area for driving improvement in the value equation [9,10]. Under a managed care model admission for less severe burns would result in minimal reimbursement and could potentially result in loss of revenue for hospitals. This study helps define areas of opportunity for not only improving cost-efficacy but also improving patient centered care by avoiding unnecessary hospitalization and treating the patient in their home.

Data analysis based on burn center status demonstrated no significant differences charges, readmission, or inpatient length of stay. A high median percent admission of Verified Burn Centers (VBC) was an interesting observation. While this was limited cohort of centers from the study, it could be explained by a number of factors, including those related to coding, distance traveled to the burn center, better processes to ensure social support is provided prior to discharge, and local practice variation. However, only a small number of the children's hospitals included in the PHIS database are VBCs, and therefore a representative comparison of verified burn centers was not possible, but also not the focus of this study. Conversely, the comparison between freestanding children's hospitals and combined pediatric and adult centers showed a significant difference between the two groups in percent of admissions. It is interesting that FS hospitals had a lower percent admission compared to CC. While this may reflect the inability of PHIS to capture specific circumstances related to patient encounters such as social needs and circumstances, it could also be a reflection of variations in ED resources available in FS hospitals versus combined children's and adult hospitals.

Increased percent admission correlated with increased charges, however these were both found to be inversely related to LOS. Specifically, we noted that high hospital utilizers patient LOS was significantly reduced compared to low hospital utilizer LOS. The finding of HH having a shorter LOS could make the argument that the institutions with increased admitting practices may have shorter LOS because many of these nonsevere burns do not actually require admission and are therefore discharged quickly. This is a pattern that has been reported in both a 2011 study by Vercruyyse etal [2] and a 2018 study by Anderson etal [7] that demonstrated high utilization of very short duration inpatient services for even low acuity burns despite efficacy of outpatient services for many of these burns. Other studies have observed differential LOS with respect to type of insurance. One study found that uninsured burn patients have increased hospital length of stay (LOS), increased charges, and increased mortality compared to insured patients [11]. However when uninsured burn patients were compared to patients with Medicare or Medicaid, uninsured patients with similar injury severity were found to have more complications and shorter LOS [12]. Conversely, our study found a significant difference between commercial and government insurance, with commercially insured patients having a significantly decreased stay. In addition, although there was an obvious difference between LOS of uninsured or self-pay patients versus government insured, it contrasted to other studies in that the LOS for self-pay patients was actually decreased. This could be because of health care providers' increased awareness of healthcare financial burden on uninsured patients.

Although we did not find any particular similarities between hospitals with high readmission rates, there were seven hospitals with readmission rates greater than 10%, and one with a hospital readmission rate of 35%. The rates of these institutions are much higher than reported averages of unexpected readmissions for burn patients [13,14]. One recent study assessed pediatric surgery procedures that involve high readmission rates as a means of improving care and costs [15]. It focused on care of nonsevere burns following ED discharge as a potential mode of cost-reduction. A more detailed investigation into the cause of high readmission rates was not possible within the confines of the accessible information gathered from the PHIS database.

3.1. Study limitations

This study has several limitations, the majority of which are inherent to the use of an administrative database. First, since PHIS is limited to in-hospital encounters, readmission rates of inpatient or observation patients could be evaluated while complication rates for the ED managed patients were not possible. Furthermore, the PHIS database is unable to distinguish between patients admitted at one hospital and then readmitted or transferred to another, and so any patients in these circumstances would not have been captured by the database. Second, it is also important to note that while the PHIS database is a large billing dataset that relies on accurate healthcare coding for fidelity [16], the accuracy of coding using the PHIS database undergoes robust analysis of data for validity and reliability [16,17]. Despite this, it is possible that more complex burns, such as full thickness or electrical burns, could be included in the T31.0 cohort if they were improperly coded. Third, as a retrospective review of a database our access to information is restricted to the data collected at the time. Finally, while cost would be a much better parameter to analyze than charge, given lack of transparency on actual hospital cost to the patient, the best surrogate to cost we have available for comparison is charge. However, despite these limitations the differential charges as well as identification of interhospital variability in management were extremely compelling.

4. Conclusions

Several interventions can be utilized to help optimize ED initiated outpatient management of these burns. First, the availability of pediatric sedation services 24/7 in the emergency department is necessary to adequately control anxiety and pain surrounding initial debridement. Employment of a readily available or accessible burn nurse to help guide ED management has been well implemented within our institution facilitating higher quality outpatient management as well as providing continuity of care.

Parental education and guidance with dressing changes help facilitate home compliance with the treatment plan and are necessary before discharge. While direct interaction with a burn clinician would be optimal, the use of telemedicine has been found to be effective in both parental education and wound assessment in patients receiving treatment for ED initiated outpatient burns [18] Telemedicine via mobile application allows for ease of follow up and regular clinician monitoring of wound healing progress. Telemedicine applications also help prevent unexpected returns to the emergency department by allowing for quick management changes or patient education without the need for appointments.

The US healthcare system is moving towards accountable care organizations with population-based reimbursement models and a focus on bundling of care. A need for focus cost-saving measures in healthcare is becoming more apparent. Based on our study, nonsevere pediatric burn treatment is an area that can greatly improve cost-efficacy for pediatric centers with medium to high-volume burn care.

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