

Predictors of Follow-up Compliance in Pediatric Burn Patients During the Time of COVID

Alejandro Chara, BS,* Erica Hodgman, MD,* Susan Ziegfeld, MSN, PNP-BC,* Carisa Parrish, MA, PhD,[†] Daniel Rhee, MD, MPH,* and Alejandro V. Garcia, MD*

The effect of the COVID-19 pandemic has led to increased isolation and potentially decreased access to healthcare. We therefore evaluated the effect of COVID-19 on rates of compliance with recommended post-injury follow-up. We hypothesized that this isolation may lead to detrimental effects on adherence to proper follow-up for children with burn injuries. We queried the registry at an ABA-verified Level 1 pediatric burn center for patients aged 0–18 years who were treated and released from March 30 to July 31, 2020. As a control, we included patients treated during the same time frame from 2016 to 2019. Patient and clinical factors were compared between the COVID and pre-COVID cohorts. Predictors of follow-up were compared using chi-squared and Kruskal-Wallis tests. Multivariable logistic regression was used to evaluate for predictors of compliance with follow-up. A total of 401 patients were seen and discharged from the pediatric ED for burns. Fifty-eight (14.5%) of these patients were seen during the pandemic. Burn characteristics and demographic patterns did not differ between the COVID and pre-COVID cohorts. Likewise, demographics did not differ between patients with follow-up and those without. The rate of compliance with 2-week follow-up was also not affected. Burn size, burn depth, and mechanism of injury all were associated with higher compliance to follow up. After adjusting for these variables, there was still no difference in the odds of appropriate follow-up. Despite concerns about decreased access to healthcare during COVID, follow-up rates for pediatric burn patients remained unchanged at our pediatric burn center.

With an incidence of approximately 490,000 cases per year, burn injuries are among the most prevalent injuries treated in the United States.¹ One fourth of these injuries occur in children aged 16 or younger.² In fact, they are the most prevalent injuries in the pediatric population, with the majority of cases affecting those below the age of five.³ These injuries can cause significant complications, including poor wound healing, hypertrophic scarring, contracture formation, infections, chronic pain, anxiety, depression, and death.^{4–8} More and more, however, many children with burns are being initially evaluated and treated in the Emergency Department (ED) without the need for admission. The success of this approach is dependent on close follow-up, which has been shown to improve both physical and emotional outcomes including depression and altered body image.^{9,10} In our institution, outpatient management begins with an initial follow-up visit within 1 to 2 weeks from the ED visit. Unfortunately, this patient population has shown nonoptimal follow-up rates. Factors such as age, insurance type, race/ethnicity, and acuity level often account for some of the low rates of compliance.^{7,11,12}

The COVID-19 pandemic has placed a higher burden on burn patients and healthcare providers in the outpatient setting. Recommendations to remain indoors has unintended consequences in the pediatric population. Children are more readily exposed to household cleaning chemicals, inhalants, firearms, or other sorts of potentially harmful environmental factors that can lead to burn injuries.¹³ Furthermore, the availability of care has been impacted by capacity restrictions in hospitals and outpatient centers as well as increased patient concern for virus transmission.^{14,15} Social isolation, limited access to or fear of public transportation, and socioeconomic impacts are added barriers patients must overcome in order to adhere to clinic appointments.¹⁶ In response to these changes, healthcare providers have introduced new avenues to continue providing care. For example, telemedicine has been incorporated in many outpatient clinics throughout the country. Its use has increased in recent years but there has been a drastic rise since the pandemic started.¹⁴

Even with new ways for patients to seek necessary care, data are limited on how COVID-19 has impacted the adherence of pediatric burn patients with their outpatient clinic visits. Therefore, this paper aims to investigate pediatric burn patient follow-up compliance in light of the current pandemic. This study will further analyze any differences in demographics and burn characteristics between pediatric burn patients before and during COVID. Lastly, overall predictors of patient compliance with follow-up will also be analyzed.

METHODS

Data Source and Study Population

This IRB-approved retrospective study queried patients from the burn registry at a level 1 pediatric burn center. This

From the *Division of Pediatric Surgery, Johns Hopkins University School of Medicine, Baltimore, Maryland, USA; [†]Division of Pediatric Medical Psychology, Johns Hopkins University School of Medicine, Baltimore, Maryland, USA.

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Address correspondence to Alejandro Chara, BS, Division of Pediatric Surgery, Johns Hopkins University School of Medicine, 1800 Orleans St. The Charlotte R. Bloomberg Children's Center Building, Suite 7310, Baltimore, MD 21287, USA. Email: achara1@jhmi.edu

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hospital is situated in an urban setting and serves a larger metropolitan area. Pediatric burn patients treated and discharged from this burn center were included in the study. Patients are entered into the registry if they present to the ED with burn injuries or if the burn team is consulted during their stay in the hospital. Any missing data from the registry was collected by accessing patient medical records via the hospital's electronic medical system. Once discharged, patients continue outpatient care in the hospital's pediatric burn center. Burn center providers include pediatric surgeons, child life specialists, psychologists, social workers, and physical therapists.

For this study, patients in the registry who were 18 years of age or younger and discharged from the ED were included. The state's stay-at-home order was implemented on March 30, 2020. Therefore, patients treated at the ED between March 30, 2020 and July 31, 2020 were included. This endpoint was chosen because it signified the height of the pandemic at the time the study was started. In order to compare pre-COVID to COVID follow-up compliance, patients seen during the same 4-month timeframe between 2016 and 2019 were also included. Children with other traumatic injuries and those who were admitted to the hospital were excluded from this study.

Demographics

Demographic information including age, gender, race, and ethnicity was collected for each patient in the registry. Race was stratified into American Indian/Alaskan Native, Asian, Black/African America, Caucasian, or other. Similarly, ethnicity was determined as Hispanic or non-Hispanic.

Burn Characteristics

Percent total body surface area, burn depth, location of injury, mechanism of injury, transfer status, and distance were evaluated for patients' pre-COVID and during COVID. Burn depth was classified as full thickness, partial thickness, or superficial based on the registry and physician notes. Location of burn injuries were categorized as indoor or outdoor burns based on the patient narrative and clinical notes. The different mechanisms of injury studied included chemical, contact, electrical, flame, friction, scalds, and sunburn. Transfer status was determined as directly from the site of injury or transferred from another medical facility. Lastly, median distance, in miles, between the site of injury and our hospital was calculated. Patient and burn characteristics were compared between the COVID and pre-COVID cohorts for all included patients and then for indoor burns only.

Predictors of Follow-up

After discharge, patients were instructed to schedule a follow-up visit at an outpatient clinic to assess their injuries or any complications. At this institution, all pediatric burn patients seen at the ED are asked to follow up with an outpatient clinic 1 to 2 weeks after injury. Therefore, follow-up compliance was defined as return to burn clinic within 2 weeks of injury. Rates of follow-up compliance during COVID were compared to the pre-COVID cohort. Follow-up over 2 weeks as well as within any time period were determined.

Additionally, predictors of overall follow-up compliance were assessed. This was analyzed by combining both COVID and pre-COVID cohorts and determining the factors affecting follow-up in all patients. All variables for demographics and burn characteristics discussed above were analyzed for overall compliance rates. The adjusted odds ratio was calculated to determine any differences in compliance between patients during COVID and those pre-COVID.

Statistical Analysis

Patient and clinical factors were compared between the COVID and pre-COVID cohorts as well as the follow-up compliance and noncompliance cohorts. Statistical analysis was completed using R version 4.0.2 (R core team, 2020), including the "gmodels" package by Warnes et al. Interquartile range (IQR), percentage calculations, and median were determined where appropriate. Predictors of follow-up were compared using chi-squared and Kruskal-Wallis tests. The significance level was set at a *P* value of less than .05. Multivariable logistic regression was used to calculate adjusted odds of compliance with follow-up within 2 weeks of index presentation.

RESULTS

Study Cohorts

A total of 401 pediatric patients with burn injuries were evaluated and discharged from the ED during the study period. Of these, 343 (84.5%) patient ED visits occurred in the 4 years prior to the pandemic, while 58 (15.5%) occurred during the COVID-19 period. Demographic patterns did not differ between the COVID and pre-COVID cohorts (Table 1). The median age at presentation was 3.5 years (IQR 1.73–8.6) in the pre-COVID cohort and 4.2 years (IQR 1.7–8.7) in the COVID cohort. Males accounted for 54.5% of patients pre-COVID and 55.2% of patients during COVID.

The largest proportion of patients in both cohorts were African American (49.6% pre-COVID and 43.1% COVID). Caucasians accounted for 37.6% of the patients pre-COVID and 36.2% during COVID (*P* = .33). Likewise, ethnicity did not seem to differ, with 6.7% of patients identifying as Hispanic in the pre-COVID cohort and 8.6% in the COVID cohort.

Burn Characteristics

This study found no difference in extent, type, location, or mechanism of burn injuries between the COVID and pre-COVID patients. Median total body surface area burned was 1.0% (IQR 0.5–2.0) pre-COVID and 1.1% (IQR 0.5–2.0) during COVID (Table 1). The most prevalent type of burns in both groups were partial thickness burns (90.0% and 94.8%, pre-COVID and COVID), followed by superficial burns (7.1% and 3.5%). Four patients (1.17%) were assessed for full-thickness burns before the pandemic started while none were treated for full-thickness burns during COVID. Indoor burns accounted for 81.3% of burns pre-COVID and 74.1% during COVID. Additionally, burn characteristics of indoor burns remained unchanged (Table 2).

Table 1. Demographics by COVID quarantine status

	Pre-COVID	COVID	P
<i>n</i> = 401	343 (85.5%)	58 (14.5%)	
Age (median, IQR)	3.5 [1.7–8.6]	4.2 [1.6–8.7]	.75
Male Gender <i>n</i> (%)	187 (54.5%)	32 (55.1%)	.92
Race			.33
American Indian/ Alaskan Native	1 (0.2%)	0 (0%)	
Asian	8 (2.3%)	3 (5.2%)	
Black/African American	170 (49.6%)	25 (43.1%)	
Caucasian	129 (37.6%)	21 (36.2%)	
Other	29 (8.4%)	9 (15.5%)	
Ethnicity			.59
Hispanic	23 (6.7%)	5 (8.6%)	
Non-Hispanic	320 (93.3%)	53 (91.4%)	
Transfer or Direct Presentation			.11
Transfer	169 (49.3%)	22 (60.1%)	
Direct	174 (50.7%)	36 (37.9%)	
Distance from hos- pital (miles)	12.0 [5.0–24.0]	13.0 [5.0–25.0]	.97
TBSA (median, IQR)	1.0 [0.5–2.0]	1.1 [0.5–2.0]	.97
Burn Depth			.61
Full	4 (1.1%)	0 (0%)	
Partial	306 (90.0%)	55 (94.8%)	
Superficial	24 (7.1%)	2 (3.5%)	
Unknown	6 (1.8%)	1 (1.7%)	
Mechanism of Injury			.38
Chemical	3 (0.9%)	0 (0%)	
Contact	93 (27.1%)	12 (20.7%)	
Electrical	10 (2.9%)	0 (0%)	
Flame	23 (6.7%)	6 (10.3%)	
Friction	7 (2.0%)	0 (0%)	
Scald	194 (56.6%)	37 (63.8%)	
Sunburn	7 (2.0%)	3 (5.2%)	
Unknown	1 (0.3%)	0 (0%)	
Indoor burns	279 (81.3%)	43 (74.1%)	.38
Follow-up within 2 weeks	214 (62.4%)	32 (55.2%)	.29
Any follow-up	223 (65.0%)	34 (58.6%)	.34

TBSA, total body surface area.

Scalds accounted for the highest number of burns in both cohorts (56.6% and 63.8%, pre-COVID and COVID respectively). Contact burns (27.1% vs 20.7%, pre- and during, respectively) and burns caused by flames (6.7% and 10.3%) were also seen in both groups. In the pre-COVID group, 49.3% of patients were transferred from another medical facility to our ED. In the COVID group, the percentage increased to 60.1%, but this difference was not statistically significant. Distance from the trauma center was not different between groups. The median distance was 12.0 miles (IQR 5.0–24.0) in the pre-COVID cohort and 13.0 miles (5.0–25.0) in the COVID cohort.

Follow-up Compliance During COVID-19

COVID-19 did not have a significant effect on the compliance of patients to follow up after discharge (Table 1). The

Table 2. Demographics by COVID quarantine status (indoor burns only)

	Pre-COVID	COVID	P
<i>n</i> = 322	279 (86.6%)	43 (13.4%)	
Age (median, IQR)	3.1 [1.5–5.0]	3.1 [1.6–5.2]	.85
Male Gender <i>n</i> (%)	147 (52.7%)	21 (48.8%)	.63
Race			.21
American Indian/ Alaskan Native	1 (0.36%)	0 (0%)	
Asian	6 (2.1%)	3 (6.9%)	
Black/African American	157 (56.3%)	20 (46.5%)	
Caucasian	88 (56.3%)	13 (30.2%)	
Other	23 (8.2%)	7 (16.3%)	
Ethnicity			.3
Hispanic	15 (78.9%)	4 (21.1%)	
Non-Hispanic	264 (84.1%)	39 (12.9%)	
Transfer or Direct Presentation			.53
Transfer	131 (46.9%)	18 (41.9%)	
Direct	148 (53.1%)	25 (58.1%)	
Distance from Hos- pital (miles)	10.0 [5.0–23.0]	13.5 [6.25–25.0]	.39
TBSA (median, IQR)	1.0 [0.5–2.0]	1.5 [0.5–2.5]	.53
Burn Depth			.77
Full	3 (1.0%)	0 (0%)	
Partial	252 (91.3%)	41 (95.3%)	
Superficial	19 (6.9%)	2 (4.6%)	
Mechanism of Injury			.46
Chemical	3 (1.0%)	0 (0%)	
Contact	63 (22.6%)	6 (13.9%)	
Electrical	9 (3.2%)	0 (0%)	
Flame	7 (2.5%)	2 (4.6%)	
Friction	6 (2.1%)	0 (0%)	
Scald	186 (66.7%)	35 (81.4%)	
Sunburn	0	0	
Unknown	1 (0.3%)	0 (0%)	
Follow-up within 2 weeks	184 (65.9%)	25 (58.1%)	.32
Any follow-up	191 (68.5%)	27 (62.8%)	.46

TBSA, total body surface area.

percentage of patients who followed up 2 weeks after being discharged was 62.4% in the pre-COVID group and 55.2% in the COVID group ($P = .29$). The rate of overall follow-up at any time point was 65.0% pre-COVID and 58.6% during COVID ($P = .34$).

Predictors of Follow-up

Of the total 401 patients, less than two-thirds of patients (61.3%) were compliant with their outpatient appointment at 2 weeks. Patient characteristics did not differ between patients who followed up and those who did not. There was also no difference in the rate of indoor burns. However, the remaining burn characteristics did show significant differences between cohorts (Table 3).

Unsurprisingly, the biggest drivers of follow-up compliance were the characteristics of the injury. Median total body surface area of patients who followed up with their outpatient

Table 3. Predictors of follow-up compliance

	Follow-up	No follow-up	P
<i>n</i> = 401	246	155	
Age (median, IQR)	3.2 [1.7–8.0]	4.3 [1.7–10.1]	.14
Male Gender <i>n</i> (%)	140 (56.9%)	78 (50.9%)	.24
Race			.75
American Indian/Alaskan Native	1 (0.4%)	0 (0%)	
Asian	6 (2.4%)	5 (3.2%)	
Black/African American	116 (47.2%)	79 (50.9%)	
Caucasian	98 (39.8%)	52 (33.5%)	
Other	22 (8.9%)	16 (10.3%)	
Ethnicity			.92
Hispanic	17 (6.7%)	11 (39.3%)	
Non-Hispanic	230 (61.7%)	143 (38.3%)	
TBSA (median, IQR)	1.5 [0.7–2.5]	1.0 [0.5–1.5]	<.001
Burn Depth			<.001
Full	2 (0.8%)	2 (1.3%)	
Partial	237 (96.3%)	124 (81.6%)	
Superficial	3 (1.2%)	23 (15.1%)	
Mechanism of Injury			<.001
Chemical	0 (0%)	3 (1.9%)	
Contact	60 (24.4%)	45 (29.0%)	
Electrical	2 (0.8%)	8 (5.1%)	
Flame	15 (6.1%)	14 (9.0%)	
Friction	6 (2.4%)	1 (0.6%)	
Scald	160 (65.0%)	71 (45.8%)	
Sunburn	1 (0.4%)	9 (5.8%)	
Unknown	0 (0%)	1 (0.6%)	
Indoor burn	209 (84.6%)	113 (73.4%)	.013
Transfer or Direct Presentation			<.001
Transfer	137 (71.7%)	54 (28.3)	
Direct	109 (51.9%)	101 (48.1%)	

TBSA, total body surface area.

appointment was 1.5% (IQR 0.7–2.5) compared with 1.0% (IQR 0.5–1.5) in those who did not ($P < .001$). Burn depth was also predictive of follow-up compliance ($P < .001$). Patients with partial thickness burns were more likely to follow up (96.3% vs 81.6%, follow-up and no follow-up, respectively) while superficial burns were predictive of a lack of follow-up (1.2% vs 15.1%, follow-up and no follow-up, respectively). The mechanism of injury was also significantly different between these groups: scald burns were more likely to follow up than patients with other mechanisms (65.0% vs 45.8%, follow-up and no follow-up, respectively) while contact burns (24.4% vs 29.0%) and burns due to flames (6.1% vs 9.0%) were more indicative of no compliance to follow up. Additionally, patients transferred from another hospital were more likely to follow up. After adjusting for these variables, there was still no difference in the odds of appropriate follow-up during COVID (OR 0.6, 95% CI 0.3–1.1; $P = .12$) (Table 4).

DISCUSSION

Quarantine and social separation restrictions have placed added burden on both the healthcare system and patients'

Table 4. Adjusted odds of follow-up compliance (all burns)

	OR (95% CI)	P
TBSA	1.2 [0.1–3.2]	.038
Burn Depth (ref = Superficial)		
Full	1.8 [0.1–50.2]	.72
Partial	2.6 [0.4–16.0]	.32
Transfer (ref=Direct)	1.9 [1.2–3.1]	.005
During COVID	0.6 [0.3–1.1]	.12

TBSA, total body surface area.

families. Although crucial to limiting the spread of disease, these factors can pose obstacles for adequate follow-up compliance and adherence to treatment.¹⁷ For example, the state's Department of Transportation limited or suspended several bus services throughout the state, which is a common method of transportation for patients seen at our institution. Similar to transportation barriers, economic hardships and psychosocial implications of the stay-at-home order may have drastically affected patients' ability to attend outpatient clinic visits.¹⁶ This is especially important for burn patients, for whom compliance with outpatient follow-up and wound care is crucial to ensure an appropriate physical and emotional recovery. This analysis supports that, even though overall follow-up is low, the pandemic has not had a significant effect on pediatric burn patients' compliance to their outpatient appointments.

Our team worried that the stay-at-home order would decrease the likelihood that a family would seek care, particularly for smaller burns or those that appeared to be less severe. The results of this study showed the demographic characteristics of pediatric burn patients seen at our burn center have remained unchanged. This is reassuring as it suggests that families of all backgrounds are still bringing in their children for evaluation, regardless of wound size or etiology. It is possible, however, that the characteristics of patients who were admitted for social reasons (eg, inability to return for close follow-up and therefore admitted for observation and wound care teaching) did change between the pre-COVID and COVID groups. This change in practice pattern would be missed as we chose to focus only on those patients who were treated and released from the ED.

Interestingly, even with the public advice to stay indoors, the rate of indoor burns has not changed during the pandemic either. Furthermore, the characteristics and follow-up rate of indoor burns has also stayed constant. This is consistent with results from a study in Israel, where demographics and burn characteristics did not differ with the onset of the pandemic.¹⁸ Collectively, these data support the theory that even with the enhanced socioeconomic barriers brought forth by the pandemic, there is no difference in patient follow-up adherence. To our knowledge, this is the first study in the United States investigating the effect of the pandemic on outpatient follow-up compliance in this patient population.

Along with the stressors exacerbated by the pandemic, other factors are known contributors to suboptimal follow-up in the pediatric population at baseline. Lack of health insurance, low parental education, and low acuity illnesses decrease follow-up compliance in these patients.¹¹ Due to the psychological, medical, and esthetical implications of burn injuries,

these patients require close monitoring by a multidisciplinary team to ensure best outcomes.^{19,20} A key component to this is attendance of patients to burn clinics following treatment in the ED. However, there have been limited data on the overall outpatient compliance in pediatric burn patients. Therefore, this study also analyzed the overall predictors of follow-up compliance after these patients were discharged from the ED. Although all patients were instructed to follow up within 2 weeks after discharge, those with larger and/or deeper burns were significantly more likely to actually present to clinic. This is likely of negligible consequence for superficial burns, which heal well with minimal if any long-term sequelae. Likewise, mechanism of injury also predicted compliance, with patients suffering from scalds being more likely to follow up as opposed to those with other types of burns.

Overall, our hospital saw a 61.3% compliance rate in the population studied. This is within range of the follow-up rates described in previous studies.^{21–23} However, there is still a large group of patients who do not adhere to the instructed outpatient follow-up regimen. On top of the baseline suboptimal follow-up, a year like 2020 brings new challenges in the efforts to increase outpatient compliance. Healthcare systems must balance providing appropriate care while simultaneously helping to minimize virus transmission.²⁴ Approaches to mitigate these challenges have been implemented around the country, with telemedicine being one of the major strategies adopted by burn centers.²⁴ Telecommunication has been shown to be an effective method for providing care in several medical specialties, including the treatment of burn patients.^{25,26} In these cases, patients with minor burns are taught proper wound care and dressing changes before discharge. They are also provided with instructional videos for physical therapy and a sufficient supply of wound care equipment.²⁴ It is essential for pediatric burn patients to continue care in the outpatient setting. Increased adoption of telemedicine follow-up appointments, particularly for smaller or less significant injuries may represent one avenue to improve our rates of follow up without placing undue burden on patient families. Future studies will be critical for the improvement in follow-up in this patient population, especially with the heightened barriers brought by the pandemic.

As with all single-center studies, our data are limited by geographical and institutional constraints. Further multi-center studies throughout different geographical regions are recommended to confirm the results shown here. Additionally, this study did not assess for differences in socioeconomic status (SES) in our sample population. Since low SES has been an indicator of increased burn incidence and severity,^{27–29} we hypothesize the pandemic might exacerbate these discrepancies. Lastly, the study period included four months during which time there may have been variability in follow-up attendance as quarantine fatigue sets in patients' families.

In conclusion, the COVID-19 pandemic has placed tremendous strains in all patients. Patients who require diligent outpatient monitoring are especially vulnerable to some of these stressors. Thankfully, the pandemic did not alter the demographics, burn characteristics, or follow-up compliance of pediatric burn patients. However, the overall

compliance in this patient population is suboptimal. Factors such as the extent, depth, and mechanism of injury affected the rate at which these patients adhered to their outpatient clinic at out institution. Strategies to mitigate the lack of follow-up should be implemented in order to improve the provision of care.

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