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The association of patient and burn characteristics with itching and pain severity

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ABSTRACT

Introduction: Itch after burn injury causes significant distress to patients and can hamper functional recovery. Itching can persist on a time scale ranging from several weeks to even years after injury. In this study, we sought to determine predictors of itching after burn injury.

Methods: We compared itch and pain severity among patients included in a burn registry at a level 1 trauma center. Both itch and pain severity was based on a 5-point scale. ANOVA, chi-squared, and multivariate analyses were performed to determine predictors of itch and pain severity.

Results: Of the 1159 patients enrolled in the registry, 58% were male and 42% female, with a median age (IQR) of 27 (8-47) years. Most patients were diagnosed with 2nd degree superficial (41%) or deep (43%) burns. Upper extremities were the most common location of burn injury (59%), followed by lower extremities (31%), trunk (22%), and face/neck (20%). More than half (53%) of enrolled patients reported itching, ranging from minimal (19%) to severe (7%) itching. Multivariate analyses revealed age, sex (female), extent of burn injuries, and location (face/neck) to be predictors of itch after burn. Predictors of pain after burn were slightly different: age, extent of burn, and depth of burn.

Conclusion: Pain and itch after burn injuries are predicted by slightly different variables, presumably secondary to different underlying mechanisms. We conclude that age, sex (female), extent of burn injuries (total body surface area %), and injuries to the face/neck predict itching of greater severity. Patients with burn injuries that match these parameters would require greater care and closer follow up to reduce itching after healing.

1. Introduction

Pruritus or itching occurs commonly during the healing phase after cutaneous trauma, causing significant distress and reduced quality of life [1,2]. Estimates of prevalence of itching among burn patients are as high as 80% during hospitalization [3] and 76-93% at discharge [4]. Itching can be caused by soluble mediators in inflammatory conditions, including histamines, leukotrienes, acetylcholine, and prostaglandins [5]. Four classes of itch have been proposed [6,7]: pruritogenic, neuropathic, neurogenic, and psychogenic. Irrespective of the underlying etiology, an itch causes a scratching response, that increases availability of inflammatory mediators, causing greater itch [8]. This self-perpetuating cycle can cause significant damage to the skin at the site

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of itching [1,8]. Patients with burns experience itching during the inflammatory phase after injury, which decreases in intensity through the remodeling phase over a few days to weeks [3,7]. However, patients report itching at burn sites several months to years after initial injury [3,4,9–11]. The mechanisms causing itch after burns are poorly understood and are believed to be due to multiple factors [2,12], similar to pain after burn-injuries [13].

Given the extent of patient discomfort due to pruritus that has been documented, it has been suggested that post-burn itch be included among the top treatment outcomes of burn management [14,15]. In case of non-traumatic causes of itch, several remedies exist [1], but post-burn pruritus requires greater scrutiny [5]. Previously published evidence suggests that chronic itching is associated with chronic pain, with potentially similar mechanisms [16–18]. Given the possibility of similar mechanisms between pain and itching, the objective of this study was to determine if variables that predict pain [19–21] also predict itch after burn injury.

2. Methods

2.1. Study design, setting, and population

Our medical center is a tertiary care, suburban, American College of Surgeons (ACS) designated level 1 trauma center with a regional burn center that admits approximately 175 burn patients per year. Our center has maintained a prospective, observational Burn Registry since 2009 with Institutional Review Board approval. Patients admitted to the burn center were included in the institutional burn registry. Written, informed consent was obtained from each patient or their legally authorized representatives prior to recording patient, burn, pain, and itch characteristics by a trained Burn Registrar. Pain and itch severity were recorded at the time of discharge from the hospital.

2.2. Measures and outcomes

Standardized data abstracted from medical records by a trained burn registrar included patient demographics (age and sex), and burn characteristics (etiology, size, location, and depth). Burn depths in the burn registry were recorded for 13 different body regions (head, face, neck, anterior trunk, posterior trunk, left arm, left hand, right arm, right hand, left leg, right leg, abdomen, genitalia). The data was aggregated into 4 groups: head/face/neck; trunk (anterior and posterior trunk, abdomen, genitalia); upper extremities (left and right arms, left and right hands); and lower extremities (right and left legs). Pain and itch scores were obtained at discharge from the burn unit. Both pain and itch were not recorded for each specific anatomic location. Patients were asked to rate the severity of itching on a 5-point ordinal scale: none, minimal, mild, moderate, and severe [22]. This scale was simple and easily understood both by patients and medical personnel. To make direct comparisons between pain and itch severity, patients rated pain on a similar 5-point ordinal scale: none, minimal, mild, moderate, and severe [23].

2.3. Data analysis

Data was downloaded into SPSS V23 for Windows (SPSS Inc., Chicago, IL) for all analyses. Continuous data are presented as means and standard deviations (SD) or medians and interquartile ranges (IQR) based on their distribution. Analysis of variance and chi-squared tests were carried out to determine significant differences. Univariate and multivariate analyses were performed to explore the association between potential predictor variables and pain/itch severity.

3. Results

3.1. General patient and burn characteristics

A total of 1159 patients were entered in the burn registry between 2009–2014. Of this population, 1056 (91%) reported scores for pain and itching. Burn characteristics of patients enrolled in the burn registry are outlined in Table 1. The study population was 58% male and 42% female, with 36% of the total being children. Median age of patients admitted to the registry was 27 years with an interquartile range of 8–47 years. Underlying etiology of burns were as follows: scalds (48%), flame (22%), contact (25%), and other (5%). Second-degree burns both superficial (41%) and deep (43%) were the most common diagnoses, followed by third- (12%) and first-degree (3%) burns. Upper extremities were the most common location of burn injuries (60%), followed by burns to the lower extremities, trunk and the face (Table 1).

Table 1 – Characteristics of patients in the burn registry (n = 1159).

Demographic information	
Male	58%
Female	42%
Children	36%
Median age (IQR)	27 (8–47) years
Reported both pain and itching severity	91%
Etiology of burns	
	Size of group (%)
Scalds	48
Contact	25
Flame	22
Other	5
Depth of burn	
	Size of group (%)
1st	3
2nd superficial	41
2nd deep	43
3rd	12
Location of burn	
	Size of group (%)
Upper extremity	59
Lower extremity	31
Trunk	22
Face/neck	20

3.2. *Itching and pain severity*

When asked to report itching severity, most patients reported no itching (47%). The remaining 53% of patients reported minimal (19%), mild (14%), moderate (13%), or severe itching (7%) (Fig. 1). Two groups of patients were devised based on reported pain and itching scores as 'None-mild' and 'Moderate-severe'. We compared the total body surface area (TBSA) of burns to levels of pain and levels of itching. The median (IQR) TBSA was higher in those with moderate/severe levels of pain than in those with none/mild pain (3 [1–6] vs 1.5 [0–4], respectively, $p<0.001$) as well as itching (3 [1.3–5] vs 2 [0–4], $p<0.001$). We also delineated the maximal burn depth at each anatomic region (Table 2). Of cases with reported burn depths for each location, 2nd degree burns (superficial and deep dermal) were most common across all four anatomic regions. First degree burns were least common on the trunk and extremities, and most common after 2nd degree burns to the head/face/neck. Third degree burns were more common across the upper and lower extremities than on the head/face/neck or the trunk.

We then compared the mean age of patients in each itching and pain score group (Fig. 2). Both itch and pain severity increased with increasing age. Within each group for both itch and pain severity, less than 50% were female. The exception was the group with the most severe itching. This group had a mean age of 35 years and was 59% female (Fig. 2C,D). Significant differences were noted between groups in the mean age category for both pain ($p<0.001$) and itch severity ($p<0.001$). While there were no significant effects between pain score groups for gender ($p=0.71$), a significant difference was noted in the itch score groups for gender ($p=0.01$, Fig. 2D). Multivariate analyses revealed an effect of age and burn total body surface area (TBSA) on pain scores (Table 3). Multivariate analyses revealed effects of advancing age, gender, extent of burn-injury, and location on itching severity (Table 4). We also catalogued reported comorbidities in the registry: pulmonary disease, COPD, asthma, interstitial lung disease, cardiac disease, endocrine, diabetes, hypertension, wound healing, chronic wounds, keloids, hypertrophic scar, other renal disease, GI disease, liver disease, CHS, GU, hematologic, neurologic, seizure, psychiatric, musculoskeletal, smoking, and other. Of these, only hypertension was associated with increasing itch severity (Table 5). However, this association was not due to treatment with Angiotensin-converting Enzyme (ACE) inhibitors [24] as there were only 10 patients (<1% of total) who were treated with ACE-inhibitors when itch severity was recorded, excluding statistical analyses. Medications given pre-injury/pre-hospital, in the ED, in the in-patient ward, and at discharge were catalogued. Unsurprisingly, while a majority of patients were treated with analgesics in the ED (51.8%) or prescribed at discharge (37.5%), only 8 patients (0.8%) were recorded as treated with anti-histamines.

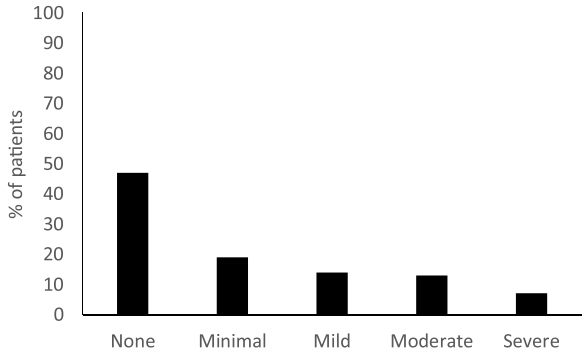

Fig. 1 – Severity of itching in patient population. Patients were asked to rate severity of itching at discharge from the burn unit on a 5-point scale. Most patients reported no itching (47%), with similar distribution across other severity groups.

4. Discussion

Itching after burn injuries has been reported to impact quality of life. In this pilot study our goal was to determine the predictors of itching after burn injuries. Using patients enrolled in a burn registry, we determined that older patients experience greater pain and itching severity, with significantly higher percentages of older women affected by itching. Multivariate analyses revealed greater pain with advancing age, and no effects of gender or depth of burn on pain severity, as has been reported elsewhere. However, itch severity did increase with advancing age and among women. Surface area of burns was a strong determinant of itch severity, as was burns on the head/face/neck. In contrast to previous studies [11,25], we report a lower proportion of patients with any itching (53%), suggesting that the prevalence of itching can vary. Willebrand et al. [11] report a higher proportion of patients with itching (60%) that is sustained over a long period, with a reduction in severity over time. Previous studies suggest a high prevalence of post-burn pruritus in children [26] and adults [4]. However, it is possible that the high incidence of post-burn pruritus in the elderly that we observed is partially attributable to the high prevalence of general pruritus in the geriatric population [27,28], itself likely due to general decline of skin function [27]. Additionally, our suburban medical center saw a greater proportion of adults (64%) compared to children (36%).

Table 2 – Number of cases with maximum burn depth by body region.

Burn depth	Head/face/neck	Trunk	Upper extremity	Lower extremity
First	19	7	12	3
Superficial second	65	59	166	84
Deep second	44	74	184	122
Third	11	21	52	44

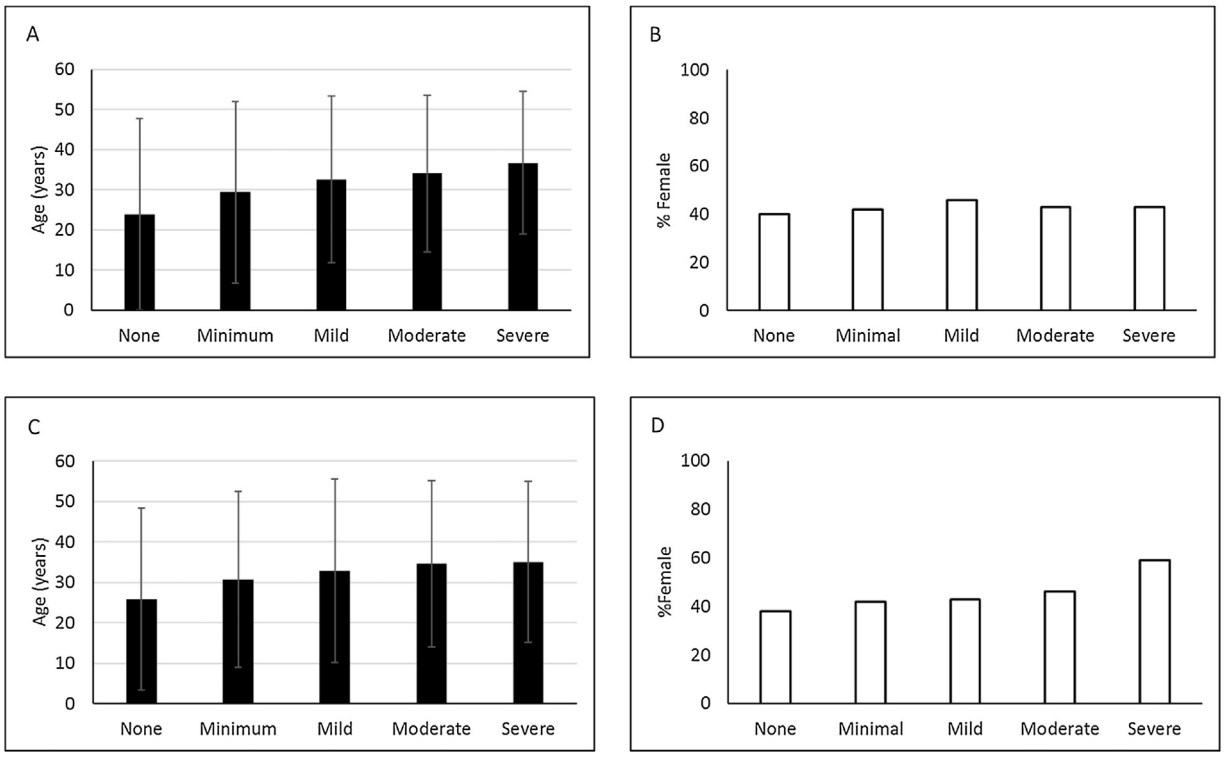

Fig. 2 – Age and gender characteristics of patient population. (A) Mean age of patients in each pain severity group showed significant differences ($p < 0.01$). Mean age was higher for patients reporting severe pain compared to those reporting none to minimal pain. (B) The proportion of females in each pain severity group showed no significant differences. Even with advancing age and pain severity, the proportion of females in each group remained unchanged. (C) Mean age of patients in each itch severity group showed significant differences ($p < 0.01$). Itching severity increased with advancing age. (D) The proportion of females in each itch severity group showed significant differences ($p = 0.01$). Data: mean ± standard deviation, n = 1056.

Compared to other itch scales used for pruritus due to multiple causes, the 5-point scale used here was validated for post-burn pruritus [22]. In a retrospective study, Casaer et al. studied pruritus in patients with small burns (TBSA < 2%) [29]. Some of our results agree with theirs. We report 53% of patients experiencing pruritus after burns, with median TBSA (IQR) for patients experiencing severe pruritus at 3% (1–5), similar to the 2% reported by Casaer et al. Patients with more extensive burns (20% TBSA and above), also reported severe itching [11,25]. Interestingly, Vitale et al. report no itching among patients with facial burns, contrary to our results. We studied a much larger sample size (n = 1056) spread across various age groups (Fig. 2A,C) compared to Vitale et al [25]. However, Vitale et al. did not delineate the depth of injury at various locations on the body and their influence on itching. We have previously demonstrated that depth of injury can influence pain [19], contrary to the belief that deeper burns do not cause pain due to a loss of sensation [30,31]. In our multivariate analyses, depth of injury does not influence pain or itching, while the extent of burns increases incidence of itching. While there is a relationship between pain and itch mediated by similar central and peripheral neurons, there are differences in the excitatory and inhibitory setting associated with these two phenomena in the central and peripheral nervous systems [12]. Multivariate analyses revealed age and TBSA but

Table 3 – Multivariate predictors of pain.

Factor	Odds ratio	95% CI
Age (per year)	1.010	1.003–1.017
TBSA (per percentage point)	1.056	1.028–1.085
Burn depth		
1st	0.31	0.09–1.12
2nd superficial	0.56	0.35–0.88
2nd deep	0.92	0.60–1.42
3rd	Reference	–

Table 4 – Multivariate predictors of itching.

Factor	Odds ratio	95% CI
Age (per year)	1.012	1.004–1.019
TBSA (per percentage point)	1.048	1.020–1.076
Female	1.52	1.09–2.12
Head/face/neck	1.56	1.04–2.33
Etiology		
Contact	Reference	–
Flame	0.82	0.47–1.44
Scald	1.44	0.92–2.24
All other	2.08	1.13–3.81

Table 5 – Comorbidity of hypertension and itching severity.

Itching	Proportion of patients with hypertension
None	1.6% (8/494)
Minimal	0.5% (1/204)
Mild	3.4% (5/147)
Moderate	3.7% (5/135)
Severe	6.6% (5/76)

$p=0.015$.

not depth as predictors of pain, consistent with previous results [19,21]. Finally, the clinical significance of the association between history of hypertension and itch severity is unclear. In particular, we are unaware of any plausible mechanistic explanation for this association.

In addition to perturbations in the inflammatory pathways, psychosocial factors are important in non-trauma related pruritus [32]. However, pruritus has relatively recently been recognized as an important determinant of post-burn and post-recovery quality-of-life [2]. In this pilot study, we analyzed predictors of post-burn pruritus. Future observational studies will focus on patients' psychosocial state and contribution to itching sensation. Given the heterogeneity in patients' sensitivity to itch [33], a larger study is required.

5. Limitations

The first limitation of this study was the single setting at a suburban hospital. Larger studies with geographic and demographic diversity could better inform predictors of itching. Second, we did not account for additional confounding variables in the patient population such as psychosocial factors and concomitant therapies. Third, we did not investigate if the itch or pain scales were clearly understood by the patients and if they could clearly distinguish between pain and itching. Finally, we did not perform long-term follow-up on most patients. Thus, we did not measure changes in itching over time after the initial admission to the burn unit.

6. Conclusions

In an observational study of 1056 burn patients in the burn unit of a suburban, tertiary care hospital, we demonstrate that itching severity is associated with increasing age, female gender, burn size, and burn location. These predictors have important clinical applicability. Female patients, older patients, burn patients with large burns, and those with burns located on the head/face/neck are associated with greater itch severity and may need greater attention early in the recovery process. These interventions could address both pathologic [5] and psychological [34,35] factors.

Conflict of interest statement

The authors declare no conflicts of interest in the study.

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