Published in final edited form as:

J Am Coll Surg. 2017 October ; 225(4): 516–524. doi:10.1016/j.jamcollsurg.2017.06.004.

Association Between Burn Injury and Mental Illness among Burn Survivors: A Population-Based, Self-Matched, Longitudinal Cohort Study

Stephanie A Mason, MD, Avery B Nathens, MD, PhD, FACS, James P Byrne, MD, Janet Ellis, MD, Robert A Fowler, MD, MSc, Alejandro Gonzalez, MSc, Paul J Karanicolas, MD, PhD, FACS, Rahim Moineddin, PhD, Marc G Jeschke, MD, PhD, FACS

Sunnybrook Research Institute (Mason, Nathens, Byrne, Fowler, Karanicolas, Jeschke), Division of General Surgery, Department of General Surgery (Mason, Nathens, Byrne, Karanicolas), Institute of Health Policy, Management, and Evaluation (Mason, Nathens, Byrne, Fowler, Karanicolas), Interdepartmental Division of Critical Care (Fowler), Department of Family and Community Medicine (Moineddin), Institute of Medical Sciences (Jeschke), Department of Psychiatry (Ellis), Ross Tilley Burn Centre (Jeschke), University of Toronto, Institute for Clinical Evaluative Sciences (Gonzalez, Moineddin), Toronto, Canada.

Abstract

BACKGROUND: Mental health disorders are prevalent before and after burn injury. However, the impact of burn injury on risk of subsequent mental health disorders is unknown.

STUDY DESIGN: We conducted a population-based, self-matched longitudinal cohort study using administrative data in Ontario, Canada between 2003 and 2011. All adults who survived to discharge after major burn injury were included, and all mental health-related emergency department visits were identified. Rate ratios (RRs) for mental health visits in the 3 years after burn, compared with the 3 years before, were estimated using negative binomial generalized estimating equations.

RESULTS: Among 1,530 patients with major burn injury, mental health visits were common both before (141 per 1,000 person years) and after (154 per 1,000 person years) injury. Mental health

Correspondence address: Stephanie A Mason, MD, Sunnybrook Research Institute, D704-2075 Bayview Ave, Toronto, Ontario M4N 3M5, Canada. stephanie.mason@mail.utoronto.ca.

Author Contributions

Study conception and design: Mason, Nathens, Fowler, Karanicolas, Jeschke

Acquisition of data: Mason, Nathens, Gonzalez

Analysis and interpretation of data: Mason, Nathens, Byrne, Ellis, Fowler, Gonzalez, Karanicolas, Moineddin, Jeschke

Drafting of manuscript: Mason, Nathens, Ellis

Critical revision: Byrne, Fowler, Gonzalez, Karanicolas, Moineddin, Jeschke

CME questions for this article available at <http://jacscme.facs.org>

Disclosure Information: Authors have nothing to disclose. Timothy J Eberlein, Editor-in-Chief, has nothing to disclose.

Publisher's Disclaimer: Disclaimer: The opinions, results, and conclusions reported in this paper are those of the authors and are independent from the funding sources. No endorsement by the Institute for Clinical Evaluative Sciences or the Ontario Ministry of Health and Long-Term Care is intended or should be inferred. Parts of this material are based on data and information compiled and provided by the Canadian Institute for Health Information (CIHI). However, the analyses, conclusions, opinions, and statements expressed herein are those of the author, and not necessarily those of CIHI.

Awarded first prize in clinical research at the American College of Surgeons Region 12 Resident Trauma Paper Competition and the American College of Surgeons Committee on Trauma Resident Trauma Paper Competition, Washington, DC, March 2017.

visits were most common in the 12 weeks immediately preceding injury. No significant difference in the overall visit rate was observed after burn (RR 0.97; 95% CI 0.78 to 1.20), although among patients with less than 1 pre-injury visit, mental health visits tripled (RR 3.72; 95% CI 2.70 to 5.14). Self-harm emergencies increased 2-fold (RR 1.95; 95% CI 1.15 to 3.33).

CONCLUSIONS: Mental health emergencies are prevalent among burn-injured patients. Although the overall rate of mental health visits is not increased after burn, the rate increases significantly among patients with one or fewer visits pre-injury. Self-harm risk increases significantly after burn injury, underscoring the need for screening and targeted interventions after discharge. An increased rate immediately before burn suggests an opportunity for injury prevention through mental healthcare.

Burn injury is a devastating event, exposing survivors to extreme stressors that can have substantial physiological, aesthetic, and psychological consequences. After discharge, recovery can be limited by several factors, including new functional limitations, visible scarring or deformity, chronic pain, and traumatic stress related to the initial injury.¹⁻⁴ Taken together, these stressors might have a detrimental impact on the mental health of burn survivors.

Many studies have attempted to describe the burden of mental illness in burn survivors, suggesting that mood- and anxiety-related disorders are prevalent,^{5,6} and that up to one-third of patients suffer from post-traumatic stress disorder.⁷ Unfortunately, the interpretation of these studies is limited by small sample sizes, short follow-up intervals, and high rates of loss to follow-up. More importantly, existing studies were unable to explicitly account for pre-burn mental illness; many did not collect any pre-injury data, or relied on potentially biased self-reporting of earlier psychiatric morbidity.

The objective of this study was to determine whether the rate of mental health visits increases after burn injury, and to identify risk factors for post-burn mental health disorders. To overcome the limitations of earlier studies, we used a population-based approach that facilitates capture of a large cohort of burn-injured individuals and their pre-injury mental healthcare use. These data are critical to identify opportunities for prevention through screening, and to inform the design and implementation of new initiatives to mitigate the long-term impact of burn injury on the mental health of burn survivors.

METHODS

Study design

After obtaining Research Ethics Board approval, we conducted a population-based, self-matched longitudinal cohort study in Ontario, Canada, using information from several linked administrative databases. We used an exposure crossover design, such that each patient acted as their own control⁸; this approach minimizes confounding due to personality, genetics, socioeconomic status, and other stable characteristics that can be difficult to measure.

Data sources

Data were derived from the following sources: Discharge Abstract Database, which captures demographic, diagnostic, procedural, and discharge information on all acute care hospitalizations in the province of Ontario; Registered Persons Database, comprising vital statistics for all residents of the province of Ontario who are alive and eligible for coverage under the Ontario Health Insurance Plan; National Ambulatory Care Reporting System, which captures demographic, diagnostic, and discharge information for all emergency department visits in Ontario; and Ontario Mental Health Reporting System, which records demographic, diagnostic, and discharge information for all individuals receiving mental health services in Ontario; up to 3 diagnoses per visit are recorded, according to the *Diagnostic and Statistical Manual of Mental Disorders*, 5th edition.⁹ These datasets were linked using unique encoded identifiers and analyzed at the Institute for Clinical Evaluative Sciences. Similar to other Canadian provinces, the Ontario government administers a single-payer system that universally funds all hospital, laboratory, and physician services for eligible residents; therefore, these data sources include records for virtually all residents in the province. The diagnoses codes for burn injury in these datasets have been validated previously.¹⁰

Study patients

The study population included all patients aged 16 years and older who were admitted to hospital for treatment of major burn injury between April 1, 2003 and March 31, 2011 in Ontario, Canada. To ensure complete follow-up, only patients who remained alive and eligible for health coverage for 3 years after their discharge were included. Similarly, to ensure the identification of all pre-injury visits, only patients eligible for health coverage during the 3 years before the burn admission were included. Individuals lacking a valid Ontario health card or those who sustained concurrent major trauma with their burn were excluded. Major burn injury was defined as any burn injury resulting in 10% total body surface area (TBSA) burn; full-thickness burns to the face, feet, hands, or perineum; or any TBSA burn with inhalation injury. These criteria were chosen because they represent injuries that are severe enough to warrant referral to a burn center, and might be most associated with subsequent mental health events.¹¹

Outcomes

The primary end point was the composite rate of mental health visits (related to mood disorder, anxiety, self-harm, substance abuse, and schizophrenia) in the 3 years after burn injury compared with the 3 years before injury. All emergency department (National Ambulatory Care Reporting System) or mental health (Ontario Mental Health Reporting System) visits with an ICD-10 or *Diagnostic and Statistical Manual of Mental Disorders*, 5th edition⁹ main diagnosis code designating these disorders, or those with an ICD-10 external cause of injury code designating intentional self-harm (range X61 to X84), were identified. Secondary outcomes included individual rates of visits for mood disorders (ICD-10 diagnosis codes F30 to F39), anxiety (F40 to F42, F44 to F48), schizophrenia (F20 to F29), substance abuse (F10 to F19), and self-harm (X61 to X84). A self-harm visit includes both a

diagnosis code for the resulting injury (eg laceration) and an external cause of injury code to indicate that the injury was intentional.

Covariates

Patient-specific variables included age, sex, comorbidity, socioeconomic status, and urban/rural residence. Comorbidity burden was estimated using the Johns Hopkins Adjusted Clinical Groups case-mix system,¹² which assigns patients to 1 of 6 morbidity categories based on earlier healthcare use. To simplify the analysis, we collapsed categories 0 and 1, representing nonusers and healthy users, into a single category. Income quintiles based on the median neighborhood income of each patient's postal code were used as a marker of socioeconomic status. Patient residence was classified as urban or rural on the basis of the Rurality Index of Ontario,¹³ which takes into account the population density of the city/town of the patient's residence, as well as the distance to the nearest basic and advanced referral center. A Rurality Index of Ontario ≥ 45 is considered rural.¹³ Injury-specific variables were derived from diagnoses codes in the Discharge Abstract Database and included %TBSA, presence of inhalation injury, and burn mechanism.

Statistical analysis

Descriptive statistics were calculated for the entire study population. The patient and injury characteristics of patients with pre-injury visits were compared with those with post-injury visits using Student's *t*-test for normally distributed continuous variables, the Wilcoxon ranksum test for non-normally distributed continuous variables, and the chi-square test for categorical variables. Rates of mental health visits per 1,000 person years were estimated for each of the pre- and post-injury periods. Time intervals were divided into segments of 13 weeks to describe the distribution of visits over time. We used negative binomial generalized estimating equations to compute rate ratios of mental health visits for the post-injury period compared with the pre-injury period, accounting for the paired nature of the observations. Negative binomial models were used because there was significant overdispersion in the outcomes counts. Incident rate ratios for relevant patient (age, sex, socioeconomic status, and comorbidity) and injury (burn size, presence of inhalation injury, and burn mechanism) subgroups were estimated.

We postulated that the severity of pre-injury mental illness, as represented by the rate of emergent healthcare use, might modify the effect of burn injury on the rate of post-injury mental health visits. Therefore, we performed a second analysis, stratifying on the pre-injury emergent mental healthcare use. Patients with 1 or fewer visits in the 3 years before injury were considered low utilizers, and patients with 2 or more visits were considered high utilizers.

In all analyses, a 1-sided *p* value < 0.05 was considered significant. All statistical analyses were performed using SAS, version 9.4 (SAS Institute). To comply with the privacy regulations of the Institute for Clinical Evaluative Sciences, all counts less than 6 have been suppressed in the tables; where a count is less than 6, a percentage range is presented rather than the frequency to minimize re-identification risk.

RESULTS

We identified 1,530 patients eligible for inclusion in the study. Baseline characteristics of the cohort are presented in Table 1. Mean age was 44 years and most were male, urban dwelling, and from lower-income quintiles. Median %TBSA burned was 15% (interquartile range 5% to 25%), 52% of injuries were flame burns, 8% involved inhalation injuries, and 3% (n = 43) were acts of deliberate self-harm.

There were a total of 1,358 mental health visits before (n = 644) and after (n = 714) burn injury. The proportion of patients with a mental health visit increased from 10% (n = 153) to 12% (n = 184) after injury ($p < 0.001$). The incident rate of mental health visits pre-burn was 141 per 1,000 patient years, compared with 154 per 1,000 patient years post-injury (incidence rate ratio 1.09; 95% CI 0.87 to 1.37).

The rates of specific mental health visits are presented in Table 2. Substance abuse-related visits were most common, both before and after injury. No significant difference in the rate of substance abuse visits was observed after burn injury. No significant differences were observed in the overall rate of visits after burn, or in visits with a principal diagnosis of mood disorders, anxiety, or schizophrenia.

The majority of patients (94%) had 1 or fewer visits in the 3 years before burn injury; 89 patients (6%) had 2 or more visits before injury. Significant differences in the rate of mental health visits after burn injury were identified between these 2 groups of patients (Table 3). Among low utilizers, there was a greater than 3-fold increase in the rate of mental health visits after burn injury; significant increases in the individual rates of anxiety, mood disorder, substance abuse, self-harm, and schizophrenia visits were also observed. In comparison, among high utilizers, the rate of mental health visits decreased after burn injury, as did individual rates of mood disorder and substance abuse. The rates of schizophrenia, anxiety, and self-harm among high utilizers were similar before and after injury.

There was almost twice the rate of self-harm emergencies after burn injury, a significant increase that was evident across virtually all patient and burn injury subgroups (Table 4). Among pre-injury low utilizers, self-harm emergencies increased 4-fold (Table 3). The association between burn injury and self-harm events was strongest among females, individuals from higher income quintiles, and those with a high level of pre-injury comorbidity (Table 4).

The greatest number of visits overall was observed in the 12 weeks immediately preceding the burn injury (Fig. 1A); the number of visits was relatively constant during the first 2 years of the pre-injury period, and then increased steadily throughout the year before the burn. After the burn injury, the number of visits remained consistent throughout follow-up. Similarly, the number of self-harm events increased throughout the year before the burn, and peaked in the 12 weeks immediately preceding the burn injury (Fig. 1B). In contrast, after burn injury, self-harm events occurred consistently throughout follow-up.

Incident rate ratios did not differ significantly among any patient or injury subgroups, with the exception of the previously mentioned differences based on pre-injury use.

DISCUSSION

In this population-based, self-matched, longitudinal cohort study, we demonstrated a high frequency of mental illness-related emergent healthcare use both before and after burn injury. Healthcare visits for substance abuse are most common, followed by visits related to mood and anxiety disorders. Although the overall rate of mental health visits did not increase significantly after burn injury, the rate of self-harm emergencies almost doubled, and rates of emergency visits related to anxiety increased by 63%, perhaps related to traumatic stress. In addition, among pre-injury low utilizers, the overall rate of mental health visits more than tripled after burn injury; similar significant increases were observed for visits related to substance abuse, mood disorders, schizophrenia, self-harm, and anxiety.

Our findings are consistent with the results of earlier studies demonstrating a high prevalence of both pre-and post-injury mental illness among burn patients,^{5-7,14-18} with rates that are higher than the general population.^{5,14} The rate of mental health-related emergency visits among burn survivors is approximately 7-fold higher than the general population. The average rate in the general population is 16 to 23 per 1,000¹⁹⁻²¹ compared with 154 per 1,000 after burn injury. Similarly, self-harm emergencies occur after burn injury at a rate that is several-fold higher than the Canadian national rate, estimated at 1.2 per 1,000.²²

We did not observe an increase in the overall rate of emergent mental health visits compared with the pre-injury rate. Few studies have directly compared the rates of mental health disorders after burn injury with pre-injury rates. However, our results are consistent with previous work that found no significant increase in mental health visits in the 2 years after burn injury compared with 2 years before.¹⁴ In contrast, among pre-injury low utilizers, we observed significantly increased rates overall and for visits related to mood and anxiety disorders, self-harm, schizophrenia, and substance abuse visits after injury. To the best of our knowledge, ours is the first study to report self-harm rates after burn injury.

We observed the greatest number of mental health emergencies in the 3-month period immediately preceding the burn; this is similar to the finding of Palmu and colleagues¹⁶ that 40% of patients had received an Axis I diagnosis in the month preceding their injury. Mental illness is an independent risk factor for unintentional injury and injury recidivism.²³ That these patients have been engaged with the healthcare system in the months before their burn suggests that an opportunity for intervention exists. Taken together, these data suggest that the treatment of mental illness might be an important target for burn prevention efforts. The high rate of mental health visits in the 3 months immediately before burn injury also has implications for inpatient burn management. Patients with premorbid mental illness are more likely to experience delirium, have poor coping, and experience delayed wound healing.²⁴⁻²⁶ These patients are also more likely to have dysfunctional adaptation to their injury, resulting in poor adherence to care plans and negative impacts on physical recovery.^{24,27} Perhaps reflecting these care challenges, multiple studies have demonstrated increased length of stay among those with premorbid mental illness,^{24,26,27} and injured patients with mental illness are less likely to be discharged home.²³

After discharge, we found that the rate of self-harm events approximately doubles, with the largest increase in self-harm observed among patients with minimal pre-burn emergent mental healthcare use. Consistent with other cohorts, self-harm rates in our study were higher among females and those with a high comorbidity burden.²⁸ Risk factors for self-harm in our study that have not been described previously include middle age (45 to 64 years), residence in an urban setting, and higher socioeconomic status. Patients with flame burns and those with smaller burns (<20% TBSA) also had higher rates of self-harm.

The key strength of our study is its design; the exposure-crossover method facilitates comparisons of pre-and post-burn mental health rates within individuals. This approach minimizes confounding due to personality, genetics, socioeconomic status, and other stable characteristics that can be difficult to measure.⁸ In addition, use of administrative data facilitated capture of a large cohort of burn-injured individuals with complete longitudinal follow-up over time. Using administrative data to identify pre-injury mental health visits also mitigates any recall bias that might be associated with patient self-reporting of earlier mental health problems.

Although administrative data offer many advantages, they also limit our ability to assess the severity of mental health conditions or to understand what treatment might have been undertaken. We have not included outpatient mental health visits in our analysis, and our study includes only those patients who sought or were able to access treatment in an emergency setting. We are also unable to characterize the association of injury characteristics beyond burn size and mechanism, as these are not well coded in the datasets used; for example, we cannot identify whether particular burn sites, such as the face or hands, are associated with mental health visits after injury. In addition, although we included all patients sustaining major burn injury during 2003 to 2011, the number of patients who experienced self-harm events both before and after burn injury was relatively low. Although we were able to generate a robust estimate of the overall rate ratio for self-harm after burn injury, the number of patients in some subgroups is relatively small. As a result, our ability to identify the patient or injury factors most strongly associated with self-harm is limited. Finally, although post-traumatic stress disorder has recently emerged as a topic of great interest, its identification in administrative data is challenging; post-traumatic stress disorder is associated with a number of symptom patterns, and emergent visits might be attributed to other mental health disorders, such as substance abuse, depression, or anxiety.²⁹ As a result, we were not able to specifically report rates of post-traumatic stress disorder.

There are other limitations of our study that are not specific to the use of administrative data. Although we observed increased schizophrenia rates among pre-injury low utilizers, it is unlikely that burn injury is associated with the onset of schizophrenia. It is more likely that these patients have received a diagnosis as a result of their burn injury and prolonged contact with healthcare providers during their hospitalization. Another limitation is misclassification of injury events; many self-harm visits might not be disclosed as intentional by the patient, or might not be recognized by the physician as self-harm. Earlier work using similar data found that for every 2 deliberate self-harm events, there is 1 event of undetermined intent.²² It is also possible that the burn injury itself represented an unrecognized self-harm attempt; in these cases, the pre-injury self-harm rate would be underestimated. However, given that

only 1% to 4% of all burns are self-inflicted,^{30,31} and patients with self-inflicted burns are more likely to die compared with unintentional burns³² (and would therefore be excluded from our cohort), we believe that this potential underestimation is unlikely to have influenced our results substantially.

We have demonstrated a considerable burden of mental illness among survivors of major burn injury. The high rate of emergency mental health services use suggests that multiple opportunities for intervention exist, with the potential to improve patient outcomes and reduce costly emergency room use. Of greatest concern is that intentional self-harm emergencies double after burn injury. Self-harm is the single most important predictor of subsequent suicide, with hazard ratios for subsequent death ranging from 2.4 to 12, depending on psychiatric comorbidity, age, and sex.³³ Therefore, self-harm visits represent an important opportunity to prevent subsequent suicide.

Effective treatments exist for mood disorders, anxiety, schizophrenia, and substance abuse. Identifying at-risk individuals through screening programs would facilitate earlier intervention. Early intervention has been demonstrated to improve outcomes across a wide range of metrics, including mortality, quality of life, and community reintegration.^{34,35} However, the high rate of emergent healthcare use in our study suggests that a barrier exists to accessing effective help from outpatient mental health services. An urgent need to characterize these barriers exists. Both burn inpatient and follow-up care provide multiple occasions to screen for psychiatric symptoms, provide integrated psychosocial care, and/or refer for psychiatric care.

CONCLUSIONS

Burn-injured patients have high rates of emergent health-care use related to mental illness. The highest rate of events occurs in the weeks immediately before burn injury, suggesting an opportunity for injury prevention through improved identification of those at risk and targeted mental healthcare. Self-harm emergencies double after burn injury, highlighting the need for screening during follow-up. Given that effective treatments are available, and early intervention improves outcomes, efforts to increase awareness and improve access to outpatient mental health services for burn-injured patients are warranted.

Support:

This study was supported by a Physicians' Services Incorporated Resident Research Grant. Dr Nathens is supported by the DeSouza Chair in Trauma Research. Dr Jeschke is supported by Canadian Institutes of Health Research #123336 and CFI Leader's Opportunity Fund Project # 25407, NIH RO1 GM087285-01. Dr Fowler's work was supported by a personnel award from the Heart and Stroke Foundation, Ontario Provincial Office. Dr Karanicolas is supported by a Canadian Institutes of Health Research New Investigator Award.

REFERENCES

1. van Baar ME, Essink-Bot ML, Oen IMM, et al. Functional outcome after burns: a review. *Burns* 2006;32:1–9. [PubMed: 16376020]
2. Davydow DS, Katon WJ, Zatzick DF. Psychiatric morbidity and functional impairments in survivors of burns, traumatic injuries, and ICU stays for other critical illnesses: a review of the literature. *Int Rev Psychiatry* 2009;21:531–538. [PubMed: 19919206]

3. van der Wal MB, Vloemans JF, Tuinebreijer WE, et al. Outcome after burns: an observational study on burn scar maturation and predictors for severe scarring. *Wound Repair Regen* 2012;20:676–687. [PubMed: 22985039]
4. Dauber A, Osgood PF, Breslau AJ, et al. Chronic persistent pain after severe burns: a survey of 358 burn survivors. *Pain Med* 2002;3:6–17. [PubMed: 15102213]
5. Fauerbach JA, Lawrence J, Haythornthwaite J, et al. Preburn psychiatric history affects posttrauma morbidity. *Psychosomatics* 1997;38:374–385. [PubMed: 9217408]
6. Powers PS, Cruse CW, Boyd F. Psychiatric status, prevention, and outcome in patients with burns: a prospective study. *J Burn Care Rehabil* 2000;21:85–88; discussion 84. [PubMed: 10661544]
7. Dyster-Aas J, Willebrand M, Wikehult B, et al. Major depression and post-traumatic stress disorder symptoms following severe burn injury in relation to lifetime psychiatric morbidity. *J Trauma* 2008;64:1349–1356. [PubMed: 18469660]
8. Redelmeier DA. The exposure-crossover design is a new method for studying sustained changes in recurrent events. *J Clin Epidemiol* 2013;66:955–963. [PubMed: 23850556]
9. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 5th ed. Washington, DC: American Psychiatric Association; 2013.
10. Mason SA, Nathens AB, Byrne JP, et al. The accuracy of burn diagnosis codes in health administrative data: a validation study. *Burns* 2017;43:258–264. [PubMed: 28069344]
11. American College of Surgeons Committee on Trauma. Guidelines for trauma centers caring for burn patients In: Rotundo MF, Cribari C, Smith RS, eds. *Resources for Optimal Care of the Injured Patient*. Chicago, IL: American College of Surgeons; 2014:100–106.
12. Weiner JP, Starfield BH, Steinwachs DM, Mumford LM. Development and application of a population-oriented measure of ambulatory care case-mix. *Med Care* 1991;29: 452–472. [PubMed: 1902278]
13. Kralj B. Measuring “rurality” for purposes of health-care planning: an empirical measure for Ontario. *Ont Med Rev* 2000; 67:33–52.
14. Logsetty S, Shamlou A, Gawaziuk JP, et al. Mental health outcomes of burn: a longitudinal population-based study of adults hospitalized for burns. *Burns* 2016;42:738–744. [PubMed: 27049068]
15. Oster C, Sveen J. The psychiatric sequelae of burn injury. *Gen Hosp Psychiatry* 2014;36:516–522. [PubMed: 24953259]
16. Palmu R, Suominen K, Vuola J, Isometsä E. Mental disorders among acute burn patients. *Burns Netherlands* 2010;36: 1072–1079.
17. Palmu R, Suominen K, Vuola J, Isometsä E. Mental disorders after burn injury: a prospective study. *Burns* 2011;37: 601–609. [PubMed: 21081260]
18. Ter Smitten MH, de Graaf R, Van Loey NE. Prevalence and co-morbidity of psychiatric disorders 1–4 years after burn. *Burns* 2011;37:753–761. [PubMed: 21334824]
19. Brien S, Grenier L, Kapral M, et al. Taking stock: a report on the quality of mental health and addictions services in Ontario An HQO/ICES report. Toronto, Health Quality Ontario and Institute for Clinical Evaluative Sciences <http://www.hqontario.ca/public-reporting/theme-reports/taking-stock>. Published 2015. Accessed January 25, 2016.
20. Larkin G, Claassen C, Emond J, et al. Trends in US emergency department visits for mental health conditions, 1992 to 2001. *Psychiatr Serv* 2005;56:671–677. [PubMed: 15939942]
21. Hazlett SB, McCarthy ML, Londner MS, Onyike CU. Epidemiology of adult psychiatric visits to US emergency departments. *Acad Emerg Med* 2004;11:193–195. [PubMed: 14759965]
22. Bethell J, Rhodes A. Identifying deliberate self-harm in emergency department data. *Health Rep* 2009;20:35–42. [PubMed: 19728584]
23. Wan JJ, Morabito DJ, Khaw L, et al. Mental illness as an independent risk factor for unintentional injury and injury recidivism. *J Trauma* 2006;61:1299–1304. [PubMed: 17159669]
24. Wisely JA, Wilson E, Duncan RT, Tarrier N. Pre-existing psychiatric disorders, psychological reactions to stress and the recovery of burn survivors. *Burns Netherlands* 2010;36: 183–191.
25. Fauerbach JA, McKibben J, Bienvenu OJ, et al. Psychological distress after major burn injury. *Psychosom Med* 2007;69: 473–482. [PubMed: 17585064]

26. Tarrier N, Gregg L, Edwards J, Dunn K. The influence of pre-existing psychiatric illness on recovery in burn injury patients: the impact of psychosis and depression. *Burns* 2005;31:45–49. [PubMed: 15639364]
27. Patterson DR, Everett JJ, Bombardier CH, et al. Psychological effects of severe burn injuries. *Psychol Bull* 1993;113: 362–378. [PubMed: 8451340]
28. Kirby M, Keon J. Mental health, mental illness and addiction: overview of policies and programs in Canada. <http://www.parl.gc.ca/Content/SEN/Committee/381/soci/rep/report1/repintnov04vol1-e.pdf>. Published 2014. Accessed August 1, 2016.
29. Brady KT. Posttraumatic stress disorder and comorbidity: recognizing the many faces of PTSD. *J Clin Psychiatry* 1997;58[Suppl 9]:12–15.
30. Rashid A, Gower JP. A review of the trends of self-inflicted burns. *Burns* 2004;30:573–576. [PubMed: 15302424]
31. Laloë V. Patterns of deliberate self-burning in various parts of the world. A review. *Burns* 2004;30:207–215. [PubMed: 15082345]
32. Forster NA, Nuñez DG, Zingg M, et al. Attempted suicide by self-immolation is a powerful predictive variable for survival of burn injuries. *J Burn Care Res* 2012;33:642–648. [PubMed: 22245801]
33. Bergen H, Hawton K, Waters K, et al. Premature death after self-harm: a multicentre cohort study. *Lancet* 2012;380: 1568–1574. [PubMed: 22995670]
34. Gysin-Maillart A, Schwab S, Soravia L, et al. A novel brief therapy for patients who attempt suicide: a 24-months follow-up randomized controlled study of the Attempted Suicide Short Intervention Program (ASSIP). *PLoS Med* 2016;13: e1001968. [PubMed: 26930055]
35. O'Donnell ML, Bryant RA, Creamer M, Carty J. Mental health following traumatic injury: toward a health system model of early psychological intervention. *Clin Psychol Rev* 2008;28:387–406. [PubMed: 17707563]

Figure 1.

(A) Distribution of all mental health visits, and (B) distribution of self-harm visits. Each interval represents a 13-week time period; error bars represent 95% CIs. Dashed line represents time of burn injury.

Table 1.

Baseline Patient and Injury Characteristics

Characteristic	All patients (n = 1,530)	Patients with 1 visit		p Value
		Pre-burn (n = 153)	Post-burn (n = 184)	
Male, n (%)	1,142 (75)	96 (63)	124 (67)	0.37
Age, y, mean (SD)	44 (17)	45 (14)	42 (15)	
Income quintile, n (%)				0.96
1 (lowest)	378 (25)	47 (32)	50 (28)	
2	339 (22)	32 (22)	40 (22)	
3	277 (18)	30 (20)	37 (21)	
4	311 (20)	21 (14)	26 (15)	
5 (highest)	211 (14)	17 (12)	25 (14)	
Home location, n (%)				0.82
Urban	1,256 (82)	130 (86)	152 (83)	
Rural	272 (18)	22 (14)	31 (17)	
Comorbidity burden, n (%) [*]				0.07
1 (lowest)	107 (7)	1–5 [†]	1–5 [†]	
2	202 (13)	1–5 [†]	5–10 [†]	
3	679 (44)	25–30 [†]	30–35 [†]	
4	307 (20)	20–25 [†]	25–30 [†]	
5 (highest)	232 (15)	45–50 [†]	35–40 [†]	
%TBSA, median (IQR)	15 (5–25)	15 (5–25)	15 (5–25)	0.61
Inhalation injury, n (%)	128 (8)	19 (12)	28 (15)	0.46
Burn mechanism, n (%)				0.15
Flame	792 (52)	60–65 [†]	112 (61)	
Electrical	96 (6)	1–5 [†]	7 (4)	
Contact	642 (42)	30–35 [†]	65 (35)	

Characteristic	Patients with 1 visit			p Value
	All patients (n = 1,530)	Pre-burn (n = 153)	Post-burn (n = 184)	
Burn center care, n (%)	780 (51)	67 (44)	77 (42)	0.72

* As measured by the Johns Hopkins Adjusted Clinical Groups case-mix system based on earlier healthcare use.

[†] Cell counts <6 have been suppressed and percentage ranges are presented to minimize re-identification risk.
IQR, interquartile range; TBSA, total body surface area.

Table 2.

Rates of Mental Health Visits

Variable	Rate per 1,000 person years		Adjusted rate ratio (95% CI)
	Pre-injury	Post-injury	
Any	141	154	0.97 (0.78–1.20)
Mood disorder	26.4	26.4	0.99 (0.70–1.40)
Substance abuse	86.7	80	0.86 (0.63–1.18)
Schizophrenia	17.9	24.4	1.26 (0.68–2.31)
Anxiety	10.5	18.3	1.64 (0.97–2.77)
Self-harm	6.3	13.3	1.95 (1.15–3.33)

Table 3.

Rates of Mental Health Visits by Rate of Pre-Injury Use

Variable	Low utilizers*			High utilizers [†]		
	Rate per 1,000 person years			Rate per 1,000 person years		
	Pre-injury	Post-injury	ARR (95% CI) [‡]	Pre-injury	Post-injury	ARR (95% CI) [‡]
Any	45.1	170.71	3.72 (2.70–5.14)	6,516.9	5,179.8	0.72 (0.55–0.94)
Mood disorder	6.25	37.47	6.01 (2.84–12.70)	1,258.43	752.81	0.58 (0.38–0.89)
Substance abuse	22.90	80.50	3.46 (2.29–5.21)	4,104.12	2,820.22	0.66 (0.45–0.98)
Schizophrenia	3.47	23.59	6.73 (2.42–18.69)	865.17	876.40	0.91 (0.43–1.96)
Anxiety	12.49	25.68	2.02 (1.04–3.90)	337.08	528.09	1.45 (0.68–3.09)
Self-harm	0.69	11.80	17.01 (2.25–128.65)	314.61	494.38	1.48 (0.81–2.70)

* 1 pre-injury visit.

[†] >1 pre-injury visit.

[‡] Estimated using negative binomial generalized estimating equations accounting for clustering of events within quarters and paired observations before and after burn.

ARR, adjusted rate ratio.

Table 4.

Self-Harm Events by Patient and Injury Subgroups

Variable	Rate per 1,000 person years		Rate ratio (95% CI)
	Pre-injury	Post-injury	
All patients	6.3	13.3	1.95 (1.15–3.33)
Sex			
Male	3.1	5.7	1.76 (0.72–4.33)
Female	3.3	7.6	2.26 (1.29–3.96)
Age group			
16 to 44 y	2.5	5.7	1.98 (0.76–5.16)
45 to 64 y	3.3	7.2	2.07 (1.14–3.77)
Older than 65 y	0.4	0.4	1.00 (0.09–11.03)
Income quintile			
1 to 3 lowest	5.0	9.6	1.72 (0.91–3.25)
4 to 5 highest	1.1	3.5	3.20 (1.13–9.05)
Home location			
Urban	6.1	10.2	1.78 (1.02–3.10)
Rural	0.2	1.1	5.00 (0.58–42.71)
Comorbidity			
1 to 3 lowest	0.7	2.2	3.33 (0.89–12.47)
4 to 5 highest	5.7	10.1	1.82 (1.03–3.22)
Total body surface area			
<20%	4.4	9.4	2.03 (1.07–3.85)
20%	2.0	4.0	1.92 (0.71–5.19)
Inhalation injury	0.4	1.7	3.99 (0.82–19.48)
No inhalation injury	5.9	11.5	1.74 (0.99–3.05)
Burn mechanism			
Flame	5.0	10	1.94 (1.08–3.46)
Electrical	0	0	–
Contact	1.3	3.3	2.27 (0.68–7.63)

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Variable	Rate per 1,000 person years		Rate ratio (95% CI)
	Pre-injury	Post-injury	
Index admission			
Burn center	2.8	6.3	1.86 (0.90–3.83)
Non-burn center	3.5	7.0	1.97 (0.92–4.24)