Mental health outcomes after major trauma in Ontario: a population-based analysis

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ABSTRACT

BACKGROUND: Major injury continues to be a common source of morbidity and mortality; improving the functional recovery of survivors of major trauma requires a better understanding of the mental health outcomes that may occur in this population. We assessed the association between major trauma and the development of a new mental health diagnosis or death by suicide.

METHODS: We completed a population-based, self-controlled, longitudinal cohort analysis using linked administrative data on patients treated for major trauma in Ontario between 2005 and 2010. All survivors were included and composite rates of mental health diagnoses during inpatient admissions were compared between the 5 years after injury and the 5 years before injury, using Poisson regression with generalized estimating equations. The incidence of suicide was calculated for the 5 years after injury. Risk factors for suicide were calculated using Cox proportional hazard regression analyses.

RESULTS: The analysis included 19 338 patients, predominantly men (70.7%) from urban areas (82.6%), with unintentional (89%), blunt injuries (93.4%). Overall, trauma was associated with a 40% increase in the postinjury rate of mental health diagnoses (incidence rate ratio [IRR] 1.4, 95% [confidence interval] CI 1.1 to 1.8). The suicide rate was 70 per 100 000 patients per year, substantially higher than the population average. Risk factors for completing suicide were prior inpatient diagnosis of mood disorder (hazard ratio [HR] 4.3, 95% CI 2.1 to 8.8) and self-inflicted injury (HR 7.8, 95% CI 3.9 to 15.4).

INTERPRETATION: Survivors of major trauma are at a heightened risk of developing mental health conditions or death by suicide in the years after their injury. Patients with pre-existing mental health disorders or who are recovering from a self-inflicted injury are at particularly high risk.

Injuries have been described as the "neglected disease" of modern times.[1] Major trauma is the leading cause of death in the first 3 decades of life and the most common cause of major disability thereafter.[2] Poor mental health outcomes, such as the development of depression, posttraumatic stress disorder, chronic pain and suicidality, have become increasingly recognized factors in patients in poor recovery from major injury.[1–3]

There is surprisingly little literature on the association between major injury and subsequent mental health outcomes. Although nearly 87% of patients with major trauma survive to discharge,[4] most trauma registries do not track patients after discharge, limiting our ability to understand the trajectory of patients' recovery beyond the acute phase of injury.

Emerging evidence shows that survivors of trauma are at heightened risks of developing major mental health disorders.[1,2,5–9] Some patients progress to attempt or die by suicide.[2,7] For instance, 1 study followed patients admitted to US level 1 trauma centres and found symptoms of depression in 20% and posttraumatic stress disorder in 6% of patients.[10] Similarly, data from Australia show that 31% of survivors of trauma have a diagnosed psychiatric disorder by 12 months postinjury, including depression (9%) and posttraumatic stress disorder (6%).[1] Canadian data also suggest that more moderate, isolated injuries, such as concussions, may be associated with suicide.[11] More knowledge about the association between injury and mental health outcomes is needed to optimize the care of survivors of trauma.

Our study builds on previous work by using large, linked, population-level health databases; a robust self-matched, before-and-after cohort design to control for confounding; and prolonged pre- and postinjury study periods. Our primary objective was to determine whether major injury is a risk factor for developing a new mental health diagnosis or death by suicide. Our secondary objective was to identify risk factors for death by suicide among this patient population.

Methods

Study design

We conducted a retrospective, population-based, longitudinal cohort study of all patients who survived major traumatic injury in Ontario, Canada, from 2005 to 2010. We used an exposure-crossover design in which patients acted as their own controls,[12] thus minimizing confounding related to stable characteristics like genetics and personality. The incidence of mental health diagnoses in the 5 years preceding injury (the exposure) was compared with the incidence of mental health diagnoses in the 5 years after injury. We also determined incidence of suicide in the 5 years after injury in the cohort.

Setting

Ontario is Canada's most populous province, with more than 13 million inhabitants,[13] who are covered by a universal health insurance program (Ontario Health Insurance Program [OHIP]) that pays for primary, emergency and in-hospital services. OHIP-related electronic health data are held by ICES, an independent, nonprofit research organization funded by the Ontario Ministry of Health and Long-Term Care. The ICES electronic data holdings include all OHIP-insured health care–related events for the complete population of Ontario enrolled in OHIP, linked to other data sources using an anonymous, unique identifier for each patient. Other data sources include databases from the Canadian Health Institute for Health Information (CIHI): the Discharge Abstract Database and Ontario Mental Health Reporting System, which capture inpatient visits, and the National Ambulatory Care Reporting System for visits to emergency departments. These data contain visit characteristics including diagnostic and therapeutic information.

All lead trauma hospitals in Ontario submit data on patients they treat to the Ontario Trauma Registry. Major traumatic injuries are defined as those with an injury severity score ≥ 12 and an appropriate external cause of injury code from the International Classification of Disease 9th (ICD9) or 10th revision Canada (ICD10-CA) (Appendices 1 and 2, available at www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.180368/-/DC1). Ontario has 11 designated lead trauma hospitals, including 2 pediatric-specific centres; when possible, patients are transported directly from the scene of injury to these designated trauma centres according to pre-hospital triage guidelines. Other patients are secondarily transferred to the lead trauma hospitals after they are assessed and stabilized at another acute care hospital.

We linked Ontario Trauma Registry records to their corresponding records in the National Ambulatory Care Reporting System or the Discharge Abstract Database for additional information about the episode of care for the injury. We used OHIP billing data to determine whether patients had trauma surgery during their care.

We linked these data sets using unique encoded identifiers and analyzed them at ICES. By linking the different administrative data sets, we were able to re-create the clinical trajectory for each anonymous patient so as to better understand the impact of major traumatic injury on subsequent mental health.

Participants

We included patients with a major traumatic injury from the Ontario Trauma Registry who were discharged between Apr. 1, 2005, and Dec. 31, 2010. As per the flow chart in Figure 1, we excluded individuals if they met any of the following criteria: did not reside in Ontario; died during admission; had more than 1 entry in the Ontario Trauma Registry between 2005 and 2015; had a previous traumatic injury before 2005; for whom emergency department or inpatient hospital records matching the injury could not be identified from CIHI data (using National Ambulatory Care Reporting System and Discharge Abstract Database data); and were not eligible for OHIP at any time before the injury.

Patient variables included age, sex and comorbidities. We used the Elixhauser comorbidity adjustment[14–16] to measure comorbidity burden. As a measure of socioeconomic status, we used postal codes to determine neighbourhood income quintile and rurality (based on the Rurality Index for Ontario[17]) for the year in which the trauma occurred. Injury-related variables included type and mechanism of injury, incident location, whether the injury was intentional, and measures of severity such as the injury severity score, treatments received and post-acute care disposition.

Primary outcome

The primary outcome was the composite rate of mental health diagnoses during inpatient admissions in the 5 years after injury, compared with the 5 years before the injury. These inpatient admissions included admission to inpatient psychiatric units and

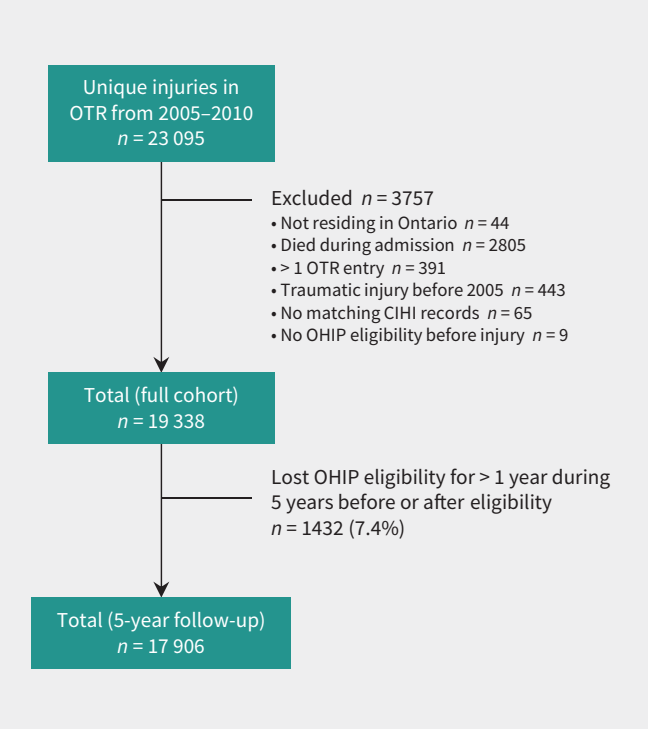

Figure 1: Data set creation flowchart. Note: CIHI = Canadian Institute of Health Information, OHIP = Ontario Health Insurance Plan, OTR = Ontario Trauma Registry.

admissions with confirmed mental health diagnoses. Typically, confirmed diagnoses are based on psychiatric or psychological assessment or records of previous assessment. We did not include suspected diagnoses. Diagnoses were based on ICD9, ICD10-CA and Diagnostic and Statistical Manual of Mental Disorders 4th edition (DSM-IV) diagnostic codes for mood, substance, self-harm and anxiety disorders (Appendix 3, available at www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.180368/-/DC1). We focused on inpatient visits rather than outpatient visits, as we felt the former would be a more reliable source of diagnostic information, although also representative of more serious mental health problems. We also grouped mental health diagnoses to investigate the association between traumatic injury and different types of mental health conditions.

Secondary outcome

The secondary outcome for this study was the rate of deaths by suicide among individuals who have had traumatic injuries, using death data from the Office of the Registrar General in Ontario. ICD10-CA codes X60-X84 and Y10-Y34 were used to determine suicide from 2005 to 2012, and "manner of death = suicide" was used to determine suicide in 2013 ("manner of death" is a new field that began to be used in 2013), as has been done in previous ICES studies.[11]

Statistical analysis

We performed cross-tabulations and descriptive statistics for the baseline demographics and injury characteristics. We used Poisson regression with generalized estimating equations to estimate pre-injury and postinjury rates of inpatient visits for mental health conditions. Incidence rate ratios (IRRs) were calculated comparing postinjury to pre-injury rates. Univariate (unadjusted) and multivariate (adjusted) models were computed investigating the effects of gender, age group, neighbourhood income quintile, home location (rural or small town v. urban), nature of injury and requirement for trauma surgery on pre- and postinjury rates of mental health conditions. The suicide rate was calculated by counting the number of deaths by suicide divided by the total amount of person-years of follow-up time on the study.

We used Cox proportional hazard models to investigate factors associated with suicide. In addition to the characteristics included in the above analyses, we hypothesized the following variables a priori to be predictors of suicide: previous inpatient visits for mental health conditions, injury severity, number of operations and discharge to a nonhome setting. Each potential predictor was included first in a simple univariate model, and then included for model building of the multivariate model. Backward selection at $\alpha = 0.10$ was used to determine which variables remained in the multivariate model.

Ethics approval

The study was approved by the Health Sciences and Affiliated Teaching Hospitals Research Ethics Board of Queens University, and by the Institutional Review Board at Sunnybrook Health Sciences Centre, Toronto, Canada.

Table 1: Baseline characteristics of the study population (*n* = 19 338)

Characteristic	No. of patients (%)
Sex	
Female	5675 (29.4)
Male	13 663 (70.7)
Age group, yr	
< 12	1013 (5.2)
13–17	1293 (6.7)
18–29	3743 (19.4)
30–49	4625 (23.9)
50–69	4613 (23.9)
70+	4051 (21)
Neighbourhood income quintile	
Lowest	4313 (22.3)
Next to lowest	4008 (20.7)
Middle	3710 (19.2)
Next to highest	3786 (19.6)
Highest	3381 (17.5)
Missing	140 (0.7)
Rurality	
Rural or small town	3357 (17.4)
Urban	15 981 (82.6)
Total score of Elixhauser Comorbidity Index*	
0	14 824 (76.7)
1	2274 (11.8)
2+	2240 (11.6)
Comorbid conditions*	
Cardiovascular disorders NOS	1120 (5.8)
Hypertension	1081 (5.6)
Neurological disorders	554 (2.9)
Chronic pulmonary disease	780 (4)
Diabetes	1005 (5.2)
Hypothyroidism	64 (0.3)
Renal failure	243 (1.3)
Liver disease	167 (0.9)
Peptic ulcer disease, excluding bleeding	44 (0.2)
AIDS or HIV	16 (0.1)
Cancer	308 (1.6)
Rheumatoid arthritis or collagen vascular diseases	63 (0.3)
Coagulopathy	150 (0.8)
Obesity	49 (0.3)
Weight loss	102 (0.5)
Fluid and electrolyte disorders	593 (3.1)
Anemia	109 (0.6)
Inpatient admission in 5 years before injury	
Any mental health condition	1386 (7.2)
Anxiety and other neurotic disorders	339 (1.8)
Mood disorders	699 (3.6)
Substance abuse and related disorders	821 (4.3)
Self-harm behaviours	97 (0.5)

Note: NOS = not otherwise specified.
*Within 3 years before injury.

Table 2 (part 1 of 2): Injury-related characteristics of the study population (*n* = 19 338)

Characteristic	No. of patients (%)*
Year of injury†	
2005 or earlier	2570 (13.3)
2006	3272 (16.9)
2007	3496 (18.1)
2008	3285 (17)
2009	3416 (17.7)
2010	3290 (17)
Primary injury type	
Missing	1 (0)
Blunt	18 064 (93.4)
Penetrating	950 (4.9)
Burns	323 (1.7)
Nature of injury or external cause of injury, code	
Land transport incidents	8911 (46.1)
Water transport incidents	56 (0.3)
Air and space transport incidents	33 (0.2)
Unintentional falls	6837 (35.4)
Mechanical forces	996 (5.2)
Unintentional drowning, submersion or other unintentional threats to breathing	17 (0.1)
Exposure to electric current, radiation and extreme ambient air temperature and pressure	15 (0.1)
Exposure to smoke, fire and flames	253 (1.3)
Contact with heat and hot substances	42 (0.2)
Exposure to forces of nature	10 (0.1)
Intentional self-harm, excluding poisoning	322 (1.7)
Assault, excluding poisoning	1611 (8.3)
Legal intervention and operations of war	28 (0.1)
Other‡	207 (1.1)
Intentional injury	
Missing	154 (0.8)
Unintentional	17 202 (89)
Self-inflicted	439 (2.3)
Homicide or assault	1543 (8)
Place of injury	
Missing	105 (0.5)
Home	4841 (25)
Residential institution	284 (1.5)
School or other institution or public area	426 (2.2)
Sports or athletics area	409 (2.1)
Street or highway	8569 (44.3)
Trade or service area	476 (2.5)
Industrial or construction area	542 (2.8)
Farm	215 (1.1)
Other specified place of occurrence	1148 (5.9)
Unspecified place of occurrence	2323 (12)

Results

The study cohort consisted of 19 338 patients identified in the Ontario Trauma Registry who did not meet any exclusion criteria (Figure 1). Of these patients, 1432 (7.4%) lost OHIP eligibility for at least 1 year during the 5-year follow-up period, and were therefore excluded. The baseline characteristics of the full cohort used for analysis (Table 1) and those with complete follow-up for 5 years were very similar (Supplementary Table 1 [Appendix 4, available at www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.180368/-/DC1]). The population was predominantly male (70.7%), older than 18 years and had sustained traumatic injuries in urban regions of the province (82.6%).

Examination of the injury characteristics of the study population (Table 2) showed significant predominance of blunt trauma (93.4%), mainly owing to land transport accidents (46.1%) and falls (35.4%). Most injuries (89%) were unintentional, and occurred either on streets or highways (44.3%), or at home (25%). The median injury severity score was 21. About one-quarter (27.9%) of patients received trauma surgery and 47.5% of patients were discharged home. Injury characteristics were very similar between the full cohort and the cohort with complete follow-up (Supplementary Table 2 [Appendix 5, available at www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.180368/-/DC1]).

Composite rates of inpatient mental health diagnoses in the 5 years before and the 5 years after admission for major trauma are shown in Table 3, and adjusted rate ratios comparing pre- and post-trauma rates are displayed in Figure 2. Overall, major trauma was associated with a 40% increased rate of hospital admission for 1 or more mental health diagnoses (IRR 1.4, 95% confidence interval [CI] 1.11 to 1.18). The most common mental health diagnoses were alcohol abuse, other drug abuse disorders and major depressive disorders (Table 4). Factors associated with an increased rate of admission for a mental health diagnosis included male gender, extremes of socioeconomic status, living in rural dwellings, having unintentional injuries, and requiring operative intervention (Figure 2). Although a test for

Table 2 (part 2 of 2): Injury-related characteristics of the study population (*n* = 19 338)

Characteristic	No. of patients (%)
Injury severity score	
9–15	1917 (10.1)
16–24	9076 (47.7)
25–40	6852 (36)
41–49	814 (4.3)
50–75	369 (1.9)
Injury severity score on arrival to trauma hospital, median (IQR)	21 (16–26)
Received any trauma surgery	5398 (27.9)
Received any general surgery procedure	1020 (5.3)
Received any cardiothoracic surgery procedure	188 (1)
Received any neurosurgery procedure	2558 (13.2)
Received any orthopedic surgery procedure	1943 (10.1)
If received surgery, no. of trauma surgeries, mean (SD)	1.2 (0.6)
Ventilator duration	
1 d	375 (2)
2+ d	1106 (5.8)
Not ventilated	17 547 (92.2)
If ventilated, no. of days, median (IQR)	3 (1–10)
Length of stay at lead trauma hospital, median (IQR)	8 (4–17)
Length of episode of care	11 (6–23)
Disposition	
Home	9038 (47.5)
Home with support	2163 (11.4)
Another acute care facility	3214 (16.9)
General rehabilitation facility	1724 (9.1)
Chronic care facility	236 (1.2)
Nursing home	404 (2.1)
Special rehabilitation facility	1572 (8.3)
Other§	677 (3.6)

Note: IQR = interquartile range, MVC = motor vehicle collision, SD = standard deviation.
*Unless otherwise specified.
†Patients with a major traumatic injury from the Ontario Trauma Registry who were discharged between Apr. 1, 2005 and Dec. 31, 2010.
‡Includes unspecified transport incidents, overexertion, unintentional exposure to other and unspecified factors and event of undetermined intent, excluding poisoning.
§Includes individuals released to foster care.

interaction by sex was significant (Z = 3.04, p = 0.002), models stratified by sex showed similar results, albeit with less statistical significance among the female patients, likely owing to reduced statistical power in this comparatively smaller population. Patients younger than 18 years had the greatest increase in rate of postinjury hospital admissions with 1 or more mental health diagnosis (IRR 3.3, 95% CI 1.5 to 7.2). The results were very similar among the cohort with complete 5-year follow-up (Supplementary Table 3 [Appendix 6, available at www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.180368/-/DC1]).

The suicide rate among the study cohort was 70 per 100 000 patients per year. Risk factors for completing suicide were previous admission to hospital with a diagnosis of mood disorder (hazard ratio [HR] 4.3, 95% CI 2.1 to 8.8) and self-inflicted injury (HR 7.8, 95% CI 3.9 to 15.4) (Figure 3). The results were the same when we included only the patients with 5 complete years of follow-up (Supplementary Table 4 [Appendix 7, available at www.cmaj.ca/lookup/suppl/doi:10.1503/cmaj.180368/-/DC1]).

Interpretation

In this large, population-based study, we sought to improve understanding of the complex association between major injury and subsequent mental health outcomes. We have shown that the experience of major trauma requiring admission to a trauma centre is associated with a significant risk of admission to hospital for new or pre-existing mental health diagnoses. In addition, our results show a significant occurrence of suicide for this patient population.

Overall, it is surprising that there are relatively few data on the rate of development of new mental health diagnoses or increase in severity of pre-existing mental health diagnosis in the months to years after major injury, given previous work showing that mental well-being is the single greatest predictor of general health, ability to return to work and satisfaction with recovery among patients recovering from trauma.[18]

In the Canadian context, a similar population-based, self-matched cohort study examined the development of mental health conditions in patients who survived major burns.[3] In this study, the overall population of patients who survived burns did not have an increase in mental health visits in the recovery period after admission; however, among the population with fewer than 1 mental health–related visit in the 3 months preceding the burn, there was a threefold increase in mental health visits during the follow-up period and rates of self-harm events increased twofold in the 3 years after a major burn.

Although we found the association between major trauma and a heightened risk of subsequent mental health–related inpatient admissions to be consistent across the entire patient population, there were several subgroups (male, low or high socioeconomic status, unintentional injury) where the association was particularly pronounced. With our study design, it is impossible to determine whether this association reflects the experience of major injury or is a consequence of the relatively lower rates of mental

health diagnoses in these subgroups in the pre-injury phase of study (Table 3). For instance, rates of depression are generally lower in men than in women,[19] and lower still in children and adolescents than adults.[20] Conversely, rates of mental health–related stays in hospital in patients admitted for self-inflicted injuries are high at baseline and do not increase as substantially in the post-injury period. The experience of a major injury may put patients from these subgroups into a better position to access mental health resources and therefore cause the increased rates of mental health diagnoses that we have identified. Alternatively, these subgroups may be particularly vulnerable to impaired mental well-being during the recovery from their injury.

Among our cohort of 19 338 patients, there were 62 suicides over a median follow-up of 5 years, yielding a rate of 70 per 100 000 patients per year. This is considerably higher than rates described for patients with concussion (31 per 100 000 patients per year),[11] military personnel (14 per 100 000 patients per year)[21] and the overall Canadian population (11.5 per 100 000 patients per year).[8]

Limitations

There are several limitations to our methods that are worth noting. First, our population consists entirely of patients treated at lead trauma centres in Ontario. If patients who received their inpatient care at nontrauma centres in Ontario were systematically different from those treated at trauma centres, this could limit the external generalizability of our findings. Additionally, we used an inpatient administrative database to obtain outcome information on mental health diagnoses. We made this decision as we felt that outpatient diagnostic information would be less reliable as a result of multiple sources of heterogeneity relating to types of providers, care settings, billing practices and confidence in making mental health diagnoses. As such, it is probable that we have underestimated the strength of association between major injury and subsequent mental health diagnoses, as many patients postinjury with mental health diagnoses may not require admission to hospital, and will seek outpatient care.[2]

A few limitations related to the exposure-crossover design[22] should be mentioned. First, the exposure of interest must be acute in onset, and the development of the outcome in association with the exposure must temporally follow the exposure. The exposure in our study did have an acute onset, although the development of mental health problems may have been somewhat delayed. Second, if there are independent time trends in the outcomes (i.e., an increasing prevalence of mental health conditions in the population at large), then the association between exposure and outcome can be spurious. We have no evidence to suggest that there are temporal trends in mental health

Table 3: Composite rates of mental health diagnoses within 5 years of major injury

	Composite rate per 1000 patient years	
Characteristic	**5 years before injury**	**5 years after injury**
All patients	5.7 (4.5–7.2)	8.1 (6.9–9.5)
Sex		
Female	6.9 (5.2–9.1)	8.3 (6.8–10.2)
Male	4.7 (3.8–5.9)	7.9 (6.8–9.2)
Age group, yr		
< 18	0.9 (0.4–2)	3 (2.1–4.3)
18–29	5.5 (4.2–7.3)	6.6 (5.3–8.1)
30–49	12.5 (10.1–15.5)	14.6 (12.2–17.4)
50–69	14.6 (11.7–18.2)	15.5 (13–18.6)
70+	6.4 (5–8.3)	7.8 (6.2–9.8)
Income quartile		
Lowest	7.5 (5.8–9.6)	11.2 (9.3–13.5)
Highest	4.7 (3.4–6.5)	7.3 (5.7–9.4)
Home location		
Rural	4.9 (3.6–6.7)	7.7 (6.2–9.7)
Urban	6.6 (5.4–8.1)	8.5 (7.4–9.8)
Intention of injury		
Self-inflicted	16 (11.6–21.9)	18.8 (14.7–24)
Assault	4.9 (3.4–7.1)	6.2 (4.8–8.1)
Unintentional	2.3 (1.9–2.9)	4.6 (4–5.2)
Any trauma surgery procedures*	5.3 (4–7)	7.4 (6.1–8.9)

*Categories = general surgery, thoracic surgery billing codes, etc.

diagnoses over the time periods of our study. Lastly, the assumption of the study design is that the exposure cannot prevent the outcome from occurring, yet it is possible that trauma may preclude some individuals from seeking mental health assistance or diagnoses because of competing health care problems or disability. However, in this case the associations we observed in our study would actually be a conservative estimate of the association between trauma and mental health problems.

Another limitation of using administrative data relates to substance abuse diagnoses. Although the exposure-crossover design controls for an individual's measured baseline conditions (like substance abuse, Table 1), it is possible that if these diagnoses were not comprehensively captured in the pre-injury period of study (i.e., if a patient had a substance abuse problem that was not severe enough to lead to an inpatient admission), compared with the postinjury phase of care, then an apparent increase in mental health diagnoses may occur that is not a result of the experience of injury itself, but rather from being exposed to health care providers who then have the opportunity to make the diagnosis of substance abuse.

We excluded several patient groups in an effort to remain focused on the primary question of the effect of a single major and unanticipated major injury on mental health outcomes. We excluded patients with more than 1 entry in the Ontario Trauma Registry, for instance, as these patients presumably suffered more than 1 major injury during the study period and we felt they were at substantially different risk of developing new mental health diagnoses than patients with only 1 admission for major injury. As there were only 391 patients (Figure 1) with more than 1 Ontario Trauma Registry entry, we believe the effects of selection bias on the study's conclusions are minimal.

We intentionally included patients with self-inflicted injuries in sample so that we would have a more robust understanding of the mental health course of this particularly at-risk patient group. Doing so, we acknowledge that there is possibly some residual confounding related to these patients' pre-injury mental health status that may artificially increase the strength of the association between major injury and a new mental health diagnosis.

It is also worth noting that at first glance, our data could be perceived as dated. There are a few reasons for our using this time

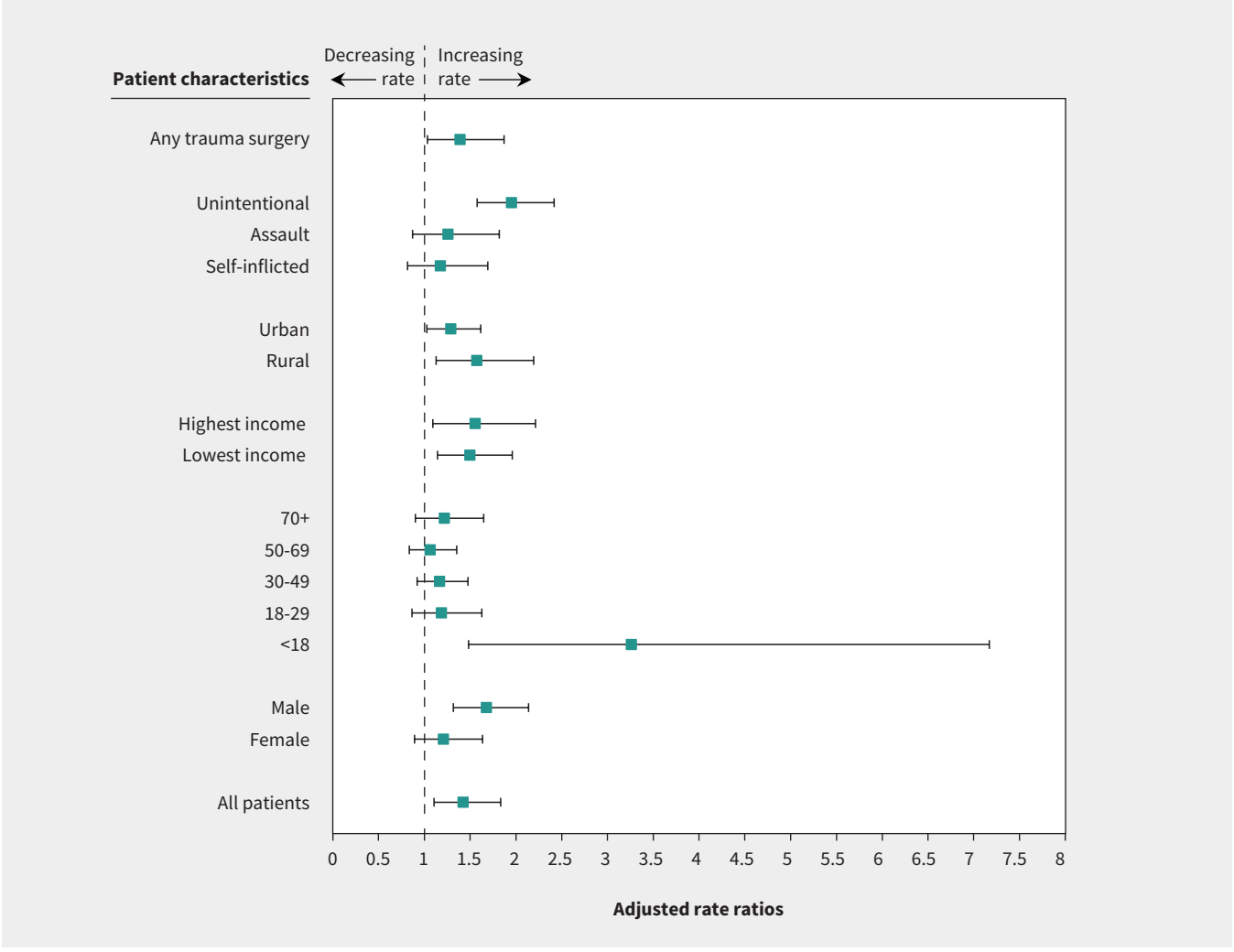

Figure 2: Patient characteristics associated with pre- v. post-inpatient mental health diagnoses within 5 years of major trauma (adjusted rate ratios [95% confidence intervals]; *n* = 19 338). Each variable was tested with the others shown (i.e., age, gender, socioeconomic status, residence, nature of injury, requirement for surgery).

Table 4: Pre- and postinjury frequency of patients with at least 1 admission with an associated mental health diagnosis by diagnosis subtype

Diagnosis	No. of patients pre-injury (%) *n* = 19 338	No. of patients postinjury (%) *n* = 19 338	*p* value
Alcohol abuse	412 (2.1)	465 (2.4)	< 0.001
Drug abuse	228 (1.2)	247 (1.3)	< 0.001
Major depressive disorders	241 (1.3)	373 (1.9)	< 0.001
Bipolar disorders	91 (0.5)	66 (0.3)	< 0.001
Other mood disorder*	40 (0.2)	16 (0.08)	0.96
Acute stress disorder, PTSD and other adjustment disorders	54 (0.3)	77 (0.4)	< 0.001
Anxiety disorders†	103 (0.5)	120 (0.6)	< 0.001
Other nonpsychotic mental disorders‡	11 (0.06)	< 6 (< 0.03)	0.99

Note: PTSD = posttraumatic stress disorder.
*Includes persistent affective disorders (i.e., cyclothymic disorders and dysthymic disorders) and unspecified mood disorders.
†Includes generalized anxiety disorder, panic disorder, phobic disorders and obsessive-compulsive disorders.
‡Includes somatoform disorders, pain disorders and unspecified nonpsychotic disorders.

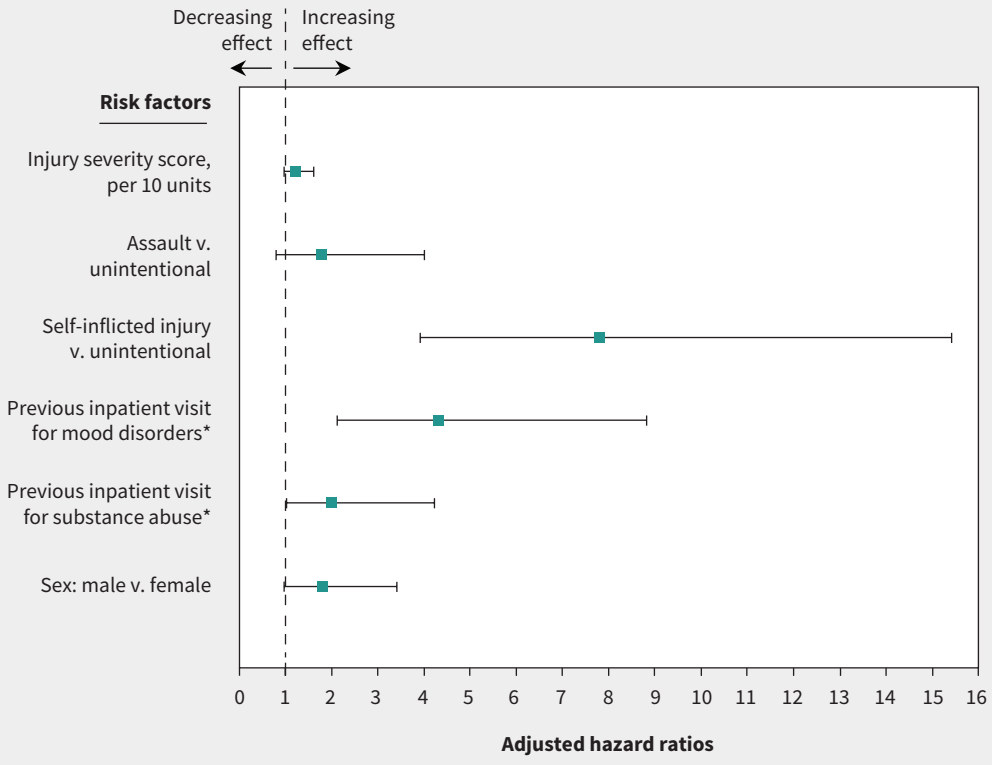

Figure 3: Risk factors associated with completing suicide within 5 years of major injury (adjusted hazard ratios [with 95% confidence intervals] for completing suicide; *n* = 19 338). Adjusted variables were age, gender, socioeconomic status, nature of injury, requirement for surgery, and all risk factors shown. *Within 5 years before injury.

period. First, the accrual window of 2005–2010 was necessary, as we wanted to have a 5-year follow-up window (2010–2015) for mental health outcomes in all patients. Using a more recent accrual period would have necessitated shortening the follow-up period, and we thought that was a less desirable alternative, as important outcomes (including suicide) might have been missed. At the time of data analysis, we did use the most recently available data from the Ontario Trauma Registry (2015), and our

population does also include 3 additional years of more recent data (2012–2015) than another recent Canadian study that examined the association between concussions and suicide.[11]

Our study was not designed to explore in detail the association between injury and mental illness among the various different subgroups of patients with major trauma. However, we found a particularly strong association between such injury and inpatient admissions for mental health diagnoses in the pediatric (younger than 18 years) population; this group should be an area of particular focus in future research efforts.

Conclusion

Patients who suffer major traumatic injury are at significant risk of increased admissions to hospital with mental health diagnoses in the years after their injury and of having high suicide rates during this period. All patients appear to be at risk of completing suicide, with the highest-risk patients being those with a history of pre-existing mood disorder and those recovering from a self-inflicted injury. Mental health resources should be offered to all survivors of major trauma, and particularly intense supports directed to the highest-risk patients.

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