Contents lists available at ScienceDirect

Injury

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Review

The prevalence of alcohol-related trauma recidivism:
A systematic review

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ABSTRACT

Objective: Recurrent admission to a hospital or trauma centre for separate incidents of traumatic injury is known as trauma recidivism. Although use of alcohol is a known risk factor for injury and associated with trauma recidivism, the scale of alcohol-related trauma recidivism has not been well described. The purpose of this review was to search the published literature for studies that evaluated the prevalence of alcohol use among trauma recidivists. Our primary objective was to determine the proportion of trauma recidivism related to alcohol use. The association between alcohol and trauma recidivism was evaluated as a secondary objective.

Methods: Four electronic databases (MEDLINE, Embase, CINAHL, Web of Science) were searched from inception until December 2015 for all articles that might provide evidence on the proportion of trauma recidivism related to use of alcohol. After removal of duplicates, the search strategy yielded 2470 records for screening. Only primary studies that reported on repeated admissions to a hospital or trauma centre for traumatic injuries specifically related to alcohol use were included. Descriptive statistics were used to assess study characteristics and the prevalence of trauma recidivism related to alcohol use. An aggregate weighted estimate of alcohol-related trauma recidivism was calculated.

Results: A total of 12 studies met all inclusion criteria. Studies were published between 1989 and 2014. Overall, there were 3386 trauma recidivists among included studies. The proportion of trauma recidivists with evidence of alcohol use on admission ranged from 26.7% to 76.9% (median 46.4%). The aggregated sample produced a weighted estimate of 41.0% (1388/3386) for alcohol-related trauma recidivism. In four studies, the association between alcohol and trauma recidivism was examined; all four found a positive association between alcohol use and repeated admission for traumatic injury. Studies varied considerably in design, trauma populations, periods for evaluating recidivism, definitions for positive alcohol on admission, and methods used to determine alcohol use.

Conclusion: Evidence from current literature suggests that 41.0% of trauma recidivism is related to use of alcohol. Due to methodological limitations among the studies included for review, this may underestimate the actual prevalence of alcohol-related trauma recidivism.

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Introduction

Trauma recidivists are patients who present to a hospital or trauma centre on more than one occasion for different incidents of traumatic injury [1]. These patients are commonly younger and middle aged males of lower socioeconomic status who suffer from chronic illness or psychiatric disorders [2,3]. Prior studies have associated traumatic injury with risk-taking behaviours such as the use of weapons, fighting, criminal behaviour, and abuse of drugs or alcohol [4–6]. With advances in trauma patient care, many patients recover from their injuries; however, some patients continue risk taking behaviours, or seek out coping mechanisms such as use of alcohol or drugs in order to deal with the disability associated with their initial trauma [3,6]. Thus, a proportion of the trauma population may have or develop a predisposition to trauma.

Alcohol use is well known to increase the risk of experiencing a traumatic event and to be associated with poor health outcomes [7–9]. It was estimated that in 2004, 15.1% (95% CI 7.43%–22.73%) of injury deaths and 11.3% (95% CI 5.81%–16.96%) of disability-adjusted life years lost from injuries were attributable to alcohol use [10]. More recently, an analysis of 37 emergency departments (EDs) across 18 countries estimated that 16.4% of all injuries were attributable to alcohol [11]. In addition to increasing the risk of sustaining traumatic injury, alcohol use can also complicate the initial evaluation of the trauma patient and result in higher health care costs [7,8]. Although alcohol has been associated with trauma recidivism [1,2,4,12,13], the scale of this issue has not been well described.

The purpose of this study was to systematically review evidence from the published literature regarding the role of alcohol in trauma recidivism. Our primary objective was to determine the proportion of trauma recidivism related to alcohol. As a secondary objective, we evaluated the association between alcohol use and trauma recidivism.

Methods

Search strategy

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [14]. A review protocol is available upon request. Four electronic databases (MEDLINE, Embase, CINAHL, Web of Science) were searched from inception until December 2015 using a search strategy that was developed in collaboration with an experienced Health Sciences librarian, modified for each database. The search strategy included a combination of medical subject headings (MeSH), Emtree headings, or CINAHL headings, and variations of keywords such as: "emergency medicine," "alcohol," "intoxicated," "wounds," "injuries," "trauma," "recidivism," and "recurrence". Truncation and proximity searches were also used in applicable databases. No limitations were placed on the initial literature search.

Study selection

Studies chosen for analysis met the following inclusion criteria: (a) design – any peer-reviewed primary study of original data involving human participants; (b) population – trauma patients who were evaluated for one or more admissions to a hospital or trauma centre; and (c) exposure – patients with a positive blood alcohol concentration (BAC) or other evidence of alcohol use on admission. Studies were excluded if they did not report on trauma recidivism specifically related to alcohol, or if study patients were presenting for acute intoxication without traumatic injury. We also excluded studies that compared the effect of an intervention on trauma recidivism, or any study for which it was not possible to determine our primary outcome of the proportion of trauma recidivism related to use of alcohol. We defined cases of alcohol-related trauma recidivism to include any patient with more than one admission to a hospital or trauma centre for traumatic injury who was documented to have used alcohol prior to at least one of their admissions. For the purposes of this review, alcohol use refers to a determination of alcohol use on admission as defined by each study and could include any use of alcohol regardless of whether it meets the clinical definitions of alcohol abuse or dependence.

One investigator (JN) applied the selection criteria to the titles and abstracts of all articles identified by the search strategy and excluded any that were not relevant to our study objectives. The full text of potentially relevant articles was independently screened for inclusion by two investigators (JN, ME), and any disagreements were resolved through consensus. If consensus was not reached, a third reviewer (RG) was consulted to resolve the disagreement. To determine inter-observer reliability for agreement on articles to include in the review, a kappa statistic was calculated [15,16]. For articles that were only published as abstracts, the authors were contacted directly to determine if their study had been published or if they could share their data. Articles not in English were translated using Google Translate® (http://translate.google.com). The reference lists of studies included in the review were manually searched for any additional relevant studies.

Data extraction

A standardised data extraction form was created using Microsoft® Excel 2007 (Redmond, Washington, USA). Two reviewers (JN, ME) independently extracted the following data elements from each included study: authorship, year of publication, study design, location, institution type, study duration, inclusion/exclusion criteria, data sources, definition of positive alcohol on admission, methods for determining/measuring intoxication or alcoholic behaviour, definition of trauma/injury, and the

follow-up period for recidivism. Any disagreements were resolved through consensus. In addition, the following patient characteristics were extracted (if reported): total number of subjects, age, gender, Injury Severity Score (ISS), Glasgow Coma Scale (GCS) score, type of trauma, number of recidivists, number of repeat admissions, and time between injuries. For each study, we recorded the proportion of trauma recidivism that was related to alcohol use. We also extracted any data regarding the association of alcohol use and trauma recidivism from each of the studies included in the review. Only data reported in manuscripts were extracted; no data was imputed.

Quality assessment of included studies

Two investigators (JN, ME) independently assessed the risk of bias for each study using the Newcastle-Ottawa Scale (NOS) [17]. The NOS was developed to assess the quality of non-randomised studies and uses a 'star system' to judge each study based on three broad objectives: (1) the selection of study groups; (2) the comparability of study groups; and (3) the ascertainment of the exposure or the outcome of interest for case–control or cohort studies respectively. Studies were included regardless of the risk of bias. A kappa statistic was calculated to determine the inter-observer reliability for

agreement across each NOS domain [15,16]. Weighted kappa was calculated for domains with more than two classifications (i.e., comparability) and for the total NOS scores.

Statistical analysis

Simple statistics including proportions, means, medians, and ranges were used to describe the results of studies included for analysis. To account for differences in sample size between studies, we calculated an aggregate weighted estimate of alcohol-related trauma recidivism. Inter-observer reliability was calculated using the R Statistical software package (V3.0.1; R Foundation for Statistical Computing, Vienna, Austria). Individual studies varied considerably in design, population, follow-up periods for recidivism, and methods for determining alcohol use among trauma patients. This heterogeneity precluded our ability to perform a meta-analysis.

Results

A total of 12 studies met all of the inclusion criteria [1,2,5,13,18–25]. A flow chart outlining the search and selection process is shown in Fig. 1. Overall, 3271 records were identified in the search. We removed 801 duplicate records, and an additional
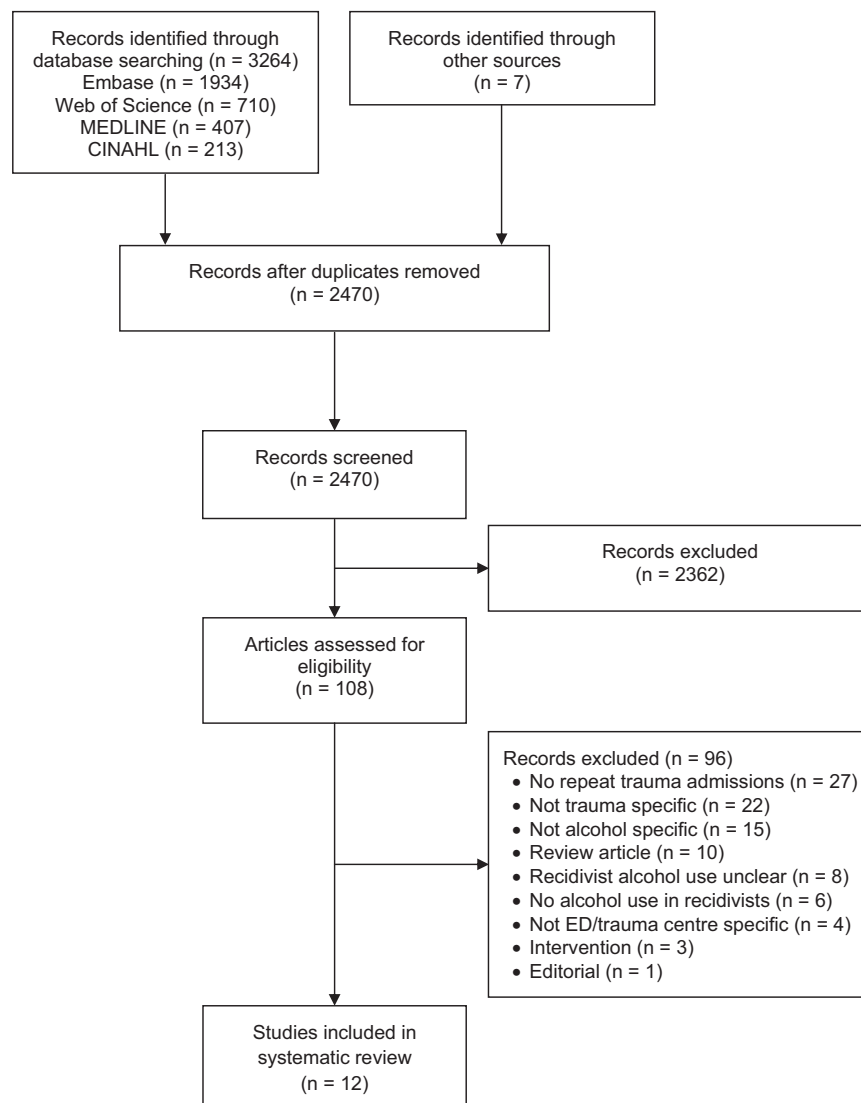
Fig. 1. Flow diagram of studies selected for inclusion in the review.

2362 records were excluded after screening of the title and abstract. Of the 108 records that remained to be assessed for eligibility, only an abstract was available for eight of these. We contacted the authors of these eight studies to determine whether their work had been published in a peer-reviewed journal; only one author responded and reported their study had not been published. An online search did not identify evidence for any of these studies being published as a full-text article, and none of these abstracts met the inclusion criteria for this review.

Two reviewers independently screened 108 articles and identified 12 studies that met all inclusion criteria (κ value = 0.804; substantial agreement). The search strategy for MEDLINE can be found in Supplementary Data file 1.

Study characteristics

Table 1 summarises the characteristics of each included study. Studies were published between 1989 and 2014, with six performed in the USA [1,5,19,20,22,23], four in Europe [13,21,24,25], one in Canada [2], and one in Australia [18]. Most studies were performed at a single centre [1,5,13,18–24], one study involved two major adult trauma referral centres [2], and one was a statewide longitudinal population-based study [25]. With respect to study design, seven studies [2,5,18,19,22,23,25] were retrospective in design, and five studies [1,13,20,21,24] were prospective. A total of 25,207 trauma patients were included in the 12 studies, with sample sizes for individual studies ranging from n = 13 to n = 15,370 patients. Studies varied in patient ages and mechanism of traumatic injury in patients examined. Some study populations were limited to patients with traumatic injury related to violence, motor vehicle collisions (MVCs) or to specific body areas such as the head, while others included all patients who presented during the study period. Trauma recidivism was assessed as early as six months and as late as 24 years after the initial admission.

There was considerable variation in the definitions used for alcohol use including a BAC > 0 mg/dL [1,19,23], the presence of any alcohol (BAC or noted clinically) [2,24,25], having a BAC > 0.08 mg/dL [5], having a BAC ≥ 50 mg/dL [13], intoxication noted clinically by physician [21], or self-reported alcohol use on day of injury [20]. In one study [22], alcohol abuse was defined as having a diagnosis of alcoholism in the medical record, an admission for a complication of alcoholism such as bleeding esophageal varices, documentation of alcoholism on the death certificate as a contributing cause of death, or a BAC > 0.15 mg/dL in the medical record. One study [18] did not define positive alcohol on admission or how it was determined. The most common methods for determining alcohol use on admission were measurement of BAC levels [1,2,5,13,19,22–25] and evidence from medical records [2,21,22,24,25].

Risk of bias for included studies

The quality assessment of each study is presented in Table 2 in terms of scoring for each NOS domain. Overall scores for included studies ranged from 6 to 9 using the NOS; 42% (5/12) of studies were allotted one of two stars for comparability of cohorts on the basis of design or analysis. Inter-rater reliability was calculated using kappa statistics; overall, there was substantial agreement between the two investigators for the eight domains of the NOS (weighted κ = 0.79, 95% CI 0.59–0.98).

Characteristics of trauma recidivists

Overall, recidivists accounted for 13.4% (3386/25207) of trauma patients across the 12 studies (range 13–1246, median 78.5). The gender of recidivists was reported in nine studies [1,2,13,18,20,21,23–25]; the median percentage of males among recidivists was 75% (range 50.9–100%). Nine studies [1,2,18,20–25] reported the mean age for trauma recidivists during their index case, with a median of 37 years (range 21–55.9 years). There were five studies [1,2,13,18,23] that reported the time between admission for trauma; four studies reported the mean time between injuries (median 35.7 months, range 26.5–58.5 months),

Table 1
Characteristics of included studies.

Authors (year)	Location	Study type	Study duration	Recidivism period	Sample size	Age of sample	Type of trauma pts.
Agir et al. [18] (2011)	Adelaide, AUS	Retrospective cohort	1990–2000	NR	n = 13	20–45 yr	Mandibular fracture
Caufeild et al. [2] (2004)	Toronto, CAN	Retrospective cohort	May 1976–Jan 1999	476 days-TDS follow-up	n = 126	All adults	Trauma team resuscitation or ISS ≥ 16
Fabbri et al. [13] (2005)	Forli, ITA	Prospective cross-sectional	Jan 1998–Dec 2003	5 yr follow-up	n = 2354	≥14 yr	Injury due to MVC
Keough et al. [5] (2001)	Chicago, USA	MM, retrospective	Sep 1997–Jan 1998	Previous 5 yr	n = 100	≥18 yr	All types
Maio et al. [19] (1994)	Ann Arbor, USA	Retrospective cohort	Jan 1989–Dec 1990	5 yr pre-/1 yr post-admit	n = 176	13–18 yr	All types
McCoy et al. [20] (2013)	Cleveland, USA	MM, prospective	May 2009–May 2010	Previous 5 yr	n = 4971	All ages	All types
Ponzer et al. [21] (1999)	Stockholm, SWE	MM, prospective	6 months	1969–1993	n = 345	15–65 yr	All types
Reiner et al. [1] (1990)	Newark, USA	Prospective cohort	NR	Any previous trauma	n = 426	5–81 yr	All types
Sims et al. [22] (1989)	Detroit, USA	Retrospective epidemiologic	1980–1986	5 yr follow-up	n = 263	≥17 yr	Stabbing, gunshot, assault
Toschlog et al. [23] (2007)	Greenville, USA	Retrospective cohort	Jan 1994–Dec 2002	TDS follow-up	n = 15,370	All ages	All types
Vaaramo et al. [24] (2014)	Oulu, FIN	Prospective cohort	1999–2009	TDS follow-up	n = 827	All ages	TBI/head trauma
Winqvist et al. [25] (2008)	Oulu, FIN	MM, retrospective	1978–2000	TDS follow-up	n = 236	≥12 yr	TBI

n: number, yr: year(s), NR: not reported, TDS: total duration of study, ISS: injury severity score, MVC: motor vehicle collision, TBI: traumatic brain injury, and MM: mixed method.

Table 2
Newcastle-Ottawa scale for risk of bias and quality assessment of included studies.

Study	Selection				Comparability	Outcome			Overall
	Representativeness of exposed cohort	Selection of non-exposed	Ascertainment of exposure	Outcome not present at start		Assessment of outcome	Follow-up length	Adequacy of follow-up	
Agir et al. [18]	★	☆	★	☆	★☆	★	★	★	6
Caufeild et al. [2]	★	★	★	★	★★	★	★	★	9
Fabbri et al. [13]	★	★	★	★	★★	★	★	★	9
Keough et al. [5]	☆	★	★	☆	★☆	★	★	★	6
Maio et al. [19]	★	★	★	★	★☆	★	★	★	8
McCoy et al. [20]	★	★	★	★	★★	★	★	★	9
Ponzer et al. [21]	★	★	★	★	★★	★	★	★	9
Reiner et al. [1]	★	★	★	★	★★	★	★	★	9
Sims et al. [22]	★	★	★	★	★☆	★	★	★	8
Toschlog et al. [23]	★	★	★	★	★★	★	★	★	9
Vaaramo et al. [24]	★	★	★	★	★★	★	★	★	9
Winqvist et al. [25]	★	★	★	★	★☆	★	★	★	8

and one study [1] reported the percentage of repeated admissions during each of three time intervals (<5 years, 66%; 5–10 years, 16%; >10 years, 19%).

The ISS of trauma recidivists was assessed in four studies [2,19,21,23]. Two of these studies reported the median ISS for recidivists and non-recidivists: in one study [2] the median ISS was 18.5 (range 1–59) for recidivists and 22 (range 1–75) for non-recidivists, and in the other study [21] the median ISS was 4 in both groups. One study [23] reported the mean ISS ± standard deviation (SD) for non-recidivists (10.8 ± 9.9), patients with one repeat trauma (8.3 ± 6.5), and patients with between three and five repeat admissions for trauma (7.7 ± 10.6). There was also one study [19] that examined ISS in groups of trauma patients with or without a positive BAC and reported similarities in patients with a positive BAC (median ISS 12.5) or negative BAC (median ISS 13.0) on admission.

Only two studies [2,23] reported the GCS score of trauma patients; one study [2] found similar GCS scores in recidivists (median 14, range 3–15) and non-recidivists (median 15, range 3–15), while the other study [23] reported the mean GCS ± SD for non-recidivists (13.1 ± 4.1), for patients with one repeat admission (14.1 ± 2.9), and for patients with between three and five repeat admissions for trauma (14.1 ± 2.9).

Primary outcome: the proportion of trauma recidivism related to alcohol (12)

All of the recidivists who were included in the 12 studies in this review were asked, screened, or tested for alcohol use on

admission. The proportion of trauma recidivists with evidence of positive alcohol on admission ranged from 26.7% to 76.9%, with a median of 46.4% (Table 3). The aggregated sample produced a weighted estimate that 41.0% (1388/3386) of trauma recidivists had at least one alcohol-related admission for traumatic injury. Of the 12 studies that reported on the proportion of alcohol-related trauma recidivism, four studies [2,19,24,25] reported alcohol use only in the index trauma, six studies [1,5,13,20–22] reported alcohol use only in repeat cases, and two studies [18,23] reported alcohol use in the index and repeat cases.

Four studies [2,13,18,23] explicitly reported the mean time between alcohol-related traumas. Of these, the study [18] with the largest rate of alcohol-related recidivism had a mean time of 51.6 months (SD = 48 months) between injuries and the study [13] with the least rate had a mean time of 58.4 months (SD = 16.4 months) between injuries. It is difficult to indicate whether time in between injuries is associated with the rate of recidivism, and is a question that requires further study.

Secondary outcome: association between alcohol and trauma recidivism (4)

The association between alcohol use and risk of recurrent admission for traumatic injury was reported in four studies [13,21,24,25] (Table 4). Two studies [13,25] examined factors that were predictors of trauma recidivism; one study [13] found a positive BAC was predictive of a recurrent MVC (relative risk [RR] 3.73, 95% CI 3.00–4.64), while a second study [25] found an

Table 3
Primary outcome for alcohol-related trauma recidivism.

Authors	No. of recidivists	% Male	Age at index case	Time between injuries	Alcohol use reported for index and/or repeat case
Agir et al. [18]	13	100	Mean 27.5 ± 8 (range 20–45 yr)	Mean 4.3 ± 4 yr (range 3 mo–15 yr)	Index: 10/13 (76.9%) BAC+ Repeat: 9/13 (69.2%) BAC+
Caufeild et al. [2]	42	88	Mean 37 yr	Mean 45 mo	Index: 20/42 (48%) BAC+
Fabbri et al. [13]	390	77	Range 14–60+ yr	Mean 4.87 ± 1.37 yr	Repeat: 186/390 (47.7%) BAC+
Keough et al. [5]	36	NR	NR	NR	Repeat: 16/36 (45%) BAC+
Maio et al. [19]	16	NR	NR	NR	Index: 8/16 (50%) BAC+
McCoy et al. [20]	1246	75	Mean 37 ± 18 yr	NR	Repeat: 436/1246 (35%) used alcohol on day of injury
Ponzer et al. [21]	120	72.5	Mean 38 ± 13.8 yr	NR	Repeat: 32/120 (26.7%) BAC+
Reiner et al. [1]	32	97	Mean 26 yr (range 14–64)	<5 yr: 66%; 5–10 yr: 16%; >10 yr: 19%	Repeat: 10/32 (31%) BAC+
Sims et al. [22]	115	NR	Mean 32 yr	NR	Repeat: 55/115 (48%) abused alcohol
Toschlog et al. [23]	528	50.9	Mean 55.9 ± 24.8 yr	Mean 26.5 ± 23.3 mo	Index and/or repeat: 310/528 (58.8%) BAC+
Vaaramo et al. [24]	827	68.2	Mean 38.6 ± 22.8 yr	NR	Index: 296/827 (35.8%) alcohol-related trauma
Winqvist et al. [25]	21	66.7	Mean 21 ± 5.8 yr	NR	Index: 9/21 (42.9%) alcohol-related trauma.

yr: year(s), mo: month(s), NR: not reported, and BAC: blood alcohol concentration.

Table 4
Secondary outcomes for alcohol-related trauma recidivism.

Authors	Association of alcohol and trauma recidivism	Confounders
Fabbri et al. [13]	Predictor of recurrent MVC: BAC+, RR 3.73, 95% CI 3.00–4.64, $p < 0.001$	Gender, night time, BAC $\geq$ 50 mg/dL, age $\leq$ 32 yr, night time NISS > 9, weekday, dangerous mechanism
Ponzer et al. [21]	Association of alcohol problems with recidivism: OR 2.22, 95% CI = 1.15–4.30	Age, gender, previous assault/battery, trouble during adolescence, alcohol problems
Vaaramo et al. [24]	Predictor of repeated TBI: alcohol-related index trauma, multivariable HR 2.51, 95% CI 1.38–4.56, $p < 0.01$	Age, gender, alcohol-related index trauma, severity of index trauma, and history of harmful drinking or previous TBI
Winqvist et al. [25]	Predictor of recurrent TBI: alcohol-related first injury, RR 4.41, 95% CI 1.53–12.70, $p = 0.006$	Gender, severity and external cause of TBI, involvement of alcohol in index case, family background, place of birth (rural vs. urban)

MVC: motor vehicle collision, BAC: blood alcohol concentration, RR: relative risk, CI: confidence interval, yr: year, NISS: new injury severity score, OR: odds ratio, HR: hazard ratio, and TBI: traumatic brain injury.

alcohol-related first injury was predictive of recurrent traumatic brain injury (TBI) (RR 4.41, 95% CI 1.53–12.70). One study [24] determined that an alcohol-related index trauma (adjusted HR 2.51, 95% CI 1.38–4.56) and history of TBI (HR 3.39, 95% CI 1.32–8.72) were independent risk factors for subsequent TBI. Finally, one study [21] reported that having problems with alcohol (based on trauma patient responses to the CAGE questionnaire) was an independent determinant of recidivist/non-recidivist grouping in their multiple logistic regression model (odds ratio [OR] 2.22, 95% CI 1.15–4.30).

Discussion

The goal of this systematic review was to examine the scale of trauma recidivism related to alcohol use through an evaluation of evidence available in the peer-reviewed literature. Overall, the rate of alcohol-related trauma recidivism ranged from 26.7% to 76.9% among individual studies, with an aggregate weighted estimate of 41.0%. Evidence of alcohol use on admission was associated with increased risk of recurrent traumatic injury. Our investigation is the first systematic review to specifically examine the proportion of trauma recidivism related to alcohol use and the association between alcohol and risk of repeated traumatic injury. The findings of our review reveal that a substantial proportion of trauma recidivism is alcohol-related.

While these findings are concerning, we urge some caution in interpreting these results due to methodological limitations and considerable variation among the studies included in this review. Studies differed in their definitions of positive alcohol on admission and the methods used to determine whether trauma cases were alcohol-related. Studies also differed in the types of trauma patients they included, with some limited to patients with injuries in a specific body region such as the head, and others broadly including all patients admitted to hospital or a trauma centre. This variation may be due in part to the lack of a universally accepted definition for a trauma patient, and may have contributed to the broad range of alcohol-related trauma recidivism rates observed among included studies. There was also considerable variation in the follow-up periods used to determine whether a repeat admission for injury had occurred. Importantly, this review is limited by the possibility that some patients were under the influence of substances in addition to alcohol when they were injured, and by the fact that all eligible patients may not have been screened for alcohol. In some studies, alcohol use was self-reported which may introduce social desirability and/or recall bias. Lastly, because most studies in this review were performed at a single centre, actual rates of recidivism may be higher than reported since some patients could have presented to different health care settings for each trauma episode, some may have failed to seek health care following their trauma, and some may have passed away before a history of previous trauma could be obtained

[3]. These limitations may make it problematic to interpret our aggregate estimate of the prevalence of alcohol-related trauma recidivism, but also suggest that it may underestimate the actual scale of this issue.

Rates of trauma recidivism have been reported to vary widely in the published literature, from less than 1% [2] to as high as 89% [26]. In our review, we observed that rates of trauma recidivism related to the use of alcohol ranged from 26.7% to 76.9%. One previous study found the incidence of alcohol-related visits to trauma centres limited to the United States ranged from 26.2% to 62.5%, with an aggregate weighted estimate of 32.5% [27]. Other US investigations have reported a positive BAC on admission in 28% [28], 33% [29], and 47.0% [9] of trauma patients, respectively. By comparison, US studies in our review observed rates of alcohol-related trauma recidivism between 31% and 58.8%. Studies from Europe have reported the prevalence of alcohol-related injury to range between 26.3% and 35.8% [30–32], and studies from Australia have reported prevalence rates from 17% to 77% [33–35]. Although alcohol-related injuries were common in all studies despite geographic location, we believe that the observed differences are likely influenced by variations in cultural norms and regional drinking patterns, as well as methodological factors associated with study design, populations, and alcohol screening [36].

Evidence from our review suggests that trauma patients with evidence of alcohol use on admission have a high likelihood of further significant traumatic injury. This is in accordance with findings from previous studies. In a large, population-based study of trauma recidivism, Worrell et al. found that use of alcohol in the first injury was associated with over a 2-fold increased risk of recurrent trauma after adjusting for age, gender, mechanism of injury, abbreviated injury score, ISS, and alcohol use (adjusted HR 2.30, 95% CI 2.12–2.51) [37]. Rivara et al. reported that repeated admission for trauma was predicted by a BAC > 22 mmol/L (RR 2.5, 95% CI 1.6–3.9), among other variables. Trauma recidivism has also been found to be disproportionately high among adolescents, and Redeker et al. have shown that alcohol use on weekdays is associated with trauma recidivism in young adults aged 15–30 years [38]. Additionally, Cooper et al. have found abuse of alcohol to be associated with an increased likelihood of violence victim recidivism [39]. These findings highlight the potential opportunity of identifying alcohol use in trauma patients and initiating strategies to limit the predictable sequelae of repeated traumatic injury suffered by both the patient and other victims.

In addition to the obvious harm that repeated traumatic injury inflicts on the patient and their family, trauma recidivism is also associated with an increased burden on the health care system [40,41]. Swearingen et al. demonstrated that trauma patients with a positive BAC utilise more resources and have worse outcomes in comparison with BAC negative trauma patients [42]. Another study by Roudsari et al. observed that acute intoxication and dependence to alcohol were both associated with more frequent

utilization of selected health care resources, and that these utilization patterns were not associated with the ethnicity of the trauma patient [43]. Interestingly, several studies have found that brief alcohol interventions are effective in reducing the risk of recidivism in trauma patients [44–48]; however, the overall evidence for brief interventions is mixed [49] and only a portion of trauma patients are actually screened for alcohol use and alcohol-related problems [50]. A retrospective review of longitudinal data (1998–2003) from the National Trauma Data Bank found that half of patients admitted for injuries were being tested for alcohol, and that half of these patients had a positive test result [51]. Barriers to screening include lack of time or resources, professional doubts about the effectiveness of interventions, various legal issues, and concerns regarding patient confidentiality [50]. Clinicians and health care providers must navigate these barriers as they face the challenge of balancing the rights of their patients (e.g., privacy) with the safety of the public at large.

One subgroup of the trauma population that poses significant risk to public health is the injured intoxicated driver. In our review, Fabbri et al. reported that a positive BAC on admission is predictive of a recurrent MVC (RR 3.73, 95% CI 3.00–4.64) [13]. Another study by Mancino et al. similarly found that alcohol abusers had significantly higher rates of recurrent MVCs, arrests for driving while intoxicated (DWI), and injuries compared with non-abusers [52]. In a recent systematic review, it was reported that intoxicated drivers seen in the ED of a hospital or trauma centre following injury in a MVC are seldom charged or convicted of driving under the influence (DUI) or DWI, and that between 6% and 40% of injured intoxicated drivers had a prior conviction for DUI or DWI [53]. The medical team is not required or authorised to report the BAC results of drivers injured in MVCs to local law enforcement authorities in most jurisdictions [54]. It is likely that the inability to inform authorities of an injured intoxicated driver places the public at risk, as the patient is likely to reoffend [13] and has little risk of legal repercussions as previously demonstrated [53]. Unfortunately, based on this current study, it is predictable that this patient is likely to cause more harm to both themselves and likely others. We believe further discussion is warranted to balance the privacy concerns of patients with the need for public safety in the case of an intoxicated trauma.

Trauma recidivism is harmful to the patient, taxing on the health care system, and of significant concern to public health. The findings of our review serve to highlight the unique opportunity and the responsibility of trauma surgeons and emergency physicians to address alcohol use with their patients in order to reduce overall morbidity and mortality, and to decrease the burden of trauma recidivism on the health care system. The re-evaluation of existing practices and policies is required to reduce the proportion of trauma recidivism related to alcohol use with the goal of minimizing unnecessary harms to both the individual and to society. We urge both health care providers and other key decision makers to explore opportunities to minimise the burden that current policies place on the health and wellbeing of our communities.

Conclusion

Data available in the current literature indicate that approximately 41% of trauma recidivism is related to alcohol use. These data may underestimate the actual prevalence of alcohol-related trauma recidivism due to methodological limitations among the studies included in this review.

Conflict of interest

The authors listed here (JN, ME, RG) declare they have no conflicts of interest, financial or otherwise, related to this study.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.injury.2016.01.008.

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