



Legal consequences for alcohol-impaired drivers injured in motor vehicle collisions: A systematic review



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ABSTRACT

Background: The treatment of alcohol-impaired drivers injured in a motor vehicle collision (MVC) is a complex public health issue. We conducted a systematic review to describe the legal consequences for alcohol-impaired drivers injured in a MVC and taken to a hospital or trauma center. **Methods:** We searched MEDLINE, Embase, and CINAHL databases from inception until August 2014. We included studies that reported legal consequences including charges or convictions of injured drivers taken to a hospital or trauma center after a MVC with a blood alcohol concentration (BAC) exceeding the legal limit. **Results:** Twenty-six studies met inclusion criteria; twenty studies were conducted in the USA, five in Canada, and one in Sweden. All were cohort studies (23 retrospective, 3 prospective) and included 11,409 patients overall. A total of 5,127 drivers had a BAC exceeding the legal limit, with legal consequences reported in 4937 cases. The median overall DUI/DWI conviction rate was 13% (range 0–85%). The median percentage of drivers with a previous conviction on their record for driving under the influence (DUI) or driving while intoxicated (DWI) was 15.5% (range 6–40%). The median percentage of drivers convicted again for DUI/DWI during the study period was 3.5% (range 2–10%). Heterogeneity between study designs, legal jurisdictions, institutional procedures and policies for obtaining a legally admissible BAC measurement precluded a meta-analysis. **Conclusions:** The majority of intoxicated drivers injured in MVCs and seen in the emergency department are never charged or convicted. A substantial proportion of injured intoxicated drivers had more than one conviction for DUI/DWI on their police record.

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1. Introduction

Alcohol-related motor vehicle collisions (MVCs) are a leading cause of preventable trauma and mortality worldwide (Brady and Li, 2014; The Alcohol-Crash Problem in Canada, 2013; Hayman and Crandall, 2009; Hingson and Winter, 2003). Alcohol-impaired drivers involved in MVCs and seen in the emergency department (ED) generally stay longer, use more resources, require hospital admission, incur higher health care costs, and have poorer outcomes compared with non-impaired drivers (O’Keefe et al.,

2013; Lee et al., 2009; Martin et al., 2013; Hsieh et al., 2013), although some research suggests alcohol use may also have a protective effect in trauma patients (Hsieh et al., 2013; Cherry et al., 2010; Plurad et al., 2010). The risk of a MVC and fatal injury increases as blood alcohol concentration (BAC) levels increase, and rises rapidly after a driver’s BAC exceeds 50 mg/dL compared to unimpaired drivers (Blomberg et al., 2009; Fell and Voas, 2014; Taylor et al., 2010; Taylor and Rehm, 2012). Intoxicated drivers involved in a MVC are more likely to have prior convictions for driving under the influence (DUI) or driving while impaired (DWI), and more likely to be involved a subsequent alcohol-related MVC (Rauch et al., 2010; Marowitz, 1998; Traffic Safety Facts, 2012; LaBrie et al., 2007).

Implementing and enforcing legal BAC limits can reduce the incidence of serious injury and mortality due to alcohol-related MVCs (Chang et al., 2012; Yao et al., 2014; Lapham and Todd, 2012; Wagenaar et al., 2007; Brubacher et al., 2014; Callaghan et al.,

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2014). In Canada and the United States, the proportion of fatal traffic crashes involving alcohol peaked in the early 1980s and gradually declined until the mid-1990s, after which it has remained relatively the same (Fell and Voas, 2014; Vanlaar et al., 2012). While significant progress has been made, the societal burden associated with impaired driving continues to be a significant public health issue. Approximately 30–40% of fatal MVCs in North America involve alcohol, the victims disproportionately younger and middle-aged men (The Alcohol-Crash Problem in Canada, 2013; Perreault, 2013; Traffic Safety Facts, 2013). Intoxicated drivers not only place themselves at risk, but also directly cause substantial death, disability and suffering of innocent citizens.

Intoxicated drivers seen in the ED following injury in a MVC may potentially evade legal consequences (McCammon, 2001; Criddle et al., 2001). Possible explanations include difficulty identifying intoxication, unavailability of a legally usable BAC measurement, lack of resources by police, poor logistical coordination between police and the ED, sympathy for the injured driver, and sanctity of doctor–patient relationship (Fell et al., 2009, 2010; Mancino et al., 1996; Orsay et al., 1994; Lowenstein et al., 1990; Goldman et al., 1998). The scale of this issue across different legal jurisdictions nationally and internationally is not well described. The objective of this systematic review is to synthesize evidence from peer-reviewed primary studies from the scientific literature that investigated the legal consequences for intoxicated drivers who were injured in a MVC and required assessment in the ED of a hospital or trauma center.

2. Method

This systematic review was performed in accordance with PRISMA guidelines (Moher et al. (2009)). The methods of analysis and eligibility criteria were pre-specified and documented in a protocol available upon request.

2.1. Data sources and search strategy

We searched three electronic databases (MEDLINE, Embase, and CINAHL) from inception until August 1, 2014 (last searched on August 7, 2014). The search strategy was developed in collaboration with an experienced librarian (see Appendix A) and modified for each database. We used a combination of medical subject headings (MeSH), Emtree headings, and variations of key words, including “trauma”; “injured”; “motor vehicle”; “automobile”; “car”; “alcohol”; “ethanol”; “intoxicated”; “impaired”; “police”; “charge”; “consequence”; “law”; “legal”; “prosecution”; “conviction” and “recidivism”. We restricted the search results to full-text articles published in English.

For this review, the terms “impaired” and “intoxicated” are used interchangeably and refer only to alcohol use. For each study in the review, we defined the “legal BAC limit” as the legal BAC cutoff in the jurisdiction at the time the study was performed. We defined “motor vehicles” to include automobiles, trucks, or motorcycles. No restrictions were placed on type or severity of injury suffered by the driver, or whether the injured driver was admitted to hospital or discharged from the ED.

2.2. Eligibility criteria

We included studies that met the following criteria: (a) design – any primary study involving human participants (randomized controlled trials, cohort studies, case control studies, case series, case reports); (b) population – drivers above the legal BAC limit (in the location and at the time of the study) who were injured in a MVC; (c) exposure – being seen for treatment in a hospital or

trauma center; and (d) outcome – any legal consequences (e.g., charges, convictions) that resulted from the case.

Our primary outcomes of interest were any legal charges or convictions for intoxicated drivers who were injured in a MVC and seen in the ED. Additional outcomes of interest were any prior or subsequent convictions reported for alcohol-impaired drivers, regardless of whether or not they were charged or convicted during the study.

2.3. Quality assessment

Two blinded investigators (N.K. and M.E.) independently assessed the quality of included studies using the risk of bias tool for nonrandomized studies (RoBANS) tool (Kim et al. (2013)). RoBANS is a domain based evaluation tool that is compatible with the Cochrane risk of bias tool and can be applied to the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) approach. We assessed studies according to six domains: (a) selection of participants; (b) confounding variables; (c) measurement of exposure; (d) blinding of outcomes; (e) incomplete outcome data; and (f) selective outcome reporting. Studies were included regardless of their risk of bias. We used the kappa statistic to calculate inter-observer reliability for agreement on all six domains.

2.4. Data abstraction and analysis

Two reviewers (N.K. and M.E.) independently applied selection criteria to titles and abstracts and then full papers. We searched bibliographies of all articles that met selection criteria to identify additional relevant studies. Any disagreements between N.K. and M.E. regarding study eligibility or quality assessment were resolved through consensus. If consensus could not be reached, a third reviewer (R.G.) was consulted to resolve the disagreement.

From included studies, two reviewers (N.K. and M.E.) used a standardized data extraction form and independently extracted data on location, design, legal BAC limit, the total number of patients, the number of patients exceeding the legal BAC limit and how many of them had police records available. Data was extracted from each study on the level of the trauma center(s) involved, which are based on guidelines developed in the United States by the American College of Surgeons Committee on Trauma (Trauma System Accreditation Guidelines, 2011), and in Canada by the Trauma Association of Canada Accreditation Committee (Resources for Optimal Care of the Injured Patients, 2014). For patients above the legal BAC limit, we extracted the following data elements when available: age; gender; Injury Severity Score (ISS); length of stay (LOS); mortality; culpability; administrative sanctions (number and type), legal charges (number and type); legal convictions (number and type); and any previous or subsequent convictions reported (number and type).

We calculated descriptive statistics for each included study. We defined the overall DUI/DWI conviction rate as the ratio of drivers above the legal BAC limit and convicted of DUI and/or DWI to the total number of drivers above the legal BAC limit and for whom police records were available. We converted any data regarding BAC levels to mg/dL and performed all analyses using RevMan version 5.3 Review Manager (RevMan) (2014) (Cochrane Collaboration, Copenhagen, Denmark) and the R Statistical software package (V3.0.1; R Foundation for Statistical Computing, Vienna, Austria). Individual studies varied by design, geography, jurisdiction, legal BAC limit, and procedure for obtaining a legally admissible BAC measurement. This heterogeneity precluded the ability to perform a meta-analysis.

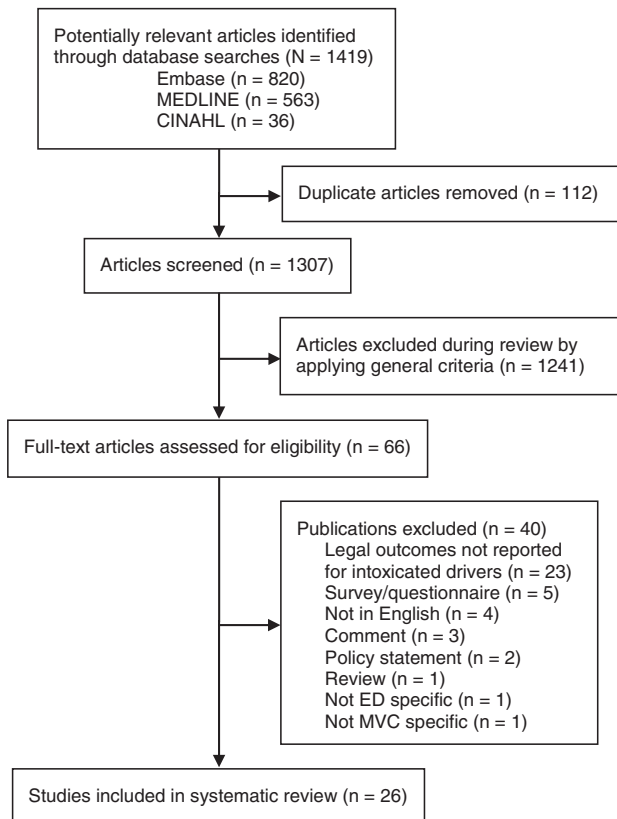


Fig. 1. Flow diagram of studies selected for inclusion in the review.

3. Results

3.1. Study characteristics

Twenty-six studies met all inclusion criteria (Fig. 1). Our search identified 1419 articles, from which 112 duplicates were removed. Two reviewers independently screened 1307 studies and identified 66 to be eligible (κ value=0.52; moderate agreement). Table 1 summarizes characteristics and the legal BAC limits of the 26 included studies (Barillo, 1993; Biffi et al., 2004; Brubacher et al., 2013; Chang et al., 2001; Cheek et al., 2013; Criddle and Carson, 1998; Colquitt et al., 1987; Cydulka et al., 1998; Evett et al., 1994; Fantus et al., 1991; Fieldus and Cain, 2012; Goecke et al., 2007; Holmes et al., 2014; Krause et al., 1998; Lahn et al., 2000; Lillis et al., 1993; Mattsson et al., 2000; Maull et al., 1984; McLaughlin et al., 1993; Pursell et al., 2004, 2010; Rehm et al., 1993; Runge et al., 1996; Schermer et al., 2001; Soderstrom et al., 1990, 1993) representing 11,409 patients overall. Twenty-three retrospective cohort (Barillo, 1993; Biffi et al., 2004; Brubacher et al., 2013; Chang et al., 2001; Cheek et al., 2013; Criddle and Carson, 1998; Colquitt et al., 1987; Cydulka et al., 1998; Evett et al., 1994; Fantus et al., 1991; Fieldus and Cain, 2012; Goecke et al., 2007; Holmes et al., 2014; Krause et al., 1998; Lillis et al., 1993; Mattsson et al., 2000; McLaughlin et al., 1993; Pursell et al., 2004, 2010; Runge et al., 1996; Schermer et al., 2001; Soderstrom et al., 1990, 1993) and three prospective cohort studies (Lahn et al., 2000; Maull et al., 1984; Rehm et al., 1993) satisfied the inclusion criteria. Sample sizes of included studies ranged from 56–2410 subjects (median = 175; interquartile range [IQR] 115–552).

Most studies were performed in North America, with twenty in the United States (Barillo, 1993; Biffi et al., 2004; Chang et al., 2001; Cheek et al., 2013; Criddle and Carson, 1998; Colquitt et al., 1987; Cydulka et al., 1998; Evett et al., 1994; Fantus et al., 1991; Holmes

et al., 2014; Krause et al., 1998; Lahn et al., 2000; Lillis et al., 1993; Maull et al., 1984; McLaughlin et al., 1993; Rehm et al., 1993; Runge et al., 1996; Schermer et al., 2001; Soderstrom et al., 1990, 1993), five in Canada (Brubacher et al., 2013; Fieldus and Cain, 2012; Goecke et al., 2007; Pursell et al., 2004, 2010), and one in Sweden (Mattsson et al., 2000). Eighteen studies (Barillo, 1993; Biffi et al., 2004; Chang et al., 2001; Cheek et al., 2013; Criddle and Carson, 1998; Colquitt et al., 1987; Cydulka et al., 1998; Evett et al., 1994; Fantus et al., 1991; Fieldus and Cain, 2012; Goecke et al., 2007; Holmes et al., 2014; Krause et al., 1998; Lillis et al., 1993; Mattsson et al., 2000; Maull et al., 1984; McLaughlin et al., 1993; Schermer et al., 2001; Soderstrom et al., 1990) reported BAC levels of drivers above the legal BAC limit. The median of the mean BAC reported for intoxicated drivers was 213 mg/dL (IQR 190 mg/dL–217 mg/dL). In thirteen of these studies (Biffi et al., 2004; Chang et al., 2001; Cheek et al., 2013; Criddle and Carson, 1998; Colquitt et al., 1987; Cydulka et al., 1998; Evett et al., 1994; Fantus et al., 1991; Holmes et al., 2014; Krause et al., 1998; Maull et al., 1984; McLaughlin et al., 1993; Schermer et al., 2001), the mean or median BAC of intoxicated patients was greater than 200 mg/dL. The majority of studies were performed at a Level 1 trauma center (Barillo, 1993; Biffi et al., 2004; Chang et al., 2001; Cydulka et al., 1998; Evett et al., 1994; Fantus et al., 1991; Fieldus and Cain, 2012; Goecke et al., 2007; Holmes et al., 2014; Krause et al., 1998; Lahn et al., 2000; Maull et al., 1984; McLaughlin et al., 1993; Pursell et al., 2004, 2010; Rehm et al., 1993; Runge et al., 1996; Schermer et al., 2001; Soderstrom et al., 1990). Three studies (Cheek et al., 2013; Criddle and Carson, 1998; Colquitt et al., 1987) were performed at Level 2 trauma centers, four studies (Brubacher et al., 2013; Pursell et al., 2004, 2010; Soderstrom et al., 1993) used data collected from multiple trauma centers (Levels 1 and 2), and two studies (Lillis et al., 1993; Mattsson et al., 2000) were performed using hospital records. Three studies (Brubacher et al., 2013; Goecke et al., 2007; Pursell et al., 2010) excluded injured motorcycle drivers, while one study (Soderstrom et al., 1993) included only injured motorcycle drivers.

Most patients were younger and middle-aged males. Sixteen studies (Biffi et al., 2004; Criddle and Carson, 1998; Colquitt et al., 1987; Cydulka et al., 1998; Fieldus and Cain, 2012; Goecke et al., 2007; Holmes et al., 2014; Lillis et al., 1993; Maull et al., 1984; McLaughlin et al., 1993; Pursell et al., 2004, 2010; Rehm et al., 1993; Schermer et al., 2001; Soderstrom et al., 1993) reported patient age and seventeen studies (Biffi et al., 2004; Brubacher et al., 2013; Colquitt et al., 1987; Cydulka et al., 1998; Fieldus and Cain, 2012; Goecke et al., 2007; Holmes et al., 2014; Krause et al., 1998; Lillis et al., 1993; Maull et al., 1984; McLaughlin et al., 1993; Pursell et al., 2004, 2010; Rehm et al., 1993; Runge et al., 1996; Schermer et al., 2001; Soderstrom et al., 1990) reported the gender of injured drivers above the legal BAC limit. The median of mean age of patients was 32 years (IQR 30.35–33 years) and the median percentage of males represented was 82.6% (IQR 79–84%). Mean ISS of intoxicated drivers was reported in 14 studies (Barillo, 1993; Biffi et al., 2004; Chang et al., 2001; Cheek et al., 2013; Colquitt et al., 1987; Fieldus and Cain, 2012; Goecke et al., 2007; Krause et al., 1998; Lillis et al., 1993; McLaughlin et al., 1993; Pursell et al., 2004; Rehm et al., 1993; Schermer et al., 2001; Soderstrom et al., 1990) with a median ISS score of 13.4. Nine studies (Barillo, 1993; Biffi et al., 2004; Chang et al., 2001; Cheek et al., 2013; Criddle and Carson, 1998; Mattsson et al., 2000; McLaughlin et al., 1993; Pursell et al., 2004; Soderstrom et al., 1990) reported in-hospital length of stay for intoxicated drivers with a median LOS of 7.2 days. Mortality was reported in nine studies (Barillo, 1993; Criddle and Carson, 1998; Colquitt et al., 1987; Fantus et al., 1991; Goecke et al., 2007; Lahn et al., 2000; Rehm et al., 1993; Runge et al., 1996; Soderstrom et al., 1993) with a median mortality rate of 6.1%. Most studies (Brubacher et al., 2013; Chang et al., 2001; Cheek et al., 2013; Cydulka et al., 1998; Evett et al., 1994; Fantus et al., 1991;

Table 1
Study authors, year of publication, location, legal limit, and participant characteristics.

Study	Location	Legal BAC limit ^a (mg/dL)	No. of patients overall	No. of impaired drivers ^b	Sex ^b (% male)	Mean age ^b (years) ± SD [range]	Mean BAC ^b (mg/dL) ± SD [range]	Mean ISS ^b ± SD [range]	Mean LOS ^b (days) ± SD [range]
Barillo (1993)	PA (USA)	100	511	511	NR	NR	193.7	16.4	12.5
Biffi et al. (2004)	RI (USA)	100	113	113	78	33.7	212.9	13.6	7
Brubacher et al. (2013)	BC (Canada)	50	2410	736	N/A ^c	N/A ^c	N/A ^c	NR	N/A ^c
Chang et al. (2001)	PA (USA)	100	213	213	NR	NR	213.7 ± 61.1 [100–484]	15.4 ± 12.5	6.7 ± 7.8
Cheek et al. (2013)	TX (USA)	80	118	118	82	NR	218	11	1.5 [0–25]
Criddle and Carson (1998)	CT (USA)	100	127	84	NR	25 [17–71] ^d	218.5 [106–354] ^d	NR	7 [1–75] ^d
Colquitt et al. (1987)	TX (USA)	100	1017	340	80	32.1	211	9.6	NR
Cydulka et al. (1998)	OH (USA)	100	70	70	73	32 ± 11.8	240 ± 86 [100–420]	NR	NR
Evelt et al. (1994)	VA (USA)	100	245	245	NR	NR	215 ± 60	NR	NR
Fantus et al. (1991)	IL (USA)	100	116	61	NR	NR	217 [100–369]	NR	NR
Fieldus and Cain (2012)	NS (Canada)	80	57	57	86	32.4 ± 13.0 [16–72]	186.2 ± 59.9 [88–318]	14.4 ± 12 [0–45]	NR
Goecke et al. (2007)	AB (Canada)	80	185	185	83	32 (23,41) ^e	190 ± 73	22 (16,33) ^e	N/A ^c
Holmes et al. (2014)	CA (USA)	80	241	241	77	34.2 ± 12.7	204 (146,258) ^e	N/A ^c	NR
Krause et al. (1998)	MI (USA)	100	71	71	77	35.0	218 [102–463]	9 [1–35]	NR
Lahn et al. (2000)	NY (USA)	100	294	18	N/A ^c	N/A ^c	NR	NR	NR
Lillis et al. (1993)	NY (USA)	80	832	173	86.1	30.2 ± 10.2	190 ± 60	13.9 ± 8.7	15.2 ± 18.7
Mattsson et al. (2000)	Umea (Sweden)	20	125	13	NR	NR	180 [110–270]	NR	NR
Mauil et al. (1984)	VA (USA)	100	56	56	84	30 [16–59]	240 [150–350]	NR	NR
McLaughlin et al. (1993)	MI (USA)	100	159	49	83.7	30.7	217.0	11.6	7.4
Purssell et al. (2010)	BC (Canada)	80	1489	267	80.5	31.5	N/A ^c	NR	NR
Purssell et al. (2004)	BC (Canada)	80	1697	619	82.6	32 ± 11.4	N/A ^c	19 ± 13	12 ± 21
Rehm et al., (1993)	NJ (USA)	100	87	87	81.6	30 [17–80]	NR	13.3 [1–50]	NR
Runge et al. (1996)	NC (USA)	100	187	187	84	N/A ^c	N/A ^c	NR	NR
Schermer et al. (2001)	NM (USA)	80	674	477	83	33.0	213	13.4	NR
Soderstrom et al. (1990)	MD (USA)	80	150	58	84.5	30.5	157.9 [87–280]	10.6	5.5
Soderstrom et al. (1993)	MD (USA)	70	165	78	N/A ^c	N/A ^c	N/A ^c	N/A ^c	N/A ^c

Notes: BAC: blood alcohol concentration, SD: standard deviation, ISS: injury severity score, LOS: length of stay in hospital or intensive care unit, NR: not reported, N/A: not available.

^a Legal definition of intoxication in the study location at the time the study was performed.

^b Based on number of drivers with BAC determined to exceed the legal BAC limit at the time of the study.

^c Data not available for legally intoxicated drivers only.

^d Reported median and range.

^e Reported median and interquartile range. Not all studies included SD and/or range for mean values.

Fieldus and Cain, 2012; Holmes et al., 2014; Krause et al., 1998; McLaughlin et al., 1993; Pursell et al., 2004, 2010; Schermer et al., 2001; Soderstrom et al., 1990) excluded drivers who died before discharge or who were not expected to drive again due to their injuries. Five studies (Maull et al., 1984; McLaughlin et al., 1993; Rehm et al., 1993; Soderstrom et al., 1990, 1993) reported on the culpability of intoxicated drivers for causing the MVC, with between 86.7% and 100% (median = 93.9%) of intoxicated drivers found culpable for the crash. In two studies (Cheek et al., 2013; Colquitt et al., 1987), drug screening identified patients with substances in addition to alcohol in their system including cocaine, heroin, tetrahydrocannabinol, and amphetamine.

3.2. Legal consequences

Table 2 summarizes the legal consequences for injured intoxicated drivers seen in an ED or trauma center. Most studies (Barillo, 1993; Biffi et al., 2004; Brubacher et al., 2013; Chang et al., 2001; Cheek et al., 2013; Criddle and Carson, 1998; Colquitt et al., 1987; Cydulka et al., 1998; Evett et al., 1994; Fantus et al., 1991; Fieldus and Cain, 2012; Goecke et al., 2007; Holmes et al., 2014; Krause et al., 1998; Lillis et al., 1993; Mattsson et al., 2000; Maull et al., 1984; McLaughlin et al., 1993; Pursell et al., 2004, 2010; Rehm et al., 1993; Runge et al., 1996; Schermer et al., 2001; Soderstrom et al., 1990, 1993) assessed police charges and convictions by linking medical records with driving abstracts, police driving records, or court records. One prospective consecutive observational cohort study Lahn et al. (2000) enrolled all drivers aged 18 or older evaluated in the ED following a MVC and used trained research assistants to collect data on patients and the police presence at the scene of the MVC. For this study, a DWI arrest was defined as either the presence of handcuffs and an officer stating the patient was under arrest for DWI, or an officer presenting a patient with a desk warrant or court appearance slip for DWI. Of the 5127 drivers with a BAC exceeding the legal limit, linkage to police records was possible in 4937 cases. Twenty-three studies (Barillo, 1993; Biffi et al., 2004; Brubacher et al., 2013; Chang et al., 2001; Cheek et al., 2013; Criddle and Carson, 1998; Cydulka et al., 1998; Evett et al., 1994; Fantus et al., 1991; Goecke et al., 2007; Holmes et al., 2014; Krause et al., 1998; Lillis et al., 1993; Mattsson et al., 2000; Maull et al., 1984; McLaughlin et al., 1993; Pursell et al., 2004, 2010; Rehm et al., 1993; Runge et al., 1996; Schermer et al., 2001; Soderstrom et al., 1990, 1993) reported data on convictions. Of the studies that reported DUI or DWI convictions, the median overall DUI/DWI conviction rate was 13% (range 0–85%). Of the 18 studies in the United States (Barillo, 1993; Biffi et al., 2004; Chang et al., 2001; Cheek et al., 2013; Criddle and Carson, 1998; Cydulka et al., 1998; Evett et al., 1994; Fantus et al., 1991; Holmes et al., 2014; Krause et al., 1998; Lillis et al., 1993; Mattsson et al., 2000; Maull et al., 1984; McLaughlin et al., 1993; Pursell et al., 2010; Rehm et al., 1993; Runge et al., 1996; Schermer et al., 2001; Soderstrom et al., 1990, 1993) that reported on convictions, the median overall DUI/DWI conviction rate was 13.5% (range 0–63%). Among the 4 Canadian studies (Brubacher et al., 2013; Goecke et al., 2007; Pursell et al., 2004, 2010) that reported on patients who were convicted, the median overall DUI/DWI conviction rate was 10.5% (range 7–16%). The one study performed in Sweden (Mattsson et al., 2000) reported an overall DUI/DWI conviction rate of 85%. Nineteen studies (Barillo, 1993; Biffi et al., 2004; Brubacher et al., 2013; Chang et al., 2001; Cheek et al., 2013; Criddle and Carson, 1998; Colquitt et al., 1987; Cydulka et al., 1998; Fantus et al., 1991; Fieldus and Cain, 2012; Goecke et al., 2007; Lahn et al., 2000; Maull et al., 1984; Pursell et al., 2004, 2010; Rehm et al., 1993; Runge et al., 1996; Schermer et al., 2001) reported data on police charges for intoxicated drivers. The median percentage of intoxicated drivers who were charged with either DUI or DWI was

21% (IQR 13.5–33.0%) with a range of 5–73%. Other charges or administrative sanctions included driving with a suspended license, intoxicated manslaughter, reckless driving, and 24 h or 90-day license suspensions. The median percentage of intoxicated drivers convicted after being charged for any offense was 65% (IQR 11–84%) with a range of 0–100%.

Eight studies examined the relationship between ISS and legal consequences for intoxicated drivers. Five studies (Cheek et al., 2013; Fieldus and Cain, 2012; Goecke et al., 2007; Krause et al., 1998; Lillis et al., 1993) found no significant difference in ISS between patients charged or convicted of DUI/DWI and those not prosecuted. Using multivariate logistic regression, two studies (Goecke et al., 2007; Holmes et al., 2014) found ISS significantly associated with conviction for DUI, while a third study Schermer et al. (2001) found no significance. One study Runge et al. (1996) used Trauma Score (TS) rather than ISS to evaluate injury severity, and showed severely injured patients (TS ≤ 12) were significantly less likely to be charged with DWI than less severely injured patients. One study McLaughlin et al. (1993) compared cohorts of intoxicated/injured drivers, intoxicated/non-injured drivers, and sober/injured drivers and found a significant difference in the conviction rate of injured intoxicated drivers (59%) compared with uninjured intoxicated drivers (100%).

Previous and/or subsequent legal consequences for intoxicated drivers who were injured in a MVC are shown in Table 3. There were ten studies (Biffi et al., 2004; Cheek et al., 2013; Colquitt et al., 1987; Lillis et al., 1993; Maull et al., 1984; McLaughlin et al., 1993; Pursell et al., 2010; Runge et al., 1996; Schermer et al., 2001; Soderstrom et al., 1990) that reported previous convictions. The median percentage of intoxicated drivers with a previous conviction for either DUI or DWI was 15.5% (range 6–40%). Seven studies (Barillo, 1993; Biffi et al., 2004; Cheek et al., 2013; Cydulka et al., 1998; Fantus et al., 1991; Pursell et al., 2010; Schermer et al., 2001; Soderstrom et al., 1990) reported subsequent legal consequences for injured intoxicated drivers during the study period. The median percentage of drivers with a subsequent DUI/DWI conviction was 3.5% (range 2–10%).

3.3. Risk of bias

Most studies were judged as having low risk of bias for participant selection, measurement of exposure, blinding of outcome assessment, and selective outcome reporting. There was high risk of bias for the domains of confounding variables and incomplete outcome reporting. Inter-rater reliability (Table 4) was calculated using kappa statistics (Cohen, 1960; Landis and Koch, 1977) and ranged from poor ($\kappa = -0.083$ for selective outcome reporting) to fair ($\kappa = 0.310$ for incomplete outcome data). Review authors' judgments for each risk of bias item are shown in Fig. 2.

4. Discussion

In our review of the literature, we identified 26 studies that investigated the legal consequences for intoxicated drivers who were injured in a MVC and taken to a hospital or trauma center. In most studies, the mean BAC of patients exceeded 200 mg/dL. The median overall DUI/DWI conviction rate for injured intoxicated drivers was 13% (range 0–85%). Among studies that reported previous or subsequent convictions, the median percentage of drivers with a previous conviction for DUI/DWI was 15.5% (range 6–40%) and the median percentage with a subsequent DUI/DWI conviction was 3.5% (range 2–10%). This is the first systematic review to synthesize evidence from studies of legal outcomes for intoxicated drivers who were injured in a MVC and taken to hospital or a trauma center. This study is important to improve our understanding of the management of impaired drivers sustaining

Table 2
Legal consequences for injured intoxicated drivers.

Study	n ^a	No. of charges or administrative sanctions for intoxicated drivers (% of n ^a)	No. of convictions for intoxicated drivers (% of drivers charged)	Overall DUI/DWI conviction rate ^b
Barillo (1993)	480	DUI: 198 (41); RD: 2 (0.4)	DUI: 195 (98)	41%
Biffi et al. (2004)	113	DUI: 12 (11); DSL: 7 (6); RD: 3 (3)	DUI: 10 (83)	9%
Brubacher et al. (2013)	736	DUI: NR; 24 h suspension: 145 (20); 90-day suspension: 84 (11)	DUI: 75	10%
Chang et al. (2001)	213	DUI: 156 (73)	DUI: 135 (87) [2 died prior to trial, 10 legal outcomes were pending]	63%
Cheek et al. (2013)	118	DWI: 21 (18); DSL: 1 (1); speeding: 1 (1); intoxicated manslaughter: 1 (1)	DWI: 17 (81); 14 were fined and put on probation, 3 received jail sentences	14%
Criddle and Carson (1998)	59	DUI: 3 (5); RD or speeding: 21 (36); criminal act: 14 (24); highway code violation: 23 (39); [some had >1 charge]	DUI: 0 (0)	0%
Colquitt et al. (1987)	251	DUI: 42 (16); serious injury collision: 6 (2); intoxicated manslaughter: 4 (2); lesser charges: 10 (4); unknown charges: 10 (4)	NR	NR
Cydulka et al. (1998)	70	DUI: 23 (33)	DUI: 15 (65)	21%
Evelt et al. (1994)	245	NR	DUI: 9 (4)	4%
Fantus et al. (1991)	55	DUI: 4 (7)	DUI: 0 (0)	0%
Fieldus and Cain (2012)	57	DUI: 13 (23)	NR	NR
Goecke et al. (2007)	168	Any charge: 69 (41)	DWI: 27 (39); dangerous driving: 13 (19); without due care: 13 (19); 16% criminal negligence: 3 (4); disqualified driving: 1 (1); license suspension: 1 (1)	16%
Holmes et al. (2014)	241	NR	DUI: 142	59%
Krause et al. (1998)	69	NR	DUI: 25 (36); DWI: 10 (14); lesser violations: 10 (14); LSA: 1 (1); 1 pending charge for DUI (arrest warrant issued)	51%
Lahn et al. (2000)	18	DWI: 4 (22)	NR	NR
Lillis et al. (1993)	173	NR	DWI: 50	29%
Mattsson et al. (2000)	13	NR	DUI/DWI: 11	85%
Maull et al. (1984)	56	Undetermined charges: 33 (59)	DUI: 0; RD: 8; No insurance: 4; improper driving: 3; manslaughter: 2; eluding police: 1; no license: 1	0%
McLaughlin et al. (1993)	49	NR	DUI: 29	59%
Purssell et al. (2010)	267	24 h suspension: 84 (31); 90-day suspension: 36 (13); other traffic violation: 44 (16)	DUI: 18 (7); other CCC: 19 (7)	7%
Purssell et al. (2004)	619	24 h suspension: 66 (11); 90-day suspension: 24 (4); other traffic violation: 155 (25)	DUI: 68; other CCC: 52	11%
	84	DWI: 11 (13)	DWI: 11 (100)	13%

Table 2 (Continued)

Study	<i>n</i> ^a	No. of charges or administrative sanctions for intoxicated drivers (% of <i>n</i> ^a)	No. of convictions for intoxicated drivers (% of drivers charged)	Overall DUI/DWI conviction rate ^b
Rehm et al. (1993)				
Runge et al. (1996)	187	DWI: 53 (28)	DWI: 32 (58)	17%
Schermer et al. (2001)	477	DUI: 98 (21)	DUI: 64 (65)	13%
Soderstrom et al. (1990)	58	NR	DUI: 2; DWI: 3; RD: 10; speeding: 7; DSL: 1; homicide by motor vehicle while intoxicated: 1; [some had >1 conviction]	9%
Soderstrom et al. (1993)	61	NR	DUI: 2 [1 also received conviction for manslaughter]; DWI: 5; RD: 4; speeding: 1; DSL: 1 [some had >1 conviction]	11%

Notes: DUI: driving under the influence, NR: not reported, DSL: driving with suspended license, RD: reckless driving, LSA: leaving scene of motor vehicle crash, DWL: driving without a license, DWI: driving while intoxicated, IDA: impaired driving activity.

^a Legally impaired drivers with police records available.

^b Percentage of injured drivers above the legal BAC limit with police records available who were convicted of DUI and/or DWI.

Table 3

Prior and subsequent convictions reported for injured intoxicated drivers.

Study (<i>na</i>)	Intoxicated drivers with prior convictions (% of <i>n</i> ^a)	Intoxicated drivers with subsequent convictions (% of <i>n</i> ^a)
Barillo (1993) (<i>n</i> = 480)	NR	DUI: 48 (10)
Biffi et al. (2004) (<i>n</i> = 113)	DSL: 33 (29); DUI: 12 (11); RD: 3 (3); LSA: 3 (3); DWL: 2 (2)	DSL: 15 (13); DUI: 10 (9); PSMV: 1 (1); LSA: 1 (1); DEPI: 1 (1); DWC: 1 (1)
Cheek et al. (2013) (<i>n</i> = 118)	DWI: 18 (15)	DWI: 4 (3); other charges: 45 (38)
Cydulka et al. (1998) (<i>n</i> = 70)	Alcohol-related citation: 4 (6)	Alcohol-related citation: 5 (7)
Fantus et al. (1991) (<i>n</i> = 55)	NR	DUI: 2 (4)
Lillis et al. (1993) (<i>n</i> = 173)	DWI: 26 (15)	NR
Mauil et al. (1984) (<i>n</i> = 56)	DUI: 9 (16); RD: 16 (29); license suspension and crash: 20 (36); moving violation: 40 (71)	NR
McLaughlin et al. (1993) (<i>n</i> = 49)	DUI: 19 (39); traffic violation: 43 (88); license restriction: 23 (47)	NR
Pursell et al. (2010) (<i>n</i> = 267)	DUI: 16 (6); IDA: 146 (55); alcohol-related crash: 32 (12); non-alcohol related crash: 91 (34)	DUI: 6 (2); IDA: 82 (31); alcohol-related crash: 17 (6); non-alcohol related crash: 31 (12)
Runge et al. (1996) (<i>n</i> = 187)	DWI: 74 (40); >1 moving violation: 99 (53)	NR
Schermer et al. (2001) (<i>n</i> = 477)	DUI: 88 (18); MVC: 90 (19)	DUI: 14 (3); MVC: 35 (7)
Soderstrom et al. (1990) (<i>n</i> = 58)	Alcohol-related: 21 ^b ; speed-related: 139 ^b ; RD: 119 ^b	Alcohol-related: 11 ^b ; speed-related: 21 ^b ; RD: 20 ^b

Notes: DUI: driving under the influence, NR: not reported, DSL: driving with suspended license, RD: reckless driving, LSA: leaving scene of a motor vehicle crash, DWL: driving without a license, PSMV: possession of stolen motor vehicle, DEPI: driving to endanger resulting in personal injury, DWC: driving vehicle without owner's consent, DWI: driving while intoxicated, IDA: impaired driving activity, MVC: motor vehicle collision.

^a Intoxicated drivers with police records available.

^b Total convictions reported for *n* = 58 drivers.

Table 4
Inter-rater agreement using RoBANS tool for assessing risk of bias in included studies.

Domain	Low	Unclear	High	Weighted kappa
Selection of participants	23	3	0	0.103
Confounding variables	7	7	12	0.017
Measurement of exposure	25	1	0	0.00
Blinding of outcome assessments	23	3	0	0.120
Incomplete outcome data	8	8	10	0.310
Selective outcome reporting	13	8	5	– 0.083

traumatic injury in a MVC by medical and law enforcement professionals, and to support forthcoming prevention policies and programs.

The findings of this review indicate that a majority of intoxicated drivers injured in a MVC and seen in a hospital or trauma center are never charged, and that a minority of these drivers had more than one alcohol-related conviction on their driving record. All but 2 of the 26 studies included in this review were performed at Level 1 and/or Level 2 trauma centers; these designations are given to centers that have been verified to provide the highest levels of trauma care within a trauma system (Level 1 being the highest, followed by Level 2), and have dedicated 24 h in-house trauma specialists and services available (Trauma system accreditation guidelines, 2011; Resources for Optimal Care of the Injured Patients, 2014). There was considerable variability between individual studies regarding the types of legal outcomes reported and the strength of evidence for each. Comparing these studies is challenging when considering they were performed over a 30-year period (1984–2014) during which there have been significant changes in driving regulations and enforcement (Callaghan et al., 2014; Asbridge et al., 2004; Fell et al., 2015), societal norms regarding drinking and driving (Elder et al., 2004; Allamani et al., 2014), legal BAC limits (Fell and Voas, 2014; Wagenaar et al., 2007), methods and procedures for measuring BAC (Glenn et al., 2011; Zamengo et al., 2014), graduated licensing systems Hartling et al. (2004), and interventions to help prevent impaired driving (Schermer et al., 2006; Shuts et al., 2001; Steinka-Fry et al., 2015). These changes have varied both between countries and among jurisdictions within the same country.

In this review, the study Mattsson et al. (2000) with the highest conviction rate of 85% was performed in Sweden at a time when the BAC cut-off was 20 mg/dL, which is considerably lower than the BAC cut-offs in the studies from the United States and Canada. The study authors suggested the high rate of convictions they observed could be attributed to procedures surrounding MVCs in Sweden where police and ambulances are simultaneously sent to crashes and blood samples for judicial purposes are requested liberally in these cases (Mattsson et al., 2000). This study analyzed data from 1991 to 1993, before the introduction of a 1999 zero-tolerance law in Sweden for driving under the influence of drugs (DUID) which resulted in a 10-fold increase in the number of cases submitted by police for toxicological analysis Holmgren et al. (2008). At present, Sweden has among the toughest impaired driving regulations worldwide. Drivers found to have BAC levels between 20 mg/dL and 100 mg/dL may face imprisonment for up to 6 months, license suspension for 1–12 months, and fines based on the circumstances of the incident, the BAC level of the driver, and even income level (i.e., heftier fines for wealthier drivers) Podda (2012). Other important differences between Sweden, Canada, and the United States include the legal drinking age (18 and 19 years in Canada, Sweden; 21 years in United States), graduated licensing systems (learner’s permit: 14–16 years in Canada, United States; 16 years in Sweden), and societal norms regarding alcohol use.

In contrast to the study from Sweden, the studies performed in the United States and Canada tended to observe much lower rates of

	Selection of participants	Confounding variables	Measurement of exposure	Blinding of outcome assessments	Incomplete outcome data	Selective outcome reporting
Barillo et al	+	?	+	+	?	-
Biffl et al	+	-	+	+	+	+
Brubacher et al	+	+	+	+	?	+
Chang et al	+	-	+	+	?	+
Cheek et al	+	?	+	+	?	+
Colquitt et al	+	-	+	+	-	-
Criddle et al	+	+	+	+	-	+
Cydulka et al	+	-	+	+	+	+
Evetl et al	+	-	+	+	-	-
Fantus et al	+	-	+	+	-	-
Fieldus et al	+	+	+	+	+	+
Goecke et al	+	?	+	+	?	+
Holmes et al	+	+	+	+	?	?
Krause et al	+	?	+	+	?	+
Lahn et al	+	-	+	+	-	+
Lillis et al	?	+	?	?	+	?
Mattson et al	+	-	+	+	?	?
Mauil et al	?	-	+	?	+	?
McLaughlin et al	+	?	+	+	+	?
Pursell et al (2004)	+	?	+	+	-	?
Pursell et al (2010)	+	-	+	+	+	+
Rehm et al	?	-	+	?	-	-
Runge et al	+	+	+	+	-	+
Schermer et al	+	?	+	+	+	?
Soderstrom et al (1990)	+	+	+	+	-	+
Soderstrom et al (1993)	+	-	+	+	-	?

Fig. 2. Review authors’ judgments about each risk of bias item for included studies. Each domain was assessed against criteria for judgments of a ‘low risk’ of bias (+), ‘high risk’ of bias (-), or an ‘unclear risk’ of bias (?).

DUI/DWI conviction, ranging between 0–63% (median 13.5%) in the United States and between 7–16% (median 10.5%) in Canada. Although impaired driving laws in the United States and Canada are similar in many ways, Canada considers impaired driving to be a serious criminal offense and has higher penalties for impaired driving than the DUI/DWI penalties in the United States Helis (2015). Most study authors offered possible explanations for the low rates of DUI/DWI convictions they observed. These included limited access to trauma patients by law enforcement during a medical emergency (Biffi et al., 2004; Cheek et al., 2013; Criddle and Carson, 1998; Cydulka et al., 1998; Evett et al., 1994; Fantus et al., 1991; Pursell et al., 2004), difficulty identifying intoxication (Barillo, 1993; Brubacher et al., 2013; Cheek et al., 2013; Goecke et al., 2007; Lillis et al., 1993; Pursell et al., 2004), lack of accurate patient identifiers Cheek et al. (2013), lack of adequate resources for law enforcement (Goecke et al., 2007; Pursell et al., 2004), difficulties with obtaining a legally admissible BAC measurement (Biffi et al., 2004; Cheek et al., 2013; Colquitt et al., 1987; Cydulka et al., 1998; Fantus et al., 1991; Goecke et al., 2007; Maull et al., 1984; Pursell et al., 2004), long distances required to transport some patients (Barillo, 1993; Biffi et al., 2004; Criddle and Carson, 1998; Cydulka et al., 1998; Evett et al., 1994; Maull et al., 1984) sympathy for the injured trauma patient (Biffi et al., 2004; Brubacher et al., 2013; Cheek et al., 2013; Colquitt et al., 1987; Cydulka et al., 1998; Evett et al., 1994; Maull et al., 1984), and the sanctity of doctor-patient confidentiality (Biffi et al., 2004; Fantus et al., 1991). Although sympathy for the injured trauma patient was often cited as a possible explanation for low conviction rates, 6 of the 10 studies which examined the relationship between injury severity and legal outcomes found no significant difference in injury severity between patients charged or convicted of DUI/DWI and those that were not prosecuted.

While the medical management of intoxicated drivers sustaining traumatic injury is relatively straight forward, the broader societal issue of keeping the public safe from intoxicated drivers is far more complex. Previous research suggests the most effective means to reduce impaired driving recidivism is a combination of legal sanctions and treatment for alcohol use (Fell et al., 2009; Asbridge et al., 2004; Schermer et al., 2006; Shuts et al., 2001; Steinka-Fry et al., 2015). Mandatory alcohol testing programs have also been shown to be effective in reducing alcohol-related MVCs Brady et al. (2009). A recent study of traffic laws targeting speeders and intoxicated drivers in British Columbia found significant decreases in alcohol-related fatal crashes, hospital admissions, and ambulance calls for road trauma in the two-year period after implementation of the new traffic laws Brubacher et al. (2014). Prevention plays a crucial role in reducing high-risk behaviors among problem drinkers. A systematic review of randomized controlled trials demonstrated that interventions among individuals with problem drinking can reduce morbidity and mortality from alcohol-related injuries Dinh-Zarr et al. (2004).

Alcohol-related MVCs are a serious public health issue, causing significant economic burden and adverse social consequences. In the United States, the estimated societal cost of alcohol-involved crashes in 2010 totaled \$125 billion Zaloshnja et al., (2013). Indirect costs such as loss of productivity, increase in disability, decrease in quality of life, and premature death are more challenging to estimate. We believe the results from this systematic review form a starting point for further discussion and research into the need for evidence-based policies directed toward the reduction of alcohol-attributable MVCs.

4.1. Strengths and limitations

The strength of this systematic review is in the adherence to a standardized objective process for the collection, abstraction, and collation of data Moher et al., (2009). An extensive search of peer-

reviewed literature was performed and all papers were evaluated independently by two reviewers. We noted a moderate inter-reviewer agreement (κ value = 0.52) for the manual article search and final evaluation phases of data collection. Poor inter-rater agreement for specific domains on the RoBANS tool may be a reflection of the inherent difficulty with rating the quality of non-randomized studies compared with randomized controlled trials. Although RoBANS was specifically designed to assess the risk of bias of non-randomized studies, rater disagreements on questions subject to individual interpretation may explain the negative kappa value that was calculated for the domain of selective outcome reporting (κ = -0.083).

This study has limitations, such as the exclusion of non-English literature, and the fact that the majority of included articles were retrospective in nature. Many of the studies only examined a small number of risk factors and did not control for confounding variables. Individual studies were limited by the availability of legally admissible blood draws. Despite these shortcomings, several studies implicated severity of injury and previous conviction history as risk factors for DUI/DWI conviction.

5. Conclusion

Evidence from available studies indicates the majority of intoxicated drivers who are injured in MVCs and require assessment in the ED of a hospital or trauma center are never charged or convicted of DUI or DWI. A substantial proportion of these drivers had at least one other alcohol-related driving conviction on their record during the study period. More research is needed to determine the overall magnitude of this important public health problem.

Conflict of interest

The authors declare they have no financial or other competing interests related to this study.

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Appendix A.

MEDLINE, Embase, and CINAHL search strategies (from inception to August 1, 2014).

MEDLINE search strategy

((“Automobile Driving”[mh]) OR (“Motor Vehicles”[mh]) OR (“Crashes, Traffic”[mh]) OR (“Driver*”[tiab]) OR (“Driving”[tiab]) OR (“Motor”[tiab]) OR (“Vehicle*”[tiab]) OR (“Traffic Crash*”[tiab]) OR (“Crashes”[tiab]) OR (“Car Crash*”[tiab]) OR (“Automobile*”[tiab])) AND ((“Alcoholic Intoxication”[mh]) OR (“Ethanol/Blood”[mh]) OR (“Alcoholic Beverages”[mh]) OR (“Alcohol Drinking”[mh]) OR (“Alcoholism”[mh]) OR (“Ethanol”[tiab]) OR (“Intoxicated”[tiab]) OR (“Impair*”[tiab]) OR (“Alcohol-impaired”[tiab]) OR (“Alcohol*”[tiab]) OR (“Drunk*”[tiab])) AND ((“Trauma Centers”[mh]) OR (“Wounds and Injuries”[mh]) OR (“Trauma Severity Indices”[mh]) OR (“Hospitalization”[mh]) OR

("Admission"[tiab]) OR ("Emergency Service, Hospital"[mh]) OR ("Emergency Medicine"[mh]) OR ("Injur*" [tiab]) OR ("Emergency" [tiab]) OR ("Trauma*" [tiab]) AND (("Law Enforcement"[mh]) OR ("Crime"[mh]) OR ("Police"[mh]) OR ("Jurisprudence"[mh]) OR (legislation and jurisprudence[sh]) OR ("Convict*" [tiab]) OR ("Charge*" [tiab]) OR ("Police" [tiab]) OR ("Legal" [tiab]) OR ("Ramifications" [tiab]) OR ("Mandatory Report*" [tiab]) OR ("Citation*" [tiab]) OR ("Recidivism" [tiab]) OR ("Prosecution" [tiab]) OR ("Court" [tiab]) OR ("Law*" [tiab]) OR ("Arrest*" [tiab]) OR ("Outcome*" [tiab]) AND (Journal Article[ptyp] AND full text[sb] AND English[lang]).

Embase search strategy

'traffic and transport'/exp OR 'traffic and transport' OR driving.ti,ab OR motor.ti,ab OR crash.ti,ab OR traffic.ti,ab OR vehicle.ti,ab AND ('alcohol'/exp OR 'alcohol' OR 'drunk sensation'/exp OR 'drunk sensation' OR intoxicated.ti,ab OR drunk.ti,ab OR alcohol.ti,ab OR ethanol.ti,ab OR drinking.ti,ab OR impaired.ti,ab) AND ('health care facilities and services'/exp OR 'health care facilities and services' OR 'emergency'/exp OR 'emergency' OR 'hospital'/exp OR 'hospital' OR 'emergency care'/exp OR 'emergency care' OR 'injury'/exp OR 'injury' OR trauma.ti,ab OR injury.ti,ab) AND ('legal aspect'/exp OR 'legal aspect' OR 'police'/exp OR 'police' OR conviction.ti,ab OR arrest.ti,ab OR recidivism.ti,ab OR prosecution.ti,ab OR police.ti,ab OR citation.ti,ab OR law.ti,ab OR legal.ti,ab OR outcome.ti,ab) AND [article]/lim AND [english]/lim.

CINAHL search strategy

(MH Automobile Driving+ OR TI Motor Vehicle* OR MH Crashes, Traffic+ OR TI Driver* OR TI Driving OR TI Traffic Crash* OR TI Crash* OR TI Motor OR TI Vehicle OR TI Car Crash* OR TI Automobile*) AND (MH Alcoholic Intoxication+ OR MH Ethanol/Blood+ OR MH Alcoholic Beverages+ OR MH Alcohol Drinking+ OR MH Alcoholism+ OR TI Drunk* OR TI Ethanol OR TI Intoxicated OR TI Impair* OR TI Alcohol-impaired OR TI Alcohol*) AND (MH Trauma Centers+ OR MH Wounds and Injuries+ OR MH Trauma Severity Indices+ OR MH Hospitalization+ OR MH Admission+ OR MH Emergency Service+ OR MH Hospital+ OR MH Emergency Medicine+ OR TI Injur* OR TI Emergency OR TI Trauma*) AND (MH Law Enforcement+ OR MH Crime+ OR MH Police+ OR MH Jurisprudence+ OR TI Convict* OR TI Charge* OR TI Police OR TI Legal* OR TI Law* OR TI Outcome* OR TI Ramifications OR TI Mandatory Report* OR TI Citation OR TI Arrest OR TI Culpab* OR TI Recidivism OR TI Prosecution OR TI Court).

References

- Allamani, A., Pepe, P., Baccini, M., et al., 2014. Europe An analysis of changes in the consumption of alcoholic beverages: the interaction among consumption related harms, contextual factors and alcoholic beverage control policies. *Subst. Use Misuse* 49, 1692–1715.
- Asbridge, M., Mann, R.E., Flam-Zalcman, R., et al., 2004. The criminalization of impaired driving in Canada: assessing the deterrent impact of Canada's first per se law. *J. Stud. Alcohol* 65, 450–459.
- Barillo, D.J., 1993. Arrest and conviction of injured intoxicated drivers in eastern Pennsylvania. *Accid. Anal. Prev.* 25, 635–639.
- Biffi, W.L., Schiffman, J.D., Harrington, D.T., et al., 2004. Legal prosecution of alcohol-impaired drivers admitted to a level I trauma center in Rhode Island. *J. Trauma* 56, 24–29.
- Blomberg, R.D., Peck, R.C., Moskowitz, H., et al., 2009. The Long Beach/Fort Lauderdale relative risk study. *J. Saf. Res.* 40, 285–292.
- Brady, J.E., Baker, S.P., Dimaggio, C., et al., 2009. Effectiveness of mandatory alcohol testing programs in reducing alcohol involvement in fatal motor carrier crashes. *Am. J. Epidemiol.* 170, 775–782.
- Brady, J.E., Li, G., 2014. Trends in alcohol and other drugs detected in fatally injured drivers in the United States, 1999–2010. *Am. J. Epidemiol.* 15, 692–699.
- Brubacher, J.R., Chan, H., Brasher, P., et al., 2014. Reduction in fatalities, ambulance calls, and hospital admissions for road trauma after implementation of new traffic laws. *Am. J. Public Health* 104, e89–e97.

- Brubacher, J.R., Chan, H., Fang, M., et al., 2013. Police documentation of alcohol involvement in hospitalized injured drivers. *Traffic Inj. Prev.* 14, 453–460.
- Callaghan, R.C., Sanches, M., Gatley, J.M., et al., 2014. Impacts of drinking-age laws on mortality in Canada, 1980–2009. *Drug Alcohol Depend.* 138, 137–145.
- Chang, K., Wu, C.C., Ying, Y.H., 2012. The effectiveness of alcohol control policies on alcohol-related traffic fatalities in the United States. *Accid. Anal. Prev.* 45, 406–415.
- Chang, S., Cushman, J.G., Pasquale, M.D., 2001. The injured intoxicated driver: analysis of the conviction process. *J. Trauma* 51, 551–556.
- Cherry, R.A., Nichols, P.A., Snavely, T.M., et al., 2010. Resource utilization and outcomes of intoxicated drivers. *J. Trauma Manage. Outcomes* 4, 9.
- Cheek, S.M., Murry, J.S., Truitt, M.S., et al., 2013. Driving intoxicated: is hospital admission protective against legal ramifications? *J. Trauma Acute Care Surg.* 75, 1081–1084.
- Cohen, J., 1960. A coefficient of agreement for nominal scales. *Educ. Psychol. Meas.* 20, 37–46.
- Colquitt, M., Fielding, L.P., Cronan, J.F., 1987. Intoxicated drivers and medical and social injury. *N. Engl. J. Med.* 317, 1262–1266.
- Criddle, L.M., Bonnono, C., Shapiro, S., 2001. ED staff's reporting of impaired drivers: understanding the issues, continuing the work. *J. Emerg. Nurs.* 27, 199–203.
- Criddle, L.M., Carson, B., 1998. The injured intoxicated driver in central Texas: incidence, demographics, and legal ramifications. *J. Emerg. Nurs.* 24, 309–315.
- Cydulka, R.K., Harmody, M.R., Barnoski, A., et al., 1998. Injured intoxicated drivers: citation, conviction, referral, and recidivism rates. *Ann. Emerg. Med.* 32, 349–352.
- Dinh-Zarr, T., Goss, C., Heitman, E., et al., 2004. Interventions for preventing injuries in problem drinkers. *Cochrane Database Syst. Rev.* 3, CD001857.
- Elder, R.W., Shults, R.A., Sleet, D.A., et al., 2004. Effectiveness of mass media campaigns for reducing drinking and driving and alcohol-involved crashes: a systematic review. *Am. J. Prev. Med.* 27, 57–65.
- Evelt, J.K., Finley, C.J., Nunez, A., et al., 1994. Judicial outcome for the intoxicated driver admitted to a regional trauma center. *Acad. Emerg. Med.* 1, 254–257.
- Fantus, R.J., Zautcke, J.L., Hickey, P.A., et al., 1991. Driving under the influence – a level-1 trauma center's experience. *J. Trauma* 31, 1517–1520.
- Fell, J.C., Tippetts, A.S., Voas, R., 2010. Drinking characteristics of drivers arrested for driving while intoxicated in two police jurisdictions. *Traffic Inj. Prev.* 11, 443–452.
- Fell, J.C., Tippetts, A.S., Voas, R.B., 2009. Fatal traffic crashes involving drinking drivers: what have we learned? *Ann. Adv. Automot. Med.* 53, 63–76.
- Fell, J.C., Voas, R.B., 2014. The effectiveness of a 0.05 blood alcohol concentration (BAC) limit for driving in the United States. *Addiction* 109, 869–874.
- Fell, J.C., Waehrer, G., Voas, R.B., et al., 2015. Relationship of impaired-driving enforcement intensity to drinking and driving on the roads. *Alcohol Clin. Exp. Res.* 39, 84–92.
- Fieldus, W., Cain, E., 2012. Impaired driving charges in injured impaired drivers requiring treatment in an emergency department. *Can. J. Emerg. Med.* 14, 290–294.
- Glinn, M., Adatsi, F., Curtis, P., 2011. Comparison of the analytical capabilities of the BAC datamaster and datamaster DMT forensic breath testing devices. *J. Forensic Sci.* 56, 1632–1638.
- Goecke, M., Kirkpatrick, A.W., Laupland, K.B., et al., 2007. Characteristics and conviction rates of injured alcohol-impaired drivers admitted to a tertiary care Canadian Trauma Centre. *Clin. Invest. Med.* 30, 26–32.
- Goldman, M., Harchelroad, F., Knapp, B., 1998. Trauma and intoxicated driving law enforcement. *Ann. Emerg. Med.* 31, 416–417.
- Hartling, L., Wiebe, N., Russell, K., et al., 2004. Graduated driver licensing for reducing motor vehicle crashes among young drivers. *Cochrane Database Syst. Rev.* 2, CD003300.
- Hayman, A.V., Crandall, M.L., 2009. Deadly partners: interdependence of alcohol and trauma in the clinical setting. *Int. J. Environ. Res. Public Health* 6, 3097–3104.
- Helis, J., 2015. Canada's Blood Alcohol Laws – An International Perspective: Update to 2002 and 2006 Reports, 2009. Canada Safety Council, Ottawa (ON) https://canadasafetycouncil.org/sites/default/files/PDF_en/bac-update-09_0.pdf (accessed 28.03.15.).
- Hingson, R., Winter, M., 2003. Epidemiology and Consequences of Drinking and Driving. Rockville. US National Institute on Alcohol Abuse and Alcoholism <http://pubs.niaaa.nih.gov/publications/arh27-1/63-78.htm> (accessed 10.08.14.).
- Holmes, J.F., Adams, C., Rogers, P., et al., 2014. Successful conviction of intoxicated drivers at a level I trauma center. *West J. Emerg. Med.* 15, 480–485.
- Holmgren, A., Holmgren, P., Kugelberg, F.C., et al., 2008. High re-arrest rates among drug-impaired drivers despite zero-tolerance legislation. *Accid. Anal. Prev.* 40, 534–540.
- Hsieh, C.H., Su, L.T., Wang, Y.C., et al., 2013. Does alcohol intoxication protect patients from severe injury and reduce hospital mortality? The association of alcohol consumption with the severity of injury and survival in trauma patients. *Am. Surg.* 79, 1289–1294.
- Kim, S.Y., Park, J.E., Lee, Y.J., et al., 2013. Testing a tool for assessing the risk of bias for assessing the risk of bias for nonrandomized studies showed moderate reliability and promising validity. *J. Clin. Epidemiol.* 66, 408–414.
- Krause, K.R., Howells, G.A., Bair, H.A., et al., 1998. Prosecution and conviction of the injured intoxicated driver. *J. Trauma* 45, 1069–1072.
- LaBrie, R.A., Kidman, R.C., Albanese, M., et al., 2007. Criminality and continued DUI offense: criminal typologies and recidivism among repeat offenders. *Behav. Sci. Law* 25, 603–614.
- Lahn, M., Gallagher, J., Li, S.F., et al., 2000. Prospective confirmation of low arrest rates among intoxicated drivers in motor vehicle crashes. *Acad. Emerg. Med.* 7, 260–263.

- Landis, J.R., Koch, G.G., 1977. The measurement of observer agreement for categorical data. *Biometrics* 33, 159–174.
- Lapham, S.C., Todd, M., 2012. Do deterrence and social-control theories predict driving after drinking 15 years after a DWI conviction? *Accid. Anal. Prev.* 45, 142–151.
- Lee, M.H., Mello, M.J., Reinert, S., 2009. Emergency department charges for evaluating minimally injured alcohol-impaired drivers. *Ann. Emerg. Med.* 54, 593–599.
- Lillis, R.P., Good, R.G., States, J.D., 1993. Correlates of detection of injured drinking drivers. *J. Traffic Med.* 21, 147–152.
- Lowenstein, S.R., Weissberg, M.P., Terry, D., 1990. Alcohol intoxication, injuries, and dangerous behaviors—and the revolving emergency department door. *J. Trauma* 30, 1252–1258.
- Mancino, M., Cunningham, M.R., Davidson, P., et al., 1996. Identification of the motor vehicle crash victim who abuses alcohol: an opportunity to reduce trauma. *J. Stud. Alcohol* 57, 652–658.
- Marowitz, L.A., 1998. Predicting DUI recidivism: blood alcohol concentration and driver record factors. *Accid. Anal. Prev.* 30, 545–554.
- Martin, T.L., Solbeck, P.A., Mayers, D.J., et al., 2013. A review of alcohol-impaired driving: the role of blood alcohol concentration and complexity of the driving task. *J. Forensic Sci.* 58, 1238–1250.
- Mattsson, S., Eriksson, A., Sjogren, H., 2000. Conviction rates among hospitalized DUI/DWI drivers. *J. Traffic Med.* 28, 21–24.
- Mauil, K.I., Kinning, L.S., Hickman, J.K., 1984. Culpability and accountability of hospitalized injured alcohol-impaired drivers: a prospective study. *J. Am. Med. Assoc.* 252, 1880–1883.
- McCammon, K., 2001. Alcohol-related motor vehicle crashes: deterrence and intervention. *Ann. Emerg. Med.* 38, 415–422.
- McLaughlin, J.G., Smith, R.J., Mattice, C.R., et al., 1993. Hospitalization and injury influence on the prosecution of intoxicated drivers. *Am. Surg.* 59 (8), 484–489.
- Moher, D., Liberati, A., Tetzlaff, J., et al., 2009. The PRISMA group (2009): preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Open Med.* 3, 123–130.
- O’Keeffe, T., Rhee, P., Shafi, S., et al., 2013. Alcohol use increases diagnostic testing, procedures, charges, and the risk of hospital admission: a population-based study of injured patients in the emergency department. *Am. J. Surg.* 206, 16–22.
- Orsay, E.M., Doan-Wiggins, L., Lewis, R., et al., 1994. The impaired driver: hospital and police detection of alcohol and other drugs of abuse in motor vehicle crashes. *Ann. Emerg. Med.* 24, 51–55.
- Perreault, S., 2013. Impaired Driving in Canada, 2011. Canadian Centre for Justice Statistics, Ottawa <http://www.statcan.gc.ca/pub/85-002-x/2013001/article/11739-eng.pdf> (accessed 17.08.14.).
- Plurad, D., Demetriades, D., Gruzinski, G., et al., 2010. Motor vehicle crashes: the association of alcohol consumption with the type and severity of injuries and outcomes. *J. Emerg. Med.* 38, 12–17.
- Podda, F., 2012. Drink Driving Towards Zero Tolerance. European Transport Safety Council, Brussels http://etsc.eu/wp-content/uploads/2014/02/Drink_Driving_Towards_Zero_Tolerance.pdf (accessed 27.03.15.).
- Pursell, R., Brown, D., Brubacher, J.R., et al., 2010. Proportion of injured drivers presenting to a tertiary care emergency department who engage in future impaired driving activities. *Traffic Inj. Prev.* 11, 35–42.
- Pursell, R.A., Yarema, M., Wilson, J., et al., 2004. Proportion of injured alcohol-impaired drivers subsequently convicted of an impaired driving criminal code offence in British Columbia. *Can. J. Emerg. Med.* 6, 80–88.
- Rauch, W.J., Zador, P.L., Ahlin, E.M., et al., 2010. Risk of alcohol-impaired driving recidivism among first offenders and multiple offenders. *Am. J. Public Health* 100, 919–924.
- Rehm, C.G., Nelson, J., MacKenzie, D., et al., 1993. Failure of the legal system to enforce intoxicated driving legislation effectively. *Ann. Emerg. Med.* 22, 1295–1297.
- Resources for Optimal Care of the Injured Patients, sixth ed. American College of Surgeons, Committee on Trauma, Chicago <https://www.facs.org/~media/files/quality%20programs/trauma/vrc%20resources/resources%20for%20optimal%20care%202014%20v11.ashx> (accessed 20.03.15.).
- Review Manager (RevMan) [Computer program]. Version 5.3. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2014.
- Runge, J.W., Pulliam, C.L., Carter, J.M., et al., 1996. Enforcement of intoxicated driving laws in cases involving injured intoxicated drivers. *Inj. Prev.* 27, 66–72.
- Schermer, C.R., Moyers, T.B., Miller, W.R., et al., 2006. Trauma center brief interventions for alcohol disorders decrease subsequent driving under the influence arrests. *J. Trauma* 60, 29–34.
- Schermer, C.R., Apodaca, T.R., Albrecht, R.M., et al., 2001. Intoxicated motor vehicle passengers warrant screening and treatment similar to intoxicated drivers. *J. Trauma* 51, 1083–1086.
- Shuts, R.A., Elder, R.W., Sleet, D.A., et al., 2001. Reviews of evidence regarding interventions to reduce alcohol-impaired driving. *Am. J. Prev. Med.* 21, 66–88.
- Soderstrom, C.A., Birschback, J.M., Dischinger, P.C., 1990. Injured drivers and alcohol use: culpability, convictions, and pre- and post- crash driving history. *J. Trauma* 30, 1208–1214.
- Soderstrom, C.A., Dischinger, P.C., Ho, S.M., et al., 1993. Alcohol use, driving records, and crash culpability among injured motorcycle drivers. *Accid. Anal. Prev.* 25, 711–716.
- Steinka-Fry, K.T., Tanner-Smith, E.E., Hennessy, E.A., 2015. Effects of brief alcohol interventions on drinking and driving among youth: a systematic review and meta-analysis. *J. Addict. Prev.* 3, 11.
- Taylor, B., Irving, H.M., Kanteres, F., et al., 2010. The more you drink, the harder you fall: a systematic review and meta-analysis of how acute alcohol consumption and injury or collision risk increase together. *Drug Alcohol Depend.* 110, 108–116.
- Taylor, B., Rehm, J., 2012. The relationship between alcohol consumption and fatal motor vehicle injury: high risk at low alcohol levels. *Alcohol Clin. Exp. Res.* 36, 1827–1834.
- The Alcohol-Crash Problem in Canada: 2010. Canadian Council of Motor Transport Administrators Standing Committee on Road Safety Research and Policies and Transport, Ottawa (ON) http://www.tirf.ca/publications/PDF_publications/2010_Alcohol_Crash_Problem_Report_4_FINAL.pdf (accessed 05.08.14.).
- Traffic Safety Facts 2010: Alcohol-Impaired Driving. Department of Transportation, National Highway Traffic Safety Administration, Washington, US <http://www-nrd.nhtsa.dot.gov/Pubs/811606.PDF> (accessed 12.08.14.).
- Traffic Safety Facts: 2012 Motor Vehicle Crashes. US Department of Transportation, National Highway Traffic Safety Administration, Washington <http://www-nrd.nhtsa.dot.gov/Pubs/811856.pdf> (accessed 15.08.14.).
- Trauma system accreditation guidelines, Calgary (AB): Trauma Association of Canada, fourth ed http://www.traumacanada.ca/accreditation_committee/Accreditation_Guidelines_2011.pdf (accessed 20.03.14.).
- Vanlaar, W., Robertson, R., Marcoux, K., et al., 2012. Trends in alcohol-impaired driving in Canada. *Accid. Anal. Prev.* 48, 297–302.
- Wagenaar, A.C., Maldonado-Molina, M.M., Ma, L., et al., 2007. Effects of legal BAC limits on fatal crash involvement: analyses of 28 states from 1976 through 2002. *J. Saf. Res.* 38, 493–499.
- Yao, J., Johnson, M.B., Beck, K.H., 2014. Predicting DUI decisions in different legal environments: investigating deterrence with a conjoint experiment. *Traffic Inj. Prev.* 15, 213–221.
- Zaloshnja, E., Miller, T.R., Blincoe, L.J., 2013. Costs of alcohol-involved crashes, United States, 2010. *Ann. Adv. Automot. Med.* 57, 3–12.
- Zamengo, L., Frison, G., Tedeschi, G., et al., 2014. Variability of blood alcohol content (BAC) determinations: the role of measurement uncertainty, significant figures, and decision rules for compliance assessment in the frame of a multiple BAC threshold law. *Drug Test. Anal.* 6, 1028–1037.