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Alcohol use and injury severity among emergency department patients in six countries

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Abstract

This study examines the individual and socio-cultural factors related to severity of injury among emergency department (ED) patients across six countries (United States, Canada, Mexico, Australia, Spain, and Italy). Probability samples of injured patients from 15 studies (N=9,599) were analyzed for severity of injury as measured by arrival by ambulance and admission to the hospital, using logistic regression models and multi-level hierarchical linear models. A dose-response relationship was found between patients drinking prior to the injury and arriving to the ED by ambulance and admission to the hospital after the injury event. Country level detrimental drinking pattern explained some of the study variation for patients arriving by ambulance but not for patients admitted to the ED. Findings support a relationship between acute alcohol consumption to injury severity however, further examination of the clinical implications related to triage, patient evaluation, and intervention for alcohol-related problems are merited.

Keywords

alcohol; injury severity; emergency department

Introduction

The contribution of alcohol misuse to subsequent injury is a well-documented phenomenon with much of the evidence derived from emergency department (ED) studies (Antelo, Bazargan-Hejazi, Ani, & Bazargan, 2008; Cherpitel, 1993; Cherpitel et al., 2009; Romelsjo, 1995; WHO, 2007). Internationally, it is estimated that 10-18% of injury patients that present to the ED had consumed alcohol prior to the injury (WHO, 2007), (henceforth referred to as 'acute alcohol consumption'). However, rates of acute alcohol consumption and injury can vary considerably depending on a variety of factors. Individual, socio-cultural, or broader organizational, societal, or policy factors can impact the incidence rates of drinking prior to an injury. For example, patient drinking characteristics such as the

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volume of alcohol consumed (Cherpitel et al., 2005) or usual pattern of drinking (Watt, Purdie, Roche, & McClure, 2004) can modify the magnitude of the relationship and socio-cultural characteristics, such as drinking in bars or pubs, have been found to increase injury risk (Williams, Mohsin, Weber, Jalaludin, & Crozier, 2011). Other factors can also determine the incidence rates of patients that have been drinking before an injury. For example, trauma centers that provide the highest level of care for injury patients (i.e., “level-1” trauma centers) and the legal intoxication level are both associated with increases in ED patients that present with acute alcohol consumption and injury (Cherpitel et al., 2003; Cherpitel, Ye, & Bond, 2004). While these studies support the positive relationship between acute alcohol consumption and the risk of injury, they underscore the need to consider other aspects of these behaviors such as the severity of the injury .

While many studies on the relationship between acute alcohol consumption and a resulting injury, the association with the severity of an injury is not entirely clear. Studies show a mix of findings in the literature and there is on-going debate as to the role of alcohol to the severity of an injury (Li, Keyl, Smith, & Baker, 1997). Data indicating no association between acute alcohol consumption and injury severity have come primarily from hospital or trauma center-based studies (Plurad et al., 2010; Plurad et al., 2006; Zeckey et al., 2011), while ED data have found a significant and positive association (Cunningham, Maio, Hill, & Zink, 2002; Fabbri et al., 2002; Gurney et al., 1992; Macdonald et al., 2006; Watt, Purdie, Roche, & McClure, 2006).

Given this mixed literature on the association of severity of injury with acute alcohol consumption, analysis proposed here will contribute to this body of knowledge by exploring the impact of drinking-in-the-event, amount consumed, and heavy drinking pattern on the severity of injury (based on arrival to the ED by an ambulance and hospitalization following ED attendance). Our aims are to 1) identify the individual-level rates and determine variation across studies; 2) determine if there is a dose-response relationship to acute alcohol consumption; 3) explore whether usual heavy alcohol consumption modifies the association of acute alcohol consumption and 4) identify if the cultural context of drinking, as reflected in the detrimental drinking pattern (DDP) or treatment at a level-1 trauma center, may explain the heterogeneity across studies. It is expected that acute alcohol consumption will be positively associated with injury severity and that rates of severity for those who are frequent heavy drinkers will be higher but the dose-response relationship between acute alcohol consumption will be greater for those who do not have a frequent heavy pattern of alcohol consumption (i.e., episodic heavy drinkers). Characteristics of the ED, represented by the level of trauma care and the detrimental impact of drinking in each country are expected to explain the variation across studies.

Methods

The present retrospective study examines data from the Emergency Room Collaborative Alcohol Analysis Project (ERCAAP). Data were collected from 1984 to 2009 with each site using a probability sample of patients consecutively arriving to the ED, with equal representation of each ED shift for each day of the week during the study period. Completion rates ranged from 59% to 93%. Reasons for non-study participation were refusal, incapacitation from injury, leaving the ED, language barriers, or police custody. Individuals 18 years and older who presented to the ED to receive care were approached to participate in the study. Patients who were too severely injured upon arrival to the ED were approached in the hospital to participate once they were stabilized. Informed consent was obtained in the language appropriate to the location of the research, in each country. Patients agreeing to participate in the study were administered an interview regarding the reason for the ED visit and demographic information including age, gender, and education. Alcohol

consumption questions include the self reported amount of alcohol consumed in the 6 hours prior to the injury, the quantity and frequency of alcohol consumed in the prior 12 months and drinking five or more drinks on an occasion at least weekly in the past year, using an abbreviated graduated frequency methodology (Greenfield, 2000). The ERCAAP data were collected using a methodology similar to that developed by Cherpitel (Cherpitel, 1989). Further descriptions of study procedures can be found elsewhere (Bazargan-Hejazi, Gaines, Duan, & Cherpitel, 2007; Cherpitel et al., 2003; Cherpitel, Martin, Macdonald, Brubacher, & Stenstrom, in press; Cherpitel et al., 2004; Cherpitel et al., 2005).

Outcome variables

Injury severity—Two measures of injury severity were used including a dichotomous measure of mode of arrival to the ED (arrival by ambulance vs. other and patient discharge status after the ED measured by admission to the hospital vs. other discharge status).

Predictor variables

Demographic predictors include education, gender, and age of the patient. Additional information used for analyses include aggregate study-level data using detrimental drinking pattern (DDP) and the level of trauma care. DDP is a measure of the “detrimental impact” of drinking and used for global comparative risk assessment in the World Health Organization’s Global Burden of Disease study (Rehm et al., 2004). The measurement of DDP is based on aggregate survey data and key informant surveys within a country with consideration to indicators of heavy drinking occasions, drinking with meals, and drinking in public places. Scores for DDP range from 1 to 4, with a higher score indicating presumed detrimental effect of the same per capita consumption of alcohol resulting in harm (Rehm et al., 2001). A dichotomous measure of the study level trauma center status (level-1 trauma center vs. not level-1 trauma center) is also included. A level-1 trauma center is an ED that provides the highest level of trauma care and includes trauma surgeons as well as the most sophisticated medical diagnostic equipment available in a country.

Drinking measures

Frequent heavy drinking—Patients that drink 5 or more drinks in a sitting at least weekly in the past 12 months (yes/no).

Acute alcohol consumption—The number of drinks consumed in the 6 hours prior to the injury. . As the majority of patients were not drinking prior to the injury, the number of drinks prior to the injury was skewed toward zero. To account of this skew, the number of drinks was log transformed and a one was added to each value.

Statistical Analysis

Demographic information with means, ranges, percentages, and logistic regressions models were conducted using the Statistical Package for the Social Sciences (SPSS) version 17.0 (SPSS Inc., 2008). Multivariate models utilized Hierarchical Linear Modeling (HLM), with HLM V6.02 (Raudenbush, Bryk, & Congdon, 2006) statistical software to determine variation across studies in the association between acute alcohol consumption and injury severity. Individual-level variables include age, gender, and education, and the drinking measures of acute alcohol consumption and frequent heavy drinking. An interaction term was created using the continuous measure of acute alcohol consumption and any frequent heavy drinking. Study-level data included trauma center care and DDP. Each demographic variable was grand centered to its overall mean for interpretability and entered as a fixed variable. Acute alcohol consumption, frequent heavy drinking, aggregate DDP, and level-1 trauma center were entered as random variables. Models 1, 2 and 3 in Tables 2b and 3b use

only individual-level data while models 4 and 5 are multi-level with DDP (model 4) and trauma center care (model 5) included as study-level variables. Only injury patients are used for the current analyses. Weights were assigned to several studies to adjust for data that were not collected with equal representation of all shifts in a day across all days of the week.

Results

Sample Characteristics

Table 1 displays the characteristics of injury patients, arranged by country and year of data collection, at 31 ED sites from 15 studies in 6 countries (total N=9,599). Information on arrival by ambulance was available for 14 of the 15 studies and hospital admission included 11 of the 15 studies. Nineteen of the 31 studies identified as level 1 trauma centers, accounting for 55% of all patients presenting to these facilities. Patients were predominantly male with the most equitable gender ratio among the patients in Spain (51%) and the least equitable among patients in San Francisco (72%). Most of the studies reported over 20% of their patients having received at least some college education. Alcohol consumption 6 hours prior to the injury was reported by over a third of the Trieste (38%) and San Francisco (34%) patients; Pachuca (7%), Santa Clara County (11%), and Quebec (12%) reported the lowest percentages of patients with acute alcohol consumption. San Francisco, Freemantle, Alberta, Contra Costa County 2, and Los Angeles studies reported over 20% of injured patients drinking five or more drinks in a sitting at least weekly in the past 12 months. Not surprisingly, incidence rates for arrival by ambulance varied considerable by study as did admission to the hospital. Spain reported the lowest rates of arrival by ambulance and admission to the hospital (at 6% and 3% respectively) and Los Angeles reporting the highest rates with 36% arriving by ambulance and half of the patients admitted to the hospital.

Adjusted logistic regression models examine the dose-response relationship of acute alcohol consumption and injury severity for each of the 15 studies in six countries (Table 2a). All of the Mexican studies report a significant positive relationship, with Acapulco demonstrating the strongest association showing a 40% increase in arrival by ambulance for every increment increase in alcohol consumption. The significance of acute alcohol consumption and injury severity is less robust for the other countries; half of the US studies, one of the Canadian studies (Alberta) and neither of the European countries report a significant relationship. Frequent heavy drinking was not predictive of injury severity for nearly all of the studies. Though seven of the studies report an odds ratio of over 1.0, only one US study (Jackson, Mississippi) reported a significant relationship with frequent heavy drinkers over 3 times more likely to arrive by ambulance compared to injury patients who were not frequent heavy drinkers.

While there is evidence that alcohol consumption and injury severity are positively related for many of the studies, there is considerable variability across studies. Table 2b displays five models that examine acute alcohol consumption, frequent heavy drinking, and study-level contextual drinking predicting arrival by ambulance for the 15 studies. All models control for age, gender, and education with models 1, 2, and 3 using individual-level data and models 4 and 5 using individual- and study-level contextual data. As anticipated, acute alcohol consumption was predictive of arrival by ambulance (model 1). However, frequent heavy drinking, after controlling for age, gender, education and the number of drinks in the event, was not predictive (model 2) of arrival by ambulance. Additionally, there was no evidence that the dose-response relationship of acute alcohol consumption and the pattern of frequent heavy drinking interacted (model 3). Additional interaction models (results not shown), using a dichotomous measure of any acute alcohol consumption and a continuous measure of the number of days of frequent heavy drinking were also not predictive of arrival by ambulance. A detrimental pattern of drinking in the region, using the DDP, significantly

explained some of the variability across studies (model 4), and, because level-1 trauma centers were assumed to have a higher incidence of patients presenting with severe injuries, it was hypothesized that these centers would explain variability across studies. However, the odds ratios, though positive, are not predictive (model 5).

Table 3a displays odds ratios predicting admission to the hospital after the ED visit, for 11 studies in 5 countries. A significant, positive dose-response relationship between acute alcohol consumption and hospital admission was significant for only one study (Contra Costa 1 in the US). Though not significant, nearly all of the studies showed a positive relationship between acute alcohol consumption and hospital admission with odds ratios of 1.1 or higher except the Jackson, Mississippi study with a slightly lower odds ratio ($OR_{adj}=0.9$). Similarly, San Francisco was the only study to identify an association of frequent heavy drinking and injury severity while the other studies did not find an association. Some of the studies showed a higher (though non-significant) hospital admission rate for injury patients that were *non*-frequent heavy drinkers (Contra Costa 2, Alberta, Quebec, and Barcelona) while the remaining studies report a non-significant positive association.

Even though Table 3A shows a very modest relationship of acute alcohol consumption to admission to the hospital, aggregate findings in Table 3b support a modest but positive relationship, with injury patients more likely to be admitted to the hospital with increased alcohol consumption (model 1). We hypothesized, frequent heavy drinkers would be more likely to have hospital admission but frequent heavy drinking was not predictive of admission, nor was there an interaction between acute alcohol consumption and frequent heavy drinking (model 3). Like arrival by ambulance, an additional interaction model, using the dichotomous terms of acute alcohol consumption and continuous measure of frequency of heavy drinking did not show significant outcomes (results not shown). Counter to hypotheses, DDP and level-1 trauma center did not explain variability across the studies for hospital admission.

Discussion

Aggregate findings support a relationship between acute alcohol consumption and severity of injury as measured by ambulance arrival. As expected, there was quite a bit of variability across studies with half of the fourteen studies showing a significant dose-response association of acute alcohol consumption to injury severity. However, the relationship between acute alcohol consumption and hospital admission was less clear. While the overall findings (Table 3b) support a relationship between acute alcohol consumption and hospital admission, there is less support for this relationship by individual study (Table 3a) and, with the exception of one study, a virtual lack of a dose-response relationship.

An unexpected outcome was the lack of an effect modification for frequent heavy drinking and acute alcohol consumption for injury severity. We expected that patients unaccustomed to heavy drinking would be more likely to acquire injuries that would require an ambulance or admission to the hospital compared to patients who drank in large quantities on a regular basis. Though we found that heavy drinkers may not differentially incur a severe injury related to injury with acute alcohol consumption compared to non-heavy drinkers, other research has demonstrated that heavy drinkers present a myriad of problems for ED and medical staff including repeated injury and readmission to the ED (35, 36), and longer hospital stays with higher medical procedural costs (37). We did not expect that our measures of ambulance arrival and hospital admission would fully capture the medical problems associated with habitual heavy alcohol use, but rather demonstrate a way in which to identify patients that may be presenting with problematic alcohol use.

The individual-level rates of severity varied across studies, yet arrival by ambulance was at least partly explained by the country-level DDP. DDP has been shown to predict risk of injury (6) but our findings support that DDP also is indicative of injury severity as measured by arrival by ambulance but not for admission to the hospital.

While this study has strength in using representative samples of ED patients across six countries, there are limitations. Our measures of injury severity are simplistic yet we believe that arrival by ambulance and admission to the hospital to be reasonable measures because in most circumstances these are strong indicators of incapacitation. We also believe that these measures are representative of the additional costs incurred by acute alcohol consumption beyond that of the ED visit. While ambulance and medical costs vary considerably by country and region, this added expense is largely placed on local governments and agencies (Al-Shaqsi, 2010), making alcohol related injury a societal concern. But, because of the simplicity of the measures, we lacked additional information to assess other reasons for arrival by ambulance or admission to the hospital. For instance, patients may have chosen to take an ambulance due to lack of adequate transportation, or hospital admission may be predicated by an ability to pay or hospital enrollment. Additionally, even though each sample is representative of each facility, no assumptions about other facilities in neighboring areas or the country can be made.

The burden of injury from acute alcohol consumption is under-identified (Indig, Copeland, Conigrave, & Rotenko, 2008; Sethi, Racioppi, Baumgarten, & Bertollini, 2006). There has been movement for more countries to institute policies for prevention of alcohol misuse (Room, Babor, & Rehm, 2005), thereby reducing alcohol-related injuries. Instituting culturally relevant brief intervention programs may be among the least expensive and evidence-based solutions (Bazargan-Hejazi et al., 2007; Cobiac, Vos, Doran, & Wallace, 2009). Successful implementation of brief interventions is feasible (Bazargan-Hejazi & Collaborative, 2010) and reproducible in countries outside the United States (Cherpitel et al., 2010); Korcha, 2012).

Our findings indicate a relationship between injury severity to acute alcohol consumption but further examination of patient, organizational, and societal factors are needed in addition to instituting intervention programs.

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Table 1

Study demographics, drinking characteristics, and severity among injured patients arriving to the ED, weighted (N=9,599).

	year of study	n	# EDs	# Level 1 trauma center(s)	% male	Mean age (age range)	% any college	% drinking prior to injury	% 5+ weekly drinking (past 12 mo)	% arrived by ambulance	% admitted to hospital
United States											
San Francisco, CA	1984-85	555	1	1	72	34 (18-89)	39	34	27	24	12
Contra Costa County, CA (1)	1985	1001	4	0	61	34 (18-93)	40	18	14	15	6
Contra Costa County, CA (2)	1986-87	815	1	0	63	32 (18-86)	38	26	22	8	6
Santa Clara County, CA	1995-96	288	1	1	64	36 (18-89)	43	11	17	22	6
Jackson, Mississippi	1996	275	1	1	55	32 (18-85)	36	22	16	10	5
Los Angeles, CA	2001	136	1	1	73	34 (18-70)	19	17	22	36	50
Canada											
Alberta	1989	335	1	1	68	36 (18-85)	29	22	23	15	6
Quebec	1989	263	1	1	59	33 (18-76)	57	12	8	14	3
Vancouver	2009	436	2	1	64	40 (18-93)	73	24	18	22	5
Mexico											
Mexico City	1986	1620	8	7	71	32 (18-89)	15	25	11	23	--
Acapulco	1987	343	3	1	71	31 (18-98)	12	29	--	19	--
Pachuca	1996-97	672	3	1	65	33 (18-68)	16	7	5	13	--
Australia											
Fremantle	1997	872	1	1	68	36 (18-89)	40	23	24	--	16
Europe											
Barcelona, Spain	1987	1684	1	1	51	40 (18-86)	25	15	4	6	3
Trieste, Italy	1990	304	1	1	69	42 (18-90)	30	38	5	21	--

-- information not collected

Table 2a

Adjusted odds ratios of the number of drinks consumed in the event predicting arrival by ambulance, weighted +

	# of drinks consumed 6 hours prior to injury (logged)	any 5+ weekly drinking in the past 12 months
	OR _{adj} (95% CI)	OR _{adj} (95% CI)
United States		
San Francisco	1.1 (1.0, 1.2)	0.9 (0.6, 1.4)
Contra Costa 1	1.2 (1.0, 1.4) *	1.3 (0.8, 2.2)
Contra Costa 2	1.3 (1.1, 1.5) **	1.0 (0.5, 1.9)
Santa Clara	1.2 (1.0, 1.5)	1.4 (0.7, 2.8)
Jackson	1.5 (1.1, 1.9) **	3.4 (1.3, 8.8) *
Los Angeles	1.2 (0.9, 1.6)	2.1 (0.9, 4.9)
Canada		
Alberta	1.4 (1.1, 1.6) **	1.3 (0.6, 2.8)
Quebec	1.1 (0.7, 1.5)	0.1 (0.1, 0.2)
Vancouver	1.1 (0.9, 1.3)	1.0 (0.5, 2.0)
Mexico		
Mexico City	1.2 (1.1, 1.2) ***	1.3 (0.9, 1.9)
Acapulco	1.4 (1.2, 1.5) ***	--
Pachuca	1.3 (1.1, 1.6) **	2.2 (0.8, 6.0)
Australia		
Fremantle	--	--
Europe		
Barcelona	1.0 (0.8, 1.3)	1.0 (0.3, 3.4)
Trieste	1.0 (0.8, 1.3)	n/a ⁺⁺

*
p<.05,

**
p<.01,

p<.001

+ models control for age, gender, and education.

++ no 5+ weekly drinkers arrived by ambulance

-- information not collected

Table 2bLogistic and multilevel logistic regression models predicting arrival by ambulance. ⁺

	Model 1 (N=7,968)	Model 2 (N=7,312)	Model 3 (N=7,312)	Model 4 (N=7,968)	Model 5 (N=7,968)
	OR_{adj} (95% CI)	OR_{adj} (95% CI)	OR_{adj} (95% CI)	OR_{adj} (95% CI)	OR_{adj} (95% CI)
<u>Individual level drinking variables</u>					
# of drinks 6 hours prior to the injury (logged)	1.2 (1.1, 1.2) ***	1.2 (1.2, 1.2) ***	1.2 (1.1, 1.2) ***	1.1 (1.1, 1.2) ***	1.2 (1.1, 1.3) ***
5+ weekly drinking		0.9 (0.8, 1.1)	0.9 (0.7, 1.1)		
acute drinking * 5+ weekly drinking			1.1 (0.9, 1.1)		
<u>Site level variables</u>					
DDP				1.1 (1.0, 1.3) *	
Level 1 trauma center (intercept only)					1.3 (0.7, 2.6)

* p<.05;

*** p<.001

* models control for age, gender, and education.

Table 3aAdjusted odds ratios of acute alcohol consumption and predicting admission to the hospital, weighted ⁺

	# of drinks consumed 6 hours prior to injury (logged)	any 5+ weekly drinking in the past 12 months
	OR _{adj} (95% CI)	OR _{adj} (95% CI)
United States		
San Francisco	1.1 (1.0, 1.3)	2.4 (1.3, 4.3) **
Contra Costa 1	1.4 (1.2, 1.7) ***	1.6 (0.7, 3.4)
Contra Costa 2	1.1 (0.8, 1.3)	0.4 (0.1, 1.2)
Santa Clara	1.1 (0.8, 1.1)	1.4 (0.4, 4.7)
Jackson	0.9 (0.6, 1.4)	2.4 (0.7, 8.6)
Los Angeles	1.2 (0.9, 1.6)	1.1 (0.4, 2.6)
Canada		
Alberta	1.1 (0.8, 1.5)	0.2 (0.1, 1.6)
Quebec	1.6 (0.7, 3.6)	0.1 (0.1, 0.2)
Vancouver	1.1 (0.9, 1.5)	1.7 (0.5, 5.2)
Mexico		
Mexico City	--	--
Acapulco	--	--
Pachuca	--	--
Australia		
Fremantle	1.1 (1.0, 1.2)	1.2 (0.7, 1.8)
Europe		
Barcelona	1.1 (0.8, 1.4)	0.2 (0.1, 0.7)
Trieste	--	--

**
p<.01,***
p<.001⁺
models control for age, gender, and education.--
information not collected

Table 3bLogistic and multilevel logistic regression models predicting admission to the hospital. ⁺

	Model 1 (N=5,879)	Model 2 (N=5,754)	Model 3 (N=5,754)	Model 4 (N=5,879)	Model 5 (N=5,879)
	OR_{adj} (95% CI)	OR_{adj} (95% CI)	OR_{adj} (95% CI)	OR_{adj} (95% CI)	OR_{adj} (95% CI)
<u>Individual level drinking variables</u>					
# of drinks 6 hours prior to the injury (logged)	1.1 (1.0, 1.2) **	1.1 (1.0, 1.2) **	1.1 (1.0, 1.2) **	1.1 (1.0, 1.2) ***	1.1 (1., 2.0) **
5+ weekly drinking		1.0 (0.7, 1.5)	1.1 (0.8, 1.5)		
acute drinking * 5+ weekly drinking			1.0 (0.9, 1.1)		
<u>Site level variables</u>					
DDP				0.9 (0.9, 1.0)	
Level 1 trauma center (intercept)					2.1 (0.7, 6.5)

**
p<.01;***
p<.001⁺
models control for age, gender, and education.