Injury and repeated injury – what is the link with acute consumption, binge drinking and chronic heavy alcohol use?

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Summary

Objectives: First, to test whether current injury is more closely related to acute intake than to usual consumption patterns, and second, to test whether repeated injury is more closely related to general consumption patterns than to acute intake.

Methods: Screening of alcohol consumption of 7,872 patients enrolling between January 1, 2003 and June 30, 2004 in an emergency department (ED) in Lausanne, Switzerland. General consumption patterns were measured as usual volume (in drinks per week) and binge drinking (5+ drinks for men; 4+ drinks for women) at least once monthly. Acute intake was measured through number of drinks in the 24-hour period prior to attending the ED. Separate logistic regression models of current injury and repeated injury on alcohol consumption patterns were estimated.

Results: Acute intake and binge drinking dominated the association with current injury, while general consumption patterns were predictive of repeated alcohol-related injury.

Conclusions: Acute intake is associated with current injury in a dose-response relationship and with binge drinking. Because acute intake can be found among moderate volume drinkers as well as among chronic heavy drinkers, for current injury usual volume adds little predictive value over the effects of acute intake. Repeated injuries occur more often among chronic heavy drinkers, and thus general consumption patterns are more closely associated with injury "recidivism" than with acute intake. A screening question assessing prior injury may be a useful tool in the ED for distinguishing between chronic heavy drinkers and usually moderate drinkers with heavy drinking episodes, and thus prove helpful when creating preventive efforts tailored to different types of drinker.

Key words: injury; repeated injury; emergency room; alcohol; drinking patterns

Introduction

Injury has been shown to be related to prior alcohol intake (hereafter called acute alcohol intake), commonly in a dose-response relationship [1, 2]. Injury has also been related to general drinking patterns such as usual volume of drinking (e.g., average consumption per day in the past 12 months) and to binge drinking (e.g., measured as frequency of drinking 5 or more drinks on an occasion in the past 12 months). Binge drinking appears to be a stronger predictor of injury than average volume of drinking [3–7]. For example, in general population studies in the United States the greatest risk of injury was found in drinkers consuming large amounts on some occasions whose greatest amounts were markedly larger than their usual amounts [8–12], suggesting that binge drinking is more closely related to injury than to volume of drinking. Some trauma surgery textbooks [13, 14] therefore view alcohol-related injury as an isolated incident due to an uncommon episode of intoxication among individuals who are otherwise moderate drinkers. This notion has been challenged [15] in that it overlooks injury as a "recurrent " disease [16, 17] to which alcohol abuse and dependence are predisposing factors. Many studies have shown that repeated injury is associated with high rates of chronic alcohol abuse or dependence [15, 17–21].

The present study attempts to clarify this apparent contradiction by arguing that single in-

juries are often related to atypical heavy drinking episodes, whereas repeated injuries are more closely associated with chronic heavy drinking. This means that acute intake, usual volume, and binge drinking must be considered to distinguish between chronic versus sporadic heavy drinkers. Measuring only acute intake prior to injury is insufficient since it does not teach us whether an acute heavy episode of drinking was merely an uncommon incident or was representative of a common chronic drinking pattern. Similarly, measuring only the volume of alcohol as a single dimension of general drinking patterns is inadequate since a volume of 14 drinks weekly may mean 2 drinks every day or 2 heavy drinking days (binging) during the weekend with no consumption on workdays. Despite the same volume the risk of injury will be different. To the best of our knowledge studies linking alcohol with injury typically fail to examine the interplay between these three aspects and rather view them individually [for an exception see 22].

In addition, a current injury may be the first or a repeated incident. Single injuries are often related to atypical heavy drinking episodes, whereas repeated injuries are associated more with chronic heavy drinking since chronic drinkers have more occasions (and are more likely) to injure themselves again. The stochastic drinking theory [9] also predicts that repeated injuries will be related to multiple exposures to drinking at different levels. Analyses of current injuries alone cannot distinguish between single or repeated injuries: it is important to consider both types.

The ability to distinguish drinker types and the association of each with current and repeated injury has major implications for intervention strategies. Emergency departments (ED) are an ideal setting for intervention since individuals may be more aware of the connection between their current drinking and its consequences, and hence more motivated to change [23]. Brief alcohol interventions (BAI) have shown themselves to have some advantages compared to more intensive treatment in hectic settings with little time to administer them, such as EDs [24], and have proved to exert favourable effects in reducing alcohol consumption [25]. Gentiello *et al.* [26] have demonstrated that brief interventions may reduce repeated injury but work best in patients with mild to moderate symptoms of problem alcohol use, whereas patients with more severe symptoms, according to the Short Michigan Alcohol Screening Tests (SMAST), derive no benefit. Patients with chronic alcohol-related disease and prior treatment have even become worse after BAI, indicating that brief intervention is insufficient for patients with more chronic alcohol-related disease [24, 26, 27]. It is thus important to identify patients with more severe or chronic symptoms of alcohol use who would need higher levels of care, such as inpatient treatment [28].

Unfortunately, physicians are often reluctant to screen for alcohol abuse [29–31]. The present article suggests that, in order to carry out BAI or more intensive interventions, a simple screening for prior injury may make it easier to distinguish between at-risk drinkers (who occasionally drink too much) and chronic heavy alcohol users.

It is hypothesised that current injury is more closely associated with acute intake than with usual consumption patterns. Since a current injury may be the first experienced by a (usually) moderate drinker or one of many for a chronic heavy drinker, it will not be closely associated with general consumption patterns since several different types of drinker will be at risk for this particular injury. In contrast, repeated injury appears to be more closely associated with general consumption patterns than with acute intake, since it is more prevalent among chronic heavy drinkers; acute intake cannot differentiate sufficiently between these and more moderate drinkers during an episode of heavy drinking. If these differences in the association between acute and general consumption, and current and repeated injury, can be demonstrated, a screening tool may, by a simple question about prior injury, be better able to distinguish between chronic heavy drinkers, who are more likely to abuse or be dependent on alcohol, and moderate drinkers [see 32]. In this way intervention efforts could be individualised more efficiently. The aim of this paper is to promote screening which provides information possibly allowing better tailoring of treatment to different types of drinker, be it brief intervention or more intensive treatment. To conclude, the study is not designed to show the partly trivial link between repeated heavy drinking and repeated injury, but argues that this link offers a means of better identifying different types of drinker through screening in EDs.

Methods

Sample and measurement

All patients entering the surgical ward of the emergency department at Lausanne University Hospital, Switzerland, between 11a.m. and 11p.m. were approached for participation. The facility is a 700-bed inner city academic hospital serving a population of 600,000 individuals in the French-speaking area of Switzerland, is the biggest ED in the region and is most representative of ED patients in the area. Sampling took place each day between January 1, 2003 and June 30, 2004, covering the entire study period. Six masters level psychologists were recruited to conduct interviews with patients, together with one experienced ED nurse to promote communication between research and ED staff. A senior physician

and a psychologist experienced in teaching motivational interviewing trained the research interviewers during a 2-day workshop on motivational interviewing, using exercises aimed at improving performance through active, empathic listening and avoidance of confrontation, as described elsewhere [33]. The interviewers all had at least one year of clinical practice and spent a minimum of 20 hours a week on the study.

The present paper used data from a screening questionnaire containing questions on general consumption patterns, including a quantity-frequency instrument to measure usual volume of drinking and a question on frequency of intake of 5+ drinks (men) or 4+ drinks (women) in the past month (binge drinking). Acute alcohol consumption in the 24 hours before attending the ED was assessed for beer, wine, and spirits. Beginning with the most recent drink, time line follow-back methods [34] were used to assess consumption during that period. Patients were asked whether they ever had an earlier injury associated with alcohol or drug use. The design of the study was approved by the Ethics Committee for Medical Research, Lausanne University Medical School.

According to administrative data from the ED, 13,509 eligible patients (aged 18 years and over) presented in the emergency department and of these: 2,041 (15.1%) could not be interviewed due to work overload of interviewers on the shift, too short a visit, or treatment after the 11:00 p.m. deadline for interviewing; 1,054 (7.8%) did not understand enough French, were deaf, or did not wish to converse; 990 (7.3%) were too ill or severely injured, as determined by the medical treatment team; and 360 (2.7%) left no recorded reason for non-participation, personally knew the interviewer, were overtly aggressive or too intoxicated, or were accompanied by the police. Active refusal to participate was fairly rare (by 255 [1.9%] patients) and was chiefly on miscellaneous, minor grounds.

The sample consisted of 8,809 patients aged 18 years and over, but for the present study 858 of these were excluded who admitted using illicit substances in the past (e.g., marihuana, cocaine, ecstasy, heroin) and might have introduced confounders on the question regarding prior alcohol-related injury, 73 furnished incomplete alcohol consumption data and 6 others did not report their age. The final yield was 7,872 patients.

General consumption pattern and acute alcohol intake

The general consumption pattern of usual drinking volume was measured in drinks per week; binge drinking was defined as consuming 5+ drinks for men (4+ drinks for women) at least once monthly. Acute alcohol intake

was measured as number of drinks in the 24 hours prior to attending the ED. Thus, we distinguish the consumption directly on the day of the injury (acute intake) from the way the patients drink usually, "usually" meaning the joint picture of average consumption (volume) and the "usual" frequency of binge drinking. It should be noted that consumption on the day of injury may well reflect the typical drinking pattern of some patients, whereas it was atypical for other patients.

Statistical analysis

Current and repeated injury risk was assessed using logistic regressions. For each of these two outcomes three models were estimated. Model 1 examined general consumption patterns, Model 2 looked at acute intake, and Model 3 combined the two measures. To allow for the fact that binge drinking may have different effects among usually moderate and usually heavy drinkers, the interaction between them was tested; results for interactions were reported if significance was reached in one of the three models. This three-step procedure was applied to investigate whether usual consumption or acute intake are more predictive of injury and injury recidivism, and to see how each of the risk exposure-to-outcome associations change when both predictors are entered simultaneously. Likelihood ratio tests were applied to determine differences between nested models, i.e., model fit changes, and Nagelkerke's pseudo R-square was calculated as a measure of explained variance [35].

The analyses were conducted in this way since general consumption patterns and acute intake are correlated and each predicts risk of injury by itself. It is hypothesised that for current injury, acute intake leads the association. Thus, the impact of general consumption patterns should fall considerably when acute alcohol consumption is added, compared to the model with usual consumption only, and the impact of acute intake should remain unchanged when usual consumption is added to the single acute intake model. On the other hand, for repeated injury it is hypothesised that usual patterns lead the association, hence the impact of acute intake should lessen considerably when usual consumption is added to the acute intake model, and the impact of usual patterns should remain unchanged when acute intake is added to the usual patterns-only model.

All regressions were adjusted for sex and age. The first dependent variable was current injury status where non-injured patients were used as "quasi-controls" for injured patients. The second dependent variable was prior alcohol-related injury or otherwise among currently injured patients.

Results

Table 1 shows that 316 (4%) of the total sample reported prior alcohol-related injury. Prior injury was more likely to be found in particular among males, patients with high acute intake prior to attendance, binge drinkers and those with large usual volumes, indicating a higher prevalence of chronic heavy drinkers among those repeatedly injured.

Table 2 shows that women were at higher risk for current injury than were men when adjustment was made for alcohol intake. Acute intake

(Model 1) and general drinking patterns (Model 2) were associated with injury in separate logistic regressions. The negative interaction of binge drinking x volume indicated that the effect of binge drinking decreases as volume increases. The effects of general consumption patterns on current injury were markedly reduced when acute intake was added (Model 3), but the effects of acute intake remained essentially the same when usual consumption patterns were added. In this full model, binge drinking remained significant, while

Table 1

Sample characteristics of 7,872 patients (%) with current injury and prior alcohol-related injury status.

	Emergency attendance		Prior alcohol-related injury	
	Injury (n = 4481)	Non-injury (n = 3391)	Yes (n = 316)	No (n = 7556)
Sex				
Men (n = 4017)	49.7	51.9	78.2	49.9
Women (n = 3855)	50.3	48.1	21.8	50.1
Age				
>25 (n = 895)	13.6	8.4	13.9	11.3
25–34 (n = 1448)	20.6	15.5	21.8	18.3
35–44 (n = 1307)	16.5	16.7	18.7	16.5
45–54 (n = 1030)	11.4	15.3	12.0	13.1
55 and over (n = 3192)	38.0	44.0	33.5	40.8
Volume (drinks per week)				
Abstainers (n = 1956)	21.7	29.0	13.6	25.3
>0 to 7 drinks (n = 4507)	59.6	54.1	40.2	58.0
>7 to 14 drinks (n = 850)	11.2	10.3	18.0	10.5
>14 drinks (n = 559)	7.5	6.6	28.2	6.2
Binge past months				
Yes (n = 1380)	20.7	13.4	49.1	16.2
Alcohol consumption 24 hours prior to ED attendance				
None (n = 5636)	65.7	79.3	56.3	72.2
>0 to 2 drinks (n = 1596)	23.5	16.0	18.7	20.3
>2 to 4 drinks (n = 404)	6.7	3.1	8.9	5.0
More than 4 drinks (n = 236)	4.1	1.5	16.1	2.4

Remarks: Binge occasion: Drinking of 5+ drinks (men) or 4+ drinks (women) on at least 1 occasion in the past month

Table 2

Logistic regressions of current injury status on usual and acute alcohol consumption.

	Model 1 (usual consumption only) CI (95%)			Model 2 (acute consumption only) CI (95%)			Model 3 (usual and acute consumption) CI (95%)		
	OR	Lower	Upper	OR	Lower	Upper	OR	Lower	Upper
Women (reference = men)	1.223	1.111	1.346	1.246	1.136	1.367	1.244	1.129	1.370
Age	0.995	0.993	0.997	0.993	0.991	0.995	0.995	0.992	0.997
Weekly volume per 10 drinks	1.154	1.154	1.295				0.916	0.811	1.035
Binge past month (reference = no binge)	2.012	1.701	2.381				1.507	1.263	1.798
Volume*binge interaction	0.801	0.704	0.912				0.922	0.806	1.054
Acute alcohol 24 hours prior to injury				1.656	1.541	1.779	1.680	1.547	1.823
Constant	1.352			1.384			1.283		
-2 log likelihood of model 3 and chi² – difference between models 1 and 2, and model 3	166.5			33. 61			471.7		
Nagelkerke's R Square	0.019			0.041			0.047		

neither volume nor the interaction of volume x binge drinking remained significant. Adding general drinking patterns to acute intake only moderately (though significantly, given the large sample size) increased the model fit (log likelihood ratio test between Models 2 and 3: chi² = 33. 6, df = 3; p <.001). Adding acute intake to general consumption patterns showed a greater model improvement (log likelihood ratio test between Models 1

and 3: chi² = 166.5, df = 1; p <.001). Nagelkerke's R-square showed that adding acute intake to the model with general consumption patterns alone increased the fit more substantially than vice versa.

As can be seen in table 3, the interplay between acute intake and general consumption patterns differed for repeated injury but not for current injury. Adding acute intake to the model with

Table 3

Logistic regressions of prior alcohol-related injury on usual and acute alcohol consumption among current injury patients only.

	Model 1 (usual consumption only) CI (95%)			Model 2 (acute consumption only) CI (95%)			Model 3 (usual and acute consumption) CI (95%)		
	OR	Lower	Upper	OR	Lower	Upper	OR	Lower	Upper
Women (reference = men)	0.507	0.352	0.731	0.419	0.295	0.596	0.518	0.359	0.747
Age	0.990	0.981	0.998	0.990	0.982	0.998	0.989	0.981	0.998
Weekly volume per 10 drinks	1.390	1.247	1.549				1.349	1.207	1.507
Binge past month (reference = no binge)	2.549	1.784	3.644				2.279	1.563	3.324
Acute alcohol 24 hours prior to injury				1.741	1.515	2.002	1.176	0.996	1.388
Constant	0.050			0.066			0.048		
-2 log likelihood of model 3 and chi² – difference between models 1 and 2, and model 3	3.6			72.7			1396.9		
Nagelkerke's R Square	0.135			0.085			0.138		

general consumption patterns (Model 3) had little additional impact compared to Model 1 with general consumption patterns alone, with the coefficients staying essentially the same. The change in model fit was not significant (log likelihood ratio test between Model 1 and Model 3: chi² = 3.6, df = 1; p = .06). Adding general consumption patterns to Model 2 with acute intake only produced a marked decrease in the acute intake effect, but substantially increased the model fit (log likelihood ratio test between Model 1 and Model 3: chi² = 72.7, df = 2; p <.001). Women were about half as likely to have experienced repeated alcohol-related injury (OR = 0. 518).

Discussion

The current study supports evidence generally found in ED literature, that acute alcohol intake has a dose-response relationship to current injury risk [1]. When acute intake is added to a logistic regression model with general consumption patterns alone the impact of patterns on current injury is reduced, whereas the effect of acute intake remains essentially the same when usual drinking patterns are added to a model with acute intake alone. The interpretation is that acute intake is more predictive of current injury than is the pattern of general consumption, since both moderate and heavy volume drinkers are increasingly at risk for injury as acute intake rises. However, it has been shown that general consumption patterns may have an effect on current injury in addition to the effect of acute intake [2]. For example, low-volume drinkers with some heavy drinking occasions are associated with a higher risk of injury even after adjusting for acute intake. This has also been found in several general population studies [8–12] where individuals with highly variable drinking patterns (e.g., heavy intake on some occasions greatly exceeding usual intake) are at high risk for injury. One explanation may be that their tolerance is lower than that of chronic heavy drinkers and is more impaired when drinking larger amounts than normal [see 36, 2 for such

an argument]. The present study supports the assumption that binge drinking has an additional effect even when acute intake is accounted for.

The present study expands on the literature by showing that the combination of acute intake and general consumption patterns has different associations with current alcohol-related injury from those with repeated alcohol-related injury. Repeated injuries seem to be driven more by general consumption patterns than by acute intake. This appears to be particularly the case for chronic heavy drinkers, where repeated injury increases with volume and binge drinking. Although actual clinical diagnoses of alcohol abuse or dependence were not used, the findings in this study appear to support others showing that repeated alcohol-related injury is indicative of alcohol abuse or dependence [15, 18–20], in that repeated injuries were more often found among those who usually drink heavy amounts, have large acute intakes, and binge-drink.

These results have some important implications for prevention. Among current injury patients, only 4.3% had any prior alcohol-related injury; this low rate of injury recidivism is consistent with other studies [e.g. 37–39]. Caufeild et al. [18] believe that prevention strategies directed at patients already injured once would not significantly

reduce overall admissions for injury and would not be cost-effective. Gentilello *et al.* [26], however, concluded from a follow-up study that brief interventions reduced injury readmission rates by almost 50%, but were less effective for patients with alcohol dependence or prior treatment.

The present study suggests a link between these two viewpoints. One alcohol-related injury may be enough to sway individuals who are not chronic heavy drinkers to be careful to avoid future injury when drinking and this effect may be reinforced by brief interventions, though this "protective" effect may not be a deterrent for chronic heavy drinkers. Brief interventions targeted at non-dependent hazardous drinkers (e.g., those drinking moderate volumes but having occasional binges) may help reduce readmissions for injury, consistent with findings by Gentilello *et al.* [26]. More intensive strategies, however, would be needed for those presenting repeatedly (and more likely to be chronic heavy drinkers) since preventive strategies in EDs are less efficient and not cost-effective for these individuals [18]. A number of studies concur that although brief interventions work, they are much less effective for patients with severe alcohol problems [24, 26, 27], thus reinforcing the notion that some patients may require inpatient care [28] or other, more intensive treatment modalities.

Unobtrusive, brief instruments are needed in ED settings to differentiate between alcohol abusing or dependent individuals and other alcohol users, in view of the time constraints and the reluctance of many physicians to use more complex types of alcohol use screens [29–32]. The present study supports the views of Israel *et al.* [32] that a single query regarding prior injury might serve this purpose. High acute alcohol intake and repeated injuries appear to be strong predictors of alcohol abuse and dependence [15]; support for this is found in the present study where repeated injury was prevalent among those who consumed large volumes, had high acute intakes and experienced binge drinking episodes.

Several shortcomings within the present study should be pointed out. There is no clinical assessment of alcohol abuse or dependence. The assessment of acute intake was for the last 24 hours whereas a more commonly used window is 6 hours [4, 40]. The longer time frame was chosen since the main aim of the major study – from which screening data were used for the present analyses – was to investigate the effectiveness of brief interventions. Thus, acute alcohol intake data were sought primarily as a screening tool, not to measure injury risk. Using an acute intake assessment window longer than 6 hours may have down-biased the present estimates of alcohol-related injury, as shown by Watt *et al.* [2]. In addition, sample selection may have biased parameter estimates. It must be noted, however, that most of those lost to the study either did not belong to the sampling frame (i.e., were not French-speaking patients) or could not be interviewed due to administrative is-

sues such as interviewer work overload during peak ED periods; this latter aspect is probably a random function of earlier versus later arrivals and should not greatly influence these results. Bias may nevertheless have been introduced when (during the busiest times) interviewers selected patients who appeared more friendly or seemed less drunk, or when excluding the severely injured. Sample selection models to test potential biases are not possible, since data from patients who did not give informed consent cannot ethically be processed, as was the case of those excluded from the study. In general, although adjusting for sample selection has some impact on parameter estimates, it does not seem to invalidate the major findings of ED studies [41], and thus we are confident that the main findings of the present study are valid. We have to acknowledge, however, that more resources should have been allocated to the collection of minimal information from patients excluded from the study, in order to rule out potential biases with greater certainty.

One further caveat is that assessment of repeated injury was through direct questioning of patients about prior alcohol-related injuries, and could be measuring the attribution of alcohol consumption as a cause of prior injury (criterion contamination). This might have biased findings if patients who were willing to admit being heavy consumers were also those who were more likely than light consumers to attribute prior injuries to their alcohol consumption. A recent meta-analysis [42] has shown that the acceptance of alcohol consumption within a culture may influence causal attribution of injury. In "wet" regions like Switzerland, where frequent drinking is integral to everyday life [43], associations between alcohol intake and causal attribution of injury were stronger than in "dry" regions, where there is a dominant pattern of infrequent but heavy drinking. The association between injury, repeated injury and alcohol consumption should be further investigated by obtaining medical records documenting repeated injury rather than depending on self-reports of alcohol-attributed prior injuries. This would provide greater insight into the causality of these relationships. However, medical records may be less useful than self-reports for actually designing preventive actions in ED settings. Unless they are in primary care, patients in ED do not usually see the same physician regularly and thus the attending physician will not usually be aware of the patient's history of prior injury or alcohol consumption and will have to depend on self-reports. The present study suggests that asking about prior injury and assessing acute alcohol intake could result in a very useful screening tool for distinguishing potential alcohol abuse or dependence from other kinds of drinking. A tailored clinical assessment of alcohol abuse or dependence could then confirm and formalise this relationship and open the way to appropriate intervention and treatment.

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