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The association between hospital admission and substance use among trauma patients

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ABSTRACT

Background: Alcohol and substance use is prevalent in trauma patients admitted to hospital.
Aim: Investigate the association between hospital admission and substance use for three different injury types among trauma patients according to age and gender.
Method: Prospective cross-sectional emergency department study. The patients were divided into injury groups and compared with respect to gender, age, hospital admission, substance use, and blood alcohol level.
Results: The study included 998 trauma patients, of whom 39% screened positive for substance use. Patients with head injury had a higher prevalence of alcohol use (29%). Patients with head injury and hazardous drug or alcohol use were less likely to stay in hospital for more than 24 hours (adjusted OR: 0.61, 95% CI: 0.41–0.93, $p = .02$), whereas patients with injuries to neck/thorax/abdomen and hazardous use had the highest risk of staying in hospital more than 24 hours (adjusted OR: 5.22, 95% CI: 1.47–18.76, $p = .01$). Injuries to pelvis/extremities were more common among women with medicine use.
Conclusion: Patients with head injury and hazardous use were less likely to be admitted to hospital, whereas patients with injuries to the neck/thorax/abdomen and hazardous use were more likely to be admitted.

Abbreviations: ICD-10, International Classification of Diseases 10th edition; GCS, Glasgow Coma Scale; ICU, intensive care unit; ED, emergency depart-390 ment; GHB, gamma hydroxybutyrate; BAL, blood alcohol level; OR, odds ratio; GP, general practitioner; CI, confidence interva

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Introduction

Worldwide, there are approximately 5.2 million deaths from injuries every year, and nonfatal injuries account for about one-tenth of the global burden of disease (World Health Organization, 2009). In 2013, alcohol and drug use was the main risk factor for death in developed countries in the age group 5–14 years and 15–49 years for both genders (GBD, 2013). The relationship between substance use and traumatic injuries has been recognized, and harmful use of alcohol is one of the main risk factors for ill health. Alcohol alone is responsible for about 2.3 million premature deaths worldwide each year (World Health Organization, 2007). Drug abuse is also an important factor affecting mortality from injury. In 2010, drug overdose was the leading cause of injury death in the United States (World Health Organization, 2009).

Several studies have addressed the issue of drug and alcohol positive patients and injury (Kuendig et al., 2008). Patients who arrive in emergency departments (ED) present with high prevalence of drug and alcohol consumption (Vitale & van de Mheen, 2006; World Health Organization, 2007). Patients with low and moderate levels of alcohol consumption also have a higher risk of acquiring all types of injuries (Kuendig et al., 2008), and there appears to be a correlation between patients who screen positive for drug and alcohol use and injuries to the head and the abdominal area (Hooper, 2007; Kuendig et al., 2008; Rubinsky et al., 2012). Studies also show that alcohol consumption causes injury in a dose-response manner, and most people with risky substance use may have poorer health and therefore increased risk of hospitalization (Taylor et al., 2010). It therefore seems important to discriminate between patients with acute alcohol intoxication and patients with a pattern of a more risky intake of psychoactive substances.

Several studies have assessed if there are any differences in treatment needs for patients screening positive for any type of substance use when admitted. Patients who have ingested both alcohol and drugs have a higher risk of inhospital complications overall and pneumonia in particular (Rootman et al., 2007) and increased risk of intensive care unit (ICU) admission (Wiener et al., 2010). Those who have abused either alcohol or drugs appear to have significantly higher complication rates, longer stays, and higher hospitalization costs than drug and alcohol negative patients (Cowperthwaite & Burnett, 2011; Hsieh et al., 2013). The clinical outcome, however, did not differ between patients who screened positive for alcohol or drugs, and patients

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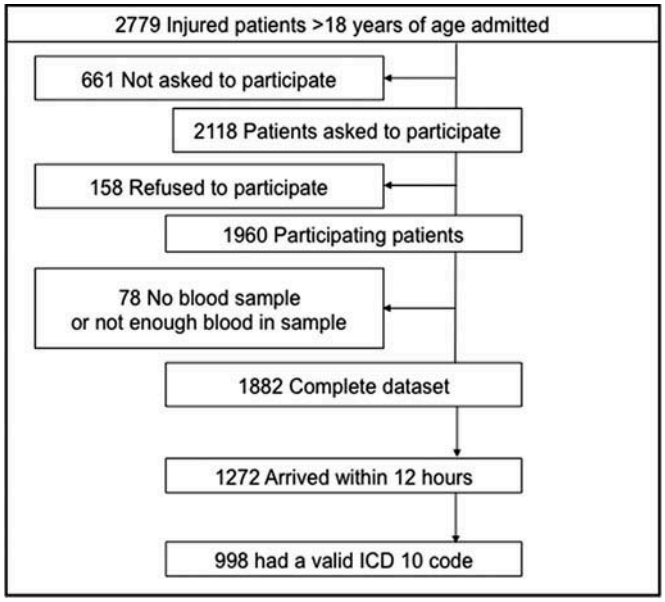

Figure 1. Flowchart shows the inclusion of patients in the study.

who screened negative (Cowperthwaite & Burnett, 2011). One study has concluded that alcohol use actually has the opposite effect; shorter length of stay, lower injury severity score and lower inhospital mortality (Lank & Crandall, 2014). It has been suggested that this could be because trauma patients who present with acute alcohol intoxication have fewer medical comorbidities, and are taking fewer medications than patients who abstain from alcohol, and further, that intoxication is directly influencing routine trauma measurements and decreased ICU admission (Lank & Crandall, 2014). Initial assessment of patients with head injuries and positive screening for drug and alcohol use may also be more difficult due to their altered state of consciousness. One study shows that patients with positive alcohol screening present with a lower initial Glasgow Coma Scale (GCS) (Hooper, 2007).

In the current study, the aim was to investigate the association between hospital admission and substance use for three different injury types among trauma patients according to age and gender.

Methods

Setting

This was a prospective cross-sectional study of all trauma patients admitted to the Emergency Department (ED), Oslo University Hospital, Ullevål in 2008. The hospital is one of the Scandinavia's largest hospitals, and is located in Oslo, Norway. The hospital is a level 1 trauma center and is the Trauma Referral Center for Eastern and Southern Norway, covering a population of approximately 2.5 million citizens.

Participants

Patients admitted to the ED with trauma injuries to the head, neck/thorax/abdomen or pelvis/extremities were included in the study if they were over 18 years of age, with intact cognition, able to understand Norwegian, and with the ability to give informed consent. If the patient could not give informed consent, and his or her next of kin was at the hospital and available for consent, they were asked if the patient could participate. In some cases, it was not possible to get an informed consent in the emergency department, usually from trauma patients. In these cases, a blood sample was obtained and the patients were asked to give informed consent later during the stay. If such consent was not obtained the blood samples were destroyed. The patients who were not asked for study participation later during hospital stay were either too severely injured on admission, or they were very slightly or not at all injured and discharged within less than 6 h of observation. Patients admitted 12 hours after injury were excluded from the study. Patients who were discharged without an ICD-10 diagnosis were also excluded. This was a subsample of a study including all patients admitted with injuries. Altogether 24% of the patients were not able to give an informed consent or were discharged before they were asked about study participation. Only 7% of the invited patients refused to participate. (Bogstrand et al., 2011). Flowchart shows the inclusion of patients in the study.

Variables

In order to investigate the admission rate, groups with comparable injuries were created, as admission rates may vary by injury type. Type of injury was classified according to the International Classification of Disease, 10th edition (ICD-10): Head injury: S0x, Neck/Thorax/ Abdomen: S1x, S3x, and S2x, Pelvis/ Extremities: S7x, S4x, S5x, and S8x. Substance use was classified in four groups: Negative, Alcohol, Illicit drug use or combinations, and Medicine. "Negative" includes a concentration of alcohol below 0.1‰ and/or no detectable illicit substance and/or medicine. "Illicit drug use or combinations" includes gamma hydroxybutyrate (GHB), cocaine, benzoylecgonine, ecstasy (3,4-methylenedioxy-N-methyamphetamine), methamphetamine, amphetamine, cannabis (tetrahydrocanabinol), heroin (metabolite 6-monoacetylmorphine), and phenazepam. "Medicine" includes carbamazepine, zolpidem, zopiclone, nitrazepam, diazepam, oxazepam, alprazolam, clonazepam, flunitrazepam, buprenorphine, dextropropoxyphene, methadone, morphine, ethyl morphine, oxycodone, carisoprodol, meprobamate, codeine, and phenobarbital. These medicines were chosen because they are potentially addictive and misused. Whole blood analysis was used to measure concentrations of alcohol, illicit substances, medicine use, and combinations of these.

Alcohol concentrations were divided into "Negative" ≤ 0.1‰, "Low" = 0.1–1.0‰, "Moderate" = 1.01–1.7‰ and "High" ≥ 1.7‰. In Table 3, the variables for substance use were combined into "hazardous drug or alcohol use". This variable included patients with an alcohol level ≥1.0‰, positive screening for illicit drug use or combination use. Combination use implies consumption of two or more of the three substance groups of alcohol, illicit drugs, and medicines. Age was divided into the three groups: 18–35, 36–64, and ≥65 years. Hospital admission was divided into "Yes" (admitted for more than 24 hours) and "No" (discharged within 24 hours of arriving at the ED).

Data collection and data source

Blood samples and questionnaires were collected from all patients who had given their consent and were admitted to the Emergency Department for treatment of injuries. All patients included were screened for substance use by analyzing blood samples that had been taken shortly after admission. An enzymatic dehydrogenase method was used for ethanol analysis (Kristoffersen & Smith-Kielland, 2005). For each substance, the cut off value used to indicate the presence of the drug was set to 3–5 times the signal to noise ratio. The blood samples were first screened for amphetamines, cannabis, cocaine, metabolites, and opiates by an immunological method (Gjerde et al., 1990). Screening for other drugs was carried out using high-performance liquid chromatography with mass spectroscopy detection (LC-MS) (Christophersen et al., 2001). The blood samples were analyzed for all impairing drugs on the Norwegian market which have been shown to be linked to increased accident risk (Morland, 2000). Medical records and questionnaires were screened for injury type according to the ICD-10 codes. All the extracted data was electronically transferred to the project database.

Ethics

All patients who were invited to participate were informed about the project verbally and in writing, and were asked to give written informed consent. Patients were also informed that they could withdraw from the project at any time. The Data Inspectorate and the Regional Ethics Committee in Norway approved the study.

Statistical methods

Categorical data were computed using bivariate cross tables, and statistical significance was calculated with Pearson's chi-square or Fisher's exact test when the expected count in a group was less than five. Adjusted odds ratios were computed using multivariate logistic regression analyses. All analyses were made in PASW 20 (SPSS Inc., Chicago IL). The level of statistical significance was ≤.05, two-tailed test.

Results

Participants

The study population consisted of 998 patients, 59% men and 41% women (Table 1). Head and neck/thorax/abdomen injuries were more common among men than women (70% vs 30% and 69% vs 31%, respectively, $p < .05$), while injuries to pelvis/extremities were more common among women, 57% vs 43%, $p < .05$. For patients with head injuries, 47% were 18–35 years old, whereas 51% of those with injuries to pelvis/extremities were ≥65 years old. Of all the patients who arrived at the ED, 30% were admitted for less than 24 hours. The admission rates differed by diagnosis; 51% of patients with head injury were admitted for less than 24 hours, compared to only 11% for those who sustained injury to pelvis/extremities. Of all the patients admitted for more than 24 hours, pelvis/extremities accounted for the largest group, 89%.

Table 1. Associations between injury, gender, age, hospital admission, toxic agents and blood alcohol level.

	Head	Neck/Thorax/ Abdomen	Pelvis/ Extremities	Total
Gender				
Male	298	127	168	593
	70%	69%	43%	59%
Female	125	56	224	405
	30%	31%	57%	41%
Total	423	183	392	998
	100%	100%	100%	100%
p-value	≤ .001			
Age				
18–35	198	72	62	332
	47%	39%	16%	33%
36–64	155	82	132	369
	37%	45%	34%	37%
≥65	70	29	198	297
	16%	16%	50%	30%
Total	423	183	392	998
	100.0%	100.0%	100.0%	100.0%
p-value	≤ .001			
Hospital admission				
No	215	37	42	294
	51%	20%	11%	30%
Yes	208	146	350	704
	49%	80%	89%	70%
Total	423	183	392	998
	100%	100%	100%	100%
p-value	≤ .001			
Toxic agents detected				
Negative	205	119	282	606
	49%	65%	72%	61%
Alcohol	123	35	19	177
	29%	19%	5%	18%
Illicit/Combined	72	15	23	110
	17%	8%	6%	11%
Medicine	23	14	68	105
	5%	8%	17%	10%
Total	423	183	392	998
	100%	100%	100%	100%
p-value	≤ .001			
Blood alcohol level				
Negative	244	142	356	742
	58%	77%	91%	74%
Low 0,1–1,0	43	14	15	72
	10%	8%	4%	7%
Moderate 1,01–1,7	62	14	9	85
	15%	8%	2%	9%
High >1,7	74	13	12	99
	17%	7%	3%	10%
Total	423	183	392	998
	100%	100%	100%	100%
p-value	≤ .001			
Hazardous drug or alcohol use				
Yes	256	145	358	759
	60%	79%	91%	76%
No	167	38	34	239
	40%	21%	9%	24%
Total	423	183	392	998
	100%	100%	100%	100%
p-value	≤ .001			

Drug and alcohol prevalence

There were several significant differences in the distribution of psychoactive substance use. Of the 39% of patients who arrived at the ED and screened positive for drug and/or alcohol use, 18% screened positive for alcohol, 11% for medicine and 11% for illicit/combination. For those with head injury, alcohol was the substance with highest prevalence, 29%. Among these, 32% had a moderate or high blood alcohol level, compared to 5% in the pelvis/extremities group. For patients with pelvis/extremities injuries, medicine use was most common, at 17%. Among all

Table 2. Associations between substance use, injury, and admission.

		Substance					
Diagnosis	Admission > 24 hours	Negative	BAL 0.1–1	BAL>1	Illicit/ combined	Medicine	Total
Head	No	93	14	54	40	14	215
	Yes	45%	50%	57%	56%	61%	51%
		112	14	41	32	9	208
		55%	50%	43%	44%	39%	49%
	Total	205	28	95	72	23	423
		100%	100%	100%	100%	100%	100%
p-value	.249						
Neck, thorax, abdomen	No	32	0	0	3	2	37
		27%	0%	0%	20%	14%	20%
	Yes	87	12	23	12	12	146
		73%	100%	100%	80%	86%	80%
	Total	119	12	23	15	14	183
		100%	100%	100%	100%	100%	100%
p-value	.014						
Pelvis, extremities	No	34	0	0	2	6	42
		12%	0%	0%	9%	9%	11%89,3%
	Yes	248	8	11	21	62	350
		88%	100%	100%	91%	91%	89%
	Total	282	8	11	23	68	392
		100%	100%	100%	100%	100%	100%
p-value	.531						
Total	No	159	14	54	45	22	294
		26%	29%	42%	41%	21%	30%
	Yes	447	34	75	65	83	704
		74%	71%	58%	59%	79%	70%
	Total	606	48	129	110	105	998
		100%	100%	100%	100%	100%	100%
p-value	≤.001						

*BAL- Blood Alcohol Level.

Table 3. Associations between admission to hospital for more than 24 hours and hazardous substance use, age and gender.

	Univariate				Multivariate			
Head Injuries	OR	95% CI		*p*-value	OR	95% CI		*p*-value
Hazardous drug or alcohol use	0.70	0.47	1.03	.070	0.61	0.41	0.93	.020
Age 18–35 (ref.)								
Age 36–64	1.15	0.75	1.75	.525	1.14	0.74	1.75	.558
Age > 65	0.68	0.39	1.18	.172	0.64	0.36	1.15	.137
Male	1.34	0.88	2.04	.169	1.37	0.88	2.13	.165
	Univariate				Multivariate			
Injuries to Neck, thorax, abdomen	OR	95% CI		*p*-value	OR	95% CI		*p*-value
Hazardous drug or alcohol use	3.57	1.03	12.35	.044	5.22	1.46	18.75	.011
Age 18–35 (ref.)								
Age 36–64	1.19	0.56	2.50	.656	1.53	0.70	3.34	.291
Age > 65	9.33	1.18	73.58	.034	13.99	1.71	114.69	.014
Male	0.81	0.36	1.80	.598	0.97	0.40	2.32	.942
	Univariate				Multivariate			
Injuries to Pelvis, extremities	OR	95% CI		*p*-value	OR	95% CI		*p*-value
Hazardous drug or alcohol use	2.01	0.47	8.72	.350	2.53	0.57	11.31	.225
Age 18–35 (ref.)								.483
Age 36–64	0.56	0.20	1.57	.268	0.54	0.19	1.54	.249
Age > 65	0.83	0.30	2.31	.717	0.54	0.18	1.62	.270
Male	0.38	0.19	0.73	.004	0.32	0.15	0.66	.002

the patients admitted, 24% had a hazardous drug or alcohol use (blood alcohol level > 1‰, positive screening for illicit drug use or combination use), and the proportion of this use was largest among those with head injury (40%) (Table 1).

The prevalence of substance use was higher among those who were admitted for less than 24 hours (46%) than for patients who were admitted for more than 24 hours (37%) (Table 2).

Of all the patients with injury to the neck/thorax/abdomen, 80% were admitted for more than 24 hours. For those who screened positive for any type of substance use and with injury to neck/thorax/abdomen, 92% were admitted for more than 24 hours, compared to 73% of the patients who screened negative, $p < .05$. There was no significant association between those who screened positive for alcohol, illicit/combination or medicine use and hospital admission and injuring head or pelvis/extremities (Table 2).

Multivariate analyses revealed that there was a significant association between having a head injury in combination with hazardous drug or alcohol use, and not being admitted to hospital for more than 24 hours (OR: 0.61, 95% CI: 0.41–0.93, $p = .02$) (Table 3). In contrast, patients with injuries to neck/thorax/abdomen combined with hazardous drug or alcohol use had a higher

risk of being admitted for more than 24 hours (OR: 5.22, 95% CI: 1.46–18.75, $p = .011$) (Table 3). For neck/thorax/abdomen injuries, patients with an age >65 revealed a higher probability of hospital admission (OR: 13.99, 95% CI: 1.71–114.69, $p = .014$) (Table 3). Among patients with pelvis/extremities injuries, there was no association between hazardous drug or alcohol use and hospital admission; however, males showed a lower risk of admission (multivariate OR: 0.32, 95% CI: 0.51–0.66, $p = .002$) (Table 3). The patients admitted with pelvis injuries were more likely to be older than 40 years of age (OR: 3.99 95% CI: 2.99–5.31), women (OR: 3.13 95% CI: 2.40–4.08) and testing negative for any psychoactive substances (OR: 0.45 OR: 0.34–0.59) compared to patients with other injuries.

Discussion

In this study, almost 40% of all the patients arriving at the Emergency Department (ED) screened positive for some type of substance use and 24% had hazardous drug or alcohol use. There was a significant association between having a head injury in combination with hazardous drug or alcohol use, and not being admitted to the hospital in excess of 24 hours. In contrast, patients with injuries to neck/thorax/abdomen combined with hazardous drug or alcohol use had a higher risk of being admitted for more than 24 hours.

The high prevalence of patients screening positive for any substance use in our study is supported by previous studies (Plurad et al., 2010; World Health Organization art. 2). Our data also revealed that the prevalence of substance use was higher among those who were admitted for less than 24 hours (46%) compared to patients who were admitted for more than 24 hours (37%). Studies report that patients with positive alcohol screening present with a lower initial Glasgow Coma Scale (GCS) (Hooper, 2007) and that the similarities in the clinical presentation of patients with acute brain injury and those who are intoxicated appear to influence prehospital care (Gurney et al., 1992). In the initial stage of hospital admission, it may be difficult to determine if head injury or substance use is the main factor for the low GCS. In our study, patients with head injury and hazardous drug or alcohol use had a lower risk of hospital admission for more than 24 hours. An explanation could be that the low GCS is mostly due to substance use and not head injury, and that the patient is no longer in need of admission once the toxic concentration has decreased.

Several studies present a correlation between patients who screen positive for drug and alcohol use and injuries to the head and the abdominal area (Hooper, 2007; Kuendig et al., 2008; Rubinsky et al., 2012). Intoxicated patients have an altered hemostasis, and injury to the abdominal area may result in more profound bleeding than among nonintoxicated patients. This may pose a greater risk for complications (Hooper, 2007). This could be an explanation for our result: greater risk of admission in the case of injury to the abdominal area and hazardous drug or alcohol use.

Studies show that trauma patients who test positive for both alcohol and drug use are found to be significantly more likely to experience complications than nonintoxicated patients (Rootman et al., 2007). Alcohol impairs compensatory responses to injury that are critical to survival, such as increased pulmonary vascular resistance and impaired cardiovascular response to acute blood loss, resulting in increased likelihood of serious complications (Blomqvist et al., 1987; McDonough et al. 2002).

The one study concludes that drug and alcohol use is common among patients with orthopedic injuries, and that these patients have more severe injuries (i.e., open fractures) and require longer hospitalization (Levy et al., 1996). There was no statistically significant correlation between being admitted for more than 24 hours and having injury to extremities, when screening positive for hazardous alcohol and drug use.

Limitations and strengths

This study had several limitations. One limitation was that comorbid conditions were not measured. This could have had an impact on the patients' risk of hospital admission. The study used the blood concentration of drugs and alcohol to assess high-risk drug and alcohol use. This is, however, just an indication of such use at the time of injury. It would have strengthened the study if we had self-reported data from the patients or other sources of information about the patients' level of substance abuse. This might have made it possible to differentiate between high- and low-risk drug and alcohol use.

The study was performed on a large number of patients, but when patients were divided into many subgroups, it was difficult to show a statistically significant correlation between admission, injury to pelvis/extremities and hazardous drug or alcohol use. Studies on larger populations are therefore necessary.

It was a strength that the study site was at a hospital that is both a local hospital and a regional trauma center. This gave a more comprehensive overview of all injury types, considering that the hospital treats both major traumas and less severe injuries. A further strength of this study was that the data was collected over a 12-month period, avoiding seasonal variations in the sample of injuries. An accredited laboratory in forensic toxicology carried out the analyses of the blood samples and this supports the high quality of analytical results (Christophersen & Morland, 1997).

There was no alternative center for emergency treatment that might have biased the patient population.

Implications

The study reveals a lower risk of hospital admission for more than 24 hours when having a head injury in combination with hazardous drug or alcohol use. Patients who are under the influence of any type of substance may be misinterpreted as having a head injury and therefore brought to the hospital. Many patients with trauma to the head are also brought to the hospital for examination using computed tomography. The examination may then conclude that the injury was not as severe as first expected, leading to the patient being discharged when sober. This might have had an impact on the result in our study, where 51% of the patients with a head injury were not admitted for more than 24 hours. Nevertheless, it is important to screen patients with possible

head injury, since severe head injury often leads to fatal consequences when undiagnosed and untreated.

When admitted to the ED, the main focus is the patient's clinical status and treatment of the injuries. Nearly half of the patients admitted with head injury screened positive for some substance use. This supports the investment of time in preventive work against substance use during treatment of the injury in order to minimize subsequent readmissions (Havard et al., 2008). Preventive work against substance use is also important in society in general, since substance users have a greater risk of injuries.

Studies show inconsistent results on how substance use impacts the patient's length of stay and risk of admission (Cowperthwaite & Burnett, 2011; Lank & Crandall, 2014; Wiener et al., 2010). This study shows that risk of admission for more than 24 hours, when influenced by alcohol and drugs, depends on the injury type. The different admission rates for different injuries must be taken into consideration in future studies. Further research should investigate hospital course, length of stay and readmission rate, to give a better understanding of the patients' outcome and the economic aspects of trauma patients with substance use.

The data in this study show a tendency toward there being a relationship between injuries to pelvis/extremities and elderly females with medicine use. Use of sedative medicine is common in this age group, normally prescribed by a patient's general practitioner (GP). Therefore, it is important that the GPs have this relationship in mind when prescribing sedative medicines, especially among patients who are at greater risk of falling. More research on this topic may prevent such injuries.

Conclusions

In summary, almost 40% of patients admitted with injury screened positive for some substance use, and 24% with hazardous drug or alcohol use. This highlights the consistency of the risk associated with substance use and injury. The risk of being admitted for more than 24 hours among patients with hazardous drug or alcohol use was higher for patients with injuries to neck/thorax/abdomen than for patients with head injuries. Older women who had used medicines (mainly benzodiazepines) were at higher risk of injuries to pelvis/extremities.

Disclosure of potential conflicts of interest

The authors declare that they have no competing interests.

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Availability of data and materials

Data will not be shared due to an institutional agreement.

Ethics approval and consent to participate

The Norwegian Data Inspectorate and the Regional Ethics Committee in South-East Norway approved the study. A written consent was obtained from all participating patients.

Author Contributions

TRE and LS contributed to the data analysis and drafted this manuscript. STB contributed to the data collection and data analysis. All authors contributed to the design of the study, the outline of the present paper, discussion of the results, the evaluation of the analytical results and data analysis, the writing of the manuscript. All authors approve the final version of the manuscript.

References

Blomqvist, S., Thorne, J., Elmer, O., Jonsson, B. A., Strand, S. E., & Lindahl, S. G. (1987). Early post-traumatic changes in hemodynamics and pulmonary ventilation in alcohol-pretreated pigs. *The Journal of Trauma: Injury, Infection, and Critical Care*, 27(1), 40–44. doi:10.1097/00005373-198701000-00007

Bogstrand, S. T., Normann, P. T., Rossow, I., Larsen, M., Morland, J., & Ekeberg, O. (2011). Prevalence of alcohol and other substances of abuse among injured patients in a Norwegian emergency department. *Drug and Alcohol Dependence*, 117(2–3), 132–138. doi:10.1016/j.drugalcdep.2011.01.007

Christophersen, A. S., Gulliksen, M., Hasvold, I., Johansen, U., Karinen, R., & Ripel, A. (2001). Screening, confirmation and quantification of drugs of abuse in whole blood by LC-MS. In M. Balikova & E. Novakova (Eds.), *Abstract of the 39th meeting of the internationale association of forensic toxicologists (TIAFT)*. Prague: Charles University.

Christophersen, A. S., & Morland, J. (1997). Drugged driving, a review based on the experience in Norway. *Drug and Alcohol Dependence*, 47 (2), 125–135. doi:10.1016/S0376-8716(97)00081-1

Cowperthwaite, M. C., & Burnett, M. G. (2011). Treatment course and outcomes following drug and alcohol-related traumatic injuries. *Journal of Trauma Management & Outcomes*, 5, 3. doi:10.1186/1752-2897-5-3

GBD. 2013. Retrieved from http://ihmeuw.org/3r58

Gjerde, H., Christophersen, A. S., Skuterud, B., Klemetsen, K., & Morland, J. (1990). Screening for drugs in forensic blood samples using EMIT urine assays. *Forensic Science International*, 44(2–3), 179–185. doi:10.1016/0379-0738(90)90248-W

Gurney, J. G., Rivara, F. P., Mueller, B. A., Newell, D. W., Copass, M. K., & Jurkovich, G. J. (1992). The effects of alcohol intoxication on the initial treatment and hospital course of patients with acute brain injury. *The Journal of Trauma: Injury, Infection, and Critical Care*, 33(5), 709–713. doi:10.1097/00005373-199211000-00020

Havard, A., Shakeshaft, A., & Sanson-Fisher, R. (2008). Systematic review and meta-analyses of strategies targeting alcohol problems in emergency departments: Interventions reduce alcohol-related injuries. *Addiction*, 103(3), 368-376; discussion 377-368. doi:10.1111/j.1360-0443.2007.02072.x

Hooper, M. (2007). The effect of a positive Blood Alcohol Level on the pattern and severity of injury, initial management and hospital course of road trauma patients. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine*, *15*(15), 11–15.

Hsieh, C. H., Su, L. T., Wang, Y. C., Fu, C. Y., Lo, H. C., & Lin, C. H. (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. *The American Surgeon*, 79(12), 1289–1294.

Kristoffersen, L., & Smith-Kielland, A. (2005). An automated alcohol dehydrogenase method for ethanol quantification in urine and whole blood. *Journal of Analytical Toxicology*, 29(5), 387–389. doi:10.1093/jat/29.5.387

Kuendig, H., Hasselberg, M., Laflamme, L., Daeppen, J. B., & Gmel, G. (2008). Alcohol and nonlethal injuries: A Swiss emergency department study on the risk relationship between acute alcohol consumption and type of injury. *The Journal of Trauma: Injury, Infection, and Critical Care*, 65(1), 203–211. doi:10.1097/TA.0b013e318068fc64

Lank, P. M., & Crandall, M. L. (2014). Outcomes for older trauma patients in the emergency department screening positive for alcohol, cocaine, or marijuana use. *The American Journal of Drug and Alcohol Abuse*, 40(2), 118–124. doi:10.3109/00952990.2014.880450

Levy, R. S., Hebert, C. K., Munn, B. G., & Barrack, R. L. (1996). Drug and alcohol use in orthopedic trauma patients: A prospective study. *Journal of Orthopaedic Trauma*, 10(1), 21–27. doi:10.1097/00005131-199601000-00004

McDonough, K. H., Giaimo, M. E., Miller, H. I., & Gentilello, L. M. (2002). Low-dose ethanol alters the cardiovascular, metabolic, and respiratory compensation for severe blood loss. *The Journal of Trauma: Injury, Infection, and Critical Care*, 53(3), 541-548; discussion 548. doi:10.1097/01.ta.0000023162.46773.c8

Morland, J. (2000). Driving under the influence of non-alcohol drugs. *Forensic Sciences Reviews*, 12(1–2), 79–105.

Plurad, D., Demetriades, D., Gruzinski, G., Preston, C., Chan, L., Gaspard, D., … Cryer, G. (2010). Motor vehicle crashes: The association of alcohol consumption with the type and severity of injuries and outcomes. *The Journal of Emergency Medicine*, 38(1), 12–17. doi:10.1016/j.jemermed.2007.09.048

Rootman, D. B., Mustard, R., Kalia, V., & Ahmed, N. (2007). Increased incidence of complications in trauma patients cointoxicated with alcohol and other drugs. *The Journal of Trauma: Injury, Infection, and Critical Care*, 62(3), 755–758. doi:10.1097/TA.0b013e318031aa7f

Rubinsky, A. D., Sun, H., Blough, D. K., Maynard, C., Bryson, C. L., Harris, A. H., … Bradley, K. A. (2012). AUDIT-C alcohol screening results and postoperative inpatient health care use. *Journal of the American College of Surgeons*, 214(3), 296–305.e1. doi:10.1016/j.jamcollsurg.2011.11.007

Taylor, B., Irving, H. M., Kanteres, F., Room, R., Borges, G., Cherpitel, C., … Rehm, J. (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 and Alcohol Dependence*, 110(1–2), 108–116. doi:10.1016/j.drugalcdep.2010.02.011

Vitale, S., & van de Mheen, D. (2006). Illicit drug use and injuries: A review of emergency room studies. *Drug and Alcohol Dependence*, 82 (1), 1–9. doi:10.1016/j.drugalcdep.2005.08.017

Wiener, S. E., Sutijono, D., Moon, C. H., Subramanian, R. A., Calaycay, J., Rushbrook, J. I., & Zehtabchi, S. (2010). Patients with detectable cocaethylene are more likely to require intensive care unit admission after trauma. *The American Journal of Emergency Medicine*, 28(9), 1051–1055. doi:10.1016/j.ajem.2009.06.014

World Health Organization (WHO). (2009, January 25). Alcohol and injuries: Emergency department studies in an international perspective. Geneva: World Health Organization. Retrieved from http://www.who.int/en/

World Health Organization (WHO). (2007, January 25). Alcohol and injury in emergency departments: Summary of the report from the who collaborative study on alcohol and injuries. Geneva: WHO. Retrieved from http://www.who.int/en/