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Psychoactive substances have major impact on injuries in rural arctic Norway – A prospective observational study

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Abstract

Background: Rural areas have increased injury mortality with a high pre-hospital death rate. Knowledge concerning the impact of psychoactive substances on injury occurrence is lacking for rural arctic Norway. These substances are also known to increase pre-, per- and postoperative risk. The aim was by prospective observational design to investigate the prevalence and characteristics of psychoactive substance use among injured patients in Finnmark county.

Methods: From January 2015 to August 2016, patients ≥18 years admitted to hospitals in Finnmark due to injury were approached when competent. Blood was analysed for ethanol, sedatives, opioids, hypnotics and illicit substances in consenting patients, who completed a questionnaire gathering demographic factors, self-reported use/behaviour and incident circumstances.

Results: In 684 injured patients who consented to participation (81% consented), psychoactive substances were detected in 35.7%, alcohol being the most prevalent (23%). Patients in whom substances were detected were more often involved in violent incidents (odds ratio 8.92 95% confidence interval 3.24-24.61), indicated harmful use of alcohol (odds ratio 3.56, 95% confidence interval 2.34-5.43), reported the incident being a fall (odds ratio 2.21, 95% confidence interval 1.47-3.33) and presented with a reduced level of consciousness (odds ratio 3.91, 95% confidence interval 1.58-9.67). Subgroup analysis revealed significant associations between testing positive for a psychoactive substance and being diagnosed with a head injury or traumatic brain injury.

Conclusion: A significant proportion of injured patients had used psychoactive substances prior to admission. Use was associated with violence, falls, at-risk alcohol consumption, decreased level of consciousness on admittance and head injury.

Editorial Comment

Intoxication is presumed to increase risk for serious injury. In this unique cohort, approximately one-third of all patients treated for various types of injuries had either alcohol or other psychoactive substances present in blood at time of hospital admission. This was especially common in head-injured patients, those experiencing violence, injury related to falls, and patients with a decreased level of consciousness.

1 | INTRODUCTION

In Norway, every 12th hospital admission is due to injury, and approximately 2500 injured persons die annually. Accidents are the main cause of death for people below the age of 45, with falls, acute poisonings and road traffic accidents representing the majority.[1,2] In a Norwegian study from 2011 a psychoactive substance was detected in blood in 44% of patients admitted due to injury of patients in an urban setting.[3] Between 2003 and 2008, 1/3 of all drivers who died in road traffic accidents had a psychoactive substance in their blood,[1,4] in Finland from 2007-2011 this proportion was 42%.[5]

There is an association between preoperative alcohol use and postoperative morbidity and mortality, including infections, length of hospital stay, need for intensive care,[6] and intensive care complications and outcomes.[7-10] Alcohol can cause delirium tremens, a serious complication[11,12] seen in 24%-33% of alcohol-dependent patients admitted to a somatic hospital for any cause.[13] A recent study showed that about 20% of acutely ill medical patients have a harmful pattern of alcohol use,[14] and only 14%-27% of patients with an alcohol use disorder seek treatment.[15] The American College of Surgeons Committee on Trauma advocates alcohol screening and brief intervention in all trauma centres.[16] Alcohol-related death has been shown to occur significantly more frequently and several years prematurely in patients previously admitted due to a head injury in conjunction with a finding of ethanol in blood. This was true even when the earlier case of head injury was mild, without accompanying signs of traumatic brain injury (TBI) defined as unconsciousness, amnesia, reduced Glasgow Coma Scale (GCS) or neurological/radiological findings.[17] Severe alcohol intoxication is a risk factor for delayed trauma centre admission for TBI,[18] in addition to it complicating the use of level of consciousness for prediction of head injury severity.[19] Pre-existing use of illicit substances, sedatives and opioids also often presents challenges and requires appropriate management in the critical care and surgical setting.[20-22]

The county of Finnmark, the northernmost part of Norway, has only 75.000 mostly rural inhabitants, covering an area of 48.000 km^2, an area slightly larger than Denmark. It has one of the country`s highest rates of reported violent crime per capita[23] and long distances to medical services. Two emergency hospitals cover the area, and the nearest regional trauma centre lies 320 km south of the county border. Rural areas have significantly higher injury and mortality rates,[24-28] and in Finnmark, the death rate after accidents is the highest in the country,[1] almost double that of an urban area.[29] Of those who die following trauma in Finnmark, 86% expire before arriving at hospital,[30] and improved trauma systems have made no difference.[31] In general, even relatively short delays in arrival of pre-hospital care and distance to hospital impact trauma patients` mortality,[32-35] and prevention seems to be one of few options. Psychoactive substances impact the risk of injury and patients´ subsequent medical treatment, including pre-, per- and postoperative care.[20] Although an injury might have more severe outcomes in rural areas, little is known about the impact of preventable risk factors like psychoactive substance use.

The aim of this study was to investigate the prevalence and characteristics of psychoactive substance use among injured patients in Finnmark county (psychoactive substances being alcohol, prescription- and illicit psychoactive substances). The primary analysis was associations between age, gender, place of injury, general alcohol use, sensation seeking behaviour and psychoactive substance use prior to the injury. Secondary analyses were the association between self-reported use of alcohol and measured levels of ethanol, and characteristics of patients with reduced GCS or head injuries.

2 | METHODS

2.1 | Participants and study design

This was a prospective observational study including all patients ≥18 years of age admitted to the two emergency hospitals in Finnmark county after injuries from January 2015 to August 2016. The study covered all seasons and all times of every day to account for variations. All types of injuries were included. Non-accident-related injuries were excluded (eg achilles tendon rupture during normal exercise). Also excluded were patients who due to pre-existing conditions and permanently reduced mental state could not provide informed consent.

All patients in the study signed a written informed consent, and were under no circumstances included before verbal and written information could be provided to the patient while lucid and able to relevantly consider this consent. Patients unable to consider consent on admission due to incapacitation had a spare blood sample secured in the ED as part of routine blood sampling, and were later contacted and asked for possible delayed consent. Sampling time was registered to allow for evaluation of metabolization of substances. Patients lost to follow-up before consenting, or unable to consent within two months of their admittance were not included in the study and the study blood sample was destroyed. Only after consent was a questionnaire completed by the patient and admitting nurse or study co-ordinator, and the blood sample was sent for analysis in accordance with the study protocol approved by the Norwegian regional ethics committee.

Blood samples were sent to the Department of Forensic Sciences, Oslo University Hospital, Norway for analysis. Ethanol concentrations were determined using a headspace gas chromatographic flame ionization detection (HS-GC-FID) method.[36] Analysis of drugs was performed using an ultra-high-performance liquid chromatography-tandem mass spectrometry (UHPLC-MS/MS) method. Samples were extracted using liquid-liquid extraction[37] and analysed as previously described[38] with some minor modifications. Separation was performed with an Acquity HSS T3-column (2.1100 mm, 1.8 mm; Waters Corporation) using an Agilent 1290 Infinity LC System (Agilent Technologies). An Agilent 6490 Triple Quadrupole was used for detection.

2.2 | Sample size

Due to the nature of the study we were unable to perform a formal power calculation, but an earlier Norwegian study indicated that historically predicted numbers of patients would provide good statistical strength (approximately 1000 injury patients over 18 months).[3]

2.3 | Variables

The admitting ED nurse registered amongst others the reason for admittance, time of injury, time of blood sample and Glasgow Coma Scale (GCS) on admittance (tool for describing mental alertness from coma to fully alert on a scale from 3-15 by the evaluation of verbal response, eye opening and motor response). Efforts were made to ensure that registered times were as exact as possible, and they could be left blank when uncertain. The patient questionnaire contained demographic factors and circumstances surrounding the injury (type of place, whether it was a fall, type of activity if on public road, reason for injury, and specification of whether violence was part of the incident). The term "violence" was defined as being attacked by another person or otherwise being involved in a physical altercation regardless of blame. Patients were also asked to answer whether they had ingested alcohol, sedatives, psychoactive pain medication, illicit substances or hypnotics to aid sleep within the 6 hours before the incident, alcohol screening via AUDIT-C questionnaire (Alcohol Use Disorders Identification Test – Consumption)[39,40] and a validated method of assessing sensation-seeking behaviour (Brief Sensation Seeking Scale (BSSS)) shown to be associated with both unsafe driving and use of psychoactive substances.[41-43] The AUDIT-C comprises three questions about the patient`s consumption of alcohol during the preceding 12 months (how often, how many units they typically drink and how often they drink more than 4/5 units [females/males]). The BSSS comprises four degree-categorized questions indicating risk-taking behaviour (exploring strange places, participating in frightening things, enjoying new and exciting experiences even if illegal, and preference of friends who are exciting and unpredictable). Psychoactive medicinal drugs are defined as opioids, sedatives and hypnotics. The nurse registered the administration of class/type of psychoactive medicinal drugs by medical personnel, permitting removal of substances administered by health care personnel (including the ambulance service) after the injury. In cases of doubt, medical records were consulted.

2.4 | Ethics

The study was approved by the Norwegian Regional Ethics Committee (2014/2033/REK south-east A) according to Norwegian regulations/requirements. According to the approval blood samples and questionnaires were solely identified by a study code linked to the patient's name and social security number via the separately secured consent form for the purpose of correction of data. No results were registered in the patient`s medical records, or made available for anything other than research purposes.

2.5 | Statistical analyses

IBM® SPSS® Statistics 25 was used for statistical analysis, where bivariate cross tables were used to analyse associations between the presence of psychoactive substances and patient and injury characteristics. Pearson`s $Chi^2$ statistical analysis was used to assess statistical significance, if necessary Fischer`s exact test, and independent sample t-test was used for the comparison of means. Mean was reported for normally distributed data, median if not. Multivariable logistic regression was used to further define risk factors. The level of significance was set at $P < .05$. The STROBE guideline was consulted to ensure quality of reporting.[44]

3 | RESULTS

Six hundred and eighty four consenting injured patients were included in the study, details shown in Figure 1. Eighty-one percent of patients asked consented to participation. The age group > 60 showed the highest rate of declined consent, with lower age groups being similar to each other with approx. 16% declined consent. The

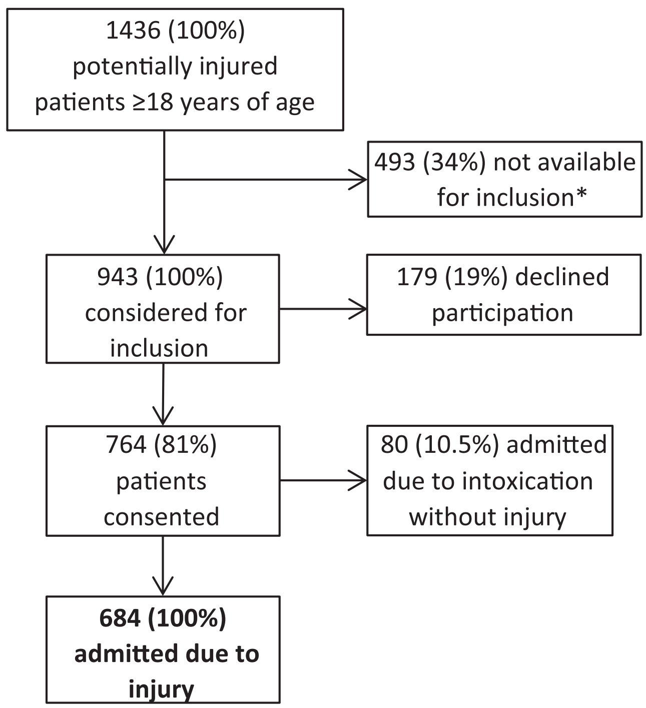

FIGURE 1 Inclusion and exclusion of patients in the study. *These patients were excluded due to reduced ability to consider consent, language barriers, death during admittance, protracted intensive care treatment, failed blood sampling, direct transfer to intensive care or regional trauma centre, and were not approached before leaving hospital, or not being available for follow-up

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TABLE 1 Detected psychoactive substances in blood and self-reported use of alcohol, total, and early and late arrivals

Substance group	Substance	Detected substance; n (%)[a] All patients	Patients sampled within 6 h of incident	Patients sampled later than 6 h after incident	Cut-off value (μmol/L)	*P*-value (chi²)
Alcohol	Alcohol detected[b]	157 (23.1)	62 (20.7)	94 (25.2)	0.1 g/L	.173
	Ethanol detected in blood	92 (13.5)	52 (17.4)	39 (10.3)		.007
	Self-reported use of alcohol[b,c]	151 (22.3)	58 (19.5)	92 (24.7)		.108
Sedatives	Any sedative	18 (2.6)	9 (3)	9 (2.4)		.613
	Alprazolam	4 (0.6)	4 (1.3)	0	0.010	
	Diazepam	10 (1.5)	6 (2)	4 (1.1)	0.200	
	Phenazepam	1 (0.1)	0	1 (0.3)	0.005	
	Flunitrazepam	1 (0.1)	1 (0.3)	0	0.005	
	Clonazepam	1 (0.1)	0	1 (0.3)	0.004	
	Oxazepam	3 (0.4)	0	3 (0.8)	0.600	
Opioids	Any opioid	69 (10.1)	22 (7.4)	47 (12.4)		.030
	Codeine	61 (8.9)	17 (5.7)	44 (11.6)	0.030	
	Morphine	11 (1.6)	5 (1.7)	6 (1.6)	0.030	
Illicit	Any illicit	23 (3.4)	11 (3.7)	12 (3.2)		.719
	Amphetamine	4 (0.6)	2 (0.7)	2 (0.5)	0.200	
	Benzoylecgonine	1 (0.1)	0	1 (0.3)	0.200	
	Cocaine	0	0	0	0.050	
	Methamphetamine	4 (0.6)	3 (1)	1 (0.3)	0.200	
	THC[d]	17 (2.5)	9 (3)	8 (2.1)	0.002	
Hypnotics	Any hypnotic	30 (4.4)	12 (4)	18 (4.8)		.638
	7-aminonitrazepam	4 (0.6)	3 (1)	1 (0.3)	0.050	
	Nitrazepam	3 (0.4)	2 (0.7)	1 (0.3)	0.050	
	Zolpidem	2 (0.3)	1 (0.3)	1 (0.3)	0.070	
	Zopiclone	24 (3.5)	8 (2.7)	16 (4.2)	0.020	
Total positive blood sample		**192 (28.1)**	**87 (29.1)**	**104 (27.5)**		.649
Total positive including self-reported alcohol use		**244 (35.7)**	**96 (32.1)**	**147 (38.9)**		.068

Note: Psychoactive substances detected in blood samples from 684 patients admitted to hospital after injuries. For alcohol, self-reported use is also shown. Blood was tested for a broad panel of substances including several known new psychoactive substances.

[a]All positive results where administration of a tested psychoactive substance was known to be, or likely to be by healthcare professionals as part of treatment of the injury in question were removed. In some cases, time of injury or time of arrival was not available, therefore the total number of results can be slightly higher than the two categories of "before and after 6 hours" combined.

[b]In addition to blood samples, patients were asked whether they had ingested alcohol during the 6 hours preceding the injury to correct for metabolized ethanol due to long transport time to hospital.

[c]One patient replied "don't know", the blood sample was negative.

[d]Tetrahydrocannabinol (main psychoactive substance in cannabis).

median time from injury to blood sample, a pseudo-measure of time from injury to admittance, was 6.65 hours (inter-quartile range 4.1-14.5 hours), the mean delay 5.7 hours for the 509 injured patients arriving within 14.5 hours of the incident). Although results are from 2015-16 we have no reason to believe they are less representative of the area`s demographic.

All detected substances are listed in Table 1, in total and by early or late arrival time. Substances in the analysis protocol which were not detected are listed in Table 2. Patients were considered positive for a psychoactive substance if any of the tested substances were detected in concentrations in blood over the cut-off limit, or they reported drinking alcohol within the 6 hours preceding the incident. Adding self-reported drinking was done to correct for pre-hospital delay from the incident to arrival at hospital for blood sampling. Unless otherwise commented, described results include self-reported use of alcohol. In total, use of any substance was detected in 35.7% of injured patients, with 23% of all patients having ingested alcohol. No difference was seen between males (36.7%) and females (33.7%), $P = .421$. A total of 5.3% of patients tested positive for two or more substances.

TABLE 2 Substances tested for, but not found in any samples

Substance group	Substance	Cut-off value (μmol/L)
Benzodiazepines	7-aminoflunitrazepam	0.02
	7-aminoclonazepam	0.10
	Etizolam	0.04
	Flubromazepam	0.01
	N-desmethyldiazepam	0.20
Opiates	6-monoacetylmorphine	0.03
	Buprenorphine	0.002
Illicit drugs	5F-APINACA	0.0001
	5F-PB-22	0.0002
	Alpha-PVP	0.01
	LSD	0.0005
	MDMA (ecstasy)	0.20
	Methadone	0.06
	Metiopropamine	0.01
	Meprobomate	5
	Phenobarbital	20

A sum of AUDIT-C questions ≥5 indicates at-risk use of alcohol, and there was a significant association between testing positive for a psychoactive substance and having an AUDIT-C ≥5 (43% of patients who tested positive had an AUDIT-C ≥ 5 compared to 20.7% of patients who tested negative, $P < .001$). AUDIT-C results overall were distributed with 114 (16%) patients scoring 0 points, 166 (24%) scoring 1-2, 208 (30%) scoring 3-4, 133 (19%) scoring 5-6, 48 (7%) scoring 7-8 and 14 (2%) scoring the highest 9-12 points.

Bivariate testing and a multivariable logistic regression analysis is presented in Table 3 and 4 and showed a significant association between psychoactive substance use and of having an AUDIT-C score ≥5, being involved in a violent incident, or having a GCS < 15. Falls gave an OR of 2.21 of detecting a psychoactive substance (95% CI 1.47-3.33, $P < .001$). Mean age was similar.

When involved in a violent incident, the OR of detecting a psychoactive substance was 8.92 (95% CI 3.24-24.61, $P < .001$). Multivariate testing revealed an OR of 3.56 for testing positive for a psychoactive substance when presenting with an AUDIT-C ≥ 5 (95% CI 2.34-5.43, $P < .001$).

Proportions of positive results by age- and main substance groups are shown in Figure 2. In the oldest age group, alcohol and illicit substances were less often detected ($P = .004$ and $P = .025$ respectively). In contrast, psychoactive medicinal drugs (opioids, sedatives and/or hypnotics) were significantly less often found in the youngest age group ($P = .003$).

No significant difference was seen between age groups regarding psychoactive substance use as a whole ($P = .277$). Alcohol was overall the most prevalent substance, identified in 20% of women and 24.9% of men, with no difference between genders ($P = .132$).

3.1 | Sub-group analysis TBI and reduced level of consciousness

Of the 684 injured patients, 86 (12.6%) received a diagnosis of TBI (International Classification of Diseases – 10 diagnoses in category S06), of which 44.7% tested positive for alcohol on admittance, 9.3% for a psychoactive medicinal substance and 3.5% for an illicit substance. Concussion (ICD-10 S06.0) accounted for 80 patients, the remaining six patients had other diagnoses of TBI. An additional 41 patients were discharged with one or more diagnoses of head injury without TBI (ICD-10 categories S00-S05 (superficial injuries, cuts, fractures, strains or eye injuries) or S09.9 (unspecified injury of the head). No patients in the study population were admitted with GCS < 11. There were significant associations between being admitted with a GCS < 15 and testing positive for a psychoactive substance (18 (69.2%) tested positive vs 8 (30.8%) patients testing negative when GCS was <15, $P < .001$). This association was significant also for females alone ($P = .001$) and the young and middle-aged, although numbers were limited. Patients admitted after a fall with a GCS < 15 more often tested positive than not (78.9% vs 21.1%, n = 19, $P < .001$). Of 26 patients admitted with a GCS < 15 only one was discharged with a diagnosis indicating more serious head injury. Associations between being discharged with head injury in general or TBI in particular and testing positive for a psychoactive substance were significant (Table 5). Of 244 patients testing positive for a psychoactive substance, 24.6% were discharged with a head injury (compared to 15.2% in the group with no detected psychoactive substance, $P = .003$).

In the 70 patients discharged with a head injury after a fall (including TBI) the OR of testing positive for a psychoactive substance was 5.33 (95% CI 1.72-16.52, $P = .004$). The OR of testing positive for a psychoactive substance when discharged with a head injury after a violent incident was 18.54, (95% CI 3.28-104.91, $P = .001$).

Patients presenting on admittance with a GCS < 15 and being discharged with a diagnosis of head injury (including TBI) had an OR of 8.81 of testing positive for a psychoactive substance (95% CI 1.48-52.42, $P = .017$).

3.2 | Self-reported use of substances

In 94.5% of our cases, self-reported use of alcohol was confirmed by blood sample (Table 1). In almost half of cases reporting having used illicit substances, none were found in blood. However, 82.6% who tested positive denied the use of illicit substances.

4 | DISCUSSION

We found a high rate of psychoactive substance use among injured patients in rural Northern Norway, with no overall difference between genders or age groups. Ethanol was most prevalent, and only patients >64 years of age showed significantly less use of alcohol

TABLE 3 Associations between psychoactive substance use and co- variables

	Detection of psychoactive substance				
	Negative; n (%)	**Positive; n (%)**	**Total; n (%)**	***P*-value (chi^2)**	
Total	440 (64.3)	244 (35.7)	684 (100)		
Gender					
Male	252 (63.3)	146 (36.7)	398 (100)	0.421	
Female	187 (66.3)	95 (33.7)	282 (100)		
Glasgow Coma Scale					
Mild (GCS 14-15)	434 (64.7)	237 (35.3)	671 (100)	0.212	
Moderate (GCS 9-13)	5 (45.5)	6 (54.5)	11 (100)		
Severe (GCS 3-8)	0	0	0		
Place of injury					
Home	127 (59.6)	86 (40.4)	213 (100)	<0.001	
Street/road	106 (59.9)	71 (40.1)	177 (100)		
Café/bar/restaurant	5 (33.3)	10 (66.7)	15 (100)		
Workplace	66 (83.5)	13 (16.5)	79 (100)		
Other	128 (68.1)	60 (31.9)	188 (100)		
Situation					
Fall	248 (60.3)	163 (39.7)	411 (100)	<0.001	
Violence	7 (22.6)	24 (77.4)	31 (100)		
Other	185 (76.4)	57 (23.6)	242 (100)		
AUDIT-C ≥ 5	91 (46.4)	105 (53.6)	196 (100)	<0.001	
					95% CI[a] of differences
Median age	56 (n = 432, SD = 21.67)[b]	54 (n = 236, SD = 20.09)			
Mean BSSS[c] sum	4.18 (n = 440, SD = 4.13)	4.30 (n = 244, SD = 4.42)		0.216	−0.78 to 0.55
Mean blood alcohol concentration (g/L)		1.24 (0.20-3.30), (n = 92)[d]			

[a]Confidence interval.

[b]Standard deviation.

[c]Brief Sensation Seeking Scale.

[d]Mean of samples with ethanol above cut-off level. 25th percentile 0.7 g/L, 50th percentile 1.2 g/L, 75th percentile 1.6 g/L.

or illicit substances than younger age groups. Patients who had ingested psychoactive substances were significantly more often involved in violent incidents, falls, indicated harmful use of alcohol and presented with a reduced level of consciousness. Significant associations were found between having tested positive for a psychoactive substance and being discharged with a diagnosis of head injury or TBI with significantly increased odds of this outcome when the incident was a fall or involved a violent incident.

In a 2011 study from Oslo, 27% of admitted injured patients tested positive for alcohol,[3] similar to our results. Psychoactive medicinal drugs were detected in 15.2% of our cases, which is less than in the study from Oslo (21%). However, more than twice the number of patients in our study tested positive for codeine, our most prevalent opioid (8.9% vs 3.9%). Illicit substances were found in 3.4% of cases compared to 9% in the study from Oslo. Illicit substances found in our study were THC (tetrohydrocannabinol), amphetamine, methamphetamine and a metabolite of cocaine. This corresponds with a roadside study testing random drivers in Finnmark in 2014-15, where only one other illicit substance was found.[45] The most comparable international results from the past decade show the prevalence of psychoactive substances in injured patients in an emergency ward to be 27% in a city in Holland[46] and 45% in Spain.[47] In the study from Holland, alcohol was detected in 19%, psychoactive medication in 7% and illicit substances in 4% of injured patients, based on the patients` self-reported use. The cut-off level for alcohol was higher than in our study, and in the study from Spain where alcohol was detected in 23%, psychoactive medication in approximately 18% and illicit substances in approximately 7% (approximated due to differences in reporting). Our results for alcohol are comparable, but findings

TABLE 4 Logistic regression analysis of patient and incident factors vs odds of detecting a psychoactive substance

	Odds ratio	95% confidence interval	*P*-value
Male[a]	1.03	0.70-1.53	.872
Age	1.00	0.99-1.01	.916
GCS < 15[b]	3.91	1.58-9.67	.003
Place of injury			
Home	1.6	1.00-2.56	.049
Street	1.43	0.90-2.28	.135
Social establishment	1.61	0.47-5.53	.453
Workplace	0.43	0.21-0.88	.021
Other[c]			
Reason for injury			
Falls	2.21	1.47-3.33	<.001
Violence	8.92	3.24-24.61	<.001
Other[c]			
AUDIT-C sum (cut-off ≥ 5)[d]	3.56	2.34-5.43	<.001
BSSS sum[e]	0.99	0.94-1.03	.529

[a]Reference category: female.
[b]Reference category: GCS 15.
[c]Reference category: "other" (not categorized in any other group).
[d]Reference category: "AUDIT-C < 5".
[e]BSSS: Brief Sensation Seeking Scale.

of psychoactive medicinal substances lie at the higher end of the spectrum. All studies mentioned here were conducted at large city hospitals, and to the authors` knowledge, no comparable rural results from the past decade exist. Considering pre-2010 studies, a review attempting to quantify the magnitude of alcohol-related visits to United States trauma centres published in 2011 found a range from 26.2% to 62.5%, however, with major caveats regarding methodology.[48] Although results are slightly lower in our study than in the study from Oslo performed in 2007-08,[3] the impact of psychoactive substances in relation to injury is still very concerning, with recent findings of an even higher prevalence of alcohol in the more severely injured (Finland, 54% alcohol-positive).[49]

Our findings of a significant association between using a psychoactive substance and falling support similar conclusions in other studies.[50-52] In our study, there was little difference in use overall of psychoactive substances between age groups, but the type differed. Alcohol and illicit substances were significantly less often detected in the oldest age group, indicating that vigilance is warranted for these substances also in middle-age, not only young adults. Psychoactive medicinal drugs were significantly less often identified in the young age group (18-34 years of age), suggesting that an age-adjusted approach could be warranted, but falls in relation to psychoactive substances in general are an important problem in the young as well as the geriatric population.[53,54] A population-based study on severe TBI in Iceland showed the most common mechanism of injury to be falls from low heights with 28% injured under the influence of alcohol and a mean age of 41 years.[55]

AUDIT-C has been shown to be sensitive for identifying harmful alcohol use in emergency department populations,[39,40] and our results showed that increased AUDIT-C was associated with testing positive for a psychoactive substance. Findings of a possible harmful use of alcohol in general were quite high, and the AUDIT-C cut-off ≥5, which we used for both males and females was found optimal in

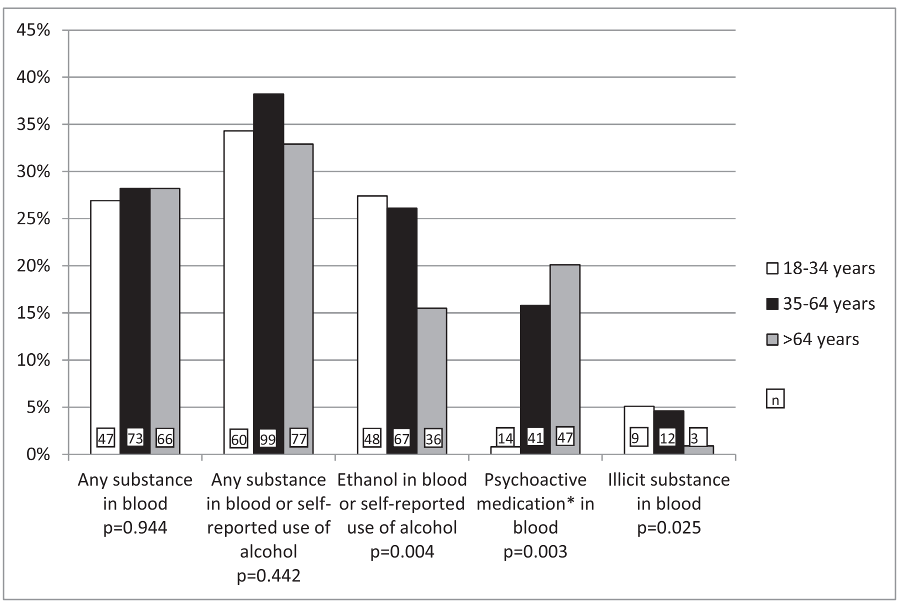

FIGURE 2 Proportions of positive results in each age group by type of substance. Results are shown with and without self-reported use of alcohol ≤6 hours prior to the incident for all-cause total and for ethanol. Number of patients in each age group is noted in the bar-chart itself, significance levels according to Pearson`s Chi^2 analysis are shown to illustrate differences between age groups in each category. *Opioids, sedatives and/or hypnotics

TABLE 5 Sub-group analysis of patients with head injury and/or TBI

	Detected psychoactive substance		
	Negative (n (%))	Positive (n (%))	*P*-value
Head injury[a]			
All head injury	67 (15.2)	60 (24.6)	.003
Female	26 (13.9)	19 (20)	.186
Male	41 (16.3)	40 (27.4)	.008
Age			
<35	28 (24.3)	23 (38.3)	.053
35-64	16 (10)	25 (25.3)	.001
>64	20 (12.7)	9 (11.7)	.819
Fall	34 (13.7)	36 (22.1)	.027
Violence	4 (57.1)	15 (62.5)	1.000
TBI[b,c]			
All TBI	43 (9.8)	43 (17.8)	.003
Female	14 (7.6)	16 (17)	.016
Male	29 (11.6)	26 (17.9)	.077
Age			
<35	21 (18.3)	17 (28.3)	.125
35-64	11 (6.9)	19 (19.6)	.002
>64	9 (5.8)	4 (5.2)	1.000
Fall	19 (7.7)	26 (16)	.009
Violence	2 (28.6)	10 (43.5)	.669

Note: Table 5 shows how many patients were discharged with a diagnosis of head injury, or more specifically TBI, depending on whether they tested positive for a psychoactive substance on admission or not.

[a]Patients discharged with any ICD-10 diagnosis indicating an external force injury to the head. For this purpose, ICD-10 categories S00-S09 were considered, excluding one patient due to suspected isolated involvement of the eye.

[b]Traumatic Brain Injury.

[c]Patients discharged with ICD-10 category S06 or its sub-categories. Patients in other ICD-10 categories than S06 – intracranial injuries were reviewed (including categories S02, S07 and S09) to ensure that aberrant coding did not exclude relevant cases involving intracranial injury.

a study of admitted trauma patients.[39] Even with a cut-off ≥4 a meta-analysis revealed increased long-term mortality.[56,57]

Sub-group analyses of patients admitted with a GCS < 15 or discharged with a diagnosis of head injury or the more serious TBI, show the main substance involved to be alcohol, where this combination is already known to be an indicator of early death.[17] The combination alcohol and TBI accounted for 5.6% of all admittances due to injury in our hospitals. Our results did not support admittance GCS at these levels being an indicator of risk of serious intracranial head injury with only 1 of 26 patients arriving with a reduced level of consciousness ending up being discharged with a serious cerebral diagnosis.[18] These findings should be considered with caution since we did not have any patients with a GCS less than 11, and only six with more serious intracranial pathology than concussion. Patients with serious intracranial pathology precluding consideration of consent could be an issue, but we have no reason to believe that this represents many cases.

We suggest targeted prevention to be recommendable rather than focusing solely on improved treatment of injuries. Screening, with self-reported use of alcohol, AUDIT-C, and blood sampling should be surmountable.[14] A screening program not including blood sampling could be of limited use for substances other than alcohol due to our findings that self-reported use of other substance groups to a lesser degree can be validated by blood sampling. We believe identification and particular care while admitted should precede a plan for follow-up in primary care.

4.1 | Limitations

Our study has several limitations, it did not include fatalities, patients transferred to the regional trauma centre or, patients injured to such an extent that they could not consider consent within two months. Most patients are stabilized locally, but exact data are not available. Regarding fatalities, according to the Norwegian cause of death registry in the years 2014 and 2015, 42 and 35 people, respectively, registered as residing in Finnmark county died of traumatic causes.[58] Of these, during those two full years, road traffic accidents accounted for seven of the fatalities in addition to 18 suffering severe injury.[59] Statistics regarding psychoactive substance use were unavailable. Time of injury although perceived as mostly quite exact was in some cases registered using an estimation made by the patient.

The high rate of consent to participation indicates that fear of prosecution was not a major bias in recruitment of patients. It was clearly stated in the written information and verbally confirmed that there was no risk of any results from this study being used for purposes detrimental to the patient. Blood samples or questionnaire were not registered in their hospital file, neither could they be used for any purpose apart from this research.

Correlation was satisfactory between measured ethanol in blood and self-reported alcohol use during the 6 hours preceding the incident, which supported applying self-reported alcohol use as a pseudo-measure for metabolized ethanol after long transport times to hospital, as previously recommended by a study investigating this challenge.[60] This was less clear for other substances and the cut-off point of 6 hours could at least partly explain the lacking correlation with self-reported use. To further investigate possible associations one could apply cut-off levels accepted to involve impairment, but that was not the aim of this study. Finally, the study design does not allow for evaluation of causality.

5 | CONCLUSION

A high rate of psychoactive substance use among patients admitted for acute injuries was identified, where alcohol was the most prevalent substance. Particularly violence, falls, at-risk alcohol consumption, decreased level of consciousness on admittance and head injury were associated with the use of a psychoactive substance, and all age-groups and both genders appear to be at risk. The combination of blood samples and questionnaires was valuable in identifying correlations. Risk-taking behaviour was not found to be associated with the use of psychoactive substances.

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CONFLICTS OF INTEREST

No conflicts of interest have been identified.

DISCLAIMER

Views regarding future research or possible interventions in this article are those of the authors, and not necessarily official views of the institutions involved.

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