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ORIGINAL RESEARCH

The Impact of Intoxication on the Prognosis of High-Speed Motor Vehicle Accidents: A Tertiary Care Center Experience

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Abstract: **Introduction:** Several studies suggest a causal link between psychoactive agents and motor vehicle accidents (MVA). This study aimed to evaluate the impact of substance abuse and alcohol intoxication on the prognosis of high-speed MVA victims.

Methods: This is a single-center retrospective cross-sectional study involving adult multiple trauma cases who were admitted to the emergency department for high-speed MVA and underwent toxicological screening. The cohort was conducted based on two main outcomes; the survival status and the neurological outcomes.

Results: 894 patients with the mean age of 27.8 ± 9.24 (range:18-37) years were studied (97.9% male). The most common indicators of severity were car rollover and ejection from the car. 296 of the patients had severe traumatic brain injury (TBI). 622 of the patients had a positive toxicological screening, with benzodiazepines (51.2%) and alcohol (26.6%) being the most commonly abused substances. The mortality rate was 5.8% and 12.1% of the patients had unfavorable neurological outcomes upon discharge. On multivariate logistic regression, predictors of mortality among high-speed MVA victims were report of a death at the scene (adjusted odds ratio (aOR): 2.529; 95% confidence interval (CI): 1.026-6.232; p = 0.044), severe TBI, the presence of dilated pupils (aOR: 11.074; 95% CI: 1.293-94.812; p = 0.028), hypotension (aOR: 0.456; 95% CI: 0.227-0.916; p = 0.027), and hypoxia (aOR: 2.95; 95% CI: 1.46-5.95; p = 0.003). Predictors of unfavorable neurological outcomes were report of a death at the scene (aOR: 3.133; 95% CI: 1.445-6.791; p = 0.004), positive toxicology screening (aOR: 3.30; 95% CI:1.68-10.204; p = 0.038), severe TBI, the presence of hypoxia (aOR: 2.96; 95% CI:1.645-5.319; p = 0.000), hypotension (aOR: 0.437; 95% CI: 0.252-0.758; p = 0.003), and bleeding (aOR: 0.287; 95% CI: 0.164-0.501; p < 0.001).

Conclusion: A concerning proportion of high-speed MVA victims had a positive toxicology screening. Although intoxication did not increase mortality of high-speed MVAs, it was a significant predictor of unfavorable neurological outcomes of survivors.

Keywords: Accidents, Traffic; Alcohol Drinking; Substance-Related Disorders; Illicit Drugs; Alcoholic Intoxication; Saudi Arabia

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1. Introduction

Motor vehicle accidents (MVAs) remain a significant cause of morbidity and mortality worldwide, with an estimated annual death rate of 1.3 million (1). The burden of MVAs extends beyond the injured individuals and their families; it also significantly impacts the healthcare system responsible for their care (1, 2). In the Kingdom of Saudi Arabia (SA), the statistics concerning the burden of MVAs are particularly alarming, despite the implementation of road safety measures. Reports indicate that 20% of hospital admissions and 81% of deaths in Ministry of Health Hospitals are related to MVAs, with approximately four individuals injured every hour (3, 4) SA has the highest accident-to-injury ratio of 8:6, compared to 8:1.8 worldwide (4).

Alcohol and psychoactive substances, including amphetamines, cocaine, and cannabis, are known to adversely affect alertness, coordination, mood, memory, and judgment

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(5). Additionally, some substances, such as cannabis, may induce psychosis (5-7). Driving under the influence of these substances is a tragedy in its own right, as their negative effects on cognition and psychomotor function contribute significantly to MVAs (8). Beyond alcohol, cannabis is the most frequently detected substance in MVA-related morbidity and mortality, followed by benzodiazepines, opioids, cocaine, and amphetamines, accounting for 32%, 15%, 11.5%, 11%, and 6%, respectively (9).

Toxicology screening in high-speed MVA cases suspected of intoxication is crucial, as it poses serious public health and safety concerns (1, 10). Notably, the rate of opioid detection in victims of fatal MVAs has tripled from 2001 to 2016. Additionally, the rate of detecting multiple drugs in victims of fatal MVAs has increased by 10% from 1993 to 2010 (2). Despite these concerning statistics, Christophersen and Gjerde et al. reported that only 63% of fatal MVA victims were screened for alcohol and other substances of abuse (11, 12). Moreover, in Arizona, testing for blood alcohol concentration and substances of abuse in non-fatal MVA victims was performed in only 42% and 16% of cases, respectively (5).

Numerous studies have investigated this issue (5, 8, 9, 13-15). For example, a study involving 921 drivers in fatal MVAs in Canada found that alcohol or psychoactive agents were detected in 53.7% of subjects, with polysubstance use being positive in approximately 38% of cases.

Drivers who tested positive for psychoactive drugs were more likely to have been involved in multi-vehicle accidents (13). Another study conducted in Norway reported a significantly higher prevalence (24%) of alcohol and/or other substances of abuse in drivers of fatal casualties compared to surviving drivers of MVAs (4%)(14). A retrospective study estimating the risk of fatalities among intoxicated drivers revealed that the crude mortality rates were highest for alcohol-intoxicated drivers, with MVAs accounting for 1% of deaths in alcohol and opioid cases and 4.1% in methamphetamine cases (9).

As highlighted, several studies suggest a causal link between psychoactive agents and MVAs. Data indicate that the combination of two or more psychoactive agents or psychoactive agents with alcohol increases the risk of accidents (15). The fact that Saudi Arabia has a higher accident-to-injury ratio than the international average, despite implementing appropriate road safety measures, underscores the need for further studies to investigate the underlying causes of this problem (3). Unfortunately, local studies addressing this issue are limited, making it imperative to evaluate whether intoxicated victims have worse prognoses compared to non-intoxicated victims in high-speed MVAs in SA. This study aimed to evaluate the impact of substance abuse and alcohol intoxication on the prognosis of high-speed motor vehicle accident (MVA) victims.

2. Methods

2.1. Study design and setting

This was a single-center retrospective cohort study conducted at King Abdulaziz Medical City (KAMC), Department of Emergency Medicine, Ministry of National Guard-Health Affairs, Riyadh, SA. The cohort was conducted based on two main outcomes; the survival status and the neurological outcomes.

KAMC is an academic government-funded tertiary hospital that combines clinical care, training, academics with research, and state-of-the-art medical technologies.

The study was approved by the Institutional Review Board of King Abdullah International Medical Research Center, Ministry of National Guard-Health Affairs, Riyadh, SA (NRC22R/105/02). Informed consent was waived because of the retrospective nature of this study.

Access to the data was restricted to the researchers. The confidentiality of all patients was protected, and no names or medical record numbers were used.

Privacy and confidentiality were assured, and all the hard and soft copies of data were kept in a secure place within the Ministry of National Guard-Health Affairs premises. This study complies with the Declaration of Helsinki.

2.2. Participants

All adults aged 18 years or older who were admitted to the emergency department (ED) for high-speed MVA and underwent toxicological screening from 2016 to 2022 were included in the study. Those transferred from other hospitals were excluded. Patients with significant missing data compromising the accuracy of the results, such as Glasgow Coma Scale (GCS) scores or toxicological results, were excluded to maintain the integrity of the analysis. However, if a patient had minor missing data that did not impact the main outcomes of interest, they were included in the analysis.

Additionally, MVA victims who tested positive for substances on toxicological screening but had valid prescriptions for opioids, benzodiazepines, or stimulants for medically justified reasons were also excluded to minimize confounding factors that could independently influence neurological function and recovery outcomes.

2.3. Data gathering

The required data were obtained by screening the electronic medical records (via the KAMC electronic system “BestCare” Seoul, South Korea: ezCaretech Co) of all the patients who met the inclusion criteria. The following data were collected: age, gender, mode and time of arrival to the ED, extent of the injury, GCS on arrival, pupil size, the presence of cerebral hemorrhage, hypotension (defined as systolic blood pressure below 90 mmHg), or hypoxia (defined as O2 saturation below 90% and/or arterial O2 tension of less than 80 mmHg), Rotterdam computed tomography (CT) score, toxicological screening results, intensive care unit (ICU) admission and

length of stay, the need for intubation and mechanical ventilation, survival status, and neurological function at discharge for alive individuals. The GCS was used to classify the severity of traumatic brain injury (TBI) into mild (15-13), moderate (12-9), and severe (8-3) TBI.

Favorable neurological outcomes were defined as complete neurological recovery or a residual neurological deficit that does not significantly affect functional independence at discharge. Unfavorable neurological outcomes were defined as permanent neurological dysfunction that affects functional independence or decreases awareness or responsiveness to stimuli.

2.4. Statistical analysis

The Statistical Package for the Social Sciences (SPSS version 27; IBM Co., Armonk, NY, USA) was used for data analysis. Continuous variables were checked for normality and are presented as a mean ± standard deviation. Categorical variables are presented as a frequency and percentage. The Fisher's exact test was used to compare categorical variables. Two binary logistic regression analyses were conducted to identify predictors of death and neurological status among high-speed MVA victims. The factors considered in the analyses were categorized as predictors, with "Alive" and "Favorable neurological outcome" serving as the reference categories. The adjusted odds ratios (aOR), with a 95% confidence interval (CI), and corresponding p-values were calculated for each predictor. For this purpose, univariate analysis was carried out, and the significant factors were included in the final multivariate model. All reported p-values are two-tailed, and a $p < 0.05$ was considered statistically significant.

3. Results

3.1. Baseline characteristics of studied patients

A total of 894 high-speed MVA victims who underwent toxicological screening were eligible for inclusion. The majority (97.9%; n = 875) of the patients were males, with a mean age of 27.8 ± 9.24 years and an average hospital length of stay of 17.53 ± 44.46 days. Table 1 presents the baseline characteristics of the study population. Over three-quarters (91.5%; n = 818) of the patients arrived at the emergency department (ED) via emergency medical services (EMS). Blunt injuries accounted for 96% (n = 855) of the injuries, with car rollover being the most common indicator of severity (21.6%), followed by ejection from the car (18.3%), death at the scene (6.9%), and falls from significant heights (1.7%). Nearly three-quarters (74.4%; n = 665) of patients had a Rotterdam CT score of 1. Severe traumatic brain injury (TBI) was observed in 33.1% (n = 296) of the patients, and only 6.2% (n = 55) presented with fixed dilated pupils.

Positive toxicological screening was noted in 77.5% (n = 622) of patients, with the most abused substances being benzodiazepines (51.2%; n = 414) and alcohol (26.6%; n = 237).

Other substances included cannabis (24.4%), amphetamines (21.1%), and opioids (14%) (Figure 1). The mortality rate among the study population was 5.8%, with 82.1% (n = 734) of survivors achieving favorable neurological outcomes at discharge.

3.2. Predictors of survival

Table 2 compares the baseline characteristics of studied patients between survived and non-survived cases (univariate analysis). The mode of arrival ($p = 0.018$), ejection from the car ($p = 0.009$), severe TBI ($p < 0.001$), fixed dilated pupils ($p < 0.001$), hypoxia ($p < 0.001$), hypotension ($p < 0.001$), and intracranial hemorrhage ($p < 0.001$) were significantly associated with survival. Drug intoxication did not show a significant association with mortality, trends were noted for benzodiazepines (92.8% vs. 95.4%, $p = 0.136$) and opioids (97.3% vs. 93.5%, $p = 0.134$), providing valuable insight into the potential role of these substances.

In binary logistic regression analysis (Table 3), involvement in a high-speed MVA with report of death at the scene significantly increased the odds of mortality (adjusted odds ratio [aOR] = 2.529, 95% CI: 1.026-6.232, $p = 0.044$). Patients with mild (aOR = 0.226, 95% CI: 0.94-0.544, $p = 0.001$) or moderate TBI (aOR = 0.158, 95% CI: 0.36-0.697, $p = 0.015$) had significantly lower odds of death compared to those with severe TBI. Additionally, patients with fixed dilated pupils had significantly higher odds of death (aOR = 11.074, 95% CI: 1.293-94.812, $p = 0.028$). The absence of hypoxia (aOR = 0.339, 95% CI: 0.168-0.684, $p = 0.003$) and hypotension (aOR = 0.456, 95% CI: 0.227-0.916, $p = 0.027$) were associated with significantly lower odds of death.

3.3. Predictors of unfavorable neurological outcome

Table 4 compares the baseline characteristics of studied patients between cases with and without unfavorable neurological outcome (univariate analysis). The mode of arrival ($p = 0.003$), severe TBI ($p < 0.001$), fixed dilated pupils ($p = 0.006$), hypoxia ($p < 0.001$), hypotension ($p < 0.001$), and intracranial hemorrhage ($p < 0.001$) were significantly associated with unfavorable neurological outcome.

Positive toxicology screening was significantly associated with unfavorable neurological outcomes (16.0% vs. 5.2%, $p < 0.001$), with benzodiazepine intoxication showing a marked association (unfavorable: 18.2% vs. 8.5%, $p < 0.001$).

Based on binary logistic regression analysis (Table 3), high-speed MVA involving death at the scene were correlated with unfavorable neurological outcomes (aOR = 3.133, 95% CI: 1.445-6.791, $p = 0.004$). The absence of hypoxia (aOR = 0.338, 95% CI: 0.188-0.608, $p < 0.001$), hypotension (aOR = 0.437, 95% CI: 0.252-0.758, $p = 0.003$), and intracranial hemorrhage (aOR = 0.287, 95% CI: 0.164-0.501, $p < 0.001$) were associated with significantly lower odds of unfavorable neurological outcomes. Additionally, patients with a negative toxicology screening had lower odds of unfavorable neurological outcomes (aOR = 0.303, 95% CI: 0.098-0.936, $p = 0.038$), while

those with mild TBI had significantly lower odds of unfavorable outcomes compared to severe TBI (aOR = 0.530, 95% CI: 0.289-0.975, p = 0.041).

4. Discussion

Our study investigated the sociodemographic and clinical characteristics of patients who were admitted to the ED due to high-speed MVA and underwent toxicological screening in one of the largest trauma centers in SA. The main aim of this study was to examine whether intoxication, regardless of the substance abused, affects the prognosis of high-speed MVA victims.

The first observation in this study was that almost all the patients were male, which is similar to a previously published paper from SA (16).

This observation is attributed to the fact that women were not allowed to drive prior to 2017 in SA. Another observation is the young age group of high-speed MVA victims. The mean age was 27.8 ± 9.24 years in this article, which is in accordance with the local literature and, to some extent, the international literature. To clarify, based on a Chinese study investigating the correlation between MVA and the victims' characteristics, the most common age group was 31-40 years, followed by 18-30 years (17). However, according to a Saudi study, the most common age group was 20-30 years, followed by 30-40 years old (16). These findings emphasize the significant socio-economic burden posed by MVAs in young adults, particularly concerning long-term disability and financial implications (18). In this study, blunt trauma was the most prevalent mode of injury. This observation is in agreement with the results reported in local literature for both pediatrics (19) and adults (16).

Additionally, similar results have been observed in studies conducted in other locations, including India (20) and Turkey (21).

In our study, the Glasgow Coma Scale (GCS) served as a reliable indicator for the degree of TBI. Fortunately, the majority (66.9%; n = 598) of patients in this study had mild to moderate TBI, and the overall mortality rate was 5.8%. Based on a study that was conducted in Ethiopia, patients with mild to moderate TBI recover faster and have better prognosis that those with severe TBI (22). Severe TBI, which was present in 33.1% of patients, was a significant predictor of both unfavorable neurological outcomes and mortality. This study demonstrated that the fraction of severe TBI victims might be higher than the literature; for example, based on an Ethiopian study, only 14.6% had severe TBI (22).

This difference could be related to our inclusion criteria as we solely included high-speed MVA. We defined high-speed MVA as any car collision that occurred at a speed of ≥60 km/h, resulted in the inflation of airbags or significantly damage the car's body, caused the victim to fall from significant height, be ejected from the car, or the victim's car to rollover, or resulted in death of any victim at the scene. Fixed and dilated pupils, often associated with severe brain injury, were a significant predictor of mortality but not necessarily of poor neurological outcomes among survivors. A possible explanation is that we assessed neurological outcomes for alive individuals and that fixed and dilated pupils indicate severe TBI with significant edema, bleeding, and/or herniation, which is usually irreversible and fatal.

Additionally, a significant association (p = 0.009) was found between patients who were ejected from their car and mortality. This finding is likely due to the severe multi-system trauma typically sustained in such incidents, including head, chest, and musculoskeletal injuries, which contribute to the high fatality rate (23). Although we have not investigated the associated injuries, existing literature reports that head and chest injuries are the most common cause of death among MVA victims (23). This segues into death at the scene of the accident as a predictor for both unfavorable neurological outcomes and mortality in high-speed MVA. Logically, the higher the speed, the worse the collision and mechanism of injury, and the more systems injured causing death at the scene. Furthermore, we found that hypotension and hypoxia could significantly predict both unfavorable neurological outcomes and mortality; severe accident would lead to significant internal and/or external bleeding, and pulmonary contusion or pneumothorax since chest injury is the most common injury associated with MVA (18), causing hypotension and hypoxia, respectively. Another possible explanation is that hypoxia might be part of Cushing's triad, indicating severe TBI and impending brain herniation (24). Finally, cerebral hemorrhage, irrespective of its type, was a significant predictor of poor neurological outcomes among survivors of high-speed MVAs as those patients might need prolonged hospital course, ICU admission, respiratory support, and neurosurgical intervention, putting them at significant risk of poor neurological outcomes.

In our study, benzodiazepine was the most detected drug, followed by alcohol, cannabis, and amphetamine. This contrasts with an Iranian study where the most commonly detected drugs were opioids (25). Regardless, the prevalence of substance (illicit drug) use in SA is considered limited, with only 7%–8% of the population reporting drug use (26). Over two-thirds (77.5%; n = 622) of our patients tested toxicologically positive reflecting underreporting of substance abuse. The significant presence of substances like benzodiazepines and alcohol among MVA victims highlights the impact these substances have on cognitive function, motor skills, and recovery outcomes.

Benzodiazepines, for example, impair cognitive functions such as decision-making and memory, and motor skills like coordination and reaction time. These impairments increase the risk of MVAs, as drivers under the influence are less able to react appropriately. A nationwide study in Denmark found that drivers using benzodiazepines or z-hypnotics had a 150% increased risk of being involved in single-car crashes (27). Similarly, Alcohol impairs key cognitive functions like reaction time, attention, and judgment, which are crucial for

safe driving.

As blood alcohol levels rise, drivers struggle more with processing visual information, making quick decisions, and coordinating movements. These impairments significantly raise the risk of accidents when driving under the influence (28). Alcohol consumption has also been linked to an increased likelihood of risky driving behavior and a compromised ability to control the vehicle (29). In addition, as summarized by Pearlson et al., cannabis use leads to significant impairments in motor pursuit tracking, time estimation, and working memory, which are essential for controlling a vehicle and making rapid decisions.

Additionally, findings from the review indicate that these cognitive impairments translate into actual driving behaviors, such as increased braking distance, lane deviation, and errors in speedometer tracking, thereby exacerbating the risk of MVAs among cannabis-impaired drivers (30). A study conducted in the Dominican Republic and Peru found that driving under the influence of cannabis and alcohol significantly increases the risk of MVAs, confirming that intoxication might be a contributor for MVAs in general (31).

The result of this study calls for more robust strategies to effectively prevent, early detect, and mange substance abuse (illicit drug use), as it might be a major contributor to the worrisome burden of high-speed MVAs in SA despite the appropriate implementation of road safety preventive measures (3, 4). To clarify, based on a Saudi study including a total of 100 patients from a comprehensive mental health hospital, 93% of the patients reported driving while intoxicated (32). Even though they did not report whether or not they were involved in MVAs, this percentage shows the magnitude of the problem, and how intoxication might be a major contributor to the concerning numbers of high-speed MVAs in SA.

Our study failed to demonstrate an association between intoxication and fatalities of high-speed MVAs, discordant with the literature (33).

However, intoxication was a significant predictor of unfavorable neurological outcomes. This aligns indirectly with the literature; for example, a Saudi study found that MVA victims with elevated alcohol levels were more likely to suffer severe head injuries and higher sepsis rates (16).

Although only 12.1% (n = 108) of our patients had unfavorable neurological outcomes, such outcomes change the trajectory of someone's life; significant neurological dysfunction afflicts the patients' quality of life and their role in society through functional dependency, chronic pain and narcotic use, psychological or mental trauma, and financial losses from job loss or change, education dropout, and treatment costs. This impact is not limited to the patients but impacts their families or caregivers, as they require assistance, special attention, and long-term rehabilitation. Given these findings, there is a pressing need to implement effective preventive strategies that focus on lowering the rate of driving while intoxicated as well as to establish more specialized hospitals and rehabilitation centers in SA to mitigate the burden of substance abuse and addiction.

The current study has some limitations that should be acknowledged. First, the single-center retrospective design introduces selection bias by limiting the study population to patients from a single institution. This also restricts the sample size and does not allow us to track the treatment and rehabilitation success for patients with unfavorable outcomes. Then, patients' comorbidities were not collected. Also, we did not gather data about ICU admission and length of stay, the need for intubation and mechanical ventilation, and the need for neurosurgical intervention.

In addition, we did not gather data about the unfavorable outcomes such as whether the patient became paraplegic or entered a vegetative state. Finally, we did not perform survival analysis or calculate the time from the accident to hospital arrival, which might affect the outcome of the victims, thus introducing potential confounding factors that were not accounted for in the analysis.

5. Conclusion

A concerning proportion of high-speed MVA victims of present study had a positive toxicology screening. Although intoxication did not increase mortality of high-speed MVAs, it was a significant predictor of unfavorable neurological outcomes of survivors.

6. Declarations

6.1. Acknowledgments

None.

6.2. Conflicts of interest

All authors declare no conflicts of interest in this work.

6.3. Data availability

The dataset used and/or analyzed in the current study is available upon request.

6.4. Author contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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6.6. Using artificial intelligence chatbots

There was no use of artificial intelligence in the making of this article.

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Table 1: Baseline characteristics of studied patients

Variable	Value	Variable	Value
Age (year)		**Length of stay (day)**	
Mean ± SD	27.83 ± 9.24	Mean ± SD	17.53 ± 44.46
Gender		**TBI severity**	
Male	875 (97.9)	Mild	499 (55.8)
Female	19 (2.1)	Moderate	99 (11.1)
Arrival time		Severe	296 (33.1)
7 AM to 3 PM	284 (31.8)	**Pupils**	
3 PM to 11 PM	224 (25.1)	Reactive bilateral	707 (79.1)
11 PM to 7 AM	386 (43.2)	Sluggish + non-reactive	81 (9.1)
Mode of injury		Unequal pupil sizes	21 (2.3)
Blunt	855 (96.0)	Dilated pupils	55 (6.2)
Penetrating	36 (4.0)	Constricted pupils	30 (3.4)
Mode of Arrival		Toxicology screening	
By EMS	818 (91.5)	Negative	181 (22.5)
By family	76 (8.5)	Positive	622 (77.5)
Indicators of severity		**Intoxication with**	
Roll over	193 (21.6)	Cocaine	7 (0.9)
Ejected from the car	164 (18.3)	Amphetamine	170 (21.1)
Fall from significant height	15 (1.7)	Barbiturate	5 (0.6)
Death at scene	62 (6.9)	Opioids	113 (14.0)
Other	478 (53.5)	Benzodiazepines	414 (51.2)
Outcome		Methanol	41 (4.6)
Favorable neurological outcome	734 (82.1)	Ethanol	196 (21.9)
Unfavorable neurological outcome	108 (12.1)		
Death	52 (5.8)		

Data are presented as mean ± standard deviation (SD) or number (%). TBI: Traumatic Brain Injury; EMS: Emergency Medical Services.

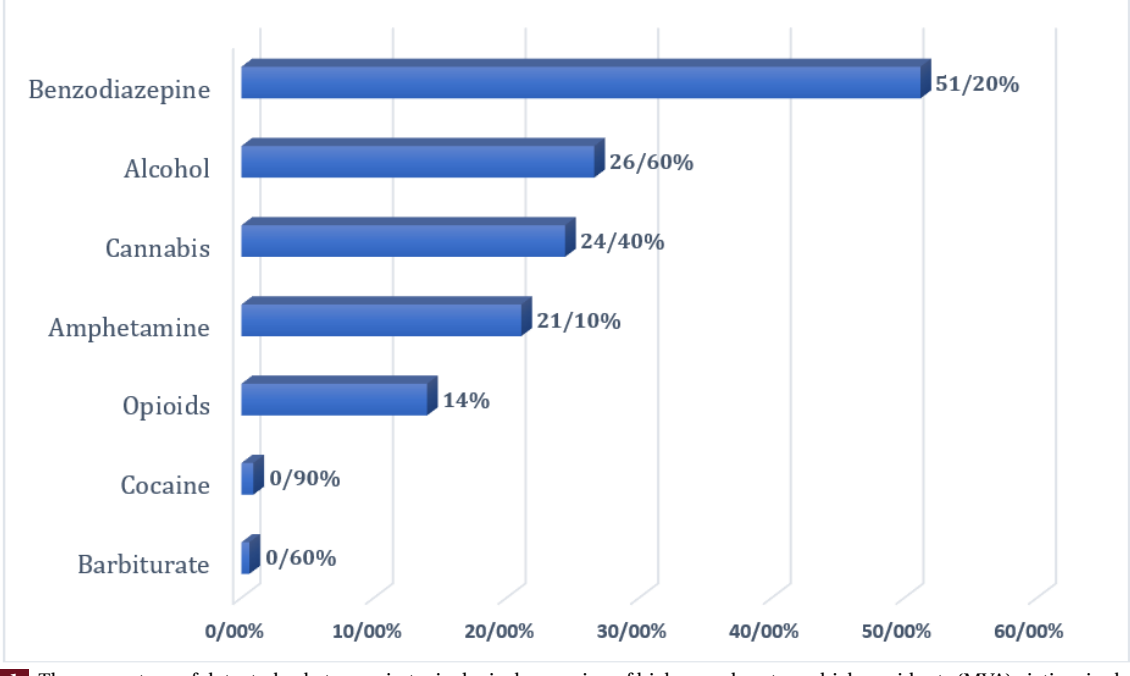

Figure 1: The percentage of detected substances in toxicological screening of high-speed motor vehicle accidents (MVA) victims in descending order. The most commonly detected substance was benzodiazepine, and it was the only one that could significantly predict unfavorable neurological outcomes among high-speed MVA victims ($p < 0.001$).

Table 2: Comparing the baseline characteristics of studied cases between survived and non-survived patients

Variable	Value	Variable	Value
Gender			
Male	824 (94.2)	51 (5.8)	1.000
Female	18 (94.7)	1 (5.3)	
Arrival time			
7 AM to 3 PM	266 (93.7)	18 (6.3)	0.222
3 PM to 11 PM	207 (95.6)	17 (7.6)	
11 PM to 7 AM	369 (93.6)	17 (4.4)	
Mode of arrival			
By EMS	766 (93.6)	52 (6.4)	0.018
By family	76 (100.0)	0 (0.0)	
Indicators of severity			
Roll over	179 (92.7)	14 (7.3)	0.384
Ejected from the car	147 (89.6)	17 (10.4)	0.009*
Fall from significant height	14 (93.3)	1 (6.7)	0.596
Report of death at Scene	53 (85.5)	9 (14.5)	0.007*
GCS			
Mild	490 (98.2)	9 (1.8)	<0.001*
Moderate	97 (98.0)	2 (2.0)	
Severe	255 (86.1)	41	
Pupils			
Reactive bilateral	681 (96.3)	26 (3.7)	<0.001*
Sluggish + non-reactive	76 (93.8)	5 (6.2)	
Difference between pupils	18 (85.7)	3 (14.3)	
Dilated pupils	38 (69.1)	17 (30.9)	
Constricted pupils	29 (96.7)	1 (3.3)	
Clinical/imaging findings			
Hypoxia	102 (80.3)	25 (19.7)	<0.001*
Hypotension	158 (87.3)	23 (12.7)	<0.001*
Intracranial hemorrhage1	205 (89.1)	25 (10.9)	<0.001*
Acute mass lesion evacuation	34 (87.2)	5 (12.8)	0.070
Toxicology screening			
Cannabis	185 (93.9)	12 (6.1)	0.864
Cocaine	7 (100.0)	0 (0.0)	1.000
Amphetamine	163 (95.9)	7 (4.1)	0.360
Barbiturate	5 (100.0)	0 (0.0)	1.000
Opioids	110 (97.3)	3 (2.7)	0.134
Benzodiazepines	384 (92.8)	30 (7.2)	0.136
Methanol	40 (97.6)	1 (2.4)	0.506
Ethanol	187 (95.4)	9 (4.6)	0.491
Total	592 (95.2)	30 (4.8)	0.699

Data are presented as number (%). 1: Epidural/Subdural or Sub-Arachnoid Hematoma;
EMS: Emergency Medical Services; GCS: Glasgow Coma Scale.

Table 3: Binary Logistic Regression for independent predictors of survival (Reference: Alive) and unfavorable neurological outcome (Reference: alive with favorable neurological outcome) following motor vehicle accidents (N=894)

Factors	AOR	95% CI		P value
		Lower	Upper	
Independent predictors of survival				
Trauma severity indicator				
Ejected from the car	1.364	0.678	2.743	0.384
Death at scene	2.529	1.026	6.232	0.044
TBI severity				
Mild	0.226	0.094	0.544	0.001
Moderate	0.158	0.036	0.697	0.015
Severe	Ref	Ref	Ref	Ref
Pupils				
Reactive bilateral	2.415	0.298	19.546	0.409
Sluggish + non-reactive	1.346	0.142	12.717	0.796
Difference between pupils	2.904	0.260	32.481	0.387
Dilated pupils	11.074	1.293	94.812	0.028
Constricted pupils	Ref	Ref	Ref	Ref
Clinical/imaging findings				
No hypoxia	0.339	0.168	0.684	0.003
No hypotension	0.456	0.227	0.916	0.027
No intracranial hemorrhage1	0.761	0.382	1.516	0.438
Independent predictors of unfavorable neurological outcome				
Mode of arrival				
By EMS	2.005	0.455	8.845	0.358
Trauma severity indicator				
Report of a death at scene	3.133	1.445	6.791	0.004
GCS				
Mild	0.530	0.289	0.975	0.041
Moderate	0.508	0.233	1.107	0.088
Severe	Ref	Ref	Ref	Ref
Pupils				
Reactive bilateral	2.029	0.525	7.845	0.305
Sluggish + non-reactive	0.689	0.152	3.125	0.629
Difference between pupils	2.332	0.415	13.111	0.337
Dilated pupils	1.803	0.337	9.638	0.491
Constricted pupils	Ref	Ref	Ref	Ref
Clinical/imaging findings				
No hypoxia	0.338	0.188	0.608	0.000
No hypotension	0.437	0.252	0.758	0.003
No intracranial hemorrhage	0.287	0.164	0.501	0.000
No acute mass lesion evacuation	0.425	0.175	1.031	0.058
Intoxication				
Negative toxicology screening	0.303	0.098	0.936	0.038
Positive benzodiazepines	0.914	0.522	1.601	0.754
With Methanol			0.052	
Negative	0.218	0.015	3.255	0.270
2.2 to 10	0.618	0.037	10.448	0.739
More than 30	Ref	Ref	Ref	Ref

AOR: Adjusted Odds Ratio; CI: Confidence interval for AOR; TBI: Traumatic Brain Injury; EMS: Emergency Medical Services; GCS: Glasgow Coma Scale.1: Epidural/subdural or sub-arachnoid hematoma.

Table 4: Comparing the baseline characteristics of studied patients between cases with and without unfavorable neurological outcome

Variable	Unfavorable neurological outcome		P
	No (n = 734)	Yes (n = 108)	
Gender			
Male	716 (86.9)	108 (13.1)	0.151
Female	18 (100.0)	0 (0.0)	
Arrival time			
From 7 AM to 3 PM	233 (87.6)	33 (12.4)	0.973
From 3 PM to 11 PM	180 (87.0)	27 (13.0)	
From 11 PM to 7 AM	321 (87.0)	48 (13.0)	
Mode of arrival			
By EMS	660 (86.2)	106 (13.8)	0.003*
By family	74 (97.4)	2 (2.6)	
Indicators of severity			
Roll over	152 (84.9)	27 (15.1)	0.315
Ejected from the car	125 (85.0)	22 (15.0)	0.415
Fall from significant height	13 (92.9)	1 (7.1)	1.000
Report of death at Scene	40 (75.5)	13 (24.5)	0.017*
GCS			
Mild	458 (93.5)	32 (6.5)	<0.001*
Moderate	84 (86.6)	13 (13.4)	
Severe	192 (75.3)	63 (24.7)	
Pupils			
Reactive bilateral	602 (88.4)	79 (11.6)	0.006*
Sluggish + non-reactive	64 (84.2)	12 (15.8)	
Difference between pupils	10 (55.6)	8 (44.4)	
Dilated pupils	32 (84.2)	6 (15.8)	
Constricted pupils	26 (89.7)	3 (10.3)	
Clinical/imaging findings			
Hypoxia	69 (67.6)	33 (32.4)	<0.001*
Hypotension	121 (76.6)	37 (23.4)	<0.001*
Intracranial hemorrhage1	146 (71.2)	59 (28.8)	<0.001*
Acute mass lesion evacuation	20 (58.8)	14 (41.2)	<0.001*
Toxicology screening			
Cannabis	161 (87.0)	24 (13.0)	0.902
Cocaine	6 (85.7)	1 (14.3)	1.000
Amphetamine	141 (86.5)	22 (13.5)	1.000
Barbiturate	4 (80.0)	1 (20.0)	0.515
Opioids	95 (86.4)	15 (13.6)	1.000
Benzodiazepines	314 (81.8)	70 (18.2)	<0.001*
Methanol	29 (72.5)	11 (27.5)	0.012*
Methanol	29 (12.1)	11 (87.9)	0.016*
Ethanol	165 (88.2)	22 (11.8)	0.710

Data are presented as numbers (%).1: Epidural/Subdural or Sub-Arachnoid Hematoma; EMS: Emergency Medical Services; GCS: Glasgow Coma Scale.