

## Alcohol and road safety: investigation and legal aspects

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**Abstract:** *Background:* Ethanol (commonly phrased as Alcohol), in spite of presence of so many 'recreational drugs', is the most common drug exploited throughout the world. *Objectives:* This study explored the deleterious role of alcohol, effect of its consumption and their legal implications in a systematic manner. *Method:* To assess the toxic role of alcohol with the effects of its consumption and their legal implications a systematic review was done through an extensive search in the books, indexed literature and website-based reports, 14 reported literatures were identified of alcohol use. *Results:* Alcohol acts as a central nervous system depressant of specialised and sensitive cells of cerebral cortex. Its adverse effects like decrease in cognitive and psychomotor skills are well documented, with special regard to driving performance. In presence of lacunae in the implementation of legal enforcements alcohol related road safety has to be research interest to reduce this preventable morbidity. Ethanol and its role as a central nervous system depressant is well documented. In the last decade, drastic changes in the age of initiation as well as the bridging of gender based gap in alcohol use have been observed. *Conclusion:* Alcohol related road traffic injuries are major threat to civilization including premature deaths on road with uncountable quantity and quality of socioeconomic effects on family as well as the community that need to be prevented by the holistic approach.

**Keywords:** Laws, Alcohol, Consumption, Drunkenness, Punishment, Analysis.

### Introduction

The harmful use of alcohol is a known global problem with problems ranging from individual to social like drunken driving, violence, absenteeism, depression etc. Some of the leading encountered problems with consumption of alcohol are driving under influence, fatal accidents, trauma deaths, suicides, crimes of violence [1]. Main source of consumed alcohol is, commercially prepared beverages, fermented alcoholic beverages and distilled alcoholic beverages. In dilute aqueous solutions, it has somewhat of sweet flavour, but in concentrated solutions has a burning aftertaste.

On consumption, majority of alcohol is absorbed by stomach and small intestine due to small molecular structure and easy exchange between blood tissue barriers. 90% of absorbed alcohol is metabolised by liver and broken down to less toxic metabolites or by-products. The peak blood alcohol level after first consumption is attained within 30 minutes. With the distribution of

alcohol within body dependent of water content, blood is the most preferred sample of analysis, as it reflects the approximate quantification of drug in the body [2].

Even with alcohol consumption within low quantities, there have been observations of increased reaction time; impaired judgement and performance errors leading to various driving mishaps. Because of these physiopathological effects of alcohol in human body every country has set defined laws specifying the legal range, fines, punishments regarding to permissible Blood Alcohol Concentration (BAC). The smell of alcohol in the breath, pulse rate, dilation of pupils, pallor of face etc. have no bearing on the level of intoxication, a thorough investigation with special details to the state of mind, coordination of movement, visual acuity etc. must be conducted along with the requisite blood investigations before deducing conclusions and punishments. In case where

punishment is decided on basis of quantification different methods of chemical and instrumental methods are available for specific analysis of alcohol and its congeners [2-3]. The article explains the role of alcohol, effect of its consumption and their legal implications.

### Material and Methods

In this study the researchers tried to find the deleterious role of alcohol, effect of its consumption and their legal implications in a systematic manner improve road safety by the comprehensive, annotated assembly of literature from different sources; published surveys and field studies in which role, effect of its consumption and their legal implications of alcohol were reported including searching of abstracts from scientific meetings in which road traffic injuries were reported. Through an extensive search in indexed literature and website-based population survey reports, we identified 14 research publications from 200 potentially relevant literatures.

The search terms included combinations of MeSH terms and empirical taxonomies such as alcohol, consumption, legal implications, investigation, management, follow-up, guidelines,

prediction model, randomized controlled trial (RCT), and outcomes including deaths. PubMed-entrez: (January 1, 2000–December 31, 2017), Cochrane Library (January 1, 2000–December 31, 2017), Web of Science (January 1, 2000–December 31, 2017), and the WHO Global Health Library (January 1, 2000–December 31, 2017) including searching of abstracts from scientific meetings (2000–2017) and abstracts from scientific meetings (2000–2017).

Review of citations and reference lists was performed to identify additional studies. Wherever possible, sources were contacted for further information on survey data not readily available in the public domain and we contacted authors for additional information or for translations from languages other than English regarding road traffic injuries. Manual searches were conducted from review articles, previous meta-analyses, and also from hard copy publications not sourced in repeated internet searches.

*Main outcome variables:* The main outcome variables of this study were to find role of alcohol in road safety.

### Results

Common Name	Melting point	Boiling Point	Molecular Formula	IUPAC name	Uses
Methyl alcohol	-97.6 <sup>0</sup> C	64.7 <sup>0</sup> C	CH <sub>3</sub> OH	Methanol	Used as a denaturant additive for ethanol manufactured for industrial purposes.
Ethyl alcohol	114.14 <sup>0</sup> C	78.37 <sup>0</sup> C	CH <sub>3</sub> CH <sub>2</sub> OH	Ethanol	Only alcohol safe for human consumption.
n-Propyl alcohol	-89.8 <sup>0</sup> C	117.7 <sup>0</sup> C	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> OH	1-Propanol	Used as a solvent in cosmetics and pharmaceuticals and in the preparation of lacquers.
Isopropyl alcohol	-89 <sup>0</sup> C	82.6 <sup>0</sup> C	(CH <sub>3</sub> ) <sub>2</sub> CHOH	2-Propanol	Widely used as a solvent and cleaning fluid.
n-Butyl alcohol	126.0 <sup>0</sup> C	97.98 <sup>0</sup> C	CH <sub>3</sub> (CH <sub>2</sub> ) <sub>2</sub> CH <sub>2</sub> OH	1-Butanol	Used as an ingredient in perfumes and as a solvent for the extraction of essential oils.

<b>BAC (mg %)</b>	<b>Countries</b>
00	Russia, Czechoslovakia, Hungary, Bulgaria, Romania, Czech Republic, Turkey, Nepal, Jordan, Armenia, Azerbaijan
10	Albania
20	Poland, Sweden, Estonia, Norway
30	India, China, Georgia, Japan, Moldova, Turkmenistan
40	Belarus, Lithuania
50	Finland, Netherlands, Yugoslavia, Portugal, Greece, Hong Kong, Argentina, Austria, Belgium, South Africa, South Korea, Iceland, Israel, Taiwan
60	Peru
80	Denmark, Germany, Belgium, UK, France, Switzerland, Australia, Italy, Spain
100	Ireland
80-100	Different states of USA
150	Swaziland

<b>State</b>	<b>Legal age of drinking alcohol</b>	<b>State</b>	<b>Legal age of drinking alcohol</b>
Andaman and Nicobar Islands	18	Kerala	18
Andhra Pradesh	21	Lakshadweep	Illegal
Arunachal Pradesh	21	Madhya Pradesh	21
Assam	21	Maharashtra	21-25
Bihar	Illegal	Manipur	Illegal
Chandigarh	25	Meghalaya	25
Chhattisgarh	21	Mizoram	18
Dadra Nagar Haveli	21	Nagaland	Illegal
Daman and Diu	21	Odisha	21
Delhi	25	Pondicherry	18
Goa	21	Punjab	25
Gujarat	Illegal	Rajasthan	18
Haryana	25	Sikkim	18
Himachal Pradesh	18	Tamil Nadu	21
J&K	21	Telangana	21
Karnataka	21	Tripura	21
U.P.	21	West Bengal	21
Uttarakhand	21		

### Discussion

*Data abstraction and analysis:* A drug, can be defined as any chemical substance that is absorbed into the body of a living organism and

causes an alternation in its normal physiology which can be used to treat the symptoms of disease or to cure them. Drugs, if misused for reasons other than medicinal are called 'recreational drugs'. Ethanol is the most

popular drink from time immemorial and in almost all parts of the world people are able to prepare it indigenously for their personal consumption. This being the only licit drug and alcohol, fit for human consumption is the most frequently encountered recreational drug in forensic toxicology for assay. Ethanol and its role as a central nervous system depressant is well documented. In the last decade, drastic changes in the age of initiation as well as the bridging of gender-based gap in alcohol use has been observed. Chemically, alcohol is a group of compounds whose saturated carbon chain contains a hydroxyl group, '-OH'. Because of this hydroxyl group attached to the molecule, it exhibits chemical properties of polarity, solubility in aqueous and lipid environment, boiling and melting point as shown in Table 1 [1- 2].

*Alcohol and Trauma:* The adverse effect of alcohol on cognitive and psychomotor skills is well known, particularly with respect to vehicle driving performance. Increases in reaction time and performance error can be found at all doses of intoxication. The consumption of alcohol, even in little dose, can increase the risk of being involvement in accidents/ crashes for cyclist, pedestrians and motorist. The adverse effect of alcohol such as impaired vision and delay in reaction time are associated with impaired judgement and often linked to other high risk road behaviours like speeding and not using seat belts [4]. Alcohol has also been linked to a number of criminal behaviours, including the violation of traffic laws which leads them to fatal accidents and death.

*Alcohol and Driving:* Drunkenness as defined by British Medical Association in 1927 is "a state produce in a person after taken a sufficient quantity of alcohol to lose control of his faculties to such an extent, that he is unable to execute safety the business in which he was engaged in that time"[5]. Across the globe, governments have defined different acceptable Blood Alcohol Concentration (BAC) levels as shown in Table 2. Alcohol concentration is usually denoted as mg%, for example 10mg% means 10mg of alcohol per 100ml of blood. However there is no minimum amount below which alcohol can be consumed without risk. With rise in blood alcohol concentration, there is progressive loss of driving ability due to increase reaction time, over

confidence, impaired concentration, degraded muscle coordination and decrease visual and auditory acuity.

*Alcohol in India:* In spite of India being an alcohol tolerant nation, there are strict policies for its Sale, Purchase and Consumption. Alcohol is the subject in the state list under the Seventh Schedule of Constitution of India. Therefore, the legal age and laws to regulate its use differ from state to state (18- 25yrs) [6]. The legal age of consumption of alcohol is shown in Table 3.

The prohibitions exercised by government regarding sale, purchase and consumptions are [7]:

*Partial prohibition- Dry Days:*

There are some days where there is complete ban on sale of alcohol throughout the nation.

- Republic Day- 26<sup>th</sup> January
- Independence Day- 15<sup>th</sup> August
- Gandhi Jayanti- 02<sup>nd</sup> October

*Total prohibition- Dry States of India:*

There are some states where sale, purchase and consumption are totally banned and possession or consumption is punished with fine or imprisonment.

- *Gujarat:* Has proscribes alcohol sale, purchase and consumption since 1960s.
- *Nagaland:* Has banned liquor in the state by passing Nagaland Liquor prohibition act in 1988. Alcohol is banned in the state since 1989.
- *Manipur:* Has imposed a ban on the sale and purchase by passing the Manipur Liquor prohibition act in 1991 by R.K. Ranbir Singh Government.
- *Lakshadweep:* It is the only Dry Union territory where consumption is totally banned. Consumption only with permission allowed on Bangaram Island.

*Indian laws related to consumption of Alcohol [5-8]*

- *Section 185 of Motor Vehicle Act 1988:* It prescribes a maximum permissible Blood Alcohol Concentration (BAC) of 30mg/ 100ml. The maximum permissible BAC in different countries are given in Table 1.

- *Section 510 of Indian Penal Code:* Under this section the punishment is described for a person whoever under the state of intoxication causes annoyance in public place or misconduct in public place.
- *Section 34 of Police Act:* This act empowers Police to arrest such person without warrant and the punishment is under the act of imprisonment upto 08 Days as opposed to section 510.
- *Section 85 of Indian Penal Code:* This law prescribes the criminal responsibility of an intoxicated person, if the person under the intoxication at the time of doing the act that he was incapable of judging the nature of his act, then he has not committed an offence, maybe he was administered that substance against the will or without his knowledge.
- *Section 86 of Indian Penal Code:* Any person, who found drunken or drinking in a common drinking house or is found there present for the purpose of drinking, shall be convicted, be punished with fine which may extend to 500 rupees.
- *Section 84 of Bombay Prohibition Act 1949:* Any person, who found drunken or drinking in a common drinking house or is found there present for the purpose of drinking, shall be convicted, be punished with fine which may extend to 500 rupees.
- *Section 85 of Bombay prohibition Act 1949:* Any person found drunk and incapable of controlling himself or behave in a disorderly manner under the influence of drink in any street or public place, shall be convicted and punished with imprisonment for a term which may extend to 3 months and with fine 200-500 rupees.
- The suspect claims that he or she unwittingly consumed alcohol, raising the BAC above the legal limit.
- Alleged inhalation of ethanol vapours from the environment is a recurring defence challenge in drunken driving litigation.
- Various medical conditions and pathological states are sometimes suggested to account for a suspects BAC being above the legal limit. Such as, consumption of Ayurvedic medicines and cough syrups.
- If the swabs used contain ethanol then there is a potential risk that the blood specimen will become contaminated during the collection procedure.
- Very often, the reported BAC and the drinking history given to the court are grossly inconsistent. A persuasive defence counsel might manage to convince the court that a mix-up of blood specimen has occurred either at the police station or at the forensic laboratory.
- The possibility of various alcohols being produced in the blood specimen after sampling is sometimes put forward to account for the BAC being above the legal limit.
- Drugs that interact with the pharmacokinetics of ethanol have social and medico-legal implications. Defence lawyers are always eager to learn about new drugs that might interact with pharmacokinetics of ethanol.
- People involved in traffic accidents sometimes require emergency hospital treatment. This might entail infusion of various solutions to counteract shock or a blood transfusion might be necessary. All infusion solutions should obviously be free of alcohol.

#### *Legal defence challenges in Drunken Driving:*

There are the numerous court room challenges to the breath test resulting from several issues like the operator falsified breath results, substances other than alcohol appearing on the subject's breath, and random error such as ratio frequency interference falsely elevated result.

- This is one of the most common defence tactic called hip-flast ploy [9]. The suspect alleges consumption of alcohol after driving but before the blood specimen was obtained for forensic analysis.

#### *Collection and Preservation of blood samples in living:*

For Blood Alcohol Analysis the collection and preservation of blood sample is very important. Few important points related in this regard are as follows.

- Spirit swabbing of the area is contraindicated. However, recent studies have shown that swabbing does not alter the BAC estimated.

- Instead dry swabbing or swabbing with 10% HgCl<sub>2</sub> is recommended.
- Sodium Fluoride (10mg/1ml of blood) is the most commonly used preservative for blood.
- 'Grey-top' vials can also be used for preservative for blood containing Potassium Oxalate as Anti-coagulant and Sodium Fluoride as Preservative(10mg/1ml of blood).
- For storage of blood, "Vaccutainers" are preferred as they are leak proof, air tight plastic test-tube with desired anticoagulant already added.

#### *Investigation of consumed alcohol:*

*Alcometer/Breathalyzer* [10-12]: An Alcometer is a device used for on spot, non-invasive analysis of alcohol concentration in blood from exhaled breath. Due to its simple design, cheap, portable and reproducible operation it is the most widely used technique for fast and approximate quantification by police. The calculation of BAC is based on Henry's Law, which states that "at a constant temperature the concentration of a gas dissolved in a fluid with which it does not combine chemically is almost directly proportional to the partial pressure of the gas at the surface of the fluid". This is 2100:1 for exhaled breath: blood alcohol. There are two types of breath analyser on basic of use.

- *Active breath analyser:* It need to below lung air moderately and continuously until instructed to stop.
- *Passive breath analyser:* It is used in cases where suspect was unconscious or weak, unable to below air or active breath.

Breathalyzer is also categorised in three types, on the basis of detectors used such as electrochemical detector, Infra-red detector, and Photocell detector. There are several manufacturer of breath analysers.

*Chemical analysis* [13]: Because of the loopholes associated with the Alcometer, it cannot differentiate between blood alcohol and breath alcohol. The analyser can give false positive tests if the person has done an oral wash with a mouthwash, consumed medicines containing alcohol or give a false quantification if not attempted as specified. The chemical analysis even though are invasive, exclusively targets the

alcohol contained in the matrix. Few chemical test are 'Cuvette test', 'Iodoform test', 'Ester test' etc.

- *Potassium Dichromate test:* It is also known as Dichromate test. 1ml of distillate is taken in a clean and dry test tube. 0.2 ml of 2% acidified potassium dichromate is added to it. The yellow colour of the dichromate solution changes to green indicating presence of alcohol. This test is not specific to ethyl alcohol, any other aldehyde, ketone or alcohol can give a positive test.
- *Cuvette test:* It is the modified form of dichromate test, here distillation of matrix is not required. Blood/ Body fluid (2ml) is taken in bottom of the beaker and potassium dichromate solution in cuvette and kept for few minutes in oven (50°C). Green ring will appear on the surface of potassium dichromate solution. Similarly, like Dichromate test, it is not specific to ethanol.
- *Iodoform test:* A few drops of 10% sodium hydroxide are added to 1ml of distillate. Iodine solution is slowly added drop wise with constant mixing till solution turns brown. Contents are warmed on a low flame. Few drops of sodium hydroxide solution are added to the mixture which changes the colour of solution from brown to yellow. The solution is again heated, if it becomes colourless iodine solution is added. The precipitate is observed under microscope, characteristics hexagonal crystals of Iodoform are seen which confirm presence of alcohol. This test can give false positive if acetone, acetaldehyde and amyl alcohol are present.
- *Ester test:* 0.5g of sodium acetate is added to 0.5ml of the distillate in a test-tube. 1 ml of sulphuric acid is added to the tube. Solution is warmed on a low flame and cooled. 5ml of sodium carbonate is added to the solution, fruity odour of ethyl acetate is observed which conform the presence of alcohol.

#### *Instrumental Analysis* [14]:

- *Gas liquid Chromatography (GLC):* Gas chromatography is basically a separation

technique based on the principle of fractionation of compounds as a consequence of partition between a mobile gaseous phase and a stationary phase held in a column. Analysis of blood for ethanol by Gas Liquid Chromatography has received considerable attention in recent years. It is one of the most modern analytical techniques for analysis of volatile compounds for its ability of highly sensitive and fast quantitative analysis. The gas chromatograph makes it possible to separate the volatile components of a very small sample and to determine the amount of each component present. The essentials required for the method are an injection port through which samples are loaded, a "column" on which the components are separated, a regulated flow of a carrier gas which carries the sample through the instrument, a detector, and a data processor.

- *Gas chromatography-Head space (GC-HS):* In gas chromatography the sample to be analysed has to be volatilised before

introduction in the column. This volatilization can either be achieved by Manual Injection, which is increasing the temperature of injection port to such as extend that sample turns to gaseous phase as soon as it is injected with hypodermic needle, or by instrumentation i.e. Headspace Sampler which heats the sample in a sealed vial and transfers the vapours via transfer the injector port. Nowadays headspace sampling is preferred due to its advantage of automation, sensitivity, accuracy, relative specificity and less chances of human interaction in sample preparation therefore reducing the sample error.

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