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## Review Article

# Effect of alcohol swabbing of venepuncture site on blood alcohol estimation: A literature review

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### ABSTRACT

Estimation of blood alcohol concentration is one of the very important investigations in medico-legal cases dealing with drink and driving, alcohol toxicity etc. There are many factors which may influence estimation of blood alcohol concentration of an individual. One of these factors is thought to be application of alcohol containing swab at venepuncture site, prior to collection of blood for alcohol estimation, either by gas chromatography or by enzymatic assay. Alcohol content of swab, either plain ethanol or iso-propyl alcohol, is said to influence blood alcohol estimation, to a significant extent, is a very common information rather misinformation given to all medical practitioners worldwide. Unfortunately, Courts of Law, in India also have to believe on this, and in many cases defence try to create benefit of doubt, using this information. It is commonly learnt and taught to Medical graduates, that while collecting blood samples from an individual for Blood Alcohol estimation, spirit swab should not be used for cleaning area of venepuncture. This is due to reason believed so far, that alcohol swabbing of venepuncture site can alter Blood Alcohol Estimation significantly. However there is no any study advocating this theory. Moreover review of literature pertaining to this subject has shown studies, which tend to prove that this concept is nothing but a myth and one has to be very particular to prove alteration in blood alcohol concentration due to alcohol swabbing of venepuncture site. Secondly, the literature and curricular statements in Forensic Medicine, which is written long back, needs exhaustive changes, and should be more evidence based.

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## 1. Introduction

The need of accurate skin disinfection at venepuncture site is always considered a necessary activity for preventing bacteraemia. More specifically, the guidelines of the World Health Organization (WHO) mandates that the venepuncture site should be cleaned with a 70% alcohol swab, and alcohol should then be allowed to dry for not less than 30 seconds before puncturing the vein.<sup>1</sup>

The Clinical and Laboratory Standards Institute (CLSI) document H3-A6 also mandates that skin disinfection with 70% isopropyl alcohol or ethanol is always necessary before venepuncture. As in the WHO guidelines, the CLSI also recommends that alcohol should be allowed to dry completely before inserting the needle into the vein.<sup>2</sup>

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Any standard text book of Forensic Medicine and Toxicology till today mention that Alcohol Swabbing of venepuncture site should be avoided, if blood sample is being taken for Blood alcohol estimation. It is presumed that, this will significantly alter Blood Alcohol estimation. However there is no any scientific data produced to advocate this presumption. Instead we herewith wish to bring following literature forward for readers, in which majority of studies conclude that there is no significant effect of alcohol swabbing of venepuncture site on Blood alcohol concentration.

### 1.1. Review of literature

Müller and Hundt<sup>3</sup> in 1976 gave the first alert about the possible interference from using alcohol antiseptics for cleansing the venepuncture site. In their elegant study, the

authors collected three sequential evacuated blood tubes from each of 10 healthy volunteers, for measuring ethanol concentrations with GC. The skin was cleansed with an antiseptic containing 10% chlorhexidine and 70% ethanol. Before alcohol evaporation had occurred, the needle was inserted into the vein and the first two blood tubes were completely filled, whereas the needle was withdrawn from the vein while the third blood tube was still aspirating. Importantly, the presence of ethanol on the skin did not produce a measurable concentration of blood alcohol in the first two tubes, whereas a measurable concentration of blood alcohol was found in the third tube in eight out of the ten subjects, with blood alcohol values between 0.4 - 743.9 mmol/L.

In a study by *Goldfinger TM et al.*<sup>4</sup>, they simultaneously obtained blood samples in emergency patients for ethanol content from both antecubital fossae, using an alcohol pad on one arm and a non-alcohol-containing germicidal solution on the other. Fifty patients with ethanol concentrations greater than zero were statistically analyzed. Twenty patients surveyed had no measurable alcohol level by either technique. There was no significant difference in the blood alcohol concentration obtained by either method of skin preparation in both groups ( $P < .01$ ). Blood alcohol concentration incidentally obtained in the emergency department by routine isopropyl alcohol skin preparation is an accurate laboratory parameter.

*Miller et al.*<sup>5</sup> reported a retrospective analysis of prospective data collected from a study of blood ethanol levels after the use of the alcohol-based hand sanitizer (ABHS). A total of 5 male volunteers were enrolled. Eight of the 10 total blood ethanol level measurements were drawn after skin preparation with Kendall WEBCOL<sup>®</sup> Alcohol Preps (APP) containing 70% isopropyl alcohol. All had an initial and post-ABHS application blood alcohol level (BAL) drawn, for a total of 10 BAL measurements. Measurements upon completion of the study were  $< 5$  mg/dL in all 5 study participants and in each of the 10 blood draws regardless of skin preparation technique. This study demonstrates that the use of isopropyl skin prep pads is unlikely to cause significant false-positive blood ethanol levels.

In a case reported by *Yigit O et al.*<sup>6</sup>, they encountered an obviously high blood alcohol level in a 20-year-old worker brought to Emergency Department after accidentally having his head crushed under a tree trunk. Head and maxillofacial computed tomography was ordered and blood samples were taken. When the results arrived, a very high blood alcohol level as 453 mg/dL was seen. The patient was questioned again for alcohol consumption; however, he denied having ingested any alcohol. The laboratory was questioned about whether there was any problem with the test measuring method and devices; the technicians denied any such problem. When the nurse who collected the blood

sample was asked about swabbing the skin, it was learned that she used an alcohol swab first and then a povidone-iodine swab before blood sampling. A new sample was collected again after povidone-iodine swabbing and the blood alcohol level was measured as 0.3 mg/dL, which was within normal limits.

In a study reported by *Tucker A et al.*<sup>7</sup>, twenty eight Volunteers aged  $> 18$  years had paired venous blood tests, which were drawn within 2 min of each other. One arm was swabbed with a 70% isopropyl alcohol swab and allowed to dry before venepuncture. The other was swabbed with saline, and these concurrent samples were used as controls. BAL was tested using the enzymatic method. Pathologists analysing the samples were blinded to the swabbing technique used. The mean differences and standard deviations of each of the paired samples were analysed using Student's t-test. Fifty-six paired venous blood samples were obtained from volunteers. Mean BAL in the isopropyl alcohol-swabbed group was 3.27 mg/dL with a standard deviation of 1.14 mg/dL. Mean BAL in the saline-swabbed group was 3.41 mg/dL with a standard deviation of 1.11 mg/dL. The mean difference was 0.14 mg/dL, with a standard error of 0.157. There was no statistically significant difference between the groups. Hence concluded that use of 70% isopropyl alcohol swabs does not significantly affect BAL when used before venepuncture.

In a study done by *Lippi G et al.*<sup>8</sup>, venous blood was collected from 23 healthy volunteers, with two sequential procedures. In the first blood collection, 2 mL of alcoholic antiseptic (0.5% chlorhexidine, 70% ethanol) were placed on a gauge pad, the venipuncture site of right arm was cleaned but the antiseptic was not let to dry before phlebotomy. In the second blood collection, 2 mL of the same alcoholic antiseptic were placed on another gauge pad, the venipuncture site of left arm was cleaned and the antiseptic was accurately cleansed before phlebotomy. Ethanol was measured with a reference GC technique in whole blood and EDTA plasma, and a commercial enzymatic assay in EDTA plasma. The concentration of alcohol in all EDTA plasma samples was always lower than the limit of detection of the enzymatic assay (i.e., 2.2 mmol/L; 0.1 g/L). Similarly, alcohol concentration was also undetectable using a reference GC technique (i.e.,  $< 0.22$  mmol/L; 0.01 g/L) in EDTA plasma and whole blood. Hence conclusion was drawn that using ethanol-containing antiseptics before venipuncture may not be causes of spurious or false positive results of alcohol measurement at least when ideal venipunctures are performed.

*McIvor et al.*<sup>9</sup> conducted a study on 20 volunteers, in whom venepuncture through the skin soaked in either ethyl or isopropyl alcohol was performed. A non-alcoholic cetrimide/chlorhexidine swab was used as a control. All subjects were initially alcohol free. Ethyl alcohol was detected in only one blood sample and the level was found

to be only 0.4 mg% (roughly the limit of detection of the assay). A slightly higher level of isopropyl alcohol (3 mg%) was found in one of the blood samples. Alcohol estimation was carried out by head-space gas chromatography using a pair of instruments each fitted with a column exhibiting different retention characteristics. The system was similar to that used by other UK Forensic Science Laboratories where accurate, definitive results are a necessity. It was concluded that under very testing conditions only minute ethanol interference is produced by using alcohol-based skin cleansing swabs. This minimal interference is unlikely to affect clinical sample results, and even in a forensic situation the inadvertent use of alcohol-based swabs is unlikely to lead to a miscarriage of justice.

In a study by *Ryder KW et al.*<sup>10</sup>, the effect of various pre-packaged skin cleansers on the results of serum ethanol analyses performed with the Du Pont automatic clinical analyzer was reported. When added directly to serum in concentrations of either 0.625 or 1.56% (v/v), neither polyvinyl pyrrolidone iodine nor benzalkonium chloride affected the ethanol results. The cross-reactivity of isopropanol with the automatic clinical analyser ethanol procedure was 3.9%. The greatest interference in the measured ethanol concentration was from the addition of green soap tincture, which contained 30% ethanol. The effect of improper phlebotomy technique on ethanol measurements was also investigated by performing venepunctures through a pool of 100% ethanol on the skin. No ethanol was detected in these samples unless an ethanol-soaked sponge was pressed over the venepuncture site while the needle was withdrawn from the skin. It was thus concluded that when correct phlebotomy technique is used, skin cleansing agents should not affect the results of ethanol measurements determined with the Du Pont automatic clinical analyser.

*Peek et al.*<sup>11</sup> reported opposite results. The authors collected blood from 10 healthy volunteers during heavy drinking by either cleansing the venepuncture site with absolute ethanol on one arm or leaving the venepuncture site un-swabbed on the opposite arm. Blood ethanol concentration was found to be significantly increased (up to 3.9 mmol/L) in samples collected from the ethanol-cleansed arm compared to the un-swabbed arm. Unlike these findings, the concentration of blood ethanol was unaltered when ethanol was replaced with isopropanol.

*McIvor and Cosby*<sup>12</sup> measured BAC by means of head-space gas chromatography in 20 subjects, whose blood had been drawn after soaking the venepuncture site with ethanol, isopropyl alcohol or non-alcoholic cetrinide/chlorhexidine swab, and concluded that a modest ethanol interference could be appreciated by using alcohol-based skin cleansing swabs.

*Malingré et al.*<sup>13</sup> studied the possible impact of cleansing the venepuncture site with an alcohol swab, by measuring

blood ethanol concentration using both gas chromatography and an enzymatic assay in 50 patients aged  $\leq 12$  years and in 20 healthy volunteers. In no sample the concentration of blood ethanol was found to be measurable (i.e.,  $< 4.3$  mmol/L in all cases).

*Higuchi et al.*<sup>14</sup> in his study collected blood from 40 healthy subjects after cleansing the venepuncture site with either ethanol or saline. Although no blood uptake of ethanol or physiological saline could be recorded by the reference gas chromatography technique when both fluids were allowed to dry for 1 min, a minimal alcohol intake (i.e., around 0.2 mmol/L) was however noticed in 40% percent of subjects when the venepuncture was performed immediately after cleaning the skin with ethanol (i.e., within 5 seconds). The rate of contamination considerably increased to 70% when the needle was voluntarily touched or swabbed by an ethanol-soaked cotton pad.

In a study conducted by *Tatiya HS*<sup>15</sup>, ten healthy adult volunteers were selected randomly for blood collection. Samples collected were preserved in commercially available grey topped bulbs with sodium fluoride as preservative. Samples were processed on the same day in a NABL accredited lab where lab technicians were kept blind about study. Irrespective of alcohol content of swab applied for cleaning, insignificant values of serum alcohol concentration as  $< 10$ mg/dl i.e. lower than the limit of detection of enzymatic assay were detected, concluding that there is no significant effect of alcohol swabbing prior to venepuncture site on serum alcohol concentration.

## 2. Discussion

Under section 129 of Bombay Prohibition Act, 1949, a prohibition officer or police officer, who has reasonable grounds for believing that a person has consumed intoxicant, it is necessary that the accused should be medically examined and his blood be collected for being tested for determining percentage of alcohol therein; vide Bombay Prohibition Medical Examination Blood Test Rules 1959.<sup>16</sup> As per this rule the medical examiner shall clean the surface of, part of such persons body, from which he intends to withdraw the blood, with sterilised water and swab and no alcohol shall be touched at any stage while withdrawing blood from the body of person.<sup>17</sup>

Even though alcohol is poorly absorbed through the intact skin<sup>18</sup>, and irrespective of all above studies denying false positive results in blood alcohol concentration, in the case of legal proceedings, current recommendations in literature support a challenge to the reliability of the evidence when a blood sample obtained for purpose of determination of alcohol content is drawn, following preparation of skin.<sup>3,19</sup>

Above review of literature clearly specifies the fact that, Blood Alcohol concentration does not vary, even though venepuncture site is cleaned with cleansing agent, especially

isopropyl alcohol and whether the analysing technique is gas chromatography or enzymatic assay. Secondly, it is also important to note that, phlebotomist, while collecting blood for alcohol estimation, should make sure that, venepuncture site if cleaned by alcohol containing swab should be dried properly and while performing the procedure, at no time, needle tip should touch the alcohol swab.

### 3. Conclusion

It is hereby concluded that, there is no any effect of alcohol swabbing of venepuncture site on Blood Alcohol estimation if phlebotomist perform blood collection with stringent precautions. Secondly, curriculum of Forensic Medicine and Toxicology needs revision and apt changes based on scientific evidences, wherever possible and necessary.

### 4. Source of Funding

None.

### 5. Conflict of Interest

None.

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