Effects of Mouth Alcohol on Breath Alcohol Results

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Abstract

This study was conducted on 50 male subjects between 21 and 46 years of age. Each subject had his oral cavity searched for foreign matter and blood in the mouth, as well as producing a breath alcohol result of .00 prior to swishing a 1.75 ounce mixture of 75 percent alcohol in his mouth for 1 minute and then gargling the mixture for 20 seconds. The mixture was then expelled from the oral cavity. Alcohol Breath Tests (ABTs) were administered at 3 minutes and 7 minutes following the expelling of the mixture from the oral cavity. Results indicated the BAC DataMaster reported mouth alcohol in 48 percent of the trials with numerical values ranging between .02 and .43, while producing the “invalid sample” result on 52 percent of the trials. Conclusions include the inability of the slope detector algorithm incorporate to the BAC DataMaster to identify mouth alcohol in a meaningful set of circumstances. Inferences are made as to the importance of oral cavity search and direct observation during the fifteen minute waiting period.

Introduction and Literature Review

The Alcohol Breath Test (ABT), first initiated in the early 1950's, has presented a number of issues relative to scientific inquiry. Harger, Forney, & Barnes (1950) presented a device for sampling breath to determine blood alcohol concentration. Borkenstein and Smith (1961) applied the use of breath alcohol concentration testing to forensic purposes. Until the 1970's most ABT devices relied on the use of a galvanometer in the null balance photometric system to measure the color decrease in reagent (Lucas, 1986).

Beginning in the 1970's, infrared technology and analysis of alcohol in breath began to be applied in ABT instruments. With the additional application of the geometric expansion of computer technology, infrared ABT instruments have become the widely accepted ABT devices for policing agencies, courts, athletics, business and industry, and education (Inaba and Cohen, 2000).

One of the five current ABT infrared devices on the market is the BAC DataMaster. This instrument, as the other instruments, attempts to eliminate the effects of mouth alcohol on the result of a breath alcohol test. In each case this is done through the use of a "slope detector" algorithm which is part of the computer programming incorporate to the instrument.

To assure mouth alcohol is not present when giving the ABT most regulations require a fifteen minute direct observation of the test subject to assure any mouth alcohol from consumption has been eliminated. The concern for elimination of mouth alcohol is based upon the theory that mouth alcohol can be measured as breath alcohol and therefore invalidates the breath alcohol test results.

The issue of mouth alcohol being present, and the need for elimination of this possible contaminant, has been addressed in numerous articles. Harding (1992) recommended a 15-20

minute observation period and that slope detection is not a substitute for the procedural countermeasures of direct observation and visual assurance that no foreign objects absorbing alcohol are in the mouth. In his research, Harding determined that in 2 out of 12 cases, denture adhesive would retain mouth alcohol for at least 20 minutes. Research by other investigators (Langille & Wigmore, 2000; Harding et al., 1992; Chu, Wells, King, Farrar & Drummon, 1998; and Logan & Distefano, 1998) have all supported the importance of direct observation and oral cavity examination for a period of 15 to 20 minutes in order to assure mouth alcohol is not present. These researchers also support the high importance of direct observation throughout the 15-20 minute period to assure a lack of belching or vomiting by the subject which would bring stomach contents containing alcohol into the mouth. A unique study by Veveland and Moreland (2001) has indicated mouth alcohol can be retained in the oral cavity for 30 minutes and under extreme conditions for more than 90 minutes. This study presents inferences for extensive follow-up research.

Consistent with the majority of studies cited, research has been conducted to produce mathematical models for elimination of mouth alcohol (Gullberg, 1992). Simultaneously, limited research has been undertaken to determine the adequacy and accuracy of ABT instruments regarding mouth alcohol. Research by Trafford and Makin (1995) yielded breath alcohol results in a subject significantly in excess of measured blood alcohol. These researchers, having completed a rigorous 15 minute observation period, attributed this difference to retained alcohol between dental bridges and gums in the subject's mouth. Additional research by Wilske, Eisenmenger, & Liebhardt (1991) found 23 cases of breath alcohol results meaningfully above blood alcohol results. This was suggested to be a result of slope detectors in the instrument not detecting mouth alcohol and erroneously adding the mouth alcohol measure to the breath alcohol

result. Gullberg (2000) found that for subjects already having measurable breath alcohol, biases can exist in those having mouth alcohol and remain undetected by the "mouth alcohol" (slope detector) algorithm in the BAC DataMaster instrument.

In explanation of this failure of the algorithm in the BAC DataMaster slope detector, Hlastala (1996) produced results indicating mouth alcohol will generate an erroneously high reading as the mouth alcohol will be picked up and added into the breath alcohol. He indicated this would occur on two occasions: 1) when the subject stops exhaling at approximately the point where the alcohol concentration reaches a maximum and 2) when small quantities of mouth alcohol are present.

It has been suggested that the BAC DataMaster will always present the result of "invalid sample" when mouth alcohol is present (National Patent Analytical System, 1997). As research has indicated, mouth alcohol can erroneously elevate breath alcohol concentration due to the ability to detect mouth alcohol in certain circumstances; training of this nature can be in error.

Based upon the existing research, the time limits possible for retention of mouth alcohol, the possibility of blood or stomach contents being brought into the mouth and the "slope detector" algorithms not adequately excluding mouth alcohol from results, there appears sufficient questions for further research. The purpose of this study was to determine if the BAC DataMaster would detect and report mouth alcohol as an "invalid sample" or as a numerical breath alcohol result, when mouth alcohol was present during the fifteen minute observation period.

Methods

Population

Fifty male subjects were recruited for the research. These fifty subjects were randomly selected from a pool of over 500 who had responded to advertisements for participation in alcohol research on humans. Prior to becoming a subject in the study each participant was screened using a two-tiered process. The first level of screening was to obtain two separate documents indicating the subject was a minimum of 21 years of age. The second level of the screening was for the subject to complete the Substance Abuse Subtle Screening Inventory - 3 (SASSI-3) which determines the probability of the subject being alcohol dependent. Of the original randomly selected subjects none were excluded due to age and three were excluded due to having SASSI-3 results indicating a high probability of alcohol dependence. The three original subjects excluded during screening were replaced by randomly selected replacements from the pool. Of the replacements two successfully met the two screening criteria and one was excluded due to SASSI-3 results. This excluded subject was replaced by a subject who met both screening criteria. The study subjects ranged in age from 21 to 46 years. Each subject reported to the clinic one hour prior to beginning the test. Each subject was given a breath alcohol test upon reporting to the research clinic and all subjects displayed an initial result of .00.

Conditions

Upon entering the research area each subject was given a mixture of 1.75 ounces containing 75 percent alcohol and 25 percent distilled water. Each subject swished the mixture in a timed one minute limit and then gargled the mixture for a timed 20 seconds. Upon completion of the gargled sequence each subject spit out the contents into a biohazard cup. Expelled mixtures were disposed of per university biohazard procedures. Timing for testing was

begun immediately following the subject expelling the mixture from his mouth. Timing was determined through the atomic time synchronizer 3.9, which received time from the National Institute of Standards and Technology Cesium Atomic Clock (NIST F-1).

The BAC DataMaster used for the study was installed in the University research laboratory in 1999. Calibrations have been conducted on a 120 day basis by the manufacturer's agent and simulations were conducted daily throughout the study period.

An off-duty police officer, certified in BAC DataMaster operation, entered the subject data into the instrument, while another off-duty police officer examined the oral cavity of the subject to assure no foreign objects or blood was contained in the oral cavity. This examination was conducted using a flashlight, tongue depressor and gloves to raise the tongue. No foreign objects or blood was observed in the oral cavity of any subject.

. Exactly three minutes after the subject had expelled the mixture from his mouth, the officer gave the subject the following command, as recommended by the manufacturer: "Place your mouth on the mouth piece and blow long and steady into the tube until I tell you to stop" (National Patent Analytical System, 1997). The command to stop blowing, by a priori decision, was made at a timed twelve seconds of blowing as measured by NIST F-1. On those occasions where "invalid sample" was not the result the BAC DataMaster purged itself, re-verified its internal standards and indicated it was ready for the duplicate breath sample exhalation. On these occasions, and at measured time of exactly seven minutes after the subject had expelled the mixture from his mouth as measured by NIST F-1, the officer gave the same command as with the first exhalation sample. This sample was also stopped by command at twelve seconds of blowing as timed by NIST F-1. In those occasions when the first breath sample produced "invalid sample" the instrument aborted the test sequence. On those occasions the officer

initiated a new test sequence with the instrument and the second sample was given at the seven minute post expelling time with a twelve second exhalation as measure by NIST F-1.

Results for each subject were printed on the BAC DataMaster ticket(s) and immediately entered into the data management program at the research laboratory. Results of each BAC DataMaster ticket were checked for accuracy a second time after data entry.

Results

In all subject cases two breath alcohol tests were administered. Subject results varied greatly. Table 1 presents the actual results by subject. The results from the BAC DataMaster test three minutes after expelling the mixture are captioned as BrAC-3 and the results from the BAC DataMaster test seven minutes after expelling the mixture are captioned BrAC-7. Where a numerical value was the result that numerical value is listed. Where “invalid sample” was the result “IS” is listed.

Table 1
Results of Mouth Alcohol on BAC DataMaster

Subject	Age	BrAC-3	BrAC-7
01	27	.32	IS
02	23	IS	.06
03	31	IS	.08
04	42	.26	IS
05	21	IS	IS
06	28	IS	.05
07	24	.02	.02
08	31	.24	IS
09	27	IS	IS
10	28	IS	.08
11	21	.36	IS
12	35	.43	IS
13	22	IS	.04
14	26	.19	IS
15	33	.26	IS
16	28	.29	IS
17	21	IS	.10
18	39	.33	IS
19	40	IS	IS
20	31	.13	.05
21	22	.33	IS
22	28	IS	.09
23	34	.26	IS
24	46	.36	IS
25	.26	.31	IS
26	27	IS	.05
27	34	IS	.08
28	30	IS	IS
29	23	.31	IS
30	38	IS	.09
31	21	.34	.06
32	33	IS	IS
33	26	.31	.02
34	30	.28	IS
35	23	.26	IS
36	22	IS	IS
37	29	IS	.08
38	25	.21	IS
39	23	.29	.07
40	24	.33	IS
41	38	IS	.06
42	24	IS	IS
43	21	.28	.09
44	25	IS	IS
45	30	IS	.09
46	31	.33	IS
47	24	IS	.04
48	27	.26	IS
49	22	.18	IS
50	29	IS	.07

The results demonstrate the BAC DataMaster will sometimes report mouth alcohol as a numerical breath alcohol value and sometimes result in an "invalid sample" reading. The frequency of numerical results and "invalid sample" results are presented in Table 2.

Table 2

Frequency of Numeric and IS Results in Mouth Alcohol Only BAC DataMaster Testing

Results	Frequency of BrAC-3	Frequency of BrAC-7
Numerical Value	27	21
IS	23	29

For the overall number of tests there was a 48% probability the BAC DataMaster would produce a numerical result between .02 and .43 when only mouth alcohol was present and a 52% probability the BAC DataMaster would produce a result of "invalid sample". For the BrAC-3 condition there was a 54% probability the BAC DataMaster would present a numerical result when only mouth alcohol was present and a 46% probability the BAC DataMaster would produce a result of "invalid sample". For the BrAC-7 condition there was a 42% probability the BAC DataMaster would produce a numerical result when only mouth alcohol was present and a 58% probability the BAC DataMaster would produce a result of "invalid sample." These probabilities are limited to the extent of the population in the study.

Conclusion

The purpose of the study was to determine if the slope detector algorithms contained in the BAC DataMaster would detect mouth alcohol only. The study addressed only mouth alcohol and produced BAC DataMaster results that indicate a 48% probability mouth alcohol will produce a numerical result and a 52% probability of an "invalid sample" result. This raises concern as to the ability of the slope detector algorithm incorporate to the BAC DataMaster being able to accurately detect mouth alcohol during the period of 3 to 7 minutes after alcohol

enters the mouth. Further, a concern is raised as to what numerical inflation may occur in circumstances when mouth alcohol enters the mouth in the 3 to 7 minutes immediately prior to a BAC DataMaster ABT being conducted, from blood in the mouth or belching or from some other source.

The results of this study support the work of Hlastala and others who have drawn conclusions that the slope detector algorithms incorporate to the BAC DataMaster do not function in a manner so as to exclude mouth alcohol being numerically reported and therefore inflating reported breath alcohol results.

Inferences

The slope detector algorithm in the BAC DataMaster appears to fail to detect mouth alcohol in a meaningful amount of cases. In 48 percent of the cases in this study the slope detector algorithm failed to detect mouth alcohol. An inference of this study is the need for the importance of direct and continuous observation of the subject during the 15 minute waiting period to assure no belching of stomach contents, containing alcohol, into the oral cavity does occur. If any suspicion of this does occur, the waiting and observation period should be restarted. A further inference is that a complete and thorough search of the oral cavity should be conducted both at the beginning and end of the waiting and observation period to assure the lack of foreign objects and that no blood, containing alcohol, is present in the oral cavity. Lastly, an inference is that training manuals on administration and operation of the BAC DataMaster should place the highest priority on oral cavity search and direct, face-on, observation throughout the 15 minute waiting period, this importance is based on the results of this study and that of others previously cited.

Unless the slope detector algorithm in the BAC DataMaster can be modified to correct its inability to detect mouth alcohol in a meaningful amount of instances, those using this instrument must rely on oral cavity search and rigorous observation as the primary means for assuring mouth alcohol is not present.

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