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TECHNICAL NOTE

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Comparison of the Analytical Capabilities of the BAC Datamaster and Datamaster DMT Forensic Breath Testing Devices

ABSTRACT: The State of Michigan uses the Datamaster as an evidential breath testing device. The newest version, the DMT, will replace current instruments in the field as they are retired from service. The Michigan State Police conducted comparison studies to test the analytical properties of the new instrument and to evaluate its response to conditions commonly cited in court defenses. The effects of mouth alcohol, objects in the mouth, and radiofrequency interference on paired samples from drinking subjects were assessed on the DMT. The effects of sample duration and chemical interferents were assessed on both instruments, using drinking subjects and wet-bath simulators, respectively. Our testing shows that Datamaster and DMT results are essentially identical; the DMT gave accurate readings as compared with measurements made using simulators containing standard ethanol solutions and that the DMT did not give falsely elevated breath alcohol results from any of the influences tested.

KEYWORDS: forensic science, Datamaster, DMT, breath alcohol testing, radiofrequency interference, interferents, objects in mouth, length of blow, mouth alcohol

Breath alcohol testing is often subjected to legal challenges to the reliability of the instrument. The potential effects of mouth alcohol (1–10), objects or jewelry in the mouth (11–16), solvents and other chemicals (9,17–27), endogenous acetone (28–35), gastroesophageal reflux disorders (36,37), and acetaldehyde (38–41) on the breath test result have been raised as objections for so long that most of these have been investigated in controlled experiments in response. Although most of these issues have been disproven in laboratory and field studies (9,17,38–41), they are still introduced in court as possible defenses. The State of Michigan has also seen court challenges based on the validity of the 2100:1 blood/breath ratio, the effect of the duration of the breath sample, supposed interference based on the presence of acetaldehyde, gasoline, chloral hydrate and its metabolite trichloroethanol (42,43), or radiofrequency interference.

The State of Michigan uses National Patent Analytical Systems' (Mansfield, OH) BAC Datamaster as an infrared evidential breath testing device. The software is programmed with a blood/breath ratio of 2100:1 and is inspected by a manufacturer's representative every 120 days. The instrument employs two filters, which pass light at 3.37 and 3.44 μm, and requires 1.5 L of breath for an adequate sample. A 15-min observation period is required before a subject sample is given. During a subject test, two breath samples are requested, with blank tests between and at the beginning and end of the test sequence. If the instrument detects the presence of a negative slope to the breath profile, radiofrequency interference, an interferent at the 3.37 μm filter with an apparent breath concentration of ≥0.002 g/210 L breath, is unable to purge the sample chamber of ethanol, or experiences any operating parameters outside the defined ranges, it reports an error code and aborts the test. Results are truncated and both are reported to two decimal places (i.e., 0.08 g/210 L breath). Results of 0.001–0.009 g/210 L breath are reported as negative.

National Patent Analytical Systems has recently introduced an updated model of the Datamaster called the DMT. Modifications include enhancements of the processing capability, updates to the filter positioning mechanism, upgrades to the electrical system, elimination of the print motor, and the ability to connect to an external printer. The optical system remains essentially unchanged. There are currently no published laboratory or field studies on the performance of the DMT. We therefore undertook a variety of *in vivo* and *in vitro* studies designed to evaluate the analytical capabilities of the new instrument. The purpose was twofold: to compare the function of the new version to that which is currently in the field and accepted in Michigan courts and to evaluate the response of the DMT to conditions raised in some of the more persistent defense claims.

Methods

Instruments

Two Datamaster and two DMT breath testing instruments were calibrated and function-verified according to Michigan State Police (MSP) standard operating procedures (44), using standard ethanol solutions obtained from Guth Laboratories, Inc. (Harrisburg, PA). The instruments were configured to request repeated samples until the test was terminated by the operator.

Subjects who had consumed alcohol gave breath samples on both the Datamaster and the DMT under a variety of conditions:

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with or without objects in the mouth, giving breath samples of varying lengths, or while cell phone calls or police radio transmissions were being conducted in the immediate vicinity. Blood samples were taken to compare with contemporaneous breath alcohol test results. *In vitro* studies used simulators to test the response of the two infrared instruments to acetaldehyde, chloral hydrate, gasoline, and a variety of solvents.

Solvents and Chemicals

Acetaldehyde, acetone, trichloroethanol, and other laboratory solvents were obtained from VWR Scientific Laboratories (VWR International, Inc., O'Hare AMF, Chicago, IL, http://www.vwr.com). Chloral hydrate was provided by the MSP Drug Analysis Unit. Regular and E85 gasoline and diesel fuel were obtained from the State of Michigan Department of Transportation's Vehicle and Travel Services unit. Ethanol-containing standardized simulator solutions were purchased from Guth Laboratories. Absolut Citron vodka (80-proof) was purchased by the MSP Alcohol Enforcement Unit.

Human Subject Studies

Human subject studies were conducted in accordance with informed consent parameters specified by the National Highway Traffic Safety Administration. Subjects were recruited by the MSP Alcohol Enforcement Unit. Twelve women and five men, aged 25–45 and 125–380 lbs, consumed enough 80-proof alcohol over 1 h to reach a peak blood alcohol content (BAC) of approximately 0.10 g/100 mL at the end of that hour, as calculated for each individual using Widmark's formula (41) and assuming a metabolic rate of 0.015 g/dL/h. A nondrinking subject was used as a negative control in each experiment. Simulators containing premixed ethanol solutions configured to give a result of 0.08 g/210 L served as positive controls. Subjects gave breath samples starting at 15 min after the end of the drinking period and then approximately every hour afterward on each instrument for up to 4 h. Male subjects gave samples on both the Datamaster and the DMT over the entire time course. Female subjects gave samples on both instruments the first hour, and then on the DMT thereafter. Breath results were plotted versus time and each subject's average elimination rate determined. Venous blood samples were collected once from each subject within 5 min of the first breath sample.

In addition to monitoring the changes in breath alcohol concentration (BrAC) over time on both instruments, the following conditions were investigated on the DMT:

Objects in the mouth. Drinking and nondrinking subjects gave one control breath sample and one sample with the presence of a Brach's Starlight peppermint, a stick of Trident sugarless chewing gum, a Listerine Cool Mint breath strip, or a penny held in the mouth. The object was placed in the mouth between the two breath tests.

Duration of blow. Subjects gave breath samples of short (6 sec), medium (12 sec), or long (24 sec) duration as measured with a stopwatch.

Mouth alcohol. Two nondrinking subjects rinsed their mouths with 80-proof Absolut Citron vodka for up to 30 sec, expelled the liquid, and then gave repeated breath samples to ascertain how long the DMT would register the presence of mouth alcohol.

Acetone. One nondrinking subject placed 200 μL of either pure or diluted (0.1 g/100 mL water) acetone in the mouth and held it present while giving a breath sample. In a second experiment, approximately 200 μL of the diluted acetone was placed in the mouthpiece while the same nondrinking subject gave a breath sample.

Radiofrequency interference. A handheld police radio capable of transmission at 800 MHz was placed next to the instrument. Comparison breath samples were made with the radio off or while in transmit mode. Comparison samples were also taken while cell calls using Motorola, Sprint, Verizon, or Altech phones were made by an experimenter standing next to the instrument. Calls were made to another phone in the room, so that both transmission and reception of cell calls happened simultaneously in the vicinity of the instrument during a test.

Blood Alcohol Analysis

BAC was determined by the MSP Blood Alcohol Unit. Samples were collected in 10-mL gray-top Vaccutainer tubes containing 100 mg sodium fluoride and 20 mg potassium oxalate. All samples were analyzed in duplicate. A volume of 50-μL aliquots of the blood samples were placed into 20-mL headspace vials and mixed with 800 μL of n-propanol or 400 μL of t-butanol as the internal standard. Ethanol content was quantified by headspace gas chromatography on ThermoFinnegan Trace DSQ gas chromatographs (Thermo Fisher Scientific, Waltham, MA) using an eight-point calibration curve and according to the Blood Alcohol Unit's standard operating procedures (45).

Simulator Studies

Acetaldehyde, chloral hydrate, gasoline, trichloroethanol, and a variety of laboratory solvents were diluted to a concentration of 0.001–0.1 g/100 mL with water. Solvents were chosen that had previously been subject to court challenges, usually in reference to a subject inhaling paint fumes, turpentine, gasoline, or industrial chemicals. Five hundred milliliters of the solvent solutions was decanted into simulators and heated to 34°C. The solvent-containing simulators were attached to the breath tube, and samples introduced into the Datamaster or the DMT by an experimenter blowing through the simulator mouthpiece.

Statistical Analysis

Group mean results were analyzed using Student's *t*-test, with a significance level of $p < 0.05$. Intrasubject differences between paired tests were analyzed using the Wilcoxon signed-rank test with a significance level of $p < 0.05$.

Results

In Vivo *Studies*

Figure 1 shows the ethanol elimination profile of a typical subject. Average elimination rates ranged from 0.016 to 0.025 g/210 L/h and were not significantly different between male and female subjects (0.021 ± 0.001 g/210 L/h, 0.019 ± 0.002 g/210 L/h for men and women, respectively, Student's *t*-test, $p > 0.1$). Nondrinking subject results in all cases were 0.000 g/210 L breath. Simulator solutions using premixed ethanol solutions prepared to yield 0.08 g/210 L breath were used as positive controls. All such solutions tested within the range allowed by the MSP evidentiary protocol (0.076–0.084 g/210 L breath).

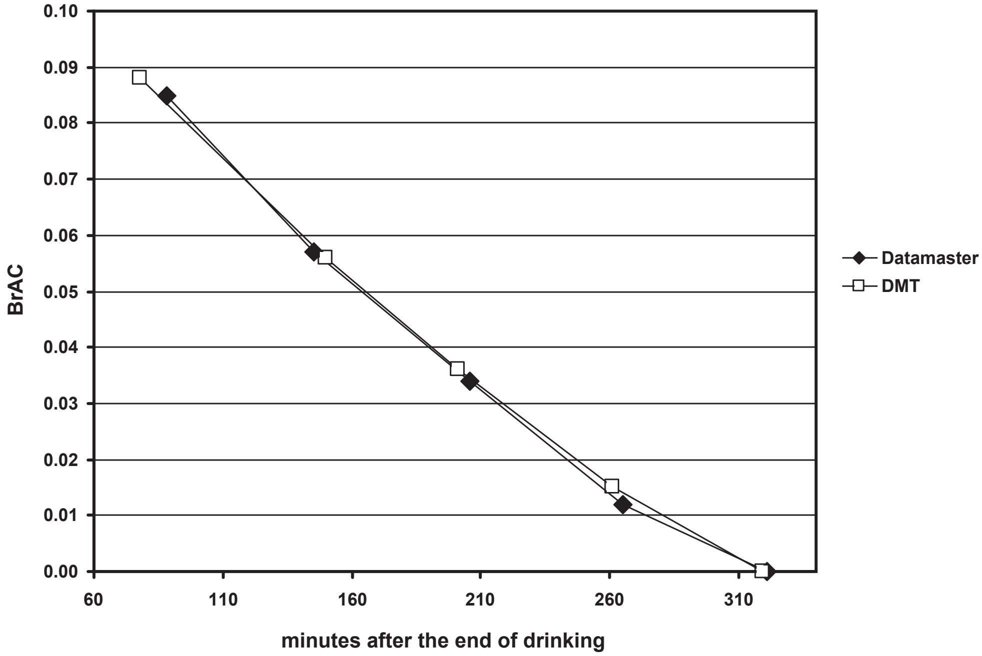

FIG. 1—*Breath alcohol metabolic profile for a male drinking subject. Results are given as g/210 L breath. Tests were given on the Datamaster and the DMT generally within 5 min of each other. Single test results at each time point are shown.*

BrAC results measured over the course of the study were essentially identical for the Datamaster and the DMT. Male subjects gave paired tests approximately hourly on each instrument; female subjects did so once during the course of the study. The differences between the paired results are shown in Table 1. The average difference between paired test results on each instrument was 0.0003 g/210 L breath. Within-subject results were not significantly different between the two instruments (Wilcoxon signed-rank test, $p > 0.1$).

Blood–Breath Comparison—Comparisons between the magnitude of breath and blood tests were investigated by having subjects produce contemporaneous breath and blood samples. Approximately 1–1.5 h after the end of drinking, venous blood samples were drawn into 10-mL gray-top Vaccutainer tubes, as previously described, after which subjects immediately (within 5 min) provided a breath sample on the Datamaster. Blood tubes were stored at 4°C and later analyzed by headspace gas chromatography. Breath tests for female subjects ranged from 0.058 to 0.092 g/210 L breath and males from 0.076 to 0.097 g/210 L breath. Corresponding blood tests ranged from 0.048 to 0.096 g/100 mL and 0.075 to 0.102 g/100 mL for female and male subjects, respectively. Breath test results were on average 3.67% lower than the blood test results. Only one subject had a breath test that would have been reported higher than a corresponding blood test (0.048 g/100 mL blood vs. 0.058 g/210 L breath). This subject was the earliest blood sample collected (50 min after the end of drinking), and its possible distribution was not complete at that point. Differences between pairs of breath and blood results for each subject were not significantly different ($p > 0.10$) as calculated by the Wilcoxon signed-rank test.

Effect of Objects in the Mouth—The effects of objects in the mouth on DMT BrAC measurements are shown in Table 2. Drinking and nondrinking subjects gave paired tests with or without the specified objects in the mouth. There were no statistically significant differences between the within-subject paired tests, using Wilcoxon signed-rank test ($p > 0.1$).

Detection of Mouth Alcohol—The response of the DMT to mouth alcohol was assessed by having two nondrinking subjects rinse their mouths with 80-proof Absolut Citron vodka for up to 30 sec, spit it out, and give immediate and repeated breath samples. For both subjects, a test at 1 min gave an immediate Detector Overflow error code (Table 3). Repeated tests at intervals of 2–3 min gave Invalid Sample error codes at 6 and 12 min, respectively, after expelling the vodka. Subject 1, who had a longer clearance time, rinsed the mouth for a much longer period than subject 2 and had presumably a greater amount of mouth alcohol present. By the end of the 15-min period that would be required in an evidential test, both subjects had completely negative results to two decimal places.

Response to Acetone—The response of the DMT to acetone was assessed in a similar fashion. A nondrinking subject rinsed the mouth with 200 μL of undiluted reagent-grade acetone and then expelled the liquid and gave repeated breath samples. The instrument returned an Invalid Sample error code for 1–3 min and then a result of 0.000 g/210 L breath thereafter (Table 4). Repeating the experiment with 200 μL of diluted acetone (0.1 g/100 mL) resulted in negative readings (0.000 g/210 L) even at the first time point. Placing 200 μL of diluted acetone in the mouthpiece, such that the solvent would be continually present during repeated samples, gave a Detector Overflow response at 1 min, an Invalid Sample messages at 3 min, and a reading of 0.000 g/210 L at 6 min. The DMT did not return an apparent ethanol result in response to the presence of acetone under any of the circumstances tested, even though the concentrations used here were several orders of magnitude higher than those that would be seen in diabetics or fasting healthy subjects (28,32).

Radiofrequency Interference—The response of the DMT to purported radiofrequency interference from police radios and cell phones is shown in Table 5. Police handheld radios were placed on the table next to the instrument either off or in the transmit mode. Cell phones in the room were either off or the operator made a call to another cell phone in the room during the subject test. Verizon, Motorola, and Altech cell phones were used. Subjects gave paired tests, one with a radio source and one without. A simulator containing a 0.08 g/210 L breath standard Guth solution was used as a positive control.

The results were statistically indistinguishable between the pairs of tests for all conditions examined (Wilcoxon signed-rank test, $p > 0.1$); neither were there any differences between the drinking subject group means for the two conditions (Student's *t*-test, $p > 0.1$). Thus, there was no demonstrable effect of radio or cell phone use during the operation of the breath test.

TABLE 1—*Paired subject test results on the Datamaster and the DMT.*

Subjects	Datamaster g/210 L Breath	DMT g/210 L Breath	Minutes After Start of Drinking
Males			
Subject 1	0.083	0.088	76
Subject 1	0.058	0.056	140
Subject 1	0.035	0.036	200
Subject 1	0.013	0.015	265
Subject 1	0.000	0.000	320
Subject 2	0.084	0.079	72
Subject 2	0.063	0.056	142
Subject 2	0.041	0.043	200
Subject 2	0.021	0.025	260
Subject 2	0.000	0.000	320
Subject 3	0.081	0.077	90
Subject 3	0.060	0.061	143
Subject 3	0.040	0.043	200
Subject 3	0.020	0.025	265
Subject 3	0.000	0.000	325
Subject 4	0.104	0.107	77
Subject 4	0.096	0.086	150
Subject 4	0.082	0.085	200
Subject 4	0.062	0.063	265
Subject 4	0.043	0.042	320
Subject 5	0.083	0.081	80
Subject 5	0.070	0.068	165
Subject 5	0.056	0.056	200
Subject 5	0.033	0.035	260
Subject 5	0.013	0.015	325
Females			
Subject 1	0.037	0.035	260
Subject 2	0.030	0.030	262
Subject 3	0.028	0.033	270
Subject 4	0.044	0.046	270
Subject 5	0.046	0.048	285
Subject 6	0.045	0.045	240
Subject 7	0.057	0.057	100
Subject 8	0.089	0.089	105
Subject 9	0.082	0.086	90
Subject 10	0.055	0.056	120
Subject 11	0.046	0.050	125
Subject 12	0.044	0.044	135

Tests were generally within 5 min of each other. Intrasubject results were not significantly different between the two instruments (Wilcoxon signed-rank test, $p > 0.1$).

TABLE 3—*Duration of mouth alcohol effect on DMT results. Two nondrinking subjects rinsed their mouths with approximately 30 mL of Absolut Citron vodka and immediately gave sequential breath samples.*

Minutes Past Mouth Alcohol Expulsion	DMT Result
Subject 1	
1	Detector Overflow
2	Ambient Fail
4	Invalid Sample
7	Invalid Sample
9	Invalid Sample
12	Invalid Sample
15	0.003
17	0.003
20	0.000
Subject 2	
1	Detector Overflow
4	Invalid Sample
6	Invalid Sample
9	0.000

All numerical values are given in g/210 L breath. Subject 1 rinsed the mouth for a much longer period than subject 2 (*c.* 30 sec vs. *c.* 5 sec), hence the longer clearance time. By 15 min, all results were negative to two decimal places.

TABLE 4—*Effect of acetone on DMT results.*

Condition	Minutes After Acetone Introduced	DMT Result
Acetone in mouth undiluted	1	Invalid Sample
	3	Invalid Sample
	5	0.000
Acetone in mouth 0.1 g/100 mL	1	0.000
	3	0.000
Acetone in mouthpiece	1	Detector Overflow
0.1 g/100 mL	3	Invalid Sample
	6	0.000

One nondrinking subject gave breath samples on the DMT after rinsing the mouth with 200 μL acetone or with 200 μL acetone present in the mouthpiece. All numerical values are given as g/210 L breath.

TABLE 2—*Effects of the presence or absence of objects in the mouth on DMT breath test results from drinking subjects and nondrinking controls.*

	Drinkers		Nondrinking Controls	
Object	Absent (*n*)	Present (*n*)	Absent (*n*)	Present (*n*)
Penny	0.039 ± 0.007 (6)	0.039 ± 0.007 (6)	0.000 ± 0.000 (2)	0.000 ± 0.000 (2)
Peppermint	ND	ND	0.000 ± 0.000 (3)	0.000 ± 0.000 (3)
Listerine strip	0.013 ± 0.008 (6)	0.015 ± 0.009 (6)	0.000 ± 0.000 (5)	0.000 ± 0.000 (5)
Chewing gum	0.064 ± 0.008 (8)	0.065 ± 0.007 (8)	0.000 ± 0.000 (3)	0.000 ± 0.000 (3)

All results are given as g/210 L breath. *n* = number of subjects. Subjects gave duplicate samples, with and without objects present. Mean results are shown for each condition. In all cases, the intrasubject differences between the paired tests were statistically nonsignificant, using the Wilcoxon signed-rank test ($p > 0.1$).

TABLE 5—*Effects of handheld police radios and cell phones on DMT breath alcohol concentration results.*

Condition	0.08 g/210 L Simulator	Nondrinking Control	Drinking Subjects (*n*)
Radio off	0.078	0.000	0.077 ± 0.014 (8)
Radio on	0.078	0.000	0.077 ± 0.013 (8)
No cell	0.078	0.000	0.070 ± 0.008 (6)
Cell call	0.076	0.000	0.069 ± 0.009 (6)

All results are given as g/210 L breath. n = number of subjects. Subjects gave duplicate samples, with and without radio or cell phone operating. Mean results and standard deviations are shown for each condition. In all cases, the intrasubject differences between the paired tests were statistically nonsignificant, using the Wilcoxon signed-rank test ($p > 0.1$). Drinking subject group means were not significantly different, using Student's t-test ($p > 0.1$).

TABLE 6—*Effects of duration of blow on breath alcohol concentration on the Datamaster and the DMT.*

	Datamaster (sec)			DMT (sec)		
Subject	24	12	6	24	12	6
1	0.085	0.083	0.085	0.088	0.088	0.075
2	0.088	0.084	0.088	0.085	0.079	0.071
3	0.091	0.083	0.091	0.086	0.077	0.072
4	0.097	0.099	0.097	0.086	0.089	0.082
5	0.084	0.084	0.084	0.081	0.072	0.068
6	0.059	0.058	0.059	0.056	0.056	0.052
7	0.067	0.063	0.067	0.063	0.053	0.056
8	0.074	0.060	0.074	0.069	0.061	0.052
9	0.097	0.099	0.097	0.086	0.089	0.082
10	0.078	0.073	0.078	0.070	0.068	0.067

All results are given as g/210 L breath; individual subject results are shown. The number of seconds refers to the length of exhalation. Nondrinking controls' test results of 6, 12, and 24-sec breath samples were all 0.00 g/210 L on both instruments.

Duration of Exhalation—Table 6 shows the effect of breath sample duration. Drinking and nondrinking subjects gave breath samples of long (24 sec), medium (12 sec), or short (6 sec) duration, as timed with a stopwatch.

Within-subject BrAC results of 24- and 12-sec breath samples were not statistically different from each other on either instrument (Wilcoxon signed-rank test, $p \geq 0.1$); 6-sec samples gave significantly lower results ($p < 0.01$) than 24-sec breath samples on both instruments and were also significantly lower than the 12-sec breath sample on the DMT. These data demonstrate that a 6-sec blow may lower the reported breath alcohol result. However, increasing the exhalation time from 12 to 24 sec does not increase the reported breath alcohol result.

In Vitro *Tests of Specificity*

Recent defense challenges in Michigan include a defendant who claimed that ingested gasoline resulted in a false positive Datamaster result, and a subject who claimed he was surreptitiously drugged with chloral hydrate which, by metabolism to trichloroethanol, produced a spurious preliminary breath test result. Other perennial challenges include miscellaneous workplace solvents, paint or turpentine use, or acetaldehyde on breath being mistaken for ethanol by the Datamaster. Some of these claims have been repeatedly disproven in the literature (9,17–35,38–41), as most such solvents and compounds are toxic or lethal in very small doses (46), and so would not be expected to be present in the breath of living human subjects at levels which could significantly interfere with a breath test result.

To investigate the effects of these compounds on the DMT, simulator solutions containing varying levels of acetaldehyde, chloral hydrate, gasoline, trichloroethanol, or a variety of laboratory solvents were tested on the Datamaster and the DMT. A Guth 0.08 g/210 L breath standard solution was used as a positive control and a nondrinking subject as a negative control. Means and standard deviations of positive control results were 0.080 ± 0.0005 g/210 L ($n = 2$) and 0.080 ± 0.001 ($n = 4$) on the Datamaster and DMT, respectively. Negative control results were

TABLE 7—*Effects of metabolites, gasoline, and solvents on the Datamaster and DMT.*

Compound	Simulator Concentration (g/100 mL)	Datamaster	DMT
Acetaldehyde	0.1	0.085, 0.090	IF, IF
	0.01	0.009, 0.009	IF, IS
	0.001	Refusal	IF, IF
Acetonitrile	0.1	0.007, 0.007	IF, IF
	0.01	0.000, 0.000	IS, IS
	0.001	0.000, 0.000	0.000, 0.000
n-butanol	0.1	IF, IF	IF, IF
	0.01	0.017	0.017, 0.016
	0.001	Refusal	0.009, IF
Chloral hydrate	0.1	0.000, 0.000	0.000, 0.000
	0.01	ND	ND
	0.001	ND	ND
Dichloromethane	0.1	IF, IF	IS, IS
	0.01	IF	IF, IF
	0.001	Refusal	IF, IF
Diesel	0.1	IS, IS	IS, IS
	0.01	IF, IF	IF, IF
	0.001	0.000, 0.000	0.000, 0.000
Ethyl acetate	0.1	IF, IF	IS, IS
	0.01	IF	IF, IF
	0.001	0.000, 0.000	IS, IF
Ethylene glycol	0.1	0.000, 0.000	0.000, 0.000
	0.01	ND	ND
	0.001	ND	ND
Gasoline (reg.)	0.1	IS, IS	DO, DO
	0.01	0.019, 0.014	IS, IS
	0.001	0.000, 0.000	0.000, 0.000
Gasoline (E85)	0.1	IS, IS	DO, DO
	0.01	IF	IS, IS
	0.001	0.000, 0.000	0.000, 0.000
Hexanes	0.1	IS, IS	DO, DO
	0.01	0.008, 0.005	IS, IS
	0.001	0.000, 0.000	0.000, 0.000
Methanol	0.1	IF, IF	IF, IF
	0.01	0.005, 0.005	0.000, 0.000
	0.001	0.000, 0.000	IF, 0.000
Toluene	0.1	IS, IS	DO, IS
	0.01	0.016, 0.010	IS, IS
	0.001	0.000	IS
Trichloroethanol	0.1	0.003, 0.002	0.000, 0.000
	0.01	ND	ND
	0.001	ND	ND
Xylenes	0.1	IF, IS	IS
	0.01	IF	IS, IS
	0.001	IS, Refusal	IF, 0.000

IF, interferent; IS, insufficient sample; DO, detector overflow. Refusal = technical refusal (adequate sample not detected within 2 min). Compounds were not tested at lower concentrations (ND, not done) if the highest concentration gave a negative result.

Numerical results are given as g/210 L breath. Individual test results are shown. Compounds were diluted to the concentrations indicated and introduced by wet-bath simulator into the instruments.

0.000 ± 0.000 (n = 2 on both instruments). Results of tested compounds are shown in Table 7.

At 0.1 g/100 mL, n-butanol, dichloromethane, diesel fuel, ethyl acetate, regular and E85 gasoline, hexanes, methanol, toluene, and mixed xylenes gave exclusively error codes (Interferent, Insufficient Sample, or Detector Overflow) on both the Datamaster and the DMT. At the same concentration, ethylene glycol, chloral hydrate, and trichloroethanol gave no reading higher than 0.002 g/210 L on either instrument. Acetonitrile at 0.1 g/100 mL gave a reading of 0.007 g/210 L on the Datamaster and an error code on the DMT. A solution of 0.1 g/100 mL acetaldehyde produced a 0.090 g/210 L on the Datamaster; however, as this concentration is several orders of magnitude higher than would ever be seen in a living subject (46), this result is unsupportive of defense claims of interference from this compound. The same acetaldehyde solution produced an Interferent error on the DMT. The 0.08 g/210 L positive control produced a 0.080 and 0.081 g/210 L on the Datamaster and DMT, respectively, and negative subject control test results were 0.000 g/210 L on both instruments.

All solvents and compounds that produced error codes were retested at lower concentrations. Most produced either error messages or BrAC < 0.01 g/210 L, which would be reported as negative in an evidential test. In some cases, the instrument could not verify the presence of the breath sample and terminated the test as an Insufficient Sample or Refusal. Apparent BrAC levels greater than 0.010g/210 L were obtained only at levels of toluene or gasoline generally regarded as toxic or lethal concentrations in humans (46). However, the presence of ethanol in regular and E85 gasoline mixtures, but not in diesel fuel, was verified by headspace gas chromatography/mass spectrometry (data not shown).

Discussion

This study is the first to compare the performance of the DMT to that of the current Datamaster, as well as to determine whether the DMT is susceptible to influences commonly cited in defense challenges, such as the presence of mouth alcohol, acetone, or radiofrequency interference.

The current Datamaster and the DMT gave essentially identical BrAC results over time for drinking subjects. Subjects' average elimination rates were consistent with values previously reported for the general population (41,46). BrACs were essentially identical with or slightly lower than temporally coincident BACs. These results are in good agreement with the consensus in the field that use of a 2100:1 blood/breath ratio is a conservative practice and legally defensible as it will not return a postabsorptive BrAC greater than the BAC (9,47–51). These results also demonstrate that both instruments are analytically reliable and consistent and either may be used in the measurement of BrACs for evidential purposes.

None of the objects tested neither had any effect on the DMT BrAC result nor caused any false positive readings when placed in the mouth. Neither cell phones nor police radios affected DMT BrAC results. This result is not unexpected, as the instrument has not only a radiofrequency detector but is also shielded by the metal cover from penetration by radio waves.

The DMT returned error codes in the presence of both mouth alcohol and acetone. Invalid Sample errors are returned when the instrument detects a negative slope to the breath profile, such as can happen in the presence of mouth alcohol. Detector Overflow and Ambient Fail errors can be returned when the instrument detects ethanol or an interferent in the ambient air and cannot establish a baseline. In no case was an apparent ethanol result produced by mouth alcohol returned beyond the 15 min required by the MSP evidential breath testing protocol. This was true even though the subjects essentially gargled with vodka and gave immediate breath samples, a situation that is unlikely to occur during an evidential test. Nor did the DMT return spurious ethanol results in the presence of undiluted acetone, a concentration several orders of magnitude higher than what could be expected to be seen in living subjects, even diabetics (28,32). These results demonstrate that neither mouth alcohol nor blood acetone can be plausibly invoked to explain a numerical breath ethanol result on the DMT.

The breath sample duration affected the test result only in that a short blow gave a lower reading than a medium or long blow; however, the medium and long blow results were not statistically different. These results are consistent with those reported previously by other researchers (52). In other words, a short blow would be to a defendant's advantage by giving a less than maximal reading. However, after the BrAC reaches an apparent maximal level, a longer blow will not give a higher reportable result.

Most solvents, gasoline, and acetaldehyde gave error codes or negative results on both infrared instruments at all concentrations tested. The only numerical readings obtained for these compounds were low (≤0.017 g/210 L) or were observed at unrealistically high solvent concentrations. Neither chloral hydrate nor its metabolite trichloroethanol gave any BrAC readings on either instrument, demonstrating that ingestion of chloral hydrate could not explain a positive breath test result.

In summary, both the Datamaster and the DMT are accurate and specific for breath alcohol when used correctly. The Datamaster has passed several *Daubert* challenges in Michigan courts and found to be scientifically acceptable (53–55). Results on the DMT are virtually identical to those obtained on the Datamaster. The DMT is not susceptible to falsely elevated BrAC results from objects in the mouth, organic solvents or acetaldehyde present on the breath, ingestion of chloral hydrate, radio waves from police radios or cell phones, mouth alcohol, breath acetone, or a long duration of blow. There is no evidence in this study that any of these conditions will detrimentally affect a breath test result on either instrument if the approved test protocol is followed.

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