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Note

Post mortem brain alcohol levels

ROBERT D. BUDD
Los Angeles County Chief Medical Examiner-Coroner, 1104 No. Mission Road, Los Angeles, CA 90033 (U.S.A.)
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In some post mortem cases, blood is unavailable for alcohol analysis owing to decomposition or the nature of the fatal injuries. In these cases, other fluids or tissue must be used to obtain an alcohol analysis.

Brain tissue is one tissue that may be chosen, as ethanol rapidly equilibrates between the blood and brain[1] and as very strong correlations between blood alcohol and brain alcohol levels have been found in studies with rats[2] and humans[3].

In this study, a rapid gas chromatographic procedure has been developed for the determination of brain alcohol levels. This procedure was then used to determine the brain and blood alcohol levels in 51 Los Angeles (LA) County Coroner's cases where both blood and brain tissue were available for analysis. The correlation between the blood and brain levels was then determined.

EXPERIMENTAL

Samples

The blood and brains analyzed in this study were from persons who died in Los Angeles County between January 19, 1982, and October 9, 1982. In all cases where the blood was found to be positive for ethanol, the brain, if also taken at autopsy, was also analyzed.

Reagents

The reagents were 10% sodium tungstate solution and an acidic internal standard solution consisting of $\frac{2}{3}$ *N* sulfuric acid containing 2 ml/l of *tert.*-butanol.

Brain analysis

To a 100-ml grinding tube, add 5 g of brain tissue, 5 ml of 10% sodium tungstate solution and 5 ml of the internal standard solution. Homogenize the mixture, then transfer 5 ml into a 12-ml centrifuge tube. Centrifuge this aliquot for 10 min.

Blood analysis

To a 12-ml centrifuge tube add 1 ml of blood, 1 ml of 10% sodium tungstate solution and 1 ml of the internal standard solution. Shake the mixture for 10 sec, then centrifuge it for 10 min.

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Gas chromatography

Inject 3 μl of the supernatant into the gas chromatograph; a Hewlett Packard Model 5750 instrument with a 6-ft. metal column packed with Parapak Q, operated at 191°C, was used. The alcohol concentration is calculated from the peak areas.

RESULTS AND DISCUSSION

Ethanol concentrations as low as 0.01% (w/w) are readily detected without interference from other alcohols (Table I) or decomposition products.

Although brain tissue is seldom taken at autopsy here, in the 51 LA County Coroner's cases examined here both the blood specimen and brain tissue from each victim were found to be positive for ethanol (concentration 0.01%, w/w). The results of these cases (blood and brain analyses) are summarized in Table II. The blood ethanol concentrations ranged from 0.01 to 0.48% (w/v) (average 0.087%, w/v), while the brain ethanol concentrations ranged from 0.01 to 0.53% (w/w) (average 0.094%, w/w). The brain/blood ethanol ratios varied from 0.29 to 8.00, although 82% of the values ranged from 0.80 to 1.50. The mean ratio was 1.24 with a standard deviation of 1.01. All of the values but one were within 1 standard deviation of the mean.

Our brain/blood ratio (1.24) is higher than that found by Backer *et al.*[3], who found a range from 0.64 to 1.20, averaging 0.86. In this study, 24% (12 out of 51) of the values determined were less than 1.00. The substantial differences between the two ratio measurements may be a reflection of the different analytical methodologies used for the brain ethanol determinations, *viz.*, a steam distillation method *versus* the extraction procedure described herein.

Owing to the nearly equal water contents of brain tissue and blood, and to the rapid equilibration of ethanol between the blood and the brain, a brain/blood ethanol ratio of 1.0 is theoretically expected. In this study 20 cases (39.2%) were found to range from 0.85 to 1.15.

The correlation coefficient for the blood and brain ethanol concentrations found in each of the 51 cases studied was high (0.92), as might be expected, indicating a strong correlation between the two concentrations in each case. It might be concluded, based on this very strong correlation, that one could use the measured ethanol concentration in either the blood or brain tissue to predict accurately the concentration of ethanol in the other. As the standard deviation for the ratios is so high (1.01), though, in actuality only a very rough estimate of the second value can be obtained [blood concentration equals brain concentration divided by (1.24 $\pm$ 1.01)].

There are several reasons for the large standard deviation. First, all concen-

TABLE I

ALCOHOL RETENTION TIMES

Substance	*Retention time (min)*	*Substance*	*Retention time (min)*
Methanol	0.20	Isopropanol	0.87
Ethanol	0.47	*tert.*-Butanol	1.42
Acetone	0.79	Propanol	1.60

TABLE II

BLOOD AND BRAIN ALCOHOL RATIOS

Case	Blood alcohol concentration (%, w/v)			Case	Brain alcohol concentration (%, w/w)		
	Blood	*Brain*	*Brain/Blood*		*Blood*	*Brain*	*Brain/Blood*
1	0.11	0.10	0.91	27	0.26	0.35	1.35
2	0.07	0.04	0.57	28	0.08	0.11	1.38
3	0.14	0.17	1.21	29	0.13	0.15	1.15
4	0.21	0.21	1.00	30	0.48	0.33	0.69
5	0.03	0.05	1.67	31	0.46	0.53	1.15
6	0.15	0.16	1.07	32	0.19	0.23	1.21
7	0.08	0.12	1.50	33	0.06	0.05	0.83
8	0.05	0.08	1.60	34	0.11	0.14	1.27
9	0.18	0.20	1.11	35	0.04	0.05	1.25
10	0.16	0.13	0.81	36	0.05	0.05	1.00
11	0.15	0.22	1.47	37	0.05	0.06	1.20
12	0.02	0.02	1.00	38	0.09	0.08	0.89
13	0.17	0.25	1.47	39	0.18	0.22	1.22
14	0.16	0.05	0.31	40	0.07	0.09	1.29
15	0.16	0.18	1.13	41	0.21	0.17	0.81
16	0.11	0.13	1.18	42	0.22	0.22	1.00
17	0.05	0.09	1.80	43	0.07	0.02	0.29
18	0.03	0.01	0.33	44	0.10	0.20	2.00
19	0.01	0.08	8.00	45	0.16	0.15	0.94
20	0.11	0.10	0.91	46	0.12	0.16	1.33
21	0.45	0.39	0.87	47	0.11	0.11	1.00
22	0.23	0.24	1.04	48	0.37	0.39	1.05
23	0.02	0.02	1.00	49	0.30	0.36	1.20
24	0.10	0.14	1.40	50	0.15	0.16	1.07
25	0.10	0.13	1.30	51	0.16	0.17	1.06
26	0.24	0.25	1.04				

trations were calculated to three decimal places and rounded to two decimal places, which may have led to some higher ratios. Second, at lower concentrations a change of only 0.01% (w/w) makes a tremendous change in the ratio, whereas at higher concentrations such a change has much less effect. Third, the ethanol equilibration between the blood and the brain is rapid, but not instantaneous, so that it is possible for the blood level to be higher than the brain level in a person who is rapidly drinking ethanol just before death. Likewise, once the blood ethanol concentration begins to drop, the brain ethanol concentration may decrease much more slowly. Fourth, the ethanol concentrations may not be equal in all parts of the brain.

In conclusion, brain ethanol concentrations can be rapidly and accurately determined by gas chromatography and can be used to determine a blood ethanol concentration range.

REFERENCES

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