ACETONE EXPIRATION AND BREATHE-ALCOHOL TESTING

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SYNOPSIS

Acetone may interfere with breath-alcohol testing using instruments measuring in the near infrared. But in practice considerable breath-acetone values are unlikely to occur even in risk groups of diabetic patients.

INTRODUCTION

In many countries breath-alcohol testing is a well established method to control driving under the influence of alcohol. Various analytical principles are used to measure the alcohol concentration in expired breath, such as gas chromatography, electrochemical cells, semiconductors, and infrared spectrometry. A breath-alcohol analyzer based on the last method was demonstrated at the last meeting, the 8th International Conference on Alcohol, Drugs and Traffic Safety in Stockholm by Grambow et al. (1981), named the Alcotest 7010 (Drägerwerk AG, Lübeck, Germany).

The measurement in the near infrared-range involves a beam of defined wave length passing a sample chamber and being monitored at the other end. A wave length of 3.4 microns has been selected which is sensitive to the hydrocarbon stretch found for instance in ethyl alcohol but also in other alcohols and acetone as well.

A separation of these compounds is not possible by this technique. Therefore, the question arises to what extent those compounds, mainly acetone, interfere with the quantitative assay of ethyl alcohol. This problem has been discussed by Forrester (1979) in some detail. It may lead to serious legal implications, for instance, if a person accused of driving under the influence of alcohol claims that he as a diabetic had been breath-tested in a state of ketoacidosis. Here we describe studies which were performed to measure breath acetone in drinking experiments and in diabetic patients to investigate the interference of this compound with breath-alcohol testing. In addition, we determined the acetone content of 500 forensic blood samples.

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METHODS

Using the Alcotest 7010 apparatus (Drägerwerk AG, Lübeck, Germany) we measured the acetone concentration in breath of 6 non-diabetic, healthy volunteers (males, 70 to 80 kg body weight) who drank a cocktail containing 10 ml acetone p.a. in 100 ml orange juice. Breath-tests were performed every 10 minutes during the first hour, then every 20, 30, or 60 minutes until 7 hours after drinking. The values measured correspond to those for ethyl alcohol: the instrument had not been calibrated with acetone vapor. Blood samples were taken at 30, 45, and 90 minutes and at 4 and 6½ hours after drinking. The blood acetone concentration was determined by gas chromatography in a Perkin-Elmer F-42 apparatus applying the head-space method. Breath-tests were also performed with 44 out-patients (ages 20 to 80 years) suffering from severe diabetes mellitus. In the case of a positive test, a blood sample was taken for the determination of acetone or other volatile substances. In 500 fresh blood samples randomly selected from those taken for blood alcohol determination in the area of Frankfurt and its surroundings, the acetone content was quantitatively assayed using the head-space method.

RESULTS

During the first hour after acetone consumption breath values between 0.015 and 0.025% (corresponding to ethyl alcohol values) exhibited relatively high standard deviations most probably due to equilibrium fluctuations in the early phase of resorption (Figure 1). Later, a slightly declining concentration was observed indicating a relatively slow excretion of acetone. The values from blood samples show a good correlation in acetone concentration to the breath levels 90 minutes after drinking. From these experiments we can assume that the Alcotest 7010 is able to measure acetone in breath with high accuracy, even though the instrument has not been calibrated with acetone.

Among 500 forensic blood samples where the acetone content was determined by gas chromatography, in only 4 cases were acetone values higher than 0.001% detected. Although 17 persons had claimed to have chronic diabetes, their acetone level was lower than 0.001% or even not detectable.

Of the 44 diabetic out-patients considered as a potential risk group only 4 exhibited a positive breath-test. Gas chromatographic investigation of their

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blood samples revealed that this was only partially due to acetone. In the only case where a high value was measured in breath, ethyl alcohol was identified as the main component. Furthermore, this patient was hypoglycaemic (48 mg% blood sugar). Most of the other patients were hyperglycaemic exhibiting blood sugar levels between 200 and 400 mg/100 ml; however, the breath-tests were negative excluding severe ketoacidosis (Table 1).

TABLE 1: ANALYSES OF 4 DIABETIC OUTPATIENTS

<table>
<thead>
<tr>
<th>Breath</th>
<th>Blood</th>
<th>Acetone</th>
<th>Ethanol</th>
<th>Sugar (mg/100 ml)</th>
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<tbody>
<tr>
<td>%</td>
<td>%</td>
<td>%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. 0.006</td>
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<td>0</td>
<td>136</td>
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<tr>
<td>2. 0.002</td>
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<td>3. 0.001</td>
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<td>0</td>
<td>275</td>
<td></td>
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<tr>
<td>4. 0.067</td>
<td>0.0006</td>
<td>0.059</td>
<td>48</td>
<td></td>
</tr>
</tbody>
</table>

DISCUSSION

The results of this study, especially from the drinking experiments, demonstrate that acetone is measured in breath by instruments based on infrared spectrometry (e.g. the Alcotest 7010). We were also able to show, however, that notable acetone values are unlikely to occur in practice, that is, in the control of drinking drivers, even in risk-groups of diabetic patients. Although, most of the diabetic patients tested exhibited marked hyperglycaemia, breath-tests were usually negative; those which were positive were too low to interfere with breath-alcohol testing or could be attributed to ethanol. Acetone levels in blood are common even under
normal physiological conditions, but seem to exceed rarely values of 0.001%. Acetone values higher than 0.01% may occur in states of severe ketoacidosis where, in addition, the capability of safe driving is seriously impaired.

REFERENCES


Figure 1. Breath-acetone concentrations of test persons (N = 6) after drinking 10 ml acetone in 100 ml orange juice measured by the Alcotest 7010 (ethanol reading) and the corresponding blood acetone values (open circles).