be reduced as is the case when oral glucose-electrolyte solutions are used for maintenance therapy.

The fall in world sugar (sucrose) supplies and the accompanying price increases also reduce the advisability of recommending sucrose for routine oral therapy instead of glucose. It seems more appropriate to recommend that sufficient glucose be stockpiled to anticipate future requirements in areas affected by cholera and related disorders; this will avoid the extra hazard which would accompany any recommendation for sucrose therapy.

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REFERENCES


ALCOHOL INTOXICATION AND SERUM OSMOLALITY

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Summary

The relation between serum osmolality and blood-alcohol was studied prospectively in 565 acute trauma patients. The two measurements were closely correlated. It is therefore possible to estimate the blood-alcohol from serum osmolality to assist in the clinical management of acutely injured patients.

Introduction

Emergency-room physicians and surgeons have a problem in interpreting clinical signs in the injured patient with the possibility of alcohol or drug ingestion. The smell of alcohol on the breath of a delirious, combatant patient can easily prejudice the physician's objectivity in a busy emergency room. The diagnostic challenge is frequently postponed in favour of more precise and seemingly more urgent problems.

The diagnostic pitfalls in head and abdominal injuries associated with apparent intoxication are well recorded.\(^1-5\) The physiological effects of alcohol on the shocked patient are poorly documented, but cardiovascular effects contribute significantly to the difficulties encountered in the haemodynamic management of these patients\(^4\) and diminish the chance of survival. The chronic alcoholic, though less common, presents the clinician with a variety of difficult problems which complicate evaluation and treatment.

Blood-alcohol determinations are not readily available in most emergency rooms. The measurement is not simple, and carries with it legal implications that may be uncomfortable for both patient and physician. We discuss here the findings of a prospective study undertaken to define the correlation between alcohol and serum osmolality in seriously injured patients.

Methods

565 acute trauma admissions to the Maryland Institute for Emergency Medicine were studied during 1974. From all new admissions samples of venous and arterial blood are taken immediately for baseline biochemical estimations. 2 ml. samples of whole venous blood were coded and refrigerated at 4°C for blood-alcohol determinations in the toxicology laboratory of the Office of the Chief Medical Examiner of Maryland.

Serum-sodium was estimated by flame photometry (Instrumentation Laboratories model 143). Blood-urea-nitrogen was estimated by a urease method using the Boehringer Mannheim urea-nitrogen kit, and blood-glucose by the Dubowski method using 6% o-toluidine in glacial acetic acid. Serum osmolality was measured by the freezing-point depression on Advanced Instruments osmometer model 3D. Whole-blood alcohol was determined by automated head-space gas chromatography using a Perkin Elmer ‘Multifract F-40’. Regression analysis was used to study the relationship between serum osmolality and blood-alcohol.

Results

Of the 565 samples studied, 236 (42%) contained alcohol: 151 (27%) had blood-alcohol concentrations of 100 mg. per 100 ml. or more and 103 (18%) were 150 mg. per 100 ml. or more. In general, the patients with positive alcohol tests had raised serum osmolalities. No patient with a blood-alcohol of 150 mg. per 100 ml. or more had a serum osmolality of less than 320 mosmol per kg. None of the 46 patients with a blood-alcohol of less than 50 mg. per 100 ml. had osmolalities of more than 330 mosmol per kg. (table 1). The aetiology of the raised osmolalities in these patients could not be defined and was associated with a discrepancy (mean 44 mosmol per kg.) between measured osmolality, and that calculated from the formula\(^5\):

\[
\text{osmolality} = \frac{(\text{sodium} \times 1.86) + \left(\frac{\text{B.U.N.}}{2.8}\right) + \left(\frac{\text{glucose}}{18}\right) + 5}{1000}
\]

In conclusion, the finding of an elevated serum osmolality in the acutely injured patient with a history of alcohol ingestion is a significant finding which, if properly evaluated, may have dramatic implications in the diagnosis and management of the injured patient.
TABLE I—SERUM OSMOLALITY AND BLOOD-ALCOHOL

<table>
<thead>
<tr>
<th>Serum osmolality (mosmol/kg.)</th>
<th>Blood-alcohol (mg./100 ml.)</th>
<th>Zero</th>
<th>1–49</th>
<th>50–99</th>
<th>100–149</th>
<th>150–199</th>
<th>200–249</th>
<th>250–299</th>
<th>300–349</th>
<th>&gt;350</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;300</td>
<td></td>
<td>226</td>
<td>9</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>238</td>
</tr>
<tr>
<td>300–319</td>
<td></td>
<td>63</td>
<td>15</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>85</td>
</tr>
<tr>
<td>320–329</td>
<td></td>
<td>21</td>
<td>9</td>
<td>12</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>47</td>
</tr>
<tr>
<td>330–339</td>
<td></td>
<td>10</td>
<td>3</td>
<td>10</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>43</td>
</tr>
<tr>
<td>340–349</td>
<td></td>
<td>3</td>
<td>0</td>
<td>6</td>
<td>10</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>34</td>
</tr>
<tr>
<td>&gt;350</td>
<td></td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>5</td>
<td>21</td>
<td>20</td>
<td>13</td>
<td>7</td>
<td>3</td>
<td>77</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>329</td>
<td>41</td>
<td>44</td>
<td>48</td>
<td>57</td>
<td>23</td>
<td>13</td>
<td>7</td>
<td>3</td>
<td>565</td>
</tr>
</tbody>
</table>

TABLE II—SENSITIVITY AND SPECIFICITY OF METHOD

<table>
<thead>
<tr>
<th>Serum osmolality as test for blood-alcohol</th>
<th>% of false results among positive tests</th>
<th>% of false results among negative tests</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥320 (≥50)</td>
<td>14</td>
<td>7</td>
<td>86%</td>
<td>93%</td>
</tr>
<tr>
<td>≥330 (≥100)</td>
<td>18</td>
<td>7</td>
<td>82%</td>
<td>93%</td>
</tr>
<tr>
<td>≥330 (≥50)</td>
<td>9</td>
<td>14</td>
<td>71%</td>
<td>96%</td>
</tr>
</tbody>
</table>

Of the 195 patients with serum osmolalities of 320 mosmol per kg. or more, 176 (90%) were positive for alcohol. When serum osmolalities of 320 mosmol per kg. or more are considered as a test for blood-alcohols of 50 mg. per 100 ml. or more, only 7% (27 of 370) of the negative results were erroneous (in that they had an alcohol of 50 or more but an osmolality of less than 320) and only 14% (27 of 195) of the positive results were erroneous (in that they had a blood-alcohol of less than 50 and an osmolality of at least 320). The predictive value for various ranges of serum osmolality is summarised in table II.

By regression analysis the correlation between serum osmolality and blood-alcohol was found to fit the equation $y = 2.6x - 750$ with a correlation coefficient ($r$) of 0.88 (see figure).

The time of injury was known for 414 patients, and the time between injury and testing was less than 2 hours for 66% and less than 4 hours for 87%. 43 of the 54 who were tested 4 hours or more after injury had negative blood-alcohols.

**Discussion**

Attention has been drawn previously to the relationship between concentrations of ethanol in the blood and the serum osmolality. Despite sporadic suggestions that the serum osmolality is of value in the assessment of emergency admissions resulting from trauma, its usefulness and validity have never been clearly defined in large numbers of injured patients.

To be of value in blood-alcohol assessment, the serum osmolality must be measured by freezing-point depression, not by vapour-pressure elevation. Measurements of freezing-point depression are accurate ($\pm 1\%$), inexpensive, and take about 2 minutes. The impressive correlation between the osmolality and alcohol concentrations found in our acutely injured patients agrees with reports on other patient populations and with in-vitro measurements.

Other factors that may be encountered in the emergency-room patient can influence serum osmolality. These include dehydration, vomiting, renal impairment, and diabetes mellitus. The effects of chronic alcoholism, which may or may not be associated with hepatic cirrhosis, heart failure, and delirium tremens, may confuse the clinical presentation of acute alcohol ingestion.

Studies on the difference between the observed and calculated osmolalities in acutely ill, as opposed to injured patients, serve to emphasise the presence of predominantly unidentified groups of organic compounds which also raise the serum osmolality. The measurement is also affected by alcohol metabolites such as acetaldehyde and acetic acid, and by the congeners in alcoholic beverages.
Despite these qualifications the alcohol content of the blood remains the factor most likely to affect the osmolality of patients admitted for trauma. The average age of our patients (24 years) makes renal disease and diabetes unlikely. Vomiting and dehydration producing high serum osmolalities within the first few hours after injury are uncommon. Serum osmolality indicates alcohol at the time of measurement (not time of injury) and should be determined at admission, rather than later, both because of the increased possibility of a raised osmolality being due to other factors as time elapses, and also because intravenous infusions and metabolism of the alcohol will lower the levels.

The importance of routine testing is suggested by the fact that almost half of our trauma admissions are positive for alcohol, and 64%, of these have concentrations of 100 mg. per 100 ml. or higher, a level that constitutes presumptive evidence of intoxication in most States, and one which may complicate the diagnosis and management of trauma patients. A blood-alcohol of around 50 mg. per 100 ml. can affect coordination and performance, although not until concentrations of 300 mg. per 100 ml. are reached can physicians consistently identify uninjured individuals as being intoxicated. Alcohol concentrations of about 200 can produce disorientation whilst those over 300 may result in clinical coma. These blood-alcohols relate to serum osmolalities of about 360 and 400 mosmol per kg., respectively, and may be used as a rough guide in the clinical situation.

Clinicians may find tables I and II useful in determining the degree of confidence with which they can use serum osmolalities to assess alcohol status. Although less precise than a 'Breathalyzer', the method compares favourably with disposable breath-testing devices, which generally yield a large number of false results among positive tests. Furthermore, serum osmolalities can be readily determined in most hospitals.

The potential value of this simple rapid estimate of blood-alcohol in the acutely injured patient has significant practical implications. The smell of alcohol on the breath can lead to grave medical errors. A low serum osmolality in these circumstances cautions the physician against attributing to alcohol such physical signs as depression of consciousness. Perhaps, outside the hospital settings, the use of this variable might eliminate the tragic deaths from undiagnosed head injuries which occur occasionally in some city prisons. Alternatively, the finding of a high serum osmolality may remind the physician of the possible role of alcohol when he has not considered it as a factor contributing to the clinical picture. We believe the use of this measurement in trauma patients can significantly contribute to the assessment and management of difficult emergency medical problems.

This work was supported by the Maryland Medical-Legal Foundation and the Insurance Institute for Highway Safety. We thank Brian O'Neil for his criticism and John Nolan and Mark Stiga for their help with the statistics.

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References at foot of next column