Alcohol and Accidental Submersion from Watercraft and Surrounds

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Bacchus hath drowned more men than Neptune

INTRODUCTION

The mechanism of death following submersion in fresh or salt water is classically considered asphyxial in nature, although frequently there is little or no evidence to support this concept at post-mortem examination where a diagnosis of 'drowning' as the cause of death often rests heavily on the history surrounding the event. In the absence of a substantiated history, and from a medico-legal point of view it is important to assess scientifically whether a deceased person recovered from water was alive or dead on entering the water and the length of time the body was in the water. In assisting this assessment we routinely use two supportive aids at post-mortem examination. The tests are very simple and have been of considerable help to us in arriving at an informed and scientifically supported cause of death in many 'drownings'. I am surprised they are not more commonly used and so intend to briefly discuss their use before talking in detail about alcohol and accidental submersion from small watercraft, ocean-going vessels, wharfs, jetties and gangplanks.

Drowning or other Cause of Death?

Durlacher, Freimuth, and Swann, stated that 'in all cases of drowning, irrespective of the salinity, the specific gravity of the left atrial plasma was less than that of the right atrial plasma'.3 Freimuth and Swann on further experience said that 'when a positive value is obtained for the specific gravity difference between the left and right atrial plasmas, after correction for haemoglobin, death was not due to drowning'.5 Our findings in 514 persons dying from accidental and natural causes in Geelong and district are shown in Table I.

The results shown in Table I support the findings of the two studies mentioned3,5 and show that a negative plasma specific gravity less than 0.0030 between the left and right sides of the heart support a diagnosis of 'drowning' as the cause of death when assessed in light of the alleged circumstances of the submersion. Should this difference be positive, it is presumptive evidence that the deceased was not alive when entering the water. These findings apply to both fresh and sea water drownings.

How Long in Water Since Death?

The concentration of magnesium in sea water is of the order of 40.0 to 50.0 m.mol/l. In 'fresh' water lakes from 0.1 to 10.0 m.mol/l. Our reference range for this estimation in 'normal' vitreous humour is 0.1 to 1.0 m.mol/l. In 1974, Adjutantis and Coutselinis1 showed experimentally that magnesium ions could diffuse into the human eyeball after death when it was

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immersed in sea water and that the concentration of magnesium in vitreous humour increased almost in a linear fashion for approximately twenty-four hours. They suggested this observation could be of value in determining the period of time a body had been in the sea since death. On becoming aware of the study we added the estimation of magnesium concentration in vitreous humour as part of our routine post-mortem examination of all deceased persons recovered from water. The results of these estimations are shown graphically in Figure 1.

Figure 1  Magnesium concentration of vitreous humour in 27 deceased persons recovered from either fresh or salt water.
The results of our estimations do not support the opinion of Adjutantis and Coutselinis\textsuperscript{1} that the rate of increase in magnesium concentration in vitreous humour of deceased persons is almost linear in relation to the time of immersion in sea water since death. The estimation however can be valuable as a supportive scientific aid when the concentration of magnesium is raised and provides supplementary evidence in assessing the veracity or otherwise of the alleged circumstances surrounding the submersions of persons found dead in the sea.

### BLOOD ALCOHOL CONCENTRATIONS AND DEATH FOLLOWING SUBMERSION

I have previously reported the circumstances of 142 deaths by drowning which occurred in Geelong and district during the years 1959 to 1974\textsuperscript{9}, and showed that the consumption of alcohol prior to submersion played a major role in the drowning of the seventy-nine males aged 17 years or more included in the study. Of these males 66% imbibed alcohol prior to submersion and 44% had a BAC greater than 0.100% at autopsy.

Geelong is a rural-industrial city and one of the principal seaports for the export of wool and grain from Australia. It has a population of approximately 150,000 persons with an additional 50,000 persons residing in the surrounding district. Yachting and fishing are very popular on the Bay and about the ocean beach resorts in the district. There are twenty-one effective berths for overseas vessels in the Port of Geelong and between 450 to 600 such vessels enter the Port each year.\textsuperscript{12}

The present paper reviews the circumstances of death of the twenty-four males aged 18 years and more, who were submersed either by falling from or accidents to small watercraft, or by falling from a wharf, jetty, gangplank or ocean-going vessel in Port.

The bodies of eighteen of these deceased were recovered in a condition and at a time after death to make the autopsy BAC a valid index of that existing at the moment of death.\textsuperscript{10} Of these deceased, nine died by accident to or fall from small watercraft, and the remaining nine by falling from an ocean-going vessel in port or from a gangplank, wharf or jetty.

The small watercraft included dinghies and powered craft, and most accidents occurred by using these under unsuitable conditions, by overcrowding, or by partaking of foolish activities and in particular that of consuming excessive quantities of alcoholic beverages.\textsuperscript{8,9} It is particularly significant that no 'drowning' resulted from accident to any of the many sailing yachts used for racing on the Bay, despite the great popularity of this sport in Geelong and district.

In Table II the eighteen deceased are divided into two groups depending on the event leading to submersion. Each group is further subdivided according to the BAC present at autopsy.

<table>
<thead>
<tr>
<th>TABLE II</th>
<th>Precipitating event and blood alcohol concentration at autopsy of eighteen adult victims dying as a result of accidental submersion from watercraft or from boarding or disembarking from watercraft</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRECIPITATING EVENT</td>
<td>BLOOD ALCOHOL CONCENTRATION (g/100 ml)</td>
</tr>
<tr>
<td></td>
<td>Nil</td>
</tr>
<tr>
<td>Accident to or fall from small watercraft on bay, ocean or lake</td>
<td>5</td>
</tr>
<tr>
<td>Fall from ocean-going vessel, wharf, gangplank or jetty</td>
<td>–</td>
</tr>
</tbody>
</table>
Table II shows that thirteen (that is 73%) of the deceased had imbibed alcohol and that eleven (that is 61%) had a BAC greater than 0.150% at autopsy. The nine deceased ‘drowned’ as a result of falling from a wharf, gangplank, jetty, or ocean-going vessel all had a BAC greater than 0.150%.

Table III shows the BAC present at autopsy of eighteen males drowned as a result of accidental submersion from watercraft or surrounds and divides the deceased into two groups according to their age.

<table>
<thead>
<tr>
<th>AGE IN YEARS</th>
<th>BLOOD ALCOHOL CONCENTRATION (g/100 ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.001 to .149</td>
</tr>
<tr>
<td>18 to 30</td>
<td>4</td>
</tr>
<tr>
<td>31 to 60</td>
<td>1</td>
</tr>
</tbody>
</table>

The results show that 10 (that is 83%) of the older age group of male victims had a BAC greater than 0.150% at autopsy whereas only one of six males of between 18 to 30 years of age had a BAC above that concentration.

DISCUSSION

Our findings in Geelong concerning submersions and BACs are similar to those of workers in other countries. In 1970, Giertsen reported that ‘in about 50 per cent of the drowning accidents among Norwegian seamen, and in one-third of the drownings among adults in Finland the deceased had been under the influence of alcohol’. An increased risk of falling out of a watercraft together with a decreased ability to properly react to an abnormal situation when under the influence of alcohol undoubtedly play a part in the many fatalities due to submersion which occur to persons who have imbibed alcohol. There are however many such ‘drownings’ where death appears to occur very suddenly and almost inexplicably as shown by the following case in this series: A 57-year-old healthy man was fishing from a small boat drifting in calm shallow water on the Bay. He was accompanied by his brother-in-law and each drank about 16 glasses of beer and five pots of beer during the day. At dusk when returning to the jetty, the deceased, who was a strong swimmer accidentally fell overboard and ‘just disappeared’. His body was recovered the following morning. His BAC at autopsy was 0.255%.

The circumstance of the above death is typical of many unexpected drownings in adults where an otherwise healthy person does not appear to struggle or surface following immersion, and even if recovered immediately and easily is found to be dead. Such ‘drownings’ are not all associated with the consumption of alcohol, but a raised BAC does appear to have played more than just a coincidental part in many of these deaths. I consider also that a significant finding in this survey, and reported previously, is that a high BAC occurs more frequently in deaths due to submersion in males aged more than 30 years of age than in deaths due to submersion in persons less than 30 years of age (Table III). This finding is opposite to that occurring in motor vehicular accidents where the younger age group are those in which a high BAC has been a factor in the accident.

The mechanism of virtual immediate death on immersion is undoubtedly varied and occurs also in young persons who have never imbibed alcohol. It is probable that the common cause is a reflex, sudden cardiac arrest resulting from a sudden rush of water into the nose or upper air-passages. In addition there is seldom evidence of water entering the lungs or
stomach of these deceased and death appears to have been instantaneous and accompanied by reflex spasm of the glottis. Other factors as cold water, a ‘state of tension’, or sudden fright may undoubtedly play their physiological part on some occasions. It does appear however that whatever the precipitating mechanism, the prior consumption of alcohol does play more than a coincidental part in many such deaths, particularly in the older age group. The editors of Gradwohl’s *Legal Medicine* (1976) very easily state that the mechanism ‘is usually some element which might be called a “state of hypersensitivity”, not uncommonly alcoholic intoxication’.

Finally, publicity is given to the dangers of swimming after a heavy meal or heavy exercise — it is probably far more important to warn the public, particularly those over 30 years of age, to take great care and not to risk falling from a watercraft or to go swimming if imbibing alcohol. We could quote also the old English proverb to them: ‘Bacchus hath drowned more men than Neptune’.

REFERENCES