

## Drowning under the influence of drugs and alcohol

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### Background

Alcohol is considered the most important single risk factor for drowning. Individuals under the influence of alcohol are more likely to fall into the water, to swim or boat in dangerous situations, to operate a boat improperly; and once in the water, their capacity to swim or survive can be significantly hampered. Moreover, alcohol may hamper decision-making regarding safety. The relation between drowning and alcohol has been documented in different countries and various settings, with most studies reporting 25% to 50% of drowning as alcohol-related. While the role of alcohol in drowning has been extensively investigated, little is known regarding the presence of other drugs in drowning victims, although central nervous system drugs may hamper psycho-motor performance and cognitive functions in a variety of critical tasks involved in water activities. Finnish law (459/73) allows an extensive medico-legal investigation into cause of death, with virtually 100% of drowning undergoing police investigation and a full medico-legal autopsy, including toxicology. Thorough post-mortem investigations seek to verify the diagnosis of drowning and to assess contributing factors leading to the fatal outcome in each drowning case.

### Aims

The main aims of the present study are to investigate the proportion of alcohol and drug-positive drowning cases, the nature of drugs found in victims' blood, and the role of psychoactive drugs and alcohol as factors contributing to drowning.

### Material and methods

Retrospective analysis of toxicological findings in drowning cases occurring in Finland from 1 January 2000 to 31 December 2009. All drowning cases for which a toxicological analysis was performed were selected for analysis by use of the ICD-10 'nature of injury' code for drowning (T75.1) from the database of the Laboratory of Toxicology, Department of Forensic Medicine, University of Helsinki, which carries out by statute post-mortem alcohol analysis and all other toxicology for the entire country. Blood alcohol (BAC) and drug concentration were investigated by intent of drowning (unintentional, suicide, homicide) and a set of victims' individual variables and circumstantial factors.

### Results

Toxicological analysis was performed in 2828 drowning cases, of which 2058 were unintentional, 547 suicides, 11 homicides, and 212 undetermined. BAC analysis was performed on all victims (0 to 93 years old, M: F RR: 3.5). Among all drowning victims, 1451 (51.3%) had a BAC  $\geq$  0.5 mg/dl, and 1131 (40.0%)  $\geq$  2.0 mg/dl.

Screening for drugs other than alcohol was performed on 2013 (71.2%) drowning victims. Among the victims tested, 1118 (55.5%) tested positive for at least one drug other than alcohol in the blood. In 839 (41.7%) drownings, a central nervous system (CNS) drug was identified, and in 279 (13.8%) another drug, mostly for the cardiovascular system. Among cases testing positive for nervous-system drugs, 378 (45.1%) tested positive also for alcohol, and 284 (33.8%) had a concentration exceeding the therapeutic range. Only 20 cases (1%) were positive for illicit drugs (amphetamine, tetrahydrocannabinol, gammahydroxybutyrate). The potential role and mechanisms of alcohol and psychoactive drugs in events leading to drowning are evaluated and highlighted.

### Conclusions

Psychoactive drugs, which, in addition to alcohol, may hamper psychomotor performance and cognitive functions, are detectable in a thus-far unreported high percentage of unintentional drowning victims. Alcohol and psychoactive drugs may play an additive role in events leading to boating- and non-boating-related drowning. Drowning prevention efforts should consider the risks related to combined use of alcohol and drugs in water settings, as is the practice for land traffic injuries.

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