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Alcohol and Diving

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Abstract

Alcohol is a known hazard for its impairment of physical and cognitive performance. While its use is generally accepted as incompatible with diving activity, written policies vary substantially among institutions. In this study we examined the available policies for eleven organizations in the US and abroad. Manuals available online were used, while for large organizations (e.g. NOAA) they were solicited directly. Where no written standards exist, it is possible that policy makers rationalize the issue as being adequately self-regulated or too difficult to regulate. These positions are untenable since the available literature implicates alcohol as a contributing factor in numerous diving incidents. The written policies we reviewed were found reflect one or more of the following elements: evaluation of diver history with alcohol, specific proscription and punitive actions, monitoring requirements and, less commonly, preventative and educational initiatives. We recommend that best practices for the scientific diving community should include specific direction on each of these elements, in addition to reinforcing a culture to separate alcohol from diving activities.

Keywords: alcohol, alcohol consumption policy, diving

Introduction

History of Study

Alcohol is known to impair judgment and physical performance. Problematically, the slow rate of metabolization and elimination in humans, on the order of $9.0 \text{ g}\cdot\text{h}^{-1}$ ($0.3 \text{ oz}\cdot\text{h}^{-1}$) of pure alcohol, depending on size, can produce prolonged effects. Alcohol consumption has long been at least tacitly discouraged in conjunction with diving activity. Alcohol acts as a central nervous system depressant, slowing response time and compromising performance in complex situations, such as many emergent events. Alcohol may also play a role in diving situations by potentiating narcosis (Jones et al., 1979; Fowler et al., 1986; Hobbs, 2008). Increases have been reported in nystagmus-induced disorientation (Hamilton et al., 1989) as well as motor and general vision impairment (Howland and Hingson, 1988). Alcohol has also been found to alter the diving reflex, specifically inhibiting nominal heart rate decreases and altering autonomic nervous system response (Wittmers et al., 1987). Pilot research has suggested that individuals who respond strongly to alcohol may also be more susceptible to narcosis (Monteiro et al., 1996). It is unclear how to interpret a study of commercial, saturation divers in which regular consumers of alcohol were found to have more normal electroencephalograms than their non-drinking counterparts (Todnem et al., 1991).

The influence of alcohol on decompression safety is complicated and incompletely understood. Certainly, impaired decision-making and/or inattentiveness could increase the risk or slow proper

response through the masking of symptoms. A pattern of drinking that produces a relative dehydration could also theoretically increase the risk of decompression sickness (DCS), although the magnitude of this hazard remains unclear. Pattern of alcohol use has not been shown to be associated with DCS risk in limited retrospective self-reported data (Dowse et al., 2002, Hagberg and Ornhagen, 2003; Trevett et al., 2003). Even more controversial is an animal study that reported a therapeutic benefit of ethanol treatment post-dive (Zhang et al., 1989). In this case, rabbits were exposed to a pathological decompression from 6 ATA to 1 ATA. The untreated group suffered 50% mortality within 15-35 minutes of surfacing. The experimental group receiving 25% ethanol intravenously upon surfacing had no mortality. An unconfirmed report by the same authors claimed a similar benefit in human divers (Zhang et al., 1991). An attempt to validate these effects through a controlled chamber study of humans found no impact of post-dive alcohol ingestion on bubble formation (Eckenhoff and Olstad, 1991).

While the possible biochemical interaction between alcohol and decompression stress warrants further investigation, such work must be approached carefully. The line of investigation of Zhang et al. (1989) certainly drew rapid and critical comment (Eckenhoff, 1989). Most importantly, any research on biochemical effects should not detract from the primary concerns of impaired decision-making and diminished physical performance that can undoubtedly create great overall risk to the compromised diver.

Need for an alcohol policy for diving

Given the known negative effects of alcohol, there is cause for concern on the part of the dive supervisor if a diver has been drinking. Based on recreational dive community surveys, alcohol is often consumed within temporal proximity to diving activity (Dowse et al., 2002; Trevett et al., 2003). While the impact on diving operations is typically unknown, studies in other fields of physical activity have identified problems. One recreation-based study found that alcohol was a factor in various sports injuries (Schmitt and Gerner, 2001). The mortality rate in general of alcoholics is between 2.5 and 8-fold greater than non-drinker baseline risks (Smith and Kraus, 1988). Alcohol is often a factor in recreational near-drowning incidents. There is a dearth of alcohol-related data collected post-incident in the occupational setting (Smith and Kraus, 1988).

Some governmental organizations have experienced fatalities in diving programs which have prompted examination of alcohol policies. Examples include National Oceanic and Atmospheric Administration (NOAA) following an incident in the Dry Tortugas (NOAA, 2008) and the US Coast Guard following an incident on the *m/v Healy* in Alaska (USCG, 2007).

Range of Possible Policy Positions

Diving program requirements must cover a range of exigencies. For alcohol and diving, there are a range of issues that can be considered, including:

1. history of alcohol use/abuse (related or unrelated to diving) as a predictor of future problems;
2. impairment window, timing over which consumption of alcohol could affect the diver or dive operations;
3. monitoring procedures to identify signs of alcohol use by personnel; and
4. strategies to develop a culture that limits alcohol use.

Methods

The published safety manuals for organizations with scientific diving programs were reviewed from September to December 2011 for the presence or absence of alcohol-related policies specifically

pertaining to diving activity. This review was conducted in an opportunistic fashion for organizations recognized as setting industry standards, such as the American Academy of Underwater Sciences (AAUS, 2011) and the Association of Diving Contractors International (ADCI, 2011), those with large diving programs such as NOAA, and those discovered through professional contacts to have written policies. Four primary areas were evaluated:

1. diver history inquiry (e.g., written responses to a medical questionnaire);
2. dive policy with respect to impairment discovered on the dive platform;
3. random testing requirements; and
4. preventative measures.

If alcohol policies were conjoined with other drug-related policies both are presented.

Results

The organizations for which written policies were reviewed are listed in Table 1.

Table 1. Survey of Dive Program Policy

Organization	Alcohol consumption query on medical questionnaire	Written policy addressing worksite impairment	Written policy for random testing	Preventative Standards
EPA	X			
NOAA	X	X	X	X
AAUS	X			
CRA-DFG	X			X
ADCI	X	X	X	
USN				
U Queensland				X
Reef Check Aust				X
U West Aust	X			X
DOI	X		X	
USCG	X			

EPA - US Environmental Protection Agency; NOAA - US National Oceanic and Atmospheric Administration; AAUS - American Academy of Underwater Sciences; CRA-DFG - California Resources Agency and Department of Fish and Game; ADCI - Association of Diving Contractors International; USN - US Navy; U Queensland - University of Queensland; Reef Check Aust - Reef Check Australia; U West Aust - University of Western Australia; DOI - US Department of the Interior (including National Park Service [NPS], US Geological Survey [USGS], and US Fish and Wildlife [USFW]); and USCG - US Coast Guard. All manuals and publication dates are cited in the reference section of this paper.

Existing Dive Policies on Alcohol Consumption

AAUS has long been recognized as the primary standard setting organization for scientific diving in the US. AAUS standards include some medical questionnaire coverage on alcohol consumption patterns, but do not address other items such as onsite screening, testing, or preventative standards (AAUS, 2011):

Conditions Which May Disqualify Candidates from Diving (adapted from Bove, 1998)
 " Substance abuse, including alcohol."

Appendix 3
 Diving Medical History Form
 (To Be Completed By Applicant-Diver)

"5. Substance abuse, including alcohol. Yes No"

AAUS members have the option of adopting the standard text or replacing text detailing different institutional standards. It is noted that many AAUS organizational members surveyed adopted the standard AAUS text noted above. AAUS organizational member standards were not included in this paper unless their approach differed from the AAUS 2011 standards. It is noted that the presentation of the "substance abuse" question on the AAUS medical questionnaire leaves an individual diver to qualitatively assess the normalcy of their personal alcohol consumption rate. It is highly unlikely that this qualitative self-report would produce consistent results in identifying potential problems.

The NOAA dive program is the largest civilian diving organization within the US federal government, and includes both scientific and working dives. NOAA's scientific diving training and certification standards requirements directive introduced a program of random drug and alcohol testing (NOAA, 2011a). This was the most comprehensive program encountered amongst the diving organizations surveyed. For NOAA working divers, the NOAA Working Diving Standards and Safety Manual (NOAA, 2011b) required drug and alcohol testing as well:

"D. A verified positive drug test for any employees for which diving is not included in their position descriptions will result in denial of initial diving certification or, if already certified to dive, termination of NOAA diving privileges.

E. Specific information on the drug testing program is outlined in the US Department of Commerce (DOC) Drug-Free Workplace Plan and the DOC Drug and Alcohol-Free Workplace Testing Guide; both can be downloaded at hr.commerce.gov."

The NOAA Working Diving Standards and Safety Manual (NOAA, 2011b) also includes prohibitions to avoid dive site impairment:

3.6.2 Temporary Suspension.

"8) Reporting to the dive station mentally or physically impaired due to alcohol or other substance abuse;"

5.2.6 Fitness to Dive.

"C. Divers exhibiting any effects of alcohol or substance abuse shall not be permitted to dive and will have their diving certification temporarily suspended or permanently revoked from diving pending review by the NDCSB."

Beyond consequence-related policy, NOAA (2011b) has policy to prevent impairment on the project site:

5.2.6 Fitness to Dive.

"B. Divers should refrain from alcohol consumption for a minimum of 12 hours prior to diving..."

US Federal agencies, including NOAA, EPA (EPA, 2010) and Geological Survey (USGS, 2008), require divers to complete a medical history on a yearly basis. The approach is semi-quantitative, reducing the respondent's need to make a judgment regarding abuse (NOAA, 2012):

"Drink alcoholic beverages (how much)____ Yes/No"

Numerous organizations question divers on alcohol consumption when medicals are performed, at a frequency of two to five years for USGS (2011), USFW (2011a;b) and others.

California Resources Agency and Department of Fish and Game (CRA-DFG, 2005) employs a similar approach to NOAA with respect to a preventative standard:

2.33 Diving Under the Influence of Drugs or Intoxicants

"Alcoholic beverages will not be consumed eight hours before any dive."

The University of Queensland provides proscriptive rules, guidelines and explanation (University of Queensland, 2010):

8.27 Alcohol

"Alcohol should not be consumed within 12 hours prior to diving, and must not be taken until after any diving for the day is over. At all times, especially when diving over multiple days, alcohol should only be consumed in moderation, if at all. Alcohol consumption will increase a diver's susceptibility to decompression illness, enhance the effects of inert gas narcosis, and increase a diver's rate of heat loss in cold water."

Reef Check Australia (RCA, 2010) and the University of Western Australia (UWA, 2010) both prohibit alcohol ingestion 12 hours prior to diving. The University of Western Australia safety manual incorporated the following recommendations (UWA, 2010):

"The dive tables and computers are to be used even more conservatively if the diver is subject to conditions which increase the possibility of decompression illness (i.e., dehydration, alcohol consumption, age, excessive fat tissue, injury, tiredness or strenuous exercise before, during or immediately after a dive)."

The US Navy diving manual (USN, 2008) includes the following explanatory text regarding alcohol:

3-10.4.4 Prevention of Hyperthermia

"... Adequate pre-dive hydration is essential. Alcohol or caffeine beverages should be avoided since they can produce dehydration."

11-5.1 General Precautions for Ice and Cold Water Operations

"... Dives should be well rested, have a meal high in carbohydrates and proteins, and should not consume alcohol. Alcohol dilates the blood vessels in the skin, thus increasing heat loss."

ADCI is recognized as the standards setting organization in the US for commercial diving. ADCI did not have any alcohol-related policy specifics within their consensus standard, instead noting that member organizations shall have a policy with respect to alcohol and drugs (ADCI, 2011):

2.3.6 Disqualifying Conditions

"A person having any of the following conditions, as determined by a physician's examination, shall be disqualified from engaging in diving or other hyperbaric activities.... Chronic alcoholism, drug abuse or history of psychosis."

5.3 Drug and Alcohol Screening

- A pre-employment drug screening program shall be in place.
- A routine, random and 'for cause' drug screening program shall be in place."

All US Department of Interior (DOI) divers (USGS, National Park Service, etc.) likewise have a random testing policy:

"(2) Take a drug test administered in accordance with 370 DM 792.9 and 792.10 for which a negative drug test is received prior to appointment. Once employed, the diver will be subject to the DOI's random drug testing program." (personal communication, M. Blouin, USGS, 2012).

Discussion

We reviewed written policies on alcohol and diving from 11 standards-setting diving organizations. Specific policies may not be a priority for organizations conducting the majority of their dive operations on a "dry" (alcohol-free) vessel at sea for weeks at a time, such as the EPA, NOAA and the military. The state of enforced abstinence applies fully to diving activity. Similarly, organizations such as the military may have an umbrella "no alcohol policy" that encompass all on duty activities. Only organizations with specific written diving-targeted prevention policies are discussed here. The effects of unwritten policies or expectations for alcohol consumption were not evaluated. These could range from verbally conveyed "everyone stops drinking when the divemaster does" or informal drink limits or rates of drinking.

Alcohol impairment may be obvious or less so depending on the presentation of the individual and the level of training that the dive site supervisor possesses, making a dive site standard difficult to reliably enforce. A dive partner or supervisor may not be able to discern subtle alcohol impacts in a diver until performance is substantially impaired. Further complicating this issue, rough sea states can obscure a supervisor's ability to evaluate a diver's gait or ability to discriminate between alcoholic impairment and motion sensitivity. Dive supervisors may also be reluctant to take a diver aside for a field neurological exam to look specifically for indicators of inebriation, such as signs of nystagmus, even though such tests take minutes for a practiced administrator and would not be expected to unreasonably delay dive operations (NHTSA, 2011). The odor of alcohol or ketoacidosis indicating incomplete metabolism of alcohol could be missed in a scent-rich or well-ventilated environment. Cultural norms and chain of command issues may make it uncomfortable for a dive supervisor or partner to ask or challenge responses to questions regarding drinking prior to diving raised in a pre-dive briefing.

With respect to medical questionnaires, it is unclear whether the majority of divers in any program have an understanding of what "history of abuse" actually constitutes. Does this refer only to individuals with a medical diagnosis? To those that have undergone treatment? The annual questionnaires of NOAA and EPA, for example, notably avoid this confusion by simply asking the diver how much they consume on a regular basis, then leaving it to the medical professional to interpret. This contrasts the AAUS questionnaire that asks individuals to characterize their

consumption as to whether it constitutes abuse. One might argue that wording the question with "abuse" might encourage a "no" selection whether or not this is accurate.

Liability and risk management are often issues when discussing the ability of a dive organization to meet an industry standard, or when falling short of an industry standard. Part of a good risk management campaign is a significant effort at education of dive professionals and divers (Nimb, 2004). Educational policies with respect to the risks of alcohol and diving were not evidenced in the written dive safety policy of any of the 11 organizations surveyed. Though it can be surmised that what is contained in a diving organization's written policy would be conveyed in an initial training and ongoing education settings, this is among other important issues that could be formalized into a training program. Lastly, given the highly variable nature of alcohol policies among the organizations surveyed worldwide, ostensibly being on the less stringent end of the continuum of written policy and lack of any formal educational process may imply a higher risk of liability, should an accident occur.

The regulation of diver off-duty hours can present substantial difficulties, especially in land-based, non-military operations. This is problematic since it is not uncommon that diving accidents are reported with alcohol being ingested within hours of diving (NOAA 2001; Vann et al., 2006; Pollock et al., 2007; 2008). This runs counter to the call for 12 hours of abstinence that was the most common of any time restriction. No written policy attempted to quantify an acceptable amount of alcohol consumption. The most effective strategy to affect off-hour activities is the establishment of cultural norms decrying alcohol ingestion during the span of diving activities. Prohibition based on example and peer expectation is likely to be important to convey expectations to divers for "unpaid" hours. This should be supported by clearly documented policies.

Recommendations

Key elements of the written alcohol policies identified in this review included: rules regarding pre- and post-dive consumption, random testing, questions regarding history of drinking, and a written policy on impairment evident at the dive site. Clearly, a "no alcohol" consumption policy aboard research vessels or within working units obviates the need for more detailed policies, however, such inclusive restriction is difficult to enforce for land-based operations which encompass "off-duty" diver time. Clear and specific policies are required to ensure appropriate practice in less controlled circumstances. The obvious missing element in the alcohol policies reviewed was diver education. An awareness of both obvious and less obvious hazards of alcohol and the prolonged window of impairment should be included in initial training and reinforced through operational culture. Reinforcing positive cultural norms may effectively establish expectations regarding alcohol that can encourage peer support of proper behavior.

Written alcohol policies should include the following:

Alcohol consumption prohibitions

- 1) Pre-dive to avoid systemic effects
- 2) Post-dive to avoid symptom masking

Monitoring practices

- 1) Periodic assessment of alcohol use patterns
(for example, at hiring and/or volunteer screening, as part of an annual review with medical/health questionnaire and/or following alcohol-related incident)
Note: questions should be in quantitative versus qualitative form to allow medical professionals to assess the meaning of the data
- 2) Random testing

Intervention options

- 1) Counseling

- (including response to monitoring concerns and mandated and voluntary access)
- 2) Punitive actions for violations in prohibition and/or refusal to participate in random testing program
(for example, loss of diving privileges, employment suspension and/or termination)
 - 3) Restoration of status following punitive action
(return to diving requirements such as counseling or treatment programs)

Education

- 1) Initial diver training (working and scientific) should include discussion of alcohol effects, institutional rules including prohibitions, incident reporting and penalties for violation
- 2) Dive supervisor training should include the topic provided for initial diver training, plus specifics on evaluating divers, incident reporting, and strategies to promote a culture to minimize alcohol-related incidents
- 3) Training updates should include regular reminders to staff (for example, pre-dive briefings, staff memoranda and meetings)

Disclaimer: This paper is an illustration of steps that diving control boards might take to minimize the risk of injury related to alcohol consumption and is not the official view of the USEPA diving safety board. Mention of any specific brand or model instrument, material, or protocol does not constitute endorsement by the USEPA.

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