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The Alcohol Hangover And Its Potential Impact On The UK Armed Forces: A review Of The Literature On Post-alcohol Impairment

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ABSTRACT

Objective:

To raise awareness within the Defence Medical Services regarding the potential effect of post-alcohol impairment / alcohol hangover.

Method:

Literature relating to post-alcohol impairment / alcohol hangover, and the evidence for impairment is reviewed, with discussion relating to UK Armed Forces.

Conclusion:

The evidence for performance impairment during alcohol hangover is not conclusive. Until further evidence is available policy should acknowledge the potential for impaired functioning, particularly the morning after a heavy drinking session, and even when blood alcohol has returned to zero. Recommendations for clinical practice and areas for further research are presented.

Introduction

The acute effects of alcohol have been studied extensively. Admiral Jellicoe quoted in 1915 “the shooting efficiency of the men proved to be 30% worse after the rum ration than before” (1). The hangover (much experienced) has been under researched.

Although studies from 1901 and 1904 finding impairment during the hangover are discussed by Takala in 1958 (2), a recent review found only 108 articles on the Medline database that addressed various aspects of the alcohol hangover (3). Articles often make little distinction between post-alcohol impairment when blood alcohol is zero and ‘morning after’ effects when this might not be the case.

Within the Armed Forces post-alcohol impairment, research has been limited to pilots. Despite the lack of research the British Army has acknowledged the concept of impairment during hangover, including it in advice to Commanders as part of an education programme on alcohol. This is designed to improve professionalism and increase personal responsibility, in a move away from what is thought of as a traditional drinking culture (4). This advice has recently been updated (5, 6).

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This article reviews the epidemiology, economic cost, and role in adverse events of the alcohol hangover. Various organisations’ policies on alcohol misuse are clarified. The alcohol hangover and effects of congeners and fatigue are discussed. The literature on post-alcohol impairment is critically reviewed and possible future directions for research proposed.

Search strategy

1. Personal communication with one author, and a manual search of references for articles.
2. Literature distributed to Junior Commanders in the British Army.
3. Personal communication with researchers involved in a survey of alcohol use in the British Army.
4. An initial search of PsycLIT 1991-98 for English language reports, using key phrase identifiers: alcohol / performance, alcohol / cognitive ability, post-alcohol / cognitive function.
5. An EMBASE Psychiatry 1987-2001 search (using Ovid). Terms searched: hangover, alcoholism/alcohol-induced disorder combined with psychomotor performance, alcohol/alcohol abuse/ alcohol blood level/alcohol consumption /alcohol withdrawal / alcohol intoxication combined with motors performance/ psychomotor performance/task performance /job performance/ mental performance.
6. A Pre-Medline / Medline 1966-2002 search, using the Achoo search engine. Term searched: hangover.
7. A Cochrane Library search to the present day. Using terms: alcohol / performance, alcohol drinking / alcohol-induced disorder / alcohol intoxication.
8. An NHS Centre for Reviews and Disseminations database search.

Epidemiology

The General Household Survey in 1992 reported 27% of males and 11% of females drank more than the recommended weekly limit (the Governments current recommended healthy drinking limits are 28 units of alcohol per week for men and 21 units per week for women). In doing so they doubled their risk of sickness, and 4% of males had taken time off work with a hangover in the previous 12 months. The

OPCS 1991 report showed that 7% of men admitted working below par because of drinking (7). In the three months prior to an earlier survey 7% of males reported having a hangover at work, and 70% of these were classified as moderate or light drinkers (8).

Studies in the United States report that 15% of men and women experience hangovers every month (3). The United States Air Force puts the rate of alcohol problems in its service personnel at 14% (9).

Economic

The effect of the alcohol hangover on work efficiency, and estimates of economic cost, are difficult due to limited data and the difficulty of separating hangover effects from those relating to alcohol in general. What data exists suggests extensive inefficiency and cost.

Most alcohol problems (including hangover) at work occur in the light to moderate drinking groups, as they are more numerous, at an estimated economic cost to the UK of between $90 million to $3 billion (8). This compares with 12% reported reduced efficiency days, as a result of drinking or its after-effects, which contributed to a total loss of productivity estimated to cost $57 million per year in New Zealand (10). In Canada this figure is about $7.5 billion, of which $1.4 billion is attributed to hangover (3). In the United States the National Institute on Drug Abuse and National Institute on Alcohol Abuse and Alcoholism estimate that the total cost of alcohol abuse is $148 billion per annum (this includes all alcohol related costs not simply those as a result of hangover) (11).

Adverse events

Reviews on hangover have examined its role in accidents:

In 1988 Gibbons discussed post-alcohol impairment, and positional alcohol nystagmus, (PAN: is an observable manifestation of unusual labyrinthine involvement that occurs after ingestion of alcohol without external stimulation). He reports work by Wise 1979 reporting decrements of performance 14 hours after ingestion of alcohol, then reviews PAN postulating its role in some specific aviation accidents.

A causal relationship is suggested. Some evidence is dismissed on the basis that the subjects were tested on less complex tasks (12).

Kolstad 1992 confirmed the role of alcohol in transportation accidents, and includes comment on the limited research on impairment during hangover (13).

Among alcohol related accidents a subsequent peak is found between 08.00 and 10.00 hrs, perhaps associated with hangover (8).

Hangover is shown to impair athletic performance by 11.4% and may have a role in increased injury risk. There is even a higher risk of cardiac arrhythmias when suffering from hangover if one takes a sauna (14, 15).

The British Army

Surveys in the British Army have identified problems relating to alcohol (16). Reports include comment on: the need for sobriety at work; the effects of hangovers; poorly understood aspects of alcohol e.g.: time for recovery, (65% of soldiers felt 7-8 pints was a heavy drinking session, only 34% recognised the need for more than 12 hours to recover). These findings support research on pilots in Cook's review (9). Pilots over estimate the drinks required to reach blood alcohol limits, and overestimate alcohol elimination to reduce blood alcohol levels. Soldiers also felt that physical exercise would work the alcohol out of the system more rapidly, having no concept of the increased stress and dehydration.

In response to the surveys, and as part of a wider program of change, Commanders were issued with 'The Junior Commander's Guide to Alcohol Misuse' in 1998(4). This document has been superseded by 'Alcohol and Drug misuse, Commanders Guide', and a document for soldiers 'Alcohol and Drugs, the Facts' (5, 6). These documents do contain some information on hangovers:

'hangovers the following day often meant that soldiers and officers were not in a position to perform their duty safely or professionally…. the days when such behaviour was acceptable are long gone.'

The focus is on personal responsibility and the document goes on to describe policy (Section 43/1 of the Army Act 1955); that it is an offence to be unfit for duty through drink. The guide states that responsible, professional soldiering requires all serving personnel to conform to sensible blood alcohol concentration (BAC) limits:

- For driving and normal duties Army guidelines are a limit of 80mg of alcohol (per dl of blood).
- For safety critical duties, activities like range work, guard duty, handling dangerous machinery etc, you should not have any alcohol in your blood at all.

As regards fitness Commanders are advised: 'Do not punish hungover soldiers with extra PT as it could kill them'.

(In the UK being under the limit does not mean you cannot be prosecuted. If the police can prove that your ability to drive was affected by alcohol you can still be

charged with attempting to drive or being in charge of a vehicle, while unfit through drink.)

These documents are an excellent move, away from the previous drinking culture within the services.

Alcohol policy in other organisations

The British Army is not alone in having policy based on BACs, and advice on the detrimental effects of hangover. One fifth of large employers in 1994 had alcohol policies, although there were more smoking policies (7). The United States Federal Aviation Administration (FAA) maintains its 8 hours 'bottle to throttle' rule. The civil aviation regulations require that crewmembers shall not consume alcohol less than 8 hours prior to the specified reporting time for flight duty or commencement of standby, and shall not commence a flight duty period with a BAC in excess of 20mg% (17). London Underground also has an 8 hour 'bottle to tube' rule, with a limit of 7 units in the previous 16 hours. The Royal Liverpool University Hospital NHS Trust considered an 8-hour rule for employees, but this was changed to 'staff must report for duty fit to work' in response to staff dissatisfaction (7). On a national scale, as a result of published research, Sweden produced brochures and took out full-page adverts in local newspapers to warn of the risks of hangover impairing driving performance (18).

The Hangover

Kerr and Hindmarch (1998) state: 'the effects of alcohol on performance are very variable at low doses (under 1g per kg body weight). The variability is due to the different measures and methods employed by researchers and to the large interindividual and interoccasional differences in the effects of alcohol. That is, alcohol affects different people in different ways, and it affects the same person differently on separate occasions'(19). Wiese would also include hangover as a subjective experience that varies from person to person and episode to episode, there is little correlation between subjective analyses of hangover and impairment. Psychosocial factors are better predictors of symptoms of hangover than the amount of alcohol drunk (3, 18, 20).

Wiese reviews the many physiological aspects of hangover. The review stops short of a formal meta-analysis as the studies are few in number and not similar in design or hypothesis (3).

Other reviews report studies that show impairment, and studies for which no evidence was found of post-alcohol impairment. In those that do not report impairment it has been suggested that this was because they utilised tasks that were too simple. Most of the research relates to pilots and cannot be generalised to other employment.

Congeners

A review on hangover would not be complete without mention of congeners. These are by-products of preparation of individual beverages e.g.: methanol, esters and aldehydes, found in brandy, wine, tequila, whiskey and other dark alcoholic beverages. They have been implicated in the pathogenesis of hangover. Controlled clinical studies by Collins and Chiles 1980, and Dowd 1973, on various different alcoholic beverages containing different levels of congeners did not support this hypothesis, but used low doses of alcohol. Controlled trials by Chapman 1970 and by Parwan 1973 supported the hypothesis using higher doses of alcohol, reporting that congeners increased severity of hangover symptoms. Other trials reviewed used high doses of congeners confirming their role in severity of hangover, and showed effects on risk taking, the electroencephalograph (EEG) and nystagmus. All the trials were small and there were no randomised-controlled trials. Although it appears that congeners affect hangover severity it is not clear to what extent they influence post-alcohol impairment and more research will be needed (20, 21).

Fatigue

Fatigue is often an important additional factor in hangover. Krull (1993) found that sleep deprivation reduced reaction time (22). Roth and Roehrs (1996) reported drugs as one of the four causes of excessive daytime sleepiness; this increases the risk of accidents and reduces work performance (23).

Lamond and Dawson (1999) compared alcohol, non-alcohol and fatigue in a small controlled trial. They found that moderate fatigue (20-25hrs) produced performance impairment at the same levels as alcohol intoxication deemed unacceptable when driving and/or operating dangerous equipment (24).

No evidence for impairment?

Collins and Chiles (1980) also reported a controlled clinical trial on 11 pilots using a Multiple Task Performance Battery and tracking tasks in a laboratory. Subjects were tested 8 hours later, the morning after alcohol ingestion; they had slept for 4-5 hours. Hangovers were reported. Beyond small circadian effects there was no impairment due to alcohol, no congener effects and no evidence contrary to the

FAA 8-hour rule (21).

They reviewed previous work. This consisted of seven case series: four reported no effect of hangover on performance; three suggested impairment at 12 hours or more post-alcohol consumption. Variable amounts of alcohol were given in different forms, with different outcomes measured. Two controlled clinical trials were reviewed; one with an unusual methodology (Seppala 1976) showed impairment in choice reaction time. The addition of sugar appeared to improve choice reaction time but impaired co-ordination skills during hangover. The second controlled trial showed no detrimental effect, both the controlled trials were small and there was limited analysis to account for the multiple comparisons made in the first trial (25).

Collins (1980) extended his previous work; in a small controlled trial he found no impairment of flight simulator performance 8 hours after ingesting alcohol, at simulated altitude (12000ft). Once again the alcohol dose was small and the tasks relatively simple (two dimensional tracking task and reaction time) (26).

The United States Federal Aviation Authority employed Collins; this could represent a conflict of interest. He does note that in both his studies results should be interpreted with caution, as his subjects were well motivated, the tasks were performed without other stresses that would occur during flight and that higher BACs might give different results.

There are two randomised-controlled trials on this subject. Lemon (1993) studied simple reaction time, vigilance tests and divided attention while intoxicated and the morning after. He failed to find any impairment the morning after. These results are perhaps an indication of the test complexity rather than of impairment as during intoxication there was only statistically significant impairment for divided attention, with only a trend of impairment in the other tests (27). Finnigan *et al* (1998) tested 40 subjects aged between 18-45 at a peak BAC just above the limit for driving; the following morning there was no impairment in performance. Subjects did report subjective symptoms and an effect on sleep quality. The conclusion was that: if no alcohol was left in the blood after a dose of 100mg/100ml, and the individual does not feel hung over they will generally be fit to drive. The conclusion is unhelpful as; a higher dose may have caused post-alcohol impairment, at a lower dose the individual may have been fit to drive that night (28). This highlights the difficulty of choosing a dose of alcohol to study.

In two articles reporting several trials (one of which appears to be reproduced in both) researches were attempting to measure impairment as a result of alcohol and post-alcohol using a computer test, the Automated Performance Test System (APTS). Using the APTS they tested various levels of BAC, and included hangover, and produced alcohol equivalents, i.e. scores on the APTS that correlated to various BACs. They found no impairment during hangover, which was explained as an effect of learning as the subjects had been tested on several occasions. The authors who designed this test had hoped it would correlate well with the Armed Services. The Vocational Aptitude Battery (ASVAB) is a cognitive test of military aptitude that should correlate to operational performance, a test not designed for serial use. Unfortunately the APTS proved insensitive to lower BACs. The small study did not have a control group, they used a modified version of the ASVAB rather than the full ASVAB, and as the APTS was being actively developed during the series of trials they may not have been using the same test throughout (29, 30).

The study by Takala in 1958 found a small hangover effect, but he concludes that this is probably associated with lack of sleep (2). Three further studies using lower doses of alcohol found no effect on surgical skills, managerial tasks or repeated tasks (boredom possibly having a detrimental effect on performance) (31, 32, 33).

Evidence for impairment?

In a small study by Hogman (1977) visual re-adaptation time after photo-stress was examined. This was prolonged during alcohol intoxication, recovered when the BAC reached zero and then a second prolongation of re-adaptation occurred in the hangover phase suggesting CNS impairment (34).

The EEG has been shown to change during hangover (14-16hrs after ingestion of alcohol). A controlled trial (35) found a reduction and slowing of alpha activity and increased theta activity. These were statistically significant changes that could not be explained by BAC, hypoglycaemia or acidosis. Fatigue had been controlled for. The study concluded that there was a depressant effect of alcohol or its metabolites on cortical function. Gevins and Smith (1999) found an impairment of task performance in a small controlled trial; this impairment could be identified on EEG with 92% accuracy (36).

Chait and Perry found only weak evidence for subjective effects the morning after a dose of alcohol of 1.2g/kg (37). Work by Chapman concluded that 1.5ml of ethanol per kg body weight induced definite hangover in approximately 50 percent of subjects, 1.75ml/kg did not increase the proportion of hangovers reported, but

greatly increased the incidence of undesirable behaviour (reported in 38).

Driving

Driving during hangover has been studied fully. Tornros and Laurell reported reduced ability on complex driving manoeuvres three hours after blood alcohol returned to zero, and subjects were unable to tell if they were fit to drive or not. Further work found impaired performance the morning after a BAC of, on average, 150mg/dl. They were tested on a simulated, difficult, 20km course. It is important to note that BAC was not zero but below 40mg/dl. Later in the day, on repeat testing, no impairment was shown, when one would expect the BAC to have returned to zero (39, 40).

Anderson also concluded that the alcohol hangover affected driving by reducing ones ability to allocate cognitive resources to competing stimuli (41).

Studies in aviation

Gibbons (1988) reviews post-alcohol impairment work by Wise in 1979 that supports impairment at 14 hours, and also work on positional alcohol nystagmus (PAN) by Ryback and Dowd (1970), Hill, Collins and Schroeder (1973), and Oosterveld (1970), that demonstrated that PAN could be manifest 34 hours after alcohol ingestion. Oosterveld showed that increased G forces could provoke PAN up to 48 hours later (12). Work on PAN seems particularly relevant to impairment in pilots, but does not generalise to other occupations in which establishing the evidence for post-alcohol impairment would seem the priority.

In 1986 a preliminary report on a controlled trial by Yesavage and Leirer found hangover affects aircraft pilots 14 hours after alcohol ingestion. This was a small study using a high dose of alcohol. Results showed significant impairments in three of six variance measures and one of six performance measures, the trend was non-significant impairment in the other areas. The pilots were unaware of impairments. They felt their tests showed reduced ability in processing information and impaired working memory capacity, and could be generalised to other tasks e.g.: operating equipment or train driving (42).

In 1990 Morrow found impairments in communication skills of young pilots 8 hours after alcohol ingestion. In 1991 Morrow reported that older pilots were more aware than younger pilots of impairments in performance 4 hours after alcohol but not at 8 hours.

In 1993 Morrow published a controlled trial, on the time course of impairment, which appears to use different data collected on the same subjects during previous trials. This trial seems to be reworked again in a study reported by Taylor, and linked to a later controlled trial with Yesavage as the principle author. The 1993 study concluded that there was no statistically significant impairment at 8 hours after ingestion of alcohol in the 28 pilots tested, but this may have been the effect of practice as there was non-significant impairment. Further examination of results revealed statistically significant variation across subjects (i.e. subjects differed on acute and hangover effects) this was used as evidence that their study was too small to detect a significant difference. In the later controlled trial the subjects had not practiced for ten months, this study showed detrimental effects at 8 hours. Taylor's 1994 preliminary study reported impairment at 8 hours but had methodological flaws. In a further preliminary study on gender differences in impairment, Taylor (1996) found no significant difference. They then began to look at individual subjects, associating slow elimination of alcohol with poor performance 8 hours after alcohol. Women seemed to eliminate faster although they did receive a smaller dose initially. The study admits; low power, small sample size, no control groups were used and there were peak BAC sampling difficulties. Despite these difficulties they concluded that they would expect a difference at 8 hours as women eliminate alcohol more quickly; therefore elimination rate is an important predictor of susceptibility of impairment 8 hours after ingestion of alcohol (43-48).

Conclusion

The terminology used ('post-alcohol impairment') is perhaps unsuitable as it implies a direct effect, when the evidence does not provide a clear picture of the effect of hangover on performance, or which aspects of hangover are responsible should impairment of performance be demonstrated.

Variability in the methodology, the alcohol dosing and outcome measures, in the studies reported, and the lack of randomised controlled trials, make it difficult to analyse previous research. It is evident that the measures used may not be sensitive enough to detect impairment during hangover when BACs are zero. The generalisability of these tests to other occupations remains doubtful.

Impairment of performance during hangover has safety implications. Although evidence of impairment is not conclusive we should accept those trials showing impairment as our standard until better evidence is available. Cook (1997) proposes two fundamental principles that should influence aviation policy that could generalise to other occupations (49):

- Low BAC can impair performance of aircrew in a way that might affect flight

safety; therefore the blood alcohol for flying should be zero.
- Post-alcohol impairment research suggests further impairment, and that aircrew should not fly until well after their BAC has returned to zero.

Modell and Mountz (1990) propose a 12-hour rule, extending to more than 24 hours if over five drinks are taken or after effects are noted. They also propose an ignition-interlock test, where the driver or pilot cannot start the car or fly until a test is completed. The US National Highway Transportation Safety Administration has developed such a test for the motorcar (50). Driving is only one facet of a soldier's potential tasks.

Research suggests current alcohol related policies are not robust enough. Whilst continuing the current program of education the British Army, and UK Armed Forces as a whole, should attempt to establish if the drinking patterns surveyed do result in impairment of performance in the various occupations. Consideration of the following recommendations and directions for research will be required.

Recommendations for clinical practice

- Where policy exists we should advise clients to adhere to it, and should be actively involved in reviewing the policy and current research, whilst considering the fundamental principles.
- Where no policy exists we should be actively involved in its development.
- Our assessment of clients alcohol drinking should include assessment of hangover (frequency, symptoms and effects).
- Our assessment should also include aspects of risk of hangover to their particular occupation.
- We should be educating clients as to the risks of alcohol, including impairment whilst suffering from an alcohol hangover.

Future directions for research

- The role of congeners in impairment.
- Further research on the effect of hangover on performance.
- Research on tests that could show impairment in other occupations.
- Attitudes towards hangover and occupation.
- The effects of education regarding hangover.
- The comparison of, and effect of different alcohol policies.

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