

CELL MEDIATED IMMUNITY AND ALCOHOL INTAKE IN ANTARCTIC WINTERING PERSONNEL

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ABSTRACT

The relationship between cell-mediated immunity and alcohol intake was studied in an Antarctic wintering group. Cell-mediated immune responses have previously been shown to be significantly lowered on the Antarctic Continent. The cause for this is yet to be elucidated. The cutaneous CMI Multitest was used to assess cell-mediated immunity. Carbohydrate deficient transferrin (CDT) was used to assess chronic alcohol consumption and acute consumption was self-reported. Results showed a significantly elevated incidence of anergy when compared with previous results (53 v.6.5%). The incidence of hypoergy was similar to previously reported levels (34%). There was no relationship demonstrated between both acute or chronic alcohol consumption and levels of cell-mediated immunity using the Spearman Rank Correlation Coefficient. There was also no correlation found between CDT and self-reported alcohol intake. It is concluded that factors other than alcohol are responsible for the decrease in cell-mediated immunity in Antarctic wintering personnel. (*Int J Circumpolar Health* 2002; 61:208-215)

Key words: Cell-mediated immunity, carbohydrate deficient transferrin, self-reported alcohol consumption, Antarctica

Cell-mediated immune responses have been shown to be significantly lowered in groups wintering on the Antarctic Continent (1, 2, 3, 4). Although no disease has accompanied these changes, there are obvious implications in such isolated communities. Previous studies have shown no association with testosterone levels, vitamin D metabolite or anxiety scores, all of which are known to be altered in Antarctic expeditioners (5).

There is epidemiological, clinical and laboratory evidence that chronic alcohol exposure is associated with depressed cell mediated immunity in humans. However, some of the laboratory evidence has been conflicting and the pathophysiologic mechanisms are still debated. Less evidence is available about the effects of acute alcohol intoxication on cell mediated immunity. The effects of chronic and acute alcohol intake on human immunity have recently been reviewed (6).

Alcohol has long had a role in the life of Antarctic ex-

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peditions. Writing of the heroic era, Huntford comments "The first time Mawson met Wild, in New Zealand, during the Nimrod expedition, Wild was being carried drunk out of a hotel. Since the Antarctic was virtually dry, Mawson reasoned that there, Wild would be absolutely reliable" (7). While Wild proved to more than reliable, his ability to get intoxicated can't be questioned either. During the Endurance expedition, whilst awaiting rescue from Elephant Island, Wild and others were regularly so drunk on spirits that Wild was quoted as once saying "If the Boss (Shackleton) turned up now, tonight, he wouldn't take us off" (7). Scientific (8,9,10) and anecdotal (11,12) evidence of heavy alcohol consumption in modern day over-wintering parties abounds.

The present study aimed to assess the relationship between the observed depression of cell mediated immunity in wintering personnel on Australian Antarctic Stations and their consumption of alcohol, both acute and chronic.

MATERIALS AND METHODS

Study population: The 20 members of the 49th Australian National Antarctic Research Expeditions (ANARE) who wintered at Davis Station in 1996 were volunteer subjects for this study. All had undergone a pre-departure medical examination and the Australian Antarctic Division Ethics Committee (Human Experimentation) had approved the study. Subjects had provided written informed consent after the nature and possible consequences of the study were explained.

It was originally intended that all 20 subjects would participate for twelve months and that the tests would be done simultaneously on each subject. However, the arrival of the subjects in Antarctica occurred on four separate voyages spanning seven months from October 1995 – April 1996). Two expeditioners commenced participation in the study after two months at Davis. All others commenced within five days of arrival. The tests were thus staggered through the year in order of arrival. One expeditioner who arrived in April 1996 departed in October of the same year; this being the period of total physical isolation.

Physical Characteristics: There were eighteen males and two females. Mean age was 33.7 years (range 23-50), mean height was 175.2 cm (range 164-194), mean weight



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Table I. Quarterly cell mediated immune responses.

Quarter	Nov 95-Feb 96	Mar 96-Jun 96	Jul 96-Oct 96	Nov 96-Dec 96
Number of expeditioners	18	20	18	20
Anergy	14	11	10	6
Hypoergy	3	6	6	11
Normal	1	3	4	1

was 83.5 kg (range 51.6-116.3) and mean Body Mass Index (BMI) was 27.1 (range 18.9-35.6). There were five expeditioners with a BMI in excess of 30.

Immunological Assessment: The quarterly assessment of cell-mediated immunity (CMI) was done using the CMI Multitest manufactured by Institut Merieux, Lyon, France. The antigens assessed were tetanus, diphtheria, streptococcus, tuberculin, candida albicans, trichophyton, proteus and glycerine control. Details of the test have been previously described (4) and it has been shown to be a good screening test for cell-mediated immunity (13). It has been used successfully in immuno-incompetent patients (14) as well as challenging environments such as space flight (15). The same investigator conducted all the tests.

Skin reactions to antigens were assessed at 48 hours. All tests were conducted in the morning and at the same time of day for each expeditioner throughout the year. A reaction was considered positive if the mean diameter was 2mm or more. The subject score equals the total of the positive reactions in millimetres. The compound score was calculated by dividing the subject score by the number of antigen responses. In this study the term hypoergy corresponds to subject scores of less than 10mm in males and less than 5mm in females. Anergy corresponds to a subject score of zero or only a single positive response and a subject score of less than 5mm.

Assessment of Alcohol Intake: Long term alcohol consumption was assessed by measuring serum carbohydrate deficient transferrin (CDT). Carbohydrate deficient trans-

Table II. Quarterly assessments of alcohol consumption.

Quarter	Nov 95-Feb 96	Mar 96-Jun 96	July 96-Oct 96	Nov 96-Dec 96
Number of expeditioners	18	20	20	18
Expeditioners with raised CDT	8	5	10	7
Expeditioners with alcohol intake prior to CMI test	15	11	15	15

ferrin has a high sensitivity and specificity for detecting regular alcohol intake of 50–80g of ethanol per day (16). CDT levels were measured using the Pharmacia CDTest™ immunoassay. Blood was collected by venipuncture in the morning during working hours. It was then allowed to clot, centrifuged for ten minutes at 1000–1300 rpm, the plasma transferred to a storage tube and then stored in a -70°C freezer. For transport back to Australia the samples were transferred to liquid nitrogen. The samples were assayed at the Hunter Pathology Service, Royal Newcastle Hospital, N.S.W., Australia.

Estimation of acute alcohol consumption was achieved with each expeditioner completing a questionnaire estimating the alcohol consumed in the 48 hours prior to each assessment of CMI. Self-reporting of alcohol consumption has previously been found to be an accurate method in young adults when compared with Breathalyzer readings (17).

Statistical Analysis: This was performed using the statistics package of SPSS Inc, Chicago Illinois. Power analysis revealed that 62 samples would be required to give a power of 0.8 to detect a correlation coefficient of 0.35 using a two-tailed test at a significance level of 0.05. The Spearman Rank Correlation Coefficient was used to assess the correlation between the CMI results and the measures of alcohol consumption. This was because we could not assume a normal distribution for the CMI results given their ordinal nature.

RESULTS

The number of subjects tested in each quarter and the results of the CMI tests are shown in Table I. There was an increased incidence of anergy (53%) as compared with similar groups (6.5%), though the incidence of hypoergy was comparable (34% v. 36%) (3). The uniform pattern of depressed CMI throughout the year in Antarctica was also not repeated with a steady decline in the number of expeditioners with anergy throughout the study period.

Four of the 76 samples for CDT analysis were lost or destroyed during storage. Of the 72 assayed, elevated CDT levels (>20 U/L in males, >26 U/L in females) were found in 30 samples (Table II). Four expeditioners had no elevated CDT levels, nine expeditioners had elevated levels on one occasion, one on two occasions, four expedi-

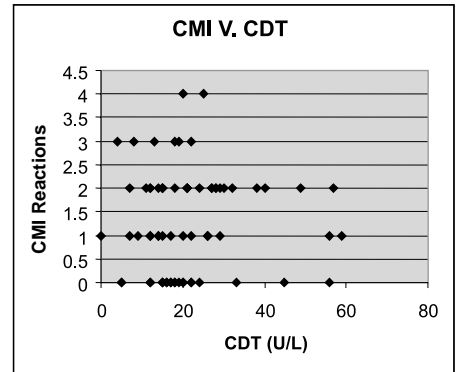


Fig. 1. The relationship between positive reactions on the CMI Multitest and serum carbohydrate deficient transferrin.

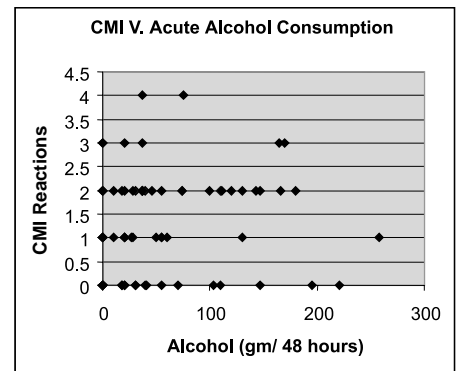


Fig. 2. The relationship between positive reactions on the CMI Multitest and the amount of alcohol consumed in the previous 48 hours.

tioners on three occasions and two expeditioners on all four occasions. One elevated CDT level was found in a reported non-drinker.

Alcohol was reported to have been consumed in the 48 hours prior to each assessment of CMI on 56 out of 76 occasions. Consumption ranged from 0-257gm, with a mean of 50.61 gm (95% C.I. = 36.84 to 64.39) over the 48-hour period. Standard error of the mean was 6.91. Thus the average consumption was well below that recommended as safe by the National Health & Medical Research Council for adult males (not more than 40 gm per day) and just above that for adult females (not more than 20 gm per day) (18). Three expeditioners reported no acute alcohol intake at any of their assessments. Fifteen expeditioners had consumed alcohol in the first quarter, 11 in the second, 15 in the third and 15 in the final quarter.

The results of the CMI tests for each quarter were correlated against the carbohydrate deficient transferrin (Fig. 1) and acute alcohol consumption (Fig. 2). Using the Spearman Rank Correlation Coefficient, there was little demonstrable association between both chronic (Coefficient = 0.02273 with $P = 0.85$), or acute (Coefficient = 0.1455 with $P = 0.21$) alcohol consumption and suppression of cell-mediated immunity in the expeditioners.

DISCUSSION

It has been known that Antarctic continental expeditioners suffer from decreased levels of cell-mediated immunity in comparison to population norms. Neither the cause nor the actual mechanisms of this immunodepression are clear. Fortunately, it does not appear that it is associated with an increase in incidence of disease, either in modern times (1) or the days of early exploration (19).

There are both clinical and scientific evidence to indicate a suppressive effect of alcohol on cell-mediated immunity. Both the frequency and severity of tuberculosis are much greater in alcoholics than in the general population and cancers of the head and neck (often associated with recurrent isolations of Epstein-Barr virus) are six times more common. Acute intoxication has been found to cause a marked suppression of natural killer (NK) cell activity *in vivo* and a ten-fold increase in the number of metastases (using a NK sensitive metastatic process) (20). There is also an inhibition of cell mediated immune skin

test sensitisation that is dependent on the dose and duration of alcohol ingestion (21). Obviously, malnutrition may also be a compounding influence for the suppression of cell-mediated immunity seen in alcoholics. In vitro evidence suggests decreased lymphocyte transformation, decreased lymphocyte migration, decreased natural killer cell activity (22), decreased antibody-dependent cellular cytotoxicity and decreased alveolar macrophage adhesion, phagocytosis and bactericidal activity (21).

Carbohydrate deficient transferrin was used because it is at least as sensitive and probably more specific than GGT as a biological marker of heavy alcohol consumption (23). As such it is the best objective measure of drinking behaviour (24, 25, 26). As a single marker of alcoholic drinking it has been reported to have a sensitivity of 83% (27) and a specificity of 97%. There are only occasional false positives and its measurement is little affected by other conditions (16). It is also better than GGT in detecting increases in alcohol consumption in monitored subjects (28).

A significant negative correlation has been found between anxiety and CMI (2, 29) in several ANARE groups in Antarctica. Why there was such an increased level of anergy in the study population as compared with population norms for the Antarctic is unclear but psychological factors cannot be discounted.

The number of positive CDT results was surprising. Only four expeditioners (20%) did not record at least one elevated CDT; 7 (35%) expeditioners had elevated levels on two or more occasions. On eighteen (24%) occasions over 100gm was reported consumed with a mean of 152 gm.

Linear regression analysis showed no correlation between CDT and 48 hour ethanol consumption. This is not a surprising result as binge drinking was the prevalent drinking pattern observed in this study group and also in previous groups (8). Previous authors have reported a low correlation between CDT and a subjective indicator of drinking habits measuring weekly consumption (30). A strong correlation was reported in males between CDT, the MAST questionnaire and a structured alcohol use interview (31). However the study population was only 5. Conversely, when comparing the AUDIT questionnaire and CDT, only 7.6% of those identified as having elevated and risky levels of alcohol consumption were identified by both instruments (32). When compared with the EDAC

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test, 61% were identified using both instruments (33). Using 90 day self-reporting of alcohol consumption as the comparison, there was no correlation with CDT on 3 of 4 reporting periods (34). Given that the period of self-reporting in this study was 48 hours (chosen to best reflect the effect of acute ingestion on cell mediated immunity) and the prevailing pattern of binge drinking, it is not surprising that there was no correlation found between CDT levels and acute ingestion.

The level of alcohol consumption on Antarctic wintering stations has been a concern for many years (11). In recent years occupational health and safety concerns have led to some debate about the correct amount to allow expeditioners and the appropriate way it should be supplied and consumed. However, there is conflicting evidence on which to base these concerns.

Lugg (35) reported in 1966 that alcohol featured in less than 4% of conversations during a full year in Antarctica. A recent study into the psychology of wintering found that alcohol was mentioned only 22 times in a total of 785 negatively themed reports (3%) in eight Australian wintering groups over two years, including the population represented in this study (36). Furthermore, alcohol has been found to be a contributing factor in only 6.7% of accidents resulting in injury over an eight-year period at the four Australian Antarctic stations (37). Our study found that the average daily consumption was within the guidelines for safe consumption of alcohol in males (18). However, Williams (8) has previously found that alcohol consumption per capita in Antarctic winterers to be somewhat greater than the applicable Australian average (16.29 v. 10.74 litres of absolute alcohol per annum), and that most problems related to binge drinking patterns.

The results seem to support the findings of Williams (8) in that there was a group of expeditioners with chronic heavy intake of alcohol. Binge drinking was also a concern with 24% of reported intakes over 48 hours averaging in excess of 15 standard drinks. It is interesting to note that the only two incidents where injury was related to alcohol in this group involved expeditioners who had reported intakes greater than 100gm on two occasions.

In conclusion, while this study showed an increase in suppression of cell-mediated immunity and evidence of excess alcohol consumption, there is no statistical relationship between the two; factors other than alcohol being

responsible for the altered immune response.

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