

A SURVEY OF ALTITUDE DECOMPRESSION SICKNESS IN A GROUP OF VETERAN CANBERRA AIRCREW.

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ABSTRACT

Background Aircrew operating future fighter aircraft may be exposed to cabin altitudes in excess of 18,000 ft for prolonged periods. Altitude chamber experiments at such medium altitudes have shown a higher than expected incidence of decompression sickness. There is scant data on the prevalence of decompression sickness in aircrew exposed to similar operational profiles. **Methods** A postal questionnaire was sent to 550 members of a Canberra aircraft aircrew veterans group. Respondents were asked to record demographic information and exposures to cabin altitudes in excess of 18,000 ft and 25,000 ft. They were then asked to report whether they had experienced a range of symptoms at altitude during and/or after flights. If symptoms had been experienced, questions were asked about duration, reporting, treatment and personal strategies to reduce risk. **Results** Questionnaires were received from 252 (46%) subjects of whom 43.2% were pilots, and 53.6% were navigators. Of responders, 21.4% reported upper limb pain during flight (above 18,000 ft and not below), rarely or more frequently during flights, and similarly 15.1% reported pain in the lower limb. Of those experiencing limb pain, 78.4% indicated that generally the pain was slight or mild and did not interfere with normal duties, whereas 21.6% reported moderate pain interfering with concentration on task. 18.6% of responders indicated that they had needed to descend or abort a flight due to a crew member developing symptoms of decompression sickness. **Conclusions** Symptoms suggestive of decompression sickness may occur more frequently than official figures suggest.

Background

Decompression sickness (DCS) affects people exposed to substantial falls in ambient pressure. It is thought to be due to gas, previously dissolved in body components, coming out of solution as bubbles that deform tissues, obstruct blood and lymphatic vessels and initiate cascades of inflammatory responses. The broad features of altitude decompression sickness have been well known and largely understood for many years.¹ Mild ("Type I") symptoms manifest as limb pain, and skin itch or rash whereas more serious symptoms ("Type II") include chest pain and /or breathlessness and a wide range of neurological symptoms such as unconsciousness, partial paralysis, speech problems and sensory disturbance.² Prevalence of DCS has been shown to increase with the magnitude, rate, duration and frequency of decompression, age and body mass index also.¹ On the basis of Haldane's classical studies³, the threshold for altitude DCS was thought to be around 18,000 ft, but there have been case reports of symptoms suggestive of DCS below this altitude⁴⁻⁷.

The USAF experience of decompression sickness mishaps was reported by Kemper⁸. The DCS mishap rate for "Type I" and "Type II" DCS for 1975 to 1988 was between 0.2 and 0.3 per 100,000 flying hrs. 15% occurred below 18,000 ft, 63% between 18,000 and 25,000 ft and 22% above 25,000 ft, the greatest proportion of incidents being in unpressurised training or transport aircraft. In a postal survey of U2 aircrew, Bendrick reported that 75% of respondents had experienced DCS and that 12.7% had descended or aborted a flight due to DCS.⁹ Operational experience in the RAF, which in recent years has been largely a low-level air force, of DCS has reportedly been low. Only 2 cases were recorded in the 10 years between 1980 and 1990, both in Canberra aircrew¹⁰. However, it was policy for aircrew reporting DCS to be re-assigned to a low-level role, usually helicopters, and it was possible that many anecdotal events went unreported.¹⁰ More recently, hypobaric chamber experiments investigating onset of circulating venous gas emboli (VGE) and symptoms of DCS have shown a significant proportion of subjects with circulating VGE at 20,500 ft on a representative oxygen/nitrogen breathing mixture, and a higher than expected proportion of subjects experiencing early symptoms of DCS at altitudes up to 25,000 ft¹¹.

Agile high altitude aircraft will be capable of maintaining altitudes which result in cabin altitudes up to about 22,500 ft resulting in a risk of decompression sickness. The aim of this study was to establish by questionnaire the incidence of DCS in a population of aircrew who had been exposed to similar cabin altitude profiles. The English Electric Canberra was first manufactured in the 1950's and has seen service with many Commonwealth and foreign air forces. Several Mk's are in service today as a long-range multipurpose aircraft. For the standard aircraft, service ceiling was 48,000 ft, resulting in a maximum cabin altitude of above 25,000 ft, and for normal operations a cabin altitude in excess of 18,000 ft.

Methods

After securing Local Research Ethics Committee approval for the study, 550 postal questionnaires were distributed to all current members of a UK Canberra veterans organisation who indicated that they had been Canberra aircrew. Recipients were given information regarding the background and aims of the study and reassured that participation was entirely voluntary and they could remain anonymous if preferred. The questionnaire collected general epidemiologic data, flying career information, frequency and duration of exposure to cabin altitudes in excess of 18,000 ft and 25,000 ft, and the occurrence of DCS symptoms while at altitude and in the 24 hrs following flights. If symptoms had been experienced, further questions about resolution, treatment and outcome were asked. Subjects were asked to recall, for a range of complaints, the frequency of symptom occurrence above and/or below a cabin altitude of 18,000 ft.

For the purposes of analysis, only symptoms which occurred above 18,000 ft and not below were considered to be possibly due to altitude decompression sickness. Where possible, descriptive statistics were used to examine the data. Simple analysis of the proportions of respondents with various risk factors who indicated symptoms above 18,000 ft were performed where possible using the Chi-squared test.

Results

The overall response rate was 46% (252 responses from 550 questionnaires distributed). Of responders, 109 (43.2%) were pilots and 135 (53.6%) were navigators. The remaining 8 (3.2%) were observers or other. All respondents were male. Two hundred and twenty four (89%) and 164 (65%) respondents had been exposed to cabin altitudes above 18,000 ft and 25,000 ft respectively. Figure 1 shows the frequency of reported exposures to cabin altitudes above 18,000 ft and 25,000 ft, and the most common duration of exposure to altitudes in excess of 18,000 ft.

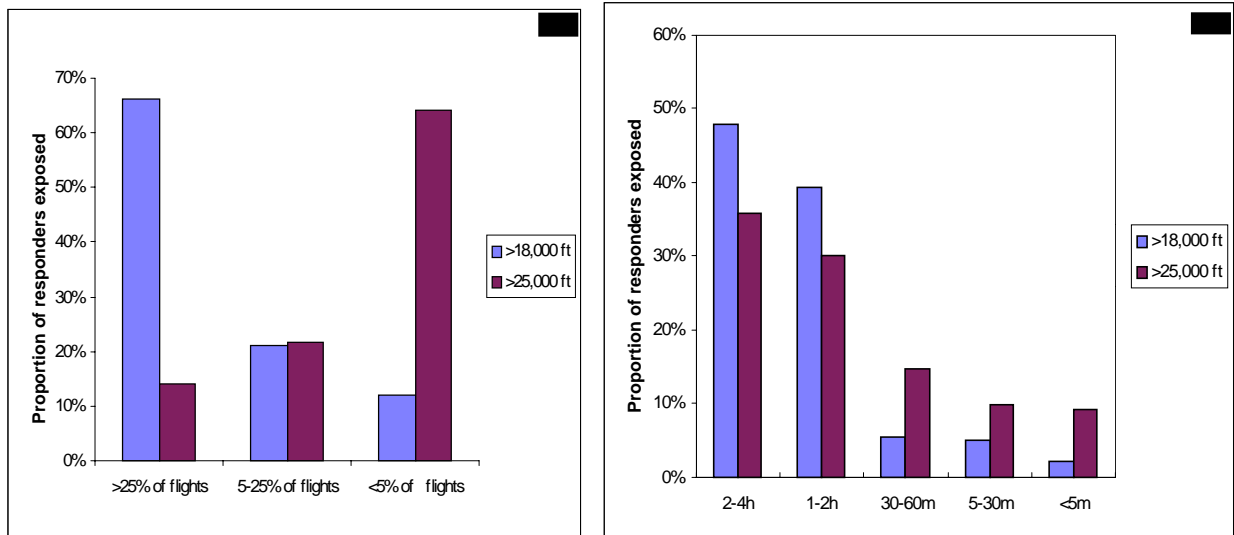
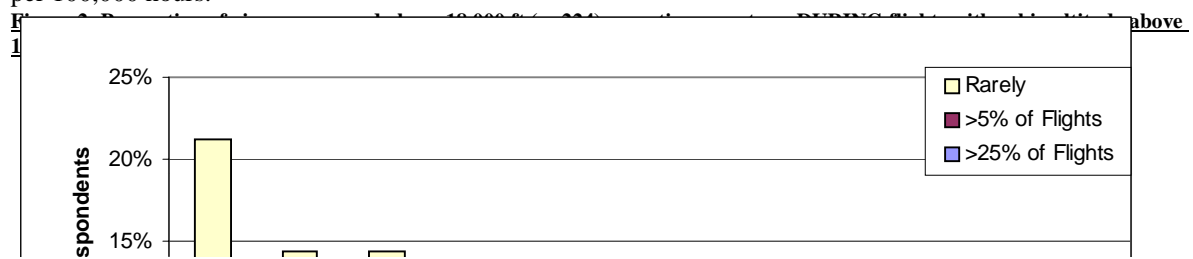


Figure 1: A: Frequency of exposure to cabin altitudes above 18,000 ft, B: Most common duration of exposure to cabin altitudes above 18,000 ft

Respondents were commonly exposed to altitudes above 18,000 ft and relatively infrequently exposed above 25,000 ft. Almost half of the aircrew reported the most common duration of exposure above 18,000 ft to be 2-4 hours, and 40% for 1-2 hours. Unexpectedly, a significant proportion of aircrew reported prolonged exposure above 25,000 ft: 36% and 30% of those exposed for 2-4 hours and 1-2 hours respectively. Given the duration of exposure, it is not surprising that the number of aircrew exposed to cabin altitudes in excess of 18,000 ft twice or more in a day was low.

Figure 2 shows the proportion of respondents reporting symptoms during and after flight. Only those who reported the symptoms above a cabin altitude of 18,000 ft and not below were included. Over 20% of respondents experienced upper limb pain during flights rarely, with 8% experiencing symptoms on more than 5% of their flights. The next most frequent symptoms were lower limb pain and skin itch or rash. Symptoms of more severe ("Type II") decompression sickness were less frequently reported by responders and then only rarely. Nearly 5% of responders indicated upper limb pain after flights with cabin altitudes above 18,000 ft. Other "Type I" and "Type II" symptoms were less frequently reported, but over 3% of responders reported inappropriate fatigue after flights. When asked to rate the severity of the worst episode of limb or joint pain, 5 indicated "Slight (barely noticeable)," 32 "Mild (noticeable but did not interfere with normal duties)," 18 "Moderate (difficult to concentrate on normal duties)," and 8 Severe (disrupted ability to perform normal duties)." Hence 21.6% of responders with pain had symptoms which had interfered with normal duties on at least one occasion. For aircrew who experienced pain more than once, the average severity was reported as "Slight" by 10, "Mild" by 30, and "Moderate" by 11.

When asked if they had ever been on a Canberra flight when they had needed to descend or abort a flight due to themselves, or another member of the crew, developing symptoms of decompression sickness, 47 (18.6%) responders indicated yes; 25 indicating only once, 13 twice, 1 four times and 3 five times. This correlates with the percentage of respondents with pain that impacted on ability to perform normal duties. Totalling all responders Canberra flying hours, 96 missions were affected in over 389,000 hours, giving a mishap rate of 24.7 per 100,000 hours.



Only 39 (15.5%) of respondents reported any symptoms to a doctor, with only 5 incidents described as “bends.” Ear, nose and throat (ENT) problems and back pain were most commonly reported. Twenty-two were given some form of treatment, but oxygen and/or hyperbaric therapy were not mentioned. The most common treatments were rest/observation or ENT medication. Six respondents had flying altitude restricted as a result of reporting symptoms. When asked the reason for not reporting, 47 recorded that “symptoms disappeared”, 53 “did not consider symptoms serious” and 13 “feared losing fitness to fly”. Other reasons stated were: “commonly accepted,” “no Medical Officer,” “knew it was bends,” and “expected symptoms.” Twenty-eight (11%) responders took actions to avoid decompression illness of whom 8 denitrogenated prior to flight, 8 breathed 100% oxygen throughout the flight, 5 kept their limbs still, and 5 “descended.”

Discussion

The number of respondents indicating that they experienced symptoms is much higher than that reported officially¹⁰. Minor (“Type I”) symptoms were most frequent with major (“Type II”) much less so. This distribution of symptom type is expected¹, but it is also possible that if mild symptoms were experienced it is likely that the aircrew would have taken action to reduce symptoms before major problems were encountered. Similarly the severity of the episode of worst pain or average pain was generally not severe enough to disrupt the ability to perform normal duties. It is possible that some of the symptoms experienced above 18,000 ft and not below are not attributable to decompression sickness but due to the environmental conditions in the cabin, such as cramped space, and temperature. For example, the higher proportion of “numbness” is probably due to the confounder of low cabin temperature at high altitude. It is difficult to know whether or not the high proportion of the rather vague symptom of “inappropriate fatigue” was due decompression sickness or just due to long flights of more than 4 hours. Of the responders exposed above 18,000 ft and 25,000 ft a high proportion reported that their most common duration of exposure was over 1 hour, which certainly would put them in the window of probable VGE formation and early symptoms¹¹. However, analysis of reporting of symptoms did not show any consistent effects for the exposure risk factors particularly most common duration of exposure and repeated flights in the day.

Nearly one fifth of responders indicated that they had needed to descent or abort a flight due to DCS in a crewmember. This equates to 24.7 mishaps / 100,000 flying hours, compared with Kemper’s study⁸ which gave a figure of 0.2-0.3 incidents/100,000 flying hours. When asked why symptoms were not reported, a high proportion indicated fearing losing fitness to fly, this may be reduced in current times as DCS does not necessarily restrict future flying in many air forces. Of more concern is that responders did not consider the symptoms as serious or accepted the symptoms, though many took precautions to reduce DCS risk themselves.

With ever increasing “duty of care” issues, especially in respect of the possible importance of circulating venous gas emboli without symptoms, further work to elucidate the hazard and risk of decompression sickness in aircrew operating future aircraft at high altitude is required. More formal health surveillance of operational aircrew may be required if operations expose aircrew to prolonged cabin altitudes in excess of 18,000 ft.

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