

Abstracts of Current Aerospace Medical Literature

Acceleration Physiology

Van Lieshout EJ, Van Lieshout JJ, Krol J et al : Assessment of Cardiovascular Reflexes is of Limited Value in Predicting Maximal +Gz-tolerance. *Aviat Space Environ Med* 1992; 63:21-6.

The importance of +Gz-induced loss of consciousness as a major cause of inflight incapacitation emphasizes the need for predicting +Gz-tolerance and investigating its possible determinants. The cardiovascular changes from +Gz-stress are initially counteracted reflexly by the cardiovascular autonomic system. The integrity of neural cardiovascular reflex control can be assessed by analysing the blood pressure (BP) and heart rate (HR) responses to different manoeuvres, such as the Valsalva manoeuvre, standing and forced respiratory sinus arrhythmia. The aim of the present study was to investigate a possible relation between the cardiovascular responses to these tests and +Gz-tolerance. In 10 healthy subjects continuous finapresTM BP and HR responses to the tests have been determined and correlated with their G-levels of peripheral light loss (PLL) during centrifuge-runs (0.1 G/s). Only mean BP recovery during Valsalva manoeuvre correlated marginally significantly with PLL ($r=0.63$, $p=0.049$). Cardiovascular findings were within normal range revealing no cardiovascular autonomic dysfunction. These results indicate that intact neural cardiovascular control seems to be a condition for tolerating +Gz-stress without determining maximal +Gz-tolerance. We conclude that assessment of cardiovascular reflexes may only confirm baroreflex integrity. However, they may have limited value in predicting +Gz-tolerance.

Lyons TJ, Harding R, Freeman et al : G-induced loss of consciousness accidents : USAF experience 1982-1990. *Aviat Space Environ Med* 1992; 63 : 60-66.

Discussion of acceleration protection measures should be based on analysis of relevant accident data, including determination of high risk aircraft, G profiles, and pilot descriptions. There were 18 accidents (14 fatalities) attributed to G-induced loss of consciousness (G-LOC) in the United States Air Force (USAF) from 1982

through 1990. All 18 accidents occurred during single crew member sorties, for an average rate of 2.1 per million single-seat flying hours (pmfh). The average G-LOC accident rate for 1982-4 was 4.0 pmfh, decreasing significantly to 1.3 pmfh for 1985-90. This decrease is associated with the USAF initiation of an anti-G-LOC training programme. We reviewed accident records for G-LOC cofactor data and compared them to normal data for USAF pilots for age, height, weight, systolic and diastolic blood pressure, heart rate, total flying time, and aircraft-specific flying hours. Only for systolic pressure (higher) and aircraft-specific flying hours (shorter) were the mishap pilots significantly different from other USAF pilots. We found no evidence to support weight training vs aerobic training, missed meals, or heat in causing G-LOC accidents. Thus the mishap pilots appeared to be a representative cross section of USAF pilots with respect to personal variables. More significant factors appeared to be G duration, G magnitude, use of G trousers, and experience in assigned aircraft.

Baldin UI, Seigborn J : G-endurance during heat stress and balanced pressure breathing. *Aviat Space Environ Med* 1992; 63 : 177-80.

The effect of heat stress and balanced pressure breathing during G (PBG) on G-endurance was investigated. Ten fighter pilots wearing anti-G suits with increased bladder coverage were warmed to 38.2°C and exposed to 15-s periods at 4.5 and 7 G in a heated human centrifuge gondola until exhaustion during PBG and normal breathing (NB). During both NB and PBG, the rectal temperature rose to a mean of 38.3°C, and the dehydration was about 1.2 Kg. With NB the endurance was a mean of 254 s, while it was 300 s with PBG (n.s.). Oxygen saturation and ratings of perceived exertion were mainly unchanged, while the maximum heart rate decreased by a mean of 13 bpm during PBG. In conclusion, the G-endurance was not deteriorated with PBG, in comparison with NB, during heat stress. In conjunction with experiences from other studies, however, it emphasizes the importance of avoiding heat stress and dehydration during G-loads, even with PBG.

Aviation Accident Pathology

Conroy C, Russell JC, Crouse WE et al : Fatal occupational injury related to helicopters in the United States, 1980-1985. *Aviat Space Environ Med* 1992; 63 : 67-71.

This paper discusses characteristics of occupational traumatic deaths caused by helicopters, during 1980-1985. Death certificate data are used to describe demographic characteristics and causes of death. Information from National Transportation Safety Board (NTSB) investigations is used to describe pilot experience and environmental circumstances surrounding the incident. During 1980-1985, 374 worker deaths involving helicopters were identified in the National Traumatic Occupational fatality (NTOF) database. The majority of deaths resulted from trauma to body organs (including the brain). According to NTSB investigations, 59% of crashes in this study were attributed to pilot error, compared to 16.5% from mechanical failure of the helicopter. Thirty percent of deaths were related to military use of helicopters. While death due to occupational exposure to helicopters is not common, some workers (eg, helicopter pilots) appear to be at especially high risk. This group should be studied further to develop better strategies for their protection.

Yacavone DW, Borowsky MS, Banson R et al : Flight experience and likelihood of US Navy aircraft mishaps. *Aviat Space Environ Med* 1992; 63 : 72-74.

Although the flight experience level of US Navy pilots has not declined in the recent years, current budget constraints will eventually lead to reduction in flight hours per pilot. This implies an eventual shifting of the distribution of flight hours. Analyses show that the rate of aircrew factor and pilot error mishaps tends to decrease as pilots' flight experience in model increases. Aviation loss rates are higher during a pilot's first 500 hours in model. This seems to be true no matter if the pilot is simply inexperienced overall or a highly experienced aviator transitioning to a different aircraft. These data suggest, therefore, that if the in-model experience levels of naval aviators decline sufficiently, the mishap rate will increase.

Aviation ENT

Bellenkes A, Bason R, Yacavone DW : Spatial disorientation in naval aviation mishaps : A review of class A incidents from 1980 through 1989. *Aviat Space Environ Med* 1992; 63 : 128-131

Spatial Disorientation (SD) has long been a major aeromedical factor contributing to naval aviation mishaps. In the past, it has been viewed as a generalized phenomenon, described by its vertigo related symptoms. More recently, however, three distinct types of SD have been identified, each based on whether the aviator recognizes and responds to its onset. In the current retrospective study, Flight Surgeon and Mishap Investigation Report narratives from 33 Class A mishaps occurring from 1980 through 1989 were reviewed. SD was determined to have been a causal factor in all cases. The mishaps were examined to categorize SD into the three descriptive types and to describe the relationship (if any) between SD and various mission-related factors. Aircraft type, phase of flight, time of day, pilot experience, and flight topography were all considered. The results indicate that types I and II SD could be identified as causal factors in all 33 Class A mishaps. Further, most Type I SD was experienced primarily by helicopter pilots at night while most Type II SD incidents affected jet pilots during day missions.

Norfleet WT, Degioanni JJ, Calkins DS et al : Treatment of motion sickness in parabolic flight with buccal scopolamine. *Aviat Space Environ Med* 1992; 63 : 46-51.

Treatment of acute motion sickness induced by parabolic flight with a preparation of scopolamine placed in the buccal pouch was investigated. Twenty-one subjects flew aboard a KC-135 aircraft operated by the National Aeronautics and Space Administration (NASA) which performed parabolic manoeuvres resulting in periods of 0-g, 1-g, and 1-8g. Each subject flew once with a tablet containing scopolamine and once with a placebo in a random order, crossover design. Signs and symptoms of motion sickness were systematically recorded during each parabola by an investigator who was blind to the content of the tablet. Compared with flights using placebo, flights with buccal scopolamine resulted in significantly lower scores for nausea (31%-35%

reduction) and vomiting (50% reduction in number of parabolas with vomiting). Side effects of the drug during flight were negligible. We conclude that buccal scopolamine is more effective than a placebo in treating ongoing motion sickness.

Golding JF : Phasic skin conductance activity and motion sickness. *Aviat Space Environ Med* 1992; 63 : 165-71.

Sweating is commonly associated with motion sickness. Previous studies have attempted to relate sweating or the associated electrodermal activity to the degree of motion sickness symptoms. This study was aimed at improving methodology by study of 1) recording site-palmar finger versus forehead; and 2) signal analysis - tonic skin conductance level (SCL) versus phasic skin conductance responses (SCRs). Eleven subjects were exposed to a cross-coupled motion challenge, produced by repeated head movements (16 per minute) during rotation around the Earth vertical axis in which rotational velocity was incremented on a staircase profile from 3° to 99°s^{-1} to an end point of moderate nausea. Six subjects underwent additional control conditions of rotation only and head movements only. A group of 12 subjects underwent sessions of vertical and horizontal sinusoidal linear motion through the head z-axis at 0.3 Hz, 1.8 ms^{-2} rms. Sweating responses were recorded in a further three subjects by mass spectrometry for water vapor from the skin using a dry N_2 gas flow method. Phasic skin conductance activity at the forehead site provided the best correlate of motion sickness onset and recovery. Other combinations of signal analysis or recording site were less useful.

Aviation Neuropsychiatry

Seay WJ, Greenberg MK : Cases from the Aerospace Residents' teaching file. Case #48. *Aviat Space Environ Med* 1992; 63 : 147-149.

A student pilot is referred for evaluation of a "head injury with post-traumatic amnesia." The case study presents a temporal association of injury and symptoms that were assumed to be related. A differential diagnosis of an amnesic syndrome is presented. Transient global amnesia is discussed as a possible etiology until an EEG

revealed an epileptiform abnormality. The aeromedical implications, military and FAA, of the clinical and electrophysiologic findings are discussed.

Aviation Ophthalmology

Miller RE II, Kent JF, Green RP Jr : Prescribing spectacles for aviators : USAF experience. *Aviat Space Environ Med* 1992; 63 : 80-85.

The special report was written for USAF vision specialists to use as a guide when prescribing spectacles for military aviators and to extend to the civilian sector the knowledge gained from the USAF experience. Visual correction in aviators presents some unique problems, especially for presbyopes. The demands of each individual aircraft environment need to be well understood. Ophthalmologists and optometrists must consider all pertinent aeromedical factors before prescribing spectacles for ametropic aviators.

Dennis RJ, Green RP Jr, Ketchum NS : The medical acceptability of soft contact lens wear by USAF Tactical aircrew. *Aviat Space Environ Med* 1992; 63 : 122-127.

Seventy-two Tactical Air Command (TAC) aircrew members completed one full year of soft contact lens (SCL) wear. A daily wear regimen, using extended wear lenses, was used to minimize corneal stress. Baseline measurements of visual acuity with SCLs and with spectacles after SCL removal and ocular indicator gradings were compared to measurements at 5-d, 10-d, 1-month, 3-month, 6-month, and 12-month examinations. Visual acuity did not decrease during the test. No aircrew member developed corneal ulcers or other serious complications requiring elimination from the test. Two aircrew members lost a total of 9 "duties not to include flying" (DNIF) days: one flyer was grounded for one day with a corneal abrasion and another for 8 d with epithelial microcysts. The TAC SCL test, as designated, was generally successful. The conservative approach to SCL wear during the test and the meticulous follow-up care by United States Air Force eye care professionals most likely contributed to the low ocular complication rate.

Biodynamics

Mawn SV, Lambert JJ, Catyb JL Jr : The Relationship Between Head and Neck Anthropometry and Kinematic Response During Impact Acceleration. *Aviat Space Environ Med* 1992; 63:32-6.

Research on the effects of impact acceleration on the body, primarily the head and neck, has been conducted at the US Naval Biodynamics Laboratory for nearly two decades. Over 150 Navy enlisted men have been subjected to impact acceleration on a sled propelled by a nitrogen-powered horizontal acceleration. Their head and neck kinematic responses during the experimental impact were measured and stored in automated data bases. Similarly, anthropometric measurements were recorded for these subjects. To investigate the relation between head and neck anthropometry and response to impact acceleration, tests involving 15 subjects were selected. A strong relation was found between head and neck anthropometry and linear acceleration of the head along the Z axis. Lesser correlations were determined between the anthropometric measurements and linear acceleration along X axis and angular acceleration about the Y axis. These findings are potentially applicable to areas such as aircrew selection, physical training and protective equipment development.

Clinical Aviation Medicine

Bohner BK : Performance Evaluation Impairment Prior to HIV Seropositive Diagnosis : A Preliminary Navy Population-Based Study. *Aviat Space Environ Med* 1992; 63 : 212-8.

Significant work problems were noted in two US Navy personnel immediately prior to being found Human Immunodeficiency Virus (HIV) seropositive. This finding suggested a preliminary study on performance evaluation impairment prior to HIV seropositive diagnosis. Cases studied were 75 (of a possible 82 available) HIV seropositive male sailors in the E-6 paygrade identified in 1987. One-sided analysis was conducted on categories from Navy performance evaluation reports prior to diagnosis, with controls' frequency matched for Rate, Rank, Date of Rank, Race, and Male sex ($n = 71$). The cases were significantly lower for Personal Behaviour (OR = 2.04, $p =$

0.038 one-sided) and Overall (OR = 1.80, $p = 0.048$ one-sided). After adjustment by logistic regression for sea-shore duty, significant impairment was demonstrated for Personal Behavior (OR = 5.76, $p = 0.002$ one sided, with significant interaction $p = 0.014$), Reliability (OR = 2.89, $p = 0.024$ one-sided), and Overall (OR = 2.47 $p = 0.036$ one-sided). These findings suggest further studies on performance evaluation impairment prior to HIV seropositive diagnosis.

Environmental Physiology

Wenger CB, Latzka WA : Effects of pyridostigmine bromide on physiological responses to heat, exercise and hypohydration. *Aviat Space Environ Med* 1992; 63: 37-43.

Five men underwent eight heat stress tests (HSTs) at 35°C, each consisting of four 25-min treadmill walks (35% Vo_2max), separated by 5-min rests, in four conditions: 1) 20% relative humidity (rh), subjects euhydrated and drinking ad libitum; 2) 20% rh, euhydrated; 3) 75% rh, euhydrated; and 4) 20% rh, hypohydrated 3% of body weight. In conditions 2-4 subjects drank during the walks to maintain their pre-HST weight. In each condition we tested subjects once after 30 mg pyridostigmine bromide (PB) by mouth and once after placebo. PB lowered heart rate a mean of 3 beats/min overall, most with hypohydration. PB did not significantly affect rectal temperature (T_{re}), but reduced the rise in T_{re} during hypohydrated exercise. In condition 2, chest skin temperature decreased more during exercise with PB. PB had no significant effect on other skin temperatures, sweating, hematocrit, hemoglobin, total plasma protein, osmolarity, ad libitum drinking, rate of O_2 uptake, or subject ratings of temperature, discomfort, or exertion. PB thus had little effect on physiological responses to moderate exercise-heat stress.

Sullivan PJ, Mekjavic IB. Temperature and humidity within the clothing microenvironment. *Aviat Space Environ Med* 1992; 63 : 186-92.

The present study investigates clothing microenvironment conditions that may develop during prolonged exposure of workers to a hot environment. Five subjects were exposed to linear increase in ambient temperature from 20-40°C over a 90-min period, and then remained at 40°C

for an additional 90 min. During the exposures, subjects were clad in four types of helicopter personnel suits (Gore-Tex, Cotton Ventile, Nomex/Insulite, and Nomex/Neoprene), incorporating both dry-suit and wet-suit designs. Continuous assessment was made of skin temperature, rectal temperature, and of microenvironment temperature, relative humidity, and vapour pressure (T , RH_{μ} and VP_{μ}) 8 mm from the surface of the skin. Results indicate that although microenvironment temperatures were similar among suits and slightly lower than that of the environment, the RH_{μ} and VP_{μ} were much greater than those of the ambient air. The Nomex/Insulite and Nomex/Neoprene suits showed the highest VP, of which only the Nomex/Insulite resulted in significantly greater increases in rectal temperature, likely due to complete covering of the body with the impermeable insulite component. The present study demonstrates the need to discern between the ambient conditions and the conditions encountered next to the skin when protective clothing is worn.

High Altitude Physiology

Black WR, DeHart RL. Decompression sickness: an increasing risk for the private pilot. *Aviat Space Environ Med.* 1992; 63: 200-2.

Decompression sickness is not an appreciated hazard among the private pilot community. This is of growing concern with the increasing number of nonpressurized aircraft capable of flying to altitudes in excess of 5,468 m (18,000 ft). A case report is presented of a 42-years-old pilot who apparently experienced decompression sickness at flight level 250 which went unrecognized until several months after the incident.

Space Medicine

Gharib C, Maillat A, Gauquelin G et al: Results of a 4-Week Head-Down Tilt with and without LBNP Countermeasure: I. Volume Regulating Hormones. *Aviat Space Environ Med* 1992; 63: 3-8.

The volume regulating hormones were studied during a 4-week head-down tilt (CNES HDT) in five subjects with and without (controls) lower body negative pressure (LBNP). LBNP was applied 3 times a day for three weeks, 4 times a day

for 4 d, and 6 times a day for 3 d the last week. In both groups we observed a significant decrease in body weight (3% in controls, 0.8% in LBNP), a significant increase in plasma renin activity and aldosterone (with an amplification of their rhythms), and significant decrease in norepinephrine with no difference between the two groups. The only major hormonal difference was observed for atrial natriuretic factor (ANF), which decreased significantly in the control group and increased in the LBNP group. These results are compared with the improvement in orthostatic tolerance (OT) after HDT in the LBNP group in the same protocol (17). We conclude that many factors could be involved in the improvement of OT. The results suggest that better conservation of plasma volume in the LBNP group might have prevented a decrease in ANF. Whether, ANF plays a role in the regulation of baroreceptor reflex with improvement in OT is currently unknown.

Arbeille P, Gauquelin G, Pottier JM, et al: Results of a 4-week Head-Down Tilt with and without LBNP Countermeasure: II. Cardiac Peripheral Hemodynamics-Comparison with a 25-day Spaceflight. *Aviat Space Environ Med* 1992; 63: 9-13.

Cardiovascular hemodynamics were assessed by ultrasound echography and doppler during a 28-d head-down tilt "CNES HDT: 87-88," and during the 25-d French-Soviet spaceflight "Aragatz 88". For both studies we used the same ultrasound methodology. The main hemodynamics parameters of the left heart function and of the peripheral arterial system (cerebral, renal, femoral arteries) were measured four times during the HDT (day 7, 14, 21, 28) and twice post-HDT. The same measurements were performed six times during the flight (day 4, 5, 15, 18, 20, 24) and five times postflight. During the HDT, two groups were studied: six subjects with no countermeasures and six subjects with repeated lower body negative pressure (LBNP). In the first group the cardiac volumes and the cardiac output were significantly decreased, whereas in the group with LBNP these parameters were superior to the basal value. In the group without LBNP the cerebral flow was maintained because of decrease of the brain vascular resistance. In this group the renal

vascular resistance was decreased as in flight. In the lower limbs we observed loss of the vasomotor control. The vascular resistance was decreased after the end of the HDT and the subjects suffered orthostatic intolerance. In the population with LBNP, we did not observe the same decrease of vascular resistance during the HDT, and after the HDT no sign of orthostatic intolerance was observed. During the flight the left ventricular volume was significantly decreased. The carotid flow was maintained owing to a decrease of the cerebral vascular resistance. The local vascular resistance in the kidney and in the lower limbs was decreased as it was during the HDT without LBNP. Postflight, the vascular resistance in the cerebral and renal area recovered progressively, whereas the femoral resistance showed oscillations probably related to the disadaptation of the vasomotor regulation at this level. In conclusion, the reduction of the cardiac volumes (inflight and during the HDT) is in favor of a hypovolemia which triggers a decrease of the vascular resistance in the main vascular areas (brain, kidney). The results of both experiments confirm that vascular deconditioning develops in the absence of countermeasures.

Markham CH, Diamond SG : Further evidence to support disconjugate eye torsion as a predictor of space motion sickness. *Aviat Space Environ Med* 1992; 63 : 118-21.

Disconjugate eye torsion in hypo- and hypergravity of parabolic flight was examined in four former astronauts and four previously tested ex-astronauts to replicate an earlier study and to further test the asymmetry hypothesis of otolith function. Results in the new subjects supported the asymmetry hypothesis and confirmed previous findings that those with low scores of torsional disconjugacy on the KC-135 did not suffer space motion sickness in their prior Shuttle missions while those with high scores did. Tilting subjects with high disconjugacy scores slightly to one side and the other failed to find a position that decreased disconjugacy in hypergravity, leading to conclusion that a simple planar asymmetry about the Y-axis was probably not the cause of the observed torsional differences in the two eyes. Disconjugacy increased at 0 G with increased parabolas, much more so in subjects who had suffered SMS. Because of this, 10 to 20 parabolas were deemed to be more certain discriminator than a fewer number.