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DARK FOCUS OF ACCOMMODATION AS DEPENDENT AND INDEPENDENT VARIABLES IN VISUAL DISPLAY TECHNOLOGY. Sherrie Jones, M.S., Naval Training Systems Center; Robert Kennedy, Ph.D.*, Essex Corporation; Deborah Harm, Ph.D., National Space and Aeronautics Administration.

INTRODUCTION. When inadequate stimuli are available for accommodation, as in the dark or under low contrast conditions, the lens seeks its resting position. Individual differences in resting positions are reliable, under autonomic control, and can change with visual task demands. We hypothesized that motion sickness in a flight simulator might result in dark focus changes. METHOD. Subjects received training flights in three different Navy flight simulators. Two were helicopter simulators and entailed CRT presentation using infinity optics; one involved a dome presentation of a computergraphic visual projection system. RESULTS. In all three experiments there were significant differences between dark focus activity before and after simulator exposure when comparisons were made between sick and not-sick pilot subjects. In two of these experiments, the average shift in dark focus for the sick subjects was toward increased myopia when each subject was compared to his own baseline. In the third experiment, the group showed an average shift outward of small amount and the subjects who were sick showed significantly less outward movement than those who were symptom free. CONCLUSIONS. Although the relationship is not a simple one, dark focus changes in simulator sickness imply parasympathetic activity. Because changes can occur in relation to endogenous and exogenous events, such measurement may have useful applications as dependent measures in studies of visually coupled systems, virtual reality systems, and space adaptation syndrome.

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ELECTROENCEPHALOGRAPHIC COMPUTERIZED TOPOGRAPHIC MAPPING DURING MOTION SICKNESS. W.E. Chelen*, M. Kabrisky*, G. Vogen, R.L. Kohl*, S. Rogers. Dept. of Elec. Eng., Air Force Institute of Technology & AAMRL, Dayton, OH 45433.

INTRODUCTION. We've recently reported the observation of electroencephalographic (EEG) delta wave activity as a reliable correlate of motion sickness symptom onset and progression. This study spatially characterized these EEG changes. METHODS. 8 subjects participated in a laboratory experiment using rotating chair Coriolis stimulation to induce motion sickness symptoms. A 14 channel montage using subdermal electrodes was used to record the EEG during a pre-stimulation baseline through to frank sickness. Colorized topographic mapping using a computerized system demonstrated the location of the origin and propagation of power spectral changes. Sequential video imaging of the topographic maps was then used to generate animated sequences of spatial evolution. RESULTS. 7 subjects responded with high energy delta activity onset unilaterally in the temporal or temporo-parietal regions during early motion sickness symptoms. This activity propagated occipitally, ipsalaterally, and then contralaterally to the temporo-parietal and/or occipital hemispheres. CONCLUSIONS. EEG delta activity begins as a relatively focal process and becomes bilateral and diffuse as frank sickness evolves.

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CHANGES OF THE QUALITY AND OF THE STRUCTURE OF THE NOCTURNAL SLEEP DURING THE ADAPTATION AT THE HIGH ALTITUDE (4940 m.). S.PORCU'* DASRS-Pratica di Mare Airport, Pomezia (Rome) Italy; E.VELARDI - Stato Maggiore IAF (Rome) Italy.

INTRODUCTION: The altitude insomnia affects the sea level inhabitants staying at high altitude without an adequate period of previous adaptation. Few studies have been carried out focusing on the relationship among the self-reported quality of the sleep, the sleep structure, and the other physiological variables (EKG, RESPIRATION) involved in the adaptation to the hypobaric hypoxia. METHODS: Forteen healty adults, age range (24-52), answered general and daily questionnaires about the quality of their nocturnal sleep. Six of the 14 subjects underwent 4 times also poligraphic recordings (EEG, EOG, EMG, EKG, THORACIC IMPEDENCE) with Oxford 9000 dynamic recorders: two times at sea level (two subsequent nights before climbing, the first one just as adaptation to the experimental procedure) and two times at 4940 m. altitude: once during the first week and once during the third week of stay. The sleep scoring was performed according to Rechtschaffen and Kales rules. RESULTS: The sleep quality complaints were concentrated during the first two weeks from the beginning of the climbing. The scoring of the sleep during the first week showed (at least $p<0.05$): longer sleep latency, reduced % of REM sleep, reduction of the sleep efficiency and of the slow wave sleep (SWS), increase of the number of the awakenings and of the % of stage 1.During the third week a significant reduction of the SWS was still present. Central apnoeas were evident during NON REM sleep in most subjects mainly during the first week. Staying at high altitude is also associated with an increase in heart rate until at least the third week following the ascent. CONCLUSIONS: The physiological measures used in this study were much more sensitive than the subjective scorings to indicate the adaptation process. The neurophysiological and cardiopulmonary adaptations are not completely achieved after 3 weeks at 4940 m.

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INVESTIGATIONS OF G-INDUCED LOSS OF CONSCIOUSNESS (G-LOC) USING THE RODENT CENTRIFUGE MODEL. P.M. Werchan* and A.R. Shahed. Armstrong Laboratory and Operational Technologies Corp, Brooks AFB TX 78235.

INTRODUCTION: The problem of G-LOC continues to exist and could potentially escalate as advances are made in aircraft maneuverability and speed. In order to investigate this problem and understand the mechanism of G-LOC we have used unanesthetized laboratory rats and mice. These animal models for G-LOC research are used because of the abundance of literature and proven techniques in their basic energy metabolism. METHODS: A small animal centrifuge (SAC) was fabricated (21" radius with onset rate of +20 Gz/sec) with the unique capability of brain fixation during G exposure using liquid nitrogen or microwave irradiation. Additional SAC capabilities include monitors of EEG/ECG activity, brain blood flow, blood and intracranial pressure and a syringe infusion/withdrawal pump. RESULTS: The +Gz tolerance was found to be 20-25 G and 30-35 G for rats and mice, respectively. The times to G-LOC (isoelectric EEG) at these G levels are 14.5+2.9 sec for rats and 17.6+3.3 sec for mice. The EEG remained isoelectric for an additional 10-30 sec following deceleration. Brain fixation techniques have proved to be effective for measuring metabolic alterations before, during and after the high +Gz exposure. The time course of changes in energy metabolites for both rats and mice were identical showing significant differences within 15 sec after onset. CONCLUSION: The SAC provides an excellent tool with which to study the mechanism of G-LOC at the cellular level in rodent models. The use of laboratory animals is required since this information is currently unattainable from human subjects.

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ESTIMATION OF CEREBRAL BLOOD FLOW VOLUME IN RATS DURING +Gz STRESS. S. Galindo, Jr., P.M. Werchan* and A.R. Shahed. KRUG Life Sci., Operational Tech. Corp., and Crew Technology Division, Armstrong Laboratory, Brooks AFB TX 78235-5000.

INTRODUCTION: +Gz induced loss of consciousness (G-LOC) has been proposed to result from a critical reduction of cerebral blood flow (CBF) during high +Gz stress. However, an accurate measurement of CBF during +Gz stress has been difficult to accomplish. Methods such as transcranial doppler and radiolabelled microspheres have been used in humans and primates to measure CBF, but neither method estimates residual blood in the brain during +Gz stress. In the present study, 3 other methods to estimate CBF in rats and mice were used. METHODS: Rats were exposed to a single +25 Gz and brain samples were collected by freeze fixation at desired times. Mice, similarly were exposed to +15 to 35 Gz for 30 s and brains were fixed by microwave. Brain tissue hemogenates were analyzed for total protein, hemoglobin (Hb) and iron (Fe). RESULTS: Total protein (25%) and Hb (38%) content decreased maximally 15 s after onset of +25 Gz in rats. Total Fe content showed a similar decrease. Total protein concentration in mice brain decreased at +20 Gz and higher. Hb and Fe content in mice brain tissue are being investigated. CONCLUSION: The decreases in total protein and Hb are indicators of a decrease in total blood flow to the brain. But the presence of Hb suggests that trapped blood remains in the brain. We believe that this residual blood acts as an energy pool that could delay the onset of G-LOC in a high +Gz environment that follows a decrease in carotid artery blood pressure.

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CEREBRAL BIOCHEMICAL BASIS OF +Gz INDUCED LOSS OF CONSCIOUSNESS (G-LOC). A.R. Shahed and P.M. Werchan*. Operational Tech Corp and Crew Technology Div., Armstrong Laboratory, Brooks AFB TX 78235.

INTRODUCTION: Although G-LOC in pilots is known to have occurred as early as World War I, its mechanism is unknown. G-LOC occurs in conjunction with a critical reduction in cerebral blood flow during high +Gz exposure. Eye level arterial blood pressure is reduced to zero within 2 sec, but G-LOC is observed 7-10 sec after the onset of +Gz. This suggests that the reduction in blood flow may lead to factors that cause G-LOC. The present study investigates the effect of +Gz exposure on rat brain metabolism. METHODS: Awake rats with implanted EEG electrodes were restrained and placed on our small animal centrifuge. Control rats were exposed to base +Gz and experimental group was exposed to +7.5 to +25 Gz for 30 s and brain samples were collected 1 m post +Gz. Two other groups of rats were exposed to +25 Gz for 0, 15, or 30 s and brain sampled immediately. Brain extracts were analyzed for glucose, lactate, creatine phosphate (C-P) and adenosine triphosphate (ATP). RESULTS: G-LOC was observed 14.5 + 3 s after the onset of > +20 Gz with the EEG remaining isoelectric for an additional 15-34 s. A significant increase in lactate (87 and 118%) level and a decrease in glucose (23 and 46%), C-P (52 and 63%) and ATP (44%) were observed 15 s and 30 s after +Gz onset. CONCLUSION: These changes in brain energy metabolism within 15 s of +Gz onset suggest that since 50 to 60% of brain total energy is used for maintaining cellular ionic gradients, G-LOC may occur to slow metabolic rate to conserve energy thereby preventing tissue lactate accumulation and resulting acidosis.

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USE OF EEG SPECTRAL ANALYSIS TO IDENTIFY G-INDUCED LOSS OF CONSCIOUSNESS (G-LOC) IN THE RAT. S.K. Garcia, J. Garza, D.J. Coffey, and P.M. Werchan*. Armstrong Laboratory and KRUG Life Sciences, Brooks AFB TX 78235.

INTRODUCTION. Despite numerous technological advances to improve G-tolerance, loss of consciousness due to +Gz stress continues to be a problem with fighter pilots. In recent years, research has focused on the use of EEG relating G-LOC with cerebral activity. It has been shown that with G-LOC EEG amplitude decreases and can become isoelectric. However, the isoelectric point may occur beyond useful consciousness. Thus changes in EEG frequency components during this period may be a more sensitive indicator of the level of consciousness. METHODS. Male rats (250-350g), with surgically implanted bipolar parietal electrodes, were exposed to +25 Gz in a small animal centrifuge until loss of EEG amplitude (G-LOC). EEG recordings were obtained for each rat and subjected to EEG spectral analysis. RESULTS. Preliminary results suggest that during baseline and onset of acceleration EEG activity consisted of all component frequencies from 0-30 Hz. Early in the G exposure there was a significant shift towards the delta frequency band (0-4 Hz). At the point of isoelectric EEG, delta frequency disappeared along with all other frequencies. Early recovery following G exposure was again marked by a pronounced increase in delta activity. CONCLUSION. Spectral analysis of EEG provides a more objective/sensitive approach to G-LOC detection by identifying changes in component frequencies.

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RAT BRAIN EDEMA AFTER MULTIPLE +Gz EXPOSURES. J.A. Barber, A.R. Shahed and P.M. Werchan*. KRUG Life Sci., Oper. Tech. Corp., Crew Technology Division, Armstrong Laboratory, Brooks AFB TX 78235-5000.

INTRODUCTION: Phenomenon of acceleration or +Gz induced loss of consciousness (G-LOC) is known to occur in pilots of high performance aircraft and has been reproduced in animal models in the laboratory. It has been demonstrated that during +Gz exposure cerebral blood flow is significantly reduced resulting in brain ischemia. This situation could be repeated several times by pilots during flight maneuvers. Unfortunately, we know little about pathological effects on the brain. One of the earliest pathologic changes of ischemic stress is brain edema. In the present study occurrence of brain edema in the rat after +Gz exposure was investigated. **METHODS**: Male rats (n=4) were exposed to 6, +25 Gz runs with 5 min rest period between each run. Brains were removed 15 min, 30 min, 3 hr, and 24 hrs (n=5 in each group), after the last centrifuge run, and weighed (wet weight) and then oven dried to constant dry weight. The ratio of wet to dry weight was used to assess % change in brain's water content (edema). **RESULTS**: The data show that % of water in brain tissue increased significantly up to 3 hr after the centrifuge run, but not after 24 hr. The largest increase in water (2%) was observed at 15 min. **CONCLUSION**: These results show that multiple +Gz exposure can cause brain edema. Edema can result in post +Gz exposures hypoperfusion and could cause secondary ischemia thus exacerbating the functional effects related to G-LOC.

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IFR CAPABILITY LOWERS ACCIDENT RATE OF CIVILIAN HELICOPTER AMBULANCES: A MULTIFACTORIAL EPIDEMIOLOGIC STUDY. R.B. Low*, J.A. Sousa, D. Dufresne, Patty Collins, J. Nelson, C. Brown. East Carolina University School of Medicine, Greenville, NC 27858

The accident rate of civilian helicopter ambulances had been a matter of considerable concern. There are multiple studies of the accidents, but epidemiologic comparisons of accidents to safely completed flights are rare. Our previous study of US and Canadian civilian helicopter ambulances was presented at the Aerospace Medical Association meeting in 1989: at that time the only statistically significant finding was a marked decrease in the accident rate of busy helicopter ambulance programs, compared to the less busy ones. Since then the use of IFR helicopters has doubled from 15% of patients transferred to 30% ($p<.0005$). The accident rate of these IFR certified helicopters is 11.3/million, compared to 46.6 for helicopters certified only for VFR flight ($p=.020$). There have been no accidents involving helicopters certified for IFR flight, flown by IFR current pilots who are permitted to fly under IFR at their discretion ($p=.023$). Logistic regression shows a safety benefit of IFR capability that is independent of program size ($p=.0095$). Programs that have had one accident seem at increased risk to have another one ($p=.05$). There continues to be a tendency for busy programs to have a lower accident rate than the less busy ones ($p<.0005$).

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CLUSTER INVESTIGATION OF AIRCRAFT MISHAPS. D.A. SALISBURY*. R.A. ALLNUTT*. Defence and Civil Institute of Environmental Medicine, North York, Ontario, Canada M3M 3B9 and Office of the Surgeon General, Tactical Air Force, Langley AFB, Virginia.

INTRODUCTION. Aircraft mishap data are frequently grouped by cause, place and time. Flight Safety Officers review this information and make inputs to the flying community based on perceived clustering of data. Not all apparent clusters are significant and traditional statistical analysis may imply significance when none is present. METHODS. Techniques analogous to those used to investigate cancer and other disease clusters are applicable to the investigation of aircraft accident clusters. Cluster analysis is confounded by ascertainment bias and the "Texas sharpshooter" effect. Several simple statistical tools including the use of the binomial distribution and Poisson's distribution are presented. CONCLUSION. When flight surgeons are made aware of clusters in aircraft mishap data, it is imperative to act. A stepwise protocol approach to clustered data analysis is outlined to aid in the allocating of scarce resources to the analysis of apparent aircraft mishap clusters.

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THE FREQUENCY OF SELF-MEDICATION AMONG U.S. NAVY AIRCREWS AND ITS ROLE IN AIRCRAFT MISHAPS. G.L.Dowell*, J.R.Brinker*, and D.F. Neri*. Naval Aerospace Medical Institute and Naval Aerospace Medical Research Laboratory, Pensacola, Fl 32508.

INTRODUCTION. The Navy prohibits the practice of self-medication in its aircrews. Self-medication is defined as the act of taking medication without the consent of a flight surgeon. Nevertheless, reports continue to reveal the unauthorized use of medications in aircrew involved in aircraft mishaps. Although self-medication is rarely listed as a causal factor in these mishaps, the anecdotal frequency of its appearance in these reports suggest the possibility of an unrecognized role. Further, the fact that highly disciplined aircrew are violating a well known regulation with some frequency speaks to the need to identify the factors pertaining to this abuse. METHOD. Naval aviators, naval flight officers, and enlisted aircrew from six training and fleet squadrons are being surveyed to identify the frequency of self-medication, the medications being used, and the conditions prompting such use. The survey is confidential in that individual anonymity is maintained during the collection process. The survey instrument elicits data on personal use of both over-the-counter and previously prescribed medications taken without medical consultation. Solicited data include: time since aircrew designation, incidence and frequency of self-medication, basis for self-medication (colds, headaches, etc.) and identification of medications used. Additionally, Naval Safety Center (NSC) and Armed Forces Institute of Pathology (AFIP) data on mishap aircrews and medication use will be reviewed for a comparison analysis. COMMENTS. The brief will review the results of the aircrew survey and correlate those results with the information obtained from the NSC and AFIP. The incidence of self-medication from the survey will be compared to the mishap data. The implications of these results for aircrew, safety personnel, flight surgeons, and policy makers will be discussed.

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THE EFFECT OF TRANS-COCKPIT AUTHORITY GRADIENT ON NAVY/MARINE HELICOPTER MISHAPS. RA Alkov*, MS Borowsky, DW Williamson and DW Yacavone*. Naval Safety Center, NAS Norfolk, VA 23511-5796.

INTRODUCTION. The pairing of pilots in the cockpit has been called the "trans-cockpit authority gradient" by Elwyn Edwards, who believes there is an optimum gradient of rank and experience or ability to allow an effective interface between aviators. In order to determine if such an optimum gradient could be identified empirically, we undertook an analysis of Navy and Marine Corps mishaps which had a pilot causal factor assigned. METHODS. All class A and B helicopter flight mishaps for the eleven calendar year period 1980-90 were examined. Mishaps were categorized into 5 pilot pairings. The distribution of the ranks of all naval aviators who were involved in aircraft mishaps which were not caused by aircrew factors was used to estimate the number of hours flown by each of the pilot/copilot combinations to arrive at the aircrew error rate per 100,000 flight hours for each category of rank pairing. RESULTS. When the most junior officers are paired with their seniors, the potential for pilot error is increased over those crews that have juniors paired together, seniors paired together, or with the junior pilot at least a Navy LT or Marine CAPT. CONCLUSIONS. The optimum authority gradient appears to occur where it is less steep with regard to experience and ability.

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IMPROPER IFR PROCEDURES IN COMMUTER AND AIR TAXI CRASHES. M.W. Lamb* and S.P. Baker.* Sunshine Aviation Safety Studies, Questa, NM 87556; Johns Hopkins Injury Prevention Center, School of Public Health, Baltimore, MD 21205.

INTRODUCTION. Of 127 commuter and 597 non-scheduled air taxi crashes during the period 1983-1988, we categorized 46 as improper IFR procedure; 67% were fatal. METHODS. NTSB briefs were reviewed for the period. An epidemiological analysis of all cases explored relationships between circumstances, hour of day, airport weather conditions, and crew factors. NTSB full reports were studied for the 11 scheduled commuters and 35 air taxi cases involving improper IFR procedure. RESULTS. Twenty aircraft were below minimums on approach; six were off course. One pilot tried to land after sighting the runway late. Six crashed attempting missed approaches, and thirteen used other improper procedures. When ceilings were low, many pilots attempted tailwind landings on runways served by ILS approaches in order to take advantage of lower straight-in minimums. 80% of the crashes were at night. Pilots often misset altimeters and avionics. CONCLUSION. Possible interventions that should be explored include night IFR route checks, requiring a given number of day IFR hours in order to qualify for night Part 135 pilot-in-command, reestablishing a minimum ceiling for all Part 135 night IFR approaches, and setting night minimum visibility at one mile.

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INCIDENCE OF INFLIGHT MEDICAL EMERGECNIES IN BUSINESS AIRCRAFT. R.T. Garrison* Wright State School of Medicine, Dayton, Ohio 45401-0297. INTRODUCTION. The incidence of inflight medical emergencies in scheduled airlines has been studied extensivley there has been no similar study of business aircraft incidences. METHODS. An analysis if inflight illness and death in business aircraft was undertaken using a mailed survey of six hundred eighty nine members of the National Business Aircraft Association. RESULTS. Twenty two point one percent indiciated they had some type of inflight illness or death in their corporate aircraft. Sixty nine point four per cent of these instances involved passengers, the rest were crew members. Eighty two point three per cent were male wheras 17.7 were female. There were three reported fatalities. The most common presenting signs or symptoms were shortness of breath, diarrhea, chest pain and loss of consciousness. CONCLUSION. The findings of this indicate there are a significant number of medical incidents on board business aircraft. The pattern of illness follows closely the findings of other studies of airline medical incidents done over the years.

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SEASICKNESS SUSCEPTIBILITY, SALIVATION AND PERSONALITY FACTORS. C.R. Gordon*, O. Spitzer, I. Doweck, A. Rolnick, A. Shupak and Y. Melamed. Motion Sickness and Human Performance Laboratory, INHI, Haifa, ISRAEL.

INTRODUCTION. We previously reported a significant positive correlation between motion sickness susceptibility (MSS) and salivary protein concentration. Other authors have reported correlations between MSS and personality factors, while yet others have described a relation between personality and salivation without mentioning MSS. The present study evaluates the relationships between MSS, salivation and personality in subjects susceptible (Ss) and subjects non-susceptible (Sns) to seasickness. METHODS. Using standard categorization, we selected a group of 29 Sns and a group of 25 Ss to seasickness. Resting and stimulated whole saliva were examined. Personality factors were evaluated by the Eysenck Personality Inventory. RESULTS. Salivary amylase levels were significantly higher in Ss than in Sns. Sns had significantly higher scores on the psychoticism scale than Ss. A significant positive correlation was found between psychoticism and the amount of the increase in salivary flow in response to stimulation. CONCLUSIONS. Significant differences in salivary amylase levels and psychoticism score are reported for subjects at the two extremes of the MSS scale. These measurements might be recommended as additional predictors of MSS.

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MAL DE DEBARQUEMENT (MD) AND HABITUATION TO SEA CONDITIONS. O. Spitzer, C.R. Gordon*, I. Doweck, Y. Melamed and A. Shupak. Motion Sickness and Human Performance Laboratory, INHI, Haifa, Israel.

INTRODUCTION. MD is the transient sensation of unsteadiness and/or disequilibrium experienced on land after disembarking from a ship. In a previous study, we reported the high incidence of MD among naval crew members. MD appeared to be related to seasickness susceptibility, but not to experience at sea. The present study evaluates the relevance to MD of habituation to sea conditions. METHODS. 116 crew members completed a questionnaire on MD and motion sickness, with emphasis on their experience of MD during their service at sea. Experience at sea ranged from 1 to 120 months (mean - 18). RESULTS. 72% of the subjects (83) had experienced MD: 29% (34) only once, 28% (32) occasionally, and 15% (17) very often. Although the appearance of MD was not related to experience at sea, most of the subjects (66%) reported a high incidence after their first sea voyages. A significant positive correlation was found between MD and seasickness susceptibility. CONCLUSIONS. MD was found to be a frequently experienced phenomenon. Although MD incidence can be explained by short-term adaptation to ship motion, its high incidence during initial voyages and its reduced occurrence with time can be partially explained by long-term habituation to sea conditions.

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DDAVP INHIBITS THE DIURESIS INDUCED BY IMMERSION IN COLD WATER. S. Farrow,* T. Kaschak, A. Mers,* and W. Lockette.* Wayne State University School of Medicine, Detroit; VAMC, Allen Park; and the University of Michigan Medical School, Ann Arbor, MI; and Naval Health Research Center, San Diego, CA.

We reported that 1-desamino-8-D-arginine vasopressin (DDAVP), an analogue of antidiuretic hormone, significantly decreased the diuresis and natriuresis induced by immersion in thermal-neutral water (33°C). Immersion in comfortable water reduces catecholamines; exposure to cold is associated with an increased concentration of these autocoids. Since vasopressin-mediated inhibition of urine and sodium excretion is modulated by adrenergic agonists, and since cold increases circulating catecholamines, we tested the hypothesis that DDAVP can also decrease the diuresis and natriuresis induced by immersion in water sufficiently cold (22°C) to increase [catecholamines]. After receiving 20 ug DDAVP or placebo intranasally, 15 sodium replete subjects were seated quietly in 22°C water for one hour. This temperature evoked shivering in all subjects. Core temperatures did not fall, but almost all subjects had a significant after-drop upon rewarming. Despite a five-fold greater concentration of catecholamines with cold water immersion compared to warm water, DDAVP significantly inhibited the diuresis induced by the cold water (in ml/hr, placebo, 310 ± 61; DDAVP, 48 ± 17, $p<0.005$). In cold water, this agent had no effect on sodium excretion (in mEq/hr, placebo, 16.7 ± 1.8; DDAVP, 14.5 ± 3.5, p=n.s.) Despite greater increases in [catecholamines], DDAVP can effectively inhibit the diuresis induced by cold water; it may reduce the volume loss from man exposed to cold environments.

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ECONOMY CLASS SYNDROME: STUDIES DURING A LONG DISTANCE FLIGHT (VANCOUVER-FRANKFURT) IN HEALTHY VOLUNTEERS. H.Landgraf*, D.Schulte-Huermann, M.von Mülmann, B. Vanselow, E.Mandler, L.Bergau* Department of Internal Medicine, University Hospital Frankfurt and Medical Department of the Deutsche Lufthansa, 6000 Frankfurt/Main, Germany

INTRODUCTION. Studies of factors possibly contributing to thromboembolic diseases were performed during a long distance flight from Vancouver to Frankfurt in the economy class of a Boeing 747-400. Altogether 18 apparently healthy volunteers were studied. METHODS. Lower leg volumes (photoelectronic device) bodyweight, blood pressure and heart rate, fluid intake (protocol) and urine production as well as several rheological and hemostaseological parameters were determined initially and after 6 and 9 hours. RESULTS. The volumes of the lower legs of all volunteers increased statistically significantly when compared to their initial values. The increase seemed to be more marked than in earlier mock up studies. Rheological and hemodynamic parameters and most of the hemostaseological parameters showed only slight and no relevant changes. Only factor VIII values showed an increase at the end of the flight. All volunteers showed a positive fluid balance and an increase in bodyweight. CONCLUSIONS. Under actual long distance flight conditions the volume increase of the lower legs seems to be more marked than during earlier mock up studies. In accordance to these studies rheological as well as hemostaseological parameters did not show relevant changes thus confirming these results.

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FLYING A BOEING 737 AIRCRAFT INCREASES THE CHANCE OF A BAROTRAUMA? H. W. Kortschot* and W. J. Oosterveld* Academical Medical Center, Amsterdam, The Netherlands.

INTRODUCTION. During the ascent of an airplane the atmospheric pressure decreases and the volume of gas within the semiclosed cavities of the middle ears and the paranasal sinuses increases, whereas the volume of the gas decreases during the descent. When the pressure in these cavities can not be equated with the cabin pressure, symptoms of barotrauma appear. Last three years several aircrewmembers of dutch airlines consulted our clinic with symptoms of otitic or sinus barotrauma. Surprisingly they all had flown a Boeing 737 aircraft. METHODS. To test the hypothesis that flying a Boeing 737 aircraft increases the chance of a barotrauma, the cabin pressurization schedule of a Boeing 737 was compared with the schedule of both a Boeing 747 and a DC 10 aircraft. RESULTS. The maximum aircraft altitude of all three airplanes is 37000 feet. The maximum cabin pressure of the Boeing 737 is 8000 feet. This is considerably above the levels of the aircrafts of the type Boeing 747 and DC 10. Respectively 5350 and 6100 feet. CONCLUSION. The pressurization schedule of the Boeing 737 aircraft is less comfortable than the schedules of the Boeing 747 and the DC 10 aircrafts. Flying the Boeing 737 aircraft seems to increase the chance of a barotrauma.

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PHYSIOLOGIC "AGE" VERSUS CHRONOLOGIC AGE IN PILOT MEDICAL STANDARDS. B. J. McKinnon. Naval Aerospace Medical Institute, Pensacola, FL 32508-5600.

INTRODUCTION. In 1959 the Federal Aviation Administration (FAA) set into place the "AGE 60 RULE". The "AGE 60 RULE" requires mandatory retirement of commercial airline pilots at age 60. The intent was to reduce "human factor" in air accidents due to the age related deteriorations in pilot performance. This has proven a highly controversial regulation in view of recent age discrimination legislation. The FAA defends the regulation on the basis that no other method has been proven accurate enough to screen pilots who wish to fly for commercial airlines after the age of sixty. The Thousand Aviator Study data is being reviewed, to determine if a physiologic standard can be derived through present medical screening modalities that can replace the present chronologic standard. METHODS. Retrospective chart review of the Thousand Aviator Study subjects examining annual exercise stress test results as a predictor of cardiovascular health and performance. RESULTS. Chart review presently on going, results not yet available. CONCLUSION. Sufficient data exists within the Thousand Aviator Study data base to determine if physiologic standards are a better indicator of age related decline in performance as compared to a chronologic standard.

PANEL ABSTRACTS

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THE AGING PILOT DILEMNA: E. Altekruse, Johnson, SC 29832 INTRODUCTION. Historically pilots emerged from WW II with reputations as fast living reckless daredevils. On the Big Screen they smoked, drank and caroused. Now we know these unhealthy life styles can have disasterous consequences. In the 1940s and 1950s, it was common to attribute those consequences to aging. As a result, the stigma of age has lead to discrimination in many forms. In 1960 the U.S. FAA established a mandatory retirement age of 60 for airline pilots. Prior to that time the retirement age for pilots varied amongst airlines. PRESENT STATUS. Currently, the application of epidemiological techniques has enlightened the medical community and society to the fact that, strictly speaking, aging has taken a "bum rap" and the etiology of some health condition can more properly be attributed to abuses listed above and other life style factors. Many agencies and institutions are now reevaluating their policies relating to the consequences of aging. PANEL. Assembled here are experts representing the FAA, National Institute on Aging, NASA, the Naval Aeromedical Institute, professionals from academia and medical directors of international airlines. They will bring us up to date on their institutions endeavors to scientifically determine the consequences of aging and establish realistic policies relating to age, qualification and retirement.

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THE AGING PILOT QUESTION: HISTORY AND TECHNOLOGY STATUS. *S.R. Mohler. Wright State University , School of Medicine, Dayton, Ohio 45401.

INTRODUCTION. The widespread practices of unhealthy life-styles among large numbers of pilots in the 1940's and 1950's resulted in high prevalence among older pilots of cardiovascular and pulmonary disease. In addition, alcohol abuse and alcoholism are estimated to have affected as high as 1 in 5 pilots. The consequences of unhealthy life-styles began to particularly be manifested in middle age. In the 1940's and 1950's it was quite common to ascribe life-style caused diseases to the "aging process." Accordingly, although many pilots who did not practice "deleterious to health" life-styles, and who demonstrated a robust post middle-age health and vitality, a mandatory age cut-off to get rid of those whose life-style led to early disease seemed logical. DEVELOPMENT. A mandatory age limit , thus, was institutionalized by Government for airline pilots in 1960, even though it was not the correct solution to the problems of alcoholism, smoking, poor nutrition, lack of exercise, obesity, and other life-style practices. Untreated hypertension was a major life-shortening problem also. TODAY. Modern diagnostic and treatment technology, along with knowledge of disease prevention, and modern performance assessments that provide objective simulator and flight measures, justify the abolition of the now-outdated age 60 cut-off limits for airline pilots flying under FAR 121.

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STUDIES ON MANDATORY RETIREMENT AGE FOR PILOTS. P.S. Della Rocco and D.S. Schroeder*. Human Resources Research Division, FAA Civil Aeromedical Institute, Oklahoma City, OK 73125.

INTRODUCTION. The "Age 60 Rule" (14 C.F.R. Part 121) has generated varying levels of controversy during its 30 year existence. Research by Golaszewski (1983) has been used to support the conclusion that pilots of age 60 and older have higher accident rates. Questions concerning these findings and other issues surrounding the regulation led the FAA Associate Administrator for Regulation and Certification to renew research efforts on the relationship between age, experience and pilot performance. APPROACH. Information will be presented about the status of ongoing research within the FAA concerning the "Age 60 Rule". Research studies were designed to improve upon the historical methods of investigation, as well as to pursue research recommendations from groups of experts that had previously reviewed the question. The first study consolidates existing historical databases (the National Transportation Safety Board's Accident database, the FAA Airmen Certification database, and the FAA Medical database) in a replication and extension of the Golaszewski study. Analyses of pilot age, experience, and accidents will be conducted to assess the relationship. Subsequent studies assess the feasibility of using new or existing psychological and performance assessment methodologies for predicting subtle or age-related cognitive deficits in pilots. CONCLUSIONS. The purpose of these studies is to improve upon historical research methodologies that have purported to establish a relationship between age and accidents. Findings from the three investigations will be used to reassess the status of the "Age 60 Rule".

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MENTAL HEALTH ASPECTS OF THE AGING FLYER. D.R. Jones, MD.
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As fliers age, their attitude toward flying changes. The nature of this change is shaped by the original motivation to fly, and also by experince: aircraft accidents, deaths, other losses, marriage, divorce, children, job tension, finances, etc. Aging takes its own toll of perception of health, loss of "invulnerability," physical endurance, sense of slow reaction time or inability to respond to sudden novel stimuli. The rate of lessened functions differs, as does the sense of their loss and the utility of coping skills. If these skillls fail, the results may be dangerous denial, depression, counterphobic activity, fear of flying, or other pathology. Aeromedical practitioners should be familiar with these patterns, and should know how to use careful history-taking and skilful mental status evaluations to elicit information about possibly harmful patterns of adaption and behavior.

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PILOT AGING POLICIES IN INTERNATIONAL AIRLINES

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INTRODUCTION: For decades regulatory agencies adhered to an arbitrary upper age limit for pilots engaged in passenger operations. Based on these rules and other considerations airlines set up contractual agreements with unions and/or individual pilots. With the advent of modern diagnostic techniques and operational monitoring these rules and contracts were recently challenged.

DEVELOPMENT: Stress should be put on medical-physiological criteria rather than purely chronological arbitrary limits. Performance capability is essential in determining one's fitness as a pilot. Medical technology provides new diagnostic techniques which enable us to predict with better confidence that a pilot will not become suddenly incapacitated especially where the cardiovascular system is concerned. The degradation of a pilot's perceptual, psychomotor and intellectual functioning which is expected in the aging process may be detected and assessed with a great measure of confidence by physicians, co-workers and family and documented during simulator performance and line checking. In a relatively small airline like EL-AL the medical officers and flight operation supervisory staff know each pilot personally and in many cases are familiar with the family environment. This enables them to detect occasionally some hidden stresses. EL-AL maintains the long-established mandatory retirement of operating crew members at age of sixty. However it was recently agreed (as first officers only) on a yearly contract provided they fulfil the medical and operational criteria. This meets the current government regulations and we feel confident that no undue risk is involved. Similar arrangements exist in a few other airlines. Our first year's experience will be discussed.

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REVIEW OF PERFORMANCE, MEDICAL, AND OPERATIONAL DATA ON PILOT AGING ISSUES. J.H. Stoklosa, Ph.D. Life Sciences Division, National Aeronautics and Space Administration, Washington, D.C. 20546

Introduction: An extensive review of the literature and studies relating to performance, medical, operational, and legal data regarding pilot aging issues was performed in order to determine what evidence there is, if any, to support mandatory pilot retirement. Popular misconceptions about aging, including the failure to distinguish between the normal aging process and disease prosesses that occur more frequently in older individuals, continue to contribute to much of the misunderstanding and controversy that surround this issue. Results: Review of medical data related to the pilot aging issue indicate that recent improvements in medical diagnostic and treatment technology have made it possible to identify to a high degree individuals who are at risk for developing sudden incapicitating illness and for treating those with disqualifying medical conditions. Performance studies revealed that after controlling for the presence of disease states, older pilots are able to perform as well as younger pilots on many performance tasks. Review of accident data showed that older, healthy pilots do not have higher accident rates than younger pilots and, indeed, evidence suggests that older pilots have an advantage in the cockpit due to higher experience levels. The Man-Machine-Mission-Environment interface of factors can be managed through structured, supervised, and enhanced operations, maintenance, flight reviews, and safety procedures in order to endure safe and productive operations by reducing the margin of error and by increasing the margin of safety. Conclusion: There is no evidence indicating any specific age as an arbitrary cut-off point for pilots to perform their flight duties. A combination of regular medical screening, performance evaluation, enhanced operational maintenance, and safety procedures can more effectively ensure a safe pilot population than can a mandatory retirement policy based on arbitrary age restrictions.

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FLIGHT CREW FATIGUE IN ADVANCED LONG-HAUL COMMERCIAL AIRPLANES - R.C. Graeber*. Boeing Commercial Airplane Group, Seattle, WA.

The rapid increase in two-crew glass cockpit airplanes operating on long-haul routes has generated international interest in better understanding how fatigue affects crew performance on advanced commerical flight decks. This topic provides a unique opportunity for human factors experts to focus on a combination of biomedical, operational, and equipment design issues that directly impact human operators. The panel will examine the issue from the different perspectives of individuals who are actively involved in the ongoing debate. The presentations will emphasize the physiological basis for long-haul crew fatigue, the contribution of the flight deck environment to crew alertness, and the operational factors unique to such airplanes in the long-range environment. Panelists will also discuss both regulatory, operational and design approaches for mitigating the potentially negative effects on overall crew performance. A general discussion will follow completion of the individual papers.

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ALERTNESS MANAGEMENT IN TWO-PERSON LONG-HAUL FLIGHT OPERATIONS. M. R. Rosekind and P. H. Gander*. NASA Ames Research Center, Moffett Field, CA and San Jose State University Foundation at NASA Ames Research Center.

Long-haul flight operations involve cumulative sleep loss, circadian disruption, and extended and irregular duty schedules. These factors reduce pilot alertness and performance on the flightdeck. Conceptually and operationally, alertness management in flight operations can be divided into preventive strategies and operational countermeasures. Preventive strategies are utilized prior to a duty period to mitigate or reduce the effects of sleep loss, circadian disruption and fatigue during subsequent flight operations. Operational countermeasures are used during operations as acute techniques for maintaining performance and alertness. Results from previous NASA Ames field studies document the sleep loss and circadian disruption in three-person long-haul flying and illustrate the application of preventive strategies and operational countermeasures. One strategy that can be used in both a preventive and operational manner is strategic napping. The application and effectiveness of strategic napping in long-haul operations will be discussed. Finally, long-haul flying in two-person highly automated aircraft capable of extended range operations will create new challenges to maintaining pilot alertness and performance. Alertness management issues in this flight environment will be explored.

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A PILOT'S PERSPECTIVE ON LONG HAUL OPERATIONS IN TWO CREW COCKPITS. - Paul D. Gallaher, Northwest Airlines, Minneapolis, MN.

A comphehensive approach to the issue of flight crew fatigue must address crew performance requirements as well as psychophysiological factors such as sleep loss and circadian rhythmicity. Emphasis on the former has increased with the relatively recent introduction of advanced two-crew airplanes and the acompanying growth in flight deck automation and CRT displays. This paper will address these factors from a pilot's perspective. Included will be a description of typical flight profiles and crew duties along with the associated occurrence of boredom and fatigue. One topic of particular concern is the programming of automated flight systems in terminal areas at the end of long-haul flight segments. The discussion will also focus on the use of augmented crew during extended range operations and the problems encountered in the scheduling of rest breaks in onboard sleep facilities.

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TWO-MAN CREW OPERATIONS: PILOT'S VIEWPOINT. D. E. Hudson*. Airline Pilots Association- Aeromedical, Denver, Colorado.

Commercial air operators are moving toward greater use of advanced-technology aircraft with increasing levels of automation. Frequently, this transition entails a reduction in the size of cockpit crew; specifically, from 3 to 2 pilots, eliminating the position of flight engineer. This reduction is being accomplished in the context of a dramatic increase in commercial traffic, no revision in FAA Flight Time/Duty Time regulations and efforts by commercial carriers to exploit the full potential of the new, long range aircraft coming into service. Professional pilot groups are very concerned that human factors considerations, i.e., fatigue, circadian dysrhythmia, scheduling parameters and the human/automa-tion interface are not being adequately addressed.