INTRODUCTION. Whern inadequate stimuli are available for accommodation, as in the dark or under low contrast conditions, the lens pumps a variable amount of accommodation into resting positions that are reliable, under autonomic control, ad can change with visual task demands. We hypothesized that motion sickness in a flight simulator might result in dark focus activity before and after simulator exposure when comparisons were made between sick and non-sick pilot subjects. In two of these experiments, the average shift in dark focus for the sick subjects was found to exceed 1 diopters when each subject was compared to his own baseline. In the third experiment, the group showed a significant shift outward of small amount and the subjects who were sick showed significantly less outward movement those who were symptom free. CONCLUSIONS. Although the relationship is not simple one, dark focus changes in accommodation imply parasympathetic activity. Because changes can occur in relation to endogenous and exogenous events, such measurement may have useful applications, as demonstrated in the current studies of visually coupled systems, virtual reality systems, ad space adaptation syndrome.

ESTIMATION OF CEREBRAL BLOOD FLOW VOLVNE IN RATS DURING Gz STRESS. A.K. Shahed* and P.N. Werchan*, Moo. of 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 reported to result from critical reduction of cerebral blood flow (CBF) during high Gz stress. However, accurate measurement of CBF during high Gz stress has been difficult to accomplish. Methods such as PET require the constant supply of tritiated water to maintain brain glucose levels. The present study investigates the effect of Gz on blood flow and G-LOC. In the present study, 3 other methods to estimate CBF were used. METHODS: Rats were exposed to a single +25 Gz and brain samples were collected at the time of G-LOC. The blood flow was measured by a Microflowmeter, which is more sensitive than the subjective scorings to indicate the adaptation of G-LOC. A unique capability of brain fixation during Gz exposure using liquid nitrogen or microwave irradiation. Additional CBF capabilities include mapping of the CBF activity, blood flow, blood and intracranial pressure and the synaptic input through slow flow. 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+1.3 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 and during the high Gz exposure. The time course of changes in energy metabolism and CBF are presented in the current study. The results of these studies indicate that G-LOC is a complex process that involves a decrease in cerebral blood flow and a decrease in energy metabolism. This decrease in energy metabolism might be a result of a critical reduction of cerebral blood flow and a decrease in energy metabolism. This decrease in energy metabolism might be a result of a critical reduction of cerebral blood flow and a decrease in energy metabolism. This decrease in energy metabolism might be a result of a critical reduction of cerebral blood flow and a decrease in energy metabolism. This decrease in energy metabolism might be a result of a critical reduction of cerebral blood flow and a decrease in energy metabolism.

INTRODUCTION. Despite numerous technological advances to improve G-tolerance, loss of consciousness due to Gz stress continues to be a problem with high performance aircraft. In recent years, research has focused on the use of EEG relating G-LOC with cerebral activity. It has been shown that with 6Gz EEG amplitude decreases and can become isoelectric. However, EEG isoelectric point may occur beyond useful consciousness. Thus changes in EEG frequency components during the portion of consciousness might be more sensitive indicator of the level of consciousness. METHODS. Male rats (n = 20) were exposed to Gz's 6, 12, and 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 electric Gz, delta frequency disappeared along with all other frequencies. Early recovery following exposure was again marked by a pronounced increase in delta activity. CONCLUSION. Spectral analysis provides a more objective/sensitive approach to G-LOC detection by identifying changes in component frequencies.


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 lab. 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 = 10) were exposed to Gz's 6, 12, and 25 Gz with 5 min rest periods 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 percent of water in brain tissue increases significantly up to 3 hr after the centrifuge run, but not after 24 hr. The largest increase in water (25%) was observed at 15 min. CONCLUSION. These results show that multiple Gz exposure can cause brain edema. Edema can result in post Gz exposure hypotension and could cause secondary ischemia in the brain. Ischemia exacerbates the functional effects related to G-LOC.


The accident rate of civilian helicopter ambulances has 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 = 0.005). The accident rate of all IFR helicopters is 11.3/1000, compared to 46.4 for helicopters certified only for VFR flight (p = 0.02). There have been no accidents involving helicopters certified only for IFR flight flown by IFR current pilots who are permitted to fly under IFR at their discretion (p = 0.03). Logistic regression shows a safety benefit of IFR capability that is independent of program size (p = 0.0095). Programs that have had one accident seem at increased risk to have an increased accident rate than the less busy ones (p = 0.005).


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 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 a highly disciplined aircrew is violating a well known regulation with some frequency speaks to the need to identify the factors pertaining to this abuse. METHODS. Naval aviators, naval flight officers, and enlisted flight officers 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 solicits 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 (cold, headache, 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. CONCLUSIONS. 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.

THE EFFECT OF TRANS-COCKPIT AUTHORITY GRADIENT ON NAVY/MARINE HELICOPTER MISHAPS. RA Alkova, MS Berkovsky, DM Williamson and GM Yacoubian. Naval Safety Center, NAS Norfolk, VA 23511-5798.

INTRODUCTION. The pairing of pilots in the cockpit has been called the "trans-cockpit authority gradient" by Edwyn Edwards, who believes there is an optimum gradient of rank and experience 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 these 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 least steep with regard to experience and ability.
MAL DE DÉBARQUEMENT (MD) AND HABITATION TO SEA CONDITIONS.
Motion Sickness and Human Performance Laboratory, INHI, Halfa, Israel.
INTRODUCTION. MD is the transient sensation of unsteadiness and/or disorientation experienced on land after disembarking from a ship. In a previous study, we reported the high incidence of MD among naval crew members. MD appears to be related to seasickness susceptibility, but not to experience with motion sickness conditions. The present study evaluates the relevance to seasickness of motion sickness susceptibility, with emphasis on their experience with motion sickness during their service at sea. METHODS. 116 crew members completed a questionnaire about MD and motion sickness, with emphasis on their experience with motion sickness during their service at sea. The questionnaire included a 21-point scale for MD experience during the last voyage and a 10-point scale for motion sickness. RESULTS. 72% of the subjects had experienced MD during their service at sea. A significant positive correlation was found between MD and motion sickness susceptibility. CONCLUSIONS. MD was found to be a frequently experienced phenomenon. MD is related to high incidence during initial voyages and its reduced occurrence can be explained by short-term adaptation to ship motion or high incidence during initial voyages and its reduced occurrence can be explained by short-term adaptation to ship motion. MD is related to high incidence during initial voyages and its reduced occurrence can be explained by short-term adaptation to ship motion.

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 relationship between MSS and salivation without mentioning MSS. The present study evaluates the relationship between MSS, salivation and personality in 116 naval crew members. METHODS. Using standard categorization, we selected a group of 52 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 and salivary flow were significantly higher in Ss than in Sns. Sns had significantly higher scores on the psychotism scale than Ss. A significant positive correlation was found between psychotism and the amount of the increase in salivary flow in response to stimulation. CONCLUSIONS. Significant differences in salivary amylase levels and salivary flow were reported for subjects at the two extremes of the MSS scale. These measurements might be recommended as additional predictors of MSS.
FLYING A BOEING 737 AIRCRAFT INCREASES THE CHANCE OF A BAROTRAUMA?
H. W. Kortchotch and W. J. Oosterholt Academic Medical Center, Amsterdam, The Netherlands.

INTRODUCTION. During the ascent of an airplane the atmospheric pressure decreases. The volume of the cabin pressurized cavities of the middle ears and the paranasal sinuses increases, whereas the volume of the tympanic membrane decreases during the descent. When the pressure in these cavities is greater than the cabin pressure, symptoms of barotrauma appear. 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 39,000 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. CONCLUSION. The pressurization schedule of the Boeing 737 aircraft seems to increase the chance of a barotrauma.

PANEL ABSTRACTS

THE AGING PILOT DILEMNA: E. Altkruse, Johnson, SC 29812

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 disastrous 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. As technology and sophistication of aviation and medical techniques has enlightened the medical community and society to the fact that, strictly speaking, aging has taken its "bus rap" and the stigma 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.

STUDIES ON MANDATORY RETIREMENT AGE FOR PILOTS. P. S. Della Rocca and P. S. Schroeder.

Human Resources, Research Division, FAA Civil Aeromedical Institute, Oklahoma City, OK 73128. INTRODUCTION. The "Age 60 Rule" (4 C.F.R. Part 121) has generated varying levels of controversy during its 30 year existence. Research by Golazewski (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, qualification and pilot performance. APPROACH. Information will be presented on the status of ongoing research within the FAA concerning the "Age 60 Rule." Research studies set designing to improve 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 Golazewski study. Analyses of pilot age, experience and accidents were conducted to determine a relationship. Subsequent studies assess the feasibility of using new existing psychological and performance assessment methodologies for predicting subtle age-related cognitive deficits in pilots. CONCLUSIONS. The purpose of these studies is to improve upon historical research methodologies that have purposed to identify a relationship between age and accidents. Findings from the three investigations will be used to reassess the status of the "Age 60 Rule".


As fliers age, their attitude toward flying changes. The nature of this change is shaped by the original motivation to fly, and also by experience: 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 skills fail, the results may be dangerous denial, depression, counter-phobic 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 skillful mental status evaluations to elicit information about possibly harmful patterns of adaption and behavior.

PHYSIOLOGIC "AGE" VERSUS CHRONOLOGIC AGE IN PILOT MEDICAL STANDARDS. B. J. McIlroin, Naval Aerospace Medical Institute, Pensacola, FL 32506-5600. 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 Aviators 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.
PILOT AGING POLICIES IN INTERNATIONAL AIRLINES

I. GLAZER, M.D.

Chief Medical Officer EL-AL ISRAEL AIRLINES LTD. BEN GURION AIRPORT, ISRAEL.

INTRODUCTION: For decades regulatory agencies adhered to an arbitrary upper age limit for pilots engaged in passenger operations. Based on these regulations, many commercial 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 age 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 documented during simulation 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 fulfill 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.

REVIEW OF PERFORMANCE, MEDICAL, AND OPERATIONAL DATA ON PILOT AGING ISSUES. LISHI STALING. 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, occupational, and legal 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 processes 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 a high degree of individuals who are at risk for developing sudden incapacitating stress 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-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 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.

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 commercial flight decks. This topic provides a unique opportunity for human factors experts to focus on a combination of biomedial, 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 flight 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.

ALERTNESS MANAGEMENT IN TWO-PERSON LONG-HAUL FLIGHT OPERATIONS. M. R. Rosekind and P. H. Gonder*. 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.

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

A comprehensive 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 airways. The accompanying 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 plans 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.


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/automation interface are not being adequately addressed.