ASSESSING MEDICAL RISK FOR HUMAN COMMERCIAL SPACEFLIGHT

ÉVALUATION DU RISQUE MÉDICAL POUR UN VOL SPATIAL COMMERCIAL AVEC PASSAGERS

Authors: JM Vanderploeg, TL Castleberry

Affiliation of first author: University of Texas Medical Branch at Galveston

Address for communication:
University of Texas Medical Branch at Galveston, 301 University Blvd., 2.102 Ewing Hall, Galveston, Texas, USA, 77555-1110 
jmvander@utmb.edu

Introduction: The preparation leading up to human commercial spaceflight has revealed that many potential spaceflight participants (SFPs) have significant medical histories and ongoing medical conditions that may raise the risk to their health and safety under the stresses of a spaceflight. Under the regulatory regimen in the United States, the Federal Aviation Administration has instituted a process of Informed Consent rather than a set of medical standards against which SFPs are to be evaluated. Consequently, each spaceflight operator must establish for themselves the criteria by which they evaluate and accept customers for a spaceflight.

Methods: Research test subjects and potential SFPs are asked to complete a detailed medical questionnaire as part of their medical evaluation for consideration of acceptance for a future spaceflight or acceleration training in a centrifuge. Each individual's medical questionnaire is independently evaluated by two aerospace medicine specialists and scored on a 1 to 10 scale with 1 being no medical concerns and 10 being highest risk and unlikely to be accepted for spaceflight or acceleration research participation. Further information is requested from individuals who have significant medical history or ongoing medical conditions.

Results: Our results from evaluating nearly 200 individuals indicate that approximately 85% are scored in the 'Green' range of 1 to 4; 12% are scored as 'Amber' in the 5 to 7 range; and 3% are scored in the 'Red' range of 8 to 10. Those in the Amber range are considered for research participation or future spaceflight if their medical status can be further improved or is stable with proper medical treatment. Those in the Red range are excluded for future participation unless significant improvement in their medical status can be achieved.

Conclusions: Empirically we can postulate on what increases risk levels from a medical perspective and prophylactically attempt to mitigate that risk. However, informed consent, at this stage, should identify that added risk as largely unknown until we have actual spaceflight experience with sufficient people with various medical conditions to make evidence-based risk assessments.
Commercial orbital spaceflight provides access to space for individuals that are not career astronauts. These spaceflight participants are older and may have medical conditions not previously flown in space. The first payload specialists flew on the Space Shuttle to support company payloads and more recently were supported by the Russian program. Flights with companies such as Boeing and SpaceX that support commercial crew for NASA may provide wider space access for spaceflight participants.

UTMB provided the screening and operational medical support for six of eight spaceflight participant Soyuz flights to the ISS and has screened many others for back-up roles and future flights. These candidates are screened based on the ISS and Russian medical requirements. Following the initial screen, the spaceflight participants are again evaluated by the Russian medical team and presented to the ISS multilateral space medicine board. Medical certification procedures and typical medical findings from spaceflight participants are reviewed. Medical risk mitigation strategies to be discussed include additional and focused diagnostic testing, monitored preflight analog environment exposure, optimum pharmaceutical control of existing medical conditions, and certain surgical interventions.

Following medical approval for short-duration orbital flight, each participant undergoes extensive training and has appropriate medications manifested for the flight. Immediate preflight examination and inflight private medical conferences provide timely interaction for medical issues arising in flight. The frequency of inflight medical communication depends on medical status and is altered real-time based on need.

Experience with orbital spaceflight participants is limited; however, as access to space widens through suborbital programs plus the orbital CST-100 and Crew Dragon, the need to safely fly individuals with medical challenges will accelerate. Finally, when launch vehicles and destination facilities are totally private, medical certification responsibility changes to the private sector, and a thoughtful process for appropriate medical approval must be developed.
In 2012 the UK Civil Aviation Authority was tasked by government to review and report on the operational and regulatory requirements needed to facilitate spaceplane operations in the UK. Medical aspects of the Spaceplanes I project included the assurance of flight crew fitness to fly, training of pilots and passengers in the effects of high G forces, the necessary infrastructure (encompassing equipment and Aviation and Space Medicine expertise) and information that would be needed by operators. The review was published in July 2014.

Further work is subsequently being undertaken to establish the regulatory framework to allow spaceplane flights from a UK spaceport. Although space tourism is the main purpose, spaceplane flights also present opportunities for research that requires a microgravity environment.

The medical tasks that form part of the operations workstream in the Spaceplanes II project include medical requirements for spaceplane flight crew and guidance for operators on medical considerations for passengers and the management of medical risks. The regulatory approach has the overall aim of minimising harm to the occupants of the spaceplane and uses the concept of informed consent for passengers. The review will consider the likely hazards to which the occupants may be exposed and how the risks may be mitigated. Aviation and Space Medicine capability will be central to the successful introduction of spaceplane operations in the UK.
Our ability to understand and treat medical conditions has developed at a dramatic pace as technology impacts the effectiveness of medical research. The need for better treatments grows as developed societies age. The potential exists for this need to soon develop to crisis proportions. A new field of medicine, that of space medicine, with its symbiotic relationship with technology, has significant commonality with terrestrial medicine’s need to combat the aging process and its effects.

Many of the effects of spending time in space are closely related to those caused by ageing processes or an overly sedentary lifestyle. Significant research and effort has been, and continues to be, directed by the space industry towards the prevention of deconditioning caused by space. In so doing the space life science / medicine community is gaining a better understanding of how the processes of physical deconditioning occur and how they might be countered. For example, we now have an improved knowledge of how best to load and stimulate bone to combat bone loss in sedentary subjects. This can be coupled with a high-protein, high-alkaline diet to decrease bone resorption, further preventing the deconditioning of bone during inactivity. Other examples of translational benefits are that the adoption of short periods of standing or simple locomotion type activity during periods of bed rest can reduce postural instability when normal ambulation is once again resumed; and may reduce the losses of insulin sensitivity, muscle cross-sectional area and tendon stiffness noted to occur during space analogue inactivity studies.

A new age approaches for developed societies; one in which the percentage of the population considered elderly far exceeds that of today. But developed societies will not stop expanding the boundaries of our physical world and consequently space exploration will grow. We can harness the budgets and effort expended by the space medicine community supporting the human condition in space, to improve terrestrial healthcare as the ‘era of age’ on Earth approaches.
Introduction: Suborbital spaceflight for fee paying passengers is likely to commence within the next few years. One of the significant physiological stressors that spaceflight participants (SFP) will experience is G, be it Gz, Gx, or a combination of both. Much debate exists about what G-training, if any, SFP are likely to require, and whether this training should be optional or compulsory. Centrifuge based G training has several benefits for the prospective SPF, and the benefit of such G training can be assessed objectively by an analysis of the influence G training has on the likelihood of G-induced Loss of Consciousness (GLOC), and the G level that GLOC occurs.

Methods: A retrospective study examined the outcome of 458 centrifuge runs involving well briefed but untrained subjects aged 18-50 undergoing their first day's session on a centrifuge. All of the runs were conducted at the QinetiQ centrifuge facility at Farnborough, UK over a 6 year period. The incidence of GLOC, and the acceleration at which GLOC appeared in these untrained subjects, was compared to data from well-trained subjects.

Results: The incidence of GLOC in untrained subjects was 1.5% (7 in 458), and occurred at accelerations over the range 2.8 to 4.0 +Gz (mean 3.6Gz). This compares to an incidence level of < 0.1 % in well trained subjects.

Conclusions: The results indicate that, amongst other tangible benefits, centrifuge training plays an important role in reducing the incidence of GLOC at the levels likely to be experienced by SFP. GLOC during spaceflight could be viewed as a commercial disaster, destroying the experience for both the individual and fellow passengers. Centrifuge training significantly reduces the risk.
MONITORING TISSUE OXYGEN SATURATION IN MICROGRAVITY: A PARABOLIC FLIGHT STUDY

SURVEILLANCE DE LA SATURATION EN OXYGEN DES TISSUES EN MICROGRAVITÉ: UNE ÉTUDE SUR DES VOLS PARABOLIQUES

Authors: TG Smith, F Formenti, PD Hodkinson, M Khpal, BP Mackenwells, NP Talbot

Affiliation of first author: University of Oxford

Address for communication:
University of Oxford, Aerospace Medicine Research Group, Nuffield Division of Anaesthetics, John Radcliffe Hospital, Oxford, Oxfordshire, UK, OX3 0RW
thomas.smith@ndcn.ox.ac.uk

Introduction: A moderately hypobaric and hypoxic cabin atmosphere is proposed by NASA and others for future spacecraft and crew habitats, so as to make extravehicular activity safer and easier by minimising the associated risk of decompression sickness. This has raised concerns about potential hypoxia-mediated adverse effects on astronauts. Noninvasive technology for measuring tissue oxygen saturation (StO2) that has been developed for use in critically ill patients may provide a useful means of monitoring oxygenation during spaceflight, possibly including the detection of subtle tissue hypoxia that may not otherwise be apparent.

Methods: We undertook a formal evaluation of a handheld portable StO2 monitor, the recently-developed InSpectra StO2 Spot Check device. The aim was to establish its basic function in microgravity using parabolic flights. Although primarily a technical evaluation, unique StO2 data were obtained from six subjects in the course of this evaluation, and we took the opportunity to conduct a preliminary analysis of the effect of dynamic transition from modest hypergravity (up to ~1.8 G) to 0 G.

Results: The InSpectra technology operated normally in all gravity conditions. There was considerable variability in StO2 between and within individuals, but we consistently observed a slight fall in StO2 in each subject on transition to microgravity. Overall, StO2 decreased by 1.1 ± 0.3% in microgravity.

Conclusions: This study demonstrates the potential for exploring the use of StO2 monitoring in space. The very small reduction in StO2 associated with microgravity has no physiological or clinical significance in itself, but it is interesting to speculate whether this might represent the beginning of a larger effect of microgravity on tissue oxygenation that would have continued to develop if the weightless state had been maintained. This study highlights our incomplete understanding of the physiological interaction between microgravity and hypoxia, which will be relevant to suborbital spaceflight operations as well as future long-duration exploration missions.
Introduction: The efficacy of cardiac screening programs for aircrew is highly debated.

Methods: Screening echocardiograms on pilot training applicants and noninvasive testing on asymptomatic trained aircrew from the USAF School of Aerospace Medicine's Clinical Sciences Database was analyzed.

Results: Between March 1994 and September 2006, there were 20,208 pilot applicant screening echocardiograms performed. The most common aeromedically disqualifying diagnoses were bicuspid aortic valve (N=154, 0.76%), mitral valve prolapse, N=51, 0.25%), and trileaflet aortic valve with mild aortic insufficiency (N=58, 0.29%) all of which were waiverable for continued flight duties. A permanently disqualifying diagnosis was found in 9 cases (0.045%). Noninvasive tests performed in 903 asymptomatic trained aircrew included exercise treadmill testing, nuclear stress imaging and fluoroscopy for coronary calcification. Positive predictive values were 16%, 21%, and 29% respectively for significant CAD on coronary angiography. The annual event rate of death, MI, or revascularization was 0.5% for exercise and nuclear stress testing regardless of study outcome while calcium seen on fluoroscopy yielded a 1.1% annual event rate.

Discussion: Screening echocardiography and stress testing non-stratified asymptomatic aircrew is not efficacious.
Objectives: A cross-sectional study was conducted to find the prevalence of cardiovascular disease (CVD) risk factors among Singapore male commercial pilots.

Methodology: Study population comprised of 2979 male commercial pilots who were Singapore citizens or permanent residents, and did their licensing medical examination between January and December 2013. Data of CVD risk factors, physical characteristics, and fitness assessment of pilots were retrieved from their medical records in anonymous format. Prevalence rates of CVD risk factors of pilots were compared to that of general population. Prevalence rate ratio of restriction in medical fitness certificate among pilots with CVD risk factors was calculated.

Results: Singapore pilots had a lower age-stratified prevalence of obesity, smoking, hypertension, diabetes, and hypercholesterolemia as compared to the male general population. 17.5% of pilots were in high-risk BMI category (≥ 27.5 kg/m²) for Asian population. Age-stratified prevalence of high-risk BMI was 20.7%, 20.2% and 25.4% in age-groups 40-49, 50-59 and 60-65 years, respectively. Malay ethnicity of the study population had the highest prevalence (28.7%) of being in high-risk BMI category, followed by Indians (25.8%), and Chinese (14.5%). There was an increase in prevalence of high cholesterol from age 40-49 years. Prevalence of hypertension, diabetes, and hypercholesterolemia were higher among pilots in high-risk BMI category. Prevalence rate ratio of having restriction in medical fitness certificate was significantly higher among pilots with CVD risk factors than those pilots without such morbidity.

Discussion: Lower prevalence of CVD risk factors among Singapore pilots was consistent with a healthy worker effect. The study findings support the impetus to implement policy to emphasize preventive approach to identify those with increased future medical risks for targeted health education. Combining preventive health policy with workplace wellness initiatives could result in significant improvements in health and quality of aircrew's lives, which in turn could improve flight safety besides enhancing career longevity.
Introduction: Military aircrew are generally considered to be fit and healthy. However, in order to perform high hazard occupations safely, periodic cardiovascular screening is undertaken. If abnormal, CCT or CMR may be performed.

Methods: A retrospective cohort analysis of all CCT and CMR requests to two military cardiologists for military aircrew was undertaken to assess demographics, reason for referral, results of investigation and occupational outcome.

Results: Between 2011 and 2014, 51 aircrew (93% male, median age 47 years (range 21-69)) were referred for cardiac CT (n=20), CMR (n=31) or both (n=9). Referral indications included ventricular ectopy (17.6%), other arrhythmias (15.7%), equivocal (9.8%), or positive exercise testing (9.8%) and abnormal findings on echocardiography (0.2%). Of the patients who had CMR, 9.7% had abnormal valves (33.2% mitral, 66.7% aortic). Perfusion defects were demonstrated in 3.2% of patients and late gadolinium enhancement in 29.0%. Evidence of previous myocarditis was seen in 9.7%, hypertrophic cardiomyopathy in 6.5% whilst 22.5% of CMR scans had features suggestive of athletic heart or dilated cardiomyopathy. CT demonstrated coronary calcium scores of 0 (44.9%), 1-10 (10.3%), 11-100 (13.8%), 101-400 (17.2%) and >400 (13.8%), whilst 55.2% had normal coronary arteries (CACS=0 and no luminal narrowing), 13.8% minor (<30%), 17.2% moderate (30-50%) and 13.8% severe (>50%) CAD. Of those with CAD, 7.7% had purely non-calcified plaque disease, 30.8% calcified and 61.5% mixed plaque disease.

Following investigation, 31.7% of aircrew returned to unrestricted duties, 41.7% returned to duty as or with co-pilot suitably qualified on type, and 26.6% were grounded.

Conclusion: Periodic screening with ECG and other first line investigations reveals a significant burden of cardiovascular pathology in usually asymptomatic military aircrew. Following risk stratification, a substantial number are able to return to active duties.
INTRODUCTION: Electrocardiograms (ECG) have been time honored in Flying Duty Medical Examinations (FDME). Early repolarization (ER) creates a question of possible underlying cardiovascular risk. ER is J point elevation or notching associated with concave upward ST segment, prominent T waves in 2 contiguous leads. Considered a normal variant since described 80 years ago. Possible relation to sudden cardiac death (SCD) reported by Haissaguerre et al in 2008 if the ER is in the inferior leads. The Military Flight Surgeon or Aviation Medicine Examiner (AME) must determine if this is a benign variant or undergo further evaluation. Recent reviews have focused on before and after exercise training. To evaluate the incidence and risk, data was extracted from the US Army Aeromedical Epidemiology Data Register (AEDR) at Fort Rucker, Alabama, USA.

METHODS: The US Army Aeromedical Epidemiology Data Register (AEDR) was established in 1984 with approximately 700,000 FDME for approximately 150,000 aircrew. The AEDR was searched for code G204 nonspecific ST segment elevation (early repolarization). Any associated diagnoses at the time of the most recent FDME were reviewed. Two time periods (2001-2010 A, 2010-2015 B) and two groups (applicants and rated aircrew) were evaluated.

RESULTS: During the two study periods, A and B, thirty-five (35) and thirty-four (34) cases were identified, respectively. Prevalence ranged from 0.2-2.0 per 1000 aircrew. No applicant or rated aircrew was disqualified. Search for associated ventricular fibrillation or disqualifying arrhythmia found no cases. Review of findings, and follow-up will be presented. Evaluation by FAA, JAA, ICAO, and US military will be reviewed.

CONCLUSION: Incidence of ER in US military is lower than general population of 5-13%. No cases of disqualifying arrhythmias were found. In aircrew, recommend that ER continue to be regarded as a normal variant without risk of arrhythmia or sudden death.
Coronary artery disease is a major contributor to morbidity and risk in aviators, and most jurisdictions have identified pathways to detect and manage this issue. Most regulators consider relicensing certificate holders following coronary artery stenting no earlier than 6 months post procedure. This has been based on evidence of the potential unacceptable aviation risks related to re-occlusion within this initial period.

The landscape for cardiological procedures has changed over the last number of years, with increased access to methods of early detection of coronary artery disease in asymptomatic individuals, and a change in technical aspects of coronary artery stenting, including the frequent use of drug-eluting stents.

Following an industry Cardiology workshop in late 2013, CASA introduced a change in approach to relicensing in elective stenting situations, where specific circumstances were met indicating a low risk population group. This change allowed relicensing from 6 weeks in a sub-set of individuals with factors including no established myocardial damage prior to or related to the procedure, and satisfactory functional testing following the procedure. CASA has been utilising this change to practice for a period of over 12 months.

Over this period, CASA has developed a better understanding of risks of restenosis and mitigation for this with medication use, and also has some gathered experience from the practice of certification in these situations.

This paper explores the current state of our knowledge on the use of coronary artery stents, evidence for CASA's current policy on early return to certification, and practical issues in its implementation. It then attempts to establish whether the threshold for early return to certification is appropriate and effective.
English and French Titles:

CARDIOVASCULAR PATHOLOGY IN UK MILITARY AIRCREW AND ITS OCCUPATIONAL IMPACT

LA PATHOLOGIE CARDIO-VASCULAIRE CHEZ LE PERSONNEL NAVIGANT MILITAIRE AU ROYAUME-UNI, ET SON IMPACT AU TRAVAIL

Authors:  J D'arcy,  R Chamley,  A Pavitt,  C Pavitt,  K Harron,  E Nicol

Affiliation of first author:  RAF Medical Services

Address for communication:

RAF Medical Services, Clinical Aviation Medicine Service, Centre of Aviation Medicine, RAF Henlow,
Bedfordshire, UK, SG16 6DN
joanna.d'arcy@nhs.net

Introduction: This abstract describes breadth of cardiovascular pathology seen in UK military aircrew during the first 2 years of the RAF Clinical Aviation Medicine Service and the occupational effect on flying status of each specialty.

Methods: Consecutive cardiovascular referrals over a 2 year period were included. Predictors of flying restriction on referral and following consultation were modelled using binary and multinomial logistic regression.

Results: 558 new cardiology referrals (96% male, median age 46 years (range 20 to 75)) were received. Following assessment 218 aircrew had normal cardiovascular assessment. Cardiac diagnoses included arrhythmia, Ischaemic Heart Disease (IHD), myo-pericarditis, valve disease, structural heart disease, cardiomyopathy/heart failure, cerebrovascular disease (CVD), chest pain, hypertension (HTN) and hypercholestrolaemia (HCh).

Pilots (OR 0.64 95%CI 0.44 to 0.93; p=0.02), aircrew who ultimately had normal cardiovascular assessment (OR 0.48 95%CI 0.25 to 0.94; p=0.03) and those referred for HTN/HCh modification (OR 0.44 95% CI 0.20 to 0.94; p=0.03) were less likely to have flying restrictions on referral. Following consultation, increasing age (1.03 95%CI 1.01 to 1.06; p=0.04) increased the likelihood of being made unfit solo flying. Those referred for CV risk factor modification (OR 0.29 95%CI 0.09 to 0.91; p=0.03) were less likely to be restricted. Individuals with IHD (OR 29.71 95%CI 3.34 to 262.17; p<0.01) and CVD (OR 36.56 95%CI 1.19 to 1125.40; p=0.04) were more likely to be unfit flying or controlling.

Conclusions: This abstract demonstrates the breadth of cardiovascular pathology seen in UK military aircrew and that the majority of patients restricted at referral are upgraded to full or partial flying/controlling duties after specialist consultation. IHD and cerebrovascular disease increased the likelihood of being unfit flying with increasing age associated with increased restrictions on flying.
Introduction: Neurocysticercosis is an infection of the central nervous system by Taenia solium cysticerci. According to the International League against Epilepsy, cysticercosis is probably the single most common cause of acquired epilepsy in the developing world. In India, some studies have reported neurocysticercosis as being responsible for up to 50% of epilepsy cases and up to 90% of cases of symptomatic seizures in children. There is no published study in worldwide aeromedical and military medicine literature on the impact of neurocysticercosis in military medicine and aviation. This study was carried out to analyze the nature of neurocysticercosis in officers in the IAF and its impact on aero medical disposal in aircrew.

Materials and Methods: Medical records of all officers were accessed through a medical information database which was available in electronic format since 2004. On the day of data retrieval, there were a total of 12 officers with neurocysticercosis in the database. Detailed information was retrieved from their medical records.

Results: Of the twelve officers with neurocysticercosis, two thirds (n=8) were aircrew. Of the aircrew, half were navigators. Almost two thirds of aircrew (66%, n=5) and 75% of the ground duty officers presented with a seizure. Imaging revealed a mix of solitary and multiple cystic lesions with perilesional edema. All of them received cysticidal therapy under steroid cover and AED for varying periods. None of them had a recurrence of seizure after stoppage of AED. Three navigators and one pilot have been returned to flying duties, albeit with residual calcified lesions.

Conclusion: The paper discusses CT/MRI findings along with serological testing in the diagnosis of Neurocysticercosis. Treatment paradigm in terms of AEDs in the presence of imaging abnormalities is suggested. Aeromedical disposal in the presence of residual calcified lesions is discussed. Overall, a discussion of our experience so far with neurocysticercosis and flying is discussed.
STRONG SUSPICION FOR MALARIA WITH NEGATIVE LABORATORY RESULTS: TO TREAT OR NOT TO TREAT?

FORTE SUSPICION DE PALUDISME MAÏS RÉSULTAT DE LABORATOIRE NÉGATIF: TRAITER OU NE PAS TRAITER?

Authors: MA Cima, NL Moulin, P Rodriguez, V Feuillie, B Davidson, E Lacono

Affiliation of first author: Air France, KLM, A.Argentinas, El Al

Address for communication:
Air France, KLM, A.Argentinas, El Al, 877 Stewart Ave, Suite 28, Garden City, New York, UNITED STATES, 11530
M.Cima@aol.com

Background: Despite advances in the treatment and prevention of malaria, the disease continues to affect airline crew members and recently fatal outcomes have been reported. Here we present two cases that consulted with clinical pictures highly suggestive of Malaria. One of them tested positive by lab means and was promptly treated but the second case tested negative twice creating the dilemma of administering or withholding treatment.

Observations: A 35 year old male flight attendant developed severe chills, high fevers, malaise, and a significant compromise of his health status. He had been in Africa 3 weeks earlier and did not take Malaria prophylaxis. A thick blood smear showed plasmodiums in the red blood cells and he was promptly treated with rapid resolution of his symptoms. A few hours later a 42 year old male flight attendant presented with a similar syndrome strongly suspicious for malaria. He had also been in Africa 3 weeks earlier and he neglected malaria prophylaxis as well. The lab test was negative twice 3 hours apart and he was observed carefully without treatment. As time went by, his conditioned deteriorated and he was then treated empirically with antimalarials. In the ensuing hours the fever and chills resolved and eventually he sustained a full recovery.

Conclusion: Confronted with a clinical picture highly suspected of Malaria in a patient with history of travel to endemic areas and failure to comply with prophylactic measures, the treating physician should probably offer empirical treatment as untreated disease may lead to significant disabilities or fatal outcomes. A review of the situation with specialists in Infectious Diseases shows that without exception the suggestion of treating empirically was fully justified. I propose that in similar circumstances one should apply the "Moulin Rule" and proceed with the administration of antimalarials even with negative lab results.
AEROMEDICAL DECISION MAKING IN A PILOT WITH MYOCARDIAL BRIDGE

DÉCISION AÉROMÉDICALE POUR UN PILOTE PORTEUR D’UN PONT MYOCARDIQUE

Authors: P Masrani, R Kumar, V Masrani

Affiliation of first author: V M Medical Centre

Address for communication:
V M Medical Centre, #78 B Pankaj Mansion, Dr. A.B. Road, Worli, Mumbai, Maharashtra, INDIA, 400018
punita.aviation@gmail.com

Introduction: Myocardial bridging (MB) is a congenital anomaly where a segment of epicardial artery runs intramurally through the myocardium beneath the muscle 'bridge', frequently resulting in compression of the vessel during systole. Although considered benign and asymptomatic, it is known to be associated with angina, myocardial ischemia, infarction, ventricular dysfunction, arrhythmias and sudden cardiac death (SCD). These can be potentially incapacitating in flight. Though commonly found during angiography and necropsy, not many cases have been reported in pilots. We used the ADM algorithm proposed by Navathe et al for risk analysis and determining his fitness to fly.

Methods: A 43-year-old airline pilot presented with a single episode of atypical chest pain, hypertension and non-specific ECG changes, with no evidence of ischemia. As per the DGCA policy, observation and further evaluation were required. CAG revealed mid-LAD intracardial myocardial bridge with 90% narrowing in systole becoming near normal during diastole. The pain however seemed unrelated to the MB.

Results: Review after a year ruled out further changes, ischemia, arrhythmias and hypertrophic cardiomyopathy (HCM). BP was adequately controlled. He had no family history of SCD. Using the algorithm, the pilot was considered to have an acceptable risk inspite of MB and was permitted to fly without operational restrictions. Periodic surveillance was recommended.

Discussion: Evidence shows that SCD with myocardial bridges is often associated with HCM, cardiac implants and severe exercise, though no statistics are available. Our pilot had atypical chest pain not associated with other pathologies. Thus likelihood of incapacitation and unacceptable outcome inflight was low. Medical management with beta-blockers, CCBs, diuretics and anti-platelet agents further lowered the risk associated with MB and hypertension to an acceptable level. He was considered eligible to fly. In medical conditions not frequently reported in aviation, the ADM algorithm was useful in determining the acceptability of risk and determining fitness to fly.
Introduction: The RAF set up a new Clinical Aviation Medicine Service (CAMS) for UK military personnel in 2011. Clinical and occupational data was collected from the outset so a prospective cohort study could be performed assessing the clinical, occupational and financial outcomes of the service.

Methods: For this study, consecutive patients over a 2 year period were included. Predictors of flying restriction on referral and final outcome following consultation were modelled using logistic regression. NHS Payment by Results tariffs and Defence capitation data were used to assess the financial impact of the service.

Results: 816 new referrals (94.5% male, median age 45 years (range 19-75)) were received and 1025 consultations performed. Cardiovascular disease was the commonest reason for referral. CAMS clinical activity cost (at NHS tariff) was £453,310 representing a saving of £316,173 as the service cost £137,137 to deliver over the first two years.

Thirty-eight percent (310/816) of patients had employment restrictions on referral with 49.0% of these returned to full employment following their initial consultation. Compared with cardiology, general medicine and respiratory patients were more likely to have been occupationally restricted prior to referral (50% vs. 35%, OR 1.81; 95% CI 1.18 to 2.76, p-value=0.006 and 53% vs. 35%, OR 2.12; 95% CI 1.15 to 3.90, p-value = 0.016 respectively). Overall 581/816 (71.2%) of patients returned to full employment with 98/816 (12.0%) unable to continue in any aircrew role. The service saved 10,000 lost working days per year at an estimated occupational saving of approximately £1 million per annum.

Conclusions: This bespoke service has allowed rapid, occupationally relevant clinical care to be delivered with both time and financial savings. This model may have significant occupational and financial relevance for other environmental and occupational medical areas.
CASE HISTORY: A 'STRIKINGLY HARMLESS' TYPE OF SUBARACHNOID HAEMORRHAGE IN AN AIR TRAFFIC CONTROLLER

HISTOIRE DE CAS : UN TYPE ' REMARQUABLEMENT INOFFENSIF' D'HÉMORRAGIE SUBARACHNOIDIENNE CHEZ UN CONTRÔLEUR DE LA CIRCULATION AÉRIENNE

Authors:  R Chang

Affiliation of first author:  NATS

Address for communication:

NATS, NATS Aeromedical Centre, OHS, Mailbox 34, Swanwick Centre, Sopwith Way, Swanwick, Hampshire, UNITED KINGDOM, SO31 7AY
rae.chang@nats.co.uk

Introduction: This unusual case of an air traffic controller (ATCO) who suffered a subarachnoid haemorrhage (SAH) highlights a rare subtype that has an excellent prognosis and very low risk of subsequent incapacitation.

Case history: A 46 year old male ATCO was undertaking shot put training using an overweight implement. He used a full instead of partial valsala, consequently causing an acute rise in intracranial pressure. He developed transient tunnel vision with delayed vomiting and photophobia, although remaining fully alert with no seizures or focal signs. After 24 hours, he was diagnosed with a perimesencephalic haemorrhage on CT scan; no underlying aneurysm was identified.

Discussion: From an occupational viewpoint, the consequences of intracranial haemorrhage can compromise safety-critical functions including; sudden bleeding affecting comprehension, decision making, speech and vision. Seizures can cause sudden loss of consciousness and loss of communication with aircraft. Sudden severe headache can be distracting. In the ATCO's case, he had mild headache which fully resolved after 2 weeks and no neurological sequelae.

The perimesencephalic subtype comprises 10% of SAH and is considered strikingly harmless with an excellent prognosis (van Gijn & Rinkel 2001). A large follow-up study (Greebe & Rinkel 2007) found no increased risk of re-bleeding or epilepsy and recommended no occupational restrictions.

According to the regulatory authority flowchart for head injury, the ATCO could be considered as sustaining a severe injury which would have led to unfit status for 3 years. The Civil Aviation Authority considered the evidence in this case and concluded that he could resume controlling without restriction.
Nous rapportons le cas d'un pilote de ligne ayant présenté un Paludisme à _Plasmodium Falciparum_ compliqué de troubles de conscience ayant nécessité une intubation prolongée. Il s'en est suivi une paralysie bilatérale des cordes vocales qui a posé un problème d'aptitude médicale aéronautique du fait d'une dyspnée laryngée à l'extubation. Plusieurs contrôles endoscopiques ont confirmé l'existence d'une paralysie des cordes vocales en fermeture. Ce cas a requis une étroite collaboration entre le médecin ORL traitant du patient, le centre d'expertise et l'autorité, pour l'obtention d'une dérogation d'aptitude trois ans après l'accès Palustré chez ce pilote. Ce cas démontre la gravité encore aujourd'hui du Paludisme chez le personnel navigant et l'utilité de l'existence des nouvelles techniques thérapeutiques pour récupérer une aptitude aéronautique.
The last few years have had some high profile airline incidents that have resulted from mental health issues. The latest Germanwings incident with its attendant loss of life, is something that has prompted cries for immediate action to prevent a similar incident from occurring in the future. All sorts of suggestions have been made: higher scrutiny of pilots, eliminating privacy in their lives, having two people in the cockpit at all times, etc. This presentation explores the relationship between the risk assessment and the consequences and the role of chance in any risk assessment. Given that the consequence are enormous, action is justifiable. Terrorism has resulted in alterations to personal privacy--should the same apply for operators of any equipment that has the potential for disastrous consequences? The most important question is whether action can lead to a preventive outcome? And is the level of intrusion, time and resource acceptable? A case is made for a measured and considered response with the awareness that exceptions will happen.
The presumed suicide of the Germanwings pilot Andreas Lubitz on the 24th of March 2015 and death of all passengers and crew has raised questions about the screening and psychological assessment of commercial pilots. The subsequent media storm prompted the question: how and why was he allowed to fly?

The full accident report, due in the coming months, will likely highlight shortcomings in the current psychological assessment of pilots and also make recommendations for change. There have already been calls for routine psychometric testing of pilots before commencing training and annually as part of crew licensing. Any changes need to be carefully considered before implementation if they are to improve detection and air safety.

We argue that there is a critical balance to be found between robust and appropriate screening, and stigmatising mental health issues and increasing stress among pilots. Screening through psychometric testing alone is unlikely to be sufficiently accurate to predict rare events such as suicidal intent, and the risk of false positive results resulting in pilot attrition may also deter some pilots from presenting for help with transient and treatable mental health problems.

This paper addresses (a) the parameters and limitations of the use of psychometrics in crew selection and mental health screening; (b) the place of the clinical interview in mental health assessment; (c) redefining the limits of confidentiality in the AME-civilian physician relationship; (d) delivering proactive mental health training and peer support to air crew; and (e) introducing an annual appraisal system within the industry to engage pilots in face to face discussions about their career trajectory, psychological wellbeing and personal challenges. There is now a window of opportunity to implement evidence-based methods of pilot selection and screening, and enhance mental health provision within aviation.
AN APPROACH TO SELECTING-OUT CIVIL AVIATION PILOT APPLICANTS ON THE BASIS FOR THEIR
OVERALL MENTAL HEALTH

UNE APPROCHE DE SÉLECTION-NÉGATIVE DES CANDIDATS PILOTES EN AVIATION CIVILE SUR LA
BASE DE LEUR ÉTAT GÉNÉRAL DE SANTÉ MENTALE

Authors: DJ Schroeder

Affiliation of first author: DJS Consulting

Address for communication:

DJS Consulting, 6109 Walnut Lane, Oklahoma City, Oklahoma, USA, 73132
davids20@cox.net

Introduction: Historically, pilot selection has focused on assessing the cognitive and psychomotor abilities of applicants. More recently, attention has included assessments of the interpersonal skills or social competencies that are linked with crew resource management. However, the recent GermanWings incident has highlighted a need to assess a pilot's overall mental health. With a significantly smaller number of former military pilots, U.S. air carriers can no long count on the lengthy screening and experience that was present several decades ago. Butcher (2004) identified concerns associated with the potential behavioral and psychological problems in pilot applicants. This presentation will illustrate an approach to screening pilot applicants for mental health problems.

Methods: The U.S. literature regarding the approach to select out applicants on the basis of mental health concerns was reviewed. Concerns include (1) compliance with the Americans with Disability Act (ADA) whereby medical (psychiatric/psychological) assessments can only occur following a conditional offer of employment, (2) the reliability/validity of instruments used in high-risk safety occupations, and (3) the availability of normative data from the group being assessed.

Results: The high-risk safety-related occupations where select-out occurs includes nuclear power facilities, law enforcement, airline pilots, firefighters/paramedics, and air traffic controllers (King, Schroeder, Manning, Retzlaff, & Williams, 2008). While several U.S. carriers administer personality questionnaires to applicants, information in the scientific literature reveals only a single U.S. carrier where psychological tests are used to assess an applicant's overall mental health. Pilot norms are available for the MMPI-2. Normative data are available for use of the PAI and IPI for police officers. Details will be provided regarding the select-out process and approach to using the MMPI-2.

Conclusions: The process for screening-out applicants on the basis of psychological problems has been relatively well established for police officers and nuclear power plant operators. The U.S. approach for pilots differs from what could be implemented internationally.
The Australian regulator has been permitting the medical certification of pilots and controllers who have depressive illness for over ten years as long as they are in stable remission. Continuing approved pharmacotherapy is also acceptable. In addition, six years ago, two questions screening for depression were added to the application questionnaire.

Much debate continues about the best approach to enhance aviation safety through effective aeromedical assessment of psychiatric illness. Furthermore, there remain striking differences in the regulatory approaches internationally.

This presentation reviews the responses to the depression screening questions and the subsequent management in Australian applications for an aviation medical certificates. The effectiveness of standard screening batteries in a regulatory context is considered as well as the importance of collateral sources of information in case-identification.

In the light of these findings and a recent workshop held in Sydney, recommendations are tabled for the wider psychological assessment, and how the utility of commonly available existing information can be utilised most effectively.
ATTRIBUTION OF MENTAL ILLNESS TO WORK: A DELPHI STUDY

L'ATTRIBUTION DE LA MALADIE MENTALE AU TRAVAIL: UNE ETUDE DE DELPHI

Authors: MG Wong, J Poole, R Agius

Affiliation of first author: NATS Aeromedical Centre & Occupational Health

Address for communication:

NATS Aeromedical Centre & Occupational Health, Swanwick Centre, Mailbox 34, Sopwith Way, Swanwick, Southampton, Hampshire, UK, SO31 7AY
marcus.wong@nats.co.uk

Background: Pilots' mental health has recently attracted media attention [1]. The prevalence of common mental disorders in civil aviation pilots has previously been estimated at 6.7% [2]. Clinicians may be asked whether mental ill-health has been caused by work, but there is no guidance on how this judgement should be made. Mental illness is associated with workplace stressors [3] as well as with personal factors of vulnerability [4], but it is unclear how they should be evaluated and whether they are mutually exclusive. The concept of occupational mental illness is relatively novel and there is no generally agreed definition.

Aims: To seek a consensus on the factors that should be considered; how they should be sought and the threshold for causality when attributing mental ill-health to work. To seek a definition for occupational mental illness.

Methods: A three-round Delphi study involved expert academics, occupational physicians, psychiatrists and psychologists from the UK and the rest of the world. Consensus was said to have been reached when 66% or more of the experts were in agreement.

Results: Consensus was reached for 11 workplace stressors: high job strain; effort-reward imbalance; major trauma; interpersonal conflict; inadequate support; role ambiguity; person-job mismatch; organisational injustice; organisational culture; work scheduling and a threat to job security. Seven personal factors were identified as being important: previous mental illness; personality traits of neuroticism; adverse life events or social circumstances; low resilience; a family history of mental illness and secondary gain. The employee, manager and co-employees were thought to be the most useful sources of workplace information. Consensus was reached for a definition of occupational mental illness. Conclusions: The attribution of mental ill health to work is complex and involves the consideration of both workplace stressors and personal factors of vulnerability. Clinical consultation with a physician who is familiar with the workplace is central to the process.
CO-PILOT INTENTIONALLY CRASHES AIRCRAFT: SHOULD THE MILITARY BE CONCERNED?

UN CO-PILOTE ÉCRASE INTENTIONNELLEMENT UN AVION: EST-CE QUE LE MILITAIRE DEVRAIT ÊTRE PRÉOCCUPÉ?

Authors: BH Campion, J Rollo

Affiliation of first author: RAF

Address for communication:
RAF, Centre of Aviation Medicine, RAF Henlow, , Bedfordshire, UK, SG16 6DN
ben.campion906@mod.uk

Introduction: On 24 March 2015 Germanwings flight 9525 crashed in the French Alps; all 144 passengers and six crew members were killed. It soon became apparent that the crash was deliberately caused by the co-pilot, Andreas Lubitz, who had previously been treated for suicidal tendencies and been declared “unfit to work” by a doctor. Lubitz kept this information from his employer and reported for duty. Should we (the military) be concerned?

Methods: The authors reviewed the current policy, both within the British Armed Forces and in the wider aviation industries, along with the literature released as a result of this tragedy. The military flying community is considered and the key differences with their civilian counterparts.

Discussion: Factors that help to mitigate the military against such a disaster are discussed in the presentation:
§ Open Cockpit.
§ Squadron Ethos.
§ Duty Holder.
§ Medical Oversight.
§ Mental Health Resources and Access to Care.
§ Mental Health Awareness Training.
§ Aircrew Selection and Training.
§ Psychological Testing Office Training
§ Through Life Stress Management Policy.

Conclusion: These factors do make the risk for the Military less than for commercial airlines. Defence Mental Health services are a well resourced and effective service. Fear of grounding from aircrew remains the greatest risk to flight safety, with some not asking for help until it is too late. The MOD has done as much as it can to mitigate such risks, but it remains a salutary lesson that stigma towards mental health remains our key issue.
SUBCORTICAL WHITE MATTER AND DIFFUSION TENSOR CHANGES ON MAGNETIC RESONANCE IMAGING ASSOCIATED WITH REPETITIVE HYPOBARIC NON-HYPOXIC EXPOSURE: PATHOPHYSIOLOGICAL IMPLICATIONS

LA SUBSTANCE BLANCHE SOUS-CORTICALE ET LES MODIFICATIONS DU VECTEUR DE DIFFUSION SUR L'IMAGERIE PAR RÉSONANCE MAGNÉTIQUE ASSOCIÉ À L'EXPOSITION RÉPÉTITIVE HYPOBARE

Authors: SA Mcguire, PM Sherman, P Kochunov

Affiliation of first author: USAFSAM

Address for communication:

USAFSAM, 103 Zornia Dr, San Antonio, Texas, US, 78213
dr.stephen.mcguire@gmail.com

Introduction/Background: We performed high resolution magnetic resonance imaging (MRI) on 106 U-2 pilots (U2P) and 162 doctoral controls (DOC) and have previously reported increased subcortical white matter hyperintensity (WMH) burden associated with normoxic hypobaric exposure (p<0.001). We postulated that additional structural changes would be occurring and these changes might suggest an underlying pathophysiological mechanism.

Materials and Methods: Subjects underwent high resolution MRI with quantification of findings. We compared fractional anisotropy (FA) from diffusion tensor imaging (DTI) to WMH burden. Statistical analysis was performed utilizing the two-tailed parametric t-test and the nonparametric Spearman's rho coefficient test.

Results: U2P had significant reduction in FA compared to DOC (p=0.009). Furthermore U2P with higher burden of WMH were significantly different from DOC (p=0.003) while lower burden U2P were not (p=0.155). Finally the Spearman rho correlation to U2P subcortical WMH burden was not significant for volume (r=-0.0133/p=0.894) or count (r=0.0021/p=0.984).

Summary/Conclusions: Repetitive normoxic hypobaric exposure to 28-30k feet (4.73-4.37 psi) is associated with a persistent reduction in average FA and increase in WMH burden. We previously reported this increase in WMH burden was associated with a decrease in neurocognitive test performance. This study demonstrates a more diffuse process is occurring affecting the integrity of axons, possibly providing an explanation for the decrease in neurocognitive performance. The pathophysiology behind this cerebral white matter injury is unknown but does not appear to be a simple gaseous embolic phenomenon.
Introduction: Our goal is to characterize the pathophysiologic response of the brain to high altitude exposure in order to understand its association with subcortical white matter injury. We postulated that a single exposure to a hypobaric environment (25,000 ft), with or without hypoxia, would induce transient MRI changes in addition to changes in inflammatory biomarkers.

Materials and Methods: Four limbs include 1. Hypobaric, hypoxic [altitude chamber]; 2. Hypobaric, non-hypoxic [inside observer technicians]; 3. Hypoxic, non-hypobaric (reduced oxygen breathing device [ROBD]); and 4. Normal controls. MRI performed on a 3T Siemens Verio with a 32-channel phased array head coil 1 day prior, 1 day post, and 3 days post exposure. Protocol included MPRAGE (TR 2200, TE 2.88), MRS with TE of 30 and 135 within the right and left frontal white matter and anterior cingulate gyrus, DTI and Q-space imaging, ASL perfusion imaging, and 3D FLAIR (0.8 mm, TR 4500, TE 311) images. Phlebotomy performed prior to and post altitude chamber or ROBD, and prior to MRI #2 and #3. Laboratory analyses included S100B, TNF alpha, interleukin-6, interferon gamma, and microparticle analysis. Control patients underwent the four blood draws at equivalent times during the day as the other 3 study limbs.

Results: Data from the first 38 subjects, predominantly limb 1 (n=25) demonstrates an increase in CBF to white matter 24 hrs after altitude exposure in addition to an up-regulation of glutamate in the anterior cingulate gyrus. There was an associated increase in microparticles < 1 um in size (2nd, 3rd samples) and a more delayed platelet activation (4th sample).

Conclusion: Initial MRI results suggest that a single altitude exposure to 25,000 ft results in an increased metabolic demand on the brain and oxidative stress. Initial laboratory data suggests an inflammatory response after altitude exposure with an acute increase in microparticles and delayed platelet activation. A somewhat heterogeneous pattern may reflect inherent individual biovariability or small sample size.
IF INTENSE DECOMPRESSION STRESS CAUSES WHITE MATTER INJURY IN ALTITUDE WORKERS, IS THE SAME TRUE FOR DIVERS?

SI LE STRESS DE DÉCOMPRESSION INTENSE PROVOQUE DES LÉSIONS DE LA SUBSTANCE BLANCHE CHEZ LES TRAVAILLEURS EN ALTITUDE, EST-IL DE MÊME POUR LES PLONGEURS?

Authors: DM Connolly, VM Lee

Affiliation of first author: QinetiQ Aircrew Systems

Address for communication:
QinetiQ Aircrew Systems, Cody Technology Park, Bdg A5 Rm 2022, Ively Road, Farnborough, Hampshire, UK, GU14 0LX
dmconnolly@qinetiq.com

Introduction: United States Air Force studies on U-2 pilots and altitude chamber workers suggest that occurrence of white matter injury, observed as white matter hyperintensities (WMH) on magnetic resonance imaging (MRI) brain scans, is related to intensity of exposure to decompression stress. If so, then the same should also be true of those undertaking frequent hyperbaric exposures, since every dive is inevitably associated with significant decompression stress upon return to the surface, yet published data are inconsistent and contradictory. We report a meta-analysis of case-control studies to evaluate the influence of diving on prevalence of WMH.

Methods: Eligible studies examined the MRI brain scans of experienced divers with no past history of decompression illness, and healthy non-diving controls, for evidence of any WMH. Studies were assessed for methodological quality, including MRI technique, sample size and sources of bias in recruitment, control matching and confounding factors. Odds ratio (OR) meta-analysis was conducted, using a random effects model, after exclusion of poorer quality studies.

Results: Eleven eligible studies encompassed 410 divers and 339 controls of which 136 (33%) and 79 (23%), respectively, exhibited WMH (OR 1.925, 95% CI 1.088 to 3.405, z = 2.249, P = 0.025). Exclusion of four low quality studies eliminated meta-analysis heterogeneity with 98 of 279 divers (35%) and 44 of 232 controls (19%) having WMH (OR 2.654, 95% CI 1.718 to 4.102, z = 4.396, P < 0.001). The majority of WMH in divers were fronto-parietal subcortical or deep white matter lesions.

Conclusion: Frequent diving increases the prevalence of white matter injury in experienced healthy individuals with no past history of decompression illness or diving accidents. This supports a possible association with intensity of decompression stress and findings of increased WMH in asymptomatic altitude workers exposed repeatedly to reduced ambient pressure.
THE EFFECT OF THE MK VI GRAVITY-LOADING COUNTERMEASURE SKINSUIT (GLCS) UPON MAXIMAL AEROBIC EXERCISE (VO₂MAX)

LEFFET DU GLCS (COMBINAISON AUGMENTANT LA GRAVITÉ) SUR L'EXERCICE MAXIMAL AÉROBIQUE

Authors: J Attias, JP Scott, T Russomano, DA Green

Affiliation of first author: King's College London

Address for communication:
King's College London, Guy's Campus, London, , London, UNITED KINGDOM, SE1 1UL
julia.attias@kcl.ac.uk

Introduction: The Gravity Loading Countermeasure Skinsuit (GLCS) compresses the body in a manner analogous to Earth's gravity via incremental increases in z-axis fibre tension. The current Mk VI GLCS is scheduled to be evaluated aboard the International Space Station during cycle ergometry, thus it is necessary to determine its effect on the cardiorespiratory responses to maximal aerobic exercise.

Methods: In two separate visits, six male subjects (31 ± 6 y; 178.5 ± 7.4 cm and 75.5 ± 7.6 kg) completed a cycle ergometer maximal oxygen uptake (VO₂max) test (Bruce protocol) wearing either a custom-fabricated Mk VI GLCS or loose fitting clothing (GYM). Cardiorespiratory parameters (breath-by-breath; HR, V̇e, FR, T/TTOT, VE, RER and VCO₂), and subjective comfort, body control and rating of perceived exertion (RPE) were measured. Student's t-test for paired data and Wilcoxon test was used to analyse physiological (± SEM) and subjective data (±95% confidence intervals).

Results: Absolute VO₂max and the wattage required to achieve VO₂max were not different between GLCS and GYM. However, total work product (KiloWatts [KW]) was 14% lower in the GLCS (144.29KW ± 18.56 vs. 163.24KW ± 18.44 in GYM; p=0.001). No significant differences were found between attires in any cardiorespiratory variable at VO₂max. Movement discomfort (p=0.02) and body control (p=0.02) - both with scales of 0-10 where 0 is least discomfort and most control - were increased in the GLCS at rest albeit remaining moderate, but were no different at VO₂max, whereas RPE and thermal comfort were unaffected throughout.

Conclusions: The MK VI GLCS did not significantly affect VO₂max, or wattage and cardiorespiratory responses at VO₂max, but reduced the total work performed. These data suggest that the GLCS does not inhibit oxygen uptake during maximal exercise, but may reduce the duration of work required to achieve a given physiological output.
Introduction and Methods: The effects on human physiology of different types of propulsion systems are an important consideration in the selection of the spacecraft engines. As part of an advanced level graduate level curriculum project, a spaceflight physiology class consisting of aerospace engineers determined the engineering, logistic, and physiologic impacts, including the advantages and disadvantages in each category, for spacecraft propulsion in a simulated deep space mission to 1) Mars and 2) Beyond.

Results: The overall consensus for selection of the propulsion types was: For Mars travel: Conventional (62%), Plasma (20%), Nuclear (8%), Ion (basic) (5%), and Solar wind (5%); For travel Beyond: Plasma (56%), Ion (basic) (13%), Conventional (12%), Nuclear (11%), and Solar wind (8%).

Discussion: Each has potential concerns for the occupants. Vibration was determined to be maximal for conventional propulsion at 0.56 G sinusoidal peak to peak force at 15-50 Hz, but well under the ISO 2631 limit of 0.8Gs. Radiation exposure (Galactic Cosmic Radiation) would be expected at 0.5 Sv/yr. with 15gm/sq cm shielding for all types with additional shielding required for nuclear reactors in the amount of 10cm lead or 180cm water between the reactor and the crew compartment to keep the additional exposure less than 0.1 Sv/yr. Noise exposure would peak at 220 dB for conventional propulsion to less than 60 dB in solar sail (mostly due to other spacecraft noise sources). This could be mitigated by standard spacecraft insulation techniques. In addition, magnetic field and temperature concerns and their potential mitigation techniques will be discussed.

Conclusion: Deep space travel may soon be possible using currently evolving technological advances in propulsion but this will require the careful application of the principles of aerospace medicine at the early stages of these preparations.
ELECTROACUPUNCTURE AS A COUNTERMEASURE AGAINST CARDIOVASCULAR DECONDITIONING DURING 4 DAYS OF HEAD-DOWN BED REST IN HUMANS

L’ÉLECTRO-ACUPUNCTURE COMME CONTREMESURE CONTRE LE DÉCONDITIONNEMENT CARDIOVASCULAIRE DURANT 4 JOURS DE REPOS AU LIT EN POSITION TÊTE-BASSE CHEZ LES HUMAINS

Authors: XQ Sun

Affiliation of first author: School of Aerospace Medicine

Address for communication:

School of Aerospace Medicine, Fourth Military Medical University, 169 Chang Le Xi Road, Xi’an, Shaanxi, CHINA, 710032
sunxiqing@fmmu.edu.cn

Introduction: Spaceflight is associated with cardiovascular deregulation. However, the influence of microgravity on the cardiovascular system and the underlying mechanisms and countermeasures remain unknown. Our previous studies have demonstrated that electroacupuncture (EA) is effective at improving orthostatic tolerance (OT). The purpose of this study was to determine if EA treatment can attenuate cardiovascular deconditioning induced by a 4-day 6° head-down bed rest (HDBR).

Methods: Fourteen healthy male subjects were randomly allocated into a control group (Con, n=6, 4 days HDBR without countermeasure) and an EA treatment group (EA, n=8, 4 days HDBR with EA at Neiguan [PC-6] for 30 min daily for 4 consecutive days during HDBR). OT was estimated with a combination of +75°/20 min head-up tilt and lower body negative pressure test before and after HDBR. Plasma hormones, plasma volume and heart rate variability were assessed before and after HDBR. Cardiac functions and cerebral blood flow were measured before, during, and after HDBR.

Results: The data showed that EA treatment prevented OT and cardiac function from decrease, activated the peripheral sympathetic nervous system, partially prevented a plasma volume reduction after bed rest, and increased the concentrations of plasma angiotensin II and aldosterone.

Conclusion: These results indicate that 30 min of daily EA treatment at PC-6 is effective in partially maintaining OT and cardiac function. Activation of the peripheral sympathetic nervous system and increased plasma hormones is largely responsible for maintaining OT after a 4-day HDBR. Therefore, EA treatment appears to be an effective countermeasure against cardiovascular deconditioning induced by HDBR.
HUMAN PERFORMANCE AND AVIATION MISHAP REDUCTION

PERFORMANCE HUMAINE ET RÉDUCTION DES ACCIDENTS D’AVION

Authors: KM Belland

Affiliation of first author: Aerospace Medical Association

Address for communication: Aerospace Medical Association, 20 Billingsley Drive, Pensacola, FL, USA, 32508
   kris.belland@gmail.com

Introduction: In 1998, the Navy's center of excellence for advanced air wing combat operations, namely the Naval Strike and Air Warfare Center (NSAWC), had a spike in Class A flight mishaps. The spike triggered an intense review of prior mishaps and current mishap-reduction practices using the Human Factors Analysis and Classification System (HFACS). The review resulted in NSAWC instituting a comprehensive multifactorial mishap reduction plan applying Operational Risk Management (ORM) precepts.

Methods: This is a nonrandomized investigational study with use of a historical comparison population. The Class A mishap rate per flight hour covering 10 yr prior to the mishap reduction efforts was estimated and compared to the Class A mishap rate per flight hour for the 10 yr after implementation using Poisson regression.

Results: Combined Fleet and NSAWC data shows a 27% reduction in mishap rate, but the 21% reduction in the Fleet alone was not statistically significant. The mishap reduction at NSAWC was statistically significant with an 84% reduction. Fallon carrier air wing mishap rates post-ORM mishap reduction efforts are approaching those seen in the Fleet, but are still elevated overall (3.7 vs. 2.4).

Conclusion: The incidence rate ratio was 80% lower at Fallon than the rest of the Fleet, indicating a significantly greater reduction in NSAWC air wing mishaps and suggests focused aviation mishap reduction efforts in similar circumstances could result in similar reductions. This investigational study will be utilized as an example to bridge to larger Human Performance issues and their applicability to Aviation and Medicine in general.
Background: The association between errors, incidents, accidents and duty hours is of great concern in the medical, mining and transport industries. This study aims to investigate how differences in self-reported errors in flight across varying duty hours might be explained, initially by demographic factors and subsequently by experiences of sleep and fatigue due to occupation.

Methods: This study is based on a cross-sectional survey of 892 European-registered commercial airline pilots. Responses to a self-rated questionnaire were dichotomized and binary logistic regression was used to identify errors in flight between typical duty hours per week (<25; 25-30; 31-35; 36-40; 41-45; 45-50; >50). These differences were further adjusted for demographic factors (age, position, employment etc.) and subsequently for various experiences of sleep and fatigue due to occupation (experiences of fatigue in the cockpit, experiences of microsleeps in the cockpit and sleep disturbance due to working schedule).

Results: Respondents who typically spend longer hours on duty per week (<25 hours vs. 45-50 hours) were five times more likely to report making an error in flight (OR = 5.25; 95% CI: 1.9-12.53). As soon as demographic factors were included, these differences were reduced OR = 4.48 (1.84-10.90). However, once sleep and fatigue due to occupation were added to the model, these differences were greatly reduced or disappeared OR = 1.90 (0.72-5.03).

Conclusion: While self-reported errors in flight associated with duty hours can be partially explained by demographic characteristics, they can be further explained, and greatly reduced, by pilots experiences of sleep and fatigue due to occupation. Reducing sleep disturbance and decreasing fatigue levels and microsleep events in the cockpit is suggested to reduce errors in flight thought to be associated with varying duty hours. Further investigation into sleep and fatigue measurement and monitoring is warranted.
Introduction: Fatigue is an important factor in aviation, and is associated with sleep loss and shift work. Long duty hours can cause pilots to become inattentive, careless and inefficient. Large number of studies exists on long duration commercial flying and its effects on pilots and various FDTL-related issues. However, domestic pilots have somehow been ignored in these studies and today, with every increasing air traffic and commercial profits, there is tremendous pressure on the domestic civil pilots to cope up to this demand.

Aim: This paper aims to ascertain how much subjective fatigue short haul pilots report and suggests some remedial measures. Material & Methods: This study was conducted through a web-based survey, where the commercial pilots from various govt sector & private sector airlines answered an anonymous questionnaire. Data was collected from 212 pilots and statistically analysed.

Result: Eighty-seven per cent of the pilots reported severe fatigue and 85% wanted change in FDTL rules for domestic pilots. Seventy three per cent considered their thought processes & judgment were reduced due to fatigue, while flying. Large number of pilots reported flying beyond FDTL time limits and had lower physical and psychological health, and overall fatigue scores. 53% of the pilots agreed with the fact that Micro naps do improve the alertness level. Making the environment conducive to sleep was considered the best physiological method as a prevention strategy for fatigue. This paper also discusses the operational prevention strategy and the suggestions as brought by commercial pilots in detail.

Conclusion: It is therefore important that all accident prevention research agencies explore all avenues and work together to implement strategies and effectively link human factors and fatigue information.
QUALITY AND RESTORATIVE VALUE OF EARLY CIRCADIAN SLEEP INDUCED WITH MELATONIN AND ITS COMPARISON WITH ZOLPIDEM

QUALITÉ ET VALEUR RÉPARATRICE DU SOMMEIL AVANCÉ DU RYTHME CIRCADIEN INDUIT PAR LA MÉLATONINE ET SA COMPARAISON AVEC LE ZOLPIDEM

Authors: KK Tripathi

Affiliation of first author: SMO & SR ADVSR (AV MED), AIR FORCE STATION

Address for communication:
SMO & SR ADVSR (AV MED), AIR FORCE STATION, STATION MEDICARE CENTRE, AIR FORCE STATION, BIDAR, KARNATAKA, INDIA, 585401
tripfamily@gmail.com

Introduction: Idiosyncratic reactions and gender/age induced variations in the pharmacokinetics of zolpidem may render it unsuitable for its use as a "no-go" pill in certain individuals. The present study examined suitability of melatonin as an alternative in terms of quality of an early circadian sleep induced by these agents and psychophysiologic state in the subsequent awake period (oral temperature, sleepiness, fatigue and performance).

Methodology: In a double blind, crossover design, an early circadian sleep was induced in 13 healthy, non-sleep deprived and well rested humans (21-45 years) at ~1400 h with the help of melatonin (3 mg) or zolpidem (10 mg). After spontaneous awakening, hourly assessment was made of sleepiness, fatigue, oral body temperature and performance in the Psychomotor Vigilance Task (PVT) between 2200 h to 0400 h (on the next day). Quality of induced sleep was measured after awakening. Multi sample hypotheses were tested with repeated measure Analysis of Variance (ANOVA)/ its non-parametric equivalent (Friedman's ANOVA). Wilcoxon Matched Pair Test was used for paired comparisons. Comparison of number of scores on SSS in the two conditions was done with a Chi-squared Test.

Results: Quality of sleep induced with melatonin was comparable with that with Zolpidem and also with that in the night preceding the study. Oral temperature showed a significant main effect of sleep deprivation, but the effects of pharmacological manipulation and the effect of interaction between sleep deprivation and pharmacological manipulation were insignificant. Hourly measures of sleepiness and fatigue exhibited significant increase across the subsequent awake period (2200 h to 0400 h), but were comparable across the two pharmacological groups. Performance in PVT was without a significant effect of awake period, previous pharmacological manipulation or the interaction between the two.

Conclusions: In healthy individuals, melatonin is an effective alternative to zolpidem a"no-go" pill.
AN INSIGHT INTO AIRCREW DISORIENTATION; ANALYSIS OF UK MILITARY DISORIENTATION INCIDENTS

UN APERÇU DE LA DÉSORIENTATION DES ÉQUIPAGES; ANALYSE DES INCIDENTS DE DÉSORIENTATION CHEZ LES MILITAIRES BRITANNIQUES

Authors: TL Grimshaw, JR Stott

Affiliation of first author: QINETIQ

Address for communication:
QINETIQ, BLDG A5, RM 2022, CODY TECHNOLOGY PARK, IVELY ROAD, FARNBOROUGH, HAMPSHIRE, UK, GU14 0LX
TLGRIMSHAW@QINETIQ.COM

Introduction: Spatial disorientation (SD) still represents a real risk to military flight safety. In order for the UK MOD to develop strategies to mitigate the risk of disorientation accidents, it is important that up to date disorientation incident data is collected.

Method: An anonymous tri-service incident survey was developed, in which aircrew described occasions in flight when they had become confused or in error about their aircraft attitude or position. These aircrew descriptions were then analysed to determine the factors underpinning the incident. This survey has been conducted regularly since 2004, most recently in 2013, enabling detailed analyses of causal factors. This paper describes the findings from the most recent survey and an overview of analyses of all incidents collected since 2004, including descriptions of actual incidents to demonstrate critical disorientation factors.

Results: In the 4 year period from 2010 to 2013 there were 144 reported SD incidents. Many of the rotary wing incidents featured landing or take-off in dust, and in maritime operations, deck landing at night, with difficulties judging the distance from a minimally lit ship. For fast jet aircraft, several height errors were associated with severe implications for flight safety. For multi-engine aircraft, disorientation often resulted from procedural errors associated with high workload. Visual misperceptions were also a critical risk to flight safety, for example irregular cloud formations which led to uncertainty about aircraft attitude. Distraction played a crucial role in many incidents. Analysis of over 400 incidents collected since 2004, using stepwise logistic regression, showed strong correlations between certain factors and unrecognised disorientation or incidents with a severe risk to flight safety.

Discussion: Results show that the most dangerous form of disorientation arises insidiously, and many incidents could readily have become accidents given slightly different circumstances. These findings are being used to inform flight safety and training.
Introduction: Spatial disorientation (SD) is a significant contributory cause of accidents in aviation. One-in-five fatal civil, and UK military accidents are due to SD. Over a third of US Army accidents resulting in injury or fatality are caused by SD. Whilst the overall accident rate has decreased in the last 30 years, the SD-accident rate has remained stubbornly static despite enhancements in cockpit instrumentation and training efforts. Theoretical and practical SD training for UK military aircrew make use of Disorientation Trainers (DISOs) and is delivered with internationally agreed practice at RAFCAM. Notwithstanding this, aircrews with an input into aircraft control and orientation should have the best available training to enhance recognition of disorientation and disorientating situations in order to reduce the risk to life of SD-related accidents.

Methods: An examination of current UK military SD training was undertaken. Areas for quality improvement were listed, prioritised and undertaken. Current aircrew across the range of platform types were consulted for advice on the fidelity of technical simulation and enhancement of the disorientation scenarios; air safety occurrence reports were examined for lessons to be learned from risky situations. Communication with the DISO manufacturer was maintained and development improvement work was undertaken.

Results: The organisation of training was changed and technical limitations resolved. Rotary-wing simulation technical aspects were improved, enhancing fidelity for handling aircrew. Improved platform-specific scenarios were fielded and standardised between instructors. Simple technological enhancements of the visual displays and audio-enhanced learning for observing aircrew students.

Discussion: Continuing refinement of the technological aspects of simulation is required to ensure the simulator matches the flight characteristics of real aircraft. Accident and near-miss reports remain a key source of information which can be exploited to update learning and enhance aviation safety. Ongoing dialogue with aircrew trainees allows scenario refinement and augments potential learning.
PUBLIC HEALTH LABORATORY METHODS FOR MONITORING HUMAN EXPOSURE TO TOXICANTS IN AVIATION ENGINE LUBRICANTS AND FUEL PROPELLANTS

MÉTHODES DE LABORATOIRE DE SANTÉ PUBLIQUE POUR LA SURVEILLANCE BIOLOGIQUE DE L'EXPOSITION AUX TOXINES DANS LES LUBRIFIANTS DE MOTEUR ET LES CARBURANTS DANS LE DOMAINE DE L'AVIATION

Authors: MD Carter, SL Isenberg, D Johnson, LA Graham, TP Mathews, JD Thomas, RC Johnson

Affiliation of first author: CDC

Address for communication:
CDC, CDC, 4770 Buford Hwy NE, MS-F44, Atlanta, GA, USA, 30341
melissa.carter@cdc.hhs.gov

Introduction: The Division of Laboratory Sciences at the Centers for Disease Control and Prevention provides laboratory support that improves the rapid and accurate detection and diagnosis of selected toxins. Recently, methods were developed for monitoring human exposure to toxicants in aviation engine lubricants and fuel propellants, specifically cresyl saligenin phosphate and hydrazine.

Methods: Isotopically-labeled standards were used in the development of methods needed for confirming human exposure to the chemical toxicants hydrazine and cresyl saligenin phosphate. Protocols compliant with the United States 1988 Clinical Laboratory Improvement Amendments (CLIA, 42 USC 263a) were prepared for use during technology transfer, emergency response and collaborative technical assistance. Laboratory instrument methods were developed using high-performance liquid chromatography coupled with tandem mass spectrometry. Only 10% of hydrazine excretion in urine was expected to remain intact so a chemical derivatization process was used to ensure optimal recovery and accurate detection during analysis. The detection method for cresyl saligenin phosphate exposure targets butyrylcholinesterase inhibition in human blood products by using an automated antibody-bead extraction of butyrylcholinesterase and on-bead pepsin digestion prior to analysis.

Results: The hydrazine detection method spans an analytical range of 0.0493 to 12.3 ng/mL and dilution up to 123 µg/mL, allowing for the determination of pharmaceutical, industrial and event-level exposures. The reportable range for cresyl saligenin phosphate detection is within literature values for butyrylcholinesterase from 2.0 to 250 ng/mL. The precision and accuracy reported is representative of best practice guidelines from the United States Food and Drug Administration. Each method's time-to-first-result is under four hours and was tested initially against a commercial convenience set of uninhibited human urine and serum.

Conclusion: CLIA methods were developed for monitoring exposure to hydrazine in urine and cresyl saligenin phosphate in serum and plasma. The methods are available for transfer to public health laboratories, emergency response activities and collaborative technical studies.
Introduction: General aviation pilots in the United Kingdom are permitted to fly to altitudes of up to 13,000 ft without using supplementary oxygen or pressurisation systems. The partial pressure of oxygen falls with ascent to such altitudes, potentially leading to hypoxic hypoxia and possibly adverse effects on the body including a diminished cognitive ability, with associated implications for flight safety. Some pilots use their own pulse oximeters, yet actual in-flight physiology is not well documented within the general aviation sector.

Methods: We developed a protocol for continuous in-flight measurement of pilots' arterial oxygen saturation (SpO2) and altitude during routine general aviation flights, data that has not previously been reported in the literature. Our method utilised a wrist-mounted data-logging pulse oximeter and a portable data-logging altimeter in order to quantitatively assess the changes in SpO2 over the course of a flight. A post-flight hypoxia symptoms questionnaire was also performed. Recordings were made on 13 pilots flying from CAE Oxford Aviation Academy, Oxford Airport. All participants held at least a DVLA Class II medical.

Results: Our recordings were made on training flights which all followed a similar profile, with a mean maximum altitude of ~7,800 ft. As expected, SpO2 fell during flights with a mean (± SD) decrease of 9.4 ± 2.2% (P < 0.0001). The mean minimum SpO2 was 87.6 ± 3.3% and the lowest value recorded on any flight was 80%. Pilots spent 60% of flight duration with SpO2 < 95% and 9% of flight time with SpO2 < 90%.

Conclusion: This study has demonstrated evidence of in-flight hypoxia in general aviation pilots during routine flight operations up to 8,000 ft. Further research is needed into operations within the 8,000-13,000 ft altitude range, as well as how any hypoxia may influence cognition or interact with underlying pathology within this environment.
Introduction: There is an ongoing discussion about health promotion and disease prevention in the context of pilot certification medical exams. The effectiveness of preventive interventions is affected by the motivation of target populations. This study aimed to describe the attitudes and opinions of EASA class 1 pilots on the possible routine inclusion of preventive activities in aeromedical exams.

Methods: This was an observational study with prospective data collection. All class 1 pilots presenting for a medical at the main Portuguese Aeromedical Centre on 26 consecutive days were asked to fill out an anonymous questionnaire, including ranking of health prevention topics by order of relevance and likelihood of licence suspension/loss. Descriptive statistics were applied.

Results: The response rate was 84%: 271 pilots, of which 257 (95%) male, 165 (61%) aged 30-59 and 96 (35%) less than 30 years. Most (91%) considered that prevention during their medical was important/opportune. The three topics they considered most relevant were fatigue, stress/anxiety and sleep; smoking, solar exposure and STDs were given by far the least importance. Asked which issues they felt were most likely to cause loss of licence they put vision, heart problems and hearing first, and obesity and migraine last. Issues like depression, alcohol, drugs, medicines were ranked mid-list.

Conclusion: The more apparent medical tasks (e.g., vision assessment, ECG) possibly modulate pilots' perceptions on the relative importance of health topics. There was a seemingly significant focus on issues around work/life balance and mental well-being. Depression and anxiety excepted, the hierarchy of concerns did not seem to match the topics for which there is the most evidence of intervention effectiveness (e.g., alcohol, smoking, drugs, obesity) or of likely epidemiological import (e.g., skin cancer, tropical diseases, side effects of medicines). The subsamples of female and older (60-65 yrs) pilots are also discussed.
Introduction: The Clinical Aviation Medicine Service (CAMS) for UK military aircrew was set up in 2011. This abstract describes the general (internal) medical (GIM) referrals (by sub-specialty) referred to CAMS and demonstrates the breadth of medical pathology seen in UK military aircrew during the first 2 years of CAMS and the occupational effect on flying status of each specialty.

Methods: For this study consecutive patients with a G(I)M over a 2 year period were included. Cardiology patients were excluded and are presented separately. Predictors of flying restriction on referral and final outcome following consultation were modelled for each specialty using logistic regression.

Results: 208 new G(I)M referrals (91% male, median age 40 years (range 22 - 69)) (excluding cardiology) were received. They covered renal, respiratory, haematology, gastroenterology, neurology, rheumatology, dermatology, endocrinology, oncology and psychiatry. Cardiology referrals are reported separately. 101/208 (49%) were downgraded on referral, with no statistical difference in likelihood of downgrading between specialties (P>0.05 for all specialties). Following consultation at CAMS 58/208 (29%) were downgraded (12.5% no flying controlling, 16.5% partial restrictions on flying/controlling), again with no difference in likelihood of downgrading between specialties (P>0.05 for all specialties).

Conclusions: This abstract shows that the majority of patients restricted at referral are upgraded to full or partial flying/controlling duties after specialist consultation. However there is no difference in the likelihood of occupational restrictions either on referral or following specialist consultation based on G(I)M specialty, gender, service, specialty or trade (pilot/non-pilot aircrew).
This narrative explores the history of Computer Patient Interviewing (CPI), from the first paper published in the 1960's and the extensive evidence published since; it develops the argument for CPI's potential use as a part of aircrew assessment.

Several studies have shown that patients will confide facts to a computer that they would not reveal to an interviewer. Such facts include information relating to psychological issues, suicidal thoughts, alcohol, illicit drugs, blackouts and other sensitive issues. It is not unreasonable to suggest that this has relevance for screening in the aviation medicine environment. Computer Patient Interviewing also allows for detailed structured data gathering for all aspects of the medical and family history and facilitates coding of all items for future analysis.

Given the statistics about the medical issues involved with aircraft accidents, especially relating to Public Transport and in the light of recent tragic events, this approach could potentially augment our current methods of assessment and is worthy of exploration.

The facts presented will be drawn from the published literature and also from interviews with Health Care Professionals using this technology in their everyday practice.
The next generation USAF tanker, KC-46A, and the multi-nation fifth generation fighter, the F-35A, B and C will have the most advanced display technology of any previous military aircraft. The KC46 will utilize state of art multifunction displays and remote 3D viewing system (RVS) for the boom operator in the flight deck. The F-35 will be the first aircraft to use a Head-Mounted Display System (HMDS) as primary flight instrument.

Both aviation display systems will be presented and discussed. The KC-46 boom RVS utilization will bring a new clinical selection problem for the USAF and this presentation will introduce the OBVA research project. The F-35 HMDS is a bi-ocular (both eyes view the same imagery), monochrome design that presents symbology, as well as thermal and night vision imagery using the distributed aperture system (DAS) and the Night Vision Camera (NVC). The DAS uses multiple IR cameras integrated into aircraft structure with a head-tracking system to determine pilot head location/orientation and the DAS sensor imagery that aligns with that orientation. The DAS allows pilot view through aircraft structure (e.g. through bottom of fuselage).

The F-35 DAS Head Mounted Display system has induced spatial disorientation, diplopia, two separate eye symbology display, green glow after image, jitter and variable canopy issues. Initial research of these issues will be presented and mitigation strategies will be presented.
A HEALTH PROMOTION PROGRAM FOR AIRLINE PILOTS: A RANDOMISED CONTROLLED TRIAL

UN PROGRAMME DE PROMOTION DE LA SANTÉ POUR DES PILOTES DE LIGNE : UN ESSAI CONTRÔLÉ RANDOMISÉ

Authors: BJ Johnston, N Gill

Affiliation of first author: Air New Zealand

Address for communication:

Air New Zealand, Aviation and Occupational Health Unit, Air New Zealand, PO Box 92007, Auckland, NEW ZEALAND, 1142

ben.johnston@airnz.co.nz

Introduction. Previous research showed the incidence of obesity in this population of airline pilots is similar to the general population of New Zealand, which is ranked third for obesity among OECD countries. It is estimated that in this airline there are 300 obese pilots and an additional 150 to 200 pilots who are overweight. Over a 25 year career a significant burden of obesity-related disease is anticipated, resulting in sickness absence and safety risk.

Methods. Pilots were invited to volunteer to participate in a health and well-being program. Fifteen volunteers were then randomly allocated to a personalised intervention with a high-profile professional strength and conditioning coach, and 15 to a control group. It was impractical to blind either the participants or assessors. Both groups were evaluated at the beginning and end of a twelve week period. Evaluations included a three-day food diary, estimates of body fat using BMI, skin-fold thicknesses, waist hip and neck circumferences, and VO2-Max was estimated using a stationary bike test. The intervention group met with the strength and conditioning coach. They were then given personalised diet and exercise programs and regular support. The progress of the intervention group was incentivised by generating an environment of competition and peer support. The control group met with an occupational physician who gave them standard advice about weight loss, however they received no other support during the twelve weeks between evaluations.

Results. The average weight lost for pilots in the intervention and control groups were 6.3kg and 0.8kg respectively. The range of weight lost for individuals in the intervention group was 4 to 16.3kg. The intervention group also achieved greater improvements in skinfolds, neck hip and waist circumference and VO2-Max when compared with the control group.

Conclusions. Obesity is a common health risk for pilots. This trial showed a personalised weight loss program can be highly successful. The subsequent evolution of the program will be discussed.
CONTENT VALIDITY OF THE RAF AIRCREW CONDITIONING PROGRAMME

VALIDITÉ DU CONTENU DU PROGRAMME DE CONDITIONNEMENT DES ÉQUIPAGES DE L'ARMÉE DE L'AIR ROYALE

Authors: E Slungaard, ND Green, D Newham, S Harridge

Affiliation of first author: RAF CAM

Address for communication:
RAF CAM, RAF Henlow, Henlow, Bedfordshire, UK, SG16 6DN
ellen.slungaard421@mod.uk

Introduction: Aircrew suffer from a relatively high prevalence of spinal pain episodes and there is a need for a valid preventative exercise protocol tailored for this group. The RAF Aircrew Conditioning Programme (ACP) has been designed to enhance pilot performance through reducing fatigue and strain injuries, including injuries to the neck. Content validity of the ACP was assessed to determine the appropriateness for delivery to aircrew.

Methods: A panel of six experts was trained with a suggested exercise protocol corresponding to the second level of the ACP, which is delivered to aircrew who have completed basic instruction in cervical spine stability, core stability and initial technique instruction for strength training. Content validity on overall exercise approach (5 items) and specific exercise session (24 items) was rated on a four-point Likert-type ordinal scale with respect to relevance and simplicity. The reviewers were medical experts; four had experience delivering an exercise programme to aircrew. The item content validity index (I-CVI) was the proportion of experts rating an item/exercise as acceptable (score 3-4) while protocol-CVI was the average I-CVI across items.

Results: The relevance of the exercise approach reached an excellent I-CVI of 1.00 while for simplicity the I-CVI was fair-to-acceptable (0.80-0.83). The relevance for the suggested exercises reached an acceptable-to-excellent I-CVI (0.83-1.00) while for simplicity, twenty-one of twenty-four reached an acceptable-to-excellent I-CVI (0.83-1.00); the other three items reaching fair I-CVI (<0.83). For exercise sessions, protocol-CVI was excellent (0.91) on relevance and acceptable (0.87) on simplicity.

Conclusion: The exercise protocol demonstrated excellent relevance for the aircrew population. The supervising personnel require further training with the exercises to enhance simplicity with the protocol.

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MEDICAL SYMPTOMS AMONG PILOTS ASSOCIATED WITH WORK AND HOME ENVIRONMENT: A 3-YEAR COHORT STUDY

SYMPTÔMES MÉDICAUX CHEX LES PILOTES ASSOCIÉS AU MILIEU DE TRAVAIL ET À LA MAISON: UNE ÉTUDE DE COHORTE SUR 3 ANS

Authors: X Fu, T Lindgren, D Norbäck
Affiliation of first author: Uppsala University and University Hospital
Address for communication:
Uppsala University and University Hospital, Ulleråkersvägen 40, Uppsala, Sweden, 751 85
xi.fu@medsci.uu.se

Objective: To study associations between cockpit environment, psychosocial work environment, home environment and medical symptoms in a cohort of commercial pilots followed over 3 years.

Methods: A standardized questionnaire was mailed in February-March 1997 to all Stockholm-based pilots on duty in a Scandinavian flight company (N=622); 577 (93%) participated. During this time smoking was allowed on long haul flights but not on shorter flights. Smoking was prohibited on all flights after September 1997. The same questionnaire was sent to the cohort of 577 pilots in February-March 2000; 436 participated (76%). The questionnaire contained questions on symptoms, psychosocial work environment and the home environment. Associations were investigated using multiple logistic and ordinal regression.

Results: Symptoms were common among commercial pilots, especially eye symptoms (38.5%) nose symptoms (39.9%) and tiredness (29.9%). Pilots exposed to environmental tobacco smoke (ETS) on long haul flights had more eye symptoms (odds ratio =1.91) and tiredness (odds ratio =2.73). Pilots exposed to ETS on short haul flights had more eye symptoms (odds ratio =1.55) and tiredness (odds ratio =1.53). These symptoms were reduced when no longer exposed to ETS. Those who started working on long haul flights developed more nose symptoms. Pilots reporting increased work demands developed more nose and dermal symptoms and tiredness and those with decreased work control developed more eye symptoms. Pilots living in new houses, multi-family houses and in recently painted homes reported more symptoms.

Conclusion: Eliminating ETS exposure on board reduced medical symptoms and further work to reduce ETS exposure globally is needed. Psychosocial aspects of the work environment for commercial pilots should be considered, as well as the home.
Obstructive sleep apnea (OSA) is a disqualifying medical condition for an airman medical certificate in the United States under Title 14 of the Code of Federal Regulations, Part 67. OSA is a significant cause of fatigue, and is therefore a hazard to the safety and health of airmen. OSA inhibits restorative sleep, can cause excessive daytime sleepiness, personality disturbances, cardiac dysrhythmias, myocardial infarction, stroke, sudden cardiac death, and cognitive impairments.

In 2007, the National Transportation Safety Board recommended that the FAA increase its efforts to identify OSA in airmen. OSA education became part of every Aviation Medical Examiner (AME) Seminar, hoping AMEs would more easily recognize it and insure airmen were appropriately treated. After 4 years, there was no change in the number of airman detected with OSA. The FAA contemplated a policy requiring all airmen with a BMI greater than 40 to have an evaluation by a certified sleep medicine specialist. This caused enormous concern in the aviation community reaching all the way to the U.S. Congress. It was clear that increased screening of airmen for OSA was necessary, yet the impact of this screening on airmen without the diagnosis had to be minimal.

In March 2015, the FAA released new guidance to AMEs on how to screen for OSA. As part of the physical examination, every airman will be placed in one of 6 categories, from no risk of OSA, to extreme risk of OSA requiring a full sleep evaluation. The details of this guidance will be presented. Since implementation, 131,145 airmen have applied for medical certificates. Of these, 467 airmen (.35%) had increased risk of OSA, were required to have a sleep evaluation, but were medically certificated. 68 airmen (.05%) were denied certification due to an immediate safety risk. This new process has improved aviation safety.
The 11 air sports in which athletes compete internationally are governed by the FAI. Although no air sport is currently an Olympic sport, FAI conforms to the Olympic Code, as administered by the World Anti-Doping Agency (WADA). In this session, I shall outline the history of anti-doping, present the Prohibited List of drugs in and out-of-competition, and illustrate how Therapeutic Use Exemptions (TUE) from this list are requested and adjudicated by the TUE Committee (TUEC).

Efforts to prohibit use of performance-enhancing drugs in sports are not new, but were codified by the Olympic Committee in the early 1990s. Acceptance by sport and by government varied, but the UNESCO International Convention Against Doping in Sport has been ratified by 174 states. WADA is funded partly by the Olympic Committee and by various governments. In turn, sports governing bodies impose adherence to the code for their licensed athletes. It is the athlete's duty to avoid prohibited drugs, to provide blood and/or urine samples on demand, and if in a Registered Testing Pool (RTP,) to notify their location continuously to WADA.

If the athlete and his/her physician determine that use of a prohibited drug is necessary, a TUE may be requested. Six members of the Commission Internationale Médico-Physiologique (CIMP) of FAI form the TUEC. Four criteria are considered: the medical necessity for the drug, the possibility of enhanced performance, the potential for an equivalent, non-prohibited drug, and the use being derived from another prohibited substance or method. The incidence of anti-doping in air sports and examples of unusual or controversial TUE will be shown.
THE INFLUENCE OF PURSER SUPPORT AND OTHER RELATED FACTORS ON THE TENDENCY OF DEPRESSION AMONG CIVIL AVIATION FLIGHT ATTENDANTS IN INDONESIA

Authors: I Mariska, D Sosrosumihardjo, W Imam, B Basuki

Affiliation of first author: Aviation Medicine Postgraduate Program, Universita

Address for communication:
Aviation Medicine Postgraduate Program, Universita, Merpati 3 Kota Baru Bandar Kemayoran, Raden saleh I no.15 A, Kemanggisan Ilir Blok C No.134, central Jakarta, Indonesia, INDONESIA, 10610 drintan_mariska@yahoo.com

Introduction: Tendency of depression can occur among flight attendants, affecting their performance and causing absence from work. The purpose of this study was to identify the influence of purser support and other related factors to the tendency of depression among civil aviation flight attendants in Indonesia.

Methods: A cross-sectional study with purposive sampling was conducted among flight attendants who were taking routine medical examination at the Civil Aviation Medical Center, Jakarta from 12-18th May 2014. Inclusion criteria were subjects not taking antidepressants or benzodiazepines and not habitually drinking alcohol. The tendency of depression was measured using the Beck Depression Inventory Questionnaire. Risk factors were purser support, support outside of work and mental workload, and were assessed using NIOSH Generic Job Stress Questionnaire, and then analyzed using linear regression.

Results: Subjects were 145 from 242 respondents who met the inclusion criteria. Purser support, support outside of work, and mental workload were dominant factors for tendency of depression. Each additional point of purser support reduced 0.552 point to the tendency of depression \( (\beta = -0.552; P=0.033) \). Furthermore, each additional point of support outside of work reduced 1.191 point to the tendency depression \( (\beta = -1.191, P=0.000) \). On the other hand, one additional point of mental workload increased 0.549 points to the tendency of depression \( (\beta = 0.549, P=0.045) \).

Conclusion: Higher purser support and support outside of work reduced the tendency of depression, while higher mental workload increased the tendency of depression.
Error by medical professionals is common, and this has received much attention in the last fifteen years since publication of To Err is Human and Crossing the Quality Chasm by the U.S. Institute of Medicine. Speakers such as Dr. Atul Gawande and Captain Sully Sullenberger have applied aviation safety principles to medical safety. Medical certification of airmen has been established, in part, to prevent aircraft accidents by preventing pilot errors that may result from medical incapacitation. However, diagnostic and related medical errors by physicians and other health care professionals that have prevented otherwise qualified airmen from flying have received little or no attention. No papers on this specific topic were found on review of the medical literature.

Two cases will be presented in which medical error resulted in pilot grounding for significant time periods before those errors were recognized and medical certification re-established, the first being misdiagnosis of a brain disease because an MRI had been mistakenly labeled as the pilot's when it was that of another patient, and the second resulting from a psychiatric diagnosis being applied to a urologic problem.

There is presently no way to know how commonly this occurs, but more could be learned if certifying bodies were to identify and maintain a record of such cases. To prevent such occurrences, it is recommended that airmen be advised of their right to appeal adverse medical certification decisions, with review as appropriate by a specialist in aviation medicine on behalf of the pilot, that inconsistent data should be questioned, and that there should be open communication between the pilot, the medical examiner and the certifying authority concerning the circumstances of the case so that medical errors may be rectified. Litigation is a possible, but not a necessary outcome.
THE SWISS MEDICAL CONCEPT FOR SINGLE COMMERCIAL HELICOPTER PILOTS AGED 60 - 65 YEARS
- A PRELIMINARY MODEL

LE CONCEPT MÉDICAL SUISSE POUR PILOTES D'HÉLICOPTÈRE AGÉS DE 60 À 65 ANS EXERCANTS DES TRANSPORTS AÉRIENS COMMERCIAUX EN SOLO - UN MODÈLE PROVISOIRE

Authors: RM Maire, S Drechsel, L Sze, S Muff

Affiliation of first author: Cardiological expert FOCA

Address for communication:
Cardiological expert FOCA, Bahnhofstr. 20, Maennedorf, SWITZERLAND, CH-8708
maire@hin.ch

Introduction: Single pilot commercial air transport operations by pilots aged 60 - 65 years are prohibited according to EASA-Requirements. The Swiss Federal Office of Civil Aviation achieved a derogation of this age limit with EASA. It is a temporary exemption for helicopter pilots. The Mitigation Measures contain additional check flights and medical provisions. The medical concept is presented. It takes into account that cardiovascular events are the most important causes of sudden incapacitation in the age group between 60 and 65 years.

Methods: Swiss helicopter commercial pilots who intend to profit from the derogation must undergo evaluation by a cardiologist: clinical examination, lab screen, exercise-ECG, further tests on clinical indication. The cardiovascular annual risk of the pilot is analysed. If it exceeds 1% per year, a computed tomography coronary angiography (CCTA) is performed.

Results: Twenty one helicopter pilots applied for the exemption. Twelve could be accepted; none of these pilots needed a CCTA. The medical examination was incomplete in eight candidates, one pilot did not fulfill the medical criteria, these nine pilots were not accepted. The scientific literature of this medical concept (Swiss Model) will be presented.

Conclusions: The cardiovascular risk assessment according to the Swiss Model is a feasible method to identify pilots with a low cardiovascular risk in the age group 60 - 65 years. The Swiss Model might serve as the basis for a modification of the EASA-rules.
Introduction: Most of the pilots seen at medical examinations are young and fit, and a decision on fitness to fly is easy. For the older pilot, the effects of aging and the greater risks of disease mean that medical examinations need to be more thorough. Since 2006 Iran Civil Aviation organization has allowed pilots over the age of 60 to continue flying for the airlines, subject to regular medical review. Now I have almost 9 yrs of hands-on experience in the aero medical assessment of senior pilots. This paper shares some of our findings.

Methods: Medical data for all pilots over 60 yr of age, including examination findings, results from screening, and causes of unfitness, were reviewed. In my country, all pilot medical examinations are in the aeromedical center of Iranian Civil Aviation Organization. Questionnaires were used to survey medical status and subjective changes in memory and fatigue resistance in pilots between the ages of 60 to 65 yr old, and also in subjects who had been denied medicals at the age of 60.

Results: There is an increased variety in medical fitness of pilots with age, and an increase in the number of denials of medical certification. Some diseases such as coronary artery disease, diabetic disease and malignancy be inclined to increase with age. During 2006-2014, 29 (6.9%) of 420, otherwise healthy pilots were denied certification as a result of cardiovascular, neurological and endocrine abnormal screening findings, mainly because of asymptomatic cardiovascular problems. More than half of pilots said that their memory and fatigue resistance had subjectively reduced with age.

Discussion and Conclusion: Since the International Civil Aviation Organization (ICAO) amended the upper age limit for commercial pilots in 2006 it is likely that there will be an increase in the number of senior pilots worldwide. We question the value of routine EET, CT angiography, angiography, scan thallium and MRI screening in the senior pilot age group.
AEROMEDICAL FITNESS DECISION-MAKING TESTED BY THE EVIDENCE BASED MEDICINE APPROACH

LA PRISE DE DÉCISION D’APTITUDE MÉDICO-AÉRONAUTIQUE À L’ÉPREUVE DE LA MÉDECINE FONDÉE SUR LES PREUVES

Authors: M Monteil, C Destanque, S Nguyen, A Lepoyvre, J Mouchard, E Perrier

Affiliation of first author: CEMPN Toulon

Address for communication:
CEMPN Toulon, HIA Sainte-Anne, TOULON, VAR, FRANCE, 83800
marcmtl@free.fr

Introduction: Medical aircrew selection is a cornerstone of flight safety. However, in recent years a simplification process is emerging. Some experts have even suggested to select the cabin crew (CC) with a simple medico-biographical questionnaire form (MBQ). To assess the adequacy of such a method, the authors studied the practicalities of the aviation medicine fitness decision-making for professional aircrew (AC) candidates. This work also allows updating epidemiological data on the initial unfitness causes.

Method: A prospective descriptive study with comparative data analysis was performed in population including all applicants for a military or civilian aviation professional duty, seen in medical assessment in France in 2011. 425 candidates of a total of 5,206 were declared unfit (8.2%). The authors compared the effectiveness of each stage of the medical examination process used in 2011 in France. The gold-standard remained the full medical examination including medico-biographical questionnaire, medical history evaluation and clinical examination by a physician with specific knowledge and experience in aviation medicine, and then additional regulatory medical tests. The number of unfit candidates was measured at every step.

Results: The MBQ diagnosed only 81 unfit candidates (19%). In each sub-population of applicants, it is still the least efficient stage in the medical examination process. Results show that the use of a simple medico-biographical questionnaire will not be sufficient to determine initial fitness, regardless of aviation duty considered, including cabin crew. The five main reasons for unfitness are: ophtalmology (56.2 % of all the unfit), ENT (10.1%), cardiology (7.5%), rheumatology/orthopaedics (5.4%) and neurology (5%).

Conclusion: This evidence-based medicine approach shows that no selection stage alone is sufficient. The complementarity of each step ensures an optimal process. The physician-candidate meeting is also an added value to the medical selection of aircrew.
THE EFFECTS OF NOISE PROTECTION ON AUDIO SITUATIONAL AWARENESS

LES EFFETS DE LA PORTECTION AUDITIVE SUR LA PERCEPTION DE LA SITUATION SONORE

Authors: SH James
Affiliation of first author: QinetiQ
Address for communication:
QinetiQ, Cody Technology Park, Farnborough, Hampshire, UK, GU14 0LX
shjames@qinetiq.com

Introduction: Hearing protection requirements for UK military aircrew are now understood and there is good understanding of the range of hearing protection available. There is currently, however, a dearth of information on the types of audio cues aircrew use during flight to determine aircraft status and personal safety. Without understanding the audio characteristics of these cues it is not possible to define whether a hearing protection system will inhibit their detection in the cockpit noise environment, and this in turn could have implications for operational effectiveness and flight safety.

Methods: To understand the audio cues used, a data gathering exercise was conducted with aircrew of 19 different military air platforms. The aircrew interviewed were of varying roles and experience and the data were collected using a structured interview technique. Subsequent analysis categorised the audio cues identified into natural and introduced cues. They were also categorised on whether they related to safety or situational awareness. Once categorised and prioritised the most critical cues were identified.

Results: The results revealed reasonable commonality between the audio cues monitored across platforms. Whilst a number of specific audio cues were identified, above all else, aircrew report that they listen for a change to the normal noise environment; the change acting as a primary indicator that something has happened or is about to happen. The study also highlighted that enhanced hearing protection does impact aircrews ability to hear the audio cues presented. Whilst on some platforms this does not significantly impact operating of the aircraft, on others it has been necessary to remove hearing protection to help with fault finding during an emergency.

Conclusion: When identifying hearing protection solutions, as well as selecting a protector that will allow adherence to UK noise legislation, it must also allow aircrew to continue to hear the audio cues identified within this study. If enhanced protection focuses on reducing certain tones without regard to the total audio environment aircrew may lose a key audio cue.
INTRODUCTION. The performance and comfort of aircrew using stereoscopic displays viewed at a near distance over long periods of time is now an important operational factor to consider with the introduction of aerial refueling tankers using remote vision system technology. Examples include the USAF KC-46, RAAF KC-30, JASDF KC-767, and RNLAF KDC-10. Existing vision standards for Flying Class III aircrew with scanner duty, including aerial refueling operators, were designed for viewing real objects at long distances and may not be adequate for stereoscopic displays viewed at near distances.

METHODS. The Operational Based Vision Assessment Laboratory coordinated with the Air Force KC-46 Directorate, Boeing, and Flight Safety International to develop an aerial refueling operator remote vision system simulation. We also developed a comprehensive set of stereo acuity and ocular alignment measures, which included current standard measures, as well as several experimental vision tests. Fifteen subjects participated in one experiment to evaluate the effect of 2D, stereoscopic, and hyperstereoscopic camera configurations on refueling performance. In a second experiment, 27 subjects were selected such that about one-third clearly met current standards, one-third satisfied waiver criteria, and one-third failed current standards and waiver criteria for stereo acuity and ocular alignment. The relationship between vision test results and refueling performance was evaluated.

RESULTS. The results of Experiment 1 showed that the use of stereoscopic cameras clearly improved performance on average. The results of both experiments show that individuals with poorer quality of vision perform worse and report greater levels of discomfort.

CONCLUSION. The relationship between visual performance metrics and operationally relevant refueling performance and self-reported eye-strain is reported in detail. Coarse measures of stereo acuity, and standard measures of ocular alignment, such as phorias, may not be adequate for screening aircrew using new technologies such as the KC-46 aerial refueling operator remote vision system.
Introduction: UK military personnel injured in an operational setting will often have sustained significant haemorrhage at the time of injury and may have undergone lengthy surgical procedures, receiving massive transfusions of blood/blood products. The potential effects of early aeromedical evacuation combined with a reduced haemoglobin (Hb) status on tissue oxygenation and viability are not fully understood. A near infra-red spectroscopy (NIRS) technique has been developed to monitor regional tissue oxygen saturation (rSO2) in the aeromedical evacuation setting.

Methods: rSO2 was recorded in the deltoid muscle of 15 ventilated military casualties during aeromedical evacuation from Afghanistan, together with standard critical care physiological variables. The casualties had all experienced significant traumatic injuries, requiring damage control surgery and/or massive transfusions of blood/blood products.

Results: Deltoid rSO2 fell by 10% or more in 28% of the casualties, despite the absence of a significant corresponding change in systemic physiological variables, such as pulse oximetry or heart rate, or overt clinical deterioration.

Conclusion: This study suggests that patients with reduced Hb do not experience a greater degree of tissue hypoxia in flight. A definitive role for rSO2 monitoring to identify clinically significant physiological changes in flight has not yet been established.
Objective: Identify barriers, key measures and best practices in the development of a successful, forward deployed, air ambulance program for blood product resuscitation.

Methods: Retrospective analysis of unclassified information/decision briefs, after action reports, training/implementation standard operating procedures and extensive pub-Med review of the literature regarding forward damage control resuscitation and air ambulance.

Results: From January through May 2012, extensive coordination was made to initiate en-route blood product administration aboard U.S. Army medical evacuation helicopters. A clinical operating guideline was developed with extensive inter-disciplinary subject matter expertise. Rigorous training, standardized implementation and quality assurance protocols enabled safe and effective blood product administration for 84 severely wounded casualties from May-December 2012, without significant blood product wastage or instance of transfusion reactions. Significant challenges included developing transfusion competency in medics with basic baseline training and achieving high quality blood support in multiple forward locations. Political considerations are also important.

Conclusions: The development of blood product administration capabilities aboard the air ambulance is logistically complex and requires precautions against blood spoilage and wastage. Rigorous temperature control and attention to time sensitive qualities of blood product administration are important considerations, and require a high degree of blood bank integration. Structured and repetitive training, conducted by personnel with a high degree of familiarity with transfusion, enabled medics with basic baseline training to safely perform transfusion in accordance with a tightly regulated clinical operating guideline. In the austere environment, logistic factors are significant challenges to implementing new programs. When implementation is done in the combat environment or as part of a multi-national humanitarian effort political sensitivities are important considerations. Best practices may facilitate implementation of new en route transfusion programs in other austere environments.
Introductions: The Royal Air Force (RAF) is responsible for worldwide aeromedical evacuation of military personnel and entitled civilians. Following clinical assessment, a physician may accompany the patient in transit, if deemed necessary. The type of clinical scenario and location of the patient varies significantly, impacting prioritisation of the retrieval. This abstract reviews the workload of the RAF physician cadre and the type of pathology they evacuate.

Methods: Physician moves since January 2013 until June 2015 were retrospectively reviewed, assessing indication, location, interventions required and complications.

Results: 47 physician moves were identified, the majority evacuating military personnel (80.8%). Cardiac pathology was the commonest reason necessitating retrieval in almost half of all cases. Other reasons included respiratory, gastroenterology, neurology, oncology, endocrine, infectious diseases, heat related disorders, trauma and others that do not fit into these categories, such as lightning strike. The infectious disease category includes 3 cases of confirmed Viral Haemorrhagic Fever, repatriated as part of operation GRITROCK in Sierra Leone. Retrieval locations are predominantly from worldwide non-operational locations (23.4%). Other military locations are Cyprus, Germany, Gibraltar, Ascension Islands, Falkland Islands, Kenya, Middle East Area of Operations and those from Operation Telic, Herrick and Gritrock.

Discussion: Since the end of Operation HERRICK, the number of physician augmented aeromedical evacuations has decreased (21.5 patients/yr (2008 to 2011) vs. 15.6/yr in 2013-15). However, the geographical dispersion has broadened, often to austere and challenging environments. This has increased the logistical complexity of taskings. As has been demonstrated, it is imperative that military physicians continue to train in general medicine, enabling them to manage such a variety of patients. There remains a clear role for Physician Augmented Aeromedical Evacuation, adapting to the evolving requirements resulting from the change in military worldwide operations.
THE APPLICATION OF MILITARY FLYING AND MEDICAL EXPERIENCE TO ENHANCE MEDICAL TRAINING AND LEADERSHIP IN THE NHS

L’APPLICATION DE L’EXPÉRIENCE DE L’AVIATION MILITAIRE ET MÉDICALE POUR AMÉLIORER LA FORMATION MÉDICALE ET LE LEADERSHIP DANS LE NHS

Authors: JM Hynes, CJ Adcock, PD Hodkinson

Affiliation of first author: RAF Centre of Aviation Medicine

Address for communication:
RAF Centre of Aviation Medicine, RAF Centre of Aviation Medicine, RAF Henlow, Hitchin, Hitchin, Beds, UK, SG16 6DN
jonnymhynes@hotmail.co.uk

Introduction: Comparison of military medical and flying practices with current civilian medical care highlights a number of disparities with potential for improved practice. The aim of this quality improvement project was to apply approaches from military medicine and flying to the daily routine of the Medical On Call team with the goals of i) improving the learning and teaching environment whilst also ii) focussing on patient safety.

Methods: The daily routine was reviewed as an end-to-end process and a new system drafted incorporating elements from military flying and medical practice. The new system included initial brief, midday review and end-of-day debrief. Initial brief included roles and responsibilities, team and individual objectives for the day, review of recent lessons identified, emergency topic of the day, re-assurance of a just culture and opportunity for questions. End-of-day de-brief included safety points and lessons identified against the training objectives, which were recorded with open access for future teams to use. Data were collected with a questionnaire including Likert scale analysis.

Results: Over a 3-week initial trial period 18 doctors provided feedback. All either agreed or strongly agreed that the project improved team communication and cohesion and 58% thought the process could be modified to provide benefit in a ward based scenario. 58% responded that the project enhanced training experience. 92% agreed or strongly agreed that the brief/debrief cycle fostered a safety culture. 17% felt that the brief/debrief routine interfered with the normal working day. Conclusion: The new system for the medical on-call team working day was reported to improve team communication and cohesion, and foster a safety culture. These are important for patient safety because human factors are often cited in medical incidents. This initial trial supports further consideration of the system for medical on-call teams and adaptation for a ward based trial.

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A REVIEW OF PERCUTANEOUS HUMAN ABSCESS DRAINAGE IN MICRO GRAVITY

ANALYSE DU DRAINAGE PERCUTANÉ DES ABCÈS HUMAINS EN APESANTEUR

Authors: LA Brown, TG Smith, PD Hodkinson, J Windsor, A Phillips

Affiliation of first author: University of Oxford

Address for communication:
University of Oxford, 37a Hilltop Road, Oxford, UNITED KINGDOM, OX4 1PD
lisa.brown@ndcn.ox.ac.uk

Introduction: With the prospect of extended duration space flight, minimally invasive surgical procedures such as percutaneous drain insertion will be required to stabilize and treat astronauts in the event of intra-cavitary abscess formation. In this isolated environment it is vital that the drainage procedure is successful. On Earth, percutaneous drains fail in up to 70% of cases, predominantly due to blockage. The aim of this study was to evaluate what is currently known of percutaneous drain function in micro gravity and whether there is need for improvement in their design.

Methods: A search was undertaken of Medline, Embase, Pubmed, Compendex and Google Scholar databases using the Search terms "Fluid" and "Flow" and ("Zero Gravity" or "Space" or "Microgravity" or "Weightlessness") and "Body".

Results: A total of 31 studies were included in the final review. The main findings regarding drainage flow of abscess fluid in micro gravity were: initial aspiration of abscesses has been performed in parabolic flight, but there have not been studies evaluating ongoing drainage; flow is altered due to changes in surface tension; there is an axi-symmetric distribution of gas and solids within the liquid; without gravity the only influence on solid particles is drag and buoyancy; as the density of a fluid increases, it moves closer to the drain wall. Debris and blood adhere to the abdominal wall in micro gravity and this could attenuate the flow of abscess fluid into the drain.

Discussion: There is limited evidence regarding the flow of abscess fluid through a percutaneous drain in microgravity. Due to the change in surface tension of the abscess fluid, it is possible that the drain will block due to internal lumen surface adherence. Investigation is required with respect to drain design and best application of adjunct interventions such as suction and irrigation.
Introduction: ICAO Annex 1 standard 1.2.4.5.1, which came into effect in November 2005, requires States to ensure that their Medical Examiners have received training and demonstrate adequate competency (not only adequate knowledge) before being designated, and at regular intervals thereafter. However, implementing proper training for these Designated Medical Examiners (DMEs) is challenging and there are widely differing standards, scope and pedagogy used for medical examiner training globally. As a first step towards globally harmonised aviation medicine training ICAO convened a Medical Provisions Study Group (MPSG) in 2009 to propose a uniform approach that could be used to implement 1.2.4.5.1. Subsequently ICAO published a competency-based training framework as Part V, Chapter 1 in the third edition of ICAO’S Manual of Civil Aviation Medicine (ICAO Doc 8984) in 2012.

Methodology: The competency-based framework contained in ICAO Doc 8984 was examined systematically and translated into a training curriculum that is oriented to train physicians who have not had prior exposure to civil aviation medicine. Curricular elements were developed with a focus on creating contextually relevant learning experiences for competency acquisition. Contributions from specialist clinicians and academics were solicited to produce the course materials and deliver the course modules.

Results: The Singapore Aviation Academy-IAASM competency-based Aviation Medicine Course for Medical Examiners was launched in July 2013. The two-week syllabus is organised into the following 5 blocks: Regulatory Compliance; Foundational Aviation Medicine; Conducting Medical Examination; Risk-based Aeromedical Evaluation; and, Operational Aeromedical Topics. A total of 44 physicians from 19 countries have completed this course, which was conducted in July 2013 and July 2014.

Discussion: To develop and implement a competency-based curriculum for training DMEs is challenging as there are constraints with regards to course duration, content scope, creating realistic context and availability of resources. Our experience shows that such a programme can be successfully implemented.