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Book of Abstracts

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Part 1: Oral Presentations

Thursday 22 September 22

Gaston Berger Room

0930-1015

The 2022 Andre Allard Lecture

Luc Tytgat

Director, Strategy and Safety Management Directorate, EASA

Thursday 22 September 22

Gaston Berger Room

1045-1215

Scientific Session 1

The 2022 John Ernsting Panel

**COVID-19 Aerospace Medicine Risk Mitigation,
Controversies and Lessons Learned**

COVID-19 AEROSPACE MEDICINE RISK MITIGATION, CONTROVERSIES AND LESSONS LEARNED

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Background: Worldwide aviation has been greatly and negatively impacted by the COVID-19 pandemic. Right from the outset, organizations, businesses, and individuals within the aviation industry have faced unique and complex challenges. As the pandemic evolved, so did knowledge, attitudes, and expectations. Contingency planning has had to adapt. Controversy has not been rare, especially around the relative weight of preventive measures and harmonization, creating unique opportunities for learning. Procedures have been assessed, reassessed, implemented and made more robust, which may serve the aviation community well in years to come. In this presentation, the author will discuss controversies and lessons learned from the perspective of the medical side of frontline organizations.

Overview: As the pandemic evolved, so did knowledge, attitudes, and expectations. Contingency planning has had to adapt constantly. Controversy has not been inherent in the pandemic, especially around the relative weight of preventive measures and harmonization. The pandemic has created unique opportunities for learning in both scientific and organizational terms. Procedures have been assessed, reassessed, implemented and made more robust, which may serve the aviation community well in years to come.

Discussion: In this presentation, the author will discuss controversies and lessons learned from the perspective of the medical side of frontline organizations: the Aerospace Medical Association's interaction with International Civil Aviation Organization (ICAO), the International Airline Transport Association (IATA), the Federal Aviation Administration (FAA), AsMA and its Air Transport Committee. As AsMA representative to ICAO, Collaborative Arrangement for the Prevention and Management of Public Health Events in Civil Aviation (CAPSCA), and the CAPSCA Science Advisory Group, the author will discuss lessons learned, controversies and more specifically the evolution of the risk mitigation strategic tool of James Reason, Swiss Cheese Model which was successfully adapted to international COVID-19 pandemic response (CAPSCA, WHO, ICAO, CSAG).

NEXT PANDEMIC PREPARATION USING COVID-19 TOP LESSONS LEARNED - AIRLINE INDUSTRY PERSPECTIVE

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Background: Worldwide aviation has been greatly and negatively impacted by the COVID-19 pandemic. Right from the outset, organisations, businesses, and individuals within the aviation industry have faced unique and complex challenges. As the pandemic evolved, so did knowledge, attitudes, and expectations. Contingency planning has had to adapt. Controversy has not been rare, especially around the relative weight of preventive measures and harmonisation, creating unique opportunities for learning. Procedures have been assessed, reassessed, implemented and made more robust, which may serve the aviation community well in years to come. This presentation is expected to be part of a panel to discuss controversies and top lessons learned from the perspectives of the medical side of frontline organisations.

Overview: As the pandemic evolved, so did knowledge, attitudes, and expectations. Contingency planning has had to adapt constantly. Controversy has not been rare, especially around the relative weight of preventive measures and harmonisation. On the other hand, the pandemic has created unique opportunities for learning in both scientific and organisational terms. Procedures have been assessed, reassessed, implemented and made more robust, which may serve the aviation community well in years to come.

Discussion: In this presentation, the author will discuss top lessons learned from the perspective of the medical side of the International Airline Transport Association (IATA), the global voice of the airline industry.

PANDEMIC CONTINGENCY PLANNING IN THE AIRLINE SETTING: LESSONS FROM THE COALFACE IN RISK PERCEPTION AND MANAGEMENT

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Background: From the very beginning of the COVID-19 pandemic, organizations, businesses and individuals within the aviation industry have had to face unique and complex challenges. As the pandemic evolved, so did knowledge, risk perception, attitudes and expectations. Contingency planning has had to constantly adapt.

Overview: From the vantage point of the work of the Aerospace Medical Association Air Transport Medicine Committee, key topics emerging from operations, contingency planning advisory and peer discussions will be discussed, namely: implementation of multilayer risk mitigation measures, strategies for greater adaptability and customisation of contingency planning, modulators of risk perception, attitudes and behaviour. Two informal surveys are presented which try to address the experiences of aviation health professionals and the impact the pandemic has had on airline aviation medicine:

1. A structured facilitated debrief to airline health services nurses involved in COVID-19 case follow-up and high-risk contact tracing;
2. A survey among airline medical advisory providers.

Discussion: Are we better prepared for the next pandemic or pandemic-like event? This will be discussed based on the aviation health professionals debriefs, as well as from a risk perception and management point of view.

NEXT PANDEMIC PREPARATION USING COVID-19 TOP LESSONS LEARNED: AIRLINE CREW HEALTH AND CONTACT TRACING

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Background: Worldwide aviation has been greatly and negatively impacted by the COVID-19 pandemic. Right from the outset, organizations, businesses, and individuals within the aviation industry have faced unique and complex challenges. As the pandemic evolved, so did knowledge, attitudes, and expectations. Contingency planning has had to adapt. Controversy has not been rare, especially around the relative weight of preventive measures and harmonization, creating unique opportunities for learning. Procedures have been assessed, reassessed, implemented and made more robust, which may serve the aviation community well in years to come. In this panel we discuss controversies and lessons learned from the perspective of the medical side of frontline organizations:

Overview: As the pandemic evolved, so did knowledge, attitudes, and expectations. Airline medical departments have rapidly adapted their policies, services and procedures to manage health risks and to comply with new public health regulations. The regulations were not always well-aligned with the occupational health needs of airline crew. In addition, to assist with the protection of public health airlines have undertaken contact tracing activity on a large scale.

Discussion: In this presentation, I will discuss key lessons learned from the perspective of an airline medical department which continued international operations from within a country which maintained an elimination strategy for COVID-19 for a 20 month period. The very low public tolerance for any COVID cases in the community created some novel social and regulatory challenges for managing the health of aircrew who travelled internationally. There was also an expectation of very rapid and high accuracy contact tracing of airline passengers and crew. The evolution of technological solutions, policies and processes over that period will be presented, with view towards potential for further enhancements which may enable more effective management of future pandemics.

COVID-19 AND RETURN TO FLYING DUTIES: AN INTERESTING EXPERIENCE OF DECISION-MAKING PROCESS FROM THE AEROMEDICAL CENTERS TO THE AEROMEDICAL AUTHORITIES

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Background: Civilian and military aviation has been highly impacted by the COVID-19 pandemic. Nonetheless, even during the lock-down, some flying activities such as military flights or MEDEVAC had to continue. A case report at the end of April 2020 of a young military aircrew member suffering from in-flight hypoxia after a benign symptomatic presentation of COVID, made the practitioners of military AeMC rapidly question about aviation fitness.

Overview: There was therefore a real need to study the literature on the subject with two major difficulties: on the one hand, the disease was initially poorly described; on the other hand, no less than thousands of articles about COVID -19 were about to be rapidly published. Consequently, it was very important to remain focused on the aeronautical specificity of our population, considering the constraints, particularly hypoxia and a confined environment, and relying on the basics of the aeromedical expertise.

Discussion: In this presentation, the authors will present the algorithm imagined in the French Aeromedical centers to assist in decisions of return to flying duties after a COVID-19 episode. This work was rapidly shared with the French licensing authority, and then with EASA which used it in the following European recommendations. This algorithm was gradually updated with the evolution of knowledge on the disease, and with the mutations of the virus. Additionally, a study performed on aircrews who described a past medical history of COVID-19 between October 2020 and May 2021 will show to the audience these evolutions with a change in the use of RT-PCR and pulmonary CT by the aeromedical examiners. As an exceptional situation, this pandemic reminds us of the importance to go back to the basics of aviation medicine, the need to share the knowledge, and to constantly adapt our practice and advices in order to preserve the flight safety, the health of aircrew members and the operational capacity in a military environment.

MENTAL HEALTH ASPECTS OF COVID-19 AND PLANS FOR FUTURE SIMILAR OCCURRENCES

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Background: One of the unforeseen effects of the COVID-19 pandemic was a significant and pervasive effect on the mental health of aviation personnel. As a mental health crisis, the pandemic affected both those who lost and those who retained their jobs. Now, as traffic levels return to pre-pandemic numbers, the long-term effects of the mental health aspect are becoming clearer. Using lessons learned from COVID-19 will better allow us to put in place programs and initiatives that support the mental health of aviation personnel moving forward.

Overview: With that in mind, ICAO's Medicine section surveyed aviation mental health professionals and stakeholders to determine what areas should be of focus in the coming triennium. In addition to providing a standardized terminology and an aviation mental health framework, ICAO's Medicine section will also emphasize the importance of peer support for aviation personnel.

Discussion: Such programs can provide a trusted channel to seek aid in the event of mental health events, particularly with employee groups that are fearful of disclosing mental health issues (as some believe it can lead to revocation of their professional licenses).

Thursday 22 September 22

Gaston Berger Room

1400-1530

Scientific Session 2

**NATO WGAC: Why Screen For Heart Disease?
An International Panel on Non-Invasive Methods of Screening
for Cardiovascular Disease in Aircrew**

ROUTINE ECG SCREENING FOR AIRCREW - CON

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Background: A 12-lead resting ECG is the only routinely performed machine-aided cardiological examination in a flight physical exam. ECG screening of young individuals mainly concentrates on the detection of signs for inherited channelopathies, delta waves or signs for cardiomyopathies, whereas in individuals above age 40, it focuses on the diagnosis of coronary artery disease. Currently, it is a point of discussion as to what age and how often a routine ECG should be carried out without clinical indication. This abstract presents the disadvantages of frequent screening ECGs.

Overview: The European Union requires ECG screening for a class 1 medical certificate at the initial examination, every 5 years until age 30, every 2 years until age 40, annually until age 50, and at all revalidation or renewal examinations thereafter. For a class 2 medical certificate, it has to be carried out at the initial examination, at the first examination after age 40, at the first examination after age 50, and every 2 years thereafter. According to FAA regulations, ECG screening for first-class medical certification starts after reaching the 35th birthday and is not required for second-class and third-class medical certification.

Discussion: There have been reports of considerable interobserver variability in the interpretation of screening ECGs. This resulted in false-positive and false-negative results, increasing the social and economic costs of the screening by suggested follow-up investigations. Labeling individuals with an uncertain diagnosis originating from a false-positive ECG finding can lead to psychological effects, as well as impacts on insurance policies and employment. Studies analyzing ECG screening for aircrew found out that only a small minority of individuals had findings that should be considered for further investigation; changes in the same individual over time were rare. Standardized ECG criteria should be used.

AIRCREW SCREENING WITH ECG

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Background: The electrocardiogram (ECG) has been part of the screening process of asymptomatic aircrew for a long time. However, recently its usefulness for the screening process is being questioned.

Overview: an ECG is a non-invasive, simple, rapid, reproducible, cheap and reliable way to look for cardiac diseases that carry the risk of life-threatening arrhythmias. This includes channelopathies (long QT and Brugada syndromes), cardiomyopathies (hypertrophic and dilated cardiomyopathy (HCM), arrhythmogenic (right) ventricular cardiomyopathy (A(R)VC)) and conduction abnormalities (Wolff Parkinson White, left bundle branch block). Although the ECG is not the primary tool to diagnose coronary artery disease, it may very well diagnose its consequences, like (silent) myocardial infarction. ECGs may also contribute to risk stratification (left ventricular hypertrophy, presence of frequent and/or complex premature ventricular contractions), and to the determination of the severity of valvular disease (left and right atrial dilatation, left and right ventricular hypertrophy). The physical and aeromedical demands that are part of some functions (particularly hypoxia, and above all G forces in high performance aircraft) may increase the vulnerability of the aircrew as a triggering factor for these arrhythmias, and thus a screening finding of an abnormal ECG may save lives. Finally, in the case of HCM and/or A(R)VC, exposure to heavy exercise, as is often the case in a military function, might even accelerate the cardiac deterioration, which makes an applicant unfit for such a function.

Discussion: the ECG remains an interesting tool with many advantages to find cardiac disease with the risk of potential life-threatening arrhythmias and other cardiac conditions. It may save lives and should therefore remain a cornerstone of the screening of asymptomatic aircrew.

IMAGING SCREENING FOR AIRCREW – PRO!

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Background: Small air forces favour echocardiographic screening of aircrew candidates. The rationale is to avoid a costly drop-out after training completion. Large air forces do not perform systematic echocardiographic screening of their aircrew candidates, due to the amount of screening which would be required, which is likely to be out of proportion to the benefit of avoiding the drop-out of a trained aircrew member due to late cardiac and aortic surgery.

Overview: Screening is a process. The screening test is characterized by its sensitivity and specificity. It is about the ability to rule in or out a specific feature. The most accurate test is neither 100% sensitive nor 100% specific, but somewhere in-between. However, the use of such an approach does not always apply to aircrew. In the absence of a leading clinical condition, it puts this population at risk of false positive findings and unnecessary subsequent testing. This is the result of the lack of a clear pre-test likelihood. On the other hand, considering a small group of very well selected applicants, screening might absolutely make sense in identifying conditions that would otherwise be missed during early stages of selection.

Discussion: At first glance, the use of echocardiographic screening in aircrew is likely to be a waste of resources. Only where there is a positive likelihood of a finding based on clinical knowledge, does low-threshold echocardiographic investigation (and *not* screening) make sense. Clinicians shall praise their clinical judgment again instead of following blindly pre-set routines and guidelines. On the other hand, and particularly in small groups, screening will remain the first choice for selection, thus avoiding late and costly dropouts.

IMAGING SCREENING FOR AIRCREW - CON!

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Background: Medical assessment for aircrew licensing is ubiquitous, but variable. For cardiac assessment some organisations use only history, examination and an ECG, while others also use echocardiography. To safeguard aircrew, and to protect organisations’ investments in their training, early detection of career-limiting conditions is an attractive option. However, this must be balanced against the costs of screening, and whether the relevant conditions will be detectable at the point of screening.

Overview: TTE is a non-invasive, accessible, low-cost, and reproducible method for assessing the heart. It can be used to detect valve defects, congenital anomalies, and cardiomyopathies, which increase aeromedical risk and may shorten a pilot’s career. A structurally normal heart on TTE can also provide significant reassurance. Thus it may seem that widespread screening of aircrew with echocardiography is justifiable and sensible. But the prevalence of these conditions in the general population is low, particularly at younger ages, and those at higher risk can be identified using history, examination, and ECG. This would allow the targeted use of echocardiography by only scanning those with higher pre-test probability. Valve disease is mostly a slowly progressive condition, with intervention only usually required in the sixth decade onwards. Cardiomyopathies are usually incompatible with flying duties, but those at increased risk can again be identified on history and ECG. But even in those subsequently develop a cardiomyopathy, echocardiography may be normal at entry into aircrew training, and thus provide false reassurance.

Discussion: TTE is an effective, low cost, and accessible tool for assessing cardiac structure and function. But its unselected use in all aircrew at the start of their careers may find valve disease which will never become aeromedically significant, and will not always pick up cardiomyopathies, even in those who subsequently develop it.

CT CORONARY ANGIOGRAPHY IN AIRCREW – THE BEST WAY TO SCREEN FOR CORONARY ARTERY DISEASE IN 2022 AND BEYOND

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Background: Cardiovascular (CVD) disease is a leading cause of death and attributed to over 19 million deaths a year globally and has increased by 14.5% in the last 10 years. The most common presenting symptoms of severe CVD is sudden cardiac death and thus coronary artery disease is a leading cause of disqualification or denial of licensure in both civilian and military pilots. Optimal screening for CVD is very controversial and must be evidence based.

Overview: Screening ECG and echocardiogram as well as exercise stress testing with or without imaging are very poor predictors of CAD with a positive predictive value of 16%. A global cardiac risk score is a better predictor of risk for major adverse cardiovascular event (MACE) however, it is also limited in an asymptomatic population with a false positive and false negative rate that exceeds true positives. Coronary artery calcium scoring (CACs) has emerged as a way to further characterize cardiac risk with a sensitivity and specificity over 90% for MACE over 10 years. However, CACS is still a limited assessment of the coronary artery anatomy and can miss significant coronary artery disease. CT coronary angiography (CTCA) provides a complete assessment of degree of CAD and thus perhaps the best screening modality for aircrew and all high risk occupations.

Discussion: A thorough investigation including aircrew data on the sensitivity, specificity, and positive and negative predictive values of stress testing with CACS verses CTCA will be presented. Only invasive catheterization and coronary artery angiography image the coronary artery lumen better than CTCA. There is emerging data that a non-invasive CTCA may even perform better than invasive angiography for prognostic information in all degrees of CAD.

Thursday 22 September 22

Louis Armand East Room

1400-1530

Scientific Session 3

Space Medicine:

Aeromedical Concerns for an Extreme Environment

A REVIEW OF ASTRONAUT JOURNALS: THE RELATIONSHIP BETWEEN WORK AND MENTAL HEALTH ABOARD THE INTERNATIONAL SPACE STATION

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Background: Since the advent of crewed space flights, NASA has looked for ways to empirically study and analyze the psychological and behavioral dynamics of the astronauts. One of the most comprehensive data sources comes from the Astronaut Journals written aboard the International Space Station. In 2010, Ph.D. Jack Stuster analyzed ten journals, providing an overview of the most prominent subjects that qualitatively influence the astronauts' psychological and behavioral status. Of the 24 major topical categories, "Work" has recorded the greater frequency of entries representing a primary factor to consider in the design of future missions.

Overview: This review focuses on Stuster's research and subsequent analyses to evaluate the influence of "Work" on the other categories defining its full extent on mental health on the ISS. A semantic analysis has highlighted that "Work" is perceived beyond the science-focused physical and cognitive activities that astronauts are trained to perform. The extreme conditions of living and operating in space imply many additional tasks that include housekeeping, maintenance, and occasional extra procedures. These, along with ambitious deadlines and MCC intrusions, blur together into the perception of a constantly high-demanding workload. Besides, many entries attest how this event directly affects the quantity and quality of time meant for leisure, communication, and self-care, inducing sleep deprivation, skipping meals, fatigue, and general discontent that may target teamwork.

Over the past decade, NASA has developed new frameworks to streamline the work schedule. One example is NASA's Exploration Crew Time Model (ECTM), which proposes a new model for managing crew time for long-term missions. However, the actual data resulting from the implementation of such a model is not yet publicly available, producing a literature gap necessary to initiate further research.

Discussion: In the vision of more extended and distant missions, it is paramount to continue the systematic investigation on optimizing workload to assess astronaut well-being and define all the aspects that heavily influence mental health in space.

THERAPEUTIC HYPOTHERMIA – A FEASIBLE CONCEPT FOR CRITICAL CARE IN SPACE?

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Background: With long-duration exploration flights and touristic spaceflight on the rise, the likelihood of critical medical conditions with no immediate treatment options on board will increase. Therapeutic hypothermia (TH) has been explored as a bridge treatment in ischemic stroke, cardiac arrest, and traumatic brain injury on the ground. We have reviewed the available data in order to assess the applicability of the concept to prolong survival and to reduce neurological damage in space.

Overview: The review of published studies was tailored to determine the potential and challenges of TH in space based on its physiological effects, the cooling methods available, and the clinical evidence for its use on Earth. We also considered other conditions for treatment with TH that are likely to occur during long-duration spaceflight such as CO₂-induced headache, acute respiratory distress syndrome and elevated intracranial pressure. In a second step, a technical evaluation was undertaken concerning the use of different cooling methods in a space vehicle and the associated logistics for a trip to low Earth orbit, to the Moon and to Mars.

Discussion: Data on the impact of hypothermia on a favorable neurological outcome are inconclusive between studies due to a lack of standardized protocols across hospitals and the heterogeneity of medical conditions. In recent years, it was found that application of low normothermia leads to better outcomes than mild hypothermia in cardiac arrest. Adverse effects with systemic cooling are widely reported. These effects could be reduced through selective brain cooling or pharmacological cooling, promising techniques that currently lack clinical evidence.

We conclude that low normothermia has the potential for application as supportive treatment for multiple medical conditions in space and recommend further investigation of the concept in feasibility studies.

RESULTS OF A 3-DAY PILOT STUDY TO VALIDATE PLANETARY PREBREATHE PROTOCOLS USING A 56.5 KPA 34% O₂, 66% N₂ SATURATION CABIN ATMOSPHERE

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Introduction: Apollo missions used 100% O₂ cabin atmospheres which effectively eliminated the risk of decompression sickness (DCS) during extravehicular activities (EVAs, “spacewalks”); however, this presented a flammability risk no longer acceptable to NASA. Denitrogenation prebreathe protocols used to mitigate DCS risk for Space Shuttle and ISS EVAs are validated for the microgravity environment, but significantly increased risk of DCS during equivalent ambulatory surface EVAs make these protocols inapplicable to planetary/Lunar missions.

An “exploration atmosphere” of 56.5 kPa (8.2 psia), 34% O₂ / 66% N₂ has been recommended by NASA for future Moon and Mars missions as a compromise that balances pre-EVA prebreathe duration, hypoxia, and flammability risk, assuming a 29.6 kPa (4.3 psi) spacesuit. Prebreathe validation studies were initiated utilizing a three-story 6m diameter hypobaric chamber at NASA’s Johnson Space Center. Here, we report the results of a 3-day human-in-the-loop system checkout.

Methods: Six volunteers acclimated to the 56.6kPa/34% O₂ 66% N₂ environment for 48hrs prior to conducting a 20-minute prebreathe and a 6-hour simulated EVA at 34kPa/85% O₂ / 15% N₂. The EVA simulation was designed to include tasks that are physically and ergonomically representative of future planetary EVAs. Decompression stress was evaluated by serial doppler and echocardiographs, as well as by clinical DCS signs/symptoms.

Results/Discussion: Preliminary data analysis noted venous gas emboli (VGE) in 3/6 subjects, with peak Grade II VGE by Doppler and peak E-B score of 5 by cardiac ultrasonography. No volunteers were diagnosed with DCS during this initial test. No acute hypoxic symptoms were noted. Musculoskeletal and gastrointestinal complaints were noted, likely associated with the exercise load and the food system. Validation of exploration prebreathe protocols has since been initiated with an 11-day saturation test using the same facility and protocol.

ASTRONAUT PLAYSCAPES: INCLUSION OF RECREATION AS A DESIGN REQUIREMENT FOR FUTURE CREWED SPACE SYSTEMS

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Background: There is renewed enthusiasm and planning for future long-duration deep-space crewed missions and systems, which will lead to a persistent deep-space human presence, *i.e.* on the lunar surface, lunar orbiting space station, journeys to and from Mars and on the surface of Mars.

Future crewed habitats will need to consider, and where possible mitigate, the multi-system deconditioning associated with long-duration spaceflight as well as risks from increased levels of ionising radiation, isolation and confinement. Well established practical countermeasures (*e.g.* exercise facilities) for some of these effects are already well captured in system requirements and incorporated into the design process for future crewed space systems.

Psychological and other potential effects of space environments, such as reduced crew cohesion and motor skill degradation, are less well understood. They do not have practical countermeasures in place and, therefore, are less likely to be captured as system requirements. One area that appears to have been neglected in the design and subsequent evolution of space systems is the explicit provision of recreation.

Overview: This project associates recreation with implementation of social and group activities that involve dynamic physical activities, requiring fine sensorimotor and visuospatial skills, and including some form of game play. We are promoting the term “astronaut playscapes” to help capture and communicate this requirement. This presentation will review the use case and requirements for astronaut recreation, present a concept activity (table football) and propose a roadmap to help research and address this capability gap.

Discussion: Given the extreme isolation and containment, there is risk of failing to maintain appropriate individual psychological (*e.g.* mood) and psychosocial (*e.g.* morale) status, and crew dynamics, which may impact human performance. Therefore, for future crewed deep-space systems new countermeasures are required that address these issues; this project advocates the potential value of recreation as an engaging non-mission focused team activity.

MANAGING CYBER RISK IN SPACE MEDICINE: ADAPTING TO CYBER SECURITY COMPLEXITIES IN A DYNAMICALLY REDEFINED SPACE MEDICINE ENVIRONMENT IN LOW-EARTH ORBIT AND BEYOND

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Background: This paper will address two dynamically evolving disciplines which will have a significant impact on humans living and operating within space: Space Medicine and Cybersecurity / Cyber Risk.

Overview: Consider the following scenario: There is a medical emergency on the lunar surface. A patient (non-astronaut) requires a surgical procedure, but there is no specialist on site qualified to do it. Using telemedicine and virtual presence, medical practitioners rally together to confirm information, share diagnosis, implement tactics and techniques, and work fast, but professionally to save the patient. Systems monitor the patient's life signs, provide access to relevant data on similar cases to help the medical staff cross-reference their efforts, and even provide the medicines and oxygen for patient as the procedure is performed. It is a miracle of modern science, performing this procedure so far from Earth.

Now imagine these systems under cyber-attack at the same time. An adversary changes the oxygen concentration the patient requires. Telepresence is interrupted in mid-conversation, leaving untrained medics to guesswork. Metadata on the patient's medical records are changed to provide false data on current medications taken leading to potential issuance of the wrong prescriptions. The list goes on but suffice to say it would be a space doctor's worst nightmare. Clearly, cyber has a play in space, and the confluence of space medicine and cybersecurity is a salient issue worth reviewing and preparing for, to ensure our long-term survival in space.

Discussion: The authors, both experts in their respective fields, intend to identify these issues in more detail, posit several examples where the two disciplines convergence, and offer recommendations going forward to enable mission assurance for both. The research in this area is just the beginning, and this paper is to set the conditions for ongoing discussions needed to highlight the challenges and start the process to address each over time.

CHANGES AT THE NASA-KENNEDY SPACE CENTER, USA, TO SUPPORT AMERICA'S NEW MISSIONS TO THE INTERNATIONAL SPACE STATION AND MOON

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Background: The NASA-Kennedy Space Center (KSC), in the USA, is America's main space launch facility for launching, landing and processing space vehicles. The last major crewed program supported at KSC was the Space Shuttle, from 1981-2011. Since the Space Shuttle retirement, KSC has undergone major changes to support new programs and space vehicles such as the Commercial Crew Program (with SpaceX [first SpaceX DM1 Jan 2019] and Boeing to the International Space Station) and the Artemis Program (Space Launch System rocket and Orion capsule to the moon).

Overview: This presentation will highlight the changes to the infrastructure at KSC, including several improvements in its medical operations. Particular areas will include launch pad and ground processing upgrades, astronaut crew quarters remodeling, emergency medical services overhaul, and firing room control center console upgrades. Challenges related to this updating, in supporting multiple launch vehicles, in support to both public and private organizations, and all within the challenges of a global pandemic will be discussed.

Discussion: Updating a major and historic space launch facility, including its medical operations, to meet the needs of new crewed 21st century space vehicles and their missions will be reviewed.

Thursday 22 September 22

Louis Armand West Room

1400-1530

Scientific Session 4

Hypoxia and Hypobaria

INITIAL RESULTS OF THE U-2 PILOT LONGITUDINAL BRAIN MRI SCREENING PROGRAM

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Introduction: We previously reported increased subcortical and periventricular white matter (WM) injury and decreased white matter integrity associated with repetitive occupational exposure to non-hypoxic hypobaric conditions in high-altitude U-2 pilots. A longitudinal brain MRI screening program began in 2014 for high altitude pilots upon entry into the platform and every 3 years while flying. The cabin altitude restriction effort (CARE) decreased cabin altitude from 9,000 m (28,000-30,000 ft) while operating above 21,000 m to approximately 4,500 m (15,000 ft). We hypothesized that post CARE there would be no progression of WM injury.

Methods: Pilots underwent advanced MRI brain examinations at Wilford Hall Ambulatory Surgical Center [Siemens 3-T Verio magnet] and David Grant Medical Center [General Electric Discovery MR750 3-T magnet] which included 3-D fluid attenuating inversion recovery (FLAIR) and 3-D T1, high resolution (0.8-mm isotropic) sequences. MRI exams were reviewed by two neuroradiologists. 3-D FLAIR imaging was quantitatively evaluated for white matter hyperintensity (WMH) volume.

Results: 27 pilots completed two or more MRI brain examinations. All exams were available for review for 26 pilots. Of those 26 subjects, 22 subjects had complete imaging sequences that met quality standards for analysis. Of the 22 pilots, n= 17 had two MRIs; n= 4 had three MRIs, and n=1 had four MRIs; total of 50 MRI brain exams. Average change from baseline in total FLAIR volume was -0.025 cm³ (1.6% change from baseline). Average change from baseline in subcortical FLAIR volume 0.015 cm³ (1.2% change from baseline). Average change from baseline in periependymal FLAIR volume -0.040 cm³ (-0.4% change from baseline).

Discussion: Since the CARE modification there has been a significant reduction in reported NDCS events. There was no significant interval change in white matter hyperintensity volume as measured by FLAIR MRI. There does not appear to be increased white matter injury as assessed by WMHs alone. Consideration should be made to include diffusion tensor imaging with fractional anisotropy assessment for the U-2 pilot MRI brain protocol.

EFFECTS OF NORMOBARIC AND HYPOBARIC HYPOXIA ON ELECTROENCEPHALOGRAPHIC SPECTRAL POWER AND ENTROPY

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Introduction: Normobaric (NH) and hypobaric (HH) hypoxia are both currently being used to experimentally investigate hypoxic conditions such as high altitude. Previous studies have suggested that despite equivalent inspired oxygen levels physiological differences may exist between these conditions. Whether there are differences in neurophysiological responses to these stimuli is poorly understood. We aimed to investigate potential differences in electroencephalographic (EEG) measures of neurophysiological function in resting-state and during an attention-orienting task between HH and NH.

Methods: Five minutes of resting-state eyes open EEG and 25 minutes of a visuospatial attention-orienting task were recorded from participants during normobaric normoxia (NN), NH, and HH conditions. For the resting state data we applied a multivariate framework to characterize correlations between EEG measures (entropy and spectral power) and oxygen saturation, within each participant, for each condition. The same multivariate statistical framework was applied to investigate condition differences in EEG measures for the resting-state and during the attention orienting task. Differences between conditions in oxygen saturation were also investigated for resting-state and task data.

Results: Oxygen saturation was significantly higher in the NH condition than in the HH condition for resting-state and task. When compared to HH and NN, NH elicited an increase in alpha and beta absolute power, increased alpha relative power, and increased sample entropy at finer time scales when correlated with decreased oxygen saturation during resting-state.

Discussion: Our resting-state data demonstrated that NH has a distinct spatiotemporal pattern of correlations when compared to HH. This suggests that a difference in neurophysiological responses exists between NH and HH, as the HH condition exhibited greater individual variation in correlations. Future studies on the effects of high altitude on resting-state neurophysiology should be performed in HH, as it replicates the decrease in absolute pressure found at high altitude but not found in NH.

INDIVIDUAL VULNERABILITY TO HYPOXIA: RELATIONSHIP BETWEEN SLEEP (QUANTITY AND QUALITY) AND HIGH-ALTITUDE TOLERANCE EVALUATED BY HYPOXIC TESTING

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Introduction: Aircrew are exposed to hypoxia and sleep disturbances. In response to hypoxia, there is increased breathing mediated by chemosensitivity in order to maintain homeostasis and prevent incapacitation. Nevertheless, a reduction of inspiratory endurance (50 %) is observed after one night of sleep deprivation. We hypothesized that sleep (quantity and quality) influenced hypoxia tolerance, evaluated by hypoxic testing.

Methods: Hypoxia tolerance was determined through the predictive score of severe high-altitude illnesses (SHAI) based, in part, on individual chemosensitivity evaluated by cardio-ventilatory responses and desaturation to acute hypoxia (FIO₂ = 0.115) at rest and exercise (30% maximal oxygen uptake) (Richalet). “Tolerants” without altitude experience have a SHAI score < 5.5. Sleep was recorded before (night 1) and following test (night 2) using an ambulatory dry-electrodes headband.

Results: 39 healthy subjects were included with 25 “Tolerants” and 14 “Sensitives.” “Tolerants” had higher slow wave sleep (NREM) than “Sensitives” in night 1 (75.88 ± 5.56 versus 71.24 ± 5.99 % respectively, p=0.024) and night 2 (323.81 ± 48.47 versus 291.46 ± 44.25 min., p=0.048). A significant negative correlation existed between SHAI score and duration of NREM (Night 1: r=-0.362; Night 2: r =-0.336; p<0.05). The same negative correlation was observed between SHAI score and total sleep time (Night 1: r = -0.351; Night 2: -0.397; p<0.05). In this study, the NREM percentage during Night 1 predicts low SHAI score with a specificity of 81.8% (p=0.037).

Discussion: These results confirm a potential link between altitude tolerance and sleep (total sleep time and NREM). Future studies will be considered to assess whether sleep disturbance is a vulnerability factor to hypoxia for pilots and crewmembers, an important issue for aviation safety.

OSCILLATING INSPIRED OXYGEN RESULTS IN OSCILLATING ARTERIAL OXYGEN PARTIAL PRESSURES

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Introduction: Onboard oxygen generating systems (OBOGS) deliver increased inspired oxygen (F_{iO_2}) to sustain arterial oxygen partial pressures (PaO_2) to tactical aviators. However, F_{iO_2} generated by OBOGS are not delivered at constant levels and may follow an oscillatory pattern (ROHC) of $\pm 15\%$ of anticipated levels. Elevated but steady-state F_{iO_2} evokes increased PaO_2 , neurovascular constriction, diminished cerebral perfusion, and altered brain cortical activity. This study explored whether ROHC results in similar outcomes.

Methods: Twenty-four participants received F_{iO_2} cycling $\pm 15\%$ of prescribed set points of 35%, 50%, 65%, and 80%. This pattern of ROHC, followed by steady-state F_{iO_2} exposures, occurred at sea level, 8,000 and 15,000 feet in a hypobaric chamber. Arterial blood gas (ABG) samples were obtained from an indwelling radial catheter after each ROHC and steady-state F_{iO_2} exposure with simultaneous measurement of prefrontal cortical brain activity.

Results: ABG values at sea level exposure to ROHC of $35\% \pm 15\%$ yielded a PaO_2 (Mean \pm SD) differing significantly from steady-state 35% F_{iO_2} (216.67 ± 6.03 mmHg vs. 178.25 ± 5.46 mmHg, $p < 0.001$). ROHC of $50\% \pm 15\%$ also produced a PaO_2 significantly different from PaO_2 during steady-state F_{iO_2} (296.92 ± 7.66 mmHg vs. 255.50 ± 7.06 mmHg, $p < 0.001$). Similar patterns emerged between PaO_2 levels measured during ROHC and steady-state F_{iO_2} levels at 65% and 80%. These ~ 50 mmHg differences between ROHC and companion PaO_2 levels persisted throughout hypobaric pressures equivalent to 8,000 and 15,000 feet. Prefrontal cortical brain activity during cognitive testing was significantly during ROHC vs. steady state F_{iO_2} but only at sea level ROHC exposures of 50% and 65%.

Conclusions: ROHC induces oscillatory patterns of PaO_2 in the systemic circulation accompanied by altered prefrontal cortical brain activity, but only during a specific range of ROHC.

COMBINED ALTITUDE DEPLETED OXYGEN (CADO) VIS-À-VIS HYPOBARIC HYPOXIA: EFFICACY IN HYPOXIA INDOCTRINATION

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Introduction: Combined Altitude and Depleted Oxygen (CADO), an alternate method for hypoxia indoctrination, accounts for the lack of pressure changes seen in Normobaric Hypoxia (NH), while exposing the subjects to an altitude lower than the threshold for Decompression Sickness (DCS), which is a risk in training using Hypobaric Hypoxia (HH). This study was conducted to evaluate the efficacy of CADO in hypoxia indoctrination by comparing it with the time tested gold standard of HH in Hypoxia Indoctrination.

Methods: 40 subjects were exposed to both CADO and HH, simulating 25,000 ft for a maximum period of 05 minutes. CADO was achieved by combining exposure to an altitude of 10,000 ft in the hypobaric chamber and breathing a hypoxic gas mixture of 10.3% oxygen and 89.7% nitrogen. Physiological parameters (peripheral oxygen saturation, heart rate and respiratory rate) and psychomotor performance assessed with the help of Dual Task Test (component of pSuMEDhA) were compared between the two exposures. The incidence and severity of subjective symptoms were also collected at the end of exposures and compared.

Results: There was no significant difference in the changes induced in physiological parameters and psychomotor performance during the two exposures. Out of the 24 common symptoms of hypoxia assessed, there was a higher incidence of 20 symptoms in subjects exposed to HH compared to CADO. The severity of 15 symptoms was also found to be significantly greater ($p < 0.05$) in subjects exposed to HH.

Conclusion: The similarity of physiological changes in CADO and HH shows the employability of CADO as a means of hypoxia demonstration. However, there was decreased incidence and severity of subjective symptoms in CADO compared to HH. Hence, CADO cannot be considered equivalent to the gold standard of HH as a tool for hypoxia indoctrination.

Thursday 22 September 22

Gaston Berger Room

1600-1730

Scientific Session 5

Pilot Peer Support Programmes:

Experiences and Opportunities

PILOT PEER SUPPORT PROGRAMS – HISTORY, MODELS, STRATEGIES & IMPLEMENTATION

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Background: Pilot Peer Support Programs (PPSP) have a five-decade history of success. Five specific PPSP's provide a full range of assistance to pilots physical and mental wellness needs, each with different goals and processes. These include Aeromedical, Critical Incident Response (CIRP), HIMS (AOD), Peer Support for Pilots (PSP) and Professional Standards (ProStans) programs. Each serves to enhance individual wellbeing and flight safety.

Overview: Common characteristics of all PPSP's include administration by fellow volunteer pilots with the support, but not direct involvement, by the AOC. There may be outside professional resources available to assist the PPSP volunteers if requested. The CAA regulator is generally not involved with rare exceptions. Initial and recurrent training is mandatory for all volunteers with oversight provided an experienced peer pilot committee. Confidentiality is the keystone of all PPSP'S and serves to lower barriers for pilots seeking assistance. Peer understanding of boundaries and knowledge of additional resources available to help a pilot is essential. Many volunteers are motivated by prior personal experiences. Compassion fatigue in volunteers requires oversight.

PPSP's may either be Reactive in responding pilots who contact the PPSP or Proactive in reaching out to pilots projected to need help. CIRP is exclusively Proactive, with HIMS and Professional Standards having elements of Proactive and Reactive pilot contact. PSP and Aeromedical are Reactive to pilot-initiated requests for assistance. Duration of volunteer-pilot contact varies from extremely brief with CIRP to potentially longer with ProStans, Aeromedical, PSP and longest with HIMS.

Discussion: Aviation PPSP's are highly effective tools to reduce barriers for pilots seeking assistance with professional and personal challenges and enhance the safety and effectiveness of aviation operations. PPSP's can be an integral part of an aviation Safety Management System.

PILOT PEER SUPPORT PROGRAMS – WHY, HOW AND EXPERIENCES

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Background: EASA Regulation EASA CAT.GEN.MPA.215 (a), which mandates operators to ensure access to a proactive and non-punitive support programme, became effective in 14 February 2021. However, Peer Support Programs (PSPs) have been available already over 30 years.

Overview: The presentation covers the basics of the Peer Support systems and opens up pilots' views of PSPs focusing on fear of loss of medical certificate.

Trust and confidentiality are the cornerstones of the PSPs. For pilots it is easier to talk with trained colleagues that they trust compared to someone outside of the aviation world. The PSP program principles are similar in every program, starting with contacting the program either by pilots themselves or someone else who is concerned about the pilot. The contact is followed by discussion(s) with the peer, which is usually enough to solve the problem. PSPs have also a mental health professional, to whom the Peer may refer the colleague. The discussions are confidential, and the confidentiality can only be breached if there is an imminent threat either to the pilot concerned or flight safety. PSP programs include Medical/Psychological, HIMS (Human Intervention Motivation Study) that is a specialized drug and alcohol rehabilitation programme, CIRP (Critical Incident Response Programme), which focuses on the stresses and reactions that are generated from a single traumatic incident, and PRO-STANS (Professional Standards) that focusses on professionalism within the pilot role.

Discussion: Once the PSP has gained trust of the pilots, pilots have been satisfied and felt that the program helps. Issues and fears of the loss-of-license are common, and discussion with someone who knows the medical requirements and ways forward helps a lot.

THE ROLE OF THE MENTAL HEALTH PROFESSIONAL IN PILOT PEER SUPPORT

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Background: PSPs (Pilot Peer Support) within Europe, following from the Germanwings crash in 2015, are proving their efficacy in terms of usage, enhancing pilot well-being, and demonstrating an enviable return on investment.

Overview: Whilst the emphasis in PSPs is on suitably trained pilot-peers providing practical and emotional support to fellow pilots, experienced aviation-experienced specialist mental health professionals have a crucial role in supporting PSPs and ensuring the safety of this first-line well-being support service. Mental health professionals may come from a variety of backgrounds including psychiatry, aviation and/or clinical psychology, mental health nursing or clinical social work. They typically have several key roles in setting-up, developing and supporting PSPs as well as providing accountability to the safety management system. These roles include (a) peer selection, (b) peer training, (c) peer oversight and supervision, (d) data collection and reporting, (e) intervening in cases which require escalation due to safety-critical challenges, (f) ongoing and recurrent training of peers, and (g) devising peer competencies.

Discussion: This presentation elaborates on the rationale for the crucial involvement of mental health professionals in PSPs and on their role in supporting peers and system safety.

BRIDGING GAPS BETWEEN MENTAL HEALTH ASSESSMENT AND SUPPORT PROGRAMS

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Background: After the dramatic Germanwings accident, the study of mental health of safety-critical personnel as well as its screening and monitoring has been included as one of the prioritised topics in the area of health to be updated in aerospace Medicine. Mental Health disorders have therefore been clearly identified as elements of risk and consequently the state of Well-being as an enabling factor for the safety of operations.

Overview: The European Regulation 1042/2018 was a first attempt for building proper barriers against the incapacitation risk due to mental disorders of safety-critical operators. The Regulation introduced new technical requirements and administrative procedures related to implementing support programmes, psychological assessment of flight crew, as well as systematic and random testing of psychoactive substances to ensure medical fitness of flight and cabin crew members.

A key role in the support programmes is played by what the EASA guidelines call “platform for multi-stakeholder,” which is composed of all the interested parties in the governance of the activities, including the safety-critical personnel whom the support programmes are targeted to, the AMEs and the Mental Health Specialists.

Discussion: In the framework of the MESAFE project, it is proposed that the multistakeholder platform acts for strengthening the link between peer support groups and the AMEs, the medical assessors and the mental health specialists, thus promoting an integrated approach for mental health assessment, monitoring and care. Key enablers will be the MESAFE training material for mental fitness assessment targeted to AMEs and the human-centered toolkit for peer support groups. Both will include evidence-based recommendations for mental health assessment methods and treatment options suitable for aeromedical fitness assessments, mitigation measures for temporary and permanent loss of license as well as innovative strategies for proactive monitoring and management of pre-clinical signs and symptoms of psychological discomfort.

WELLBEING = PERFORMANCE = SAFETY

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Introduction: This presentation discusses the necessity of creating systemically safer workplaces where individual safety is perceived as an intrinsic component of Aviation Safety. A safe and supportive working environment improves wellbeing and physical and mental health, which increases performance. Increased performance improves safety. For this reason, it should be in the interest of every operator to create a safe and secure work environment for their safety critical personnel.

Discussion: Presently, the aviation system is designed to identify people within who are a threat to its safety. Every perceived weakness can easily threaten or end a career. This makes it challenging for those working in it to trust it. Trust, however, is essential to establishing a safe and supportive work environment. Without establishing a culture of trust, problems that negatively impact health, performance and safety are driven underground.

To improve safety, the thinking about it needs to be systemically different: Individual workplace safety needs to be seen as an important component to improve operational safety. Focusing on wellbeing of employees is a core component of a supportive and safe working environment. Instead of perceiving employees as the threat, it is necessary to identify the threats and risks to their wellbeing. This would enable the management and the mitigation of these risks. Correctly implemented programs such as Peer Support would create the trust needed for the shift of the present mindset.

Conclusion: This presentation questions the emphasis of aviation safety, presenting the need for the integrated inclusion of individual safety. Reflecting on the way work is done, might begin to create a work environment that becomes aware of the threats and harm it perpetuates and inflicts, and begins to take responsibility to address these in a way that ultimately positively impacts the individual the operation, the public and the system.

Thursday 22 September 22

Louis Armand East Room

1600-1730

Scientific Session 6

Sleep, Sleep Disorders, and Aircrew

RISK FACTORS OF MICROSLEEPS DURING REAL LONG HAUL FLIGHT. INTEREST OF MINIATURIZED AMBULATORY EEG/EOG RECORDERS

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Introduction: Involuntary microsleeps--temporary episode (1 to 30 sec) of sleep attacks--may occur during long haul flights. Microsleeps are associated with a brief lapse in consciousness, considered as an objective parameter of sleepiness. The aim of this study was to assess the risk factors of microsleeps for pilots during long haul military flights with a recent strategic and tactical aircraft (Airbus A400M Atlas).

Methods: 11 volunteer pilots were recorded during 18 flights (6.4 ± 2.1 h, 2.5-9.6h). Sleep/wake activities were recorded over 8 days before each flight using a wrist actimeter. Subjective Karolinska Sleepiness Scale (KSS) and sustained attentional performance (Psychomotor Vigilance Test, PVT) were studied every 2 hours during the flights. Two EEG and EMG derivations were continuously recorded during the flights using a miniaturized device fixed on the pilots' skull. Microsleep episodes were detected off-line by visual inspection. The number and cumulative duration of microsleeps were quantified per hours of flight.

Results: At least one microsleep occurred during each flight (mean duration: 6 ± 4 sec, range: 4-29 sec). Pilots' habitual total sleep time (TST) was 7.0 ± 1.3 h. TST during the night before the flight was 5.8 ± 1.6 h. Multiple regression analysis showed that the increase of microsleep occurrences and the decrease in attentional performance were associated with the decrease in TST before the flight ($p=0.01$), cumulative sleep debt during the week ($p<0.05$), the time-of-the-day ($p=0.01$) and the duty time ($p<0.05$). The main risk factor of microsleeps is a TST lower than 6 hours (OR=2.6; 95%CI=1.5-4.8, $p<0.01$). Moreover, we show correlations between microsleeps and the subsequent decrease of sustained attention performance ($p<0.05$). No subject was disturbed by the research equipment during the flights.

Conclusion: Our results demonstrated the interest of the microsleep detection during real flight, in order to identify pilots' risk of low-vigilance states, and open new perspective for on-line fatigue detection.

PREVALENCE OF SLEEP DISORDERS IN AIRCREW MEMBERS AND RISK OF IN-FLIGHT SLEEPINESS

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Background: Sleep disorders are a critical issue for flight safety. Previous studies show an important prevalence of sleep disorders and excessive sleepiness in aircrews. The objectives of this study were to measure the prevalence of excessive daytime sleepiness and sleep disorders in aircrews, and to determine risk factors for falling asleep in flight.

Methods: This is a monocentric study using questionnaires, and including all aircrew members (civilian and military) examined in an aeromedical center between January and May 2021. The questionnaire, created for this study, included information about socio-demographic characteristics, aeronautical experience, lifestyle, sleep habits, an Epworth sleepiness scale, and screening tests for chronic insomnia, sleep apnea syndrome and restless legs syndrome.

Results: 749 aircrew members were included (86.2% male, 58.9% civilian, 74.1% pilot, mean age 43.4+/-9.6 years). 45.9% of the population had at least one sleep disorder (chronic insomnia 39.5%, sleep apnea syndrome 10.5%, restless legs syndrome 4.1%), 15.5% had an excessive daytime sleepiness, and 24.6% reported in-flight sleep while on duty. Chronic insomnia, screen use before bedtime, use of sleeping pills, not having an adequate recovery time after a flight, being a female, and a civilian status were found as risk factors of in-flight sleep in the multivariate analysis.

Conclusion: This study shows us the importance of improving sleep disorders screening and prevention in this particular population.

EXCESSIVE DAYTIME SLEEPINESS AND ASSOCIATED FACTORS IN MILITARY SEARCH AND RESCUE PERSONNEL

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Introduction: Abnormal excessive daytime sleepiness (EDS) has been reported worldwide, but too little is known about EDS and its determinants in Search and Rescue (SAR) populations. We aimed to determine the prevalence of abnormal EDS and contributing factors among Royal Norwegian Air Force (RNoAF) SAR helicopter personnel.

Methods: In this cross-sectional study, a total of 175 RNoAF SAR personnel completed an electronic survey including socio-demographic and lifestyle questions. The Epworth sleepiness scale (ESS) was used as both a continuous and categorical outcome variable to measure EDS.

Results: Abnormal EDS defined by ESS was found in 41% of the participants in this study. We observed no associations between socio-demographic and lifestyle factors and abnormal EDS in this study. Abnormal EDS was not associated with any socio-demographic or lifestyle factors in this study.

Discussion: There is a high prevalence of abnormal EDS in the current RNoAF SAR population. Despite this elevated level of fatigue, we did not find that the socio-demographic and lifestyle factors assessed in this study were associated with abnormal EDS in RNoAF SAR helicopter personnel. Also unusual, the study cohort did not demonstrate higher scores in factors found to change ESS scores in similar study populations (e.g., caffeine use, tobacco use, exercise level). Further research is required to investigate other factors that may be associated with abnormal EDS in this and other SAR populations, for example, organizational or other operational factors.

CONTINUOUS WAKEFULNESS OF SHORT DURATION: EFFECTS ON PSYCHOMOTOR COGNITIVE PERFORMANCE AND SUBSEQUENT SLEEP PHYSIOLOGY

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Introduction: It is not an uncommon situation that aircrew are exposed to continuous wakefulness and prolonged duty periods. The present study was thus conducted to understand the effects of continuous wakefulness of varying hours on psychomotor cognitive functions and physiological attributes of sleep.

Methods: In a repeated measure design, psychomotor cognitive functions were evaluated among 20 healthy aircrew during a period of forced wakefulness of 18h by CogScreen Aeromedical Edition (AE) on three sessions; 1st (baseline) at 0800-0900h, 2nd at 1900-2000h and 3rd at 2300-0000h. The sleep architecture and bio-physiological parameters were studied with Alice 5 Polysomnography System[®] in subsequent sleep period following 18-h of continuous wakefulness.

Results: Consistent improvements in performance were observed in many tasks as a result of repetitive practice effects. The speed measures pertaining to computational math skills, reading comprehension and logical reasoning, sustained attention and visual motor tracking were significantly affected in the 3rd session compared to the 2nd session. Similarly, there was a significant decrement in immediate and delayed visual paired associate memory in the 3rd session compared to 2nd session, whereas spatial processing and visual working memory showed a significant longitudinal decrement in accuracy scores across the period of wakefulness. The sleep architecture and the bio-physiological variables of sleep were found to be within normal physiological limits.

Discussion: Few aspects of higher cognitive functions could be adversely affected during periods of continuous wakefulness, even though such a period is short and would not affect sleep architecture and bio-physiological variables of sleep. Appropriate mitigating measures thus need to be instituted during sustained operations and periods of continuous wakefulness.

THE DETERMINANTS OF SLEEP TIME IN A LARGE SAMPLE OF FRENCH CIVILIAN AND MILITARY AIRCREWS

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Introduction: Total sleep time (TST) is an essential health determinant, correlated with many metabolic and cardiovascular complications. A recently published study among the French general population revealed a high proportion of people in sleep debt or restriction. Insufficient sleep therefore remains an important issue for the prevention of chronic diseases. Although this is an obvious criterion to promote flight safety, few specific epidemiological studies have been carried out to assess the importance of the issue among aircrews. In France, the military aeromedical centers (AeMC) welcome a large panel of different aircrew profiles composed by military and civilian specialties, suitable for such a study project.

Methods: An anonymous questionnaire was proposed to all applicants for the revalidation or renewal of their fitness medical certificate to the Toulon AeMC for a period of 6 months. Socio-demographic and professional data were collected in parallel with retained items : TST at night, when napping, and over 24 hours (assessed on workdays and leisure days), short or long sleep, chronic insomnia (ICSD-3 criteria), sleep debt, sleep restriction, sleepiness (Epworth scale).

Results: The results, at least preliminary, will focus on determining: average TST/24 hours in aircrews, proportions of short sleepers, subjects in debt and in sleep restriction, prevalence of chronic insomnia and of sleepiness. They will be compared to those collected in general population and the statistical analysis will aim to study the main determinants, notably aeronautical factors, of these different indicators.

Discussion: The results will raise awareness on a decisive subject in the medical management of flight safety, but that is probably insufficiently taken into account in our daily practices. Better knowledge of some sleep related disorders among aircrews will allow us to adapt possible prevention strategies or countermeasures intended to optimize the risk management.

IDIOPATHIC HYPERSOMNIA: A RARE TREATABLE CAUSE OF EXCESSIVE DAYTIME SLEEPINESS

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Introduction: Idiopathic Hypersomnia is a rare condition (1/10000 subjects) that can lead to difficulties in the management of daily life activities and work.

Background: The diagnosis of idiopathic hypersomnia relies on excessive daytime sleepiness despite normal quality, normal or prolonged night-time sleep, in the absence of psychiatric disorder, chronic sleep deprivation, obstructive sleep apnea syndrome, and narcolepsia. It needs confirmation by a reference center. There are several medications available that can stimulate wake and improve the patient.

Case Presentation: We report the case of a 23 years old air controller who was referred to sleep medicine for excessive daytime sleepiness. Sleepiness began in high school when she started to fall asleep during class for a few minutes several times a day. On holiday, she would sleep from 9 pm to 12 am the following day. In 2019, she slept 12 hours a day, with at least one hour of nap. She did not present hypnagogic or hypnopompic hallucinations, nor cataplexia nor sleep paralysis. Brain MRI was normal. She had difficulties to manage to work with her increasing need for sleep.

On sleep examination, the sleep latency on iterative sleep latency tests was 7.2 minutes (normal >8) without Sleep Onset REM period (SOREM). During the 24h recording, she slept during 17h02min, without any context of sleep deprivation or psychiatric affection. The diagnosis of idiopathic hypersomnia was confirmed. She was treated with a dedicated medication. Her clinical state improved and she could work again with adaptations.

Discussion: In the context of increased sleep duration, after the elimination of other etiologies, the patient should be referred to sleep medicine to evaluate the presence of central hypersomnia, and start a treatment.

Thursday 22 September 22

Louis Armand West Room

1600-1730

Scientific Session 7

Human Performance and Aircrew

NATO'S JET FIGHTER PILOTS WITH THE APPLICATION OF LEARNING MACHINES, BIOFEEDBACK, AND PSYCHOPHYSICS

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Introduction: This study evaluated jet fighter pilot performance with a machine-learning framework applied to psychophysical and physiological metrics

Method: A group of about 36 NATO military pilots with different general aviation (between 300 to 2200h) and specialised air force experience (between 50 to 1200h) conducted a series of manoeuvres under high G-force, including taking off, ascending turnings, patrolling, descending, and landing. Experiments were conducted using an overload centrifuge for the MIG-29 flight simulator, allowing it to reach 16G on the z-axis. The vision system of the simulator provides a wide field of view (120x70°) and high-resolution images required to visualise the terrain and aerial situation in all lighting and weather conditions. The eye movement recordings and internal cabin view monitored each pilot's physiology during the experiments. Eye-tracking was sampled with a 60 Hz head-mounted device (SMI, Tetlow, Germany). The cockpit field of view was divided into 22 critical regions of interest (ROI) that captured visual attention. Each participant was characterised by the fixation duration, total dwell time, number of repetitions per ROI, reaction time, heart rate, spirometry, and ECG. Support Vector Machine (SVM) was applied to build models representing the most accurate aviation task performance.

Results: The SVM model of general air force performance reaches 79.5 in evaluating pilots' operations. The taking-off manoeuvre seemed the most challenging for the SVM to assess, as its accuracy was 69.5. The correctness of the descending during landing was confirmed by 70.3%, whereas efficiency in patrolling the air space was approved by 74.2%.

Conclusion: The proposed learning machine solution for automating a pilot's performance in particular aviation manoeuvres might be accurate enough to provide a valuable objective metric for an air force instructor.

HUMAN PERFORMANCE IN HOT WEATHER BY PILOTS

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Introduction: Switzerland has been the scene of a series of successive aeronautical accidents, these past summers, all of which happened during particularly hot periods, and involved pilots with long experience flying, or even highly experienced flight instructors. The most spectacular of these was the fatal crash of the famous "old timer" Junker 52, with 20 people on board.

Methodology: Starting from the reported crashes, we have taken the detailed reports of the Swiss Bureau of Investigation to analyze the particular problems related to these crashes, all of which occurred in the summer with experienced pilots. The flight experience, as well as the strategy of the fatal flight and the weather conditions that may have influenced human performance are reported.

Results: The analysis of the various crashes exposed clearly shows obvious errors in strategy for this type of flight, mainly among experienced pilots. The density of the air in hot conditions was clearly not taken into account, especially among pilots accustomed to more powerful machines, and the actual performance of less powerful machines was ignored in the overall approach to mountain flight.

Conclusion: The experience may be an unfavorable human performance bias by experienced pilots, who may not be careful in their usual routine. Flight preparation more specific to hot weather, especially in mountain areas with higher altitudes, should probably be implemented in the checklists of flying clubs for flights in mountainous areas.

EFFECT OF U.S. ARMY AIRCREW DIAGNOSES AND MEDICATIONS ON OPERATOR STATUS MONITORING SYSTEMS

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Introduction: Increasing complexity of modern aircraft and the trend toward single-pilot aircraft, coupled with the worldwide explosion of wearable physiological sensors, has driven a need and an opportunity for in-flight aircrew monitoring. This monitoring could detect (and predict) degraded aircrew states affecting aircrew performance and inform onboard decision agents to take appropriate action. Research thus far has found considerable individual variability, both within and between pilots, in the most promising physiological data channels. The purpose of this project was to highlight potential effects of medical conditions and medications that are currently allowed for U.S. Army aircrew on flight-status on future physiological monitoring systems.

Methods: Current published U.S. Army aeromedical standards and policies were reviewed, and a list of potentially allowable / waivable diagnoses and medications for U.S. Army aviators was compiled. This list was then reviewed and analyzed by a panel of aerospace medicine specialists to determine potential interactions with physiological measures that are currently under consideration for future operator state monitoring systems. Physiological data channels included indicators of brain activity, ocular parameters, cardiorespiratory indices, body temperature, and autonomic activity.

Results: Initial review of U.S. Army aeromedical policies resulted in a list of 27 allowable or waivable clinical conditions with potential interactions affecting physiological measures currently under consideration for operator state monitoring systems. The clinical conditions of concern were predominantly cardiac and ophthalmological. Potential pharmacological interactions were mostly related to cardiovascular, autonomic, or vision effects. Physiological measures potentially most affected include heart rate, heart rate variability, respiratory rate, and pupillary dynamics. Neurological indices (e.g., electroencephalography [EEG]), oxygenation, and core temperature appear to be more resistant to the effects of allowable medical conditions and medications.

Conclusions: This preliminary analysis of U.S. Army aeromedical policies and candidate physiological variables suggests that physiological monitoring systems should be customized for the monitored individual. In the future, this project will consider aeromedical policies of other services and the Federal Aviation Administration (FAA), as well as other related occupations with less restrictive aeromedical policies (e.g., unmanned aerial system [UAS] operators, air traffic control [ATC] personnel). Future research should define specific effects and determine strategies for biomonitoring subpopulations of the aviation population, as well as consider potential implications for future medical fitness standards.

EFFECTS OF WHOLE BODY VIBRATION ON HUMAN CONTRAST SENSITIVITY FUNCTION

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Background: Vibration is a known inevitable aeromedical stressor in rotary-winged aircraft and is known to affect visual acuity (VA). In aerospace operational conditions, contrast sensitivity (CS) takes the upper hand over VA for optimal visual performance. Examination of the effects of low frequency whole body vibration of short duration on CS was the desired objective of the study.

Methods: 30 healthy volunteers were exposed to low frequency whole body vibration using Multi-axial Vibration Simulator. Vibration frequency along the Z-axis varied from 4-20 Hz over a period of 30 mins. CS was recorded in no vibration, under vibration and 30 min following exposure to vibration using CSV-1000 equipment at spatial frequencies of 3, 6, 12 and 18 cycles per degree (cpd).

Results: CS, after an initial degradation, gradually improved with the increase in frequencies of vibration for the lower spatial frequencies (3, 6 cpd). The increasing trend was also noticed for higher spatial frequencies (12, 18 cpd) till 16 Hz; thereafter, a significant dip ($p=0.048$) was observed at 20 Hz of vibration. No significant difference was observed following 30 min of post exposure.

Discussion & Conclusion: Low frequency vibration stress in laboratory condition significantly affects contrast sensitivity function. In contrast to the popular belief, an improvement in CS with increasing frequencies of vibration could be concluded from the results of the study. However, the sudden decrement in CS at higher CPD at higher frequencies of vibration could adversely affect visual performance of an aircrew. During low contrast ambient conditions degradation of CS function under vibration stress may be a serious concern.

EXPANDING PARTICIPATION IN FLIGHT & SPACE: IMPLICATIONS FOR PREPARING THOSE WITH ABNORMAL PHYSIOLOGY

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Background: We are no longer limiting our sights to the moon, nor limiting explorers to trained crews. Captain James Tiberius Kirk himself has indeed now been to space. The environments of flight and space are abnormal for which we have traditionally screened and selected our most physiologically fit to explore. This continues for military program candidate selection. However, we are at the cusp of the creation and evolution of a space-based ecosystem.

One area that is providing growing insight into physiologic adaptation is the cohort of adults with congenital heart disease venturing to flight. Since 2014, I have reviewed 133 airmen for the FAA Civil Aerospace Medical Institute (CAMI) with the spectrum of congenital heart abnormalities. This has included 7 airmen among all classes for Special Issuance that are functioning with single ventricle physiology following Fontan-type correction.

Overview: Evaluation and study of these pilots has resulted in an increased understanding of potential chronic adaptation to hypoxic situations such as low altitude and commercial flight, despite concerns for oxygen responsive changes in pulmonary vascular resistance and pulmonary blood flow. These findings have implications for development of the concept of "pre-hypoxic" conditioning in preparation for and to increase performance at altitude.

Physiologic tolerance of relative hypoxia is, however, an incomplete picture. Parallel considerations exist for the impact of altitude or other flight-induced hypoxia on cognitive performance as potentially impacts critical high-level decision making. Recent evidence has elucidated the impact of positive and negative acceleration forces (Gz) on both cerebral hemodynamics and concentration of oxygenated hemoglobin.

Discussion: These interconnected insights will be reviewed in the creation of a synthesis that may guide potential future enhancement of pilot and passenger evaluation, training, and performance.

AIRSICKNESS IN STUDENT PILOTS: A PRELIMINARY STUDY OF PLASMA BIOMARKERS BEFORE AND AFTER DESENSITIZATION.

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Introduction: airsickness (AS) can affect many aviators, especially at the beginning of their flight career. While most individuals rapidly adapt, a few exhibit prolonged and incapacitating AS, resulting in potential candidates for desensitization. AS also generates complex changes in plasma hormones and other biomarkers. Aim of this investigation was their analysis before and after rehabilitation.

Methods: Stress biomarkers, potentially associated to AS, were analyzed in seven student pilots (5 males and 2 females) undergoing a 2-week rehabilitation, before and after a preliminary and a final strongly nauseogenic Coriolis Stress Test (CST). Peripheral blood was sampled before and after each CST, analyzing the levels of total Antioxidant Capacity (AOC), Cortisol, C reactive Protein, Ghrelin, 15-F2t-Isoprostane, Pepsinogen, Substance P, Thromboxane, and Vasopressin. The four blood samples were heparinized and separated by centrifugation, and the plasma was stored at -80 °C until testing.

Results: All individuals were successfully rehabilitated at the final CST. However, during the following real flight activity, one male subject was still affected with AS (fail case). Before rehabilitation, all subjects showed a peak of cortisol after the CST. This peak was not observed after desensitization, except in the fail case, where cortisol exhibited an even higher peak also after the second CST. The AOC did not significantly change before and after rehabilitation and between the two CST, but in two subjects, one female and the fail case, it resulted much lower (719 vs 1237 μM). Interestingly, this female pilot reported a few minor and occasional AS episodes following desensitization, in contrast with the rest of the sample, where symptoms completely and permanently disappeared. Unexpectedly, no relevant derangements were observed in all the other biomarkers.

Conclusions: Cortisol and AOC plasma levels may be useful parameters for predicting AS time course and the success of rehabilitation programs.

Thursday 22 September 22

Gaston Berger Room

1745-1900

Special Scientific Session 7a

EASA: Regulatory Updates

MENTAL HEALTH: EASA APPROACH & EXPERIENCE UNDER EASA REGULATORY FRAME

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Introduction: The Germanwings tragedy led to reviews of multiple lessons learned, once the BEA report was published. Relevance of mental health was fully considered as a fact, and organizations and regulators put in place several mitigation measures to prevent similar events. In addition to that, COVID 19 pandemic added a number of associated stressors to the situation, such lockdowns, flight disruptions, fear, financial problems, cargo vs passengers flights, that challenged the aircrews and hence the global situation of the world aviation. As a consequence, mental health became a major and multidisciplinary issue that involves almost all actors in the aviation environment, such as regulators, safety agencies, aviation support personnel, industry and aeromedical examiners.

EASA put in place several initiatives, such the regulatory frame for Mental Health, plus recommendations from a training perspective, in order to facilitate and assist the AME in the recognition of work-related stressors that impact job performance, health, and wellbeing in aviation personnel.

EASA approach has been associated to robust AME knowledge to interface with the aircrew, and to provide a standard interview pattern flexible enough to acknowledge adequate information and maintain necessary trust.

Methods: Basic concepts to be included in the interview have been reviewed and approach presented. A total of 101 cases associated to mental health issues were under review during a period of 6 months.

Results: For Class 1, out of 10.522 revalidation exams, 17 (0.16%) cases were referred due to various reasons for further PSY/PSQ evaluation and only one case finally denied. For Class 2 and 3 almost no findings.

Conclusions: Need for the appropriate tool to support interview. Key point is the medical/ aeromedical history of the applicant obtained under a mutual trust. The future is under review by EASA, ICAO, ESAM and AsMA initiatives.

MESAFE: MENTAL HEALTH FOR AVIATION SAFETY

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Background: ME-SAFE is the new research project launched by EASA to overcome challenges preventing the effective implementation of the Aeromedical certification process for pilots and air traffic controllers (ATCOs) with regards to the incapacitation risk associated with mental health conditions. Currently, there are no specific, validated mental health assessment methods for aviation use, incorporating the specific operational needs, to address the issues identified. Research is needed to further detail the specific needs, and to develop and validate assessment methods or to assess the applicability of existing methods for use in the aviation environment.

Overview: MESAFE will provide evidence-based recommendations for new medical developments for the early diagnosis as well as treatment of mental health conditions which could pose a safety risk for aviation and would consequently lead to pilots and ATCOs unfitness or the limitation of their licence privileges for safety purposes.

Discussion: The approach will be safety practitioner driven, fostering the communication and cooperation among Aeromedical examiners, Mental Health Specialists, Aviation Psychologists and peer support groups, for the sake of civil protection of citizens in the fight against safety hazards related to mental disorders during flight and air traffic control operations. The project will put at the centre of the research not only aeromedical examiners and medical assessors but also the applicants (pilots and ATCOs), and will assess and evaluate how the mental fitness certification process affects them, and how they perceive it.

EASA UPDATES REGARDING REGULATORY AND RESEARCH ACTIVITIES

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Background: In line with the evidence-based medicine principles EASA is making efforts to update the relevant European aero-medical requirements based on existing evidence and guidelines, while, at the same time, taking steps into collecting evidence relevant for the aviation environment.

Overview: In this regard, the presentation will provide the audience with details in regard to the current and future rulemaking tasks that are focused on the update of the pilot age limits as well as of the medical requirements for cardiovascular, visual and metabolic systems. Mental health remains a very important pillar, which is also requiring further attention in the future.

In the second part the presentation will provide information to the participants regarding EASA current research activities regarding looking at mental health assessment for pilots and ATCOS as well as the fitness assessment for applicants with diabetes mellitus or cardiovascular conditions. EASA will detail the expected outcomes and implementation plans for the results of the studies topics for potential future research studies.

Discussion: There is the need for evidence based and up to date requirements allowing the AME to ensure that all fit applicants can continue to safely perform the privileges of their licences. EASA is constantly consulting with medical experts to identify areas for improvement in the requirements as well as topics for research to optimise the use of medical developments in terms of diagnostic measures and therapies for the field of aviation medicine.

THE USE OF THE EUROPEAN AERO-MEDICAL REPOSITORY (EAMR) TO ENHANCE FLIGHT SAFETY

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Background: Following the GermanWings flight 4U-9525 accident, the EASA-led GermanWings Task Force investigated ways to reduce the risk of future accidents due to medical fitness. The Task Force recommendations were not linked directly with the cause of the accident but looked also at favouring factors and gaps in the current aero-medical certification system. As part of their recommendation No. 5, the Task Force recommends “the creation of a European aeromedical data repository as a first step to facilitate the sharing of aeromedical information and tackle the issue of pilot non-declaration.”

Overview: EASA started to put in place the legal framework needed to develop and use such a repository and at the same time started discussions with the relevant stakeholders, the European Commission and the European Data Protection Supervisory (EDPS) regarding the content and security measures to be put in place to ensure data protection. Following discussions and design workshops, the EAMR has become a repository of medical certificates that allow AMEs and NAAs to trace the medical certificate history of their class 1 pilots and, consequently, reducing the risks resulting from medical certificate shopping.

The majority of the European countries have a national electronic aeromedical certification system with various degrees of complexity and different levels of data protection and confidentiality requirements. This gives the medical assessors a good overview of the aero-medical examinations performed at national level, however no such system existed before the EAMR. Since July 2021 the EAMR is live and being used by the NAAs and AMEs across Europe. After a 5-month transition period, the use of EAMR became mandatory since 1 January 2022.

The presentation will provide an overview of the legal framework, the objectives of the EAMR as well as the implementation experience from the point of view of the Medical Assessors and AMEs.

Discussion: With the EAMR, Europe is taking the first steps to ensure cross border traceability of aero-medical certification of class 1 pilots having as main objective to discourage medical certificate shopping and pilot non-declaration while at the same time allowing the NAAs a better oversight of their medical certificate holders.

Friday 23 September 22

Gaston Berger Room

0830-1000

Scientific Session 8

(French Language Session)

Clinical Aviation Medicine:

Cardiovascular Concerns

SCREENING FOR SILENT MYOCARDIAL ISCHEMIA IN DIABETIC PILOTS. EXPERIENCE OF THE CEMPON OF RABAT WITH LITERATURE REVIEW

Meryem Zerrik¹, Houda Echchachoui¹, Mouna El Ghazi¹, Zakaria Iloughmane¹, Fahd Bennani Smiress¹, Sidi Mohamed El Khalifa¹, Amal Moumen², Mohamed Chems¹

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Introduction: 75% of deaths in diabetics are caused by coronary disease. Its often-asymptomatic nature delays diagnosis. In aeronautics, it can cause in-flight incapacitation, beyond which it represents a major concern for the medical expert.

Screening for silent myocardial ischemia (SMI) is still a topical subject with the advent of new cardiovascular risk biomarkers and more effective screening tests. We report the experience of the CEMPON of Rabat in screening for SMI in diabetic pilots, with a review of the literature.

Methods: Prospective study over one year including (level 2 diabetic) pilots who benefited from systematic screening for SMI after cardiovascular risk stratification according to ESC/EAS 2019. Coronary angiography is performed if a screening test is positive. Subsequent follow-up is carried out in consultation with the attending physician with regular evaluation at the CEMPON.

Results: 38 pilots were included. The average age was 55 ± 4.19 years, all male. 73% had a high cardiovascular risk. Repolarization disorders were found in 10.52%. An IMS is detected in 10.52% of cases, having required revascularization with placement of active stents. Half of the pilots with coronary disease could have an aptitude by derogation.

Discussion: Screening for SMI in diabetics is controversial, current recommendations are not unanimous. In our study, screening for SMI did not identify coronary (level 2 diabetic) pilots who could benefit from bypass surgery. Nevertheless, coronary disease was diagnosed, justifying an inability to fly, in order to preserve flight safety, an absolute priority in aviation medicine.

INTEREST OF EXERCISE TESTING IN THE APPROACH OF CORONARY ARTERY DISEASE IN PRIVATE PILOT

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Introduction: The aim of this topic is to show how an easy exercise test can bring a lot of information to the diagnosis of suspicious coronary artery disease.

Report of Two Case Histories:

Discussion:

- When should we think of coronary artery disease: check list of all coronary artery risk factors
- How to undertake an exercise testing: a reminder of good preparation for a good interpretation.
- How to interpret the results of exercise testing.

Conclusion: Treadmill Exercise Testing is still usefull as an ischemic research test in coronary artery disease.

AORTIC VALVE REPAIR IN SEVERE REGURGITATION: A SURGICAL ALTERNATIVE FOR AIRCREW COMBINING AERONAUTICAL SAFETY AND GOOD LONG-TERM MEDICAL PROGNOSIS

François-Xavier Brocq, Nicolas Huiban, Laetitia Corgie, Marc Monteil

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Introduction: Severe aortic regurgitation is a not uncommon situation in professional aviation medicine, in particular when complicating bicuspid aortic valve. Recently, a group of full-time aviation medicine and aviation cardiology experts focused on the general principles for aircrew treated with surgery for valvular heart disease. Among treatment strategy, aortic valve repair was not mentioned.

Case Report: A 28-year-old initial applicant pilots presented with a moderate regurgitation. Reassessed as a severe regurgitation, unfitness was decided. Three years later, this applicant presented after aortic valve repair. New evaluation by the licensing authority allowed a monopilot fit-to-fly assessment.

Discussion: Aortic valve repair is an alternative treatment for aortic regurgitation that deserves to be known. It protects against redo valve surgery imposed by prosthetic tissue valve and against anticoagulation imposed by mechanical valve.

CARDIAC DEVICES AND FITNESS TO FLY: CLINICAL CASE AND REVIEW

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Introduction: Aging is a common phenomenon all over the world. The incidence of arrhythmias is increasing with age. Such problems can be limiting for the fitness to fly. It will be challenging in the future to maintain the privileges of flight in these situations. Rapid technological progress may be a partial response to this problem.

Methods: Beginning with a spectacular clinical case (implantation of a pacemaker for a sudden atrioventricular block Mobitz II by a Swiss flight instructor and past acrobatic Swiss champion with a very long experience of flight), we will review the benefits of the new developments in cardiac devices, the actual recommendations of the European Union Aviation Safety Agency and the device guidelines of the European Society of Cardiology/American Heart Association.

Results: After 6 months of cardiology follow up, this flight instructor was “fit to fly” again at 73, due to no pacemaker-dependency, and able to teach a lot of young pilot candidates in the following years! According to the actual international guidelines, it is important to follow the devices regularly to avoid a total pacemaker dependency or other trouble shooting. The new technologies improve the safety by helping for the rapid screening.

Conclusion: Advances in new cardiac technologies can extend the career of experienced pilots with greater safety and facilitate monitoring by allowing early detection of problems. These pilots however require a specific follow up according to the actual guidelines.

AFTER A STROKE, THE MANAGEMENT OF THE FITNESS ASSESSMENT IN AIRCREW MEMBER

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Background: Stroke is a real public health problem worldwide and the epidemiological predictions of the coming decades are rather worrying, with an explosion in the number of cases by 2030. In France, every day, nearly 360 people are affected, with an incidence that increases significantly after the age of 55. Stroke is the leading cause of physical disability in adults, the second leading cause of death, the second leading cause of dementia, and a common cause of depression. This is why stroke, both constituted and transient, is a diagnostic and therapeutic emergency in order to limit its consequences.

Overview: Although rare in aircrew member, a stroke is a turning point in aeromedical fitness. In fact, there is the question of the etiology and its treatment, from which derives the risk of recurrence, that of neuro-cognitive sequelae and their potential impact on the ability to pilot, that of the risk of secondary epilepsy on cerebral scar, and the evaluation of global cardiovascular risk in ischemic stroke.

Discussion: Most of time, the return to fly is conditioning at least by a multipilot limitation. Authors were interested in the conditions that could lead to propose the removal of this limitation.

Friday 23 September 22

Louis Armand East Room

0830-1000

Scientific Session 9

Mental Health and Addictions in Aircrew

THE ROLE OF JOB DEMANDS AND RESOURCES IN PREDICTING SAFETY CULTURE AND WELL-BEING

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Introduction: Employee perceptions of how much the organization values safety (safety culture) is a principal element of a safety management system (SMS). Our review of the industry-wide safety culture literature revealed several gaps in the research: inconsistent list of variables, weakness in predictive validity, and lack of a systematic model. Recent research by Fogarty and colleagues (2018) demonstrated the utility of a Job Demands and Resources model (JD-R). The model was used to determine the impact of individual, organizational factors, safety culture on self-reported errors and violations. We adapted the model for use in an investigation of safety culture in civil aviation.

Methods: A 200-item questionnaire comprised of 7 job resources (JR) subscales, 5 job demands (JD) subscales, 4 individual outcomes, 3 organizational outcomes, demographics, and a usability subscale was administered to aviation maintenance personnel at four US maintenance organizations; items were tailored to meet the organizational needs of participating companies.

Results: Responses were received from 434 individuals. Structural equation modeling (SEM) revealed that the JD-R predicted both individual and organizational outcomes; that the relationship between safety culture and organizational outcomes is partially mediated through individual outcomes. Results of statistical comparisons of the relationship between JD, JR and individual outcomes demonstrated that job resources play a more significant role in predicting job satisfaction and morale, however, JDs are more than twice as important in predicting psychological wellbeing, strain and fatigue, and turnover intentions.

Conclusions: These results are consistent with the meta-analysis of Gozalez-Mule, Kim, & Ryu (2021), who support the view that the variables involved in safety culture and aspects of mental wellbeing share similar job demands. Further research is needed due to the small sample size, need for objective versus subjective performance measures, and reduce the size of the questionnaire.

AEROMEDICAL GUIDANCE FOR WATERPIPE (HOOKAH) SMOKING BY AIRCREW - OVERVIEW AND SAFETY CONSIDERATIONS

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Background: Waterpipe (hookah) smoking involves a tobacco pipe with a long, flexible hose that allows a user to inhale smoke drawn through water contained in a reservoir. The flavour and content of the tobacco or molasses within, heated by burning charcoal, vary greatly. Several factors have contributed to the increasing popularity of waterpipe smoking in Australia, including flavoured tobacco products, misconceptions about safety (particularly surrounding tobacco-free options), and the social aspect inherent in smoking as a group in shisha bars.

Overview: RAAF IAM conducted a review of the literature in order to provide aeromedical guidance for aircrew partaking in waterpipe smoking. At the time of writing, no such guidance existed for military or civilian aircrew.

Discussion: Studies show that 15 minutes of waterpipe smoking can be the equivalent of smoking 19 cigarettes, noting that smoking sessions may last for several hours. Myriad health effects were identified, including raised blood pressure, development of atherosclerotic cardiovascular disease and obstructive lung disease, and increased cancer risk (lung, head and neck). Detrimental cognitive effects (alertness, attention and memory impairment) in waterpipe smokers has also been identified, which is of particular concern with regard to aircrew. In addition, the ongoing acute and chronic effects of repeated exposure to carbon monoxide (CO) and the related toxicity presents a relevant risk to aircrew. IAM recommend that aircrew not partake in waterpipe smoking given the adverse health effects identified. Aircrew are advised not to fly for at least 18 hours after smoking where the cabin altitude is planned below 10 000 ft., or for 24 hours if the planned exposure is above 10 000 ft. This is to minimise the potential for hypoxia arising from additive effects of hypoxic hypoxia and residual effects of CO, which reduces the oxygen-carrying capacity of haemoglobin.

AIR RAGE & UNRULY PAX: WHAT SHOULD WE DO?

Trang Dao

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Background: ICAO and IATA have amended the definition of disruptive passengers several times, and separately issued different recommendations, delimitations of responsibility of consequences to protagonists since the 1929 Warsaw Convention. However, ICAO definitions and resolutions as well as the IATA Manual on the Guidance on Unruly Passenger Prevention and Management have been severely criticized by law makers who welcome predictive or anticipatory intelligence, and deemed those Manuals ambiguous and unhelpful, with *"... the most compelling aspects of the psychological factors which seems to have eluded the key players' mitigating, since they are not given the same consideration as physical wounds"*.

Overview: Statistics on incidents involving uncooperative passengers, on board of an aircraft or in the terminal have jumped sky high globally since the pandemic since the 1st case of unruly passenger was recorded in 1947. However, recordings of such crises are inconsistent within carriers of the same Nation, and across Nations; the result is under-reported number of cases, challenging eventual regulations required to secure workers, travellers and crews exposed to those incidents.

The statistics of physical and emotional impacts those crises cause upon bystanders are even worse. The magnitude of physical and emotional health impact of these phenomena is unprecedented: an American survey in found that in 2021, 85% of 5000 Flight Attendants respondents have dealt with at least one unruly passenger up to Sept 2021. 58% reported handling more than five incidents. 17% reported a physical confrontation with a passenger.

Discussion: We will discuss facts and contributing factors, specific to flying or not, consequences upon various level of victims, existing measures regarding managements, coalition actions. We will propose future measures addressed to physicians, crews, international authorities, airport managers, passengers, carriers international authorities, airport managers, and more.

ALCOHOL USE DISORDER: CLINICAL AND AEROMEDICAL PRACTICE GUIDELINES

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Background: Alcohol use is not only accepted and utilized in our society, but often many people are encouraged to participate in alcohol use. United States Air Force (USAF) personnel are not immune to this. It is known to be one of the most complex interferences in the careers of many USAF aviators.

Overview: Even legal, sanctioned use of alcohol could have negative effects on aviation safety and optimal flying abilities. A diagnosis of alcohol use disorder is disqualifying for all USAF flying classes and requires detailed and assured treatment to become eligible for a waiver. This presentation will focus on the diagnosis of alcohol use disorder (AUD), the transition from Diagnostic and Statistical Manual of Mental Disorders (DSM) IV-TR to DSM-5, and the treatment/waiver policy for aviators.

Discussion: Although specific for Air Force pilots and aircrew evaluated on the Aeromedical Consultation Service, the underlying issues are common to aviators and civilian organizations alike.

MENTAL HEALTH PROGRAM FOR FLIGHT CREW IN A NON-REGULATORY CONTEXT: DIFFERENT MODELS IMPLEMENTED IN A MULTINATIONAL AIRLINE COMPANY

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Background: Since 2011, the Brazilian civil aviation authority regulates the existence of alcohol and drug programs involving safety related professionals. In compliance with this regulation, within the context of a multinational company of South America, an area composed of health professionals was created in Brazil, additionally responsible for managing other health matters with possible safety impact. With the observation that many of the demands received by the professionals from the alcohol and drug program were not related to substance use, but to common stressful life events, in 2017 a mental health program called Seguramente (“safe mind”) was implemented, with the aim of providing support to pilots within this scope and mitigating possible related operational risks.

Overview: With the advent of the COVID-19 pandemic in 2019, and the growing worldwide concern about its impact in terms of mental health, the existing mental health program, although not regulatory in any of the countries of the group, was gradually expanded to all of them (Chile, Ecuador, Colombia, Paraguay and Peru) in the model of Peer Support, following industry best practices. The process was completed in March 2022, with the training of pilot peers in Brazil, where it was implemented in a complementary way to the model already in force, centered on health professionals.

Discussion: Among the main points considered in the implementation of the pilot peer support model, the guarantee of confidentiality and secrecy of information and the demystification of themes related to mental health stand out. The model adopted for training volunteer peers took into account the adequacy of the themes to the cultural context of each country and the need for continuous updating. Additionally, we highlight the importance of comprehensive educational actions aimed at promoting mental health and well-being.

Friday 23 September 22

Louis Armand West Room

0830-1000

Scientific Session 10

Safety Considerations of Reduced Crew Operations

REDUCED CREW OPERATIONS AND FLIGHT SAFETY – ISSUES FOR RADICAL INTERDISCIPLINARITY

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Background: Reduced Crew operations are operations where either minimum crew of long-haul operations are reduced from 3 to 2 pilots (Extended minimum crew operations or eMCO), or Single pilot operations (SiPO). The concepts are different, but are part of a general development in Aviation, and also other sectors, where the use of human operators is minimised, primarily to save cost. As such, the mentioned concepts might be seen as a part of a trend towards fully automated aircraft in some form. Several European projects, previous and present, actively study technologies and safety aspects of such operations with the expressed aim of providing a basis for future rule making for reduced crew operations.

Overview: Safety issues include incapacitation of remaining pilot(s), including incapacitation detection and management. The correct use of sensor technology, algorithms and artificial intelligence are important technological enablers. Also, providing situation awareness of anyone "taking over" the aircraft after incapacitation is important, either being ground control or a sleeping pilot possibly suffering sleep inertia after suddenly being woken up. Human-automation teaming issues which may have safety consequences include predictability, attention management, as well as fatigue and the changed social environment for a single pilot with "all" responsibility.

Discussion: Future reduced pilot operations will affect cost, jobs, pilot working environment, and may raise questions of passenger acceptance and public trust. The presentation will discuss how radical multidisciplinary, where different professionals directly interact in problem solving, may be applied in order to find optimal solutions not only affecting technical solutions, but also aeromedical risk assessment, safety, workplaces and social acceptance.

MEDICAL & HUMAN FACTORS CONSIDERATIONS FOR SINGLE PILOT COMMERCIAL AVIATION OPERATIONS

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Background: Current initiatives to consider the implementation of single pilot commercial aviation operations (cargo) are introducing a number of potential safety issues involving aeromedical and human factors considerations.

Overview: Multi-crew commercial aviation flights for transportation of passengers and cargo have been the common denominator since the beginning of commercial aviation in order to maximize safety through human redundancy. At the same time, new significant advances in cockpit automation based on advanced digital systems have supported and even augmented the capabilities of pilots through the reduction of workload and increase of situational awareness.

Discussion: The practical application of the principles of human-centered automation have been mostly effective in supporting the role of the pilot during flight. However, these advanced cockpit automation systems have also introduced other types of failures modes where the pilot must be capable of recognizing and responding to subtle or sudden system malfunctions. On the other hand, human effectiveness and efficiency during flight can be negatively impacted due to medical conditions that have the potential of causing performance impairment and/or subtle or sudden medical incapacitation. This presentation will discuss several medical and human factors aspects that must be addressed in order to ensure the safety of proposed single pilot air cargo commercial operations.

REDUCED CREW OPERATIONS – ADDRESSING THE HUMAN CENTRIC DESIGN OF THE SYSTEM – PILOTS’ PERSPECTIVE

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Background: Airline pilots have a proven track record of maintaining industry’s safety record in the day-to-day operations. Despite that, the safety role of a pilot physically present in the cockpit is being questioned by the industry. Numerous projects are ongoing to introduce single-pilot or remote-controlled operations to the air transportation system. Aircraft manufacturers consider the technology aimed at implementing reduced crew configurations “as ready to go.” But is it ready to go for all types of real-life scenarios?

Overview: To properly tackle the crew reduction issue, it is necessary to understand today’s airline pilots working methods and philosophy. During the last 30 years, the development and implementation of CRM have proven to be an undeniable factor of the improved global flight safety. Continuous cross checks of actions performed by the pilots and automation, task sharing between the pilot flying (PF) and the pilot monitoring (PM), in both normal and abnormal situations - are key pillars to safe flights. At the core of this are synergies achieved by combining the respective explicit and implicit knowledge bases of the two, which is exemplified by the common pilot-wisdom “if in doubt shout it out.”

Discussion: Reduced or single pilot operations would necessitate more than improved technology. It would require a philosophy change – a switch from a human-centric to a machine-centered system assisted by human. Currently, there is a complex interplay of two crew members, physically located next to each other on the flight deck, openly communicating with each other. Moreover, in an industry where all systems are doubled and even tripled to face possible failures, how will the pilot redundancy be replaced?

We need to study the probabilities and impact should the pilot ‘fail,’ how loneliness for long periods of time or in critical situations would affect pilot’s performance. What are the consequences of pilot incapacitation in a reduced crew operations scenario and how can it be recognized and dealt with?

SINGLE PILOT VERSUS TWO PILOT COMMERCIAL AIR TRANSPORT OPERATIONS: A COMPARISON OF ACCIDENT CAUSES

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Introduction: Due to the ongoing developments in technology, automation and autonomous unmanned aircraft, there is an interest and desire to explore whether it is feasible to operate commercial air transport (CAT) with reduced flight crews in large aircraft. Existing Air Operations rules already allow commercial air transport operations by a single pilot in smaller aircraft.

Method: To be able to understand and mitigate the risks associated with single pilot operations, a comparison was made of the types of accidents involving single pilot and two pilot commercial air transport. The scope of the analysis was limited to fatal accidents that occurred in the 2000 and 2020 time frame involving Part 135 'Air taxi and Commuter' operations. All accidents for which the accident investigation by the National Transportation Safety Board (NTSB) had been completed were included. The analysis focused on the type of accident, classified according to the CAST/ICAO Common Taxonomy Team common taxonomy for occurrence types, and the accident causes as published by the NTSB.

Results: Occurrence type and accident causes were obtained for 31 accidents involving two pilot Part 135 operations and 618 accidents involving single pilot Part 135 operations. Most frequent occurrence types for two pilot as well as single pilot operations were loss of control in flight and controlled flight into terrain. The most frequent accident cause for single pilots operations was the decision of the pilot to continue flight in low visibility conditions.

Discussion: The results show some key risks that must be addressed to enable safe single pilot operations in large commercial aircraft.

Friday 23 September 22

Gaston Berger Room

1030-1200

Scientific Session 11

(French Language Session)

Clinical Aviation & Travel Medicine

MEDICAL CAUSES OF UNFITNESS FOR ADMISSION TO MILITARY PILOTING

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Introduction: In military aviation, fighter pilots are exposed during their operational missions to a maximum of aeronautical constraints such as altitude hypoxia, GZ+ type accelerations, barotrauma and sensory illusions in flight, or the slightest physical, physiological and/or psychological failure may threaten flight safety or the pilot's life. Hence the interest of a medical examination of admission to piloting which has a mainly preventive interest. The objective of our study was to determine the main medical causes of military flying unfitness. This is the first study of its kind in Tunisia.

Methods: This is a retrospective prevalence study, mono-centric and descriptive who was interested in all the candidates who presented themselves to the Center of Expertise of Aeronautical Medicine as a part of an admission visit to military flying among the new graduates of the academic year 2020/2021.

Results & Discussion: The study population consisted of 140 male-predominant military pilot candidates (sex ratio = 0.17) and an average age of 20.1 years (extremes of 19 and 23 years), 86 among them were declared medically unfit for military pilot with a prevalence of 61.4%. 90 causes of incapacity were identified; 68.9% ophthalmological, 6.7% excess weight, 5.6% oral causes and in the same proportions scoliosis. Ophthalmological pathologies were mainly represented by decreases in visual acuity (82.3%) and heterophoria (14.5%). These results reveal the rigorous and selective nature of this intake visit in relation to the application of the "fighter pilot" proficiency standards. However, these are old ones dating back to 1988 and should be reviewed and updated in line with the considerable technological progress of the aeronautics industry and the advent of high performance aircraft of the latest generation.

Conclusion: The diversity of the military pilot's missions and the potential risks to which he is exposed in relation to the aviation community and the high-performance aircraft flown justify a very selective medical examination for admission to military flying with a dual vocation, a preventive approach to the constraints created and a predictive one to ensure a long career for the future military pilot while respecting aviation safety, which is the cornerstone of the entire aeronautical chain. An update of the medical standards for military flying fitness is required in the near future.

TRAVEL HEALTH STUDY IN COMMERCIAL AIRCREW MEMBERS

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Background: Aircrew members of airlines are exposed to travel risks. The objectives of our study are to assess the experience of aircrews about these risks and their knowledge about preventive measures.

Methods: We conducted an observational qualitative study in commercial aircrews at the aeromedical center of Percy Military Hospital between November 2018 and June 2019.

Results: 200 aircrews answered the questionnaire, 54% of which were pilots, 91% were working on long and/or medium-haul flights, 82.5% of airmen were concerned by their immunization status. Vaccination rate varied according to the vaccine. Two-thirds of airmen were used to going to malaria-endemic countries, 12% of the respondents using antimalarial treatment in such infected countries, while 93.5% protected themselves against mosquito bites mainly with insect repellent. In case of a fever after a stay in a malaria-endemic country, only 51.5% of aircrew immediately would have thought about acute malaria. Aircrews appeared very motivated by their job but 58% of them felt tired probably linked to the quality of sleep and the effects of jet-lag, with a statistically significant difference between pilots and cabin crews (43% vs 75% [$p < 0.01$]).

Conclusion: Aircrew members know a lot about travel issues. Malaria remains a major concern for aircrews, but it is necessary to maintain information about this topic throughout their career and to provide them with repellents, which many airlines actually do. Fatigue management is also important for airmen, and so they use different techniques as countermeasures. Some airlines try to help them with a guide for aircrew fatigue management. This particular population involved in flight safety has few risky behaviors; nevertheless, alcohol misuse and drug use are screened during medical examinations and by airlines.

TOBACCO USE AND ITS CESSATION AMONG FLIGHT CREWS

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Background: Smoking is the most common cause of avoidable death with 75000 deaths each year in France. In the aviation environment, smoking is responsible for disease that may impact medical fitness.

Objective: The main objective was to describe current and past tobacco consumption and the secondary objective concerned the prevalence of different means of quitting, the estimation of tobacco dependence and motivation to quit.

Methods: We realised a multicentric transversal descriptive study on CEMPN of Clamart and Toulon between November 1, 2019 and March 30, 2020. The patients were professional military and civilian aircrew. They filled in a self-administered questionnaire in the waiting room before doing the paramedical exams.

Results: 1759 questionnaires were analyzed. The prevalence of regular smoking was 10.7% with 10% in men and 15% in women. The average Fagerström and the average Q-MAT were estimated at 1.78 (+/- 1,86) and at 8 (+/- 6,04). The electronic cigarette was the most used and was judged the most effective method for quitting. Effective weaning means were underused.

Conclusion: This study shows a marked decrease in tobacco use, more important than in the general population. Female smoking is in marked decline since study 2005 and 2013 but it remains superior to that of men. Smokers maintained low tobacco dependence, and their motivation to quit smoking appears to be high with an average Q-MAT of 8 and an average of two alleged quitting attempts. The advent of electronic cigarettes has revolutionized withdrawal strategies leading to a reduction in aids requiring a medical prescription.

MUST PILOTS PERMANENTLY QUIT FLYING CAREER AFTER TREATMENT FOR LUNG CANCER?

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Introduction: Lung cancer could seriously threaten the physical and mental health of pilots. Shall they be declared unairworthy after being diagnosed with lung cancer? The purpose of this clinical case report is to premise the efficiency of targeted therapy in the readaptation of an airline pilot diagnosed with non-small cell lung cancer (NSCLC) with anaplastic lymphoma kinase (ALK) rearrangement.

Lung cancer is the most common malignancy worldwide and is a major public and occupational health problem. Adenocarcinomas account for about 40% of lung cancers and are currently the most common type in non-smokers. ALK rearrangements are present in a small subset of NSCLCs and they are highly sensitive to ALK inhibitors. Previous studies on airline pilots have reported increased incidence of specific cancers such as skin, prostate and brain cancer but insufficient studies have treated the incidence of lung cancer.

Case Report: We herein present the case of a 46-year-old male non-smoker airline pilot class 1 with 7000 hours of flight time on Airbus 330. The patient demonstrated a coughing fit, hemoptysis and dyspnea during a flight. A diagnosis of a lung adenocarcinoma Stage IV-A with ALK rearrangement was made based on PET-Scan and genetic tests. The patient underwent a targeted therapy treatment for 2 years and showed complete remission on subsequent visits. No further incidents were declared during the four years following.

Discussion: Although lung cancer is a cause of unfitness for pilots, the results of this case report highlight the possibility of granting a class 1 medical waiver for pilots diagnosed with lung cancer who underwent proper targeted therapy with regular monitoring. So far, few studies have been carried out to determine the mortality and incidence of lung cancer in pilots and fewer underlying their recovery under targeted therapy treatment. This calls for further studies to explore the safety of recovered pilots undertaking flight missions again.

ASSESSMENT OF THE PREVALENCE AND IMPACT OF THE COVID-19 EPIDEMIC IN THE FRENCH AIRCREW POPULATION IN 2020

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Introduction: Away from the first acute phase, the authors attempt to assess the epidemiological impact and the consequences of this condition within a cohort of French aircrew (AC).

Method: At the end of 2020, the authors carried out a prospective, anonymous questionnaire study within the 2 French military aeromedical centers. It includes 1,000 professional aircrew interviewed. The two main objectives are from declarative data to estimate the prevalence of COVID-19 in French AC after the 1st wave as well as the short term socio-professional impact (aeronautical employment, family, thymia).

Results: 2.3 % (23 persons) of the aircrews questioned were symptomatic AND positive for at least one COVID-19 detection test. The health crisis had socio-professional consequences for more than a third (36.8%) of the study population. This is almost two times out of three (62.5%) of partial unemployment. Compared to "Before COVID," the exercise of aviation is marked by more complex conditions (38.5% of the cohort) and by a remaining reduced activity (36.2%). Fear of contamination is reported by only 6.4%. Concern and fear of the future dominate (52% of responses) the consequences on morale noted in 18% of the questionnaires. On a scale of 0-10, morale is self-rated on survey day at an average of 7.9. It is significantly better with Navy rear crews (8.91) and less good with cabin crews (6.96) ($p < 0.01$).

Conclusion: In the last quarter of 2020, more than a third of aircrews had at least one screening test. 51 cases (5.7 %) of potential COVID disease are reported and 23 cases (2.6 %) have been confirmed by testing. The crisis appears to have had serious social consequences with nearly one in two civilian aircrew affected by partial unemployment, which in half the cases is prolonged over the long term.

MEDICAL EVACUATION OF CRITICALLY ILL COVID-19 PATIENTS IN NEW-CALEDONIA: AN EXAMPLE OF CIVILIAN AND MILITARY COOPERATION

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Background: We propose feedback about the collaboration between the French military forces in New Caledonia and medical emergency teams of Europ Assistance Pacifique, which performed unique and original missions together at the beginning of the epidemic (March 2021) from the small pacific island called Wallis to Nouméa, still COVID-free during this period.

Overview: The purpose was to provide a high level of care during the evacuation of critically ill COVID-19 patients. There are few options to achieve long-range MEDEVAC of unstable overweight patients in New Caledonia. To accomplish our mission, we reviewed all the airplanes and all medical equipment available on the spot, pointed out all the logistical issues like type and quantity of oxygen on board, electric support, adaptative stretcher needs, public health recommendations to avoid the spread of infection, low pressurisation impacts, and found joint and creative solutions.

Discussion: Our collaboration was a success, and demonstrated the performance of team work to anticipate and solve the MEDEVAC logistical challenges in the patients' best interests. It is surely an experience to share and discuss to inspire other cooperation of this kind in the future.

Friday 23 September 22
Louis Armand East Room
1030-1200

Scientific Session 12

Space Medicine:

Long Duration Space Travel and Operations

THE MANAGEMENT OF EXTRA-TERRESTRIAL PANDEMICS AND OTHER 'STARDUST' MALADIES

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Background: At our last in-person ICASM in Hungary we presented on the possibilities for extra-terrestrial life in the form of biological agents and the precautions being developed to safely examine returning samples to earth. In addition, an infrastructure of back-up preparations were described to mitigate potential breach of those protective layers.

Overview: The NASA office of Planetary Protection is engaged in an ongoing effort with the CDC to establish the groundwork for protective measures in the collection, recovery, transportation, handling, storage, and analysis of samples being returned to earth from extra-terrestrial explorations.

In addition, an educational network is being developed through the AsMA Educational and Training Committee in conjunction with the American College of Emergency Medicine Disaster Medicine section to assist in educating, preparing and facilitating communication with front line medical providers in the event of an accidental or other extra-terrestrial pandemic event.

Further forward work is underway to determine the best protective measures for astronauts, industrial workers, and colonists living and working in extra-terrestrial environments such as the moon and Mars, where the additional possibility for the health effects from working in and with the surface dust is being realized. The study even of lunar soil has revealed unexpected volatile and reactive chemicals such as Hydrogen Sulfide and Sulfuric Acid in core samples from beneath the surface.

Discussion: There is much to learn regarding the potential health effects of 'stardust' such as lunar and Martian dust which we will eventually have to learn to deal with and prevent as we move to explore and colonize these worlds. In the meantime, we also are preparing to safely study samples brought back as well as having a back-up preparation in place in the unlikely event of any material containing living or pathogenic agents.

ANAEROBIC MEMBRANE BIOREACTOR FEASIBILITY FOR LONG DURATION SURFACE OPERATIONS AND PHARMACEUTICAL IMPLICATIONS

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Background: Lunar or Martian long-duration surface operations (LDSO) are set to occur soon. Associated life support infrastructure will need to shift away from terrestrial dependence by striving for total resource recovery. Currently, the Environmental Control and Life Support System (ECLSS) on the International Space Station (ISS) processes no solid waste, thereby precluding elemental carbon, phosphorous, or nitrogen recovery. The anerobic membrane bioreactor (AnMBR) is a promising bioregenerative technology that offers carbon, phosphorous, and nitrogen resource recovery by processing all wastewater types among other waste products. Yet, it is unknown how bioreactors cope with pharmaceuticals in wastewater, a pressing research need given shifting astronaut health demographics.

Overview: A narrative review was performed to synthesize AnMBR wastewater processing technologies and performance for LDSO and medication removal capabilities. Terrestrial medication use data was cross-referenced with medications known to be aboard the ISS to identify relevant medications posing a challenge to AnMBR processing and to clarify removal capabilities of such medications. Proof-of-concept AnMBR's small enough for spaceflight have been created.

Discussion: AnMBR's removed up to 99% of biochemical oxygen demand from high-strength wastewater and recover carbon, phosphorous, and nitrogen nutrients with low to positive energy cost. AnMBR's also achieved high medication removal efficiencies—up to 100%—but efficiencies varied considerably based on medication class, medication chemical structures, and bioreactor configurations. There was only partial overlap between medications studied in AnMBR's and those widely used terrestrial or ISS medications. Anaerobic membrane bioreactors may be a viable solution for long-term surface operations by providing energy efficient wastewater processing in a small footprint. However, medication removal from wastewater via AnMBR requires further testing. Additionally, proof-of-concept AnMBR designs suitable for spaceflight and surface missions should be further developed in tandem with pharmaceutical removal research.

THE VR-MARS RESEARCH PROJECT: A MEDICAL ASSISTANCE ARCHITECTURE BASED ON MIXED REALITY FOR DISTANT CAREGIVERS

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Introduction: Long duration space flights to the Moon or Mars will be associated with increased medical risks and limited medical resources. In this context, an isolated and autonomous crew may have to perform perilous procedures without external help and under time pressure. Moreover, cognitive and physical performance may be undermined by chronic sleep and mood disorders, skill-erosion, sensorial deprivation and microgravity-related issues. Finally, communication with a distant expert will suffer latency or interruptions.

Overview: The aim of VR-MARS is to propose a complete assistance architecture based on mixed reality for distant caregivers. Communication between two remote sites consists only of data about the procedure and the context, without video or audio stream to save bandwidth. The scene is recreated in an immersive environment (CAVE) for the Flight Surgeon to enhance situation awareness. The project consortium is composed by computer science researchers, cognitive ergonomists, medical doctors and mathematicians and financed by the French National Research Agency (ANR).

For the caregiver, a virtual medical assistant is available through an augmented reality headset. It is able to correct the conveyed assistance if it detects deviation from the nominal procedure (adaptive controllability theory), and manage the caregiver's stress with an adequate leadership. It also allows to represent the flight surgeon's gestures if the latter decides to regain control of the situation and if communication conditions permit.

Discussion: First technical tests were successful in an offshore simulation scenario (abdominal pain) between an expert and a scientific ship (distance 250 km). Augmented reality permitted the expert to demonstrate in real-time the sequence of an abdominal palpation directly on the injured sailor. Two parabolic flight campaigns with the CNES also allowed our team to understand the technology of augmented reality in zero-G. The aim of those campaigns is to compare several technics to present real-time assistance.

PHARMACEUTICALS AT LOW ATMOSPHERIC PRESSURE: IMPLICATIONS FOR HUMAN SPACE FLIGHT

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Background: Previous work on pharmaceutical implications of spaceflight has not considered the effects of low atmospheric pressure on medication storage and use. These effects are pertinent and have definite decision-making implications for the future of space exploration.

Overview: Medications are the basis for modern medicine. Without access to pharmaceuticals, it is not possible to provide the medical capabilities necessary to ensure crew health and performance during long-term human space exploration. The vast majority of human knowledge accumulated on pharmacology assumes conditions found in most hospitals, pharmacies, and pharmaceutical labs, namely low-background radiation, 1G gravity, and standard ambient temperature and pressure (SATP). Previous work has not considered the specific effects of low atmospheric pressure on medication stability, pharmacokinetics, and pharmacodynamics. These effects are relevant to the future of space exploration since astronauts performing EVAs in low-Earth orbit, on the moon, or on the surface of Mars are necessarily subject to low pressure. Furthermore, any consideration of constructing spacecraft or planetary habitats with ambient environmental pressure below 1 ATM must consider the effects this would have on the delivery of medical care. This session will review the current understanding of the effects of atmospheric pressure on the storage and use of pharmaceuticals, as well as potential challenges and implications for future missions.

Discussion: During human space-exploration activities, crew and equipment are likely to be exposed to variable ambient atmospheric pressures. Current data, while limited, suggests that important effects of atmospheric pressures on medication stability, pharmacokinetics, and pharmacodynamics exist. Risk assessments and decision-making regarding mission logistics for human spaceflight should consider the effects of atmospheric pressure on medication storage and use. Further research is needed to better understand the effect of all pertinent environmental variables on pharmaceuticals.

HIDDEN HAZARD: THE IMPACT OF SIGNAL LATENCY ON CREW HEALTH AND PERFORMANCE

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Introduction: Crew communication with the ground during future deep space missions will be an enormous challenge. Time-delayed communication caused by variable signal latencies across likely Mars mission profiles presents operational challenges and impacts health and performance. The absence of synchronous communication with friends, family and colleagues will amplify isolation, with psychological and physiological consequences.

Overview: Crew communication with the ground during future missions to the Moon and to Mars will be an enormous challenge for two key reasons. Firstly, they will experience communication delays caused by distance. Communications will be carried by radio or other electromagnetic waves at ~300,000km/s. This, the speed of light, is the fastest possible speed but the distances are so large that the signals will take noticeable time to reach their destination. The one way latency between the Earth and the Moon is about 1.3 seconds. When Mars is at its closest approach to Earth the one way latency is over 3 minutes and when Mars is at its furthest from Earth the time delay is over 22 minutes. The lack of interpersonal synchrony presents a much more significant risk to health than physical isolation alone. The human nervous system has evolved to require physiological co-regulation with other nervous systems through regular synchronous interactions within attachment-bonded relationships.

The prolonged absence of co-regulation drives behavioral and physical health problems including depression, anxiety, aggression, impulsivity, sleep disturbance, cognitive impairment, and an increased risk of cardiovascular and inflammatory disease.

Discussion: In this tutorial we will present detail on the dynamic range of signal latencies across likely short- and long-stay Mars mission profiles and consider the scale of the human spaceflight risk presented by signal latency, a major risk that is hidden from view and under-researched to date.

AUTOMATION: A HELP OR A HINDRANCE IN SPACEFLIGHT AND REMOTE MEDICAL SETTINGS? A CASE DISCUSSION USING POINT OF CARE ULTRASOUND (POCUS)

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Background: Medical practitioners working in isolated, confined, extreme (ICE) environments must problem-solve in acute situations where they potentially have limited relevant specialty expertise. Autonomous aides, like artificial intelligence (AI), may help practitioners provide higher quality care in resource/experience limited settings, such as in remote communities or long duration space exploration (LDSE) missions.

Overview: For instance, AI has been proposed as a useful supplement to human clinical expertise in the interpretation of medical imaging; however, the division of roles and tasks between the human and the automation in such medical care teaming scenarios requires further delineation. In cases where access to human specialists or transfer to higher resource settings is possible, human consultation continues to be prioritized as best practice. However, in the case of LDSE, this course of action is infeasible, as round-trip communication times with ground-based specialists could be prohibitively long for emergency response. Similarly, remote communities and settings on Earth with limited internet connectivity cannot rely on timely access to outside specialist. In these communication-limited scenarios, AI/autonomous agents may improve the ability of practitioners to respond to medical situations that fall outside their expertise. In such a proposed teaming paradigm, AI may act as an adjunct to medical practice as opposed to an independently trustworthy source of diagnostic information.

Discussion: Using a theoretical case study of AI-guided Point of Care Ultrasound during an acute cardiac event in a remote northern community, we will explore the potential role for, and limitations of, AI in remote and extreme environment medicine through a human-automation teaming lens. We then expand upon the relevant issues highlighted by the case in the context of LDSE, and recommend future areas of research in remote medical training and human-automation teaming to enable safe, healthy, LDSE missions to Mars and beyond.

Friday 23 September 22

Louis Armand West Room

1030-1200

Scientific Session 13

Human Factors, Safety, and Accidents in Aviation

HUMAN FACTORS AND RISK MITIGATION IN AIR RACING

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Introduction: The identification and mitigation of risk attributed to human factors (HF) is paramount in all aspects of aviation, especially in air racing. Our medical and safety monitoring team supported the Red Bull Air Race from 2013 to 2019. During this time period an average of 1500 flights were conducted per year; all races were flown in front of live audiences. Tracks were set over water as well as over land. All race tracks included very high speed, low altitude, high G maneuvers. Each of the “dirty dozen” of aviation human factors was a challenge on any given day.

Methods: A resilient air racing aviation safety protocol was developed and implemented to assure the safety of spectators, pilots, techs and other essential personnel. The foundation of the protocol was a climate of just culture. Equally important was the ongoing building of a relationship of trust between the pilots, teams and the flight surgeon and safety officer. The implemented measures included the preseason air race medical assessment, the recurring assessment on all training, qualification and race days as well as a post season review of all findings and incidents.

Results: From the first Air Race in 2003 to the final event in 2019, 94 championships were flown around the globe. There were no fatalities, one hull loss and only minor injuries incurred during training, qualification and race flying. Not a single spectator was ever injured by flight operations.

Conclusion: The safety record of the RB Air Race is an aviation success story and a validation of the medical and safety protocols developed to mitigate risk associated with human factors which we are glad to share.

CARBON MONOXIDE EXPOSURE AS A FACTOR IN UNITED STATES AVIATION ACCIDENTS: CASE SERIES

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Introduction: In the United States, the National Transportation Safety Board (NTSB) investigates all civil aviation accidents, and the Federal Aviation Administration (FAA) Forensic Sciences Laboratory assesses available blood specimens from injured crew for carbon monoxide (CO) exposure. Review of the NTSB database found that between 2016 and 2020, CO was cited as a finding, contributing factor, or probable cause in eight aviation cases. This number is consistent with a 2009 FAA report that found that one or two fatal or serious aircraft accidents per year were attributable to CO exposure.

Background: CO is an odorless, colorless gas that is a byproduct of combustion. CO binds to hemoglobin, impairing oxygen transport and release. Symptoms of CO exposure range from mild and vague to severe and incapacitating, and are worsened at higher exposure levels, longer exposure durations, and lower oxygen partial pressures. CO therefore poses a particular risk for loss-of-control accidents in piston aircraft, the occupants of which may spend prolonged times in confined cabins at altitude and may be exposed to exhaust fumes from muffler defects in heat exchangers.

Case Presentations. Several recent aviation accident cases will illustrate how the combined expertise of operational, mechanical, and medical specialties allowed for the determination of CO as a probable cause in the NTSB accident investigation. Additionally, the challenges in interpreting toxicology results for CO exposure in fatal accidents will be demonstrated by the case examples.

Discussion: Primary prevention of CO exposure targets regular maintenance and part replacement. CO detectors are a secondary means of prevention whose effectiveness depends on device design and pilot education. Pilots' reliance on myths about how physical signs and symptoms for monitoring CO exposure are inadequate. The cases illustrate the need to address this preventable aviation safety concern.

RNOAF INSPECTION RESULTS POINT TO A NEED TO ADDRESS AIRCREW FATIGUE WITH IMPLEMENTATION OF PILOT SELF-MONITORING

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Background: While aviation safety is critical to the mission of the Norwegian Royal Air Force (RNoAF), the challenges associated with pilot fatigue and stress in military aviation have steadily increased along with safety-related concerns. As required by the Air Force Inspector Command, regular inspections are important to ensure flysafe operations. Recently inspections include assessments of psychosocial factors the squadron's working environment and its conduciveness to flight safety.

Overview: This inspection focused on a maritime helicopter unit of the RNoAF. Semi-structured interviews were conducted by an aviation psychologist and a RNoAF inspector. Data was gathered on topics related to perception of safety, organizational resources, flight safety services, event handling, knowledge and information sharing, flight surgeon services, and workload. Twelve interviews were conducted. Subjects interviewed were RNoAF active duty aircrew and squadron commanders. Thematic analysis from the inspection data was used to determine findings related to psychosocial factors and propose recommendations to flight safety.

Discussion: Results indicated 3 categories related to psychosocial factors that may influence flight safety. These were: 1) staff shortage with high operational demands; 2) lack of oversight related to crew readiness to address fatigue and stress among aircrew; and 3) high pressure to achieve operational demands. The pressure of aircrew to meet high operational demands while fatigued and stressed may pose a risk to performance which can lead to accidents. Although there are many systematic approaches instituted by the RNoAF to mitigate fatigue and stress among aircrew, such as structured scheduling of aircrew and annual medical requalification examinations, the findings of the inspection also indicate a need for increased awareness of the operational challenges that contribute to aircrew fatigue and propose self-monitoring of pilots prior to engaging in flying operations in the form of pre-flight mental health checklist.

ANALYSIS OF SERIOUS INCIDENTS AND ACCIDENTS INVOLVING FRENCH STATE AIRCRAFT FROM A HUMAN FACTORS PERSPECTIVE: RESULTS OF A FIVE-YEAR RETROSPECTIVE STUDY (2015-2019)

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Introduction: Understanding the Human and Organizational Factors (HOF) involved in serious events is of key importance for aviation safety. To date, few data relate the variety of HOF that contribute to the occurrence of serious events involving French state aircraft, i.e., mainly aircraft from the fleets of the ministries of the Armed Forces and of the Interior. In this context, the aim of our study was to provide a better understanding of HOF implied in state aircraft serious events occurring over a five-year period (2015–2019).

Methods: We included the 58 publicly available safety reports published by the French State Aircraft Accident Investigation Bureau after serious events (29 incidents; 29 accidents) that occurred during the study period to state aircraft (27 helicopters, 17 fighter aircraft, 12 transport aircraft, 5 gliders, 3 training aircraft). We extracted from each report information describing the event, its circumstances of the occurrence and causal factors. Two researchers independently coded the causal factors using the *Human Factors Analysis and Classification System* (HFACS) framework. Discrepancies were resolved by consensus. Descriptive statistics were used to describe the events (e.g., location, type of aircraft and mission, phase of flight, occurrence category) and to report the causal factors identified within each level of the HFACS framework.

Results: Out of 1,082 causal factors, 918 (84.8%) were related to HOF and distributed as follows in the HFACS framework: 224 unsafe acts (24.4%), 394 preconditions for unsafe acts (42.9%), 158 supervision failures (17.2%) and 142 organisational influences (24.4%). At least, one HOF was identified in 57 events (98.3%). More results will follow at the conference.

Conclusion: Our study analysed the various causal factors related to HOF that underpinned serious events that involved French state aircraft during a five-year period. The results are of great value for identifying appropriate and effective accident prevention measures.

MOLECULAR PATHOLOGY OF HYPOXIA IN AIRCRAFT ACCIDENT INVESTIGATION

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Introduction: Aircraft accident investigation mandatorily involves the examination for potentially incapacitating conditions in the pilots. Tissue hypoxia, for instance in the heart muscle leading to dysrhythmia, represents one major risk factor. Recognizing oxygen depletion and its underlying mechanism with current methods can be significantly impaired in severely destructed bodies. We studied the possible use of hypoxia-related microRNAs (“hypoxamiRs”) on aircraft accident victims as a novel marker system.

Methods: This preliminary study involved six casualties from aircraft accidents and three fatalities from flue gas intoxications. Three young and healthy victims from sudden death events and four patients dying from ischemic heart disease served as controls. Semi-quantitative analysis of microRNA (miR) in heart muscle samples involved miR-23a/b, -24, -26a/b, -27a, -181a/b/c, and -210. Real-time PCR studies evaluated using the $2^{-\Delta\Delta Ct}$ -method were carried out.

Results: Patients dying from ischemic heart disease showed an up to 8.5-fold increase in the expression rates of these microRNAs compared to young and otherwise healthy individuals. Juxtaposed to the same controls, victims from aircraft accidents without fire or from fire events demonstrated up to 6.9- and 11.8-fold higher expression rates of “hypoxamiRs,” respectively. Intoxications with cyanide (CN)/ carbon monoxide (CO) displayed up-regulations of those markers up to 9.9-fold/ 12.6-fold.

Conclusions: Our findings in this small but highly selective cohort of specimens identify “hypoxamiRs” as a new and valuable tool in the forensic medical examination of aircraft accident victims. Notably, possible adaptive changes to repeated hypoxic episodes in pilots responsible for an up to 6.9-fold up-regulation in their myocardium must be considered. However, overexpression rates of between 9.9- fold and 12.6-fold in heart muscle samples of fatalities from fire, CN- or CO-intoxication most probably indicate vital reactions hypoxia tissue damage. Further studies will be necessary for the additional validation of “hypoxamiRs” as markers in forensic expertise.

SPEECH INTELLIGIBILITY OVER RADIO COMMUNICATIONS WITH DIFFERENT COVID-19 FACE MASKS

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Introduction: Adequate speech intelligibility over radio communication systems between aircraft and with Air Traffic Control is essential for aviation safety. Amid the COVID-19 pandemic, concerns have been raised regarding whether face masks negatively impact speech intelligibility. There is limited research in this area in an aviation or radio communications setting. The aim of this study was to determine whether wearing a mask degrades speech intelligibility when speaking over radio communications, and to what extent.

Methods: The Modified Rhyme Test (MRT) is a standard test used to assess speech intelligibility, comprising 50 groups of six phonetically similar words. Six participants with normal hearing took turns reading aloud from randomised MRT word lists, with the other five participants listening through their communications headsets and marking the word from each group of options. After each series (50 words), the participants rotated, each taking turns being the speaker. This was repeated for four test conditions: no mask, N95 respirator, surgical mask, and cloth mask. Scores were calculated using percentage correct words adjusted for chance/guessing.

Results: There was no significant difference in speech intelligibility between the no mask condition and any of the mask conditions. MRT score mean \pm SD: No mask 0.97 \pm 0.04; N95 0.98 \pm 0.03; surgical 0.97 \pm 0.04; cloth 0.98 \pm 0.03. All scores (including standard deviations) were in the 'Normal intelligibility' (91%) to 'Exceptionally high intelligibility' (97%) range per the military standard.

Conclusions: As all mask conditions maintained acceptable speech intelligibility, personnel using radio communications can be reassured that they will be communicating effectively while maintaining personal safety and reducing potential viral spread.

Friday 23 September 22

Gaston Berger Room

1400-1530

Scientific Session 14

(French Language Session)

Clinical Aviation Medicine: Ophthalmology

KERATOCONUS AND FITNESS TO FLY

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Introduction: Of the body senses, vision is the most important for safe flight. Keratoconus causes progressive blurring and distortion of vision, which threatens the career of a civilian or military aviator. The goal of this retrospective study was to describe a series of keratoconus cases in a pilot population and to discuss decisions about their flight waivers.

Methods: To assess the impact of keratoconus on flying careers, we reviewed the records of all aviators with keratoconus examined in an Aeromedical Center over the past 5 years.

Results: The files of 19 pilots (13 line pilots and 6 military pilots (3 fighter pilots)) were collected and analyzed. The civilian pilots with ages between 25 and 49 years old presented with keratoconus in different stages (Stage 1, n=14 eyes ; Stage 2, n=7 eyes ; Stage 3, n=5 eyes). Six military pilots with ages between 24 and 42 years presented stage 1 keratoconus (n=6 eyes) or stage 2 keratoconus (n=6 eyes). Of the 19 patients, 2 did not obtain flight fitness waivers. Among the 17 who received waivers, correction for defective distant vision (glasses or contact lenses) was imposed on 5 aviators.

Conclusion: Keratoconus is a medical condition with aeromedical significance that should be detected by aeromedical examiners. The flight license can only be considered if the disease is stable and with satisfactory visual quality. This study shows that keratoconus is not always a disability for aviators. Most of them are able to continue their flying careers safely. However, it must be analyzed on a case-by-case basis.

CONGENITAL FOURTH NERVE PALSY AND FITNESS TO FLY

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Introduction: To analyze the success of surgery use in alleviating diplopia in pilots or air traffic controllers with fourth congenital nerve palsy and to provide recommendations for management.

Methods: In this retrospective cohort study, candidates presenting vertical deviation due to fourth nerve congenital palsy were analyzed. Data on evolution of the vertical deviation, motility and alignment findings are recorded. The success of surgery is assessed by follow-up records and candidate's satisfaction.

Results: The diagnosis of congenital unilateral trochlear nerve palsy is generally based on the onset of a vertical deviation, discovered on a revision visit. This deviation increases in contralateral side gaze, down gaze and ipsilateral head-tilt together with excyclodeviation which also increases in both down gaze and ipsilateral head-tilt. Both vertical deviation and excyclodeviation decrease in contralateral head-tilt. The most common age of presentation is the fourth decade.

Objective assessment of vertical deviation is performed by the alternate prism and cover test. Assessment of subjectively localised vertical and cyclotorsional deviations in definite gaze directions can be performed using Hess Lancaster test or Harms tangent scale. Ophthalmological assessment also includes realization of fusion visual field and retinophotographies. A functional symptomatology such as neck pain can be found. Neuroimaging is recommended to eliminate microvasculopathy, intracranial neoplasm or other etiologies.

Discussion: Diplopia leads to incapacity and prisms are not suitable to correct cyclodeviation in pilots and air traffic controllers. Surgery should be considered to allow professional rehabilitation by limiting zone of diplopia, while eliminating the head tilt. The preferred surgical strategies include weakening procedures on the inferior oblique, tucking or advancement of the superior oblique tendon, combination of both.

Conclusion: Fourth congenital nerve palsy may cause progressive vertical deviation and upper diplopia, leading to unfitness in the aeronautical environment. Surgical management can be proposed to allow professional rehabilitation.

COLOR VISION: WHICH SELECTION IN 2022?

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Introduction: Many tests explore color vision in pilots, each country using different tests and protocols. This study evaluates the results of 5 color vision tests used worldwide for the screening of Class 1 pilots.

Methods: Seventy color-deficient subjects were included. On the same day, they performed 5 color vision tests: Farnsworth D15, Lanthony desaturated 15 Hue, Beyne chromoptometric lantern, Color Assessment and Diagnosis (CAD) test and anomaloscope. We assessed the class 1 ability results according to the scores defined by the European texts for the CAD test and the anomaloscope, according to the French protocol for the lantern and according to the normality of 15 Hue tests.

Results: The workforce consisted of 29 deuteranomalous trichromats (41.4%), 18 protanomalous trichromats (25.7%), 12 deuteranopes (17.1%) and 11 protanopes (15.7%) according to the anomaloscope data. Farnsworth D15 was normal in 48.5% of subjects (including 2 protanopes), Lanthony's 15 Hue desaturated was normal in 23.2% (no dichromats). The class 1 certificate rate was 45.8% with the Beyne lantern, 27.1% with the CAD test and 25.7% with the anomaloscope. The lantern allowed the class 1 certificate for 2 protanopes and 2 deuteropes. The CAD test and the anomaloscope did not allow any dichromate to be pilot. These similar rates between CAD test and anomaloscope confirm the more selective value of these two tests.

Discussion: There is a disparity in results between the different color vision tests that can be used for Class 1 pilots screening. Some tests may allow subjects with severe deficiency to be pilot. These results could lead to uniform color vision assessment protocols.

EVALUATION OF SENSITIVITY TO GLARE IN AIRCREW AFTER REFRACTIVE SURGERY VERSUS HEALTHY NON-OPERATED SUBJECTS OF THE SAME AGE GROUP

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Introduction: When dazzled by a light source, the perceived halos reduce the visual abilities of the subjects. This sensitivity to glare (SE) is appreciated in operated military pilots. Corneal refractive surgery induces high degree optical aberrations which degrade visual quality. It is also assessed by air traffic controllers, whose screen work is subject to variations in light all day long. The aim of our study is to compare SE in patients undergoing refractive surgery versus healthy subjects of the same age group.

Methods: This is a single-center study carried out at the Clamart Main Center for Medical Expertise of Aircrew Personnel, including 31 aircrew (military or civilian, i.e. 62 eyes) from 20/12/2020 to 30/03/2022. The subjects included present a 10/10th VA with or without monocular correction. Subjects with tropia or phoria/tropia, ametropia $>\pm 5D$, astigmatism $\geq 1.5D$ or dyschromatia were not included. The SE is assessed with the Metrovision Glare Test "my pack one" after dark adaptation for 3 min, in monocular with a glare source on the left. The result expressed as a percentage takes into account the distance from the light source (2.5m) and the number of recognized good optotypes whose luminance is 1 candela (Cd)/m² (scotopic atmosphere) then 5Cd/m² (low photopic atmosphere).

Discussion: Our SE results in our healthy patients with Metrovision are close to the literature. The ES with the Glare test in the 2018 study by Ghasempour Z and AI (n=96 healthy eyes aged 18-25) is for an optotype luminance of 1Cd/m² for the right eye (OD) of 53.78% (48.50% in our study) and 41.18% for the left eye (LE) (48.5% in our study) with a light source on the left. And for a luminance at 5Cd/m² of the optotypes for OD 95.00% (96.67% in our study) and for OG 89.79% (100% in our study). Post refractive surgery SE has so far only been studied post refractive surgery by SMILE. Our study only included 4 eyes operated on by this technique. To our knowledge, ES with the Glare test has not been studied in patients undergoing PKR or LASIK.

Conclusion: More than 3 months after refractive surgery, the SE of operated subjects decreases and reaches that of the general population. Thus, it seems legitimate to authorize refractive surgery in aircrew, and a lifting of the incapacity to fly at 3 months postoperative in the absence of complications.

Friday 23 September 22

Louis Armand East Room

1400-1530

Scientific Session 15

Insulin and Aircrew: Advances in Diabetic Control

DIABETES MELLITUS – THE CURRENT EUROPEAN REGULATORY FRAMEWORK FOR AEROMEDICAL ASSESSMENT OF PILOTS AND ATCOS

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Background: Current requirements allow pilots and ATCOs with diabetes mellitus to perform the privileges of their licence only when there is no risk of hypoglycaemia due to treatment. Consequently, oral antidiabetics that are not likely to cause hypoglycaemia may be acceptable for a fit assessment with an OML. However, applicants with diabetes mellitus requiring insulin shall be assessed as unfit.

Diabetes mellitus is one of the medical conditions with an increasing incidence in the past decades and at the same time one of the pathologies where medicine advanced considerably in regard to the diagnostic and continuous monitoring methods, as well as regards the treatment protocols and means of administering treatment.

Overview: In line with the evidence-based medicine principles EASA is making efforts to update the relevant European aero-medical requirements based on existing evidence and guidelines, while, at the same time, taking steps into collecting evidence relevant for the aviation environment.

The knowledge regarding diabetes mellitus evolved considerably in the past decade and new technologies are available that allow reliable continuous monitoring and automated treatment. These technologies could be considered for use in aviation environment as long as they prove safe to use in the specific operational environment for each class of aero-medical certification.

Discussion: In this regard, the presentation will provide the audience with an overview of the current medical requirements for all classes of medical certificates and set the scene for a discussion regarding possible changes to these requirements in not-too-distant future.

NEW GLUCOSE MONITORING TECHNOLOGY: AEROMEDICAL CONCERNS FOR A SAFE INSULIN-DEPENDENT PILOT IN COCKPITS

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Background: France has always been regarded as severe about its position for insulin in cockpits in relation to the risk of hypoglycaemia on board. Indeed, studies performed in the real life among insulin-dependent patients have shown the reality of mild and severe hypoglycaemia episodes. Many patients are worried for driving, working and for social events, and decide to maintain hyperglycaemia or not to respect insulin prescription. Experimental studies have demonstrated the cognitive consequences of hypoglycaemia. Finally, glucose monitoring in cockpits raises questions about crew resource management.

Overview: Since the EASA regulations including particularly the LAPL protocol, very few insulin-dependent private pilots have taken the opportunity to fly in France. A US study published in 2017 showed a mean duration of three years concerning the fit decision in 1,309 private pilots flying with insulin in relation to bad control, hypoglycaemia, complications and comorbidities. Meanwhile, a UK study carried out in 26 professional pilots was not convincing about a safe protocol in the long term and its complete feasibility. Consequently, medical progress is the only way to discuss insulin in cockpits scientifically, far from discrimination and lobbying aspects of this topic.

Discussion: The FreeStyle glucose monitoring technology has been developed for patients' comfort. However, there are controversial opinions about a lower risk of hypoglycaemia. The possibility to check glycaemia very easily and frequently in cockpits, and to program thresholds for alarm, may anticipate hypoglycaemia. The memory of such systems may allow AME to control time in glycaemia target. Nevertheless, it is difficult to define criteria to disqualify a pilot, to be sure that no other tool is used in case of symptoms, and to consider the predictive value of a good control for a future period. Despite these drawbacks, France is waiting for selected diabetic pilots to be included in a protocol.

HYPOGLYCEMIC RISK WITH PRESENT GLUCOSE CONTROL-RELATED STRATEGIES

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Background: Most treatment strategies, especially insulin, have failed for decades to prevent hypoglycemic events in insulin-deficient and insulin-resistant diabetes mellitus (T1DM and T2DM, respectively). Now, T2DM innovative drugs, including GLP1-agonists, gliptins, or gliflozins prevent hypoglycemia *per se* with the consequent risk for sudden incapacitation.

Overview: However, suitable education strategies associated with technological advances have made insulin treatment much safer. Such phenomenon depends on the pharmacokinetic properties of recent, widely used long- and fast-acting insulin analogs. The former are regularly released for 24 hours to keep baseline glucose levels within a pre-established range, and the latter limit their acute prandial effects to 3 hours at most. Such change has dramatically reduced hypoglycemic event rates worldwide, primarily when associated with therapeutic education refresher courses.

However, the rate of hypoglycemic events has improved and is almost null with continuous glucose monitoring. The latter showed patients their glucose trends and alerted them of pending hypoglycemia, thus providing a clue on the best strategies to prevent rather than correct previously threatening events with proper food and insulin strategies.

Moreover, semi-closed-loop insulin pumps have become widely available. They rely on glucose sensor-dependent automated insulin rate adaptation algorithms keeping glucose levels within a defined range for even 95% of the day. Due to that, the glucose control gold standard is shifting worldwide from HbA1c to the so-called “time in range.”

Discussion: Now, nanotechnologies are taking over. In some years, “intelligent insulins” will hopefully become available on the market, and are expected to keep glucose levels regular by self-release-adaptation to local glucose changes, and thus prevent hypoglycemia and cut down glucose peaks consistently. All of the above is quite promising for insulin-treated patients’ quality of life in the next future.

SEVEN YEARS EXPERIENCE OF THE ARA.MED.330 PROTOCOL FOR THE CERTIFICATION OF INSULIN TREATED DIABETIC PILOTS IN EUROPE

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Introduction: EU Regulation 1178/2011, Ireland, along with the United Kingdom and Austria implemented the ARA.MED.330 Protocol for the certification of Insulin Treated Diabetic Pilots. Globally States (countries) including Canada implemented protocols to allow ITDM pilots to fly. Since the implementation of the European protocol, Australia and the USA have implemented certificatory protocols licencing Commercial pilots with IDTM to fly.

Methods: The Competent Authority of Ireland signed an agreement with the UK CA implementing the Protocol in 2015. This protocol provided a structured framework for the vetting, monitoring and research into the process of certifying and overseeing the safety and mitigating risk associated with pilots who were treated with Insulin for the management of their diabetes. Over the seven years since the adoption of the protocol, we have extensive experience in the operation and oversight of the protocol and its impact on certification.

Results: Publication of the five-year review of the data provided evidence of safety and has shown areas where development has taken place and further development is recommended. Our experience demonstrates the key areas of oversight necessary to mitigate risk whilst also having the unique experience of the impact of the pandemic on the execution of the protocol.

Conclusion: Implementation of the ARA.MED.330 protocol provides a safe and effective process to certify and oversee the continuing safety and mitigate risk associated with ITDM pilots in all classes of medical certification.

AN UPDATE ON THE NEW DEVELOPMENTS IN SEMI AND FULLY CLOSED INSULIN PUMP SYSTEMS FOR THE TREATMENT OF TYPE 1 DIABETES MELLITUS, HOW SAFE IS THEIR USE?

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Background: The new insulin delivery devices and glucose sensors enable direct communication between glucose sensors and insulin pumps, paving the way for future fully automatic close-loop therapy to treat insulin-deficient diabetes mellitus (T1DM). A summary of current devices in use, their safety in usual diabetes care, and future full closed loop options will be provided, all in light of any future use during a flight.

Overview: Much progress has been made in insulin delivery devices and glucose monitoring since short-acting insulin became available, glucose sensors became accurate and advanced algorithms enabled their very safe use.

Currently, there are several hybrid (semi) closed loop insulin pump systems that have become widely available and that function very well thanks to a highly advanced insulin rate adjustment algorithm. The fully closed systems are not yet on the market, but several are in development. However, their dual hormone use appears to face several challenges. The various advantages, their pitfalls and options will be summarized and discussed in perspective for future in-flight use.

Discussion: The development of new devices may facilitate pilots' glucose and insulin management during their flights. Present and future options to use a hybrid or fully closed loop pump system in air medicine will be discussed.

Friday 23 September 22

Louis Armand West Room

1400-1530

Scientific Session 16

Space Medicine:

Space Tourism Aspects

TRANSFER AND RETENTION OF TRAINING IN ANALOG AND VIRTUAL SPACEFLIGHT ENVIRONMENTS

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Introduction: With the flights of New Shepard, manned suborbital spaceflights are a reality. Passengers who fly on New Shepard pay \$5 million. With 240 seconds microgravity, that equates to more than \$20,000 per second. For spaceflight participants (SFPs), the cost of incorrectly performing tasks will be costly. To help SFPs prepare, this study evaluated two spaceflight analogous training systems: one that took place in a neutral buoyancy environment (NBE) and one that took place in a virtual reality (VR) rendered NBE.

Methods: This study compared how effectively suborbital tasks are learned in an actual NBE compared with a VR-rendered NBE across four groups. Group 1 was trained in a NBE using a lightweight scuba system. This group was taught tasks comparable with those required of a suborbital SFP and they were tested in the NBE. Group 2 was taught the same tasks as Group 1, but these tasks were taught in a VR-rendered NBE. Following instruction, Group 2 was tested in the actual NBE. Group 3 was taught the same tasks as Groups 1 and 2 in the NBE and after completion of training this group was tested in a VR-rendered microgravity environment (VME). Group 4 was taught the same tasks as Groups 1, 2 and 3 in a VME and after completion of training this group was tested in the VME.

Results: Participants who trained in either environment reduced their training time significantly with the greatest reduction being observed in the NBE group.

Discussion: The present study showed the possibilities of using a NBE and VME to train suborbital SFP scientists. The use of NBE and VEM environments are novel and each environment has potential to be a training paradigm used to augment and/or replace current methods at a fraction of the cost.

PEDIATRIC HEALTH CONSIDERATIONS FOR COMMERCIAL SPACEFLIGHT

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Background: Traveling to outer space has been the dream of many children since *Vostok 1* and *Apollo 11* missions showcased the possibilities of manned spaceflight. Commercial spaceflight companies have made the dream of traveling to space a reality for the public sector. Blue Origin broke the record for the youngest person in space when their first paid commercial flight launched 18-year-old Oliver Daemen into orbit.

Overview: To date, only adults have voyaged beyond the Earth's atmosphere. However, companies such as Blue Origin, SpaceX, and Virgin Galactic have flown passengers that have been outside of the typical fitness requirements of trained astronauts. It stands to reason that the pediatric population will soon follow suit in breaking records journeying into space. As children's bodies are still immature, there will face special challenges beyond those experienced by adult astronauts.

Discussion: In preparation for pediatric spaceflight, consideration should be given to unique health implications affecting children and adolescents. The need for research in this area is substantial. As no children have yet surpassed the Earth's atmosphere, there is no data available. Additionally, ground-based analogs for space exploration have focused on the adult population. The purpose of this presentation is to discuss differences in pediatric growth and development to consider in relation to health risks associated with space exploration. Priority focus will be based on the top five hazards of human spaceflight identified by the National Aeronautics and Space Administration (NASA).

MICROGRAVITY CARDIOPULMONARY RESUSCITATION, UPDATES FROM TERRESTRIAN LITERATURE: IS IT TIME FOR AUTOMATIC CHEST COMPRESSION DEVICES IN SPACECRAFT?

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Background: Long lasting space missions emphasize the need for effective and validated medical procedures. Cardiopulmonary resuscitation (CPR) is a major field of research in aerospace medicine. Microgravity requires new CPR techniques, especially regarding chest compression.

Routinely used on Earth, Automatic Chest Compression Devices (ACCD) have shown no inferiority to manual CPR in large scale studies. ACCD could therefore be an interesting alternative to manual chest compression in space.

Overview: Manual chest compressions, performed by the Evett-Russomano (ER), handstand (HS) or reverse bear hug method (RBH), do not provide efficient long-lasting circulatory support. ACCD, however, could provide standardized external chest compression (ECC) depth, rate, and duty cycle. CPR using a LUCAS device has recently been assessed during parabolic flight by Forti and al., raising ergonomic but no physiological concerns for its application. In space, because of hostile surroundings and untrained, limited crewmembers, we postulate that ACCD could greatly simplify and standardize CPR procedures in order to improve survival rate. However, data from the literature is lacking, and further investigations about this method are needed.

Discussion: Switching to ACCD for advanced life support should improve chest compression quality. The device should be placed on the patient once they are restrained to the spacecraft using the Crew Medical Restraint System (CMRS), after an initial phase of basic life support using the ER method. Indeed, the ER method can be performed during patient's transportation to the medical room and has been shown to be the most effective of the 3 methods presented above for basic life support.

ROAD TO T-MINUS ZERO: A NARRATIVE REVIEW OF PARTICIPANT PREPARATION FOR COMMERCIAL SUBORBITAL SPACEFLIGHT

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Background: Commercial spaceflight is a reality, and as such, brings into focus training methods for the commercial spaceflight participant. Contrary to the well-described orbital spaceflight training, optimal training for suborbital spaceflight participants is unclear and has the potentially opposing aims of maximizing participant enjoyment whilst optimizing performance in the event of emergency to reduce risk to the mission and crew. Training for commercial suborbital spaceflight involves activities to promote familiarization with the suborbital environment, and develop skills, knowledge, and understanding to reduce anxiety and risk and enhance emergency performance. However, there have been a myriad of training regimens proposed and pursued, of varying content and duration, none of which are standardized.

Overview: This study reports on existing training programs conducted for commercial suborbital spaceflight participants. Through a comprehensive literature review, training program components recommended or adopted by research and industrial teams were collated. A qualitative analysis identified common training themes: theory, emergency scenario, parabolic flight, environmental familiarization, centrifugal, and psychological training. The duration of the programs and recommendations varies between 2-6 days.

Discussion: Training programs for suborbital spaceflight participants vary in content and duration, with differing resource and cost implications. These programs share many similar features, employing both physiological and psychological training components. Most programs supply training which exceeds the FAA recommendations for spaceflight participants. It is yet unknown what the minimum requirements of a commercial suborbital spaceflight training program are, or the worth of extending a particular component, particularly for a relatively short flight. Based on existing programs, training for up to 6 days which encompasses psychological, physiological, and centrifuge components is beneficial for suborbital flight preparation, but further research is required to identify the optimal duration and make up of such a program.

COMMERCIAL SPACEFLIGHT PASSENGER MEDICAL SCREENING: A SCOPING REVIEW WORK-IN-PROGRESS

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Introduction: As commercial spaceflight becomes more accessible, health professionals will evaluate the health of individuals who want to travel in space. Publicly available spaceflight screening standards do not exist or are proprietary. Commercial space travel health preparedness evidence, risk analysis, and risk mitigation strategies are limited. Without health standards and guidance, medical screening may be suboptimal and its absence could result in adverse health events. The Aerospace Medical Association Ad Hoc Committee for Commercial Spaceflight is addressing these issues via a scoping review conducted by clinician and scientist teams. Specific aims are to identify medical issues and risk, locate medical resources, assess evidence, and describe potential mitigation strategies. Preliminary results of one team's search will be presented.

Methods: The review will be conducted per PRISMA for Scoping Reviews. Online databases will be searched for scientific and grey literature. Inclusion criteria are published in English from 2012-2022, suborbital, orbital, lunar, planetary, parabolic, or centrifuge spaceflight experiences conducted by Axiom Space, Blue Origin, Space Perspective, SpaceX, Virgin Galactic, World View, or spaceflight training centers/analogues. Key words are radiation, isolation and confinement, gravity, distance from earth, hostile/closed environment, and relevant health conditions. A custom data extraction spreadsheet will be used to summarize findings, evidence quality will be assessed with the Johns Hopkins Evidence Level and Quality Guide, and a qualitative content analysis will be conducted to describe findings.

Results: The literature search will be conducted from June 2022 through December 2022. Preliminary results for sleep and mood disorders across the five hazards and spaceflight conditions will be discussed.

Discussion: Spaceflight poses known health risks, and longer duration spaceflight even more. Results may guide preflight screening, identify practice gaps, and inform research into important individual health factors. The Committee's interprofessional approach may be useful for addressing future commercial spaceflight concerns.

Friday 23 September 22

Gaston Berger Room

1600-1730

Scientific Session 17

(French Language Session)

**Clinical Aviation Medicine:
From ENT to Neuropsychology**

STUDY OF THE OCCUPATIONAL DEAFNESS OF TUNISIAN MILITARY HELICOPTER PILOTS

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Introduction: The military aviation community is known for its diversity of noise to which all aircrew and ground crew are exposed. These noises are of varying origin and intensity depending on the type of aircraft, such as the noise of aircraft reacting, of helicopter twists and blades, and the propellers of piston aircraft. Added to this are the noise from maintenance sheds, runways and radio communications in the cabs. These noises are responsible for occupational deafness, the gravity of which lies essentially in its insidious evolutionary mode, often ignored by the pilot himself, who is not yet hindered in his professional and social life. The purpose of this project was to describe occupational deafness among Tunisian military helicopter pilots.

Methods: This is a retrospective, mono-centric, descriptive study carried out among Tunisian military helicopter pilots regularly monitored at the Centre of Expertise in Aeronautical Medicine (CEMEDA) since 1990 and who have experienced occupational deafness in the course of their careers.

Results: The study population included 32 Tunisian military helicopter pilots who had experienced occupational deafness during their career. These were monitored regularly at CEMEDA over a period of thirty years since 1990 among a total workforce of 228 military helicopter pilots, which represented a 14% prevalence of deafness among Tunisian military helicopter pilots. The average age of our study population was 52.2 years (± 6.51). 25% of helicopter pilots had aeronautical experience between 5001 and 6000 hf. 43% of the crew flew on AB 205. The study of PPE use among helicopter pilots in our population found that 63% wore helmets alone and 37% wore helmets with earplugs. The mean hearing loss in our study population was 16.4 db (± 7.9) for the right ear and 16 db (± 4.9) for the left ear. The average hearing loss in our helicopter pilots is shown in the Table. The study of the stages of occupational deafness in the study population showed that 82% of the helicopter pilots had stage I and stage II deafness with 41% for each stage.

Table. Hearing Loss in Tunisian Helicopter Pilots

Frequency	Hearing Loss (db) Right Ear	Hearing Loss (db) Left Ear
3 khz	26.3	27.3
4 khz	36.3	39.7
6 khz	42.7	47.2
8 khz	45.6	51.6

Conclusion: The military helicopter pilot's occupational deafness evolves over several years and can affect aviation safety and communication. The regular medical follow-up of military helicopter pilots at the Center of Expertise in Aeronautical Medicine (CEMEDA), with the production of systematic tonal audiograms allows an early diagnosis of this occupational deafness. Primary prevention through possible health education during periodic fitness visits remains of paramount importance for this category of seafarers.

EPIDERMOID CYST OF THE CEREBELLOPONTINE ANGLE AND AERONAUTICAL APTITUDE

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Introduction: We report an unusual case of epidermoid cyst of cerebellopontine angle in a 45-year-old women aircrew member. Epidermoid cyst is a rare benign tumor, 0.2 to 1.5 % of all intracranials tumors.

Case report: This flight attendant presented with some headache, tinnitus and light hearing loss in the left ear. Elective brain MRI confirmed the diagnosis. Neurosurgery was the main traitment. With no post-operative complications, the Aero-Medical Center (AeMC) gave a fitness-to-fly with strict temporary clinical and MRI follow up.

Discussion: The decision on fitness to fly was based on several important factors, including minimal hearing loss, no vertigo, the delay between diagnosis, treatment and expert consultation. Fitness to fly to pilot classe 1 for this pathology would require decision by the medical authority.

GENERALIZED EPILEPTIC SEIZURE INDUCED BY STROBOSCOPIC EFFECT OF HELICOPTER BLADES

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Introduction: The stroboscopic effect made by helicopter blades passage through sun light rays is known as a factor that can induce an epileptic seizure.

Case Report: We report a case of inaugural tonic-clonic generalized seizure while refueling a NH-90 helicopter by an aeronautical technician under the rotating main rotor on a sunny day at a Southern France Naval Air Station. The stroboscopic effect of helicopter blades is identified as one of the factors involved in the induction of this seizure.

Discussion: The aeronautical factor identified here during ground hot-refueling must be considered for patients predisposed to epileptic seizures who are evacuated by helicopter, but also for the medical screening of flight members. This is even more important within the military aeronautical environment, justifying the electroencephalogram testing implementation on initial aeronautical medical evaluation in France.

EPIDEMIOLOGY OF PAIN IN ALGERIAN AIRCREW

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Introduction: Pain is a public health issue. The problem is the possible high prevalence of pain among crews relative to the general population, through increased exposure to aviation risk factors. Our main objective is to study the prevalence of pain among Algerian aircrew (AC) over 24 months.

Methods: Prospective study cross-sectional type, with a descriptive and diagnostic aim, single-center, in 303 AC chosen at random. Pain of visceral origin or related to cancer was excluded.

Results: The average age is 38.96. Gender ratio is 5.3 (M/W), 45.9% were pilots. Sports practice is influenced by average BMI ($p=10^{-3}$). Aircraft used has a statistically significant relationship with number of hours flown (FH) ($p = 10^{-3}$).

Prevalence of pain in AC was 01.61%; musculoskeletal pain was 41.9%, postoperative pain was 22.44% and craniofacial pain was 12.9%. The statistical link between pain, sport, average age, BMI, HF and specific equipment was not significant ($p = 0.09$). Time of onset of pain is influenced by their diagnosis ($p = 0.02$). 24.09% of sleep disorders, clearly correlated with mean HF ($p = 10^{-3}$). Tired was objectified at 25.74%. At the HADS anxiety score, 98.3% had mild to moderate anxiety and depressive disorders at 5.8%. Significant difference was found between onset of pain and family impact ($p = 0.01$).

Discussion: Our prevalence is 01.61%, Raynaud F at 67.1% (2018) who treated a pain in a specific ACs category. Our results at low prevalence are due to the fact that our AC with frequent, intense pain or pain associated with comorbidities, have benefited from permanent incapacities and our AC are rigorously selected on criteria of good physical and mental health with other protective factors (intellectual level and resources).

Conclusions: Our results updated the epidemiology of pain in Algerian AC. Contrary to the initial hypothesis, aircrews do not have more pain and the aeronautical risk factors are not all significant. Their quality of life is influenced by aviation risk factors.

CLINICAL CASE PRESENTATION AS PART OF THE PSYCHOLOGICAL SUPPORT OFFERED TO AIRLINE PILOTS FOLLOWING THE APPLICATION OF THE EASA NOTE OF 14 FEBRUARY 2021

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Case 1: Clinical Case of Louis

Captain on long haul flights, Louis consults at the request of his hierarchy, following negative written feedback from fellow pilots who report strange behavior in the cockpit.

Identified by his hierarchy as an excellent captain, Louis brilliantly passes his simulator tests every year. Written testimonies brought to his hierarchy such as: an unusual behavior, seeming disoriented; strong reactions of annoyance and even anger, but not aggressive towards the crew; a strange behavior holding his head in his hands, elbows on his knees, leaning forward, talking to himself inaudibly, appearing regularly; clenching his fist hard and pressed it very hard against his chest.

The Director decided to place him in flight stop to make a point with the medical advisor and the psychologist.

Case 2: Clinical Case of Thomas

Thomas is a 59 year old captain, experienced, with 30 years of piloting experience ; organized, rigorous, flight suspension for recognition of sexual harassment behaviour towards a stewardess. Thomas was identified as a very professional captain, as a good pilot instructor, which was informed five months after the fact, of sexual harassment behavior against a cabin crew member while a stopover. Thomas was immediately summoned by his superiors. admitting the facts and was disciplined. Thomas was first received by the Medical Officer who referred him to us.

The psychological evaluation and disposition of these two cases will be discussed.

Friday 23 September 22
Louis Armand East Room
1600-1730
Scientific Session 18

**Advances in Cardiovascular Management:
Implications on Aeromedical Decision-Making**

AEROMEDICAL DECISION MAKING CHALLENGES IN AN UNUSUAL CASE OF HYPERCOAGULOPATHY AND VASCULOPATHY

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Introduction: An experienced airline pilot diagnosed with hypercoagulopathy and vasculopathy with associated homocystinuria, smoking and strong family history was declared medically unfit due to challenges of monitoring him on warfarin and the aeromedical concerns of the underlying condition.

Background: Hypercoagulopathy along with vasculopathy requiring long term warfarin has not been commonly reported in pilots. Warfarin is approved by most regulatory authorities for pilots with stabilised INR levels, provided the underlying condition is adequately controlled. Pilots on anti-platelet agents and direct oral anticoagulants are easier to manage with lesser side effects compared to those on warfarin; however, in this case, the former were not effective.

Case Presentation: This pilot presented with claudication secondary to stenosis at bifurcation of abdominal aorta. Angioplasty failed and restenosis was treated by aorto-iliac bypass. He was placed on warfarin and INR levels were maintained within target range. However, his tendency to hypercoagulate and dependence on warfarin were assessed as posing significant risk to flight safety (even in a multicrew environment), and certification was refused. Discontinuation of warfarin and switching to antiplatelets after 18 months (to attempt to get his medical certification) led to recurrence of symptoms.

Discussion: We explored whether an evidence-based medicine approach could be taken for aeromedical decision-making (ADM) in such conditions. Based on the ADM algorithm proposed in 2014 for assessing risks of incapacitation for long-standing and less common conditions; the risks were assessed including those posed by the condition per se, complications thereof and the mitigation strategies adopted. We also considered whether the consequences can be managed and whether the mitigated risk would permit him to operate in the airline environment.

ACUTE STEMI IN YOUNG FIGHTER PILOT WITH NO CARDIAC RISK FACTORS – A CASE REPORT

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Introduction: It is well known fact that fighter pilots selected are from the elite of the potential cadets possessing high cardiovascular and physical fitness, strong mental drive and exceptional academic records. Hence the probability of presence of advanced CAD in young healthy fighter pilot is remote. However, if it occurs, it may be catastrophic if an acute cardiac event develops in-flight.

Case Report: 31 year old F-16 pilot was brought to the base medical centre with severe central chest pain following gym workout, an episode of vomiting and excessive sweating. No radiation of pain stated. ECG showed ST elevation in V2-V6. After initiating primary cardiac care, he was transferred to tertiary hospital for management. CAG showed thrombotic lesion at proximal LAD (90%), one of LAD branch was occluded with thrombus, rest other arteries normal and EF55%; Primary PCI to LAD with 1 DES was done. He was discharged in stable hemodynamic condition. No significant cardiac risk factors noted. He is non-smoker, non alcoholic and denies any family h/o cardiac problems. He gave h/o central chest pain episodes following gym workout – 2 times (once weekly) prior to this event and relieved by rest between 30 min to 3 hrs. He did not seek medical care nor report to medical department. He gave h/o intake of commercial protein supplements for body building in the past 6 years. Presently, he is downgraded of his flying duties with regular cardiac follow up and is pending administrative clearance regarding his career progression.

Discussion: In this paper, aeromedical dilemmas related to the flying profession of this young fighter pilot with no cardiac risk factors will be discussed. The probability of chronic intake of commercially available body building protein supplements impact on cardiovascular health shall be discussed. This case sparks the debate whether such a highly motivated young pilot with unexpected cardiac event is subjected to regular intensive cardiac evaluation throughout his remaining flying career in a different stream with permanent flying fitness limitation or motivate for early career shift to facilitate non-complicated career rehabilitation.

A CASE OF TRIFASCICULAR BLOCK WITH PACEMAKER IMPLANTATION: RETURN TO FLYING CONCERNS

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Case Report: In Sep 2020, a senior commander of A-320 Fleet, aged 60 years, was diagnosed with 'cardiac arrhythmia' requiring an immediate pacemaker implant during his medical examination. He was diagnosed based on his ECG which indicated First Degree Heart Block (alternating LBBB, RBBB and Trifascicular block). He had symptoms of mild giddiness and nausea a month earlier and was being treated by a reputed neurologist. Pacemaker implant operation was undertaken on priority. Investigative angiography revealed approx 80% blockage in two arteries. Corrective angioplasty was carried out on 28 Sept 2020. Recovery was followed up for 9 months and was satisfactory. Post the mandatory observation period of 9 months as per Indian regulator in consonance with provisions in ICAO Annex I Chapter – 6, the Crew was brought before medical board.

Discussion: At present, pacemaker implants are not permitted for flying duties. Advancements in treatment of arrhythmias have allowed many pilots to return **to** flying duties, without jeopardising aviation safety. Advent of modern pacemakers and their increasing **reliability** has allowed afflicted aircrew to return to mainstream flying within 3 – 4 months of implant procedure in major aviation countries. These pacemakers have a very **low** risk of functional interference in modern flight decks.

Based on current medical evidence, opinions of cardiologists and discussion with other aviation regulators a case was taken up for issuance of waiver (for pacemaker implant). The same was granted by the civil aviation regulator in Jul 2021 and the crew was permitted to fly as PIC with QEP. As this is an index case in India, the case is being monitored on a monthly basis and the pilot has performed exceptionally well till now.

Conclusion: With the advancements in cardiology, there is an **opportunity and need** to review cases considered unfit till now. Scientific advancements, evidence-based approach and better risk mitigation strategies will definitely pave the way for permitting flying duties in such aircrew while ensuring flight safety.

CHECK CORONARY ANGIOGRAPHY AFTER STENT PLACEMENT: A NEED FOR RELOOK

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Background: The aeromedical disposition of pilots with Ischaemic Heart Diseases (IHD) who have undergone myocardial revascularisation procedure viz. Percutaneous Transluminal Coronary Angioplasty (PTCA) shall be considered for recertification by DGCA India, provided they fulfil certain laid down criteria. These criteria include a 'check' coronary angiography not earlier than eight months from the PTCA procedure. This is primarily to rule out any restenosis of the managed coronary artery and to ensure that there is no other lesion in any of the other epicardial arteries restricting the luminal diameter by 50% or more. Until then, the license holder cannot exercise the privileges of his/her flying licence.

Overview: A large number of aircrew who underwent PTCA, were denied this 'special' medical assessment, as they did not undergo 'check' coronary angiography (for various reasons). This presentation shall highlight the need to relook at this specific criterion for compliance as well as the other criteria to be met for recertification. The basis for revision of these criteria is entrenched on the risk assessment abilities of the available cardiovascular tests.

Discussion: Since most of the functional tests (to demonstrate normal coronary perfusion) have limited diagnostic accuracy in asymptomatic individuals, using cardiovascular disease (CVD) risk scores like Framingham Heart Study and Atherosclerotic Cardiovascular Disease (ASCVD) risk estimation (ACC and AHA guideline 2013), have historically proven to be more reliable and helpful. Although, some of the Civil Aviation Authorities (CAAs) are already applying different methods of CVS assessment to permit recertification for cardiovascular abnormalities, as far as DGCA, Indian is concerned, we are yet to consider this approach. Therefore, recommendations shall be made for inclusion of only those CVS variables or tests for aeromedical decision making for recertification of pilots with IHD who have undergone PTCA that statistically merit inclusion in the risk assessment equations.

HYPERTROPHIC CARDIOMYOPATHY: SCOPE TO REVIEW THE AEROMEDICAL DECISION MAKING PARADIGMS

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Background: 'Fitness to fly', both in military and civil aviation has a notch higher medical standards than fitness for other duties for the reasons well known to the aviation industry. Hypertrophic Cardiomyopathies represent a wide spectrum of clinical conditions with varied physiological etiology and clinical presentation (varying from asymptomatic coincidental findings to symptomatic cases and even have the risk of sudden cardiac death).

Overview: The prime concern for aeromedical safety in cases of hypertrophic cardiomyopathies is the risk of arrhythmia and LV dysfunction, which could not only be distraction to the aircrew but potentially incapacitating too. The fitness for flying is to be ascertained based on the clinical parameters of the aircrew, co-morbidities and the treatment prescribed, which holistically determine the future risk involved. Often the medication prescribed itself limits the feasibility for flying for example beta blockers are known to lower the G tolerance and hence not permitted in fighter flying.

Discussion: Present regulatory guidelines being followed in Indian Air Force permit only restrictive flying in transport and helicopter stream for hypertrophic non-obstructive cardiomyopathy while hypertrophic obstructive cardiomyopathies are assessed unfit for any kind of military flying. Similarly, in civil aviation, DGCA India guidelines (based on ICAO standards) impose flying restrictions based on the type of the cardiomyopathy.

Advancements both in the cardiovascular diagnostic and management fields have opened new avenues for early diagnosis and risk stratification. In light of the few case studies and scientific literature, this paper will discuss the possibilities for reviewing the paradigm for aeromedical decision making in cases of hypertrophic cardiomyopathies.

Friday 23 September 22

Louis Armand West Room

1600-1730

Scientific Session 19

ESA and NASA Approaches to Deep Space Exploration Medical Care

COMPARING AND CONTRASTING MEDICAL CARE ON THE INTERNATIONAL SPACE STATION AND ARTEMIS MISSIONS: THE CHALLENGES OF EXPLORATION ENVIRONMENTS

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Background: The Artemis missions will see the return of human missions to the moon and are designed to test engineering, technological, and operational capabilities in Lunar orbit and on the Lunar surface. While much has been learnt about human physiology and the management of medical conditions during the continuous human presence on the International Space Station (ISS) over the last 20 years, there are countless new medical challenges facing Lunar and Martian exploration class missions in the future.

Overview: Missions to the ISS benefit from instantaneous and near continuous communication, large habitable volume, and proximity to Earth, with the ability to both resupply and deorbit to reach definitive medical care within less than 24-hours. As a result, the medical risk on ISS has historically played a relatively small role in the overall mission risk. By contrast, Artemis missions will present a new paradigm with increased human system risk.

Discussion: Communication delays of potentially up to 10-seconds may limit real-time consultation with clinicians and telemedical guidance for treatments or procedures. Current vehicle designs, including the Orion spacecraft and the Gateway Lunar space station, are much smaller than ISS and may create new behavioral health challenges related to isolation and confinement. Medical capabilities will vary between vehicles and mission segments, creating operational challenges for definitive treatment and continuity of care. The near-rectilinear halo orbit (NHRO) proposed for Gateway will limit evacuation or resupply during an emergent medical contingency with total time for return to earth of up to 3-11 days in duration. As a result, crew members will be required to perform more autonomous care in a higher-risk and lower resource environment than ever before. These and many other challenges require a paradigm change to medical care in spaceflight from our current approach aboard the ISS.

MEDICAL SYSTEM DESIGN FOR SPACE EXPLORATION MISSIONS USING A PROBABILISTIC RISK AND TRADE SPACE ANALYSIS TOOL

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Background: Long-duration human exploration spaceflight missions to the Moon and Mars present unprecedented challenges for providing in-mission medical care. Compared with the International Space Station, the greater distance from Earth will mean increased mission durations, communication delays, limited to no resupply opportunities, and significant limitations on the evacuation of ill or injured crew. Spacecraft mass, volume and power, as well as crew training capabilities will likewise be curtailed. In this higher risk environment it is important to define and quantitatively estimate human system risk attributable to medical conditions. Clarifying this risk posture creates an imperative for optimization of medical system capability via trading of resources across different spacecraft systems, to minimize total risk to the astronauts.

Overview: IMPACT (Informing Mission Planning via Analysis of Complex Tradespaces) is a probabilistic risk assessment (PRA) and medical trade space analysis tool being developed by NASA to advance medical system design for exploration missions. IMPACT has made a number of enhancements on the Integrated Medical Model, the PRA tool currently used by NASA. These updates include a novel medical evidence base baselined to a long-duration, deep space exploration environment; an expanded medical condition list; and a trade space analysis capability (e.g., comparing risk profiles and mass/volume constraints for medical capabilities and resources). This presentation will describe the development of IMPACT and initial outputs on medical risk estimation and capability recommendations.

Discussion: Quantifying the medical capability set and specific resources for an exploration mission is an incredibly complex optimization problem. Tools such as IMPACT can assist decision makers in deciphering copious amounts of medical and engineering data and quantify trade space solutions. The outputs of these tools will be an integral part of the next generation of medical system design for exploration-class missions.

A HUMAN SYSTEM FAILURE APPROACH TO MEDICAL PLANNING FOR THE LUNAR GATEWAY

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Background: Future exploration missions beyond Low Earth Orbit (LEO) will introduce new medical challenges for astronauts and those that support them from the ground. The beyond LEO space environment will not only be associated with extreme temperatures, microgravity and prolonged radiation (e.g., typical duration of Lunar Gateway missions will be 30-60 days) but will present additional challenges. This includes prolonged or restricted medical evacuation capabilities, communication delays and disruption, and significant constraints on mass/volume available for medical technologies and their associated consumables. To address the myriad of medical concerns in beyond LEO space environment, ESA's Space Medicine Team, in conjunction with the other space agencies participating in future human exploration missions, is defining a medical capability for upcoming missions, starting with the 'Artemis' missions.

Overview: The aim of this project is to develop and test a model of the Medical Contingency Capability for the Lunar Gateway that is built around a human system failure approach. This approach to medical planning focuses on how human-related systems may fail (e.g., hypoxia and hypovolaemia) rather than the more traditional approaches based on hazard analysis and the probability of specified medical conditions occurring in the spaceflight environment. In particular, we focus on the development of the model for the medical management of both life threatening and non-life threatening medical conditions.

Discussion: This novel approach is intended to provide diversification of thinking with regards medical planning for human spaceflight. This will enable established approaches to be challenged and probed in comparison with this model. The intent is that, by facilitating constructive challenge in the context of medical system planning, we will be able to test and adjust current plans, particularly in relation to the ability to respond to unanticipated medical events.

A COMPREHENSIVE MEDICAL SYSTEM CONCEPT FOR HUMAN EXPLORATION MISSIONS

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Background: Human space exploration missions will put unprecedented constraints on the provision of in-flight medical care of astronauts. Starting with the forthcoming ARTEMIS Programmes, these constraints will increase in severity with increasing mission duration, distance from Earth and overall mission complexity, until astronauts must be fully autonomous in managing their own health and that of their fellow crewmates. As a result, a new concept for a medical system is needed to support this shift that evolves as new missions, with their own unique medical challenges, are defined.

Overview: This presentation describes the ESA concept for an exploration medical system (ExMS) and NASA's Crew Health and Performance Integrated Data Architecture (CHP-IDA). The ESA ExMS design philosophy is based around a portable and modular 'hub and peripherals' concept, with devices capturing relevant data and transferring it to a central data management system for storage, display, interpretation, and transmission. This concept makes such a system vehicle agnostic, allowing it to be incorporated into different Programmes and elements to follow crewmembers with a mission, and to be scaled up as medical requirements evolve. NASA's CHP-IDA enables the amalgamation of a variety of crew-relevant (medical diagnostic, vehicle, environmental) data sources and applications. The CHP-IDA is expected to yield insights into the impact of multiple, intertwined parameters on the health and performance state of the crew. In addition, CHP-IDA directly supports automated clinical decision-making capabilities, thereby reducing overall reliance on ground systems for primary guidance.

Discussion: Further development of both the ExMS concept and CHP-IDA platform are considered critical components in the development of a comprehensive medical system for human exploration that support the reduction of the risk of crew health and performance decrements and adverse medical outcomes and increase the likelihood of safe and productive missions.

NEW MEDICAL TECHNOLOGIES TO ENABLE HUMAN SPACE EXPLORATION MISSIONS

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Background: Humans have sustained their presence in space through a combination of short orbital flights, Lunar visits and prolonged orbital stays in habitats including the International Space Station. The forthcoming 'Artemis' Program aims to return humans to the Moon, construct a cis-lunar habitat, and, in the longer term, establish a sustained presence on the Lunar surface. Thus, the Artemis Program will introduce new challenges to the provision of in-flight medical care and technology will play a key role in meeting these challenges to ensure safe and productive missions.

Overview: This presentation describes novel medical technologies already in use on Earth, and in development or testing to be used in space by the European Space Agency (ESA) and National Aeronautics and Space Administration (NASA). These technologies were identified through a review of required clinical capabilities, vehicle integration considerations, and user story mapping. The candidate technologies presented are necessary to facilitate the development of a medical capability for the Artemis missions and longer, more complex explorations that will follow them. Thus, the candidate technologies are considered potentially compatible with Artemis missions, including the mass and volume constraints, evacuation delay, reduced re-supply opportunities, and time-delayed communications resulting in the need for an increased astronaut autonomy. Candidate technologies described include multi-functional vital signs monitoring, autonomous ultrasound image capture, novel effective and efficient countermeasure exercise devices, point-of-care testing systems, clinical decision-making and diagnosis support capabilities, medical data management software and novel food production technologies.

Discussion: The technologies described in this presentation represent the initial attempts by ESA and NASA to define candidate technologies to meet the medical challenges of forthcoming exploration missions. If validated, these technologies may form part of the operational medical capability of the Artemis Program and the basis for the missions beyond the moon.

Saturday 24 September 22

Gaston Berger Room

0830-1000

Scientific Session 20

Clinical Aviation Medicine:

From Current to Particular Situations

SELF-MEDICATION AMONG FIGHTER PILOTS: HOW COMMON IS THIS PRACTICE?

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Introduction: Fighter jet aircrew are a model of their kind, subjected to extreme aeronautical constraints and in whom any slight metabolic modification (pharmacological or not) might interfere with their adaptive balance, and compromise flight safety. The practice of self-medication in this population is therefore a matter of concern. However, data on this subject is scarce. The aim was to identify the frequency and determinants of the practice in this population.

Methods: A cross-sectional study was carried out among the French Air Force fighter jet military aircrew based on an anonymous questionnaire distributed electronically. The questions included personal characteristics, opinions and relations with the healthcare domain, attitudes and practices regarding self-medication in general and before a flight.

Results: Between March and November 2020, 170 answers were analyzed. The absolute rate of self-medication was 97.6%, but the average frequency of its use for a common health problem was rare or non-existent in 53.5% of cases. Factors associated with a more frequent use of self-medication were the pilot occupation, an age of less than 35 years, having a regular treatment, not paying particular attention to getting enough sleep, having confidence in the medical profession, and some identified clinical situations. The consumption of 97 molecules was recorded, and 49 before a flight.

Discussion: Almost all fighter jet military aircrew practiced self-medication, but the average frequency of its use is less common. This practice is probably the result of a complex interaction between many personal factors. However, its impact on flight safety remains uncertain.

RELEVANCE OF INCIDENTAL BRAIN CAVERNOMAS IN AEROSPACE MEDICINE

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Introduction: The Department of Imaging Diagnostics in the German Air Force Center for Aerospace Medicine has a 3 T MRI as a high-end device that covers the entire MRI spectrum with maximum performance. Therefore, we combine professional expertise in the field of military and civilian aerospace medicine.

Cavernomas are vascular malformations consisting of small thin-walled blood vessels. As a fact cavernomas are acquired in the course of life. Due to their epileptogenicity and bleeding probability of about 1-6% per year, various and sometimes severe symptoms can occur. The gold standard in diagnostics is MRI. In principle, complete cavernoma removal is the therapy of choice if a cavernoma is or was symptomatic (e.g., due to bleeding or neurological symptoms). However, the location of the cavernoma is a decisive criterion for or against surgery.

Case Report: A Swiss jet pilot of many years standing presented himself this year with atypical headache symptoms. This was followed by a comprehensive neurological evaluation, including long-term EEG and blood pressure. In the additionally ordered magnetic resonance imaging a cavernoma was incidentally detected. For a more precise classification and evaluation, a new 3T MRI examination was performed at the German Air Force Center for Aerospace Medicine in Fürstfeldbruck within the framework of the international cooperation. The case was subsequently discussed in the interdisciplinary neurosurgical and neuroradiological case conference in Koblenz. With overall easily accessible cavernoma localization in the pars opercularis of the interior frontal gyrus, there is an excellent chance of cure by surgical treatment. However, in this case of incidental diagnosis and subjective absence of symptoms, a definite exclusion from flying cannot be recommended at present.

Discussion: The aforementioned case shows that vascular malformations are a significant diagnostic entity in aviation medicine, which require an individual and interdisciplinary risk assessment and therapy recommendation.

CERTIFICATION OF OROPHARYNGEAL CANCERS IN COMMERCIAL PILOTS

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Introduction: Oropharyngeal cancers are increasingly being detected in the wider population and our aviation community is not immune from the development of this disease. Within EASA and the United Kingdom, there is little or no guidance material on the certification of pilots and air traffic controllers who present with oropharyngeal cancers.

Case Description: A 65-year-old male commercial pilot presented with a left sided neck lump with subsequent biopsy confirming a T2 N2C M0 squamous cell carcinoma of the left base of tongue and positive for human papillomavirus (HPV P16). The pilot underwent radical chemoradiotherapy and proton beam therapy. Post treatment imaging (PET-CT) did not show any sign of disease recurrence. Specialist oncology and otorhinolaryngology reports were requested to comment on the risk of disease recurrence in the first year, the risk of metastases and likely sites and complications as a result of treatment endured. The risk of death from oropharyngeal cancer is stated to be 16% within the first year and 27% at five years. The risk of metastases is quoted at 20% within five years and most likely to occur in the neck and lungs with cerebral metastases occurring in less than 1% of individuals. Following a secondary review, the pilot regained his medical certificate with an operational multi-crew limitation. Strict follow-up was implemented by the specialist especially over the first three years.

Discussion: The majority of oropharyngeal cancers are caused by environmental exposures (tobacco) yet some cases are attributed to previous exposure to HPV. Often, oropharyngeal cancers can present with local invasion, tissue destruction and lymph node spread and this case is no exception. Certification is achievable with Stage I and Stage II disease; however, the risk of recurrence is highest within the first three years and close specialist follow-up is critical during this period.

ASSURING TRANSGENDER EQUITY IN AIR SPORTS

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Background: Athletes who have transitioned between assigned gender and desired gender participate in air sports at all levels. There is consensus that transgender men have no advantage over cis males. Controversy exists as to the possible advantage that transgender women may have over cis women. The International Olympic Committee recently published guidelines for sports to assure equity. The FAI CIMP has recommended that sports commissions evaluate the possible advantage in strength and endurance for the various air sports and individual events. This review will outline the known physiology of male to female transition, and the possible advantages for these trans women.

Methods: A literature review was undertaken via Ovid Medline key words transgender and sports. The preferred terms are, "gender dysphoria" or "gender incongruence." 0.3-0.6% of the population so identify. Diagnostic and Statistical Manual criteria will be presented.

Results: There are no controlled trials in transgender sports. The hormonal treatments suppress testosterone via Aldosterone, and add estrogens and progestins. Aldosterone is on the World Anti-Doping Agency Prohibited List. Gender confirmation surgery is optional. Bone strength remains male, hemoglobin declines to female levels. Strength, lean body mass and muscle area in transwomen remain above those of cisgender women, even after 36 months of hormone therapy. Grip strength reduces by 7%. Observed advantages for transwomen are greatest in athletics, least in swimming. Sports often require that testosterone levels remain below 10nmol/l for a minimum of 1 year.

Conclusion: To adhere to IOC intent for equity, air sports will evaluate each event with the advice of expert athletes.

PREGNANCY IN MILITARY AVIATION: A HAZARD RISK ASSESSMENT

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Introduction: In 2019, the U.S. Air Force School of Aerospace Medicine (USAFSAM) was asked to perform a hazard risk assessment for pregnant aviators; the USAF was considering changing its waiver policy and wanted to examine current data. Given the scope of the request, USAFSAM assembled a multi-disciplinary team to examine relevant data. The assessment included maternal, fetal, and mission risks from a variety of military aviation exposures.

Methods: USAFSAM used USAF risk management principles to principles as the basis for determining the human health risk associated with military flight for the pregnant aviator and fetus. A team of subject matter experts identified exposures present (or potentially present) in military aviation; each exposure was assigned a hazard and severity that determined the overall risk. USAFSAM utilized a comprehensive literature review, Subject Matter Expert consultation, and extant exposure data to determine risk; an elevated risk was only identified as such when there was positive, high-quality data to demonstrate risk. For all hazards/exposures considered, it was assumed that the pregnancy was uncomplicated and singleton (not high-risk)

Results: Based on a review of >140 references and publications and input from dozens of subject matter experts, USAFSAM identified 51 specific potential hazards, broadly categorized into chemical exposures, physical exposures, and aeromedical considerations. Chemical exposures were generally low-risk, while physical exposures and aeromedical considerations had more complex risk assessment results.

Discussion: Exposures other than low-risk will be presented, with particular emphasis on heat exposure, acceleration, ergonomics, sleep disturbance, altitude exposure, noise, and vibration. Applications of this risk assessment will also be discussed; this risk assessment is not intended to suggest policy, but rather as data for aeromedical policy decisions.

Saturday 24 September 22

Louis Armand East Room

0830-1000

Scientific Session 21

AEROMEDEVAC, Infectious Diseases and Policy

AEROMEDICAL TRANSPORT OF PATIENTS WITH (RE-) EMERGING INFECTIOUS DISEASE: MOVING FORWARD WITH LESSONS-LEARNED FROM COVID-19

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Introduction: Aeromedical transport of unconventional medical cases requires early recognition and patient management with acute situation awareness of the environmental and patient status. This educational presentation will provide an overview of key clinical management and contamination containment strategies. A stimulated case representative of real world clinical presentation will provide the learning objectives platform.

Background: COVID-19 is a (re-)emerging infectious disease with variable infectivity and transmissibility. Clinical presentations range from asymptomatic hypoxia to septic shock. Acute management strategies must deviate from ards (acute respiratory distress syndrome) protocols to ensure optimal patient outcomes. Aeromedical challenges including adequate medical personnel protection, environmental security and decontamination of aerosols during respiratory procedures.

Case Presentation: A spectrum of clinical presentation signs and symptoms over time will be presented in the context of an aeromedical transport.

Discussion: Clinical expression and real-time data presentation must be integrated into medical management of all patients, but particularly those with combination injuries and infectious diseases. This presentation will address the knowledge-based advances in aeromedical clinical care based on data from COVID-19 cases. In addition, implications to aeromedical transport policy will be suggested.

COLLECTIVE AERO MEDICAL EVACUATIONS USING THE MORPHEE AND MEROPE SYSTEMS IN FRANCE DURING THE COVID 19 PANDEMIC

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Introduction: After its emergence in China at the end of 2019, COVID 19 was responsible for a high saturation of critical care resources across the world. Because of its heterogeneity throughout different regions in France, being able to transfer patients from areas with congested critical care units to others, definitely proved helpful.

Methods: The French Military Health Service (MHS) and the French Air Force (FAF) firstly used the MoRPHEE system in the Airbus A330 PHENIX, then worked together to turn it into the MEROPE Module in the Airbus A400M ATLAS. This tactical military aircraft successfully became a flying intensive care unit from June to December 2020, allowing 3 aeromedical evacuations (Aero Medevac) to be carried out between French Guyana and West Indies, and 4 others in France.

Results: Our study highlights data regarding aero medevac to the benefit of 59 patients who suffered from acute respiratory distress (ARDS) due to COVID 19. Eligible patients were selected before the flight under strict conditions and after dialogues with the local critical care teams. Patients were presenting with ARDS in 67% (MoRPHEE) and 60% (MEROPE) of cases. More than half of the patients had comorbidities hypertension, obesity and diabetes. The median age was 64 years old for the MoRPHEE missions, and 68 years old for the MEROPE ones. The median tidal volume was between 6,2 and 6,5 ml/kg/min, the median positive-end expiratory pressure was respectively 13 and 10, with a median FiO₂ at 50% and 60%. On average, the flights lasted around 71 min (MoRPHEE) or 90 min (MEROPE).

Conclusion: Therefore, these Aero Medevac achieved by a joint medical team, combining intensivists, anesthetists nurses and flight surgeons, enabled to ensure the safest transport possible for any patient, thanks to a close cooperation between the French MHS and the FAF.

AEROMEDICAL DISPATCH – IS THERE AGREEMENT BETWEEN CLINICIAN GROUPS ON APPROPRIATENESS OF CASE SELECTION FOR HELICOPTER EMERGENCY MEDICAL SERVICES?

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Introduction: There is considerable variation in helicopter emergency medical services (HEMS) dispatch systems. Neither the HEMS dispatch criteria nor the training of the dispatcher are standardised. While some utilise clinicians as dispatchers, there is no consensus on which clinical background is most appropriate to perform this role. Given the significant financial costs of over-triage and the potential for increased morbidity from under-triage, HEMS tasking must be as accurate as possible. This study compared the dispatch decisions of individual clinicians to assess if building consensus decision making was possible on real, anonymised 999 calls.

Methods: There was a two part prospective data collection approach: First, an anonymised case series survey was utilised in which participants decided to dispatch HEMS or not based on the initial written information from the 999 call. Clinicians recruited were paramedics (P), advanced paramedics (AP), emergency consultants (EM) and general practitioners (GP). Second, a confidential interviewing session was then completed to evaluate the non-consensus cases and attempt to build an expert group consensus decision using modified Delphi techniques. Outcomes were then compared to the original dispatch decision of a non-clinician dispatcher following an algorithm.

Results: There were 26 respondents to the initial survey with 6 clinicians taking part in the confidential interviewing stage. The breakdown of clinician respondents was P-8, AP-12, EM-2, GP-3, Other-1. Fourteen of the twenty cases reached a consensus decision in the initial survey stage. Overall, there was 55% agreement between the clinicians and the original dispatch decision. The highest levels of agreement with the original decision (55%) were APs and Ps.

Conclusion: Considerable variability in dispatching was evident between clinician groups. Highest agreement (55%) was found in the prehospital practitioners.

HEALTH REPATRIATION FROM WUHAN: WHY IS THIS A CHALLENGE?

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Introduction: To repatriate to France hundreds of nationals of the city of Wuhan in China, the epicenter of the COVID-19 epidemic, in safe individual and collective health conditions, and without being the source of a transmission chain on the national territory.

Methods: France organized 2 medical repatriations by air on 01/30 and 02/02/2020 through interministerial coordination. The response to this exceptional health situation was achieved through a preparation process based on the principles of detection of suspected patients and the implementation of drastic protective measures. This process allowed the creation of a medical record based on the definition of cases and a specific medical triage chain leading to categorization, identification and digital traceability of each national, diplomatic support, aircraft zoning, then placement in isolation in a shelter for 14 days.

Results: Two flights were carried out at the end of January 2020, allowing a total of 435 nationals to be repatriated. Two returnees were medically challenged. The first was classified as a possible case and the second presented with severe febrile illness and transferred to local health authorities. A national was symptomatic and then confirmed on arrival in Europe and his registration by the SINUS system enable all contact cases to be identified.

Conclusion: This unprecedented mission through its inter-ministerial coordination, and the complexity of the actions to be carried out in the context of the crisis, has made it possible to identify, management of patients suspected COVID-19 nationals by respecting the barrier measures and by protecting the caregivers, with hindsight of the two weeks quarantine.

MEDICAL EVACUATION DURING COVID-19 OUTBREAK IN MARCH 2020: A NEW MISSION FOR ARMY AVIATION FLIGHT SURGEONS

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Background: The outbreak of the COVID19 pandemic in March 2020 hit the “Grand Est” region of France with a particular severity, overwhelming critical care facilities. To evacuate critical care patients to less impacted areas, French Army Aviation selected the NH90 utility helicopter from 1st Combat Helicopter Regiment (1RHC) in Phalsbourg. The objective was to transport highly contagious patients requiring high level of care, while protecting the crews but also the maintenance teams who would work on the airframe afterwards.

Overview: Helicopters would take off from their base in Phalsbourg, pick up civilian medical team and patients from saturated hospitals and transfer them to available critical care facilities. Flight surgeons and nurses from 42 medical unit would be on board to help civilian teams to adapt to the helicopter environment, communicate with the crew, and check isolation procedures. Return to home base would then allow thorough decontamination and back to readiness, marking the end of each mission.

Over 8 days between 28 March and 6 April 2020, we conducted 24 missions and transferred 48 patients to hospitals in France, Germany, Switzerland and Austria. Up to three missions were conducted each day, with a mean duration of 7h35 [4h46-11h55]. Security objectives for flight crew and maintenance team were met when a month of medical follow-up showed no contamination of the personnel.

Discussion: The presentation will address the challenges met during planning, preparation and conduct of this operation, focusing on the necessary adaptations that differed from medical evacuation (MEDEVAC) during overseas operations. This includes multidisciplinary teamwork gathering aeronautical experts, biosecurity experts, CBRN teams from the army, and flight surgeons from Army Aviation working on isolation and decontamination procedures. We will also discuss the many roles of the military flight surgeon including advisor to senior command, physician of the crews, and MEDEVAC expert.

Saturday 24 September 22

Louis Armand West Room

0830-1000

Scientific Session 22

Acceleration and Ejection

DESIGNING RESTRAINT SYSTEM FOR SIMULATING LATERAL ACCELERATION

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Introduction: Super maneuverable aircraft are capable of executing maneuvers involving multi-axial acceleration. Consequentially, there is a need to evaluate effects of multi-axial acceleration on human performance. However, the restraint systems available in the centrifuge seat was found largely ineffective in preventing sideways movement of the torso, as well as neck snap under lateral (Gy) acceleration. Thus an additional restraint system was designed for participants undergoing lateral acceleration.

Methods: The present study was conducted on High Performance Human Centrifuge (HPHC). 28 healthy male volunteers participated in the study. A restraint was designed specifically for this acceleration profile. A combined acceleration profile +Gz/+2Gy was utilized to test the newly designed restraint system. Effectiveness of the restraint was tested both subjectively and objectively.

Results: Subjects were found to be comfortable with the new restraint and it was found to be very effective in restraining subjects while undergoing lateral acceleration.

Conclusion: The study brings out a new effective system for restraining subjects during lateral acceleration simulation in centrifuge. The operational significance of installing a restraint system in addition to the five-point harness in aircraft capable of executing significant Gy is also highlighted.

WHAT IS MOD PILOT EXPERIENCE OF THE HIGH Gz TRAINING FACILITY AT RAF CRANWELL AND ARE THERE FACTORS THAT CAN PREDICT IT?

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Background: The entry into service of the new High Gz Training Facility (HGTF) has introduced Dynamic Flight Simulation (DFS), where a pilot can fly the centrifuge like a real aircraft. DFS is a major step forward in providing realistic high Gz training and has not been reviewed in current UK or NATO country literature.

Methodology: A cross-sectional survey amongst all MOD pilots (n=110) used a questionnaire to collect information on potential predictors and Likert scale score analysis of pilot assessed centrifuge effectiveness. Data analysis examined the association between pilot demographic and centrifuge effectiveness score, possible predictors of centrifuge effectiveness and possible predictors of pilot grey-out.

Results: In preparing pilots for high Gz flight, the mean centrifuge score was 8.53 with a median score of 9 (out of 10). Scenario based AGSM practise demonstrated a mean score of 8.66 with median of 9. Confidence in AGSM demonstrated a mean of 8.06 with a median of 8. Pilots who had not previously completed a ground tour were significantly more likely to report the HGTF as effective in high G preparation (OR 3.05 CI 1.2-7.75) and felt more confident in their AGSM (OR 3.6 CI 1.5-8.5). No significant difference was found in confidence in the AGSM score when combining possible predictor variables. When examining pilot grey-out, Typhoon pilots demonstrated a significant association with grey-out when compared to Tutor/Prefect pilots. The three most common AGSM technique errors were breathing too fast, timing of the Gz strain manoeuvre and breathing too slow.

Conclusions: Descriptive analysis demonstrates a positive view of centrifuge effectiveness and the use of DFS. The potential predictors of centrifuge effectiveness and pilot grey-out have been difficult due to complex interactions between several confounding factors. Targeting younger pilots (18-25 yrs) who fly basic trainer aircraft may prove to be an efficient way to increase confidence in the AGSM.

AN INNOVATIVE AND PROGRESSIVE PEDAGOGICAL APPROACH FOR AEROMEDICAL CENTRIFUGE TRAINING BASED ON ACTIVE TRAINEE PARTICIPATION

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Background: NATO Standard AAMedP-1.2 and AAMedP-1.13 determinates minimum requirements for physiological training of aircrew in high “G” environment. In accordance with these documents, French physicians have developed an innovative pedagogical approach. Our objective is to present the three progressive and complementary steps developed and the tools used to improve the learning and efficiency of anti-G straining maneuvers (AGSM).

Overview: After theoretical briefing illustrated with +Gz accidents in France, the first AGSM is carried out in a static seat, during simulated runs. Then, the trainees, equipped with their G-protection, move into the human centrifuge gondola for four dynamic runs, under supervision physician (audiovisual connection and ECG monitoring). After a G warm-up to check procedures and equipment, trainees experiment visual effects during graduate onset rate, and effectiveness of their AGSM up to +9 Gz. The third run ensures that the AGSM is properly executed and effective at a sustained high "G" appropriate for the aircraft type. A cognitive target tracking task is added for the fourth run.

Discussion: Physiological monitoring and a list of criteria are used to improve training and effectiveness of AGSM. Muscle contractions is recorded by electromyogram electrodes placed on quadriceps and hamstrings, and a microphone on the mask record respiratory rhythm. The visual field is in the gondola and a sensor records pressure under rudder pedals. Under physician supervision, trainees self-debrief their AGMS between runs, based on data and curves presented as a biofeedback tool, according to a list of 5 criteria: anticipation, synchronization, duration, modulation of AGMS intensity and extension. Thus, trainees identify the criteria to be improved for next run.

In France, in accordance with and in addition to the NATO selective qualification, the pedagogical tools and techniques used are focused on acquisition of the optimal performance criteria of the AGSM, guaranteeing flight safety.

STANDARDISATION OF POST-EJECTION REPORTING: A QUESTIONNAIRE APPROACH

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Background: The Martin-Baker mission – as part of the wider mishap prevention community efforts – is to reduce injuries and save aircrew. These events would benefit from formalised regular and comprehensive disclosure of some of the information contained in the mishap post-investigation reports. Data analysis conducted on historical live ejections can help:

- assess the overall performance and effectiveness of crew escape systems currently in operation, in order to identify existing and emerging safety trends;
- examine the causes of aircrew injuries and fatalities, and thereby learn from past experience so that future development may be directed towards those areas that will bring about the greatest improvements in aircrew safety;
- reconstruct mishap scenarios, in support of live ejection investigations and mishap prevention;
- contribute to bridging a knowledge gap in observed differences between manikin and human response, helping the aero-medical community advance physiological airworthiness criteria that better predict ejection injuries.

Overview: Martin-Baker ejection records are comprehensive in terms of quantity and variety of seat types but can sometimes lack detail on individual ejections. It has become evident that the level of post-ejection medical surveillance undertaken by different operators is extremely variable and that the safety community would benefit from advancing the common international standards on post-ejection reporting, medical surveillance, and injury classification.

Discussion: To foster stronger cooperation within the aerospace safety community and exchange of information, a post-ejection questionnaire-style approach is proposed. This briefing will contain a demonstration run-through of how to fill out the hereby developed questionnaire. It is intended to be flexible for maximum user-friendliness as well as providing rigidity with tightly constrained multiple-choice questions.

Any feedback on the questionnaire is very welcome, as we work to refine its design with the end-user to mind. Additionally, Martin-Baker hopes that this questionnaire can be useful in contributing to accident investigators' training material.

HEAD IMPACTS SUSTAINED DURING ROCKET-ASSISTED ESCAPE: REVIEW OF UK FAST JET EJECTIONS 2002 - 2022

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Introduction: Head injuries are commonly sustained during an ejection from a fast jet aircraft. Understanding the mechanisms of head impacts in previous ejections allow us to develop escape systems that are less injurious. Identifying the primary risks of head impact can inform the evidence base for future helmet impact standards.

Methods: A review was carried out of all UK military ejection events between 2002 and 2022 from the records held at the RAF Centre of Aviation Medicine. For each ejection, key parameters were recorded; seat type, altitude, indicated air speed, presence of helmet damage, evidence of clinical head injury and mechanism of head injury. Clinically significant head injury was classed as any impairment of consciousness or any head injury scoring two or more on the Abbreviated Injury Score (AIS).

Results: 36 ejections were reviewed from 6 different aircraft types. 15 ejections resulted in a head impact, with 6 resulting in clinically significant head injuries; 3 of these were as a result of unsurvivable 'out of envelope' ejections. Three primary head impact mechanisms were identified; impact from fragments of canopy, the impact of the head into the seat headbox on exposure to windblast, impact onto the ground following parachute landing.

Discussion: Head injuries continue to be sustained during ejections. Rates of survivable head injuries found here are similar to the rates recorded in previous studies. Almost all ejections reviewed were from 'legacy' aircraft; there was insufficient data to assess the effect of more recent changes to ejection seat design. Reduction of head injuries in future ejections should be focussed on mitigating against the three main causal mechanisms identified; impact with canopy fragments, the headbox or the ground on parachute landing. Future research will aim to reconstruct these primary head injury mechanisms in order to quantify the risk of brain injury.

Saturday 24 September 22

Gaston Berger Room

1030-1200

Scientific Session 23

Fatigue and Vigilance in Aircrew

CIRCADIAN ADJUSTMENT IN COMMERCIAL AIRLINE PILOTS DURING AND AFTER BEING GROUNDED DUE TO COVID-19

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Introduction: Due to the COVID-19 pandemic, aircrew were absent from flight schedules and resulting circadian disruption. The aim of the current study was to determine the baseline circadian rhythm of airline pilots, and circadian re-adjustment, including its influencing factors, after being re-exposed to 'normal' flight schedules.

Methods: The population consisted of 41 intercontinentally flying pilots. After a baseline questionnaire and an online instruction, baseline Dim Light Melatonin Onset (DLMO) was calculated from saliva measurements performed by the pilots themselves. Follow-up measurements took place when they were flying a schedule resembling the pre-COVID-19 situation. During three rotations, participants filled out a daily sleep-, wake- and activity log by means of a data collection app. DIY saliva sampling took place the night before the 2nd and 3rd rotation.

Results: Participating pilots proved to be in good health and well rested in the first year of the pandemic. In total 36 (88%) out of 41 pilots performed their baseline saliva measurements. For 33 of them DLMO was successfully determined. Due to the ongoing pandemic 15 (37%) pilots completed their follow-up measurements before the end of the study. Results showed that in 31% of the cases, pilots experienced circadian disruption (> 45 minutes DLMO difference compared to baseline) the night before the next rotation. Schedule factors positively associated with larger DLMO deviations were a higher number of time zones crossed, and a westward direction of the rotation. No further association with either personal or schedule related factors was found.

Conclusions: Saliva collection at home was used to determine the circadian rhythm of airline pilots, and the results showed that this was valid and reliable. When flying regularly again, pilots proved to have enough time to recover from their circadian disruption in between rotations in the majority of the cases.

FATIGUE ASSOCIATED WITH MILITARY FLIGHT: NEAR INFRARED CORTICAL SPECTROSCOPY MEASUREMENTS MAY PREDICT VULNERABILITY TOWARDS COGNITIVE FATIGUE

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Introduction: Tactical aviators face unprecedented physical challenges within hostile environments. Fatigue may be among the most insidious, rendering an individual unaware of their deteriorating physical and cognitive performance. Our ongoing studies seek to establish quantitative predictors of impending fatigue. We have identified blood serum proinflammatory cytokines and other proteins that concomitantly emerged with increasing levels of fatigue within military aviators. The purpose of this study was to determine whether those biochemical changes were accompanied by differences in activity within the brain's prefrontal cortex, an area critical for cognitive processes.

Methods: Functional Near Infrared Spectroscopy measured brain prefrontal cortical activity during administration of a cognitive task in 22 military pilots. Data were collected on three days across the week-long flying schedule: Sunday (Baseline), Tuesday (Midweek) and Thursday (Endpoint). Levels of fatigue and venous blood samples were collected at the same time points, with those outcomes reported elsewhere.

Results: The study cohort was comprised of primarily males, aged 37.95 ± 4.73 years with a BMI of 26.63 ± 3.15 kg/m². No baseline differences in fatigue nor blood serum analyte levels existed between participants who would report increased fatigue scores by study endpoint ($n=13$) versus those who would not ($n=9$). Eleven serum analytes were significantly associated with onset of fatigue. In this study, we identified increased levels of prefrontal cortical brain activation during cognitive testing at Baseline ($p=0.0096$) and Midweek ($p=0.0135$) in participants who would later become fatigued.

Conclusions: Increased baseline and midweek levels of brain prefrontal cortical activity during cognitive testing, detected only within persons who would later become fatigued, may reflect heightened baseline levels of metabolic activity. This could potentially reduce the brain's functional reserve to support neural recovery from repetitive cognitive challenges, thereby increasing vulnerability towards onset of fatigue.

EFFECT OF PHYSICAL EXHAUSTION ON BASIC PARAMETERS OF VOICE

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Introduction: Fatigue is a safety concern which affects health and performance of professionals in aviation, heavy engineering, shipping, rail transport, medical and surgical services. Non-compliance with instructions due to lack of clear communication may result in catastrophe. This study aims to examine the influence of physical exhaustion on voice characteristics.

Methods: Twenty healthy subjects, 10 male (age 35.5 ± 4.5 years) and 10 females (age 29.8 ± 5.06 years) volunteered to participate in this study. Subjects ran on treadmill to the point of exhaustion and recorded English vowels using SONY IC recorder ICD-UX533F before exercise (BE), immediately after exercise (AE) and after 10mins of resting. Male and female recordings were analyzed separately using PRAAT and IBM SPSS Statistics software.

Results: For male subjects, mean energy intensity for all vowels and formant F1 for /a/,/e/,/o/,/u/ increased significantly ($p < 0.05$) after exercise (AE). However, F4 for /o/ and shimmer (apq11) for /u/ decreased significantly ($p < 0.05$). For female subjects jitter (local, rap and ddp) for /i/ and shimmer (dda) for /e/ increased significantly ($p < 0.05$) AE. Both genders showed significant increase in mean F_0 for /a/,/e/,/i/,/o/ and formant F2 for /o/ but decrease in F3 for /e/ after exercise ($p < 0.05$). All parameters returned to values close to BE after 10 mins of resting. In contrast, it was noted that for male subjects' basic measures of jitter and shimmer as well as their smoothing factor equivalents (rap, ppq5, ddp, apq3, apq5, and dda respectively) decreased marginally AE and then further decreased after 10 mins of resting for /a/. No effect of exercise was seen on harmonicity, mean autocorrelation and mean harmonics-to-noise ratio (HNR) for both genders.

Discussion: Findings indicate that voice can be used as non-invasive and non-contact indicator of physical exhaustion for Air-Traffic-controllers, pilots, athletes, and trainee soldiers so that informed assessments and diagnoses can be made to ensure safer work environment.

EFFECTS OF MODAFINIL AND CAFFEINE ON AVIATOR VIGILANCE AFTER A LIMITED PERIOD OF SLEEP DEPRIVATION: FIRST RESULTS

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Introduction: Fatigue remains an important factor in major aviation accidents. Stimulants may counteract fatigue's adverse effects, with modafinil as a promising alternative to caffeine. However, the effect of a single dose of modafinil after a limited period of sleep deprivation remains unknown.

Methods: Thirty-two volunteers of the Royal Netherlands Air Force were administered modafinil (200 mg), caffeine (300 mg), and placebo on 3 non-consecutive trial days, according to an order-balanced, double-blind, crossover design after being awake for a mean 17 h. Afterward, subjects completed 6 series of the Vigilance and Tracking test (VigTrack), psychomotor vigilance task (PVT), and Stanford Sleepiness Scale (SSS), yielding 6 primary endpoints.

Results: A factorial repeated-measures analysis of variance of the PVT and VigTrack revealed statistically significant effects of caffeine and modafinil compared with placebo on all endpoints, except for VigTrack mean tracking error and percentage omissions. Pairwise comparisons showed significantly less impaired PVT results 2 h after administration, followed by VigTrack parameters 2 h thereafter. Wilcoxon matched-pairs analysis revealed significantly better SSS scores for modafinil and caffeine than for placebo from 4 h. Compared with caffeine, modafinil significantly improved PVT and SSS scores at 6–8 h after administration.

Discussion: The present study demonstrates that 200 mg modafinil and 300 mg caffeine significantly decrease the effects of a limited period of sleep deprivation on vigilance compared with placebo. Although PVT parameters already improved 2 h after administration, the most notable effects occurred early morning. Modafinil seems to be effective longer than caffeine, which is consistent with its longer half-life.

ASSESSING AND APPROVING OPERATIONAL MEDICATIONS FOR MILITARY AIRCREW - WHAT'S REQUIRED AND AN ILLUSTRATION OF HOW IT WORKS

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Background: Approving medications for utilization by aircrew presents greater challenges than approving medications for use by ground personnel. On the ground, standard pre-market assessments of efficacy and tolerability often are sufficient to ensure safety, but in aviation where subtle alterations in physiology or cognition can have disastrous consequences, medication safety standards are far more stringent. To ensure any drug is “safe to fly,” basic laboratory research must be combined with applied studies and other information to prove that candidate drugs will produce the desired results without unwanted side effects. This process was recently followed to approve the stimulant medication modafinil for US Army operational aviation use. The experience is cited here as an example.

Overview: Information concerning the flight-performance effects of modafinil and data on side effects and risk-taking behavior were assembled from the literature. Also, the stimulant policies currently in place within other military services and mishap/incident data from military aviation safety centers were examined. This information was presented to the US Army Aeromedical Activity and the Aviation Consultation Advisory Panel (which makes recommendations on medication approval/disapproval, waivers, etc.). The efficacy and safety of modafinil as a military aviation fatigue countermeasure were evident from published aeromedical studies, the appropriateness of modafinil for operational use was substantiated by the policies of other military services, and it was clear from safety data that while fatigue was responsible for considerable military aviation losses, not a single aviation mishap or incident had resulted from modafinil or any stimulant use. Based on these findings, the Army Aeromedical Policy was updated to authorize modafinil for use as a counter-fatigue medication in especially demanding aviation sustained operations.

Discussion: The above example demonstrates “best practices” for aviation operational drug evaluation. These practices will be further illuminated in the presentation.

Saturday 24 September 22

Louis Armand East Room

1030-1200

Scientific Session 24

Space Medicine:

From the Beginning to Nowadays

METABOLIC LEGACY OF APOLLO 17

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Introduction: To mark this year's 50th anniversary of the Apollo 17 Lunar landing the author reviews the metabolic experiments conducted on that mission and discusses their significance to future studies. While Lunar exploration was the main focus of Apollo 17, metabolic experimentation was an important secondary objective.

Methods: Nutrient intake and metabolic waste were measured and metabolic rates were estimated from life support data.

Results: Energy intakes decreased from a mean of 33 kcals/kg preflight to 26 kcals/kg during the mission. The mean weight loss was 3 kg. Metabolic rates were lowest while riding the Lunar Roving Vehicle and highest during standup EVA in Lunar orbit. Net losses of nitrogen were equivalent to about 1 kg of protein. All crewmembers were in negative calcium balance inflight losing about 0.2 percent of total body calcium. This was largely due to decreased gastrointestinal absorption. There was some increase in glucocorticoid excretion. No mitigating effect of Lunar gravity was discerned.

Conclusions: The study documented losses in bone and muscle mass which set the stage for future long-duration missions. Following Apollo 17, metabolic balance studies were carried out on the 28, 59 and 84-day Skylab missions and on some Salyut, Mir and Shuttle-Mir missions. Recent studies including those on the International Space Station have employed more direct measurements of bone and muscle loss and have focused on the development of countermeasures.

THE DEAF RIGHT STUFF

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Introduction: When the US human space program was in its infancy, we knew very little about how the human body would perform in space. When we ate food, could it be metabolized normally? Would our vision be changed? Would our balance system work, or would we be dizzy and nauseous? We needed answers.

Purpose: This presentation will discuss early research done, for the US Navy and NASA, to perturb the vestibular system in a special group of research subjects who had no labyrinthine function. Further, and perhaps more importantly, it will describe these unique individuals and the variety of tests conducted.

Overview: In the 1950s and 60s, a group of deaf individuals associated with Gallaudet College, a school for the deaf in Washington, D.C., were recruited for the unique nature of their loss – deafened by spinal meningitis as young children. In addition to losing hearing, their vestibular systems were attacked, leaving them with no vestibular function. It was this that led these subjects to be selected. US Navy Captain (Dr) Ashton Graybiel was the principal investigator who led many experiments to determine how they would perform in comparison to subjects with intact balance systems. From these studies came a better understanding of how astronauts might perform when functioning in the absence of gravity. The history of these gentlemen, as well as their research experiences, examinations, and results will be reviewed.

PHYSIOLOGICAL RESPONSES TO CENTRIFUGE-SIMULATED SUBORBITAL SPACEFLIGHT

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Background: Commercial suborbital spaceflights are now available to members of the public. There are parallels between this emerging industry and the development of commercial air travel last century, and it is anticipated that suborbital operations will ultimately mature into extremely fast point-to-point travel. However, suborbital flights present physiological challenges beyond those associated with airline travel, including a robust acceleration environment consisting of a high-G launch phase, a period of microgravity, and a further high-G phase during re-entry. The high-G phases dynamically combine significant chest-to-back acceleration (+G_x) with a variable degree of head-to-foot acceleration (+G_z).

Overview: Previous centrifuge studies simulating the high-G phases of suborbital flights have established that they are likely to be tolerable for the majority of passengers, although a small sub-set may be susceptible to adverse effects. We have recently undertaken centrifuge studies exploring the physiological responses that may underlie these effects using two approaches: real-time cardiovascular and respiratory measurements during dynamic suborbital profiles; and detailed characterisation of the underlying pulmonary response using advanced measurement techniques during static +G_x. These studies have demonstrated marked changes in heart rate, blood pressure and cardiac output, alongside pronounced respiratory changes resulting in occasionally profound hypoxaemia, and frequent visual G symptoms ('greyout' and 'blackout') with one episode of G-induced loss of consciousness (G-LOC).

Discussion: Physiologically, suborbital acceleration profiles are not inconsequential. This has clinical implications for individuals as well as regulatory implications for the industry, although it is important to emphasise that physiological responses are likely to be benign for most passengers. For those with underlying pathology, the potential for adverse cardiopulmonary effects may warrant expanding pre-flight centrifuge familiarisation to include real-time physiological assessment in the form of a 'G challenge test'.

BONE MICROSTRUCTURAL CHANGES FOLLOWING SPACEFLIGHT AND RECOVERY ON EARTH

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Introduction: Microgravity-related bone loss presents a challenge to astronauts undergoing long-duration spaceflight and has larger ramifications for future space exploration. Unlike bone loss due to aging, astronauts undergo a period of rapid bone apposition upon return to Earth, which provides a unique opportunity to examine the mechanisms of rapid bone remodeling.

The objective of this study was to detect changes in bone geometry, topological connectivity and anisotropic directionality of astronauts from the International Space Station (ISS).

Methods: Seventeen astronauts had their distal tibia and radius imaged using high-resolution peripheral quantitative computed tomography (HR-pQCT) before spaceflight, at landing (R+0), and at 12 months post-flight (R+12). Bone images were three-dimensionally registered across time. A skeletonization decomposed the R+12 images to their underlying structure, allowing superimposition to the R+0 image to highlight areas of bone apposition during recovery.

Anisotropy changes were tracked using mean intercept length. To compare the sensitivity of anisotropy analyses in astronauts, a reference was established using same-day repeat HR-pQCT distal tibia (n=33) and radius (n=22) images from control participants. We assessed the precision of same-day repeat scans (RMSCV%) and differences in connectivity and anisotropy between astronauts and precision data using Wilcoxon rank-sum test.

Results: Astronauts' apposition sites were 1.7 and 1.3 times larger in the radius and tibia, respectively, versus controls ($p < 0.001$). Qualitatively examining these sites in astronauts with greater-than-average apposition showed instances of bone bridging the space between two adjacent structures, indicating trabecular repair. Precision for anisotropy measures ranged from 1.1 to 1.7%, while astronauts' change in anisotropy ranged from -4.0 to 12.3% (median -0.2%) pre- to post-flight and -28.1 to 4.3% (median 0.5%) during recovery.

Discussion: Bone resorption and apposition varied considerably between astronauts, with evidence of trabecular repair and changes in connectivity. Some astronauts demonstrated substantial change in anisotropy, suggesting directional alterations in structure that are concurrent with topology adaptation that occurs upon recovery on Earth.

FLIGHT SURGEONS AND THE SPACE DOMAIN IN NATO.

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Background: In 2020, the North Atlantic Treaty Organization (NATO) reached 30 member States, a family that now gathers almost a billion people in two continents. The strength of being an always evolving Alliance grants a significant advantage to our collective security but also poses new challenges to the interoperability of the individual national military systems to achieve synergy when acting together. Despite NATO doctrine and international standards in aerospace are widely agreed, new scenarios can trigger different national approaches within the Alliance, frequently leading to different processes and uneven results, that are difficult to conciliate at later stages of development.

Overview: In 2019, Space was declared a domain of operations by NATO Heads of State and Government in order to protect satellites orbiting Earth for the continuation of critical services to our societies. The Space Domain is a very competitive ecosystem where commercial and industrial interests are growing fast, also considering the expansion of human presence in the Solar System (tourism, mining, research...). Such scenario may generate new safety and security requirements for the launching States that can affect the military mission for the sustainment of a peaceful environment.

Discussion: Flight Surgeons are important elements in driving the medical transformation of the Alliance. However, the Space Domain is a multidisciplinary context that needs a credible medical approach to direct the efforts towards healthcare priorities and effective force health protection measures. The purpose of this presentation is to describe a general framework based on the standing Allied aeromedical doctrine where Flight Surgeons can evolve from their current role in military aviation, engage the transformation of the Alliance as new medical support requirements are generated and develop customized solutions for best healthcare quality outcomes.

THE CANADIAN SPACE AGENCY'S HEALTH BEYOND INITIATIVE

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Background: Space exploration has always been a very powerful source of motivation for achieving technological excellence, due to the extreme challenges encountered during space travel. Extending human presence in low-Earth orbit has spurred innovation in nearly every facet of modern existence. As international ambitions for space exploration extend to deep space, the new challenges to ensure crew health and safety have become increasingly complex, which has the potential to galvanize innovation in the health sector.

Overview: Traveling beyond low Earth-orbit implies longer communication delays, rendering ground-based medical support impractical. Furthermore, resupply missions and emergency evacuations are no longer possible. As current operations related to astronaut health are essentially Earth-centric, these challenges give rise to a paradigm shift in operational space medicine. The crew will be required to be medically self-sufficient; onboard systems will have to ensure end-to-end health coverage – from health monitoring to medical treatment. On Earth, technological progress in this field could help bridge the urban-rural gap in terms of access to quality care, as remote communities generally lack the expertise and the resources necessary for medical autonomy. For instance, innovation for deep space astronaut health could be co-developed in partnership with terrestrial stakeholders to help minimize the reliance of remote and medically isolated communities on medical evacuations, which often contribute to negative health outcomes for the members of these communities.

Discussion: In this context, the Canadian Space Agency's Health Beyond Initiative aims to develop innovative, relevant, and sustainable health solutions for deep space missions while considering the similarities with the health challenges that arise in remote communities on Earth. This proposal will outline in detail how Health Beyond's strategic direction could act as a catalyst for a paradigm shift in medical care delivery both on Earth and in space.

Saturday 24 September 22

Louis Armand West Room

1030-1230

AME Refresher Course

Time	Topic	Responsible
10:30	Welcome	Trond-Eirik Strand
10:35	Healthcare avoidance and underreporting in aeromedical examination	Billy Hoffman
11:00	Discussion	Trond-Eirik Strand
11:15	Obstructive sleep apnoea	Nomy Ahmed
11:30	Break	
11:45	Progress in the field of pilots on insulin	Felix Stollo
12:00	News from regulators	Francisco Rios Tejada
12:15	Discussion	Trond-Eirik Strand
12:30	End	

Saturday 24 September 22

Gaston Berger Room

1400-1530

Scientific Session 25

Mental Workload and Health:

Experimental Psychology

FACTORS CONTRIBUTING TO THE MENTAL LOAD OF TRAINEE MILITARY HELICOPTER PILOTS: A COMPARISON OF INSTRUCTORS' AND TRAINEES' VIEWS

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Background: At times, the mental load of trainee military helicopter pilots can increase to the point where it becomes difficult to acquire new knowledge and skills. The French Air Force (Armée de l'Air et de l'Espace) has reviewed its current training system, and the Helicopter Crew Training Center (Centre d'Instruction des Équipages d'Hélicoptère) has initiated a project (CAP160) that seeks to move towards individualized training. In the learning context, the literature reports several load factors, such as the intrinsic nature of the tasks to be performed, the information presentation format, and even the learner's abilities. An exploratory study was conducted to compare the views of instructors and trainees regarding the factors contributing to the mental load of trainees during their training.

Methods: Semi-structured interviews were conducted with seven former pilot trainees and eleven instructors. They were asked to describe, during training: i) situations in which trainees have a high or even excessive mental load; and ii) factors contributing to the mental load for trainees.

Results: The results revealed that the majority of participants shared the same views regarding the most mentally-costly situation (i.e., navigation flights), with the predominant load factor being the upstream preparation time. However, there were differences of opinion regarding reported load factors, for example in the context of the winching module.

Discussion: Despite a certain degree of consensus, instructors are unaware of certain load factors. Conversely, trainees may underestimate, or be unaware of, the impact of other factors that are identified by instructors. Taking account of all of the reported mental load factors will provide avenues for improvement to reduce the mental load for trainees during their training at the Helicopter Crew Training Center.

USE OF PHARMACOGENETICS TESTING TO PRESCRIBE ANTIDEPRESSANTS FOR PILOTS

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Background: Antidepressants are among the most prescribed psychotropic drugs due to the very high prevalence of depression and anxiety disorders. Prescribing antidepressants is complex. Antidepressants take a long time to reach efficacy, are not always effective and can generate debilitating side effects. As a result, for personnel in security professions (military, pilots), the prescription of antidepressants is often considered incompatible with their professional activity, which leads to potentially long inavailability.

Overview: Currently, many studies agree on the value of pharmacogenetics in order to allow individualized prescription of antidepressants. The use of pharmacogenetics in current practice could improve the risk-benefit balance of antidepressants by making it possible to find an effective and well-tolerated molecule more quickly. Thus, pharmacogenetics could constitute an important support for the clinician in his approach to care and expertise. It could also make it possible to reduce the time of unavailability or total incapacity of personnel working in security professions.

Discussion: We have started a research project to assess the value of the use of pharmacogenetics for prescribing antidepressants in the military population. The objective is to provide concrete answers on the clinical, professional and socio-economic interest of these analyses.

REPEATED EXPOSURE TO WATCHING WAR IMAGES: IMPACT ON THE MENTAL HEALTH OF REAPER DRONE OPERATORS

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Background: Air and Space Force armed drone operators are confronted with the repeated viewing of violent images. The potential repercussions on mental health must be assessed to guarantee psychological support adapted to the needs.

Overview: According to data from the international literature, the prevalence of post-traumatic stress disorder (PTSD) is lower among drone operators (between 5 and 10%) than among fighters in the field, where it can reach nearly 35%. We find polymorphic psychic manifestations often linked to the specific constraints of shift work cycles, day and night, in the world of a cockpit.

Discussion: The symptoms identified are not necessarily part of a characterized psychic disorder and can remain isolated, disappear after a period of operational pause. Nevertheless, these clinical manifestations could have an impact on flight safety. This is why any consultation at the medical branch supporting the squadron must lead to a clinical identification of the warning signs of destabilization of the psychic balance of these airmen. A medico-psychological assessment with a military mental health specialist familiar with the aeronautical environment is essential. In a context of sustained engagement with actions of fire, it is important to explore what could have been an event in the existential trajectory of the subject. Indeed, the after-effects of a possible traumatic encounter are not very predictable and can appear under the mask of operational fatigue in particular.

Recommendations can be put into perspective in different fields: primary prevention in terms of human factors, screening for manifestations of psychological distress with the proposal of a clinical interview guide and specialized care coordinated by the military medic.

INTEREST OF NON-INVASIVE BRAIN STIMULATION (RTMS, TDCS) FOR PILOTS WITH AN ANXIETY OR DEPRESSIVE DISORDER

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Background: Major depressive disorders and anxious disorders have a high prevalence in the general population. Studies highlight that many pilots currently flying are managing depressive symptoms, at least as frequently as the general population. Under-reporting of mental health symptoms is frequent and is certainly due to the public stigma of mental illness, the risk of not fitting for « duty » and fear of negative career. The reporting requirements for pilots are variable around the world. In addition, pilots may be subject to several national regulatory authorities for international flights and the use of a psychotropic drug is often disqualifying for many aeromedical certifications due to their potential side effects. So pilots frequently avoid treatment with antidepressant drugs, however this exposes the pilot to a significant risk of depressive recurrence and major psychosocial impairment, which can evolve towards more severe problems and affect future performance.

Overview: Non-invasive brain stimulation techniques (NIBS) are used to treat depression: some of them have been approved in many countries (Transcranial Magnetic Stimulation, Transcranial Direct Current Stimulation) and others are in development (Transcranial Laser stimulation, Transcranial Ultrasound Stimulation). Their tolerance is good and many studies emphasize their interest at the cognitive level with neuroprotective effects or improved performance. However, we have little data in the field of medical aeronautics.

Discussion: In this communication, we will define the principles of NIBS and discuss their place in the care of pilots suffering from depression and requiring treatment.

NEW DIAGNOSTIC AND THERAPEUTIC APPROACHES: PERSPECTIVE OF AN EXPERT IN AERONAUTICAL PSYCHIATRY AND PSYCHOLOGY

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Background: The constant evolution of screening and treatment methods for mental illnesses, resulting from both modernization of clinical approaches and contribution of new technologies, leads us to question the usual frame of reference that rules on the compatibility between psychiatric disorders and aeronautical fitness. Aeronautical psychiatrists must adapt their logic to the changes that innovation brings to patients.

Overview: This logic necessarily takes into account analysis of underlying pathologies, of possible treatments and of aeronautical motivations, but is also based on the evaluation of associated good prognosis criteria. Those criteria are, among others: absence of serious psychiatric history, comorbidity or additional treatment, monotherapy, psychotherapeutic follow-up or medical-psychological monitoring, provided by an experienced practitioner. It is now necessary to measure the impact of treatment on flight safety, specifically in terms of tolerance monitoring or lackness of undesirable effects. Improved knowledge of pharmacological effects of treatments and new access to predictability of their efficacy noticeably have an impact on the way we assess risk associated with patient's prognosis.

Discussion: The emergence of new methods for screening or treating mental illnesses may change how medical decisions will be made, and change the time to clinical response to treatment, which could improve the patient's prognosis. So what are the consequences on aeronautical fitness? In the field of psychiatric expertise, this translates into the modulation of criteria of severity and detectability, criteria which are complementary to those of frequency and motivation and which allow, in parallel with the consideration of flight personnel's experience and of possible countermeasures that can be put in place, to establish a medico-aeronautical prognosis, which will determine a level of risk deemed acceptable for the continuation of aeronautical practice.

Saturday 24 September 22

Louis Armand East Room

1400-1530

Scientific Session 26

Space Medicine:

Clinical Considerations

CENTRAL NERVOUS SYSTEM (CNS) NEOPLASMS IN MICROGRAVITY

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Introduction: Central Nervous System (CNS) neoplasms are rare yet universal malignancies that arise de novo or are induced by radiation. Modern space missions of increasingly long duration have uniquely positioned humans to study the effects of microgravity and ionizing radiation on CNS neoplasms. So far, only a few on-ground studies have been conducted to analyse the behaviour of CNS neoplasms in microgravity and ionizing radiations.

We aim to confront the molecular mechanisms of tumorigenesis and tumour suppression on-ground and in space (simulated microgravity and HZE). No experiment in space -LEO, deep space, or Martian surface-has been executed so far, leaving open questions about the precise behaviour of tumour cells in space: how will the tumour-suppression properties of microgravity interact with the carcinogenetic characteristics of ionizing radiations?

Methods: A literature review has been conducted using PubMed as the database of reference (May 2021). Search words employed were: “Central nervous system neoplasm AND microgravity;” “Central nervous system neoplasm AND spaceflight;” “Solid tumour AND Microgravity;” “Cancer stem cell AND microgravity;” “Glioblastoma AND microgravity;” “Glioblastoma AND spaceflight;” “Cancer Stem Cell AND spaceflight;” “Tumour suppression AND spaceflight;” “Tumour suppression AND microgravity.”

Results: The search strategy returned 124 references. Of these, 26 were eliminated as duplicates, and a further 82 were excluded at the title and abstract screening stage. The remaining 16 papers were included for full-text review. Of these 16 papers, 7 were included in the study. An additional study was included through citation searching. The majority of the studies in simulated microgravity suggest an inhibition in the glioma cell malignancy, which could contribute to the development of therapeutical possibilities. Conversely, ionizing radiation is deemed to enhance carcinogenesis.

Conclusions: Currently, experimental results in simulated microgravity seem to be auspicious for possible usage of microgravity as a tool for therapies. The role of microgravity in space is hypothesized to be akin to simulated microgravity. The correlation between microgravity effects and space radiation remains obscure, given the speculated propensity of a carcinogenesis enhancement under ionizing radiation. Several questions still remain open.

Further research is essential to comprehend the exact behaviour of cancer in space and the combined effects of microgravity and space radiation.

PRELIMINARY STUDY ON THE FEASIBILITY OF EXPLORING THE FEMALE PELVIC VASCULARIZATION DURING MICROGRAVITY USING THE DRY IMMERSION MODEL

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Introduction: Microgravity is one of the major factors that can jeopardize human physiology during spaceflight. It has been studied at different levels including cell biology and cardiovascular adaptation. Women take a significant place in space exploration including in the future reproductive consideration. This study therefore focusses on exploring women pelvic vascularization in microgravity because of its major contribution to female physiology.

Methods: For this preliminary feasibility study the dry immersion model was used for its ability to simulate a support-free environment already used at MEDES center. Two healthy volunteers accepted to undergo an echo-Doppler study of their common iliac arteries, external branch of iliac artery, hypogastric artery, and uterine artery before and during dry immersion. Multiple pulsatility index (PI) and resistance index (RI) were recorded.

Results: 151 measures could be performed. Mean measurement of PI for iliac arteries (pooled) were respectively 3,65 +/-0,8 and 3,61+/- 0,8 (NS) before and during dry immersion; for RI no difference was found either 0,85+/- 0.04 vs 0.86 +/-0.04. Mean measurement of PI for uterine arteries (pooled) were respectively 3,4 +/-0,87 and 3,01+/- 0,4 (NS) before and during dry immersion; for RI no difference was found either 0,87+/- 0.04 vs 0.87 +/-0.04. In a single immersion session, a complete reversal of physiological uterine artery post systolic reverse flow was observed.

Interpretation: Studying women pelvic vascularization during microgravity was shown to be feasible using the dry immersion model. First results do not show any modification on Doppler measurements except in one sequence. Larger studies will be planned, including more subject and controlling for age and different time of menstrual cycle.

MALIGNANCY AND SPACE MEDICINE, A REPORT OF A COMPREHENSIVE SYSTEMATIC SCOPING REVIEW

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Introduction: Aerospace medicine provides a comprehensive approach to averting health challenges. Although the human bodies are naturally adaptive, the extreme environment of the space endangers astronauts by exposing them to frequent stressors. Radiation, microgravity, and vacuum are hazardous, as well as other stressors such as mental illnesses, dietary alterations, difficulties with circadian rhythm, and limited space. Cancer arises from various changes within cells caused by endogenous and exogenous factors. Carcinogenesis may be triggered and be worsened by the space environment. However, cancer-induced mortality has not been higher in astronauts compared to the others. How aerospace expedition would affect cancer has much to be discussed.

Methods: We designed a search strategy using multiple databases, including Cochrane Library, PubMed, Embase, Scopus, and the Web of Sciences, to review aspects of space missions and malignancies systematically. These include the risk factors, signs, symptoms, and pathophysiology using an author-designed data extraction sheet.

Results: Our search results yielded articles showing both positive and negative effects of the extreme environment on health conditions, specifically cancer. The obtained results highlight the gaps and recommend solutions to promote the quality of care for cancer patients, specifically in aerospace medicine.

Discussion: There are various aspects concerning cancer, its pathophysiology, and prognosis. Microgravity contributes to carcinogenesis by inducing changes in gene expression, cytoskeleton rearrangement, signal transduction, and cell membrane permeability. On the contrary, findings indicate that microgravity might surprisingly help cancer regress and promote its survival. Space radiation can impair cell physiology, followed by errors in the subsequent DNA repairing mechanism inducing carcinogenesis. Radiation and microgravity together can increase the risk of developing cancer. These findings altogether had brought hope to the novel treatment strategies, reminding the necessity of multi-dimensional studies on this topic.

STRUCTURAL CHANGES IN BRAIN MRI DUE TO HEAD DOWN TILT BED REST - SYSTEMATIC REVIEW AND FUTURE RESEARCH GUIDELINES

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Introduction: Magnetic Resonance Imaging (MRI) studies performed in astronauts show changes in brain anatomy after prolonged exposure to microgravity. Head Down Tilt Bed Rest at a 6-degree angle (HDT) is a high-fidelity research model for replicating the upward shift and isolate the actions of microgravity on human brain structure. Our aim is to systematically summarize the available data on the changes in brain structure observed in MRI induced by HDT, and to create a foundation for future studies involving Brain MRI and HDT.

Methods: We performed a comprehensive literature search on EMBASE, MEDLINE, Web of Science, CENTRAL and Google Scholar, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Guidelines. We included experimental studies on healthy human individuals submitted to HDT longer than 24 hours and evaluated using structural Brain MRIs at the beginning of the intervention and during HDT exposure. We extracted the data referring to mean volumetry of grey and white matter, and detailed structural analysis of the whole brain.

Results: The authors identified 124 papers. Three papers were eligible for systematic review. Evidence for Gray Matter volume increases in the posterior parietal regions, decreases in frontotemporal regions and ventricular volume increases were found. No significant white matter changes were found.

Discussion: Volume changes identified seem to mimic those observed after prolonged exposure to microgravity. Further research with adequate protocols and higher sample size are needed to better evaluate these changes and their clinical implications.

RETINAL DIAGNOSTICS IN SPACEFLIGHT AND EXTREME ENVIRONMENTS

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Introduction: Eye changes affect about two thirds of all astronauts on long duration missions. This constellation of changes is called Spaceflight Associated Neuro-ocular Syndrome (SANS) and may include optic disc edema, optic nerve sheath distension, globe flattening, choroidal and retinal folds, hyperopic refractive error shifts, and cotton wool spots, of which optic disc edema is the most critical.

Method: To address these challenges, a technology demonstration was conducted using human-in-the-loop (HITL) testing within two isolated, confined, and extreme (ICE) environments: (1) a Mars ground analog during the 2021 Austrian Space Forum AMADEE Mission to the Negev Desert in Israel, and (2) during Increment 66 from 2021-2022 aboard the International Space Station (ISS). Retinal images from 2 spaceflight and 8 ground analog participants were collected using mobile devices (crew iPads / iPhones). Hardware ease of use was collected using the NASA Task Load Index (TLX). Time required to collect the images was recorded. All data was anonymized, encrypted, and securely downlinked.

Results: Preliminary results for ground analogs show that the retinal image collection task takes an average (standard deviation) of 10m04s (3m51s) seconds, with an average (standard deviation) mental demand of 66.6 (11.3) and effort demand of 61.6 (18.1) yielding the highest workload out of 100 point subscales. Images are now being used to train a machine learning model for object detection using Tensorflow Lite for use as a mobile app. This experiment serves to advance the Technology Readiness Level (TRL) of this eye monitoring technology from 7 (system prototype demonstration in an operational environment) to 9 (final product is successfully operated in an actual mission).

Discussion: Altogether, these results demonstrate that (1) small, lightweight, mobile, non-invasive, non-contact, light-based retinal imaging devices can feasibly capture fundus video images from crew members in isolated, confined, and extreme (ICE) environments and astronauts in microgravity conditions throughout the time-course of a mission, and (2) machine learning models could feasibly aid crew members in SANS monitoring during future ISS missions and the Artemis program.

Saturday 24 September 22

Louis Armand West Room

1400-1530

Scientific Session 27

Infectious Diseases and Aircrew

RETURN TO WORK ASPECTS IN COVID-19 AFFECTING AIRLINE CREWMEMBERS

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Introduction: The pandemic of COVID-19 drastically changed the dynamics of crew assistance while in their layover. Inconsistent international policies and procedures regarding quarantine, testing and repatriation criteria contributed to the difficulties faced from a crew assistance perspective. This study describes the differences pre- and post-COVID-19 concerning crew health.

Methods: The database of MedAire a medical assistance company was queried for airline crew assistance cases in the period of January 1st, 2018 to May 31st, 2022. Cases were initially grouped as Infectious Disease Related (IDR) or non-IDR, and further sub-divided into Symptomatic Cases, Contact-Only and Other, when an alternative diagnosis was issued. Age, gender, and position were recorded, among 73 data points. No personal identifiable information was stored.

Results: 35,023 complete cases were available for analysis. The relative incidence of IDR cases changed along the pandemic. In the early weeks the number of suspected cases affecting crewmembers was disproportionate to general published pandemic figures for symptomatic, as well as contact-only cases. With the recovery of traffic and the availability of diagnostic tools, the incidence of symptomatic IDR closely followed the pandemic waves.

Discussion: The disparity between potential crew cases and general pandemic figures could be the result of heightened awareness with consequent extended days in layover to observe quarantine/isolation. With the progression of the pandemic, data suggest that crew cases followed the general pandemic waves and were not particularly more vulnerable than the general population. The low risk of in-flight transmission, and the possibility of safely transporting simple contact cases or even initial cases suggest that the cost of keeping crew away from base for extended periods can be mitigated by early repatriation.

AEROMEDICAL PROTOCOL FOR RETURN TO FLIGHT AFTER A MALARIA INFECTION

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Background: Malaria infection is the commonest infectious disease and the commonest cause of temporary unfitness for pilots and cabin crew in Nigeria. Impact of Malaria in the Nigerian aviation industry has affected man-power and the crew differently. After adequate treatment, most are assessed fit without restrictions. Assessments for return-to-flight are made by the airline doctor (mostly AAMEs) along with the treating clinician.

Overview: Prevention, early diagnosis and treatment has been the best approach to managing malaria. Malaria poses a huge risk to flying as it is mostly incapacitating due to the infection load, sequelae or complications, and side effects of medications. Usually, clinical treatment takes three to five days but return to flying duties could take additional three days. Is it required to wait until complete recovery with or without cessation of medications? Have policies reduced the malaria impact to the industry? Should the policies be mandatorily adopted by all airlines? Is there an aeromedical protocol to assist return to duty decision? What is the approach to managing malaria outside the endemic regions?

Discussion: When re-flying after malaria infection, the company doctor considers safety of the crew and industry, and the cost to the airline. Clinical history, examination, investigations are adequate tools for efficient decisions. Existing Malaria Control Programs, could be generally adopted by all employers to mitigate the impact of malaria. The challenge of reducing the incidence of malaria presentation, and early return to flight is the common responsibility of the crew, airline doctor and treating clinician. Using the policies and programs could be a useful tool.

HIV INFECTION AND RETURN TO FLYING

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Introduction: In 2020, there were 37,7 million people living with HIV globally, more than two thirds of them in sub-Saharan Africa. Of these people, 28,2 Million people were accessing ARVs in June 2021.

Background: South Africa (SA) has the highest number of people living with HIV in the world (7.5 million), which makes HIV an area of concern for us and necessitates protocols for HIV in aviation. Based on the South African Civil Aviation Authority (SACAA) monthly desktop retrospective analysis on the cases presented, and verification conducted, the number of HIV/AIDS positive aircrew is low and is not representative of the national statistics. It should be noted, that the numbers may be under-reported as HIV testing is not compulsory for aviation medicals. On application for re-certification after HIV diagnosis, applicant is required to submit medical reports as per the HIV protocol. Screening includes complications of HIV, such as opportunistic infections and HIV associated neurocognitive decline.

Case Presentation: The pilot was a 34-year-old male, initial Class II: PPL holder. He was HIV positive and was initiated on anti-retrovirals since 2009, when his CD4 count was 353. In July 2016, treatment regimen was changed to Lamivudine 150 mgs bd; Zidovudine 300 mgs daily and Nevirapine 200 mgs daily, due to his initial regimen being unacceptable for aviation duties. There has been no history of opportunistic infections since diagnosis and no complications noted on this treatment. SACAA HIV protocol necessitates a baseline neuropsychological assessment, conducted by a clinical psychologist. Results indicated that the pilot had inadequate and inconsistent performance in the following areas: working memory, delayed auditory and visual memory and the double tracking and processing speed. As a final arbiter, a medical practical flight test was required by a panel of experts, done to assess the areas of deficit and the applicant passed.

Discussion: HIV – AIDS is a Global pandemic with 79.3 million people contracting HIV since the start of the epidemic. Advances in HIV treatment and HIV education and awareness programmes have led to a decrease in new HIV infections and AIDS-related deaths have decreased since the peak of the epidemic. However, an HIV protocol that looks at markers of disease is essential in ensuring a smooth return to duties and continued certification requires ongoing medical follow-up.

INFLIGHT TRANSMISSION OF SARS COV 2 FROM PRESYMPTOMATIC PASSENGERS TO CABIN CREW: LEVEL OF THE RISK

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Introduction: Numerous questions emerged about the risk of SARS COV transmission onboard. Several studies demonstrated the possibility of such inflight contamination, but few were dedicated to pre-symptomatic passengers. As occupational physicians, we were frequently asked by union representatives about the relevance of the pre-flight screening for lowering the transmission risk.

Most developed countries have implemented a contact-tracing process for each diagnosed case of COVID 19, even for non-symptomatic PCR detection. When the case is a recent air traveler, the airline is notified and asked to alert the passengers seated near the pre-symptomatic case. For the Air France cabin crew, this task is done by the Air France occupational health service (AF-OHS). The AF-OHS is mandatorily notified of every COVID case in the cabin crew.

Methods: To evaluate the risk of inflight transmission from pre-symptomatic passenger we compared the incidence rate of COVID in crew working in an exposed flight to the rate in crew working on a control flight, within 2-20 days after the flight. An exposed flight was defined as a flight with at least one notified COVID positive passenger onboard, and a control flight was a non-notified flight for the same flight leg 1 to 3 days before or after the control flight. The comparison used classic tests of incidence rate comparison.

Results: For 1,688 exposed flights from Aug 2020 to Aug 2021, 1,277 could be matched with a control flight, allowing comparison of incidence rate between 9,728 exposed crew to 11,585 controls. A slightly positive relative risk of 1.109 [0.78 – 1.56] is observed, $p = 0.54$.

Discussion: This powerful study has detected a small non-significant risk of transmission and does not support the hypothesis of an occupational risk of COVID for cabin crew working in a flight with pre-symptomatic passenger on board.

INCREASING NUMBER OF MALARIA DISEASE IN AIRLINE-CREWS FLYING TO TANZANIA: CAUSES AND PROTECTIVE MEASURES FOR CREWS AT SWISS INTERNATIONAL AIRLINES

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Introduction: Airline crews of international airlines are at risk for malaria. The overall risk seems to be low, mainly due to short lengths of stay.

Report of Cases: However, after the wet period in Tanzania in 2017, nine crewmembers were infected with malaria in layovers in Dar es Salaam. Seven crewmembers were infected with plasmodium falciparum, two had a double-infection with plasmodium falciparum and ovale. Four crewmembers showed a severe course of the disease. All crewmembers had used protective measures such as long sleeved clothing and insect repellents. As an immediate measures Swiss International Airlines intensified employee information on preventive measures including prophylactic Malarone-treatment. The updated occupational risk assessment showed that the crew-hotel was located in an expat-area downtown Dar es Salaam on the coast. Although the hotel followed a desinsection-regimen and proper mosquito-protection, doubts on mosquito-control remained, as there was water-retention at low-tide nearby, and because of pools and ponds in the gardens of adjacent properties. We concluded that these mosquito breeding-sites were causal for the malaria transmission. Consequently, the crew-hotel was changed to downtown with no access to the sea. As a result of these measures no cases were registered in 2019.

Discussion: With the ongoing Corona pandemic airlines have to be very alert: Funding for malaria control by the international community has been cut back, accessibility to healthcare in Africa has been limited over 2 years, the production of malaria rapid tests has been diminished in favour of COVID-19 tests, and resistance of the plasmodia against artemisin-combination-therapy and chloroquine is likely to increase due to their use in COVID-19 treatment. The overall risk of malaria infection may be higher and crew awareness must be extended.

Conclusion: Even though malaria in crewsmembers of internationally operating airlines is rare, all measures must be exhausted in order to prevent crews from acquiring malaria during layovers in malaria-prone areas.

Saturday 24 September 22

Gaston Berger Room

1600-1730

Scientific Session 28

Clinical Aviation Medicine

From Screening to Assessment

REFRAMING AEROMEDICAL SCREENING: AN INTERNATIONAL COMPARISON STUDY OF HEALTHCARE AVOIDANCE BEHAVIOR DUE TO FEAR OF AEROMEDICAL CERTIFICATE LOSS

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Introduction: Certain aircraft pilots are required to undergo periodic aeromedical examinations to ensure applicable medication standards are met. If a pilot discloses a new symptom or condition during the aeromedical examination, the pilot runs the risk of temporary or permanent loss of their medical certificate, resulting in potential negative professional, financial and/or social consequences. For this reason, recent studies have demonstrated a significant proportion of pilots experience healthcare seeking anxiety and/or participate in healthcare avoidance behavior. Aeromedical certification processes vary by country, which may result in variance in pilot healthcare avoidance behavior between jurisdictions. To our knowledge, no international comparison exists.

Methods: We conducted a cross sectional population-based anonymous survey of pilots in the United States and Canada delivered through aviation related social media groups/podcasts, email distribution lists of several U.S. based airlines and an aviation university, and flight medicine clinics of the US Air Force.

Discussion: 3,763 U.S. pilots and 1,405 Canadian pilots (72.8% v. 26.7%) were included in the analysis. The respondents included 491 female pilots (9.5%), 1,679 paid civilian pilots (34.2%) and 280 military pilots (5.7%). 55.9% of respondents admitted to at least one type of healthcare avoidance behavior due to fear of medical certificate loss (56.1% of US pilots v. 55.2% Canadian pilots, $p=0.58$). There were 67.9% of Canadian pilots who reported ever seeking informal medical advice due to fear of medical certificate loss compared to 52.7% of US pilots ($p\leq 0.01$). When asked if they had ever withheld information during an aeromedical examination, there were 39.9% of Canadian pilots and 28.7% of US pilots who affirmed ($p<0.001$). Statistical significance was found between select pilot subgroups.

Conclusion: Select pilot healthcare avoidance behaviors may have higher prevalence in certain jurisdictions due to factors unique to the local aeromedical system.

HOW TO OVERCOME LIMITATIONS OF CARDIOVASCULAR RISK ESTIMATION TOOLS

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Introduction: Cardiovascular events are the most important medical causes of in-flight incapacitation of pilots. Specific risk estimation tools (RET) are used for a risk stratification of cardiovascular diseases (CVD). Pilots with an elevated CVD risk need an enhanced cardiological examination, e. g. CT coronary angiography (CTCA). In order to check the reliability of RET results, patients with a low risk were selected and sent to CTCA scanning.

Methods: As RET the Swiss AGLA-score (a modified PROCAM-score) was used, which predicts a ten-year risk for a fatal or nonfatal CVD event. A result of <10% is considered as low, 10-20% as intermediate and >20% as high risk. Consecutive patients were selected within a period of six months, who fulfilled the following criteria: No anginal pain, RET score indicating low CVD risk, but having at least one strong CVD risk factor. They were evaluated by CTCA examination.

Results: Six men, including two pilots, and one woman were included (age range 57-66 years). All had an AGLA-estimated CVD risk of <10%. Six patients had an exercise test which was negative. Every patient had a highly positive family history for CVD and/or a high cholesterol-level. CTCA tests showed almost no coronary abnormalities in one patient, mild coronary lesions in two other patients, and significant coronary disease in the remaining four patients. Three of them were sent for invasive coronary angiography.

Conclusions: 1) RET low risk results must be interpreted with caution, when one of the risk parameters is very high. 2) CTCA plays an important role in the risk stratification cascade.

INCIDENTS OF AIRCREW DUE TO CORONARY ARTERY DISEASES: HAS GENETIC TESTING AN ADDING BENEFIT?

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Introduction: Family history is a risk factor for coronary artery disease (CAD). Recent studies identified several genetic variants associated with coronary artery disease. Some of these genetic variants are and some are not associated with classical cardiovascular risk factors. Preventive measurements in aviation is very important. The aim of the study was to analyse the feasibility of DNA tests in CAD risk prediction algorithms to clarify the mechanism of those associations.

Methods: Over the last 4 years, we have reviewed more than 5000 routine aeromedical examinations. About half of the patients showed elevated cholesterol levels, around 1% of these showed AGLA Risk Score 7.5 % or more.

The program included Pilots with high AGLA Risk Score and therefore increased risk for asymptomatic CAD. We provided a coronary CT and, in case of a strong positive family history for CAD, a specific genetic assessment to detect possible plaques and/or existing atherosclerosis.

Results: Over the period of 4 years in three cases a genetic atherosclerosis assessment was performed. Assessing local genetic information's has had a direct impact in further preventive medication and control rhythm.

Conclusion: The genetic assessment is an additional element in the prevention of an incident of aircrew caused by CAD due to a therapeutic benefit.

USAF PILOT APPLICANT DISQUALIFYING CONDITIONS AND WAIVER RATES FOR FY21

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Introduction: To attend USAF pilot training, applicants must meet Flying Class I (FCI) medical standards described in the Medical Standards Directory of DAFMAN48-123. The standards are not static but are updated regularly by the Flight and Operational Medicine Corporate Board, based on operational requirements and medical advancements. Most flight surgeons are unaware of the most commonly disqualifying conditions nor the actual waiver rates for aeromedical waivers submitted for pilot training.

Methods: FCI examination certification authority is delegated from the AF Surgeon General and Chief of Aeromedical Services (SG3P) to a centralized office at Randolph AFB. FCI exams are submitted electronically via the Physical Examination Processing Program (PEPP). Conditions requiring waiver have an aeromedical summary submitted via the Aeromedical Information Management Waiver Tracking System (AIMWTS). The certification office uses a database to track all certifications and disqualifying conditions for FCI examinations. Queries of this database were run for the Fiscal Year 2021 (FY21 = Oct 20 through Sept 21) timeframe and disposition of FCI exams. Rates of qualification, waiver and disqualification were calculated for all FCI dispositions.

Results: Total number of pilot applicant exams submitted for certification for FY21 was 2074. Overall qualification rate is 58%. Overall medically acceptable for FCI with waiver is 26%. Overall disqualified rate is 16%. A descriptive analysis will present the most frequent diagnoses as well as a breakout of top grouped ICD-10 codes requesting waiver with the actual waiver rate for these grouped diagnoses.

Discussion: Overall, the vast majority of applicants for USAF pilot training are medically acceptable, not unexpected in this military accession screened population. The most commonly waived conditions include myopia, defective binocular vision, asthma, excessive astigmatism and hearing loss. Mood disorders, attention deficit disorders, and anxiety disorders are also very common. As expected for military aviation, mental health conditions are waived at somewhat lower rates. Changes in the medical standards account for some of the annual variance in waiver requests.

DESIGN, TESTING, AND IMPLEMENTATION OF THE USAFSAM AEROMEDICAL CONSULT SERVICE MEDICAL RISK ASSESSMENT MATRIX (AMRAM)

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Introduction: The U.S. Air Force (USAF) School of Aerospace Medicine (USAFSAM) developed a conceptual framework for a risk matrix approach to evaluating and communicating aeromedical risk; this resulted in the Aeromedical Consult Service Medical Risk Assessment Matrix (AMRAM). Prior to implementation, the ACS conducted a study to evaluate results using the AMRAM to results using the legacy method (essentially the 1% rule).

Methods: The ACS adapted existing USAF standards to evaluate aeromedical events of concern. This produced a matrix which evaluates likelihood and severity of a given medical condition separately, using five levels of likelihood ranging from rare to frequent and four levels of severity ranging from negligible to catastrophic. The AMRAM definitions for likelihood and severity are directly linked to USAF airworthiness standards. After gathering feedback from experts, the ACS sampled 100 previously adjudicated cases to compare the legacy case dispositions to those generated from the AMRAM using polychoric correlation.

Results: Subject matter expert feedback was positive. The AMRAM disposition showed strong agreement with legacy dispositions, with $\rho^* = 0.9424$ ($p < 0.0001$). One case was discarded as it did not meet inclusion criteria. Of the 99 remaining cases, 88 had perfect agreement between legacy and AMRAM dispositions. Only 3 of the 11 cases with different dispositions were more restrictive with the AMRAM; two of those were due to an error in the legacy disposition.

Discussion: The AMRAM produces disposition recommendations that are highly consistent with the legacy approach informed by the 1% rule. In cases where the AMRAM and legacy dispositions disagreed, the AMRAM disposition tended to be more permissive. The USAFSAM AMRAM represents a critical advancement in USAF aeromedical risk assessment. It allows a more dimensional evaluation of risk than does the 1% rule, communicates aeromedical risk consistent with other USAF risks, and harmonizes aeromedical risk with the level of risk the USAF has defined for all flying systems. The ACS has begun to use the AMRAM as standard practice in future aeromedical risk assessments. Lessons learned from initial implementation and implications for future use will be discussed.

Saturday 24 September 22

Louis Armand East Room

1600-1730

Scientific Session 29

AEROMEDEVAC and Operational Considerations

SEARCH AND RESCUE MISSIONS PERFORMED BY THE FRENCH ARMY FROM 2015 TO 2019

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Introduction: Search and Rescue missions are carried out by the French Air and Space Force for the benefit of civilians and the armed forces. The objective of our study is to know how many lives have been saved by these missions in France over a period of 5 years.

Methods: An analysis of the forms written at the end of each mission by the doctors taking the alert on seven metropolitan bases was carried out between 2015 and 2019. The main judgment criterion was to determine how many patients are in “imminent life-threatening danger” when the medical team arrives. To do this, we have created a composite criterion which is based either on the clinical state of the patient or on the clinical classification of patients in mobile emergency and resuscitation structures (CCMS) assigned to him by the doctor on his arrival.

Results: Of the one hundred and seventy-five charts analyzed, sixty-one patients were considered to be in imminent danger to life at the time of medical treatment (34.9%). Secondary transport, neurological distress and cardiac distress accounted for 62% of the most serious patients. Across all missions, the most frequent reasons for leaving concerned traumatic pathologies (18.9%), secondary transport (16%), neurological distress (14.3%) and cardiac distress (12.6 %). The procedures the most regularly performed were volume expansion (77 times), administration of morphine (33 times), oxygen therapy (30 times) and administration of antiaggregant or anticoagulants (15 time).

Discussion: SAR missions seem to take care of serious patients because of their isolation and the lack of first aid on the scene. They are frequently triggered as last resort. They regularly fill a capacity deficit where conventional rescuers cannot operate and contribute to improve the prognosis of rescued patients.

LEVEL OF ONBOARD CARE FOR CRITICAL PATIENTS: ANALYSIS OF THE FRENCH ARMED FORCES AIR MEDICAL EVACUATIONS FROM THE SAHEL SINCE 2013

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Introduction: Since 2013, the French Armed Forces have been engaged in the Sahel. The aim of our work was to study the characteristics of severe patients evacuated according to the composition of the aeromedical staff: an anaesthesiologist/intensive care physician (AICP) or an emergency physician (EP).

Methods: This was a retrospective cohort analysis including all French service members repatriated from the Sahel with a speedy evacuation priority between 2013 and 2019. Data were collected from the evacuation report, the in-flight report and the military digital medical file.

Results: A total of 191 patients were evacuated. The causes were trauma for 103 patients and disease for 88. Trauma patients included war injuries (n=58) and non battle injuries (n=44). For disease patients, the main pathologies were cardiovascular (n=17), infectious (n=17), neurological (n=15) and gastrointestinal (n=12). Highly dependent patients were significantly ($p<0.001$) more likely to be managed by an AICP (n=41) than an EP (n=5). Moderately dependent patients managed by an AICP (n=51) were more frequently unstable hemodynamically (n=5 Vs n=0, $p<0.05$) and referred to an intensive care unit (n=24 Vs n=2; $p<0.001$) than those managed by an EP (n=41). There were no deaths in flight.

Discussion: The evolution of armed conflicts has led the FMHS to re-examine the terms and conditions of STRATEVAC. Greater involvement of EPs could be envisaged in order to best match patients health status with the level of care expected in flight. It also would provide more personnel trained in long-distance air transport.

TRANSFUSION OF LABILE BLOOD PRODUCTS DURING FORWARD MEDICAL EVACUATION MISSION

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Introduction: Early transfusion of labile blood products (LBP) improves the survival of combat casualties in hemorrhagic shock, especially if it contains platelets. The French Military Health Service provides different LBP to aeromedical evacuation teams: lyophilized plasma LP (since 2015), red blood cells concentrate RBCC (since 2019) and cold-stored low-titer group O whole blood CS-LTOWB (since 2021). Only CS-LTOWB contains platelets. France is one of the few nations transfusing LBP, including CS-LTOWB, during a forward medical evacuation (FWD MEDEVAC).

Methods: In a single-center retrospective study, we included all patients who received a transfusion, initiated or continued, during a FWD MEDEVAC for a critically wounded casualties during Operation Barkhane West Zone between January 2015 and May 2022. Excluded were patients transfused during a tactical medevac (TACEVAC).

Results: Out of 126 missions of 164 critically wounded patients, we included 50 patients. 5 patients were excluded (transfusion during TACEVAC). We traced the use of 62 LBP, including 42 units of LP, 12 units of RBCC and 8 units of CS-LTOWB. Twenty nine percent of the wounded were troops from Barkhane coalition. Introduction specific portable cooler for LBP enabled 38% of critical casualties to be transfused, and increased the ratio of critical casualties who benefited from LP, rising from 19.5 to 32%. The average flight time with patient was 41 minutes. FWD MEDEVAC mission for critical casualties concerned 2.05 patient per flight; 26% of the time, the second patient was also a critical casualty.

Discussion: Early administration of platelets enabled by CS-TLOWB for hemorrhagic shock casualty is a major advance in terms of morbidity-mortality. CS-TLOWB is actually not available in pre-hospital mobile emergency and resuscitation capacity in France. The introduction of the specific cooler, combined with enhanced dedicated training, played a large role in increasing the number of early transfusions.

CASA MEDEVAC PROOF OF CONCEPT: TEN YEARS OF ACTIVITIES IN THE SAHEL

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Introduction: Medical support of French military operations in Sahel justifies the deployment of several aircrafts to offer the shortest medical evacuation (MEDEVAC) timelines in an area of more than five million square kilometers. One fixed wing aircraft CASA CN 235 located in Gao is specifically dedicated to perform forward (from the point of injury to the role 2) or secondary tactical MEDEVAC.

Method: All flights performed by the CASA MEDEVAC team were prospectively collected from January 2013 to May 2022 and retrospectively analyzed in this observational study.

Results: 5544 flight hours were achieved. 749 MEDEVAC were performed for 1550 patients. Their initial categorization included 10% Alpha, 23% Bravo and 67% Charlie patients. 34.5% had non battle medical or surgical problems, 34.2% were combat casualties mostly by explosion, and 18.7% suffered non-battle injuries. Mechanical ventilation was performed for 5%. Improvement of logistics allowed transfusion of blood products with lyophilized plasma since 2015, red blood cells since 2019 with the portable cooler and more recently since 2021 cold stored low titer O whole blood. No difficulties related to the aeronautical environment were reported by the teams. MEDEVAC were performed for French or allied service members but also for local nationals.

Conclusion: Tactical MEDEVAC with fixed wing aircraft has become a crucial capability for the French military medical support in remote areas. Aeromedical teams, thanks to a specific training program before a deployment, were able to provide En-Route intensive care before or following damage control surgery, including transfusion.

CONTINUOUS TISSUE OXYGEN MONITORING DURING AERO MEDICAL EVACUATION IN A PORCINE MODEL

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Introduction: Tissue oxygenation is reduced during hemorrhagic shock. While continuous invasive monitoring remains the gold standard for detecting hemodynamics changes in the wounded, its implementation may be limited particularly at time of conflicts and during aero-medical evacuation. An oxygen sensing hydrogel using the principle of phosphorescence quenching (Lumee, Profusa, CA) was used to detect changes in tissue oxygen/hypoxia in response to air transport of polytraumatized swine.

Methods: Anesthetized Yorkshire underwent combined brain injury and hemorrhagic shock. Lumee probes were placed subcutaneously for continuous tissue oxygen measurements 5 days before catheter placement and craniotomy of the animals. In injured group, animals (n=12) were injured via fluid percussion followed by a 30% hemorrhage. Sham group (n=9) was instrumented but not injured. After 2h post-injury the animals were transferred from gas to IV anesthesia before being transported to the hypobaric chamber. The evacuation consisted of a 4 hours evacuation at 8000ft and 1 hour stabilization at 300ft. Controls were evacuated at 300ft (ground). Vitals and Lumee data were normalized and analyzed for the evacuation duration (5 hours).

Results: Tissue oxygenation increased during the transfer to the chamber and initial take off in all groups. Oxygenation stabilized thereafter. This was attributed to the effect of the IV anesthesia. At landing in the hypobaria Sham or injured groups tissue oxygenation increased noticeably. This was due to the change in oxygen partial pressure from 8000ft to 300ft. Some of the physiologic indices (MAP) also indicated changes when returning to ground level.

Conclusion: Changes of altitude at landing as well as the return to ground barometric oxygen pressure might have an impact on tissue oxygenation and blood pressure that need further consideration.

Saturday 24 September 22

Louis Armand West Room

1600-1730

Scientific Session 30

Occupational and Travel Medicine in Aviation

LONGTERM SICKNESS IN PILOTS AND CABIN CREW: THE POSITIVE IMPACT OF A MULTI-DISCIPLINARY TEAM

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Introduction: A pilots' medical license needs to be suspended after 20 consecutive days of sickness and then reinstated once recovered.

Methods: The database of the General Civil Aviation Authority of the UAE was searched for all reported loss of medical license and temporary suspension of license between 2018-2021. The ICD-10 codes were extracted and morbidity was divided into 9 different specialties: dermatology, ear nose and throat (ENT), medical, musculoskeletal, ophthalmology, psychiatry, surgical and urology.

Table. Period of Incapacitation for Pilots

Specialty	N	Mean Days	STDEV	Range	95% CI	Did Not Return
Dermatology	21	44.9	39.6	9-162	25.2-64.6	3
ENT	59	150.4	285.9	1-1727	75.3-225.6	1
Gynaecology	30	419.4	382.6	5-1390	268-572.7	4
Medicine	335	189.3	324.8	58-2170	151.7-226.9	37
Musculoskeletal	392	115.2	188.4	2-1446	96.3-134.2	13
Ophthalmology	68	90.3	128.7	2-719	58.6-121.9	2
Psychiatry	61	385.6	594.3	6-2757	195.5-575.6	20
Surgical	174	101.6	231.4	1-2025	64.9-138.4	10
Urology	93	109.4	223.5	2-1268	27.8-131.5	10
Total	1233	148.4	276.8	1-2757	63.0-98.6	100

Results: Musculoskeletal conditions accounted for 32% of all cases. Cardiology, Neurology and Psychiatry often have regulatory groundings of minimum time periods based on each condition. This makes it very difficult to reduce the impact of these conditions on the company and the individual. The majority of gynecology cases were for pregnancy.

I analysed the time off work for all pilots that had shoulder surgery in the last 4.5 years. Half were managed by doctors with musculoskeletal background and had their rehabilitation with the multi-disciplinary team of Emirates Airline. The rest were case managed by company general practitioners and had their rehabilitation at various different external service providers.

Discussion: I will demonstrate how a multidisciplinary team taking care of musculoskeletal conditions can reduce the financial burden and operational impact of these conditions to the individual as well as the company.

CASE STUDY OF CABIN AIR QUALITY EVENTS

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Introduction: The Safety Investigation Authority of Iceland (RNSA) proposes an introduction to a cabin air quality investigation, which is in its final stages before publication. The investigation is based on cabin crew illness incidents that have occurred on aircraft equipped with high-bypass turbofan engines, where the cabin crewmembers had in-flight symptoms and/or have been dealing with long-term illness after the events.

Method: During the investigation process, RNSA investigated eight cases of cabin air quality events as well as preparing statistics for all such events on Icelandic registered aircraft over the 10-year period of 2011-2020. The investigation touched subjects such as lack of airflow, ozone, cabin air contamination, possible on-board air sampling, matching possible contaminants with symptoms, hair sample analysis, surface sample analysis, and oil sample analysis. The aim was to trace cabin contaminants to find possible source of the contamination.

Results: The investigation revealed that in many cases the cabin air quality events could be traced to lack of air flow, being caused by contaminants in the air conditioning system, or by broken or dislodged air conditioning ducts. In some cases, the investigation obtained data indicating the presence of TCP contamination in the aircraft. The TCP was used for tracing to a possible source of the contamination.

Conclusion: The ITSB determined a possible cause of the TCP in the aircraft to be from the engine bleed air. Review of the cabin air quality events showed many engines to have incurred multiple cabin air quality events. Acceptable limits for onboard air contaminants are set by FAR 25 and EASA CS.25 for large airplanes equipped with high-bypass turbofan engines, but no collection of air samples is performed to ensure continued airworthiness during wear and tear.

BIOLOGICAL MONITORING IN AIRCREWS WHO EXPERIENCED A FUME AND SMELL EVENT (FUSE)

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Introduction: Cabin air of aircraft is supplied by bleed-air from the aircraft engines. In case of malfunction, engine oil may be released into cabin air resulting in unpleasant odour or even visible smoke. However, unusual odours can also have other causes. Aircrews and passengers experiencing such “fume and smell events” (FUSE) reported symptoms such as exhaustion, headache, sight disorders and even incapacity to act. Tricresyl phosphates (TCPs) including the neurotoxic ortho-TCP isomer from engine and hydraulic oils, as well as a concurrent interaction of several organophosphates or exposure to volatile organic compounds (VOCs) have repeatedly been addressed to be responsible for reported symptoms. Therefore, we conducted a study using Biological Monitoring to evaluate to which extent aircrews are exposed during a FUSE.

Methods: Between 11/2018 and 02/2020 we enrolled 375 flight attendants and pilots from 167 flights directly after landing at 12 German airports. According to their own statements, all of them had experienced an event during the flight before. For comparison we enrolled 88 control persons. In blood and urine samples we quantified metabolites of 21 isomeric TCPs along with four additional organophosphate flame retardants, 10 VOCs including neurotoxic n-hexane and toluene, as well as changes in the activity of acetylcholine esterase (AChE).

Results: None of the aircrew samples contained metabolites of ortho- or meta-TCP. A few samples from crews as well as controls contained para-TCP metabolites. Metabolites of tributyl, triphenyl and chlorinated alkyl phosphates were detected in nearly all samples but were not found to be significantly higher in aircrews. Similarly, no FUSE indicator substance was found among the VOCs. However, in a few individual crews we measured elevated alkane concentrations which may represent an exposure typical for the profession - not indicating a toxicological relevance. A reduction of the AChE activity was not seen in aircrews, neither in a collective comparison nor on individual basis.

Conclusions: Specific exposure to organophosphates including ortho-TCP, the combined exposure to organophosphates, or exposure to the neurotoxic VOCs n-hexane and toluene can hardly be attributed to the reported health effects after FUME.

LOW BACK PAIN AND RELATED DISABILITY IN HELICOPTER PILOTS: A SURVEY OF PREVALENCE AND RISK FACTORS

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Introduction: Helicopter flying has long been associated with Low Back Pain (LBP). The study investigated the prevalence of and the associated risk factors for helicopter pilots LBP, the related disability and potential mitigation strategies.

Method: A quantitative descriptive research was carried out, involving the administration of a semi-structured, anonymous, voluntary questionnaire, to all active duty Cyprus Air Force helicopter pilots, stationed at Paphos Air Base. The questionnaire concerned flight-related and individual risk indicators, psychosocial factors, frequency of LBP episodes, pilot perceptions and associated disability. Multivariate regressions, with the potential to control for confounding factors, were used to estimate relative risks (RR). The response rate was 75%.

Results: The reported 3-month prevalence of LBP was 69%, 80% of pilots blaming 'flying a helicopter' and 66% pinpointing at 'Vibration' and 'Posture.' The helicopter type reported ranking in terms of association with LBP, was Mi-35 (47.5%), followed by Bell-206 (35%), Gazelle SA-342 (15%) and AW139 (by 2.5%). A history of recent pain in a closely related anatomical region (RR=3.65, 95% CI=1.79-2.53, p=0.035*) and a previous history of low back pain (RR=1.50, 95% CI=1.20-1.87, p=0.0003*), were significant risk factors for LBP*, while height and BMI, greater than 1.75m and 25.1 respectively, showed a non-statistically significant associated trend towards increased risk. On the other hand, muscle strength training was a significant risk reduction factor (RR=0.46, 95% CI=0.24-0.90, p=0.023. Among LBP cases, 38% reported pain interfering with flying duties and 41% 'considerably less' LBP when wearing a Lumbar Support in flight.

Conclusions: LBP is a common, universal occupational disorder among helicopter pilots. Its prevalence, appraised aetiology and associated disability in CAF helicopter pilots, were comparable to other corresponding populations. The reported interference with flying duties highlights the potential threat posed to Flight Safety. Identified risk indicators can be useful tools in risk management.

INITIATING OPTIMIZATION OF THE HUMAN WEAPONS SYSTEM: A NEW FIGHTER PILOT ENTERPRISE

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Background: High prevalence of neck/back pain is a perennial concern in fighter aircrew. As high performance aircrew helmets have gained additional functionality, they have also become heavier, exacerbating this condition. Additional functionality is gained by attaching modifications to helmets; this offsets the center of gravity of the head. In combination with exposure to high +Gz, aircrew are forced into awkward head/neck positions. The confluence of these factors cause fatigue, pain and a high cervical injury rate; neck pain may also lower fighter aircrew retention rates. In order to reduce neck pain in fighter aircrew, USAF developed the Optimizing the Human Weapons System (OHWS) initiative. OHWS is a program that mirrors the “high performance athlete” model of care by utilizing “pre-habilitative” therapies to address fighter pilot neck and back pain.

Overview: OHWS is a data driven initiative, with analytic support capabilities used to determine efficacy of the program. The data collection plan is designed to determine effectiveness of modalities utilized as well as the efficacy of the program based on aircrew participation. Multiple questionnaires have been used to garner subjective assessments of impact of neck pain on mission and evaluate the program. Objective measures are collected on aircrew to determine changes in perceived pain, range of motion and strength. Aggregate data is made available to line/USAF leadership.

Discussion: OHWS is available to an estimated 3,000 fighter aircrew across 3 Major Commands of the USAF. The personnel of the OHWS program will include physical therapists, athletic trainers, massage therapists and strength and conditioning coaches. OHWS will mirror support provided to high performance athletes through embedded personnel. Ensuring accessibility, OHWS anticipates high utilization within the fighter pilot community. Major objectives are improving long-term quality of life, optimizing human performance and readiness while avoiding injury prior to occurrence.

HOW DUTY ROSTERS AND STRESS RELATE TO SLEEP PROBLEMS AND FATIGUE OF INTERNATIONAL PILOTS

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Background: While previous research focused on pilots' fatigue, rosters, potential performance-impairment and aviation-safety, this research investigates, how pilots' work-related and psychosocial stress and rosters can affect their sleep and fatigue.

Methods: A cross-sectional online survey was completed by 192 pilots flying for European operators, 180 Australian pilots and 34 pilots from UAE, Turkey and Asia Pacific. Pilots reported their actual duty- and flight-hours, flown sectors, standby, rest, vacation days, number of early starts, night-flights and sports-hours for the last two months. Schedule-related data, way to work, age, flight-hours on the present type of aircraft, subjective job-security and psychosocial stress were used as independent variables to investigate, which significantly predict sleep problems (JSS) and fatigue (FSS).

Results: Seventy-six percent (76%) of the active pilots reported significant fatigue ($FSS \geq 4$), 33.4% high fatigue ($FSS \geq 5$), although pilots were rostered for only 56.25% to 61.32% of the legally allowed duty and flight hours/month. Considerable sleep problems in ≥ 8 nights/month were reported by 24.2% pilots. Sleep problems were strongly associated with sleep restrictions and fatigue risks experienced on flight duty. More sleep problems were predicted by more stress and fatigue risks on flight duty. Higher fatigue-severity was predicted by more sleep problems, more stress, more fatigue risks experienced on flight duty, less physical exercise and shorter ways to work.

Conclusions: Our findings suggest that present flight-time-limitations likely cannot prevent fatigue and potentially foster sleep-problems. In line with work-psychology and stress-research, psychosocial stress plays an important role for pilots' sleep.

Part 2: Poster Presentations

Day 1 Posters

TRANSIT CRISIS : OPERATIONAL IMPACT OF THE COVID-19 PANDEMIC ON BA 123 SQUADRONS

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Introduction: Air Force Base (BA) 123 "Major Charles Paoli" in Orléans Bricy is the historical base of military air transport. It is the only maintenance point for the A400M. All units with crew members are supported by the 100th Medical Service (MS).

Method: This retrospective descriptive study, conducted between March 2020 and February 2022, aims to quantify the operational impact of the COVID-19 on the crew members supported by the 100th MS. The diagnosis of a COVID-19 infection is based on the positivity of a polymerase chain reaction, or an antigen test. The period of operational unavailability is set at 10 days per case positive for COVID-19, and at 48 hours after a vaccine injection.

Results: BA 123 has 205 PN. Fifty-eight suffered from COVID-19 disease (28.3%), none presented a serious form requiring hospitalization. On the 07/31/2021, the vaccination coverage considered complete (2 immunizations) for the crew members population was 94.6%. On the 02/28/2022, it was complete (3 immunizations) for 88.3%. In total, 575 vaccine doses were injected for the benefit of the crew members. The total operational unavailability of the crew members represents 1730 days, ie 4 years and 9 months.

Discussion: Crew members are not a population at risk of severe form of COVID-19 thanks to their medical selection and the vaccination coverage. Their ability to fly is conditioned by a complete vaccination. Finally, despite the inevitable biases linked to the under-declaration of infections and the failure to count isolations relating to "contacts at risk", the aeronautical operational unavailability amounts, in fine, to 1730 days, i.e. 4 years and 9 months.

THE COVID 19'S CONTROL AT NIAMEY AIR BASE

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Introduction: The projected air base (BAP) in Niamey is the main logistics HUB of the western zone of Operation Barkhane. She has not escaped infection by COVID-19, the spread of which is favored by social contact, the warm atmosphere and the logistics of containing positive cases. This observation may lead to fears of a major impact on the operational capacities of the BAP.

Methods: This single-center retrospective descriptive study describes the number of patients who presented with a COVID-19 infection on the Niamey BAP between October 2021 and January 2022. The diagnosis of COVID-19 infection was based on the positivity a test: a polymerase chain reaction or an antigenic test. The identification of the variants was carried out by a civilian laboratory in Niamey. In parallel, the anti-COVID vaccination campaign is analyzed, making it possible to describe the evolution of vaccination coverage during the study.

Results: 1683 tests were carried out, making it possible to diagnose COVID-19 infection in 207 patients, without any serious form. The infection of BAP personnel took place in two successive waves: 118 cases exclusively positive for the DELTA variant between 20/10 and 27/12/2022 then 89 cases only positive for theOMICRON variant between 28/12/ 2021 and 01/27/2022. A total of 893 doses of vaccines were injected. Full immune coverage was 55.5% as of 12/28/2021 and 97.8% as of 01/16/2022.

Discussion: The study finds two waves of COVID-19 very close together, caused by two different variants. The contact tracing strategy associated with the rapid achievement of significant immune coverage made it possible to break the extension of theOMICRON wave, greatly limiting the total duration of operational unavailability. Vaccination is an important weapon in the fight against COVID-19 during an OPEX in sub-Saharan Africa.

SAFETY MEASURES IN COVID-19 SITUATION: RMAF EXPERIENCES

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Background: Year 2020 was the mark of COVID-19 pandemic throughout the world. Malaysia, a small country in Southeast Asia, was also badly affected. In the middle of 2020 where the situation getting worse, the only air transportation available were from RMAF. RMAF deployed its transport aircraft to fulfil country requirements. RMAF did all the air tasking during pandemic critical time. This presentation shows our experiences with safety measures for aircrew deployment during pandemic situation. Air tasking includes aeromedical evacuation, transporting goods and necessities between states, especially between east and west Malaysia, sending COVID-19 sample media to respective laboratories, distributing COVID-19 vaccine and the medical personnel. These were some deployment taskings they did and HADR. This was stressful and fatigue situation for the RMAF aircrews.

Overview: These were RMAF aircrews experienced throughout the pandemic time. This topic is about how the public health physician of Institute of Aviation Medicine helped the aircrews in terms of safety measures to protect the aircrews from the virus and psychological support during the pandemic. It is to identify a critical aspect in aviation medicine in terms of emergency public health situation.

Discussion: This is to highlight the safety measures taken for the aircrews and the importance of psychological support for aircrews during public health emergencies. It also shares the RMAF experiences in handling the pandemic.

AIRCREW CONFIDENCE AND TRAINING INTERVALS IN HELICOPTER UNDERWATER EGRESS TRAINING

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Introduction: Evidence-based assessment of the effectiveness of underwater egress training is lacking, and competency standards are difficult to establish. Ideal training intervals to maximize training efficiency and retention require establishment. This study aims to compare pre-training and post-training confidence ratings between fixed-wing and rotary-wing aircrew personnel and preferred egress theory training intervals.

Methods: The sample (N = 186) included United States aircrew personnel participating in underwater egress training. Before training, participants completed a questionnaire on training experience, underwater egress skills, knowledge, confidence, and desired training intervals. Post-training questions asked participants to rate their training performance and confidence in egress ability. A repeated measures ANCOVA was run to determine whether egress training and aircraft classification impacted crew member confidence in egress ability accounting for preferred theory training interval.

Results: The ANCOVA found that training had a significant impact on egress confidence (pre and post-training), $F(1, 175) = 31.13, p < .001$. Additionally, a significant interaction was found between egress confidence and preferred theory training interval, $F(1, 175) = 6.59, p = .011$, but not between egress confidence and aircraft classification, $F(1, 175) = 2.00, p = .160$.

Conclusions: Results indicate that egress training increased confidence across aircraft classifications. Aircrew preferring a shorter theory training interval also had greater increases in confidence following egress training. It is likely that those reporting a preference for a shorter training interval confer the most benefit from the combined practical and theoretical egress training because they have insight into their level of retention, are more acutely aware of the dangers of their position, or are more reliant on theoretical refresher courses. Future studies should assess the potential differential benefit of shorter intervals for theoretical, practical, and combined egress training.

HUMAN CHALLENGES TO ADAPTATION TO EXTREME PROFESSIONAL ENVIRONMENTS: A SYSTEMATIC REVIEW

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Introduction: NASA is planning human exploration of the Moon, while preparations are underway for human missions to Mars, and deeper into the solar system. Isolated and Confined Environments (ICE), and Extreme and Unusual Environments (EUE) are known to adversely affect a human being's psychology and physiology. Data from historical and analog missions, such as research stations in Antarctica and space flights, suggest that prolonged periods of social and sensory monotony can have negative impacts on human functioning, notably psychosocial health, cognition, a decreased ability to regulate stress and emotions with an increase of negative emotions. This systematic review focuses on professional ICE/EUE. It provides an insight into their impacts, and how humans adapt to them.

Methods: Seven electronic databases were screened for scientific studies examining the impact of ICE/EUE on individuals. A manual search was also used. A total of 81 publications were selected using PRISMA methodology since 2005.

Results: Our analysis reveals a heterogeneity of methodologies that are deployed in a wide variety of analogs. In view of the health risks associated with this type of environment, results highlight the need for a better understanding the physiological, biological, cognitive, and behavioral impacts of ICE/EUE on the human body, and how humans adapt. In all cases, ICE/EUE environments deteriorate the health of these professionals.

Discussion: The review highlights the need to consider new analogs for future long space missions and the necessity to understand how extreme environments lead to adaptation. These conclusions are essentials not only to better-manage pre-departure risks, but also to propose relevant and effective countermeasures to reduce them during the mission. This is particularly important in light of the upcoming longer-duration space expeditions to more distant destinations.

"TO BE OR TO DO": JOHN BOYD AND EFFECTIVE ACTION - RELEVANCE PERSISTS

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Background: Situational awareness as practiced in its highest form allows prediction of potential future states. When combined with a foundation of recognition primed decision making, it results in necessary flexibility and adaptability as required for timely and effective action.

Overview: Beginning with Energy and Maneuverability Theory, and its contributory role in the formation of Agile/Scrum, John Boyd's teachings put individuals in the center of a decision loop process that can be extended to teams and culture. As such, his principles are invaluable for all who work under dynamic conditions of stress and uncertainty to not only cope with their environment, also to succeed. A review of the synthesis that informed and guided Col. Boyd has direct application to the considerations and constraints common to human endeavor, including available operating space and resources, how rapidly we may respond and pivot, and how much pressure we can tolerate to achieve change. The concept of Fast Transients remains valid and functions optimally for an enterprise when synchronized with utilization of Commander's Intent, distributed decision making, and a "Multiplier" philosophy that supports the creativity and initiative of all members of the organization. The result is an evolution in insight, initiative, adaptability, and harmony.

Discussion: Examples of these principles will be presented in the context of pandemic preparedness and response and medical device innovation critical to generational achievement such as continuing space exploration.

ACUTE HYPOBARIC HYPOXIA AFFECTS REACTION TIMES BUT NOT ACCURACY IN AN ASSOCIATIVE MEMORY TASK

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Introduction: Previous studies about the effects of acute hypobaric hypoxia (AHH) exposure on cognitive functions showed that memory may be particularly sensitive to hypoxia. In fact, memory impairment is one of the most often reported symptoms during AHH exposure. Here we investigated whether simulated AHH affects a specific memory function such as the ability to remember associations in memory, e.g., pairings of different items.

Methods: A group of undergraduates from University of Chieti performed an associative recognition memory task for pictorial stimuli in different simulated AHH conditions. In particular, at encoding, they were presented with a series of neutral expression faces paired with neutral content-based pictures. Subsequently, participants were asked to indicate the extent to which they were confident whether each pair was either the same as the one presented at encoding or anew, on a 6-point Likert familiarity scale. Each participant performed the associative task under three different oxygen concentration (OC) conditions: sea-level altitude (0), medium altitude (1), and high altitude (2).

Results: Results suggest that OC affects reaction times but not accuracy in retrieving associations. That is, participants were still able to recognize whether the face-picture pair changed from encoding to retrieval phase. However, their average reaction times slow down drastically in condition 2 compared with the other two conditions.

Discussion: Associative memory is the ability to bind together different types of information in memory. This cognitive function allows to remember, for instance, where or when a particular episode happened. Our findings are the first to show that acute hypobaric hypoxia do not affect participants' accuracy in remembering associated face-pictures. However, it may slow down reaction times for correct recognition, indicating that hypoxia may reduce attentional resources.

AGE-RELATED SP02 DESATURATION DURING HIGH ALTITUDE HYPOBARIC EXPOSURE

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Introduction: While SpO₂ and heart rate (HR) effects at altitude have been described in aviation literature, relatively little is known about the effects of demographic factors on desaturation. To address this, we conducted a preliminary study looking at the effects of age, height, BMI, and weight on SpO₂ and HR at 25,000 feet and 17,500 feet altitude using a hypobaric chamber. We hypothesized that these demographic factors would affect recorded SpO₂ levels and HR, with those participants in the higher age, weight, height, and BMI groups showing more pronounced desaturation and higher compensatory HR, over the course of simulated flights.

Method: 33 Canadian certified pilots with current Transport Canada aviation medicals were recruited. Median splits were used for each demographic factor for the purpose of grouping. Once altitude was reached, participants were exposed to ambient chamber air without supplemental oxygen for 5 minutes at 25,000 feet with SpO₂ recordings every minute and 20 minutes at 17,500 feet with SpO₂ recordings every 5 minutes.

Results: Significant age-related effects occurred for the first 2 minutes of testing when comparisons were made between the higher (24.5 years and older) versus lower (below 24.5 years) age groups at 25,000 feet. No significant differences for Age and SpO₂ were seen past the first 2 minutes of testing; suggesting that those above 24.5 years old had more pronounced early desaturation effects. No Group by Demographic effects were observed for other factors and time points at either altitude.

Discussion: The results of this study suggest that age is a relevant factor when addressing the effects of hypobaric hypoxia at high altitudes and may lead to differential cognitive and behavioural effects for aging pilots. Future research should attempt to replicate these results using larger samples that include older individuals.

CARDIORESPIRATORY RESPONSES TO VOLUNTARY HYPERVENTILATION DURING NORMOBARIC HYPOXIA

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Background: Unexplained physiological events (PE), possibly related to hypoxia and hyperventilation, are a concern for some air forces. Physiological monitoring of aircrew could aid research into PEs. Given the similarities in physiological response to hypoxia and hyperventilation the present study characterized the cardiovascular and respiratory responses to each.

Methods: Ten healthy subjects were exposed to normobaric hypoxia simulating altitudes of 0, 8,000 and 12,000 ft while breathing normally and voluntary hyperventilating to double minute ventilation. Respiratory gas analysis and spirometry were used to measure end-tidal gases (PETO₂ and PETCO₂) and minute ventilation. Arterial oxygen saturation (SpO₂) was assessed using finger pulse oximetry. Mean arterial, systolic and diastolic blood pressure were measured non-invasively. Cognitive impairment was assessed using the Stroop test.

Results: Voluntary hyperventilation resulted in a doubling of minute ventilation and lowered PETCO₂ while altitude had no effect on these. PETO₂ and SpO₂ declined with increasing altitude. However, despite a significant drop in PETO₂ of 15.2mmHg from 8,000 to 12,000ft the SpO₂ was similar when hyperventilating (94.7±2.3% vs 93.4±4.3%, respectively). The only cardiovascular response noted was an increase in HR while hyperventilating. Altitude had no effect on cognitive impairment while hyperventilation impaired it.

Discussion: For many cardiovascular and respiratory variables there is minimal difference in responses to hypoxia and hyperventilation making these challenging to differentiate using physiological monitoring. SpO₂ is not a reliable marker of environmental hypoxia in the presence of hyperventilation and should not be used as such without additional monitoring of minute ventilation and end-tidal gases.

GENETIC VULNERABILITY TO HYPOXIA: ASSOCIATION BETWEEN HMOX2 POLYMORPHISM AND CHEMOSENSITIVITY EVALUATED BY HYPOXIC TESTING

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Introduction: Altitude hypoxia may impact flight safety inducing incapacitations or pathologies with high individual variability, linked in part to genetic factors. A functional genetic polymorphism Heme oxygenase-2 (HMOX2, rs4786504 T>C), an essential enzyme in heme catabolism, has been associated with high-altitude adaptation in Tibetans. In carotid body, heme oxygenase-2 is sensitive to oxygen availability and mediates the hypoxic response inducing increased breathing, which is different between individuals and linked to tolerance. We hypothesized that HMOX2 polymorphism influenced the chemosensitivity related to ventilatory response to hypoxia in Caucasians.

Methods: Ventilatory response to acute hypoxia (FiO₂ = 0.115) was measured at rest and exercise (30% maximal oxygen uptake) (Richalet). Calculated ventilatory response to hypoxia (HVR) at exercise (HVRe) is considered as the best predictor of tolerance to high altitude. Low chemoresponsiveness was defined when HVRe $0.5 \leq$ L.min⁻¹.kg⁻¹ and high chemoresponsiveness when HVRe ≥ 0.8 L.min⁻¹.kg⁻¹. The LAMP-MC technology was used to determinate HMOX2 polymorphism.

Results: 84 healthy subjects were included with 47.6 % homozygous C/C, 41.7 % heterozygous C/T and 10.7 % homozygous ancestral T/T. The C/T and T/T were grouped for analysis. HVR was significantly higher for C/C subjects than for T allele carriers at rest (0.78 ± 1.16 versus 0.38 ± 0.405 L.min⁻¹.kg⁻¹ respectively, $p = 0.043$, $F = 4.22$) and exercise (0.736 ± 0.470 versus 0.534 ± 0.426 L.min⁻¹.kg⁻¹, $p = 0.042$, $F = 4.36$). A high HVRe was more frequent in subjects carrying C/C polymorphism versus T allele ($p = 0.003$, OR = 5.33 [1.67-17.03]).

Discussion: In this population, there is a significant association between HMOX2 polymorphism and chemosensitivity evaluated by HVR at rest and submaximal exercise. Although significant, this finding must be confirmed in larger samples. These results help to better understand the part of genetic factors in chemosensitivity, the first step of hypoxia response.

FLUID BALANCE OF MALE HELLENIC AIR FORCE PILOTS DURING FLIGHT

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Introduction: Dehydration refers to a state of water deficit in the human body. Loss of 1-2% of body mass in the form of fluids can interfere with cognitive and task performance. Aviators are exposed to thermal, mental, and physical stress while they perform complicated flight missions. Any possible impairment of their skills may potentially lead to accidents. This study investigated the impact of flight and its parameters on pilots' hydration state in healthy male pilots of Hellenic Air Force's 120 Air Training Wing in Kalamata.

Methods: Pilots' weight, urine specific gravity and blood haematocrit were measured pre-and post-flight. Data on flight duration, type of flight mission performed, heat stress index, pilot's role (instructor vs student), age and pre-flight hydration status were collected. Statistical analysis was performed using RStudio software (v.1.2).

Results: Forty-eight (48) pilots performing 49 sorties were included in the study. In 16 sorties(33%), a fluid loss of over 1% was measured. There was statistically significant weight loss from the flight (Mean: 0.73kg SD: 0.45kg P<0.001). A positive correlation was found between fluid loss, Heat Stress Index and flight duration (P:0.02). Urine specific gravity and haematocrit rose significantly due to flight-related fluid loss by 0.005 g/ml(P<0.001) and 5% (P: 0.001) respectively. No significant difference in fluid loss was found when comparing instructors versus students, neither regarding hydration status, flight mission nor pilots' age.

Conclusions: This study shows that the pilots can become significantly dehydrated during and as a result of the flight. Urine specific gravity and haematocrit can potentially be used to monitor hydration levels. Further research is needed from actual flight operations to investigate the parameters for the fluid loss during flight and possibly develop a comprehensive hydration protocol during operations.

HABITUAL CAFFEINE CONSUMPTION ALTERS ATTENTIONAL PERFORMANCE DURING TOTAL SLEEP DEPRIVATION

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Introduction: Caffeine, the most widely used psychoactive substance in the world, is well known to mitigate deleterious effects of fatigue induced by sleep debt. However, little is known about the impact of daily caffeine consumption on cognitive vulnerability to sleep deprivation, especially attentional processes.

Methods: Thirty-seven subjects were evaluated in a double-blind and crossover caffeine versus placebo design total sleep deprivation (TSD) protocol. They were categorized in low, moderate and high (0-50, 51-300 and > 300 mg/day) sub-groups, according to their habitual caffeine consumption. Vigilant attention was evaluated every six hours during TSD using the 10-min psychomotor vigilance test (PVT) along with electroencephalographic recordings (EEG) at the nadir of deterioration (i.e., 09:15).

Results: As expected, PVT reaction time (RT) during TSD was significantly lower in the caffeine vs. placebo condition, regardless of caffeine group. Reaction time (PVT-RT) was shorter in low users compared to moderate and high users before and during TSD, in both conditions respectively. In spite of the TSD-related increase in EEG power is attenuated by acute caffeine regardless of habitual consumption, individual alpha frequency (IAF), which is a marker for cognitive functioning, is lower in high caffeine consumers. The IAF is negatively correlated with the score of daytime sleepiness assessed by the Karolinska Sleepiness Scale (KSS), reflecting somewhat difficulty to maintain higher alpha frequency when sleepiness increased. Moreover, correlation analysis showed that higher levels of daily caffeine consumption were associated to slower RT and lower IAF.

Discussion: A high habitual caffeine consumption decreases attentional performance and individual alpha frequencies before and during total sleep deprivation, thus decreasing tolerance to sleep deprivation. This work suggests habitual caffeine consumption shall be considered in the military operational context to individualize advice in terms of fatigue and sleep debt management.

IMPACT OF BOARDING ON THE AIRCRAFT CARRIER CHARLES DE GAULLE ON NAVY PILOTS' SLEEP PARAMETERS. INTEREST OF A CONNECTED HEADBAND FOR SLEEP RECORDING

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Introduction. Boarding an aircraft carrier is associated with subjective bad sleep conditions triggered by high noise level and aeronautical activities. Sleep loss is considered as a main factor of fatigue in aviation. The development of connected sleep devices allowed data recording during prolonged periods. The aim of this study was to assess objective sleep parameters onboard the aircraft carrier Charles de Gaulle during an operational training mission.

Methods: Sleep parameters of 20 Navy pilots were recorded during 20 days before boarding (10 holiday night and 10 nights of duty), during 16 nights onboard in the Mediterranean Sea and 13 nights during the holidays after the mission. Sleep monitoring was done using the Dreem® connected headband. Total sleep time, sleep stages duration and wake after sleep onset periods were automatically detected using the Dreem® viewer software and controlled visually by a sleep specialist.

Results: The connected head band was well accepted and 602 nights recorded with a good index of quality (45.5% of studied nights). In particular, 180 nights were analyzed onboard (43.3% of recorded nights). Any subject declared secondary effect induced by the device. We observed onboard, a decrease of the average total sleep time (TST) with an increase of the percentage of TST under 6 hours per night (51% vs. 28% during at home recordings) ($X^2=45,9$, $p<0.001$; $OR[IC_{95\%}]=2.7 [1.7-4.3]$). Slow wave sleep (1h 25min vs. 52min, $p<0.01$) and REM sleep duration (2h 01min to 1h 26min, $p<0.01$) decreased and the wake after sleep onset (WASO) increased on board ($p=0.03$).

Conclusion: Our work objectively demonstrated the decrease of sleep quality and duration of Navy pilots during an aircraft carrier boarding. Monitoring sleep parameters using a connected headband offers new opportunities for monitoring fatigue risk factors onboard.

VIGILANCE STATE RECORDING USING A CONNECTED DEVICE

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Introduction: During long haul flights, pilots' lack of sleep induces a decrease of vigilance and microsleeps that could increase the risk of fatigue, air safety reports and accidents.

Methods: We developed miniaturized EEG/EMG connected glasses (LUNELEC project) using dry electrodes, in collaboration with the French start-up Dreem. The originality of this innovation is the integration of dry electrodes and an electronic acquisition system in the commercial eyeglass branches. The pilots are able to implement this device without the intervention of sleep specialist. To meet computer and operational constraints, the electroencephalographic signals are transmitted and recorded in real time to a nearby peripheral (tablet, computer...) by WIFI or wired without the use of a remote server. First, we validated the system in a resting situation with eyes closed. The signals obtained from the glasses (N1, left Nasion and O1, left occipital) were compared with those from a laboratory measurement EEG chain (E2 (above the right eye and O1)).

Results: A correlation of power spectral density (8-12Hz) exists between N1-O1 and E2-O1 ($R=0.31$, $p<0.05$, Spearman's test). We are developing new algorithms for the detection and even prediction of the appearance of micro-sleeps during real flights.

CONCLUSION. We show that this device may inform the pilots about the level of vigilance.

CAUSES OF UNFITNESS IN FRENCH MILITARY AIRMEN

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Introduction: Fitness for employment in aeronautical specialities meets standards set by regulatory texts. We were interested in the reasons for unfitness during a career among military aircrew.

Method: We conducted a systematic analysis of all the files presented to the Military Aeronautics Medical Commission (CMAD) between 1st January 2012 and 31st December 2017. 40,832 military review visits were conducted within the three military aeromedical centers during this period. 708 CMAD submission files were analyzed.

Result: In 65% of the cases, it was the first presentation to the CMAD. Air force is the main army concerned. The sex ratio is very strongly male. The average age of the patients was 39 yo and they were mainly officers and pilots or navigators. Four specialties accounted for more than 61% of the reasons for presentation (ophthalmology, cardiology, oncology and psychiatry). In 19% of the cases a recommendation of unfitness was made. The main cause of definitive unfitness was represented by psychiatry (32%). Comparing these results with a previous period (2006-2011), we note some significant variations. Two specialties seem to emerge: pneumology and psychiatry. Pneumology files rose from 1.97% to 6.50% ($p < 0.001$), and psychiatry files rose from 4.81% to 11.86% ($p < 0.001$).

Conclusion: Main causes of unfitness are quite constant over time, nevertheless improvement of medical knowledge, the evolution of society, or the strong operational constraint seem to modify somewhat the type of files presented in CMAD, as shown by the emergence of pneumology and psychiatry files.

NARCOLEPSY TYPE 1 AND AERONAUTICAL ACTIVITY

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Introduction: Narcolepsy type 1 or narcolepsy with cataplexy or Gelineau syndrome is a rare disabling sleep disorder of the young subject. Narcolepsy with cataplexy remains a clinical diagnosis but must be completed by nighttime and daytime polysomnography (MSLT)

Background: The main features are excessive daytime sleepiness and cataplexy. Other less consistent symptoms include hypnagogic or hypnopompic hallucinations, sleep paralysis, fragmented nocturnal sleep.....Therefore this pathology is incompatible with any aeronautical activity

Clinical case: The authors report the case of a 44-year-old flight engineer who presented to the CEMPN of Rabat for a medical examination of fitness. He declares to be treated for narcolepsy type 1 for 16 years, stabilized by Modafinil then by behavioral measures only for 3 years (regular sleep hygiene, scheduled naps). Maintain of Wakefulness Test was negative, he was declared fit by derogation with restrictions, including regular monitoring by MWT.

Discussion: The 3rd edition of the International Classification of Sleep Disorders (ICSD-3) defines type 1 narcolepsy by the presence of sleepiness evolving for more than 3 months associated with: either cataplexy with a mean sleep latency below 8 minutes (MSLT) and at least 2 sleep-onset in REM periods (MSLT, PSG); or a low hypocretin level (values below 110pg/ml in the cerebrospinal fluid). It is a pathology which interferes with flights safety, the inaptitude is the rule, nevertheless, a derogation can exceptionally be granted after a sufficiently long delay, in a non pilot crew, stabilized by behavioral measures only with a satisfactory MWT (absence of falling asleep at 40 minutes)

CBD AND FLIGHT SAFETY

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Introduction: The use of therapeutic or recreational cannabidiol (CBD) has been increasing since its legalization. Pharmacokinetics studies of cannabinoids show individual variabilities depending on consumption mode (occasional or chronic) and according to administration form (smoked, sublingual, oral).

Case Report: This case deals with a positive delta-9-tetrahydrocannabinol (THC) test of an air traffic controller during a routine medical check presumed to be due to cannabidiol (CBD) consumption.

Discussion: Law evolution in France regarding CBD will be presented first. Then, psychoactive effects and the consequences on flight safety are discussed. Finally, we present how we managed this case.

POST VACCINAL ACUTE DISSEMINATED ENCEPHALOMYELITIS AFTER COVID VACCINE, CASE REPORT AND CLINICAL EVOLUTION

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Introduction: Post vaccinal acute disseminated encephalomyelitis (ADEM) is a rare central nervous system condition. Among other causes, it occurs after different vaccinations. ADEM present with extensive white matter, and sometimes grey matter, lesions on MRI. The patient's clinical presentation varies according to the localization and extension of central nervous system lesions. ADEM can occur as an isolated event but is sometimes followed by the occurrence of multiple sclerosis.

Case Report: We report the case of a 43-year-old man, flight engineer, with no medical history. He was vaccinated on May 28, 2021 against COVID-19 with Pfizer Comirnaty vaccine. In the first days of July 2021 he presented after 6 episodes of throwing up in the evening, gait instability and stuttering. There were no associated headaches. On July 29, a brain MRI showed several extensive FLAIR hypersignal areas, supra and infra tentorial, with annular Gadolinium enhancement.

He was hospitalized in neurology on July 30. Clinical examination showed an enlargement of the sustentation polygone, oscillations increasing when closing the eyes at the Romberg test. During speech, he presented with hypophonia, stuttering and arthric difficulties. Cognitive evaluation showed mild dysexecutive and attentional impairment. Blood test did not show acute infection or arguments for an immunological disorder. Lumbar puncture showed 0.5g/l proteinorachia, 4 elements/mm³ and presence of oligoclonal bands in the CSF. Medullar MRI showed T2 hypersignals regarding C1, C2, C3, C5, T8-T9.

The diagnosis of ADEM was consistent with this monophasic neurological episode in a patient without medical history of previous neurological impairment, the presence of synchronic cerebral and medullar white matter lesions. Infusions of SOLUMEDROL were started and the patient showed rapid clinical improvement, with normal neurological examination at discharge.

Discussion: Follow-up with clinical examination, cognitive screening and brain MRI showed a complete clinical recuperation and regression of the cerebral lesions. He recovered his flight habilitation.

PREDICTING NEURO-INCAPACITATION IN FLIGHT PERSONNEL: NEW APPROACHES AND CHALLENGES

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Background: While acute neurological events are rare in pilots, they are a common cause of pilot grounding. Furthermore, brief episodes of inattention, memory loss, or confusion can result from relatively benign conditions such as Transient Global Amnesia (TGA) or stress/fatigue or more seriously seizures or transient ischemic (TIA)/stroke. An inability to predict which individuals are at highest risk for long-term recurrence of potentially incapacitating events results in pilot grounding for months to years to ensure the events don't reoccur. This results in careers ending prematurely and loss of substantial training investments. However, new computation approaches such as artificial intelligence can be used to develop predictive models of risk using large datasets from electronic health records and registries.

Overview: Using the Norwegian military Armed Forces Health Registry (NAFHR), a cohort of 1500 Air Force personnel engaged in flight-related activities between 1970 – June 2022 was identified and evaluated for the presence of at least one ICD-10 code for the most commonly incapacitating neurological events (seizure, TGA, Traumatic Brain Injury, or TIA/stroke). This cohort was predominantly male, and between the ages of 19 and 45. None of the common neurological ICD-10 codes were found in this cohort.

Discussion: Preliminary work to identify a cohort of Norwegian flight personnel at increased risk for inflight neuro-incapacitation illustrates the challenges of using NAFHR and registry data for predictive modeling. Based on previously published neurologic all-cause data in civilian pilots, we would have expected to find at least a handful of individuals with the listed ICD-10 codes, especially those for TGA and TBI, which are not uncommon in this age-group. Common pitfalls and newer approaches for developing comprehensive cohorts for use in predictive modeling will be discussed.

BRAIDING: A NOVEL TECHNOLOGY TO FACILITATE SPACE/GROUND COLLABORATION UNDER SIGNAL LATENCY

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Introduction: Braiding is a novel, text-based software designed to facilitate the communication between space crewmembers and mission support on Earth under signal latency. It addresses communication problems associated with signal latency by arranging communication topics into 'braids' along a carousel. Remote team members communicate with each other by viewing opposite sides of the carousel and adding content to the braid directly in front of them. After a set time (fixed by signal latency and number of topics) the carousel rotates and brings new content awaiting response.

Methods: The feasibility and benefits of braiding for time-delayed communication were assessed in a Human-in-the loop study involving five flight surgeons/mission support personnel (MCC) and five former participants in space exploration simulations (Crew). Pairs of MCC/Crew volunteers collaborated remotely on four operationally relevant tasks, e.g., medical consultations or joint planning for an emergency. Volunteers received fictional but realistic information for each event to help them perform in their assigned role (MCC or Crew). The study consisted of two sessions each presenting participants with two 45-min scenarios and short surveys.

Results. Participants rated the quality of their communication and benefits of braiding along a 100-point bi-polar visual analog scale (e.g., unnatural vs. natural). Descriptive analyses indicate that time-delayed communication with braiding felt natural, was coherent, easy to follow, clear, straightforward, and effective (all ratings ≥ 76 for positive anchor). Participants rated braiding as easy to use and supportive of common ground and cooperation (all ratings ≥ 85 for positive anchor).

Discussion: Findings suggest that braiding may facilitate effective remote cooperation despite signal latency. It enables remote team members to experience the familiarity of normal conversation as the software holds together the thematic and chronological structures of discourse that time delay would otherwise disrupt.

REMOTE MONITORING OF EMOTIONAL STATE DURING SPACE MISSION- AX-1 MISSION EXPERIENCE

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Introduction: Considering the constantly extending duration of professional astronauts' space missions and the increasing number of unprofessional space tourists, the risk of mental disorders development and adverse behavioral changes during space missions is increased. Unlike the numerous measures to monitor and diagnose acute medical conditions, there is a lack of equivalent capability to detect a possible development of emotional distress and mental emergencies. Based on past experiences with space flight and analogue missions, risk of adverse behavioral and psychological changes are among the most serious and difficult to mitigate during space missions. Despite the serious consequences that emotional distress may cause, previous publications presented that several astronauts have avoided scrutiny by not informing their flight surgeons regarding emotional problems, which raises concerns regarding the limitations of current methods of detecting such events.

Based on the remote-care and digital health methods developed at Sheba Medical Center during our dealing with the COVID-19 pandemic in Israel, we developed a dedicated mobile app to monitor cognitive performance associated with changes in emotional state.

Methods: Three crewmembers of the AX-1 mission, the first private mission to the International Space Station, completed a daily use of the app throughout all the mission phases- pre-flight, in-flight, and post-flight, alongside sleep monitoring and vital signs measurements and filling subjective questionnaires.

Results: Preliminary analysis of our study results shows that this method can be an effective way to monitor the crew's cognitive and emotional states throughout the mission.

Discussion: Our findings open a window to the possibilities of remote-care and digital health technologies that are integrated in a non-intrusive way into the daily routine in favor of collecting comprehensive performance data, which enable monitoring and identification of the development of emotional distress among space mission crews.

ENHANCING INTERNATIONAL EXPLORATION PLATFORMS AND ANALOG DEFINITION PROGRAM

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Background: The successful *Inspiration 4* all-civilian orbital spaceflight mission had an array of biomedical data collected from the commercial astronauts during pre/in/post phases of the mission. With anticipation of the emerging commercial spaceflight industry blossoming into a highly desired enterprise and experience for humanity, The Translational Research Institute for Space Health (TRISH) has established the Enhancing eXploration Platforms and Analog Definition (EXPAND) Program.

Overview: EXPAND collects biomedical data and bio-samples from early commercial spaceflight pioneers; stores the original and processed biomedical, environmental, and mission data in a robust database; and distributes the data to researchers, stakeholders, and government agencies with legitimate scientific inquires.

Discussion: EXPAND is an all-encompassing program with the following capabilities and processes. (1) A funding opportunity for researchers to perform biomedical research on commercial astronauts that address risks to human health, safety, and performance on commercial spaceflight missions. Researchers are encouraged to develop protocols that are minimal to no burden on the commercial astronauts while minimizing mass, volume, power, and maximizing ease-of-use. (2) The EXPAND biobank will preserve and store bio-samples provided by commercial astronauts. (3) The EXPAND database is designed to ingest a variety of biomedical, environmental, and mission data types and formats described above. (4) EXPAND has one unified, generic institutional review board (IRB) protocol for medical data; research data; environmental and mission data; and bio-samples collection. (5) A data privacy and release board will review, approve, and release data and bio-sample requests to researchers, spaceflight providers, and government agencies. (6) EXPAND has established a set of essential measures to serve as a foundational dataset that will be proposed to all commercial astronauts for data collection during their spaceflight mission. EXPAND has already successfully collected data from *Inspiration 4*, MS-20, and AX-1.

SPACE INTEGRATIVE MEDICINE MODEL (SIMM): AN APPROACH TO REDEFINING SPACE MEDICINE

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Background: Space Medicine, as it is commonly discussed today, has been primarily viewed as the domain of flight medicine and similar disciplines. And, for a score of years, its focus has mainly been in-atmospheric flight issues. In fact, one of the current definitions for space medicine follows the genre for preventive or occupational medicine in which the patient or subjects are aircrews, pilots, and sometimes even astronauts. As such, most of research conducted or practices performed surround earth-based / in-atmosphere medical issues.

Overview: Only until the advent of the Gemini Program did the focus shift slightly to sub-orbital or “space” (defined as out-of-atmosphere flight). We say “slightly” as even this area is narrowly defined to encompass “astronauts” as they are viewed today. But how will this change when the majority of humans begin traveling into space?

Discussion: In this paper, the author proposes a novel approach to Space Medicine: SIMM. The Space Integrative Medicine Model has as its main target to encompass all disciplines that are going to be needed in the near future to make Space habitable for humans. These include: Engineering, Medicine, Biology, Astrophysics and Business. By training a new generation of workers in all these disciplines, we will be able to equip companies with workers that truly and deeply understand the needs of the human body in space. As such, all areas related to technologies, pharmaceuticals and R&D would be supplied with a workforce that is knowledgeable of both the human body and the harmful conditions of space.

Day 2 Posters

TEAM DYNAMICS AND COPING STRATEGIES IN EXTREME ENVIRONMENTS

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Background: Teams in extreme environments frequently encounter unique challenges and must use powerful coping strategies to problem solve. While there are efforts being made to understand team dynamics from an individual and experimental point of view, there are very few interpretations of high-visibility teams as a whole from the past. In our ongoing research, we analyzed significant high-stress, high-visibility events to better understand team adaptation that occurs in these conditions.

Overview: Our project examines multiple cases simultaneously across different industries, i.e. aerospace, rescue, corporate, in an attempt to generate a broader appreciation for coping strategies in extreme environments. Through criteria search across several research databases and manual search in journals related to extreme environments, we narrowed our study down to eight cases, including Apollo 13, the Chilean Mining Incident, and the Enron Scandal. The inclusion criteria were: must operate in an extreme environment, must have publicly available primary sources, and must have international news coverage. We developed an initial coding frame to systematically organize key strategies describing how each team realized they were in trouble, their main challenges, and how they adapted and moved forward.

Discussion: Preliminary results have supported current literature coping frameworks, including specific examples in seeking social support, persistence, and superstition. We have identified several underemphasized coping categories, such as mindfulness and normalcy, with the goal of building a more robust coping framework for future teams in need. Proven coping strategies, like role clarity, communication, and a unified goal, are strongly supported in our study. We have also found that softer coping skills, such as meditation, prayer, and mindfulness, are common in situations where physical health is threatened.

While more research is needed to make generalizable claims, our study highlights practical insights into teams working in extreme environments that can be used to inform training across industries.

HIGH ALTITUDE PARACHUTING AND THE RACE TO 35,000 FT; IS NATO READY?

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Background: High altitude parachuting has been conducted since the mid-1900's. This capability has grown to covertly insert tactical operators who conduct a variety of missions; As the capability increases through High Altitude High Opening (HAHO) operations; the austere nature takes our soldiers further from definitive care and increases the risk of physiological incidents

A modernization of STANAG 7056 would prepare signatories for the rigors of exposure to reduced atmospheric pressures, enhancing operational capability, and permitting operators to conduct the missions required for global security.

Overview:

1. Commercial oxygen equipment is visually fitted due equipment design; traditional mask seal checks cannot be completed; therefore, no qualitative standard.
2. Sufficient oxygen storage is required for extended decompression and increased exposure at altitudes up to 35,000 ft.
3. Safety standards advising distance from definitive care while conducting austere training and operations.
4. Increased education and focus for the identification of signs and symptoms simulating complete HAHO operations.

Discussion:

1. Qualitative methods confirming mask seal are required or this sets the standard for potential failure at higher altitudes.
2. A review of the minimum standard for gaseous oxygen storage during extended decompression, oxygen pre-breathe and descent times for HAHO would further reduce potential injury.
3. Military diving has strict standards for NATO signatories enforcing diver proximity to definitive care. Minimum guidelines will add a layer of safety to high altitude operations.
4. Aviation physiology training has evolved to reduce the risk of DCS in Hypobaric training. Increased focus utilizing realistic training methods for full HAHO would better prepare signatories for their missions.
5. Modernized minimum standards would further prepare signatories for the eventuality of physiological incidents, modernize planning, and further reduce the potential for mission failure.

ALCOHOL AND DRUG TESTING PROGRAMS IN CIVIL AVIATION: A REVIEW OF THE BRAZILIAN REGULATION

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Background: In line with the guidelines of the ICAO's Manual on Prevention of Problematic Use of Substances in the Aviation Workplace, the National Civil Aviation Agency of Brazil (ANAC) published, in 2011, a specific regulation on the subject (RBAC 120), which addresses the Program for the Prevention of the Risk Related to the Misuse of Psychoactive Substances in Civil Aviation (PPSP).

Overview: This regulation is applied to all safety-sensitive employees (flight and cabin crew members, aircraft maintenance personnel, security screeners) and seeks to act mainly in a preventive manner, providing continuing education on psychoactive substances, but also contemplates the need for monitoring and rehabilitation of employees in whom a health problem related to substance use is identified, which must be addressed in a non-prejudiced and non-punitive way.

Discussion: Psychoactive toxicology tests must include the laboratory identification of, at least, the following substances: alcohol, opiates, cannabinoids, cocaine, amphetamines and methamphetamines. In general, testing should be performed in specimens with a short detection window such as expired air (for alcohol), and urine or oral fluid for other substances.

Random testing must be carried out in an unannounced manner during the work shift, on a minimum annual percentage of randomly selected employees. In the event of a positive result or refusal, the worker is included in a follow-up subprogram in which, in addition to monitoring by a specialist, unannounced follow-up toxicological tests must be carried out. Toxicological tests must also be performed before admission for performing a safety-related activity, upon reasonable suspicion of psychoactive substance misuse, after an accident and before returning to safety related activities after a violation.

After more than 10 years since implementation, the processes adopted by this regulation, including random and other testing, are well established, as well as the importance of the continuing education component of the programs.

HIMS - 48 YEARS OF SAFETY AND SOBRIETY IN PROFESSIONAL PILOTS

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Introduction: Alcohol and drug abuse/dependence affects a significant portion of the world's population including pilots. The consequences of this disease adversely affect physical and mental health, aviation safety and productivity to the airline industry. Programs that provide a safe haven for pilots to request help for their disease without job or career jeopardy avoid concealment of diseases by pilots and colleagues. The HIMS program demonstrates 48 years of success in improving pilots' health, lives and aviation safety.

Methods: The Human Intervention and Motivation Study (HIMS) is a joint effort between airline pilot unions, operators, the FAA and health care professionals to identify, intervene, treat, rehabilitate and safely return pilots with substance use disorders to active flying. A thorough evaluation process and rigorous monitoring after return to flying assures both health and safety are maximized.

Results: Since 1976, approximately 10,000 US professional pilots diagnosed with substance (drugs and alcohol) use disorders have been medically certified to return to flight duties by the FAA. Approximately 80% maintain sobriety and do not relapse during their careers. Some who relapse self-refer for treatment with others discovered through the monitoring process. Many advance to leadership positions with their airline or union. Significant cost savings in lower sick leave use, reduced health care and training costs, improved reliability and performance make HIMS a most cost effective safety and health program.

Conclusions: HIMS is the original peer support program with success due to many factors. Cooperation among aviation stakeholders, provision of a safe haven for career security, destigmatizing of a common disease, rigorous monitoring, financial support and continuous education efforts lead to ongoing success. The HIMS Program serves as a model for other peer support programs addressing aviation professionals' mental health, productivity and safety.

IN-FLIGHT INCAPACITATION OF DYSAUTONOMIC ORIGIN

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Introduction: In-flight incapacitation is defined as "the aviator's awareness of a painful state which can alter his means of perception and reaction and which occurs during the flight." This maladjustment to the aeronautical environment, endangering flight safety, will lead to a polymorphous symptomatology which reflects functional dysregulations dominated by the neurovegetative imbalance. The autonomic nervous system is permanently solicited during aeronautical activity. Hence the interest of its exploration in aircrew victims of in-flight incapacitation.

Methods: This is a retrospective study including 18 aircrew, both civilian and military, followed within the aircrew medical expertise center in Rabat, having presented with an in-flight incapacitation. The study of the autonomic nervous system by Ewing's cardiovascular reactivity tests, aimed at confirming the dysautonomic character of the in-flight incapacitation, after a negative etiologic investigation.

Results: A dysautonomic cause of the malaise was found in 8 aircrew. Five dysautonomic syndromes were associated with the flight incapacitation: reflex dysautonomic syncope, including 3 vasovagal syncopes and one micturitional syncope, orthostatic hypotension syndrome, two cases of postural tachycardia syndrome, and cardiac autonomic neuropathy in a diabetic pilot. As a result, 3 aircrew were declared permanently unfit.

Discussion: The aeronautical constraints whose effects can interfere with the neurovegetative balance and risk to induce an in-flight incapacitation will be discussed.

Conclusion: Our study reveals firstly, the interest of the exploration of the autonomic nervous system in case of any in-flight incapacitation, whose etiologic investigation is negative, and raises, secondly, the problem of the incompatibility of certain treatments with aviation safety.

MALIGNANT MELANOMA IN A HIGH TIME AIRLINE PILOT

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A 42-yr-old male civilian airline pilot, previously Air Force pilot had been diagnosed with malignant melanoma of the right leg in March 2013. As a civilian pilot, he is an airline transport rated pilot for a large domestic carrier with about 7600 hours flown; in addition, has about 2400 hours military flight experience as instructor and evaluator pilot.

Upon initial diagnosis, his lesion was 0.85 mm thick, extending into the deep margins. 1/4 superficial inguinal lymph nodes positive. Family history was negative for malignant disease. Laboratory testing reveals Stage III B melanoma, included multiple MRIs, PET scans, without evidence of metastatic disease. Laboratory testing reveals strong positivity for Melan- A and S-100, supportive of the diagnosis. Therapy included wide excision with lymphatic mapping and induction interferon, lymphadenectomy with Sartorius transposition flap.

The aviator completed 20 treatment cycles of induction interferon. About 9 years after initial diagnosis completely disease free, in remission and without any residuals, completely asymptomatic. Waiver submission to US Air Force MAJCOM resulted in disqualification from air force aviation duties due to stage III B, retention as officer with ALC -C3 possible, with termination of flying duties. Under FAA medical certification criteria- fully qualified as command pilot, First Class Medical no limitations - with special issuance.

Conclusions: Malignant Melanoma is a dermatological cancer occurring more frequently than expected, especially among aircrew and pilots. However, even advanced stage III B melanoma can be successfully cured.

DILATION OF THE ASCENDING AORTA IN CIVILIAN 1ST CLASS PILOTS: WHEN IT IS TIME TO WORRY?

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Introduction: The aorta is an elastic artery; a dilation of 0.9 mm in males and 0.7 mm in females in 10 years is considered normal. A dilation of the ascending aorta may represent a danger. Dilation of the ascending aorta is an occasional finding during cardiovascular examination and may be related to other conditions such as bicuspid aortic valve or hypertension.

Methods: During the period April 2001 – June 2022, we performed 2,107 cardiologic evaluations in 1st class pilots, and in 47 visits a dilated ascending aorta was noticed in 12 pilots.

Results: The 1st class pilots were all male, age 54 ± 9 yrs, height 178 ± 6 cm, weight 85 ± 6 kg, BMI 27 ± 2 ; The follow up in our structure was 2 ± 3 yrs. The ascending aorta in our population at the beginning of follow up was 42 ± 2 cm; at the end of follow-up was 43 ± 3 cm.

In one case, a surgical operation was required with replacement of the aortic valve with a mechanical and replacement of the ascending aorta with a Dacron prosthesis.

In many cases, the pilot was lost to follow-up probably due to flight restrictions applied in our institute. In one case, after years of follow-up in other institution, a pilot originally in our group died while not on duty.

Discussion: According to the latest guidelines of the European Society of Cardiology, surgery should be considered in case of aortic root ≥ 55 mm, but if additional risk factors are present, the limit should be ≥ 50 mm. The risk for rupture and dissection in these patients increases proportionally to the diameter of the ascending aorta, so a follow up and flight restrictions in selected cases are highly recommended.

USAF OPERATIONAL BASED VISUAL ASSESSMENT (OBVA) LABORATORY AUTOMATED VISION TEST: THE FUTURE COMPREHENSIVE, STANDARDIZED, COMPUTERIZED, VISION TEST DEVELOPMENT AND RESULTS

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Introduction: For over 100 years, aerospace vision standards have been anecdotal “lines in the sand” based on historical and observational science. Technologies did not exist that allowed military medical services to validate or correlate clinical and laboratory visual performance measures with the visual performance requirements of operational tasks required in the aircraft. Many current Air Force standards and screening tests therefore date back to the World War I and II eras, despite new technologies exist which may better and more accurately measure visual health (Winterbottom, Hadley et al., 2014).

The OBVA lab developed a new Automated Vision Tester (AVT) that includes visual acuity, contrast sensitivity, cone contrast color, stereo acuity, fusion range, motion sensitivity and automated phoria for far, near and intermediate vision testing to individual threshold.

Methods: This prospective IRB-approved study consisted of 27 individuals aged 18-40. Automated, computer-based visual tasks assessed high and low (5% Michelson) contrast visual acuity, letter contrast sensitivity (CS) at 20/25 and 20/50 acuity levels, color CS and stereoacuity. All tasks used a four alternative forced choice (up, down, left and right buttons) with responses captured on a hand-held keypad. Each task used both a Bayesian adaptive procedure [3-5] to determine true visual threshold as well as a screening mode that would be applicable for routine clinical use. The visual stimulus used for acuity, contrast and color testing was a Landolt C, with the gap oriented at the top, bottom, right or left position.

Results/Discussion: Test-retest characteristics (R Squared) for each computer-based automated task will be presented. A second method used to assess repeatability by calculating mean differences between test one and test two as well as the standard deviation of these differences will be presented. Comparisons between the automated tasks and the analogous task using current methods will also be presented.

ASSOCIATION BETWEEN TOTAL FLIGHT HOURS, OCCUPATIONAL RISK FACTORS, AND INDIVIDUAL BEHAVIOR WITH CARDIOVASCULAR DISEASE RISK IN INDONESIAN CIVILIAN PILOTS

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Introduction: Cardiovascular disease can cause incapacitation and long-term unfit period for pilots. Physical and physiological effects together with poor individual behavior can lead to a high cardiovascular disease risk.

Methods: This cross-sectional study investigated the prevalence and association between total flight hours, occupational risk factors, and individual behavior with cardiovascular disease risk in Indonesian civilian pilots using the Framingham 10-year Risk Estimation Score. Data was collected from pilots aged ≥ 35 years who had renewal medical examination on 12 to 27 May 2022 at the Directorate General of Civil Aviation Medical using questionnaire. Bivariate and multivariate analyzes were performed using SPSS version 22.

Results: Of the 121 subjects, 54.5% (n=66) had a high cardiovascular disease risk. Total flight hours and physical activity were significantly associated with high cardiovascular disease risk ($p < 0.001$ and $p = 0.003$, respectively). Both are also dominant factors for the cardiovascular disease risk. Pilots with total flight hours ≥ 10.850 hours had high cardiovascular disease risk 4.64 times greater than they with < 10.850 hours (OR= 4.64, 95% CI 2.09-10.26, $p < 0.001$). Inactive pilots had a high cardiovascular disease risk 2.63 times greater than active civilian pilots (OR= 2.63, 95% CI 1.18-5.86, $p = 0.019$).

Discussion: Total flight hours and inactivity were contributed to high cardiovascular disease risk in Indonesian civilian pilot. Calculation of the estimated risk of cardiovascular disease should be applied during periodic medical examination for civilian pilots in Indonesia as an early detection in mitigating risk factors for cardiovascular disease. Health promotion can be done for pilots with high total flight hours and education is needed to reduce the risks of sedentary lifestyle by increasing their physical activity.

EVALUATION OF CHANGES IN LIPID INDICES OF BLOOD SERUM IN THE COURSE OF SPECIAL TRAINING FOR CADET-PILOTS

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Introduction: Lipid parameters have a high diagnostic value in people burdened with physical exertion. The aim of this study is to investigate the effect of a special training process for cadet-pilots on changes in serum lipid parameters.

Methods: The study involved 55 cadets in two groups aged 20. Group A (n= 41, examined) underwent a programme on Special Aviation Gymnastic Instruments (SAGI). Group B (n=14, control) followed a standard programme of military physical education. In both groups, the examined material for research was blood which had been taken twice prior to (test A) and after (test B) training I, II and III. In the blood serum was marked total cholesterol, HDL, LDL, triacylglycerols (TG), apolipoprotein A1(Apo-A1) and B (Apo-B), using available test kits. The lipid index was calculated from Wochynski and Sobiech formula (WS).

Results: Group A showed a statistically significant increase in Apo-A1 concentration, WS values and a decrease in TG in study B compared to study A in training I. In training II, there was a statistically significant increase in Apo-A1 concentration and a decrease in TG in study B with regard to study A. In training III, there was a decrease in Apo-B, TG and an increase in WS in study B as compared to study A. In group B, training I showed a significant decrease in TG concentration in study B compared to study A. Training III showed an increase in Apo-A1 and a decrease in TG in study B as opposed to study A. There was a statistically significantly higher value of Apo-A1 in group A than in group B in training I and II.

Conclusions: In group A in training III, the observed increase WS in study B compared to study A may indicate that adaptation to special exercises has been achieved.

HOW TO HANDLE RETINOSCHISIS IN THE MILITARY AVIATION ENVIRONMENT?

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Introduction: Retinoschisis (RS) is a rare finding in aviation ophthalmology. In contrast to juvenile retinoschisis, acquired retinoschisis is occurring from microcystoid degeneration in the peripheral retina resulting in a split of neurosensory layers, usually at the outer plexiform level. Incidences range from 3.7% to 7% for patients 40 years of age or older. In the presence of aircraft-related vibrations and accelerations seen in military aircraft, these numbers might be higher than in the general population. Here, we present a case series of acquired RS in German Air Force active combat pilots.

Methods: An internal database query was performed addressing flight crew and ground personnel ophthalmic examination results from 2007 to present. Data were extracted and retrospectively analyzed with regard to individual RS findings. Incidental findings in aviators were allocated to the aircraft types flown and total flight hours spent in the respective aircraft. Odds ratios (OR) were calculated at 95% confidence level for flying and non-flying personnel.

Results: There were 32 cases of incidental RS identified, 25.0% (n=8) of which were ground personnel, while 75.0% (n=24) were flying personnel. From these, 50.0% were helicopter, 29.2% fixed wing, and 20.8% fighter jet pilots, respectively. OR was 2.36 [1.06;5.25] for exposed flyers as compared to non-exposed ground personnel (p<0.036). Most cases (90.6%; n=29) were asymptomatic, whereas all symptomatic cases were related to helicopter pilots, displaying visual field deficiencies in two cases, and ablatio in one case.

Discussion: In this case series, aviators appeared to be at a considerably higher risk of developing retinoschisis as compared to non-flying personnel. Although overall numbers are small and might have been biased by the recent introduction of more sensitive screening methods, results appear to be consistent and indicative for a role of rotor-related vibrations in active helicopter pilots. Further studies will be needed to define the impact of aviation related environments and to re-establish interventional strategies specific for military flying personnel.

THE RISK FACTORS OF RECURRENT POSITIVE TREADMILL TEST AMONG CIVILIAN PILOTS IN INDONESIA

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Introduction: Coronary artery disease is one of the common diseases among pilots. The treadmill test is a screening examination, which is performed regularly among pilots, and recurrent positive treadmill tests are frequently found. This study aimed to determine the incidence, risk factors, and risk prediction of recurrent positive treadmill test among civilian pilots in Indonesia.

Methods: This is a retrospective cohort study. Data were obtained from medical records of civilian pilots who underwent examination during January 2019 – June 2020 at Aviation Medical Center, Jakarta. Data of pilots with positive treadmill test were followed up to six months and a year later. Outcome was recurrent positive TMT, while determinant variables were total flight hours in the last six months, license type, aircraft cabin system, limitation, cardiologic intervention received, Body Mass Index (BMI), blood pressure, lipid profile, fasting glucose, history of smoking, family history of Coronary Arterial Disease, and age.

Results: There were 54 out of 87 pilots (62.1%) with recurrent positive treadmill test. All were male with the median age of 51 (40-64). Flight hours >275 in last six months (OR 5.00, 95% CI 1.23-20.41, $p=0.025$), dyslipidemia (OR 3.86, 95% CI 1.30-11.43, $p=0.015$) and age >60 years old (OR 4.75, 95% CI 1.01-22.35, $p=0.049$) increased the risk of recurrent positive treadmill test. Having all three risk factors increased the probability of recurrent positive treadmill test up to 100%.

Discussion: The incidence of recurrent positive TMT test among civilian pilots in Indonesia was high. Cumulative flight hours of more than 275 in last six months, dyslipidemia, and age of 60-65 years old were risk factors. Medical providers should identify this risk and provide active intervention to prevent the recurrence.

SPACEFLIGHT OMICS: UTILISATION IN A PERSONALISED PRECISION MEDICINE APPROACH TO OPTIMISE ASTRONAUT HEALTH FOR EXPLORATION CLASS MISSIONS

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Background: A robust personalised precision medicine strategy is vital for the success of crewed long-duration exploration missions. As space agencies & commercial entities plan for crewed long-duration exploration missions to Mars, a variety of hazards that present with health risks must be addressed. The major hazards associated with human spaceflight include radiation; isolation & confinement; distance from Earth; variations in gravity fields; & hostile, closed environments. Employing & utilising omics in a personalised precision medicine approach may mitigate or monitor many of these health risks to ensure crew health, safety, & performance.

Overview: A review was carried out to provide an overview of omics in a spaceflight context & how work in this field may be used in a personalised preventative precision medicine approach to keep astronauts healthy. Subdomains of omics--from epigenomics to metabolomics--were described. These were then subdivided into health hazard umbrellas such as radio, nutri, & ocular-omics. The legal & ethical considerations are outlined, along with existing & suggested omics standards.

Discussion: The largest set of astronaut data & space biology data ever produced was published by Cell Press in 2020. NASA's omics initiative of the Space Biology and Human Research Program & Twins Study formed the foundation of the collection. A report by the Potomac Institute for Policy Studies summarised the potential of not just omics, but many other aspects of precision medicine, & recommended directions for NASA to leverage this valuable approach. Many studies have analysed the effects of the spaceflight environments using omics – the focus now needs to be long-duration & exploration class stressors & their effects on health. To allow for collaboration & standardisation, there are publicly available resources & databases at various space agencies, including the NASA GeneLab platform & the NASA Life Sciences Data Archive (LSDA).

THE ROLE OF INDUCED PLURIPOTENT STEM CELLS IN IMPROVING RADIATION RISK ASSESSMENT PROTOCOLS FOR DEEP SPACE MISSIONS

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Background: For future deep space missions, astronauts will encounter a level of radiation not previously encountered in space. Radiation risk assessment protocols for low Earth orbit missions use the NASA Space Cancer Risk Model (NSCR), which is restricted to population data of terrestrial radiation exposures. Newer efforts involving induced pluripotent stem cells (iPSCs) are directed towards creating personalized radiation sensitivity profiles that can more accurately predict the effects of unique space radiation environments for each astronaut. This presentation will inform aerospace medical personnel on how current radiation risk assessments are made with terrestrial population data and how iPSCs may augment this process for future deep space missions.

Overview: Radiation risk assessments necessitate a personalized approach that encompasses the multifactorial nature of radiation-induced illnesses. The factors that contribute to radiation sensitivity vary from the organs targeted to genetic susceptibilities. iPSCs are of particular interest as they have the potential to characterize the risks on a case-by-case basis. iPSCs, which allow for the recreation of specific tissues from an individual's cells, have been shown to be useful in elucidating various disease mechanisms in the setting of genetic mutations and radiation exposure. The process and development of iPSCs will be presented in relation to capability gaps in the current radiation risk assessment protocol.

Discussion: Personalized radiation risk assessments involving the use of iPSCs may advance current capabilities for determining radiation sensitivity. Terrestrial radiation data, taken from occupational hazards to atomic bomb exposures, is limited in that it does not represent the unique space environment for non-low Earth orbit missions as well as individual susceptibilities of each astronaut. Hence, understanding the current usage, limitations, and future applications of iPSCs in the context of predicting and preventing future astronaut health risks is of great interest to aerospace medical personnel.

5-DAY DRY IMMERSION-INDUCED NEURO-OPHTHALMOLOGICAL CHANGES IN HEALTHY FEMALES

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Introduction: Neuro-ophthalmological changes named spaceflight associated neuro-ocular syndrome (SANS) reported after spaceflights are important medical issues. Moreover, little is known about the impact of spaceflight on SANS in women due to the fact that fewer female astronauts spent time in long-term missions. Dry immersion (DI), an analog to microgravity, rapidly induces a centralization of body fluids, immobilization, and hypokinesia similar to that observed during spaceflight. The main objective of the present study was to assess the neuro-ophthalmological consequences of a 5-day DI in women.

Methods: Eighteen healthy female subjects underwent 5 days of DI. Peripapillary retinal nerve fibre layer thickness (RNFLT) was assessed with optical coherence tomography (OCT). Intraocular pressure (IOP) was determined by Goldman applanation tonometer. Optic nerve sheath diameter (ONSD) was measured by ocular ultrasonography. The normality of the distributions was assessed with the Shapiro-Wilk normality test. Paired-t test and Wilcoxon tests were used to compare OCT and IOP data. One-way repeated-measures ANOVA was used with Dunnett's multiple comparisons test to compare ONSD data.

Results: After DI, we observed a thickest global peripapillary RNFLT ($P=0.028$). We also noticed a thickest RNFLT both in the temporal ($P=0.041$), temporal-inferior ($P=0.012$) and nasal-inferior ($P=0.032$) quadrants. IOP remained steady after DI ($P=0.801$). ONSD increased significantly by 9% during DI 1 ($P=0.006$), 11% during DI 3 ($P<0.001$), 15% during DI 5 ($P<0.001$) and remained higher by 6% after DI ($P=0.008$).

Conclusion: These findings suggest that 5 days of DI induced significant ophthalmological changes in women. Although it is quite difficult to extrapolate these results to those observed after long-term exposure to microgravity, DI can be considered as a reliable model simulating neuro-ophthalmological changes observed after short-term exposure to microgravity.

DEVELOPMENT OF A VIRTUAL REALITY SYSTEM TO ASSESS ITS IMPACT ON HUMAN PHYSIOLOGY DURING HYPOGRAVITY SIMULATIONS

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Background: Interest in space tourism has been growing and is a reality. Missions to colonize the Moon and Mars are in an advanced planning stage. The altered gravitational environment during spaceflights and the environmental experiment after landing resulted in spatial disorientation, especially in the early days of the new space era. Notably, the absence of gravity alters vestibular perception so that the vestibular system is no longer stimulated as it would be on Earth.

Research on spatial environment shows that altered gravity causes structural and functional changes in the vestibular processing, so the study of vestibular orientation with Virtual Reality (VR) intervention can contribute to the understanding of how to optimize training programs that eliminate or reduce the symptoms of both motion sickness and space motion sickness.

Overview: This study aims to develop a VR system to use in spatial disorientation on land and in space and assess the impact of VR use on spatial signs and symptoms related to motion sickness on land, integrating vestibular, cardiopulmonary, and biomechanical responses using a hypogravity simulator. The research will be developed by an interdisciplinary group of researchers using resources from the UFCSPA Neuroscience and Experimental Virtual Reality Lab – NERV, and the Center for Aerospace Medicine Studies – CEMA, in the Faculty of Medicine, University of Lisbon.

Discussion: It will be a VR system developed in studies adjusted to spatial orientation with subjects of both sexes, aged between 20 and 40 years. For simulation of spatial disorientation in hypogravity, AlterG will be used with and without VR. Data relating to spatial and physiological disorientation will be collected, along with a symptom report before and after each intervention. Statistical analysis will be performed within and between tested groups.

TELEMEDICINE IN SPACE: PAST, PRESENT, AND FUTURE

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Background: On April 12, 1961, Yuri Gagarin made the first assessment of human health in orbit: "I feel great!" This brief report, transmitted from Vostok 1 to a ground station in Khabarovsk via very high frequency (VHF) radio, is the first instance of health communications between Earth and space, and the first moment in space telemedicine history.

Overview: Since 1961, the application of telemedicine in space has grown from passively monitoring the health of crewmembers on short-duration missions to actively providing healthcare to astronauts, cosmonauts, taikonauts, and spaceflight participants over the course of months and years.

Discussion: In this presentation, we trace the evolution of space telemedicine from 1961-2022 and discuss its impact on the past, present, and future of human spaceflight.

DRY IMMERSION – AN INNOVATIVE GROUND-BASED MODEL FOR STUDYING THE PHYSIOLOGICAL EFFECTS OF WEIGHTLESSNESS

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Background: The evident constraints of using the space environment to study space-related physiological adaptations have led science teams to focus parts of their research on ground-based analog models mimicking some of the effects of weightlessness.

Overview: The model most used in humans is the -6° head-down bedrest (HDBR). However, a Russian-developed model is recently being used in France called the dry immersion (DI) model. It consists in immersing the subject in a tub containing thermoneutral water, covered by a tarp preventing the skin from macerating, while completely immersed. This reproduces another effect of life in space, called supportlessness. A few studies had been carried out at Medes space clinic in Toulouse for the past 7 years, all in men, for durations of 3 to 5 days of immersion.

DI studies have shown the model could reproduce some of the effects of weightlessness, brought about in a more rapid way than with the HDBR model. These adaptations include orthostatic intolerance, a decrease in plasma volume and aerobic capacity, loss in muscle strength and volume, an imbalance between bone resorption and formation markers, and an increase in insulin resistance. Also found were a suggested increase in intracranial pressure (ICP) associated with a lesser recovery in cerebral autoregulation and with slight ophthalmological changes akin to spaceflight associated neuro-ocular syndrome (SANS).

Discussion: The European Space Agency (ESA) has decided to carry out a standardization study of the DI model and create a reference dataset. This enterprise has started in 2021 with the realization of a study in 18 healthy female subjects and will continue in 2022 in male subjects. The results from these two studies will provide further insight into the integrated physiological adaptations caused by DI and validate its use to test countermeasure protocols.

INSPIRING THE ARTEMIS GENERATION: LESSONS LEARNED PRESENTING ROCKET SCIENCE AND HUMAN PHYSIOLOGY

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Background: The Artemis program is a multi-billion dollar program that will send the first woman and first person of color to the surface of the moon. Therefore, the program's monumental goals, cutting-edge technology, and scientific questions present a once-in-a-generation opportunity to increase science, technology, engineering, and mathematics (STEM) engagement across audiences worldwide.

Overview: The aerospace medical science community has a unique chance to leverage the excitement surrounding the Artemis program. Specifically, the community can increase the public's general interest in STEM and spur particular interest in the biomedical sciences. To successfully engage a wide variety of audiences, aerospace medical clinicians, scientists, and engineers should: (1) highlight the unique intersection among human physiology, exploration, and aeronautical/aerospace engineering; (2) leverage social media and popular media; (3) show the scientific process through demonstrations; (4) practice respectful debunking of conspiracy theories; (5) advertise the technological spinoffs and advancements born from space exploration; (6) personally advocate for STEM pipelines by engaging schools, libraries, and science competitions; (7) tactfully use humor; (8) and distill their expertise into easily understandable language.

Discussion: The technological and societal impact of the Apollo era persists today. The Artemis program is Apollo's ambitious descendent that will not only highlight technological advancements, but highlight the importance of successful international collaboration, diversity initiatives, and the curiosity and bravery of humankind. The aerospace medical science community is in a unique position to engage the public's curiosity and interest in both the vastness of outer space and the personal space of the human body. Through entertaining and enlightening public outreach experiences, aerospace medical clinicians, scientists, and engineers can impact and influence the next generation of scientists, engineers, and explorers and increase the public's interest in humankind's return to the moon, journey to Mars, and beyond.

MENTAL HEALTH DIFFICULTIES AND COUNTERMEASURES IN SPACE EXPLORATION

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Introduction: The presentation will introduce key state of the art insights on how to maintain acuity in distressing environments characteristic of human space exploration.

Methods: Information will be gathered via a mixed-methods research approach including an in-depth updated literature review on the topic covering published scientific literature and mission reports, a survey distributed to cosmonauts and medical ground crew, and structured interviews with a select few pilots, scholars, and specialists at the forefront of mental health in space exploration and space analog environments.

Results: Recommendations to minimize or eliminate factors damaging crew acuity, resilience, morale, and overall cognitive and emotional health will be summarized. Factors would include potential implementation pathways for future missions, and highlights core areas requiring further attention and research.

Conclusions: The presentation will show possible emerging fields of space psychiatry, both at the individual and collective levels, and strengthen the field as an essential interdisciplinary element of space medicine.

PROJECT CHEIRON: A FRAMEWORK FOR THE EVALUATION OF QUALITY CARE PROVISION IN LONG DURATION SPACE MISSIONS

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Introduction: This proposal is a first step in project Asclepius, aimed at providing a start point for students to do important research in space medicine. The NASA integrated medical model (IMM) suggests 100 medical and surgical conditions that are likely to occur on future exploration class missions. Currently the ISS has medical capabilities that won't be available on these missions and therefore there is a need to re-evaluate the equipment required. We aim to create a framework so the conditions outlined in the IMM are evaluated by students to propose what equipment would be required to provide a level of care as close to international guidelines as possible.

Methods: A literature review is required to investigate the current recommendations outlined on the medical capabilities and predicted care on exploration class missions. The IMM will be grouped into sections that students can take on (focused around a physiological system, a particular type of intervention or treatment such as surgery). By comparing how the European and American medical systems assess their own (earthly) care, a framework is developed for students to use. The second part of the study will outline the different requirements that exploration class missions impose to medical capabilities.

Results: The main output of this first project is a protocol for the authors and students to follow in order to investigate and publish on a focused subset of medical conditions and their requirements.

Conclusions: In conclusion, this will open up a rare opportunity for students to get involved in research. The final project output will also be a comprehensive assessment of the whole IMM conditions list and recommendations of equipment that should be on board a spacecraft to maximise the quality of care delivered to crewmembers.

CREATION OF AN ONLINE AEROSPACE MEDICINE COURSE FOR MEDICAL STUDENTS

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Background: To date, only a few medical schools and institutions offer formal Space Medicine courses despite the rapid growth of the field. Due to this limited accessibility, many students remain unaware of the field, and interested students face difficulty gaining academic exposure. Thus, we endeavored to create a readily adaptable online space medicine course to address this gap in medical education.

Overview: The two-week online course consists of ten modules (below) covering topics adapted from: 1) Fundamentals of Space Medicine by Clement 2) Space Physiology by Buckey and 3) Space Physiology and Medicine by Nicogossian. Each module contains readings, PowerPoint presentations, clinical cases, quizzes, and supplementary journal articles, videos, podcasts, etc. The course also includes a pre/post course assessment, a final presentation, and further readings, opportunities, and resources.

- Module 1: Introduction and Historical Perspectives
- Module 2: Operational and Life Support Systems
- Module 3: Preflight and Postflight Recovery
- Module 4: Radiation in Space
- Module 5: Neuro-Vestibular System in Space
- Module 6: Vision in Space
- Module 7: Cardiopulmonary System in Space
- Module 8: Musculoskeletal System in Space
- Module 9: Psychological Considerations in Space
- Module 10: Nutrition in Space

Results: The course is formalized at the University of Michigan Medical School and the University of Cincinnati, and over 60 students have taken it. The qualitative/quantitative data gathered include 1) Knowledge Gained (100% of students) 2) Course Satisfaction (100% of students) 3) Course Influence on Future Goals (>50% of students) and 4) Quality Improvement/Program Evaluation.

Discussion: This course structure successfully provides students an introductory exposure to space medicine and career possibilities within it. Next steps include 1) incorporating students' and experts' feedback and 2) piloting the course at other medical schools. Future directions include making the elective widely available online to support students across international and civilian/military spheres.

ENGINEERING AND MEDICAL COLLABORATION FOR EDUCATION IN HUMAN SPACEFLIGHT: THE UNIVERSITY OF COLORADO MEDICINE IN SPACE AND SURFACE ENVIRONMENTS COURSE

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Background: Human spaceflight requires interdisciplinary collaboration among practitioners, human health and performance experts, and the engineers who design the systems and devices used for medical care delivery. Maintaining astronaut health and safety in extreme, exploration environments necessitate unique training, preparation, technology, and advanced medical care.

To address these challenges, the University of Colorado Department pioneered an interdisciplinary course for university students called Medicine in Space and Surface Environments (MiSSE). The course begins with traditional didactics and concludes with an immersive field simulation conducted at an analogue Martian Habitat. This allows participants to learn the challenges conceptually and then experience them first-hand.

Overview: Course participants receive didactic education on aerospace and extreme environmental medicine, and learn basic hands-on skills, such as primary assessment, Wilderness First Aid, and CPR. Students then apply this conceptual knowledge to an operational environment with simulated EVAs. During each EVA, a medical scenario arises that they must address using the didactic training as well as operational skills, such as effective radio communications, task prioritization, group dynamics, and situational awareness. Students are also asked to apply engineering solutions to address the challenges of remote, operational medicine. They identify a conceptual need; assume the role of an engineering design team, and work to design devices under mass, power, and volume constraints. This helps them to better understand the unique requirements that human physiology and medicine pose for their systems such as a rocket delivery system with a payload for medical supplies and a wireless physiological monitoring of field teams.

Discussion: The challenges of spaceflight in human health and performance requires significant input and collaboration between engineers and physicians. The MiSSE course has successfully integrated these fields and experts and is an example of how to train the next generation of innovators in space medicine.

EDUCATION IN AEROSPACE MEDICINE IN BRAZIL FROM MEDICAL UNDERGRADUATE TO POSTGRADUATION

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Background: Education in aerospace medicine is extremely important for specialization, and is a big part of the process for the specialty of aerospace medicine.

Overview: In Brazil, aerospace medicine became recognized in 2018 by the competency format. The civil formal education process started in 2006, with the undergraduate medicine student for more than ten years, until becoming part of the formal curriculum in the undergraduate medicine course.

The postgraduate includes two types: Lato Sensu course and Residency. The Lato Sensu Post Graduate of Faculdade Paulista Ciencias da Saude started a new format that includes strategic practical areas, like aeromedical transportation, emergency, and airport medicine.

Discussion: The education process in aerospace medicine is essential for aerospace medicine being recognized, from medical undergraduate to postgraduate. However, the need for this education in each country must be considered, and we will discuss what makes the curriculum dynamic.

Day 3 Posters

ASSOCIATION BETWEEN FLIGHT HOURS AND RISK OF DEPRESSION IN INDONESIA CIVILIAN CABIN CREW DURING COVID-19 PANDEMIC

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Introduction: The risk of depression or subclinical depression is the earliest stage of depression. The risk of depression can increase in individuals who work in high stressors environments such as cabin crew because they are constantly exposed to occupational risks such as long and irregular working hours. The risk of depression can cause incapacitation in cabin crew due to symptoms that can interfere with their flight performance. The COVID-19 pandemic increases the risk of depression in cabin crew related to regulations that limit flight activities in preventing the spread of COVID-19. The purpose of this study is to determine the prevalence and the relationship between flight hours and other factors on the risk of depression in civil aviation cabin crew in Indonesia during the COVID-19 pandemic.

Methods: This was a cross-sectional study conducted at the Directorate General of Civil Aviation Medical and Garuda Sentra Medika Jakarta from 17 May – 8 June 2022. Data were collected using a questionnaire which was then analyzed using SPSS version 22.

Results: Among 159 samples, 80 cabin crews (50.3%) had a risk of depression. Flight hours were not significantly associated with the risk of depression ($p = 0.579$). Excessive fear of COVID-19 and sleep disturbances can increase the odds of cabin crews of having the risk of depression 3.21 (95% CI 1.68-6.14); $p < 0.001$) and 2.48 (95% CI 1.30-4.72); $p = 0.005$) times, respectively.

Discussion: The prevalence risk of depression in civil aviation cabin crew in Indonesia during the COVID-19 pandemic was relatively high. Among all the factors analyzed in this study, only excessive fear of COVID-19 and sleep disturbances were associated with the risk of depression in cabin crew. More studies are needed to assess other factors that can also contribute to the risk of depression.

PSYCHOPHYSICAL DETERMINANTS OF COPING WITH STRESS DURING THE FIRST SOLO FLIGHT OF AN AVIATION UNIVERSITY STUDENTS

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Introduction: A correctly performed first solo flight is a ticket to further aviation training at an aviation university. The assessment of this flight determines whether to continue training the pilot candidate or remove him from the pilot course. Stress related to the implementation of such a flight is conditioned mainly by the features of temperament and psychophysical fitness.

Methods: Study subjects - a group of students of the aviation school pilot course was tested (n=30). Test methods - There were two methods: 1) Coping Inventory for Stress Situations - The results are presented on three scales: Style concentrated on the task, style concentrated on emotions, and style concentrated on avoiding. 2), A Questionnaire of Temperament – Formal Characteristic of Behavior. The temperament describes two characteristics moderating human behavior, namely: a) energetic characteristic of behavior, which encompasses emotional reactivity, activity, endurance, sensor sensitivity, and b) temporal characteristic of behavior that contains the following dimensions: briskness and retentiveness.

Results: The results obtained were analyzed with “Statistica” application and they indicated that the study subjects modified their stress coping styles depending on external situation (before and after the flight). Statistically significant differences were obtained in the styles of coping with stress used by students. This applies to the style focused on the task (0.007) and on emotions (0.003). These results indicate that the situation of the first solo flight (avg = 75.7) in relation to the pre-flight situation (avg = 64.4) requires higher task concentration and alters the emotional state. However, in terms of the style focused on avoidance, there was no statistically significant correlation (0.333).

THE PERSONALITY TRAIT OF NEUROTICISM IN A CLINICAL SAMPLE OF USAF PILOTS

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Introduction: The personality trait of neuroticism, the tendency to experience negative emotions, may predict the development of anxiety and depression. Within the USAF, the assessment of personality traits on the NEO-PI has been studied in student pilots, with a consistent finding of lower neuroticism compared to the general population. Few studies have focused on NEO-PI in clinical evaluations of trained pilots or how neuroticism scores in a pilot clinical population referred for clinical evaluation may aid in clinical diagnosis.

Methods: 198 USAF pilots with mental health diagnoses were evaluated at the ACS for waiver recommendation. All pilots underwent cognitive and psychological assessment, including the NEO-PI-R or NEO-PI-3. The neuroticism factor and facet scores were compared to the general population. Additionally, differences were explored on the neuroticism factor and facet scores for those that received recommendation for waiver versus those that were not.

Results: Compared to general population on the NEO-PI, trained pilots with a history of mental health diagnosis exhibited overall lower levels of neuroticism. All facet scores were lower than the general population, with the vulnerability to stress facet score rated the lowest. Those recommended for waiver (n=156) exhibited lower levels of anxiety, anger/hostility, depression, and vulnerability to stress than those not recommended for waiver (n=33). While there were differences between the two groups, the average scores for both groups remained lower than the general population.

Conclusions: Overall neuroticism scores in the clinical population of trained pilots referred for evaluation were generally lower than those in the general population. Of those pilots that were not recommended for a waiver for a mental health condition, higher scores on neuroticism facets were seen. Findings may assist with the interpretation of the neuroticism personality factor when evaluating trained pilots in a clinical setting.

INTERACTIONS OF INTERNATIONAL PILOTS' FATIGUE, SYMPTOMS OF DEPRESSION, ANXIETY, COMMON MENTAL DISORDERS AND WELLBEING

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Objective: This study Investigates more dimensions than previous studies simultaneously: pilots' duty rosters, stress, sleep difficulties, fatigue levels, wellbeing, symptoms of depression, anxiety, and common mental disorders (CMD), and how they are interrelated.

Background: Several scientific studies have confirmed that fatigue can pose a significant risk to flight safety. Other studies reported positive depression screening results for more pilots, compared with the general population.

Methods: A cross-sectional online survey was completed by 406 international pilots, who reported their duty rosters of the last two months. Pilots also self-assessed their stress-levels, sleep problems, fatigue, wellbeing, and mental health.

Results: Although pilots were on average rostered for only 60% of maximum legal duty and flight hours, three out of four pilots (76%) reported severe or high fatigue. Every fourth pilot reported considerable sleep difficulties (24%). 18.7% pilots reported positive depression screening results, 8.5% positive anxiety screenings, 7.2% reported significant symptoms of depression and anxiety. Highly significant to high correlations between stress, sleep problems, fatigue, symptoms of depression, anxiety, CMD and well-being were found.

Conclusions: Chronic stress appears to be linked to psychophysiological wear and tear, and was associated with higher levels of fatigue, more sleep disturbances and more impaired mental health. Future research should not only consider fatigue as an immediate threat to aviation safety, but also as a significant threat to pilots' safety-relevant fitness to fly.

ASSESSMENT OF THE RESIDUAL SLEEPINESS RISK IN AIRCREW MEMBERS WITH OSAS

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Background: Obstructive sleep apnea syndrome (OSAS) is a major problem in aviation medicine because it is responsible for sleepiness and high cardiovascular risk, which could jeopardize flight safety. Residual sleepiness after the treatment is not a rare phenomenon, and its management is not homogeneous in aviation medicine. Thus, we decided to perform a study to describe this management and propose guidelines with the help of the literature.

Methods: This is a retrospective study including all aircrew members (AM) with a history of OSAS who performed a visit in our aeromedical center between 2011 and 2018. Residual sleepiness assessment was particularly studied.

Results: Our population was composed of 138 AM (mean age 50.1+/-9.6yo, 76.8% of civilians, 80.4% of pilots), 65.4% of them had severe OSAS with a mean Epworth Sleepiness Scale (ESS) at 8.5+/-4.7, and a mean AHI at 36.2+/-19.2/h. 59.4% of our population performed maintenance of wakefulness tests (MWT), and 10.1% had a residual excessive sleepiness. After the evaluation, 83.1% of our population was fit to fly.

Discussion: An evaluation of the treatment efficacy is required in AM with OSAS. Furthermore, it is important to have an objective proof of the absence of sleepiness. In this case, ESS is not sufficient and further evaluation is necessary. Many tests exist but MWT are generally performed, and the definition of a normal result in aeronautics is important. This evaluation should not be reserved to solo pilots only.

FATIGUE STUDY OF ALGERIAN AIRCREW PERSONNEL

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Introduction: Fatigue in the aeronautical environment can lead to a decrease in performance or efficiency, due to increased information provided to perform a task. For aircrew (AC) it can interfere with flight safety. Our objective is to study the prevalence of fatigue among ACs, aeronautical risk factors and flight safety.

Methods: Cross-sectional, prospective, descriptive and analytical study, carried out over 18 months using a questionnaire and fatigue assessment scales.

Results: The average age of the 524 AC is 38.23 years old, the sex ratio was 5.5 (M/W), the pilots are represented by 45.9%. The prevalence of fatigue is 25.74%. The aircraft used, the hours flown (HF) and the specific equipment have a statistically significant difference with fatigue ($p=10^{-3}$) and gender ($p=0.0173$). On the other hand, it was not influenced by the age of the AC ($p=0.093$). The association with pain and fatigue is 23%. The preventive means applied have a significant statistical difference ($p=0.01$).

Discussion: Fatigue is observed in 25.74%, excessive on the Pichot scale (5.2%), clear agreement with the LP Zhou study (2017), but in the general population (21.9%, C Galland-Decker, 2019). These results are due to the cumulative HF, stress and living conditions on board. The Raynaud F study (lower prevalence and unrelated to the aeronautical specialty, 2018) only interested fighter pilots, small sample size and study methodology. The link with sex and age is consistent with the results of A Hinz (2020). The association of pain and fatigue is close to the study by Oksa (1999). The role of prevention in our study is consistent with that of F Cramp (2019).

Conclusion: Our results have updated the epidemiology of AC fatigue, its occurrence is influenced by aeronautical risk factors and prevention remains effective to preserve flight safety.

FATIGUE OPTIMIZATION DURING UNIVERSITY TRAINING OF HELICOPTER PILOTS**Krisztina Szabó¹**, Botond Szűcs¹, Máté Petrekanits²¹*PHARMAFLIGHT, Debrecen, Hungary*²*University of Physical Education, Budapest, Hungary*dr.szabo.krisztina@pharmaflight.com

Introduction: We evaluated the applicability of a fatigue risk measuring and optimizing program during university helicopter pilot training. We measured cardiovascular risk factors and changes in autonomic regulation.

Methods: A total of 12 helicopter pilots (all males, age: 30.47 ± 5.39 years) participated in a 36-month program. Interventions were changes in diet, physical activity and lowering burden at academic studies. We measured blood pressure, pulse, augmentation index (AIX), pulse wave velocity (PWV), diastolic area index (DAI). Changes in autonomic regulation were evaluated using heart rate variability (HRV). Parameters included: minimal (p.min), average (p.avg), maximal pulse (p.max), maximum-minimum pulse difference (p.max-p.min). Long-term continuous RR intervals (stda), standard deviation of beat-to-beat variability (stdb), the percentage of pairs of adjacent NN intervals differing by more than 50 ms (pNN50). Spectral analysis provided the low-frequency/high-frequency ratio (LF/HF).

Results: Individualized intervention protocols, normalizing circadian rhythms caused improvement in cardiovascular risk factors: Systolic (133.38 ± 22.15 vs. 126.48 ± 20.22 mmHg) and diastolic blood pressure (76.95 ± 14.37 vs. 75.4 ± 12.7 mmHg) showed a reduction tendency. Pulse decreased (76.95 ± 14.37 vs. 72.53 ± 13.65 bpm). AIX showed slight improvement ($-33.54 \pm 5.59\%$ vs. $-31.93 \pm 3.79\%$); PWV data showed minimal change (7.74 ± 2.13 vs. 7.4 ± 2.73 m/s); DAI showed moderate improvement (49.32 ± 6.81 vs. 51.1 ± 7.01 m/s).

HRV showed decreased p.max-p.min difference (18.78 ± 9.2 bpm vs. 15.5 ± 9.01 bpm), normalized dynamics (stda: 44.56 ± 35.97 vs. 69.63 ± 33.5 ; stdb: 30.88 ± 41.5 vs. 32.72 ± 35.84) with sympathetic overload (pNN50: 7.33 ± 6.76 vs. 11.17 ± 5.24 , LF/HF: 169.52 ± 208.83 vs. 252.01 ± 351.16).

Discussion: As a consequence of the fatigue risk management program, overall quality of life and everyday performance improved.

DEVELOPMENT OF PILOT FATIGUE LEVEL EVALUATION SYSTEM USING DEEP LEARNING CLASSIFIER

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Introduction: Fatigue is a risk factor that threatens flight safety. The ROK Air Force is using an operational risk management (K-ORM) checklist to monitor pilot fatigue levels. This study is being conducted to develop a deep learning fatigue-level classifier that can increase the reliability of fatigue level evaluation by excluding the subjective evaluation of K-ORM checklists and make customized evaluation of fatigue levels.

Methods: Fatigue levels will be classified into five levels by processing the pilot's visual, thermal, and audio signals. Data for classifier learning was obtained through daily multidimensional fatigue inventory (DMFI) created by fusion of a part of K-ORM checklist and multidimensional fatigue inventory. Fatigue level data obtained through DMFI underwent a refinement process to remove abnormal data through physiological indicators related to fatigue, to mitigate limitations of self-report fatigue evaluation.

Results: Physiological indicators related to fatigue were PVT for acute fatigue, lactic acid for physical fatigue, C-reactive protein (CRP) for cumulative fatigue, and cortisol for mental fatigue. Although physiological indicators were not sufficient to classify fatigue levels, errors in subjective self-report fatigue evaluation could be found through high levels of fatigue-related physiological indicators at low DMFI fatigue levels. Reaction time of PVT, CRP, and lactic acid showed a positive correlation with fatigue levels, but Cortisol level near 9 am showed a negative correlation with fatigue levels.

Discussion: In conclusion, the deep learning algorithm that classifies the fatigue level through visual, thermal, and audio signals is trained by the fatigue level extracted after being refined into fatigue-related physiological data. This system will determine the pilot's fatigue level in real time in situ, and will evolve into customized system and increase reliability. This study suggests that this system can contribute to flight safety by systematizing pilot fatigue management.

MEASUREMENT OF HEART RATE VARIABILITY AS AN INDICATOR OF FATIGUE IN AEROBATIC AND LINE AVIATION. COMPARISON OF A WEARABLE DEVICE WITH A GOLD-STANDARD: A PILOT STUDY

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Introduction: The measurement of heart rate variability (HRV) is a method for studying the activity of the autonomic nervous system. It is used to assess stress, the state of fatigue and to follow the training of athletes. While airline pilots are confronted with long flights of low intensity, aerobatic pilots are confronted with short flights of high intensity. The aim of this work is to study and compare HRV in airline and aerobatic pilots, and to compare the use of a consumer heart rate monitor with that of a professional Holter in the analysis of HRV.

Method: The study pilots will be equipped with both a "Spiderview" digital Holter recorder (two-channel recording with 5 electrodes) and a Polar H10 heart rate monitor coupled with the Elite HRV phone application. The recording of the heart rate will be carried out concomitantly with the digital Holter and the heart rate monitor during the entire flight. The analysis of the HRV, with the time and frequency indices, will be obtained using the Synescope interpretation software from Microport and the HRVanalysis software respectively. A questionnaire for assessing the state of fatigue, the Samn Perelli (SP) and the Karolinska Sleepiness Scale (KSS).

Results: Study in progress and results planned for the beginning of September. Hypotheses to be validated: comparison of HRV with airline and aerobatic pilots correlated with a level of fatigue, and validation of the use of a device for measuring HRV by a heart rate monitor that is easier to wear and sufficiently reliable.

Conclusion: Pilot feasibility study for validation of a simple, inexpensive and accessible HRV monitoring device, which will allow the pilot a personalized and objective follow-up of his state of fatigue.

BARIATRIC MEDEVAC: VITAL COLLABORATIONS BETWEEN CIVILIAN AND MILITARY HEALTH CARE SERVICES - FEEDBACK FROM NEW-CALEDONIA

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A high prevalence of overweight people and obesity has been found in the population of New Caledonia and other Pacific Island Countries and Territories.

The insularity of these islands often requires the provision of medical care which includes aeromedical transport. The weight of the passengers is a current logistic problem for the civilian emergency teams.

The military health care service with the French Air Force provides for the needs with more adaptative airplanes and helicopters.

We propose feedback about 5 missions during the last year, to rescue civilian patients to relate the contribution and cooperation between the civilian and the military teams in taking care of these patients. Through these missions, we better understand why and how the military force fills in the gaps.

Without the military assistance, at least 2 patients will die cause of lack of means, unacceptable fact in an economically developed area.

Few lessons learned but very useful to improve the civilian emergency airplanes and helicopters to take care of more and more overweight patients in the future.

IS BASIC SEMIOLOGY USEFUL DURING AN INFLIGHT MEDICAL EMERGENCY FOR VOLUNTEER DOCTORS?

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Introduction: Medical emergencies on board happen very often, in a ratio of 1:604 flights. Nonetheless, when onboard medical assistance is needed during a flight, a volunteer doctor faces many challenges in clinically evaluating a passenger, due to limitations of a commercial aircraft environment such as the presence of noise, vibration, and inadequate lighting. Considering the impact of these factors on basic steps for physical examination, especially considering how it affects percussion and auscultation, an analysis was held in 2022, by a group of aviation medical postgraduate doctors to find out which method is more effective.

Methods: A group of 17 (seventeen) postgraduate medical doctors in Aerospace Medicine simulated inflight emergency procedures, by comparing cardiac and pulmonary auscultation and percussion in-cabin conditions. A stethoscope was used for auscultation and percussion was performed according to medical propaedeutic practice. The aircraft engine simulated noise varied from a range of 80dB (cruise) to 120dB (during take-off). The clearness in the listening used according to the following criteria was: 1- Good; 2- Fair; 3- Almost nothing; 4- Nothing.

Results: There was no difference between cardiac and pulmonary percussion when applied. During auscultation, there was a significant difference between cardiac and pulmonary semiology.

Conclusion: Since the same simulation was also performed also by students from Medical School during propaedeutic classes, it is possible to compare both simulations and conclude that semiology will vary depending much more on the examiner's experience than the interfering factors from the environment itself. Due to aircraft limitations, as already mentioned, it turns out that clinical stabilization in a flight emergency must be the priority over trying to make a diagnosis.

REVIEW OF THE SEARCH AND RESCUE ACTIVITY BY THE 186TH MEDICAL CENTER

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Introduction: A doctor / nurse pair from the Cazaux medical unit (186th AMC) take part H24 in the "Search and Rescue (SAR)" mission, joining the Caracal crew of the 01.067 "Pyénées" helicopter squadron in French Air Force base n°120.

In this generic term "SAR," several missions are grouped together:

- As a priority, the search and rescue of ejected fighter pilots and military and civil aircraft in distress, within the framework of the International Civil Aviation Organization (ICAO).
- Medical evacuations of sick or injured soldiers, in particular during risky activities
- Rescue and medical aid at sea within the framework of the International Maritime Organization (IMO), in support of the public health service.

Methods: We have retrospectively analyzed the missions carried out over a period of 22 years between 1999 and 2021. The data retained are the number and type of missions, the number of patients treated and the type of emergency presented.

Results: 249 medicalized interventions were carried out by the 186th AM from 1999 to 2021. The annual volume is variable: 11.3 per year on average (min: 2; max: 24). More than half are search, rescue and urgent medical aid operations at sea for the benefit of shipwrecked people. 60% take place between June and September, probably in connection with summer activity. 354 people were rescued. 253 were safe while 75 required medical care and hospital evacuation. 42 had died. Note the rescue of 29 children, 3 babies and 4 animals. Finally, more than 79 people have not been found.

Conclusion: The 186th AM is particularly invested in the SAR mission, by regulation for the benefit of aeronautical crews, particularly in the south-west zone, and also in maritime search and rescue. This activity involves a perfect knowledge of the aeronautical environment, the permanent maintenance of skills in emergency medicine and appropriate equipment.

AEROMEDICAL RETRIEVAL OF A CRITICALLY INJURED BURN VICTIM FOLLOWING A QUADBIKE ACCIDENT IN THE REMOTE AUSTRALIAN OUTBACK

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Introduction: The Royal Flying Doctor Service of Western Australia provides critical care aeromedical retrieval services to the remote Australian outback travelling 9 million kilometres per year. In the middle of the harsh wet season in the West Australian Kimberley an RFDS medical crew were already en route to the scene a high priority motor vehicle rollover when the crew were diverted to a critically injured burns victim. The actions of the bystanders, pilot and medical team saved the life of a young man.

Case Report: A 20 y/o man was working in a remote cattle station in the Western Australian outback as part of a team mustering cattle using quadbikes and helicopters. He crashed his quadbike into a termite mound, causing the quadbike he was on to explode, engulfing him in flames and resulting in significant burns to his lower body.

He sustained 60 percent total body surface area burns, causing hemodynamic instability and critical compromise to the circulation to his hands and legs. The remote setting of the accident, severe weather, and competing medical taskings on the day, delayed the arrival of the aeromedical retrieval team by four hours, and initial first aid was provided by the mustering team.

On arrival of the RFDS aeromedical retrieval team, he was stabilised in the bedroom of the isolated homestead, provided analgesia, burns dressings, and fluid resuscitation, and maintained in spinal precautions. The 2878km journey to Perth was further delayed by significant thunderstorms.

Discussion: This case presentation details the aeromedical retrieval of the patient from an isolated cattle station to a tertiary burns centre for lifesaving treatment, and the interactions between the pilot, medical crew, the patient, and bystanders. The complex interplay of crew resource management factors, human factors, environmental factors, and aeromedical factors contributed to his medical stabilisation and successful recovery.

MANAGEMENT OF A CIVIL PILOT WITH HEREDITARY HEMOCHROMATOSIS: A CASE REPORT

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Introduction: We present a rare case of aviation pilot diagnosed with hemochromatosis at age 49. Hereditary haemochromatosis (HH) is an iron storage disorder characterized by an increased intestinal absorption of iron and its accumulation in many tissues. The disease causes an iron overload with tissue damage also seen in haematologic disturbances and hepatic disorders.

Case Report: A 49-year-old commercial pilot reported abdominal discomfort without specific symptoms. The aeromedical examiner suggested abdominal ultrasound and routine blood test which demonstrated high level of ferritin (2100 ng/ml), iron (220 ug/dl), percentage of transferrin saturation (100%).

A liver MRI examination was performed after the ultrasound results and showed diffuse signal changes in the liver, which could be siderosis. A liver biopsy confirmed that the pathological change was consistent with hemochromatosis. The pathology showed liver cell degeneration, a large number of cytoplasmic hemosiderin granules, portal area fibrosis and lymphocyte infiltration. The genetic investigation confirmed hemochromatosis in homozygosity C282Y. The patient was given a low iron diet and phlebotomy therapy initially once a week.

The case of the pilot was deferred to the Authorities, in accordance with EASA guidelines. Thanks to a multidisciplinary approach, after an unfit period, the AME in agreement with the Authority proposed a plan for the patient to be able to resume work with specific limitations: periodic evaluation from a board-certified gastroenterologist and hepatologist, periodic blood test, avoid flying in the 48 hours following phlebotomy.

Discussion: Please note that only a multidisciplinary approach with AME, specialist doctor and occupational doctor, coordinated by the Authority, can guarantee an acceptable result: health for the patient and safety for the flight.

HAEMOCHROMATOSIS IN COMMERCIAL PILOTS - BEYOND MATTERS OF THE HEART

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Introduction: Hereditary haemochromatosis (HHC) is an autosomal recessive disorder that disrupts the body's regulation of iron. As a result, iron overload can occur and is detected by the presence of increased serum ferritin levels and transferrin saturation with or without symptoms. HHC can cause end-organ damage to multiple systems if not treated in a timely manner. From an aeromedical certificatory perspective, the main focus has centred on cardiological manifestations; the intention of this case is to consider the potential aeromedical considerations of other organ systems affected by this disease.

Case Report: A 55-year-old pilot who has had HHC for the past 40 years transferred to the United Kingdom from another non-EASA state. The pilot had not had a recent haematology review and was found to have an elevated ferritin level and transferrin saturation accounted by the fact that there had been a gap in regular venesection treatment. Cardiological reports include a specialist review, exercise ECG stress test, a 12-lead ECG and 24-hour Holter to look for arrhythmias and echocardiography to check for cardiomyopathy. However, liver ultrasonography had shown some potential echogenic changes which may suggest hepatic fibrosis. Following a careful assessment and subsequent hepatic biochemistry and normal imaging tests, the pilot was granted a Class 1 (commercial pilot) medical certificate.

Discussion: Within the medical literature, HHC is known to cause cardiac iron overload manifesting as subsequent dilated cardiac myopathy, diastolic dysfunction, cardiac arrhythmias and heart failure, other systems can be adversely affected. Hepatic iron overload can lead to an increased risk of hepatic fibrosis progressing to cirrhosis and development of hepatocellular carcinoma. Endocrine manifestations include diabetes mellitus and hypopituitarism whilst central nervous system manifestations include cognitive impairment. Multi-system monitoring should be strongly considered for pilots with HHC via haematological, biochemical and non-ionising imaging methods.

AEROMEDICAL DECISION MAKING PARADIGM FOR RETURN TO FLIGHT AFTER AN INFECTIOUS DISEASE

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Background: Infections, whether respiratory, blood borne, parasitic, bacterial or viral are a common cause of temporary unfitness for pilots and cabin crew. After adequate treatment, most are assessed fit; sometimes with restrictions. Assessments for return-to-flight are made by the airline doctor along with the treating clinician.

Overview: Infection in an aircrew poses various risks to flying in terms of sub-optimal health, due to the infection load itself, sequelae or complications of illness, side effects of medications, need for frequent monitoring and the likelihood of passing the infection to other crew/passengers. Even after clinical treatment, complete clinical and biochemical recovery could take a long time, e.g. malaise after viral illness or anaemia after malaria. Carrier states (e.g. hepatitis), prophylaxis (e.g. malaria), long term medications (e.g. tuberculosis) or sequelae (e.g. COVID-19) pose additional concerns. Is it required to wait until complete recovery and cessation of medications; or can they be considered fit once stable and non-infective, by assessing their functional capability and risk acceptability? Can an evidence based medicine approach be taken for such aeromedical decisions? Based on earlier paradigms for assessing risks of incapacitation for longer standing conditions, a new Aeromedical Decision Making (ADM) paradigm for managing infectious diseases is proposed to help consistent decision patterns within the industry.

Discussion: When re-flying after an illness, the employer needs to answer the triad of safety of the crew, safety for the industry and cost to the airline. History, clinical examination, investigations and/ or treating physicians fitness opinions may not be adequate tools for efficient decisions. The new ADM paradigm, with its evidence based and objective approach could assist airline doctors to address and mitigate the risks involved.

In the era of routine cross border country flying where contracting infections not previously exposed to, is commonplace; the challenge of return to flight in a reasonable time is the common responsibility of the crew, airline doctor and treating clinician, and using the ADM paradigm could be a useful tool.

RETURN TO FLYING CONCERNS IN TUBERCULOSIS – APPLICABILITY OF THE ADM PARADIGM

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Introduction: Tuberculosis is an infectious disease predominantly of respiratory origin. It leads to long-term confinement of cockpit and cabin crew, as the current guidelines do not permit return cockpit while on antitubercular therapy. The ADM paradigm provides a risk assessment-based template for better and early re-fighting of such crew.

Case Reports: Four cases of pulmonary Tuberculosis among cockpit crew are presented with the decision-making considerations in their aeromedical disposal. All these cases were grounded at diagnosis. Thereafter, rigorous monitoring and follow up were ensured while on 9 months of anti-tubercular therapy. They were re-flighted after thorough physical and functional recovery and assessment of the same. The average period of grounding in these cases was 9 ½ months.

Discussion: The strongest determinants in this decision making was based on ensuring that the period of infectivity was safely negotiated; drug side-effects were studied extensively; and the status of recovery (to include anatomical and functional) was well complete. Correlating this process with the ADM paradigm provides an evidence based risk assessment matrix ensuring a scientific approach for risk mitigation. It is felt that application of the ADM paradigm is likely to provide a scientific template for safe and early reflighting of the crew in cases of tuberculosis where the average return time is about 9 months.

Conclusion: The ADM paradigm provides a scientific and evidence-based approach to infectious diseases. Though it is still in the initial stages, it provides a robust framework for a pragmatic approach in dealing with such diseases. In this study, it is felt that the ADM paradigm would permit early re-fighting of the crew at 3 months instead of the 9 months even while addressing all the associated risks adequately.

PREVALENCE OF LEUKOCYTURIA IN ASYMPTOMATIC AIRCREWS: INTEREST OF SEXUALLY TRANSMITTED INFECTIONS TESTING

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Introduction: Sexually transmitted infections (STIs) can cause leukocyturia. We aimed at estimating the prevalence of leukocyturia in asymptomatic aircrews and the STIs proportion in those presenting a leukocyturia.

Methods: This survey was a prospective cohort study conducted among aircrews from 14 October 2019 to 13 March 2020, at the Toulon aeromedical center, in France. All participants have performed a dipstick urinalysis. Those positive for leukocyturia were offered a STIs screening by nucleic acid amplification test (NAAT) for *Chlamydia trachomatis*, *Neisseria gonorrhoeae*, *Mycoplasma genitalium* and *Trichomonas vaginalis*.

Results: Among 2236 (1912 men and 324 women) asymptomatic participants included, 127 (36 men and 91 women) were positive for leukocyturia. The prevalence of leukocyturia was 1.9% (1.3-2.6) in men and 28.1% (23.3-33.3) in women ($p < 0.001$). In men positive for leukocyturia, the NAAT positivity rate for *C. trachomatis*, *N. gonorrhoeae*, *M. genitalium* and *T. vaginalis* was 28.6% (3.7-71.0) in the 18-24 age group, 20.0% (0.5-71.6) in the 25-34 age group, and zero in the older ($p = 0.65$). In women positive for leukocyturia, it was 16.7% (4.7-37.4) in the 18-24 age group, 18.2% (2.3-51.8) in the 25-34 age group, and zero in the older ($p = 0.16$).

Discussion: In asymptomatic aircrews, leukocyturia is rare in men and more common in women. In asymptomatic aircrews under 35 years old with leukocyturia, multiplex NAAT shows high proportion of STIs and might be useful in improving STIs detection.

FRENCH DEFENCE AVIATION MEDICAL PERMANENT WORKING GROUP. ORGANIZATION AND ACTIVITIES.

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Background: A French defence aviation medical permanent working group has been created within French military health service in December 2020.

Overview: This multidisciplinary team brings to the French military health service staff his competence for all aeronautical medical questions submitted (medical selection and standards, medical physiological and psychological monitoring, physiopathology, ergonomics, aeronautical constraint countermeasure, aeromedical teaching, survival aspects, human factors, aeromedevac).

Discussion: We will describe this working group composition, functioning, tasks and activities since its creation.

COMPARISON OF INFLIGHT MEDICAL SUPPORT IN 10 MAJOR INTERNATIONAL AIRLINES AND GUIDELINES FOR EMERGENCY AND NON-EMERGENCY CONDITIONS

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Introduction: About 44,000 in-flight medical emergencies take place worldwide each year, according to a 2013 study in The New England Journal of Medicine. With the advent of more air travel, there are increasing number of passengers travelling by air and hence more in-flight emergency medical events (IEMEs) and Inflight Non-emergency medical events (INEME). There is not too much data analysis of IEME and INEME nor a protocol to handle those events.

Method: We collected data from 10 major airlines on IEME and INEME that the airline crew had to take care of during jet travel. We also collected data about how they were resolved with or without the help of any medical personnel involved, either on board or with the assistance of ground medical personnel. We collected data for how often the flight had to be re-routed or an earlier descent had to be made based on the patient's condition. We also looked at the protocols available during IEME and INEME. It was observed that generally there were no written protocols or recommendations available. The inflight medical kit was also reviewed for their content including medications, equipment, devices and instructions and written recommendations available for the inflight crew in case of a IEME or INEME.

Results: There is a big variation of protocols with different airlines -even from the same country-- as to what medications, equipment, and devices are available, as well as different set of protocols to be followed in case of IEME or INEME.

Discussion: The majority of IEMEs are not life-threatening conditions, and can be easily managed by cabin crew or on-board physicians. Ground-to-air medical assistance may help better optimization of diagnosis and decision for IEME if live video or audio chat available.

Conclusion: On international flights, BLS certification of at least two crewmembers should be mandated. Contents of inflight medical kits including medications, equipment, devices, and protocols in handling of IEME and INEME on all airlines should be standardized.

PROGRAM MODELS FOR ESTIMATING THE LEVEL OF CREW'S EXPOSURE TO COSMIC RADIATION ON FLIGHTS IN THE AIR SERBIA

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Introduction: The aim is to use software models to assess the level of cosmic radiation exposure of crews on flights in the Air Serbia airline and compare it with measurements obtained through thermoluminescent dosimeters (TLD).

Methods. In a retrospective study, the airline flights to 27 destinations were analyzed, for the year of the last solar maximum (2014) and solar minimum (2019). The CARI-6 computer program was used, developed by the FAA, and confirmed by in-flight measurements and recommended by EURADOS. From the Crew and Flight Planning Department, parameters for observed crew members were obtained for the number of flights to each destination, and from LIDO program parameters for flights were obtained, related to take-off and landing time, flight duration, time of climb and descent (TOC & TOD), and time spent at a certain altitude. The effective doses received by the crew members in the year of the solar minimum and in the year of the solar maximum were calculated, in μSv , and comparison with TLD measurements was made.

Results and Discussion. Annual effective doses calculated with CARI-6 show that crew members exceed annual limit of 1 mSv. The values of ambient ($H^*(10)$) and personal ($H_p(10)$) equivalent doses, measured by TLD, show that deviations of effective doses from the previously estimated effective dose are acceptable, considering their measurement uncertainty, which is accepted in the literature by 7% to 20%. The mean value of all relative deviations for the ambient dose equivalent on the selected flights is 8.44%. The mean value of all relative deviations in case of personal dose equivalent is 12.6%.

Conclusions. Cosmic radiation exposure of crews can be estimated based on software models and can be used when planning to assess the level of crew's exposure. Also, can be used for optimization of the flight schedule planning.

FROM THE GROUND UP – THE EXPERIENCE OF AN IN-HOUSE GROUND-BASED MEDICAL SUPPORT SERVICE FOR AN INTERNATIONAL AIRLINE

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Background: Ground-based medical support (GMS) is part of the passenger health services that many international airlines utilize to get medical recommendations for in-flight medical emergencies (IMEs) or pre-flight screening. In fact, IATA recommends that passenger health services should be a key function of an airline medical department, however, most usually use a third-party GMS contractor. Bringing the GMS service in-house has been a remarkable achievement that has been valuable for the airline's operations.

Overview: Providing a high-quality GMS service is crucial since the recommendations impact the general operations, for example, diversions for a medical condition and the on-time performance for pre-flight screening. In 2019, we started the in-house GMS service that is committed to providing an excellent evidence-based approach for our passenger health service. Since then, we have managed thousands of passenger and aircrew health cases with outcomes that are similar to other industry standards. Unlike third-party GMS providers, the in-house service bridges a gap where we have access to more resources and work closely with our network control centre team, well-trained cabin crew and other stakeholders. GMS also assists our 24-h aircrew support team in managing out-station cases more effectively. Our GMS physicians have training in emergency medicine, medical evacuation, aviation medicine and primary care; we leverage the talent of our diverse team in delivering excellent service.

Discussion: The in-house GMS service has proven to be effective for cost-saving by significantly reducing long-haul diversions, providing appropriate pre-flight screening, and maximizing onboard resources by working closely with our well-trained cabin crew. We have positively impacted the general operations by reducing our case activation fees, monthly retainers, repatriation fees, reducing the average length of stay and returning the aircrew to work sooner.

EFFECT OF PRE-FLIGHT BODY WEIGHT ON URINARY CALCIUM EXCRETION IN SPACE

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Introduction: Microgravity-induced bone loss increases urinary calcium excretion which increases kidney stone formation risk. Not all individuals show the same degree of increase in urinary calcium and some pre-flight characteristics may help identify individuals who may benefit from in-flight monitoring. In weightlessness bone is unloaded and the effect of this unloading may be greater for those who weigh more. We studied whether body weight is associated with increased in-flight urinary calcium excretion using data from Skylab and the International Space Station (ISS).

Methods: A retrospective analysis of Skylab and ISS data was conducted. The study was reviewed and approved by the National Aeronautics and Space Administration (NASA) Institutional Review Board (eIRB) and data was sourced from the Longitudinal Study of Astronaut Health (LSAH) database. The effect of weight on urinary calcium excretion was examined using linear mixed effect models with day-in-flight, weight, and program (Skylab or ISS) as fixed effects and the subject's responses over time as random effects.

Results: The combined Skylab and ISS data included 45 participants (9 Skylab, 36 ISS). Both weight and day in flight were positively related to urinary calcium excretion. There was also an interaction between weight and day in flight with higher weight associated with higher calcium excretion earlier in the mission.

Discussion: Several factors can affect urinary calcium excretion in space including baseline urinary calcium excretion, dietary intake, and genetic makeup. This study shows that weight is also a factor and could be included in the risk assessments for bone loss and kidney stone formation in space.

PATENTS IN SPACE MEDICINE: AN IMMEDIATE CALL FOR INNOVATIONS IN THE FIELD

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Background: Space medicine, as a distinct field, was still in its infancy five decades ago. Scientists studying the effects of space travel on the human body have begun to appreciate the relevance and possibility of future discoveries in the field. Major innovations in healthcare, including insulin pumps and cochlear implants, are a result of space medical research. The enormous potential predicted has now been realized and is being reaffirmed every day.

Overview: Space presents ample opportunities for a wide range of highly innovative applications, as well as products and services that directly benefit humanity. Patents are an excellent barometer of innovation. Over the last four decades, researchers have made novel discoveries about the human body in space, and global patent filing in the space sector has consistently grown. The previously patented innovations were the result of collaboration between government entities, academic and research institutions, and industry partners. Despite significant breakthroughs in the field, space medicine research is under-represented in patents and commercialized inventions. While patents are becoming more prevalent in space medicine, they are not as ubiquitous as other manufacturing and technology sectors. Herein, we discuss several aspects pertaining to patents in the field of space medicine.

Discussion: The rapid advancements in human space exploration endeavors boost the demand for research and innovation in space medicine. Patents are intended to protect and promote creativity and innovation. Physicians continue to develop new medical innovations that are eventually included in granted medical patents. The most innovative solutions come from a diverse pool of problem solvers, which includes competent and motivated students and young professionals from all over the world. These people will continue to promote space exploration and technological advancement. Global collaboration is becoming increasingly important in most fields, and space medicine is no exception. The rapid advancements in human space exploration endeavors boost the demand for research and innovation in space medicine.

SPACE NEUROSCIENCE: CURRENT UNDERSTANDING AND FUTURE RESEARCH

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Background: Space exploration is crucial for understanding our surroundings and establishing scientific concepts to explore, monitor, and save our planet's environment. However, the response of the human nervous system in the environment of space poses numerous challenges. Brain complexity explains the vulnerability and intrinsic difficulty of recalibration after disturbance. Over the millennia, the brain has evolved to function at 1-G. Studying the brain and its physiology in different environments may shed light on multiple conditions encountered on Earth that are yet to be solved and dictate collaboration at international levels. The nervous system is affected by several stressors due to microgravity, radiation, isolation, disruption of circadian rhythm, impaired sleep dynamics, and hypercapnia associated with space travel.

Overview: Herein, we aim to review several aspects related to the nervous system in weightless conditions, as well as the development and future of the emerging field of "space neuroscience."

Discussion: Long-distance space flights and the establishment of interplanetary space facilities are necessary for research, human development, and possible survival. The human nervous system is an ultrasensitive and extremely complex biocomputer and prediction/learning machine, which makes it prone to significant disturbances in zero-G conditions. Cephalad fluid shift and abnormal intracranial fluid dynamics are the major contributors. These disturbances represent safety concerns for long-distance space flights and raise serious ethical considerations. Improved monitoring may help make space flight safer in the future. Space neuroscience is a fascinating, embryonic field that requires significant development. The establishment of frameworks for the strategic development of space neuroscience is vital, as more research and collaboration are required to overcome these challenges, minimize risks, and optimize crew performance during planetary operations.

MEDICAL STUDENT INTEREST IN AND EXPOSURE TO AEROSPACE MEDICINE IN THE UNITED STATES

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Introduction: Aerospace Medicine (AM) is experiencing a renaissance. The field provides physicians with the expertise to promote the health and safety of space travelers. Commercial spaceflight is now a reality, so individuals with various medical conditions will be flying in space. NASA has Mars plans and SpaceX plans to send humans to Mars within the next decade, so today's medical students may be future physicians on these crews. Considering these developments, we evaluated interest in and exposure to AM among medical students in the United States (US).

Methods: This study was approved by the Dartmouth College Committee for the Protection of Human Subjects. A 19-question anonymous multiple-choice questionnaire was emailed to medical students throughout the US in October-December 2021. Information about demographics, career and research interests in AM, opportunities available at students' respective institutions, and possible avenues for supporting students' interests was collected and analyzed.

Results: 1,244 students (490 men, 751 women, 3 other), age 25.8 ± 3.0 years from 61 institutions responded. 1,061 (85.3%) expressed an interest in learning more about AM if given the opportunity with 208 (16.7%) specifying an interest in research and 939 (75.5%) in career opportunities. 55 (4.4%) indicated that they had access to research opportunities at their institutions. 98 (7.9%) of respondents reported that their institution offered an AM interest group or elective. Those who had access to an interest group, elective, or research opportunities expressed more interest in AM careers than those who did not ($p < 0.001$).

Discussion: Most respondents expressed an interest in learning about AM during their training. Interest in research as well as career opportunities exists despite the majority reporting minimal access to opportunities for AM involvement at most of the surveyed institutions. With an expected increase in demand for AM physicians, medical schools should increase access to opportunities.

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