

11:15 AM

[385] VENTILATION, RESPIRATORY DRIVE AND BREATHING MECHANICS DURING SUSTAINED +GX ACCELERATION RELEVANT TO SUBORBITAL SPACEFLIGHT PROFILESRoss Pollock¹, Alec Stevenson², Caroline Jolley¹, Gerrard Rafferty¹, Luis Estrada¹, Mitchell Segal¹, Henry Tank², Tobias Menden³, Steffen Leonhardt³, Thomas Smith¹¹King's College London, London, United Kingdom; ²QinetiQ, Farnborough, United Kingdom; ³RWTH Aachen University, Aachen, Germany*(Original Research)*

INTRODUCTION: The lung has little actual tissue mass and deforms under its own weight, and postural effects of gravity on respiratory function can be important in clinical medicine. Members of the public will soon be flying on commercial suborbital spaceflights with short periods of hypergravity expected to peak at up to +6 Gx. We used two-minute centrifuge exposures to explore how the lungs are affected by G loads over this range. We hypothesized that increasing Gx would progressively change the distribution of pulmonary ventilation and impair breathing mechanics, leading to increased work of breathing, increased neural respiratory drive (NRD) and breathlessness. **METHODS:** This study was approved by the QinetiQ and King's College London Research Ethics Committees. Healthy participants (8 men and 3 women) were studied at 2, 4 and 6 Gx. 16-electrode electrical impedance tomography was used to determine regional distribution of ventilation. In nine participants, the crural diaphragm electromyogram (EMGdi) was recorded continuously using an esophageal multipair electrode catheter, and quantified as a proportion of maximum volitional EMGdi (EMGdi%max) to provide an index of NRD. Transdiaphragmatic pressure was measured simultaneously using a dual pressure transducer tipped catheter, with the proximal transducer in the mid esophagus and the distal transducer in the stomach. Breathlessness was assessed using the modified Borg scale (mBorg). Data were analyzed using repeated-measures ANOVA. **RESULTS:** With increasing Gx there was a reversal of distribution of ventilation from dorsal to ventral lung regions ($P < 0.05$). There was a progressive increase in the diaphragm pressure-time-product (PTPdi) and EMGdi%max from baseline to 6Gx. Mean (SD) PTPdi at 1Gx, 2Gx, 4Gx and 6Gx was 243.0 (67.6), 394.0 (126.1), 476.0 (173.4) and 604.5 (258.0) cmH₂O.s.min⁻¹ respectively ($P = 0.0013$). EMGdi%max at 1Gx, 2Gx, 4Gx and 6Gx was 11.6 (5.0), 17.4 (9.7), 33.4 (18.1) and 45.0 (21.3) %max respectively ($P < 0.0001$). Breathlessness was severe at 6Gx (median mBorg 5 (IQR 3.5 - 7)). **DISCUSSION:** Sustained Gx profoundly alters the mechanical behavior of the lung and chest wall and the regional distribution of pulmonary ventilation. This is associated with a substantial increase in NRD and breathlessness. Suborbital flights will transiently trigger these responses, which may have clinical implications for some individuals such as those with pre-existing respiratory disease.

Learning Objective:

1. The audience will learn about how the acceleration loads associated with suborbital spaceflights may affect respiratory physiology, including the regional distribution of ventilation, breathing mechanics and the neural drive to breathe.

Thursday, 05/09/2019

Exhibit Hall

9:30 AM

[S-76] POSTER: CLINICAL AEROSPACE MEDICINE

Chair: Richard Bachmann

Co-Chair: Ross Pollock

[387] BRANCH RETINAL VEIN OCCLUSION IN A C-17 LOADMASTER: A CASE REPORTPaul Vu¹, Michael Parsons², Jonathan Ellis³¹USAF School of Aerospace Medicine, Wright-Patterson AFB, OH, USA; ²Ophthalmology Aeromedical Consultation Service, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH, USA*(Education - Case Study: Clinical / Human Performance)*

INTRODUCTION: This case report describes a USAF C-17 loadmaster who experienced visual impairment from an occluded branch retinal vein. **BACKGROUND:** The USAF C-17 loadmaster is responsible for the proper and safe on- and off-loading of cargo. They perform visual and operational inspections on loading systems and ensure the safety and comfort of passengers. During flight, they conduct inflight systems inspections, often in low-light conditions. Additionally, aerial cargo drops at night require excellent vision for effective mission execution. Degraded vision in loadmasters can have severe consequences. **CASE PRESENTATION:** The subject was a 41-year-old man. He was an experienced aviator with 5500 total flying hours. He presented to optometry with a complaint of worsened vision and a "spot" in the right eye. Symptom onset was sudden, but he waited 2 weeks before presenting. He insisted that his flying duties were not impacted as he still had a functioning left eye. Exam revealed an inferior hemiretinal vein occlusion of the right eye with macular thickening. He was removed from flight duties and followed closely. The only other abnormal clinical finding was a single elevated blood pressure reading of 144/86. After 3 months, repeat macular optical coherence tomography (OCT) showed resolution of his macular thickening. He was subsequently granted a flying waiver and returned to flying duties. **DISCUSSION:** Although retinal vein occlusion is the second most common retinal vascular disorder, not many clinicians are familiar with the condition. The occlusion is most commonly caused by vein compression by an adjacent artery. Some risk factors are hypertension, venous disease, cerebrovascular disease, diabetes, smoking, obesity, dyslipidemia, and open angle glaucoma. Decreased blood return from an occluded retinal vein can lead to hypoxic conditions in the retina, causing vision and visual field deficits, degraded stereopsis, and reduced contrast sensitivity. Although most lesions resolve over 3-6 months, some persist and require intervention. Retinal vein occlusion can occur in any aviator and the aeromedical considerations must account for the aviator's responsibilities, the present debilitation, and the likelihood of recurrence. If workup reveals no other underlying pathology and clinical resolution is achieved, the condition is expected to remain stable – and therefore safe for flight.

Learning Objectives:

1. Retinal vein occlusion is the second most common retinal vascular disorder.
2. Important risk factors of retinal vein occlusion.

[388] IMPACT OF AUTOREFRACTIVE THRESHOLD VARIATION ON MEDICAL FITNESS RATES IN MILITARY PILOT APPLICANTSFrank Jakobs¹, Diana Hering¹, Vanessa Wahl², Manuela Hoffmann³, Michael Gebhard², Joerg Frischmuth¹¹German Air Force Center of Aerospace Medicine, Muenchen, Germany; ²University of Applied Sciences, Jena, Germany; ³German Forces Service Headquarters, Koblenz, Germany*(Original Research)*

INTRODUCTION: As recently shown by the authors, retest reliability of automated refractometry is not sufficient to display refractometric measurements by means of zero or near-zero deviation when assessed by repeated measurements or multiple examiners. In order to model the hypothetical impact of a +/- .25 D tolerance implementation on the selection of flying personnel, we recalculated the retrospective fitness rates of a 10-years cohort of pilot and non-pilot applicants seen at the German Air Force Centre of Aerospace Medicine. **METHODS:** Refractometric data of pilot applicants of the years 2005 to 2015 were extracted and retrospectively analyzed with regard to their empirical sensitivity on optometric threshold variation. Modelling was performed for spherical refraction, cylindrical refraction, and spherical equivalents. In accordance with real-life conditions, unilateral threshold excess in one eye was assessed as unfit to fly. Data were compared with the respective limits in rotary and fixed wing applicants as well as additional crew members (ACM) and non-flying ground personnel. **RESULTS:** We assessed n=4,451 military pilot applicants, n=951 additional crew members, and 2,307 non-pilot/non-ACM applicants. Implementation of a .25 D tolerance revealed a decline in medical unfit rates from maximally 24.7% to 14.8% for fighter jet, while the effect was considerably lower for rotary/fixed wing aircraft (5.4% vs. 4.8%), and only marginal for ACM (2.8% vs. 2.2%) or ground personnel (1.0% vs. 0.9%).