

both objective and subjective criteria, by an independent physician U/S expert. Wilcoxon Rank Sum and Fisher's exact test were used in statistical analysis. Stony Brook University Hospital IRB approval was obtained. **RESULTS:** Volunteers' exams were scored as acceptable or ideal by the expert reviewer (Likert scale) at the following percentage for the following exams; 83%-pericardial effusions, 83%-pneumothorax, 83%-pulmonary edema, 33%-LV dysfunction, 0% for diaphragm dysfunction and pleural effusion. No significant differences were seen in clinically useful exams between volunteers and residents/fellows for pericardial effusion, pneumothorax, or pulmonary edema exams ( $p=1, 1, 0.481$ , respectively). Time to complete the U/S exams was longer in volunteers compared to residents/fellows (median 10m39s vs 4m16s,  $p=0.0081$ ). **DISCUSSION:** Volunteers were able to carry out clinically useful exams with high frequency for ruling out pericardial effusion, pneumothorax and pulmonary edema, however not for exams assessing for LV dysfunction, diaphragm dysfunction and pleural effusion. They were able to carry out these U/S exams in a reasonable time, though required longer time than residents/fellows, unsurprisingly. These data show that non-medical personnel are able to carry out adequate U/S exams for some pathology, but perhaps not so for other, more difficult exams.

#### Learning Objectives:

1. To learn how remotely guided ultrasound exams carried out by non-medical experts compare to formally trained physicians (residents and fellows).
2. To learn which ultrasound exams carried out by non-medical personnel, under remote guidance by experts, may be clinically useful, as well as those that may not be.
3. To learn that while ultrasound exams carried out by non-experts under remote guidance may take longer than their physician counterparts, they are able to achieve thorough examinations within a reasonable timeframe.

#### 10:45 AM

### [384] PULMONARY OXYGEN TOXICITY IN ASTRONAUTS PERFORMING SIMULATED EXTRAVEHICULAR ACTIVITY AT THE NASA NEUTRAL BUOYANCY LABORATORY

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(Original Research)

**INTRODUCTION:** Within hyperbaric environments, pulmonary oxygen toxicity can cause harm with prolonged exposures to partial pressures of oxygen greater than 0.5 ATA. Previous medical evidence has demonstrated that a decrease in lung vital capacity and diffusing capacity may result from prolonged exposure. A recently published paper using data from NASA's Neutral Buoyancy Laboratory (NBL) described central nervous system oxygen toxicity in the astronaut cohort (Walker, et al. 2018). The undersea and aerospace medical communities requested that pulmonary oxygen toxicity also be studied in the same cohort. Unlike existing studies, this particular study focuses on long-term, intermittent oxygen exposures rather than acute, high-dose exposures. The work will determine if hyperbaric oxygen exposure in chronic, intermittent doses when near or beyond established exposure limits causes any pulmonary function change.

**METHODS:** All exposures in this data represent astronauts, training underwater wearing "space suits." Suited subjects breathe a mixture of 46% oxygen and 54% nitrogen (nitrox), resulting in a maximum partial pressure of oxygen of 1.15 ATA at a depth of 40 feet. Cumulative Pulmonary Toxicity Dose (CPTD) was calculated for each of the 1772 exposures, as well as mean and maximum dose for each of the 85 astronauts. **RESULTS:** Spanning the past 20 years, more than 10,000 simulated EVA runs have been performed at the NBL. In this sample of 85 astronauts and 1,772 exposures, only one run exceeded the NOAA/NASA CPTD limit of 694 units. The NASA CPTD limit of 694 units was derived from a target of 2% decrement of vital lung capacity in 50% of the subjects. By protocol, CPTD calculations were performed using the maximum partial pressure possible at the NBL pool. **DISCUSSION:** Because CPTD calculations are performed using the maximum partial

pressure during a dive, our results may represent a conservative assessment. This study validates the safe nature of NBL training, documenting the low risk for pulmonary oxygen toxicity. Forward work will compare these individual exposures to pulmonary functions over time with respect to the published limits.

#### Learning Objectives:

1. The audience will learn about the strong safety record of simulated space walks at the Neutral Buoyancy Lab; specifically, they will understand the low-risk for pulmonary oxygen toxicity.
2. The audience will understand how pulmonary oxygen toxicity can be calculated using time at depth.
3. The audience will understand how chronic, intermittent, high-dose oxygen exposures lead to a decreased risk for pulmonary oxygen toxicity when compared to acute, high-dose oxygen exposures.

#### 11:00 AM

### [386] IMPAIRMENT OF GAS EXCHANGE IN THE LUNG DURING SUSTAINED +GX ACCELERATION RELEVANT TO SUBORBITAL SPACEFLIGHT PROFILES

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(Original Research)

**INTRODUCTION:** Members of the public will soon be flying on commercial suborbital spaceflights with acceleration loads expected to peak at up to +6 Gx. The physiological and clinical implications of this environment for the general population have yet to be fully established. Centrifuge studies have suggested that suborbital acceleration profiles could impair gas exchange in the lung and cause a degree of in-flight hypoxemia, and this could be compounded by the use of airline-style cabin pressurization. This centrifuge study used two-minute Gx exposures to characterize the underlying pulmonary response more fully. We hypothesized that increasing Gx would progressively impair gas exchange and reduce arterial oxygenation, and that hypoxemia would be more pronounced at a simulated cabin pressure altitude of 8,000 ft. **METHODS:** This study was approved by the QinetiQ and King's College London Research Ethics Committees. Eleven healthy participants (8 men and 3 women) were each studied twice at 2, 4 and 6 Gx: once breathing air and once breathing a 15% oxygen mixture to simulate an altitude of 8,000 ft. Respiratory gases were measured breath-by-breath using a novel laser-based molecular flow sensor. Ventilation and arterial oxygen saturation (SpO<sub>2</sub>) were measured continuously. In a sub-set of participants, arterial blood gases including the arterial partial pressure of oxygen (PaO<sub>2</sub>) were measured towards the end of each Gx exposure, allowing calculation of the alveolar-arterial (A-a) gradient. **RESULTS:** There was a progressive fall in SpO<sub>2</sub> at each Gx load which was magnified when breathing 15% oxygen ( $P < 0.05$ ). At 4 Gx, the minimum SpO<sub>2</sub> was  $84 \pm 2\%$  when breathing 15% oxygen compared with  $92 \pm 1\%$  when breathing air ( $P < 0.05$ ). Corresponding SpO<sub>2</sub> values at 6 Gx were  $78 \pm 1\%$  vs  $86 \pm 1\%$  ( $P < 0.05$ ). The A-a gradient widened substantially with increasing acceleration. The lowest recorded value for PaO<sub>2</sub> was 41 mmHg (5.5 kPa). **DISCUSSION:** When sustained, Gx loads associated with suborbital spaceflight cause marked hypoxemia that is exacerbated by simulated airline-style cabin conditions. Gx loads during actual suborbital flights will be relatively brief. The extent to which they evoke these underlying physiological responses and become clinically meaningful is likely to depend on interaction with individual factors such as age, smoking history, baseline fitness and pre-existing disease.

#### Learning Objective:

1. The audience will learn about the effects of high +Gx acceleration relevant to commercial suborbital human spaceflight on pulmonary physiology.