mimicked SAD, demonstrating an inconsistent pattern of FEF_{25-75\%} and a small degree of variation of RV around normal. Horseshoe lung demonstrated similar physiology to NASAD.

**Conclusions** Clinicians need to consider the above mentioned diseases as an alternative diagnosis to emphysema and asthma in those with a characteristically SAD flow volume loop, a high RV and normal gas transfers.

**Background** The advantages of multiple breath washout tests, and in particular lung clearance index (LCI), over conventional spirometry in cystic fibrosis (CF) are now well established. Although the majority of studies have used exogenous sulphur hexafluoride (SF\textsubscript{6}) as the tracer gas this has also led to an increased interest in nitrogen washout tests, despite the differences between these methods. Although it is increasingly appreciated that the two systems may produce different results in patients with lung disease, the impact on nitrogen washout progression of body nitrogen excreted across the alveoli has previously been ignored.

**Methods** A two compartment lung model was developed that included ventilation heterogeneity and dead space (DS) effects, but also incorporated previous experimental data from adults on nitrogen excretion. The model was used to assess the impact of nitrogen excretion on washout progress and accuracy of
functional residual capacity (FRC) and LCI measurements at varying degrees of DS and ventilation heterogeneity. An estimate was also made of the effects in children, based upon extrapolation adult clinical data.

**Results** Excreted nitrogen had a small effect on accuracy of FRC (1.8%) in the healthy adult model. The error in LCI calculated with true FRC was greater (6.3%), and excreted nitrogen contributed 21% of the total nitrogen concentration at the end of the washout. Increasing DS caused further increase in measurement error, whilst increasing ventilation heterogeneity caused a bell shaped curve with initially increasing error falling again as ventilation heterogeneity approached a maximum. LCI was increased by 6–13% in a CF child model, and excreted nitrogen increased the end of washout nitrogen concentration by 24–49%.

**Conclusions** Excreted nitrogen appears to have complex but clinically significant effects on washout progress, particularly in the presence of abnormal gas mixing. This may explain much of the previously described differences in washout outcomes between SF6 and nitrogen. Caution should be applied in applying conclusions derived from using one tracer gas to another.

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**S42**

**EFFECT OF IRON DEFICIENCY ON OXYGEN TRANSPORT IN HYPOXAEIC PATIENTS: IMPLICATIONS FOR HAEMODYNAMICS AND CLINICAL MANAGEMENT**

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**Background** Oxygen transport in the blood does not only upon oxygen partial pressure (or saturation, SaO2), but also the concentration of haemoglobin to which oxygen binds, and blood volume in any given period. In current clinical studies and guidelines, it is rare for these components to be discussed together.

**Methods** An observational cohort study was performed in 165 consecutive unselected patients with pulmonary arteriovenous malformations, including 98 before and after embolisation. 159 (96%) had hereditary haemorrhagic telangiectasia (HHT). Prior to statistical analyses, patients were stratified by self-reported exercise tolerance, and serum iron/ferritin.

**Results** Patients were aged 17–87 (median 49)ys, with median SaO2 95% (range 78.5–99%) Many had biochemical/haematinic evidence of iron deficiency, predominantly attributable to HHT-blood loss, but several had undergone venesection for secondary polycythaeemia, as recommended in current UK haematological guidelines. Haemoglobin ranged from 7.7–20.9g/dl (median 14.1g/dl), and was higher in patients with lower SaO2: For every 1% fall in SaO2, haemoglobin rose on average, by 0.82g/dl (p < 0.0001), SaO2 explained only 0.1% of the variance in oxygen carriage per unit blood volume. Embo- lisation treatment increased SaO2 (median +2.5%), but usual subsequent haemoglobin fell restored oxygen carriage/unit volume. Concurrent iron deficiency reduced erythrocyte haemoglobin content. Secondary erythrocytosis was achievable with low ferritin, but only if serum iron was high-normal. Oxygen carriage was lower if iron deficiency was present (median 16.1 [IQR 14.7, 18.1]mLs/dl compared to 19.0 [IQR 17.4, 20.2]mLs/dl, p < 0.0001), implying ~15% higher cardiac outputs were required to maintain oxygen delivery. At rest, this was not met by a higher pulse in the iron deficiency group, indicating stroke volume would need be higher. Self reported exercise tolerance was used as a crude indicator of whether compensating for reduced oxygen carriage was achievable in this patient group. There was a very clear inverse correlation between exercise grade and oxygen carriage such that exercise tolerance was worse in patients with lower oxygen carriage (coefficient -0.0012 (95% CI -0.0017, -0.00061) p < 0.0001). The trend was evident across all grades of exercise tolerance.

**Conclusions** Low oxygen carriage per unit volume, and not low PaO2/SaO2, per se, are predictors of impaired exercise tolerance in PAVM patients.

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**S43**

**DYSPNEA AND EXERCISE CAPACITY ARE NOT RELATED TO ARTERIAL HYPOXEMIA IN THE ABSENCE OF ALVEOLAR HYPOXIA: PROSPECTIVE STUDIES IN PATIENTS WITH PULMONARY ARTERIOVENOUS MALFORMATIONS**

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**Background** Low blood oxygen concentrations (hypoxemia) usually result from alveolar hypoxia which also stimulates hypoxic pulmonary vasoconstriction, thereby increasing right ventricular work. In contrast, anatomic right-to-left shunts such as pulmonary arteriovenous malformations (PAVMs), cause hypoxemia without alveolar hypoxia. Our aim was to test whether isolated arterial hypoxemia is associated with dyspnoea or impaired exercise capacity.

**Methods** Two prospective studies were performed in patients with radiologically-proven PAVMs. Exercise tolerance was graded by a modified MRC dyspnoea scale. Other patient variables were quantified at rest and on exercise.

**Results** In 165 consecutive patients, aged 17–87 (median 49)ys, resting SaO2 varied widely (78.5–99%, median 95%). Five patients were athletes, despite severe resting hypoxemia (SaO2<85%). SaO2 displayed no clear relationship with dyspnoea grade. Higher grade dyspnoea was significantly more common in patients with coexisting cardiorespiratory disease who were more likely to report symptomatic improvement post embolisation. During cardiopulmonary exercise testing, 21 PAVM patients (SaO2 80–96%) were no more dyspnoeic than 12 age-matched volunteers (SaO2 96–99%). Within the 21 PAVM patients, the majority achieved their predicted workload and peak VO2, and there was no difference in maximum workload, or peak VO2 according to the severity of hypoxemia. PAVM patients demonstrated similar relationships between peak heart rate and peak VO2 as controls. For five patients restated post embolisation, when SaO2 rose from 88–94% to 94–96% (p = 0.009), there was no difference in perceived dyspnoea, maximum workload (medians 119/113W) or peak VO2 (medians 1.69/ 1.72Lmin⁻¹). Treated patients reset to virtually identical peak VO2 at rest and on peak exercise was lower in PAVM patients compared to controls, and in the more hypoxemic patients. During exercise, PAVM patients increased minute ventilation (V˙E) more than controls. Protected by copyright.http://thorax.bmj.com/ Thorax: first published as 10.1136/thoraxjnl-2013-204457.48 on 14 November 2013. Downloaded from http://thorax.bmj.com/ on October 28, 2023 by guest. Protected by copyright.