Acceleration atelectasis after high +Gz flight breathing 60% oxygen and influence of cabin altitude

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The views expressed in this presentation are my own and not those of the MOD

What is acceleration atelectasis?

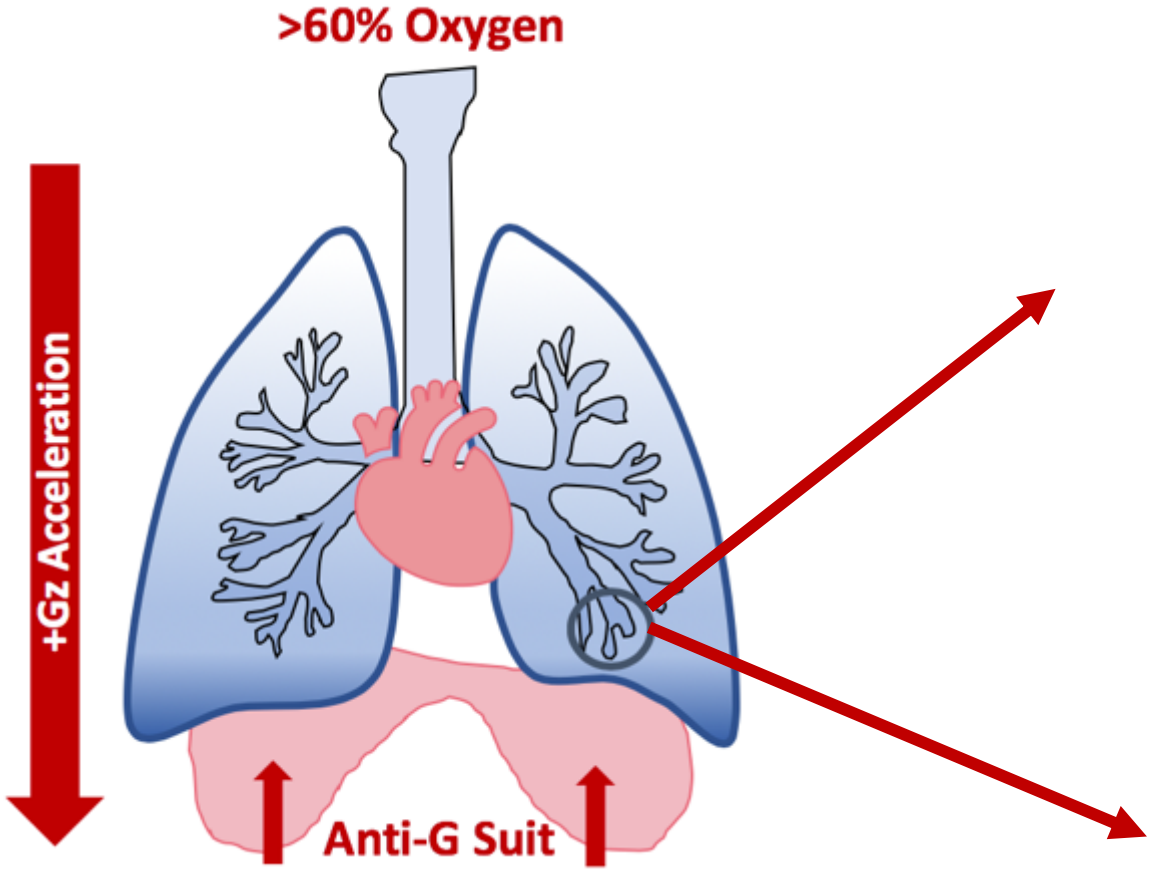
- Physiological ‘side-effect’ of advances in fast-jet capabilities and equipment

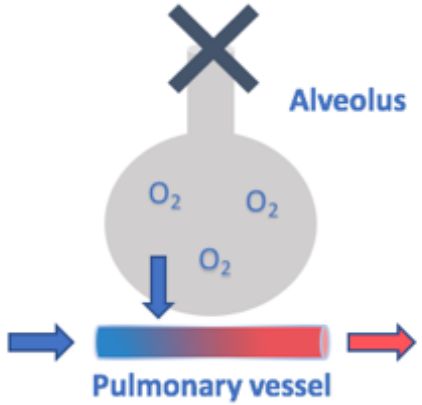
- Classical symptoms of chest discomfort/chest tightness, coughing, shortness of breath
- Can affect pulmonary blood flow resulting in fall in blood oxygen levels

Risk Factors

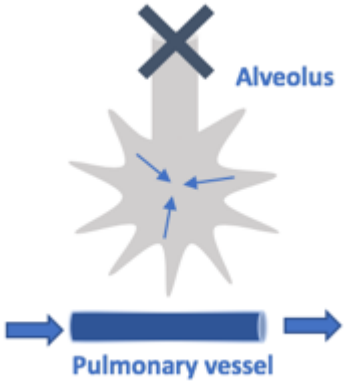
1. High inspired oxygen concentration (FiO_2)

2. Moderate sustained +Gz exposure



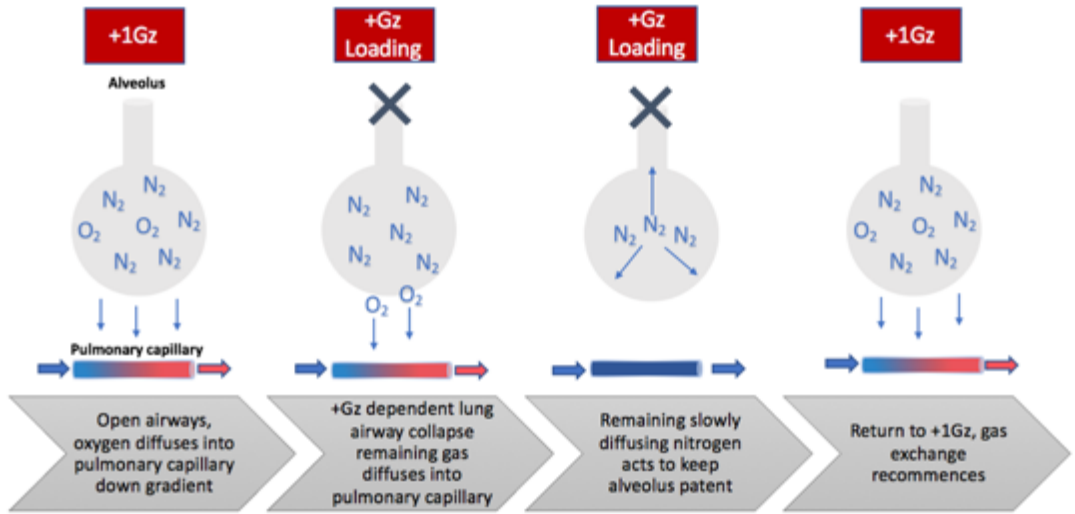


If insufficient nitrogen present, there is rapid absorption of trapped gas with alveolar collapse leading to R→L shunt

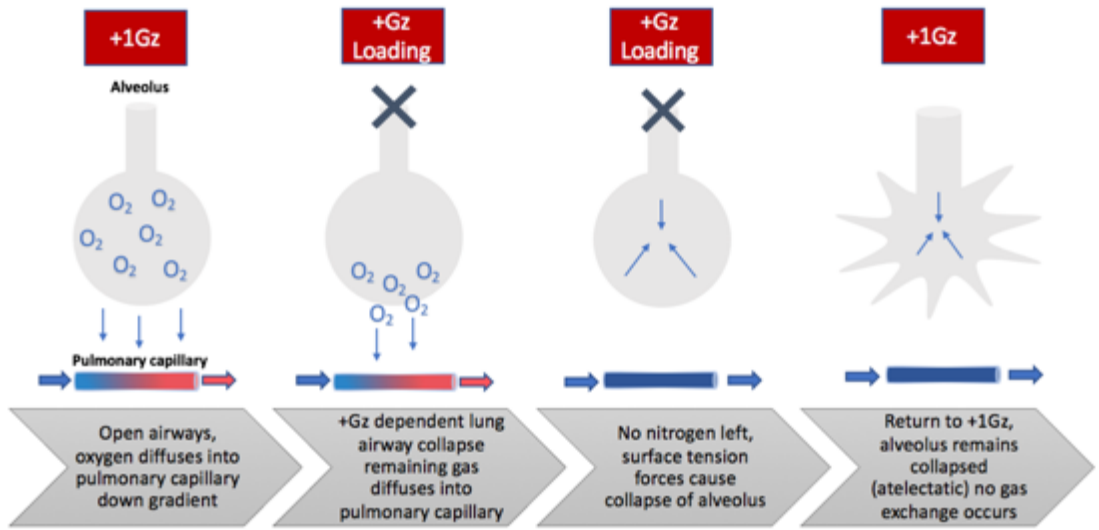


3. Wearing of anti-G suit

Nitrox: 60% Oxygen 40% Nitrogen



100% Oxygen



Study Aims

Does breathing 60% oxygen during high performance flight manoeuvres with use of contemporary full coverage anti-G trousers induce atelectasis formation in pilots during high +Gz flight?

Is there an influence of cabin altitude on atelectasis formation?

Study design

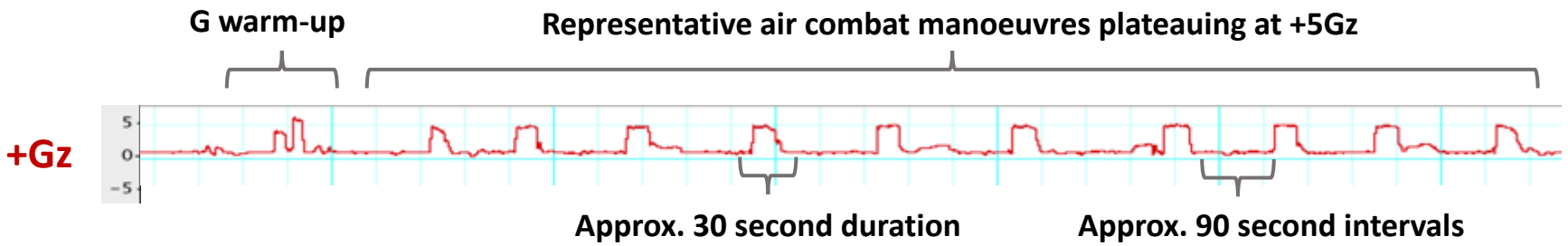
- n= 14 (experienced, healthy, male pilots of high performance aircraft)
- Flights flown on 2 separate days in a Hawk T Mk1 trainer aircraft flown by safety pilot

Day 1

High cabin altitude sortie (14500-18000ft)

Day 2

Low cabin altitude sortie (4000-6000ft)



Methods

- Series of non-invasive measurements taken **PRE** and **POST** sortie – in cockpit, with pilot wearing full Typhoon aircrew assembly

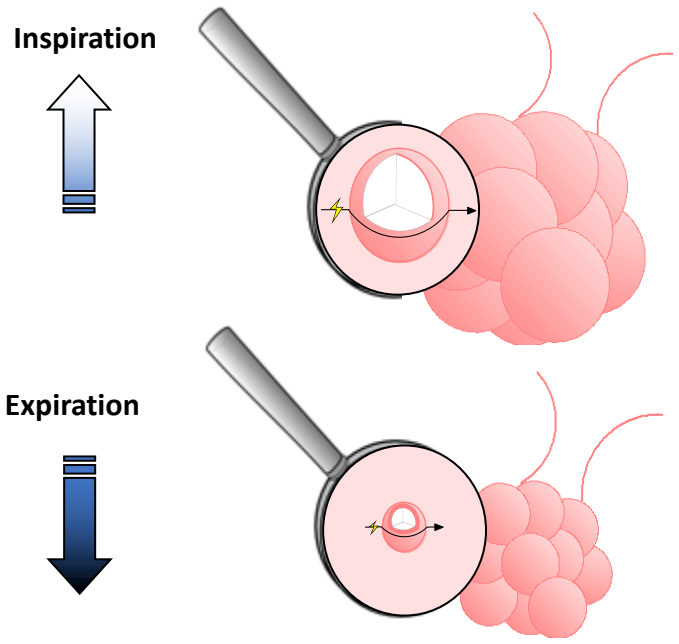
Forced inspiratory vital capacity (FIVC) x4

Peripheral oxygen saturation (SpO_2)

Measurement of basal lung volume (Electrical Impedance Tomography – EIT)

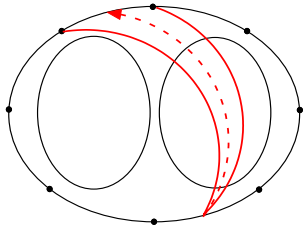
Electrical Impedance Tomography (EIT)

With increasing air volume, lung tissue presents greater resistance to the flow of electrical current – provides indirect measurement of lung volume

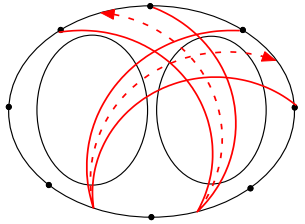


By applying an alternating current between circumferentially placed electrodes on the chest, cross-sectional imagery of thoracic impedance can be made

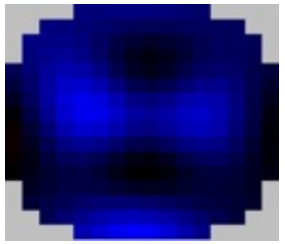
Attenuation of voltage between electrodes measured



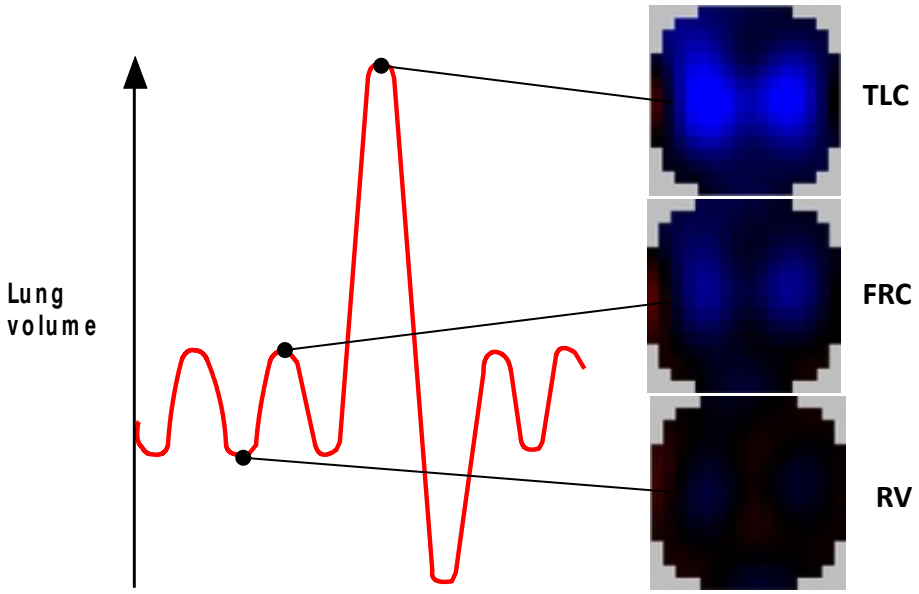
Rotation of drive electrodes



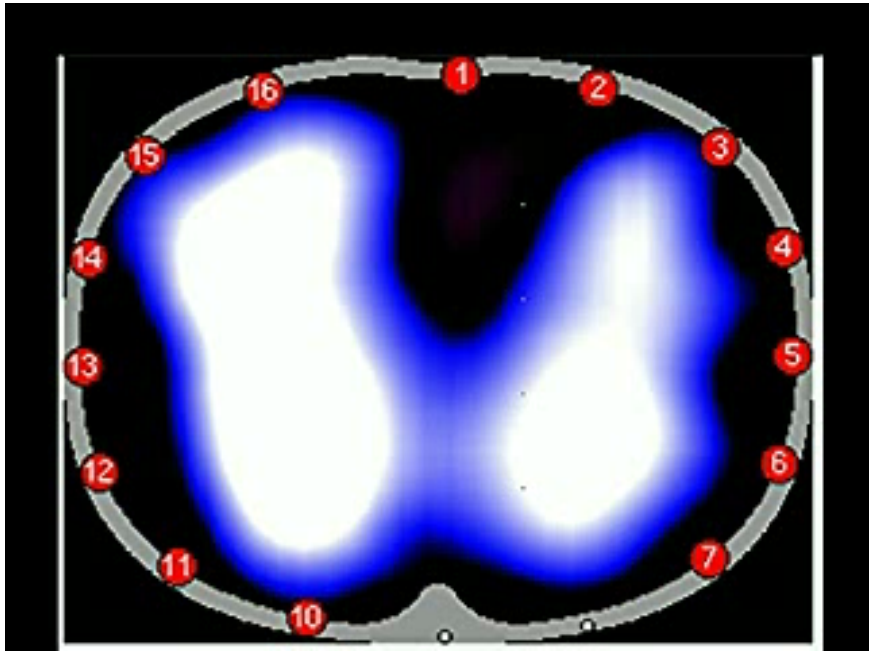
16x16 pixel array of relative impedance change



Electrical Impedance Tomography (EIT)

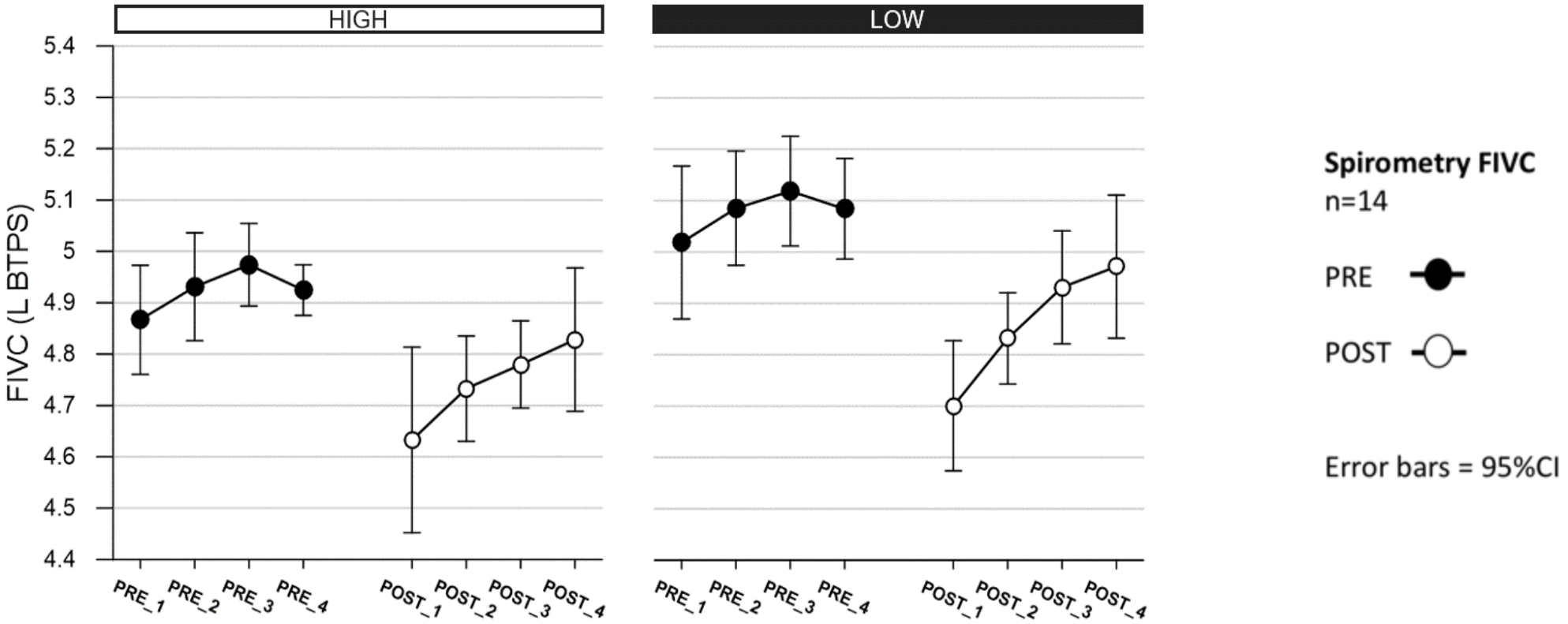


Impedance increases from a minimum at RV to the maximum value when the lungs are fully inflated. Blue colour and intensity indicates increased impedance and hence regional lung volume

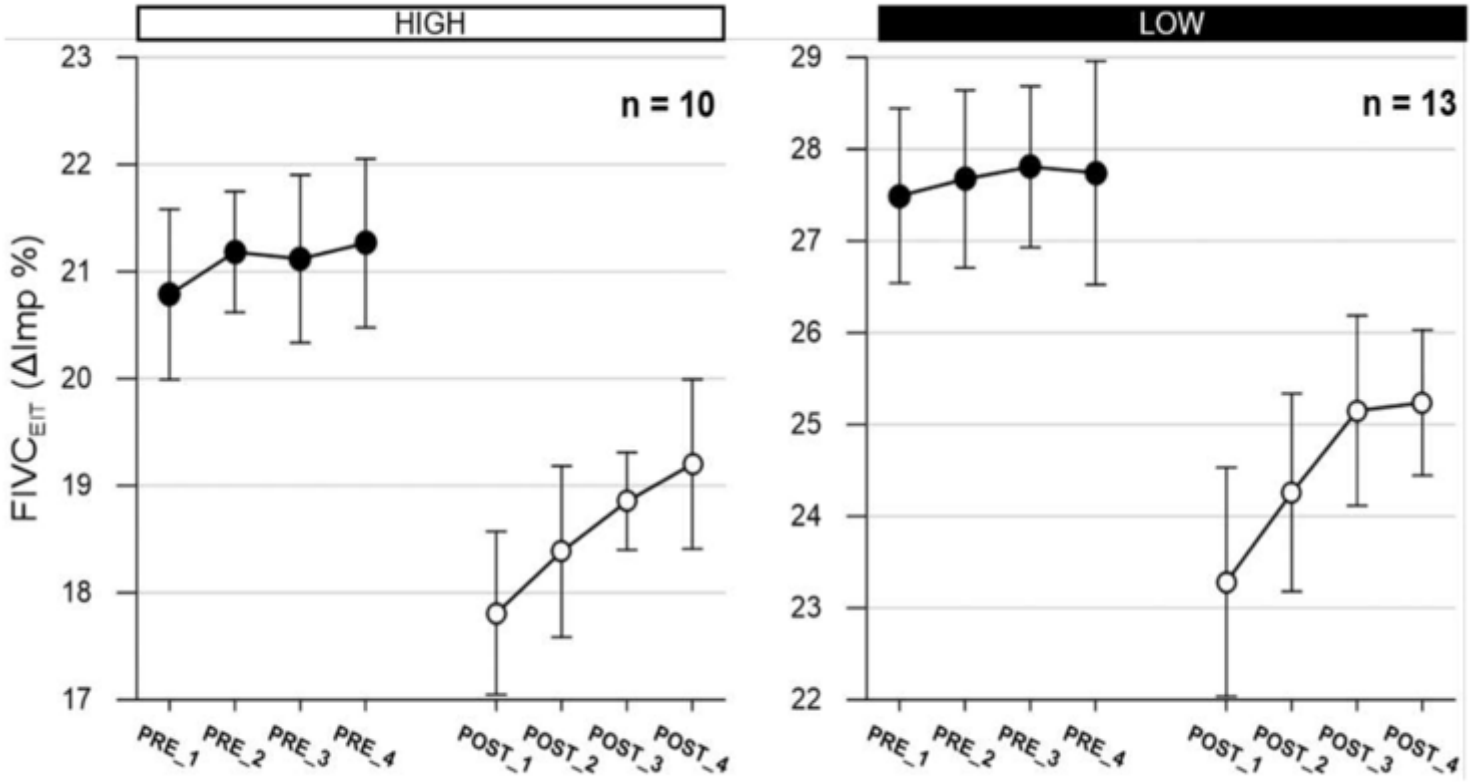


Changes in impedance during the breathing cycle can be visualised and measured

Results: FIVC spirometry data



Results: FIVC EIT data



Impedance FIVC
Delta impedance from RV
n=10, n=13

PRE

POST

Error bars = 95%CI

Results: SpO_2

- SpO_2 lower post flight (P= <0.05) in all inspired oxygen conditions measured

n= 14

SpO_2 (%) Normoxia

	PRE	POST
HIGH	97.7 ± 0.6	96.2 ± 0.8 *
LOW	97.6 ± 0.7	96.5 ± 0.7 *

SpO_2 (%) hyperoxia

	PRE	POST
HIGH	99.1 ± 0.6	98.7 ± 0.6 *
LOW	99.3 ± 0.8	98.6 ± 0.5 *

SpO_2 (%) Hypoxia

	PRE	POST
HIGH	94.1 ± 0.9	92.3 ± 0.8 *
LOW	94.5 ± 1.0	92.7 ± 0.9 *

Conclusion

Statistically significant changes in pulmonary function occur with pilots breathing 60% oxygen suggesting mild atelectasis formation

Changes are small, hence unlikely to have an operational significance

No effect of cabin altitude on atelectasis formation

Thank you

Questions?