

EIT's Expanding Horizons: From Critical Care to Global Health Innovations

Workshop on:

Whither EIT: Opportunities and Challenges in Medical Monitoring and Beyond,
Tsinghua University, Beijing

Andy Adler

Carleton University, Ottawa, Canada

2025-06-08

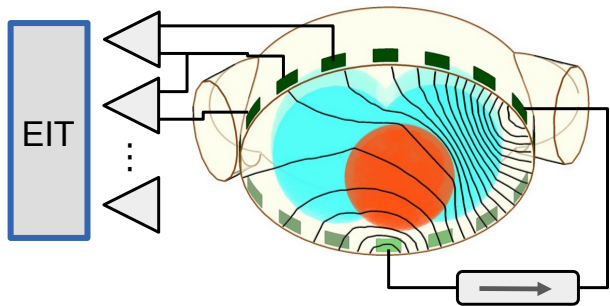
Electrical Impedance Tomography: Non-invasive



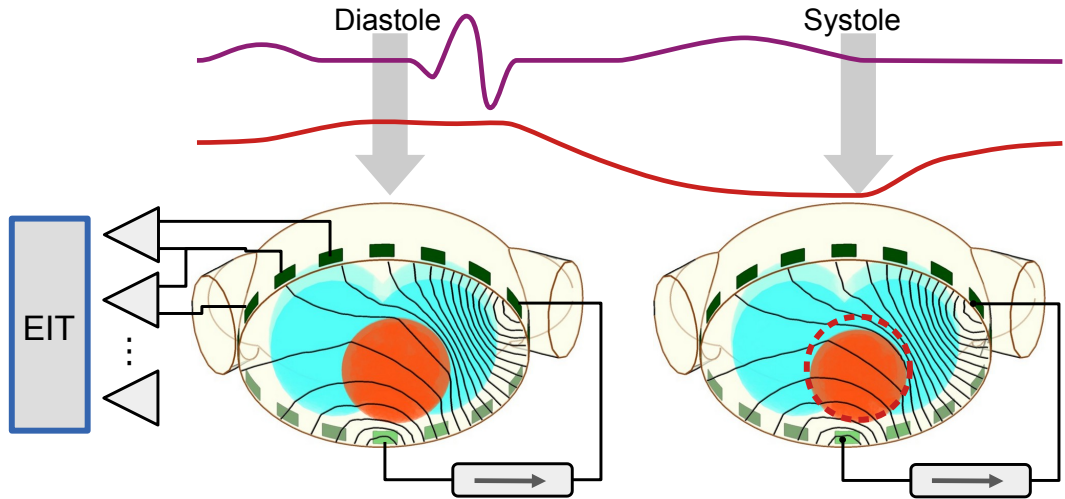
[1]

¹Heinrich *et al* (2006) **Body and head position effects on regional lung ventilation in infants ...** Int Care Med 32:1392–1398

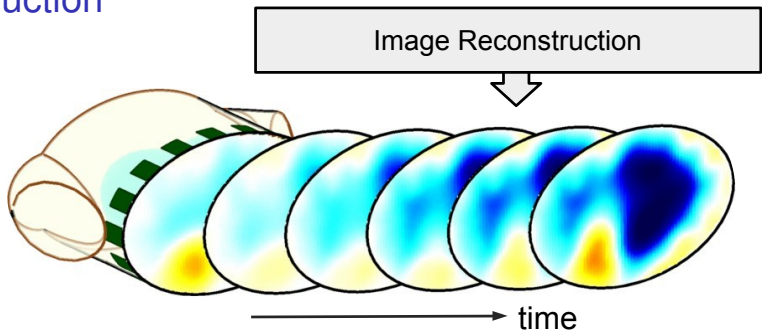
EIT: apply current
and measure voltages



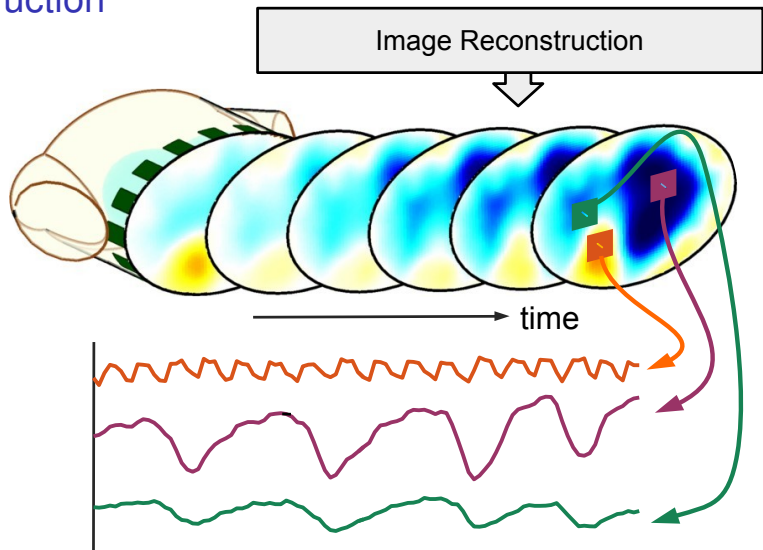
EIT: Physiology



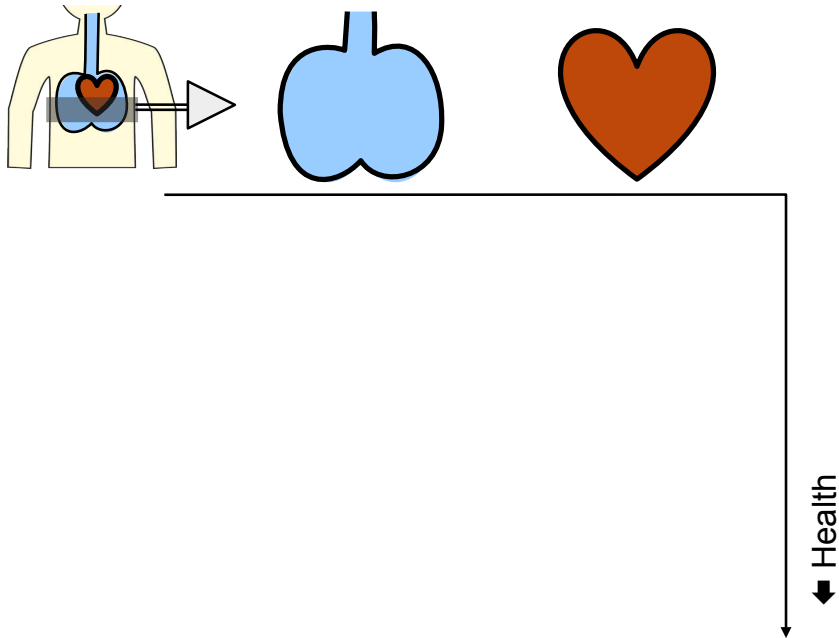
EIT: Image Reconstruction



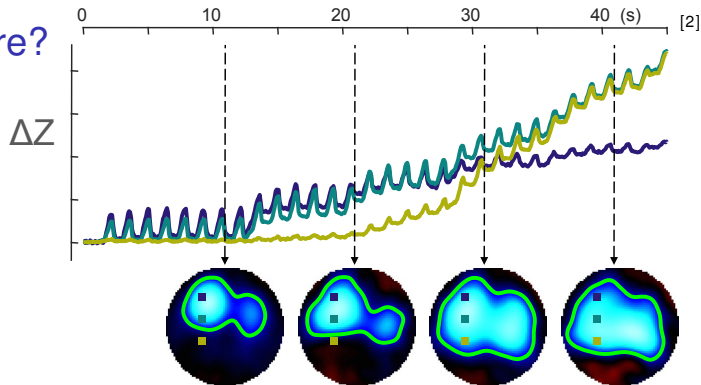
EIT: Image Reconstruction



EIT: What's it for?

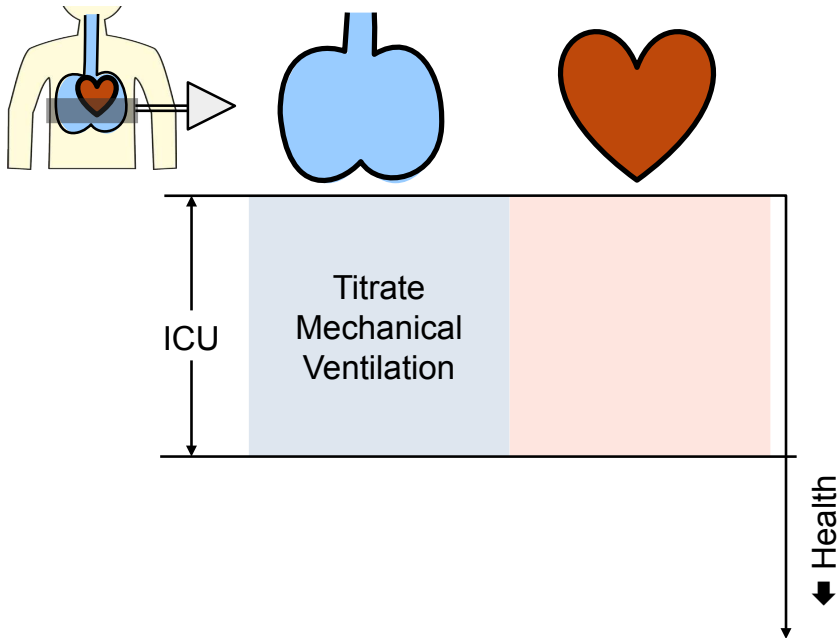


What does EIT measure?

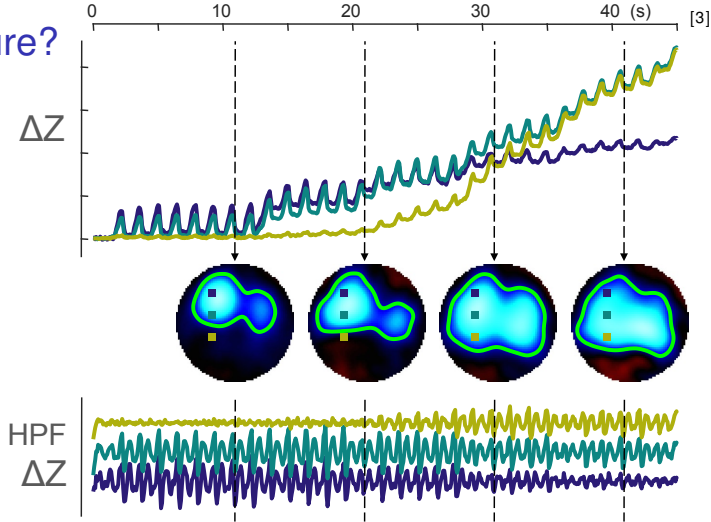


²Frerichs *et al* (2003) [Electrical Impedance Tomography – a method for monitoring regional lung aeration and tidal volume distribution](#) *Int Care Med* 29:2312–2316

EIT: The market

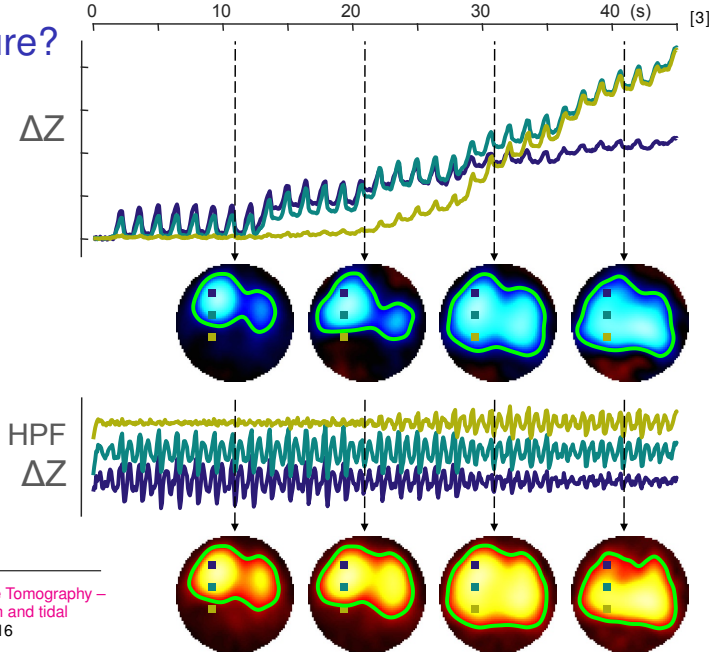


What does EIT measure?



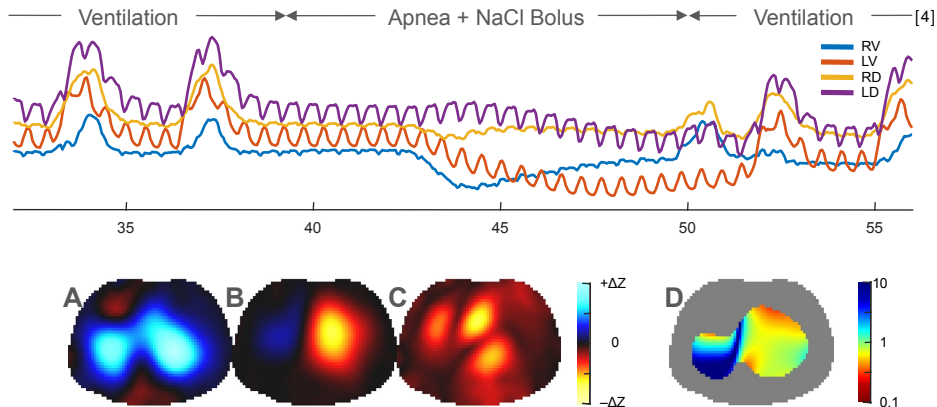
³Frerichs *et al* (2003) Electrical Impedance Tomography – a method for monitoring regional lung aeration and tidal volume distribution *Int Care Med* 29:2312–2316

What does EIT measure?



³Frerichs *et al* (2003) Electrical Impedance Tomography – a method for monitoring regional lung aeration and tidal volume distribution *Int Care Med* 29:2312–2316

EIT and blood flow: Bolus- and Filtering-based

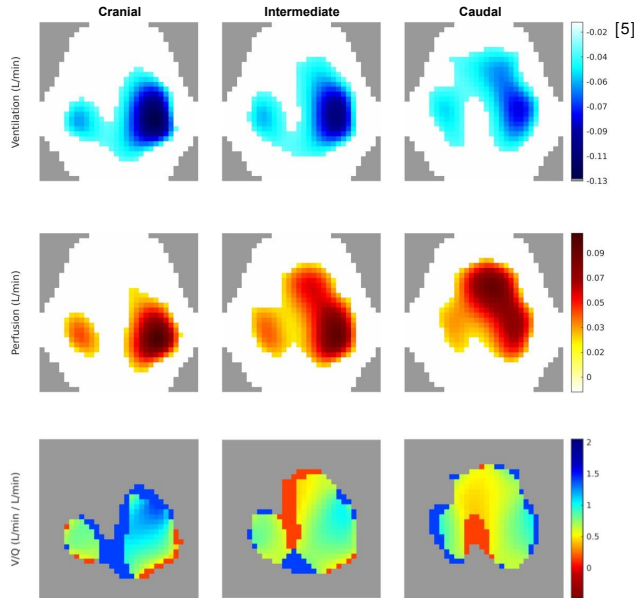


EIT waveforms and images from [Wang et al 2024] during a NaCl bolus and apnea (38–50 s) in 4 quadrants. A) Tidal Ventilation, B) Bolus-based perfusion image, C) HR-filtered EIT image, D) relative EIT- $\dot{V}/Q$ in lungs.

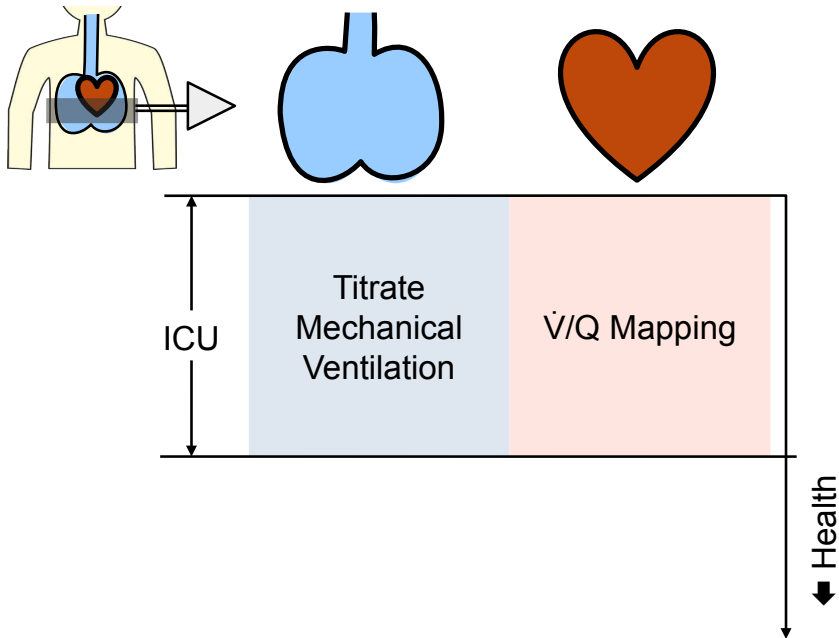
⁴Electrical impedance tomography monitoring in adult ICU patients: state-of-the-art, recommendations for standardized acquisition, processing, and clinical use, and future directions, *Critical Care*, (2024)

3D Ventilation / Perfusion

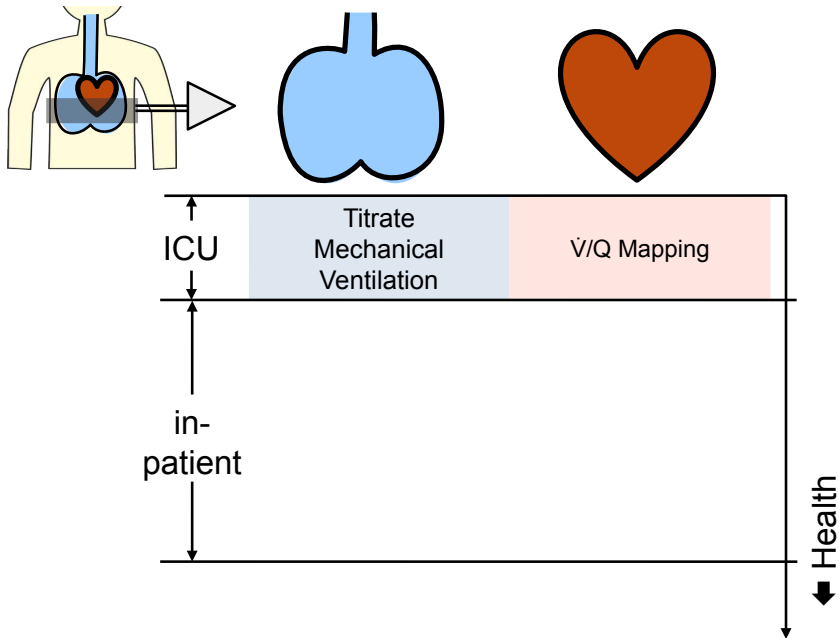
$\dot{V} / Q$



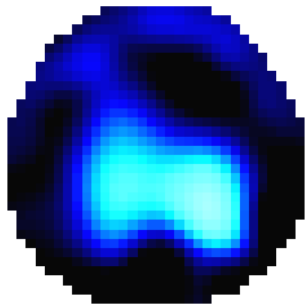
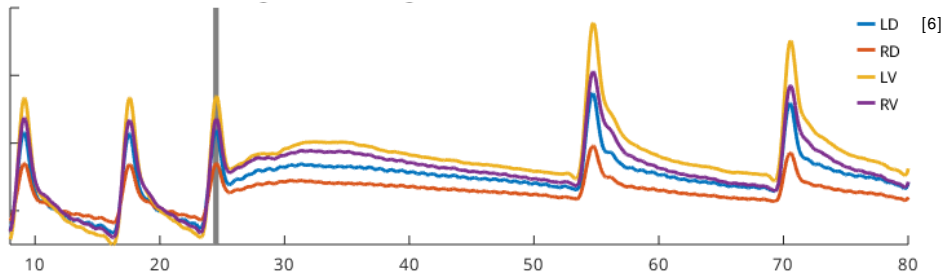
EIT: The market



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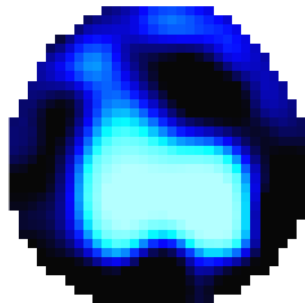
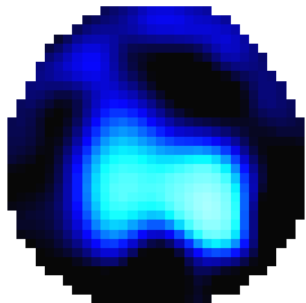
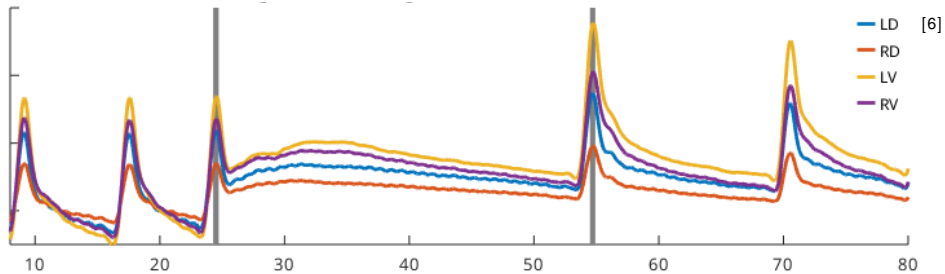


CPAP



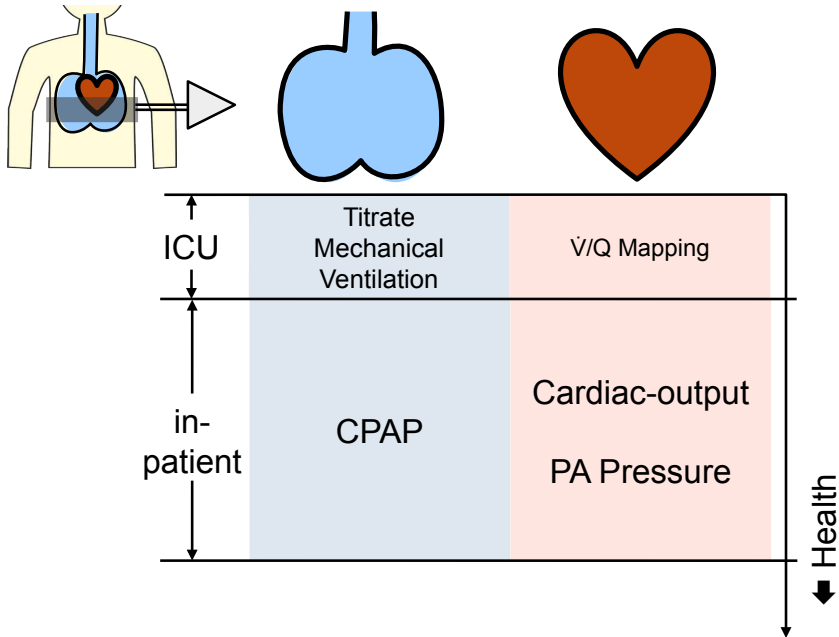
⁶Araos et al (2025) *In Preparation*

CPAP

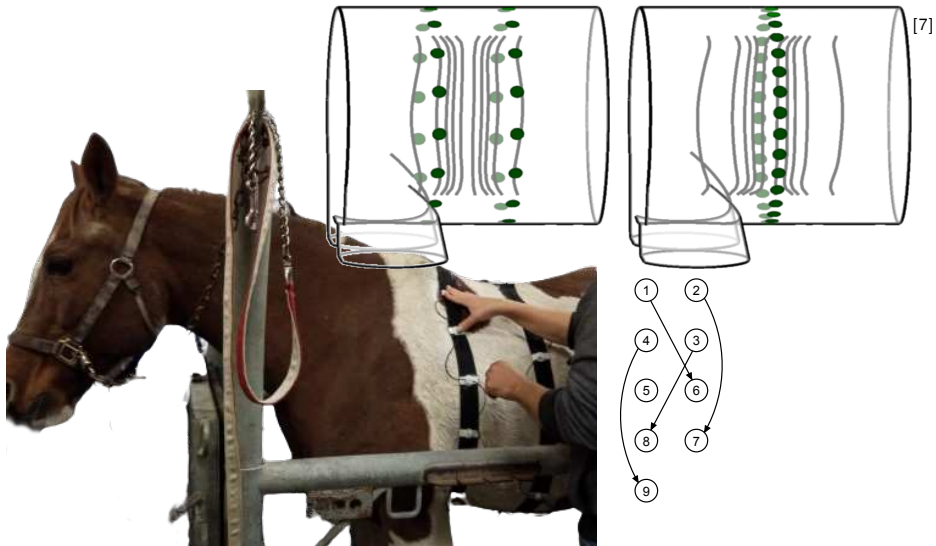


⁶Araos et al (2025) *In Preparation*

EIT: The market

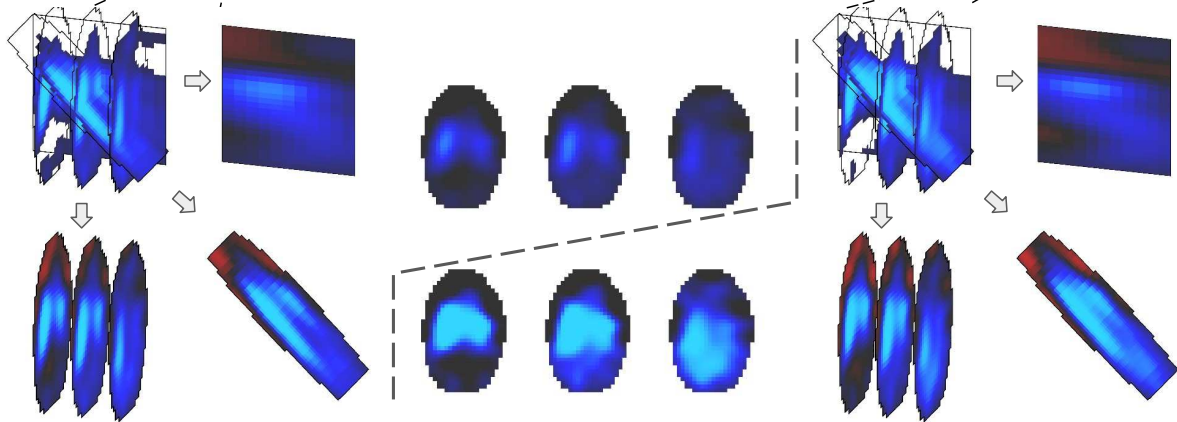
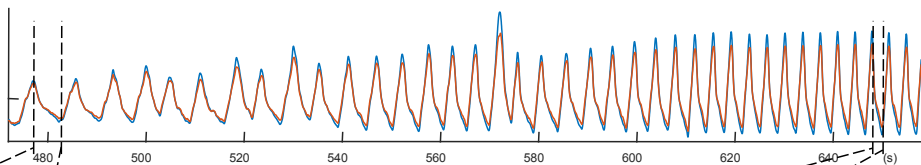


EIT in 3D

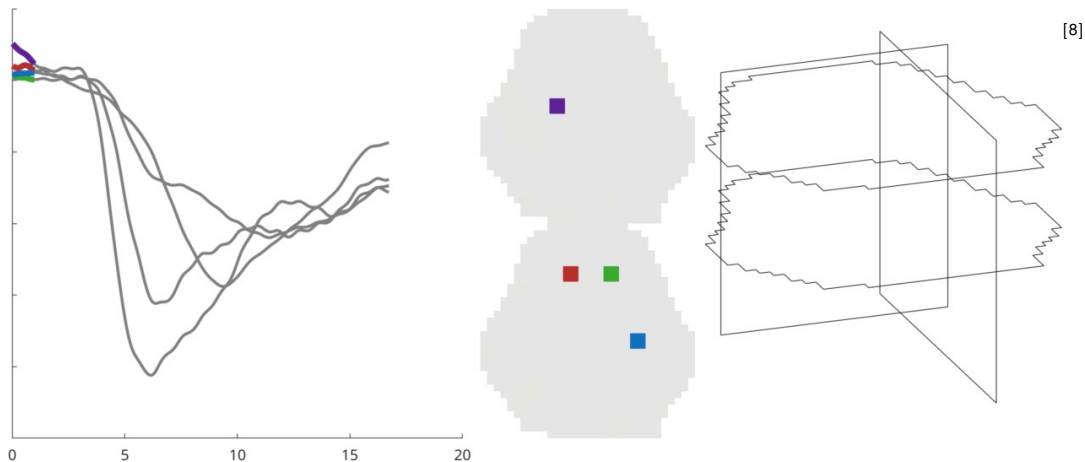


⁷Byrne *et al* (2023) [Validation of three-dimensional thoracic ...](#) *Physiol Meas* 45:035010

EIT in 3D

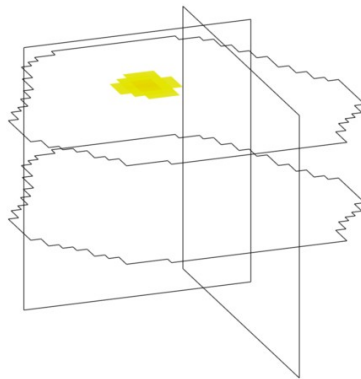
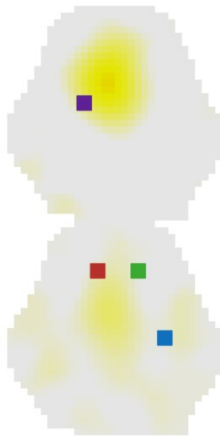
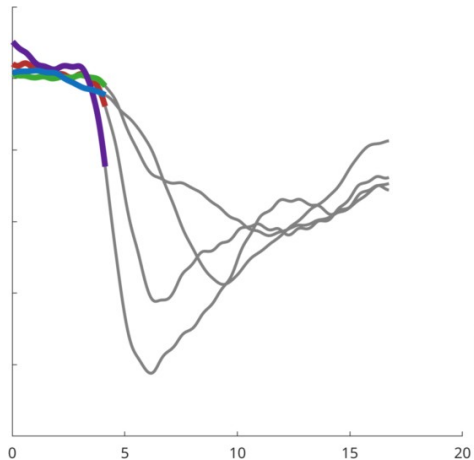


Perfusion with 3D EIT



⁸ Larrabee *et al* (2023) *Am J Physiol: Lung*

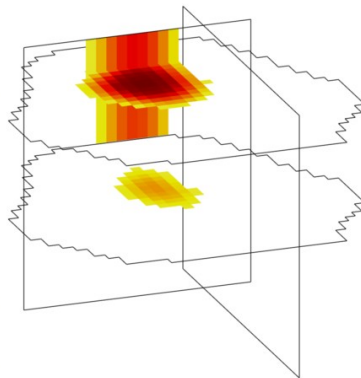
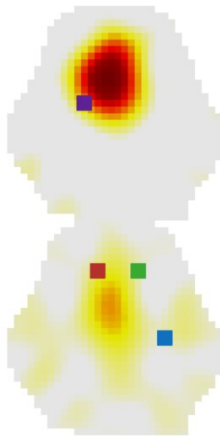
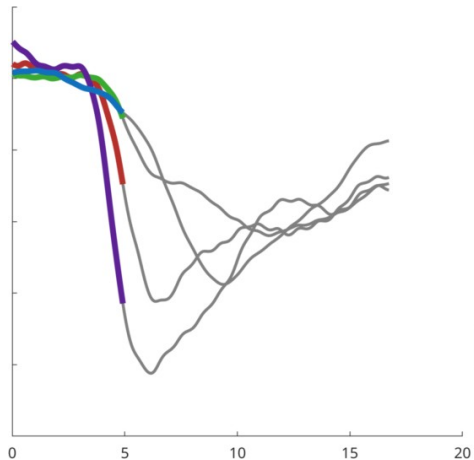
Perfusion with 3D EIT



[8]

⁸ Larrabee *et al* (2023) *Am J Physiol: Lung*

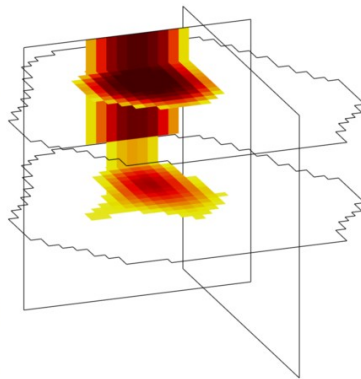
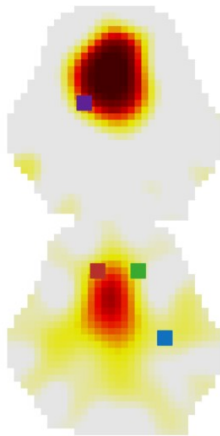
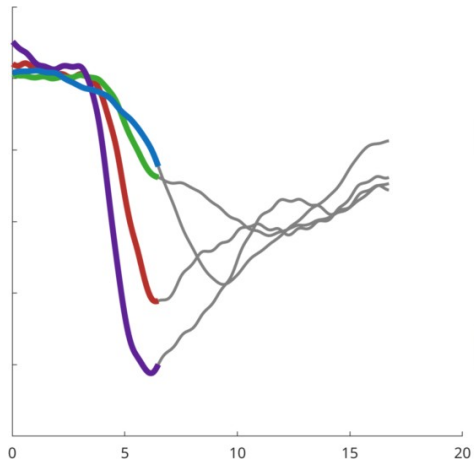
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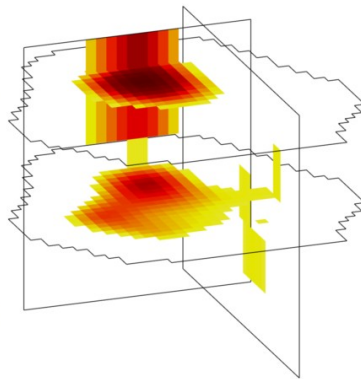
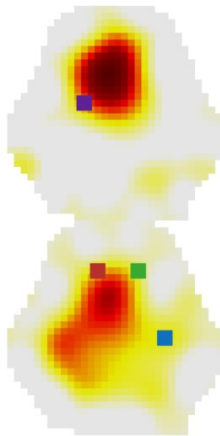
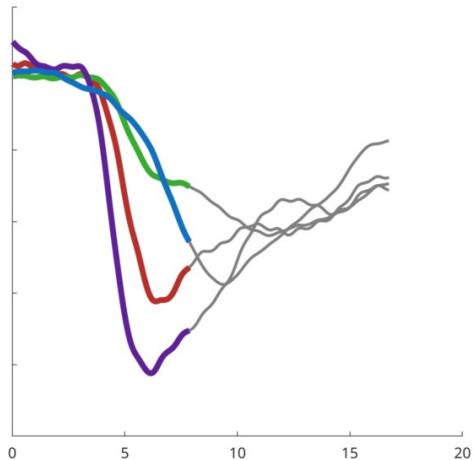
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⁸ Larrabee *et al* (2023) *Am J Physiol: Lung*

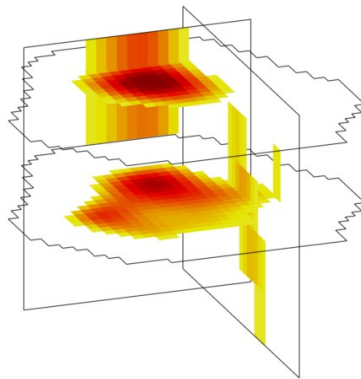
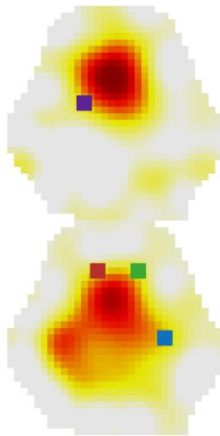
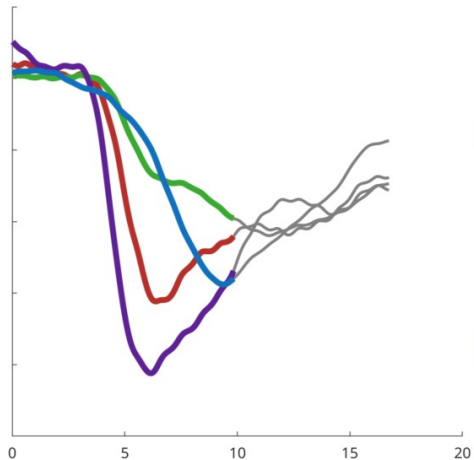
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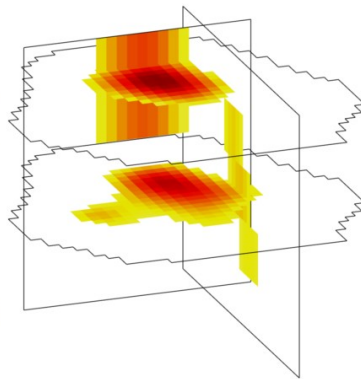
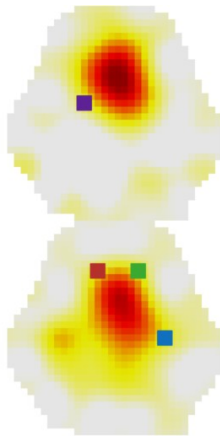
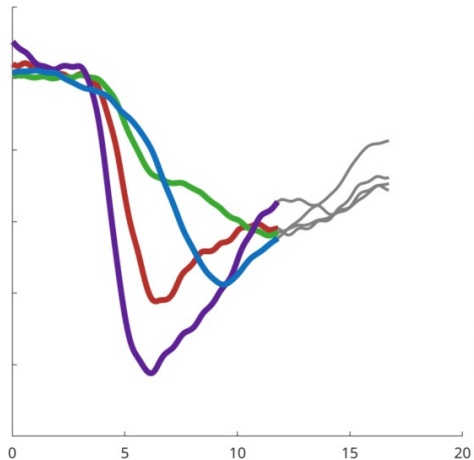
Perfusion with 3D EIT



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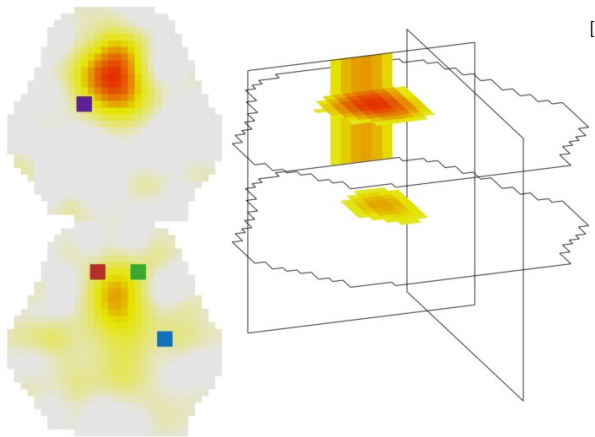
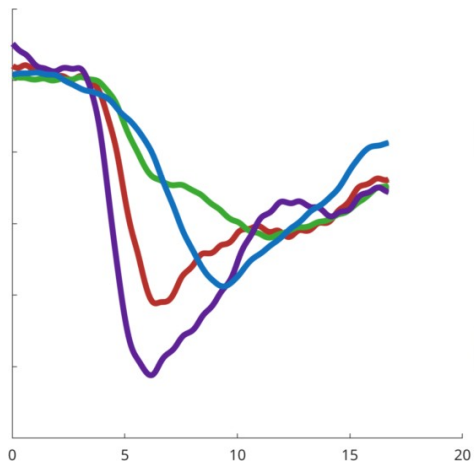
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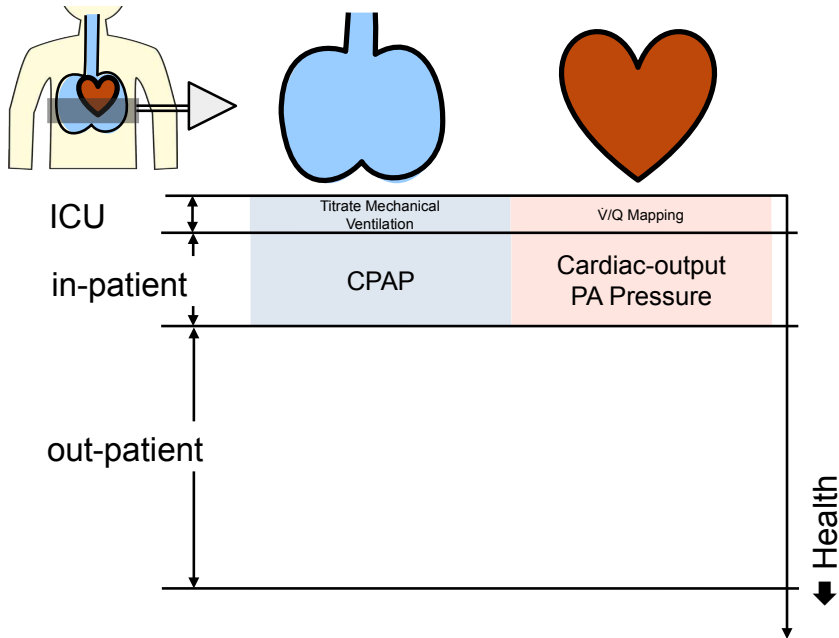
Perfusion with 3D EIT



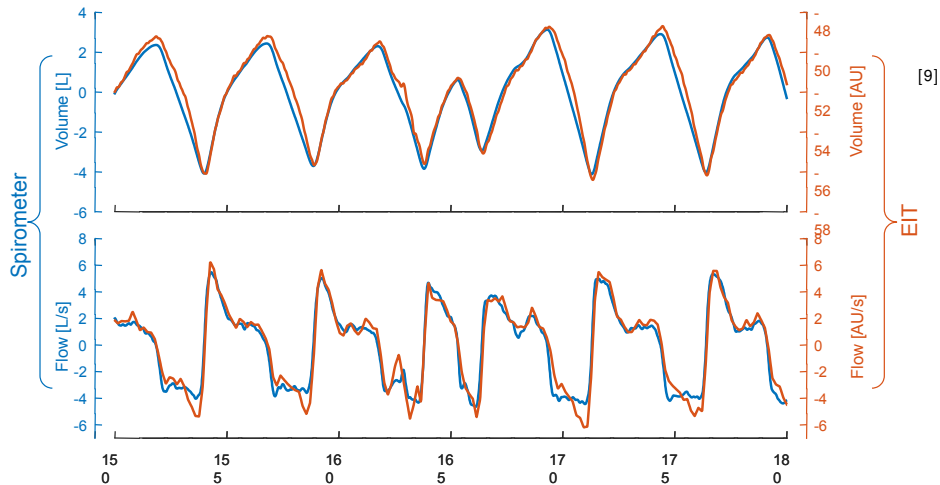
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⁸ Larrabee *et al* (2023) *Am J Physiol: Lung*

EIT: The market

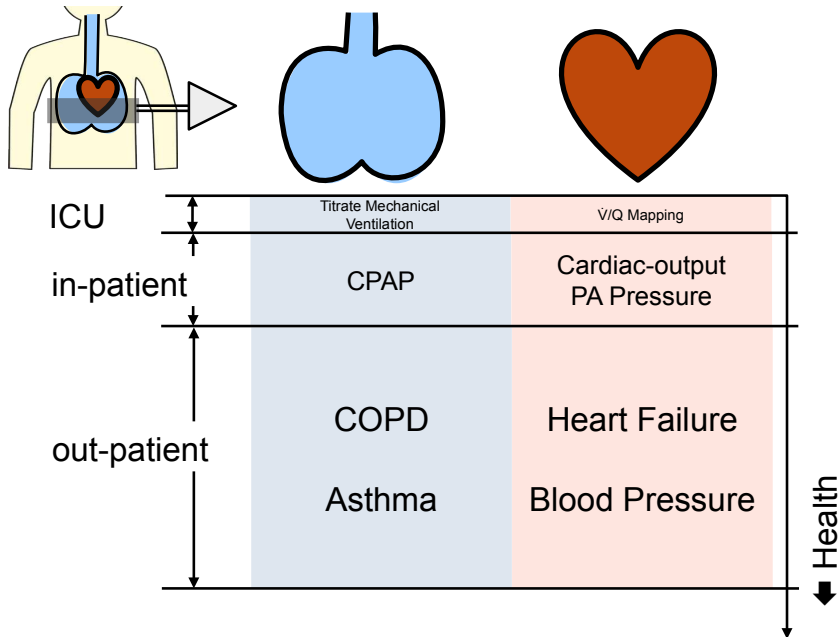


EIT measures lung volume

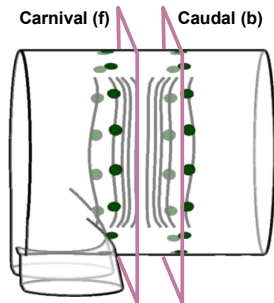


³Byrne *et al* (2023) Comparison of electrical impedance tomography and spirometry-based measures of airflow in healthy adult horses, *Frontiers Physiol* 14:1164646

EIT: The market

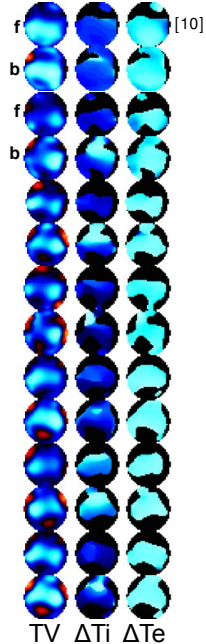
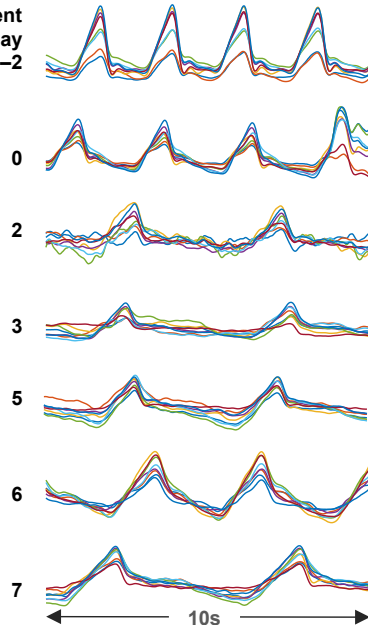


COPD / Asthma



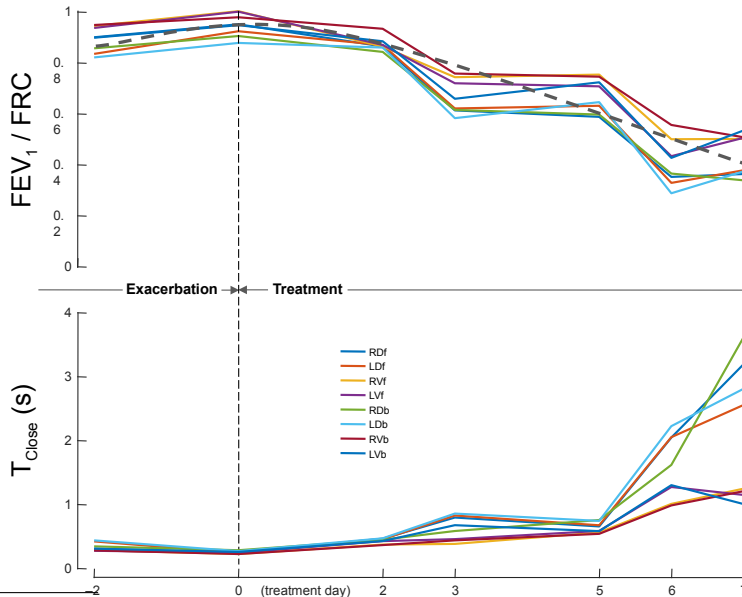
— Rdf
 — LDf
 — RVf
 — LVf
 — RDf
 — LDb
 — RVb
 — LVb

Treatment
Day
-2



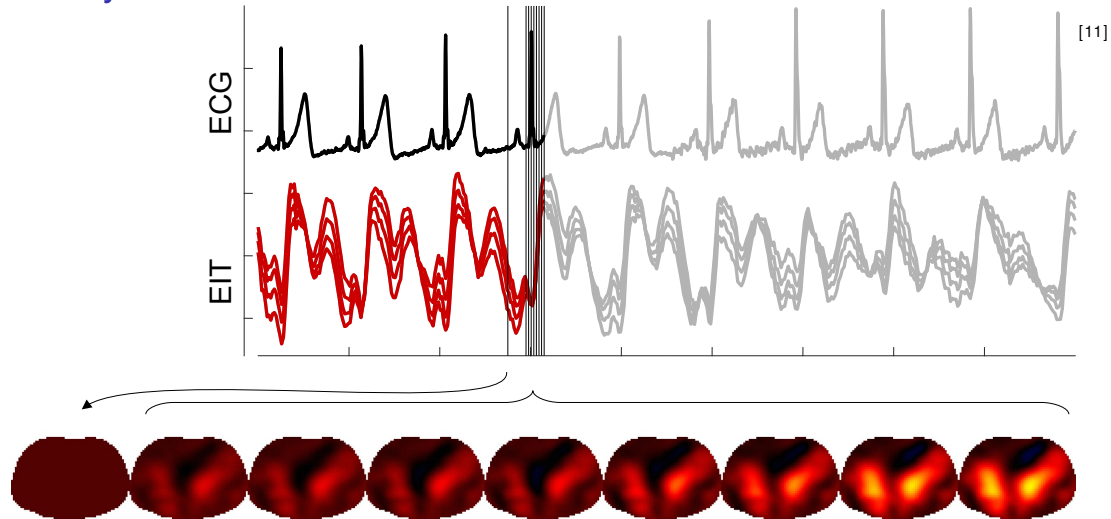
COPD / Asthma

[10]



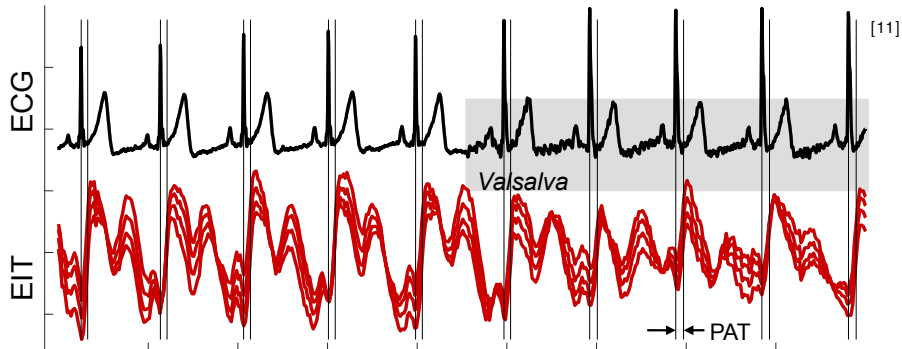
¹⁰Byrne et al (2025) In Preparation

Pulmonary Arterial Pressure



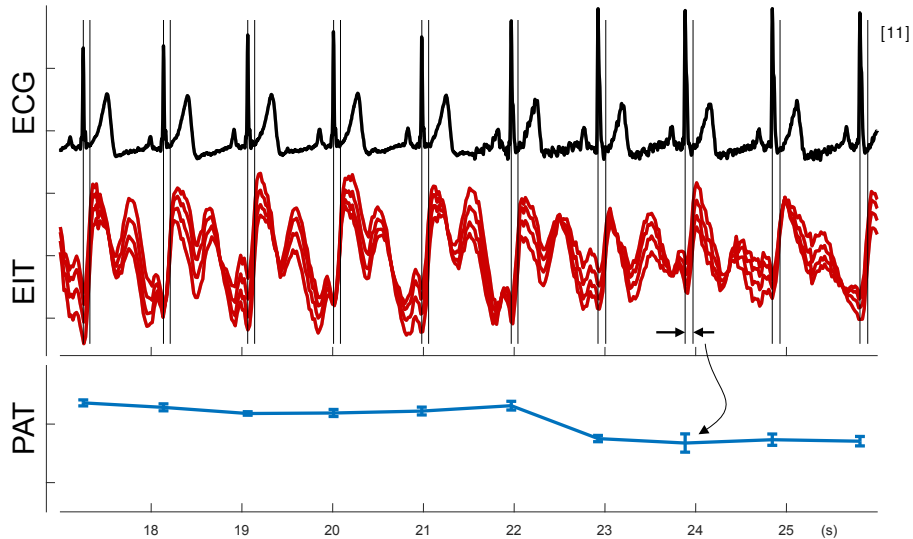
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Pulmonary Arterial Pressure



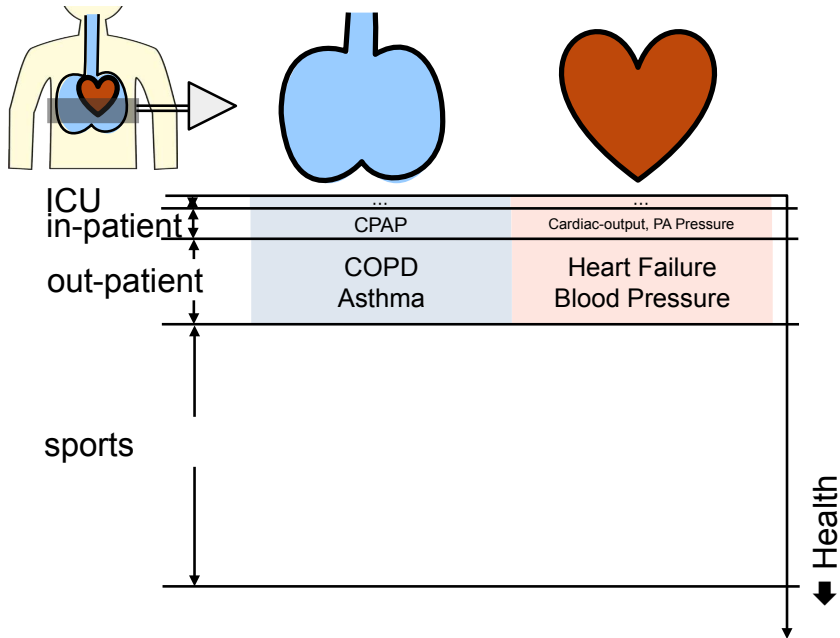
¹¹Byrne *et al* (2025) *In Preparation*

Pulmonary Arterial Pressure

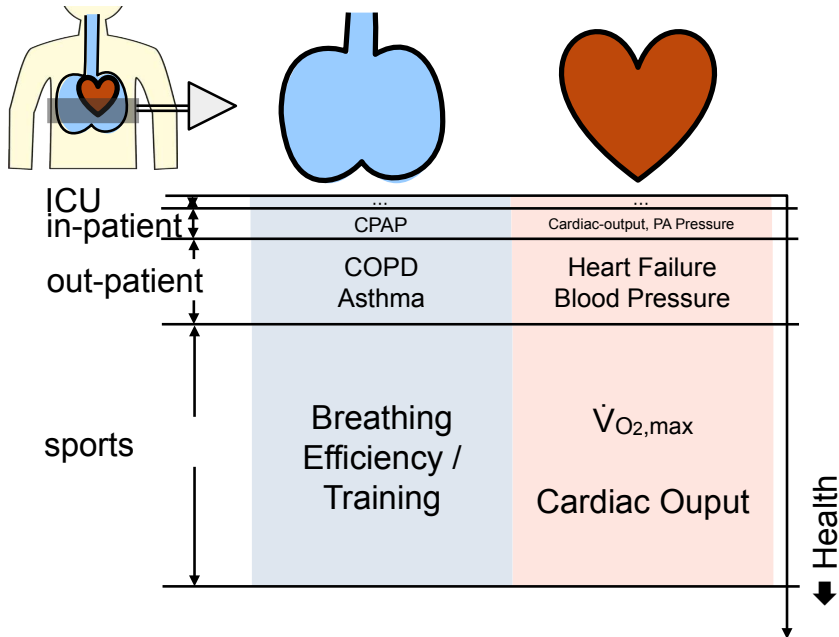


¹¹Byrne *et al* (2025) *In Preparation*

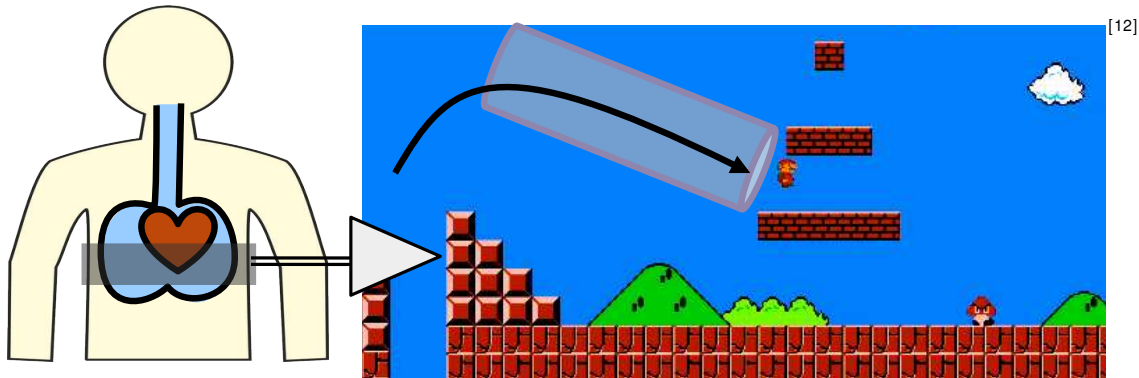
EIT: The market



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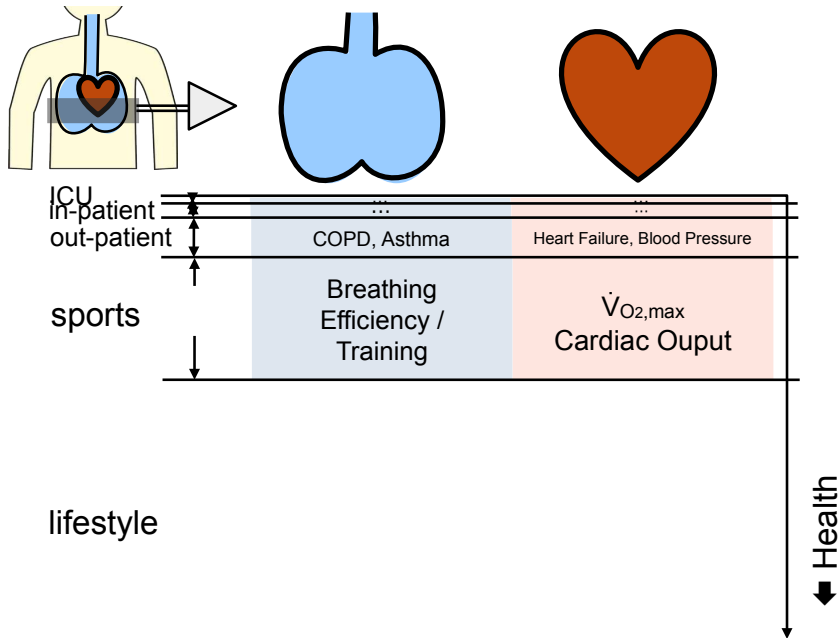


Breathing Training

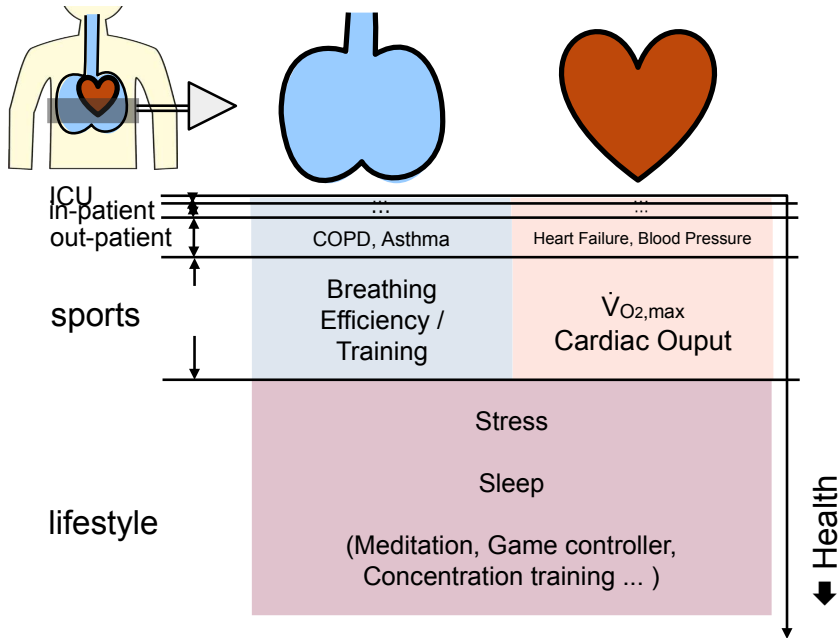


¹²<https://www.freegameplanet.com/super-mario-typing-bros-browser-game/>

EIT: The market

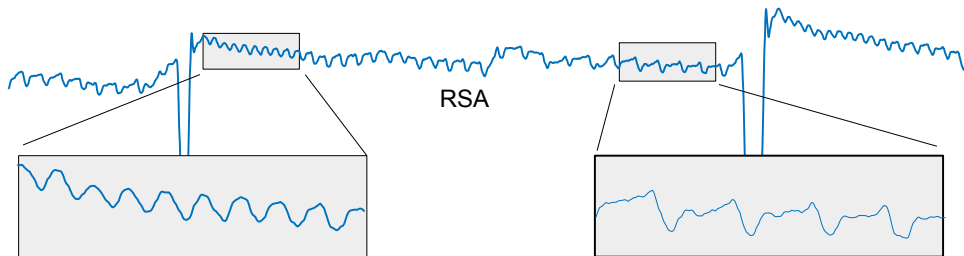
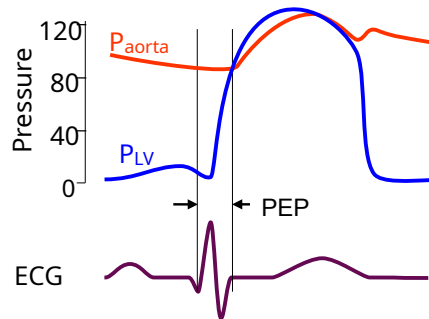


EIT: The market



Stress

- Pre-ejection Period (PEP)
→ Sympathic
- Respiratory Sinus Arrhythmia (RSA)
→ Parasympathic



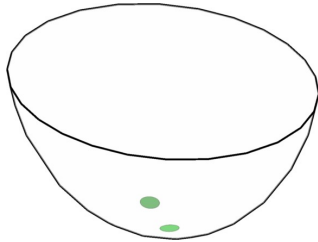
The biggest biomedical market for Electrical Impedance

[13]

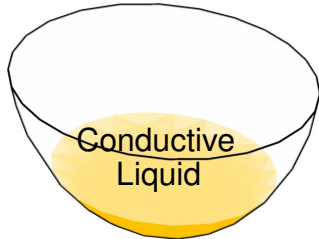


¹³Fisher-Price Cheer for Me! Potty, toddler toilet training seat with music and sounds

The biggest biomedical market for Electrical Impedance

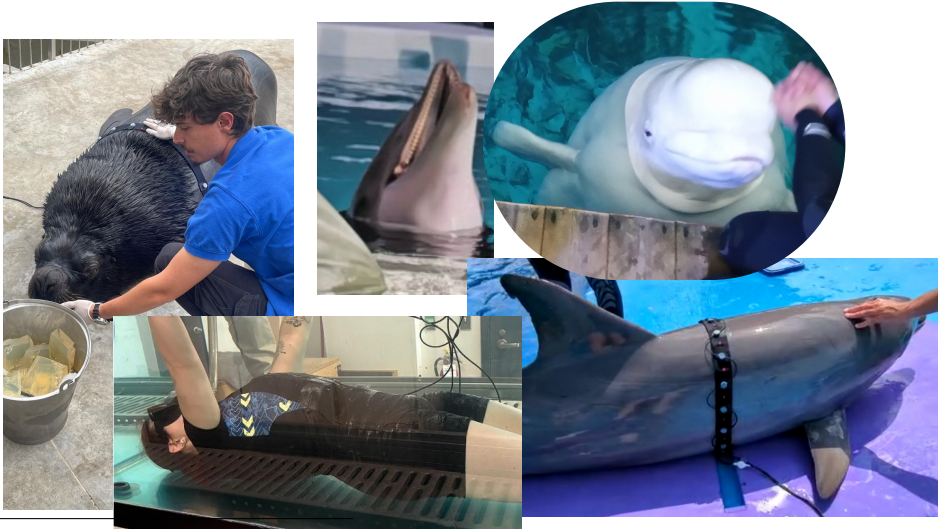


The biggest biomedical market for Electrical Impedance



The smallest biomedical market for EIT

[13]



¹³Adler *et al* "In-water electrical impedance tomography: EIT and the sea", *Physiol Meas* 2025

Discussion

EIT has many potential markets:

- ICU
- In-patient
- Out-patient
- Sports
- Lifestyle

Discussion

EIT has many potential markets:

- ICU – Current market
- In-patient
- Out-patient
- Sports
- Lifestyle

Requirements

- Advanced analysis of signals
- Portable, small hardware
- Differentiate from other monitors