SCREENING FOR IMMERSION PULMONARY EDEMA (IPE, SIPE) SUSCEPTIBILITY

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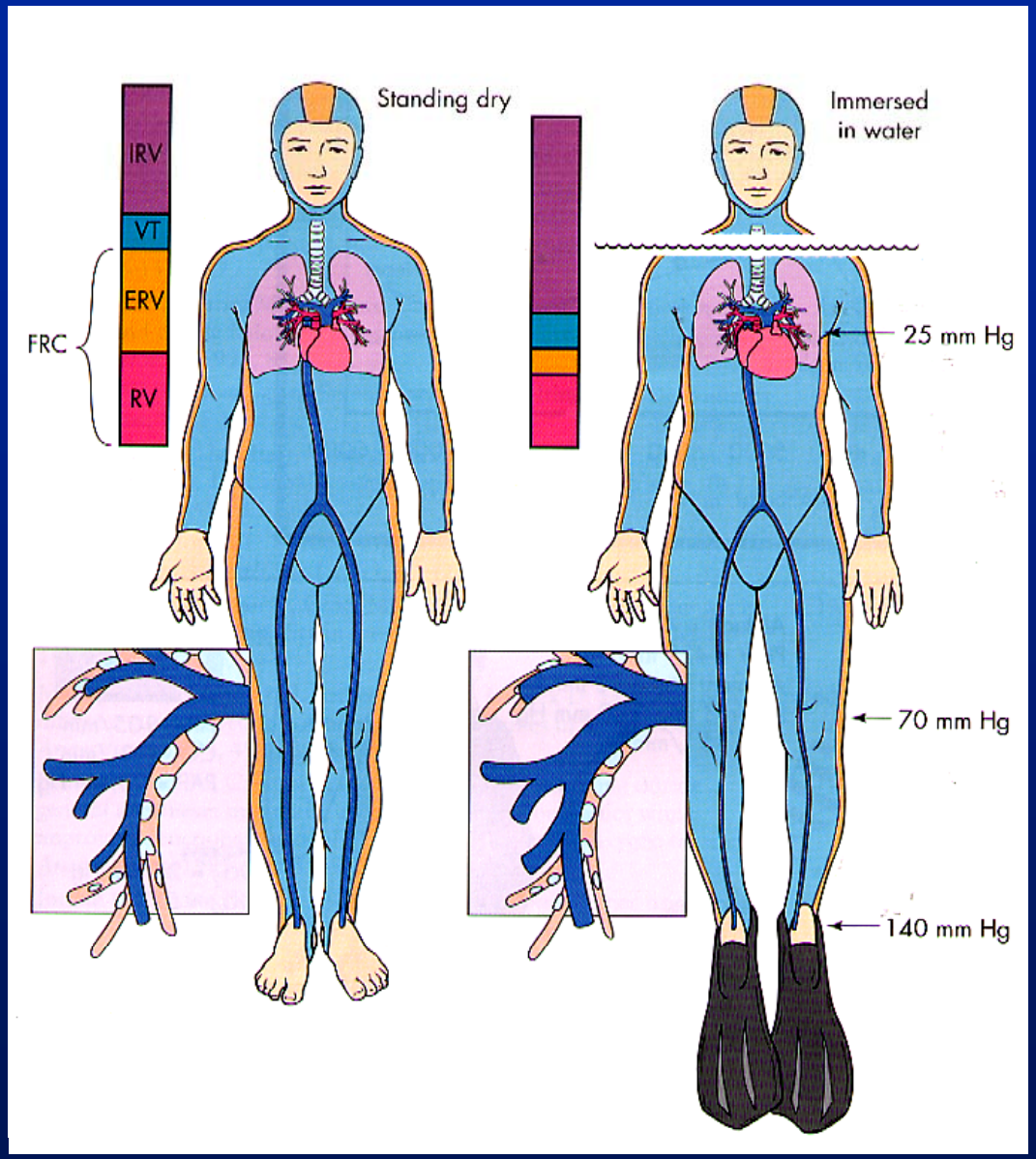
Immersion Pulmonary Edema
(Swimming-Induced Pulmonary Edema)

- Sudden onset dyspnea, hemoptysis during swim/dive
- Occurs in divers, triathletes, Navy trainees (NEDU, BUD/S)
- Prevalence in 2.4-3.6 km open sea military swimming trials typically 2%§, up to 60%*
- Can be fatal
- Pathophysiology may be exaggerated increase in pulmonary vascular pressures during immersed exercise, particularly in cold water

§Chest 126:394, 2004
*Respir Physiol 121:25, 2000

Immersion



Moon RE, Stolp BW. In: *Scientific Principles of Anesthesia* D Schwinn (Ed). Philadelphia, PA: Current Medicine, 1997

Venous Capacitance

Normal

Sympathetic Block

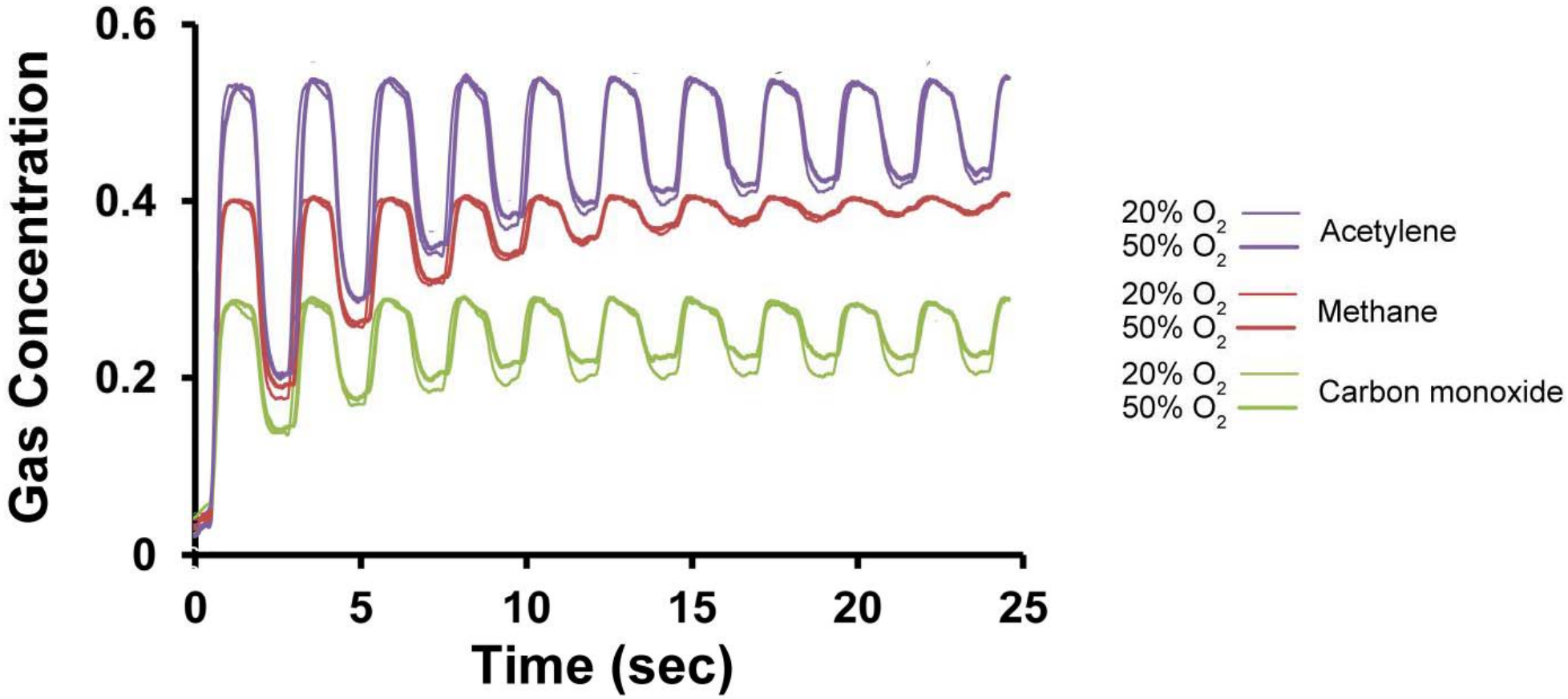
Hypotheses

- Individuals susceptible to SIPE have exaggerated increase in pulmonary artery pressure (PAP) and venous tone in response to cold water exercise
- Susceptibility to SIPE is due to specific genotypes related to vasoreactivity
- Oral fluid loading prior to cold water immersed exercise increases the likelihood of developing SIPE. Water is more likely than electrolyte-containing fluids to produce pulmonary edema

Specific Aims

- Measure lung water in 200 volunteers before and after 40 minutes of exercise during head-out immersion in 20-21°C water
- During exercise, measure systolic RV pressure and LV systolic/diastolic properties
- Establish genotypes related to vasoreactivity for individuals susceptible to SIPE
- Test oral fluid loading with different formulations (water/electrolyte solution) on hemodynamics and lung water during exercise in cold water

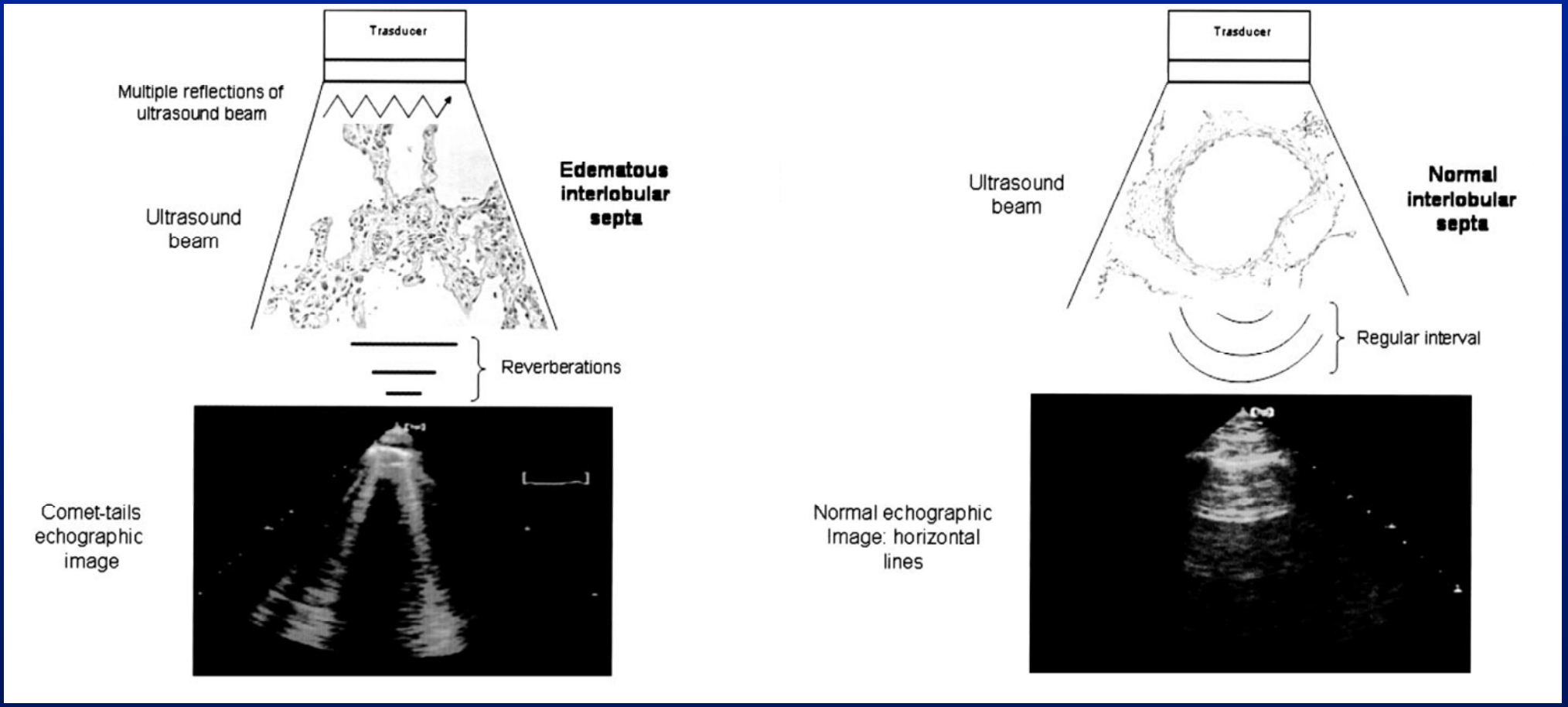
Lung Water Assessment: Trace Gases



$$\frac{1}{DL_{CO}} = \frac{1}{Dm_{CO}} + \frac{1}{\theta_{CO} \times Vc}$$

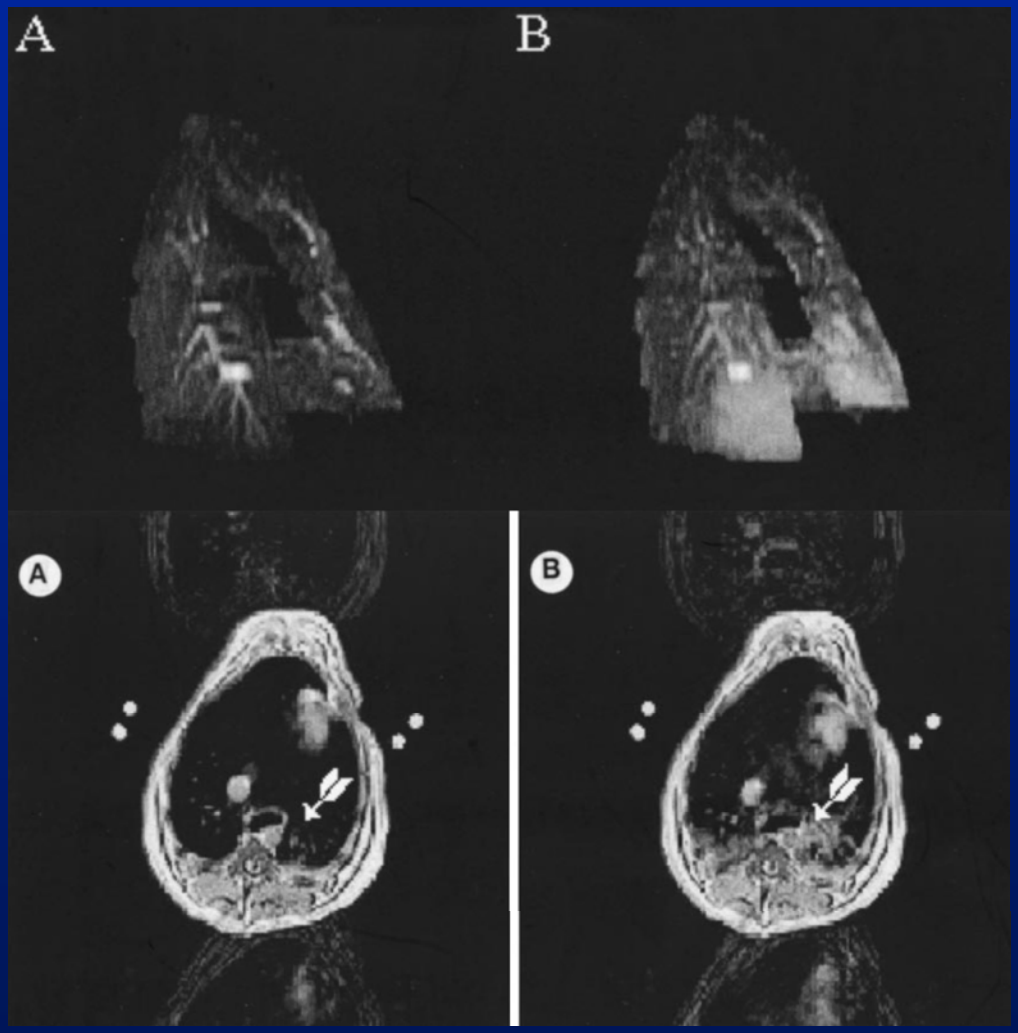
Method from Ceridon ML, et al. *J Appl Physiol* 109:643, 2010

Lung Water Measurement: Echo



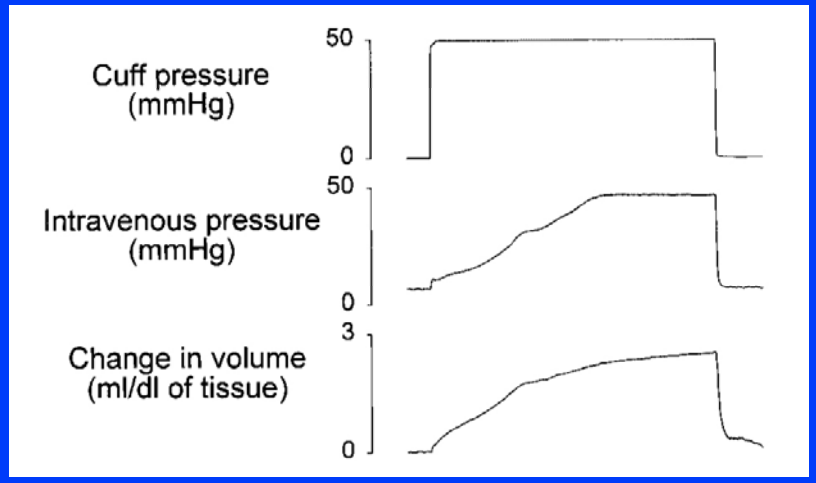
Agricola E, et al. *Chest* 2005;127;1690

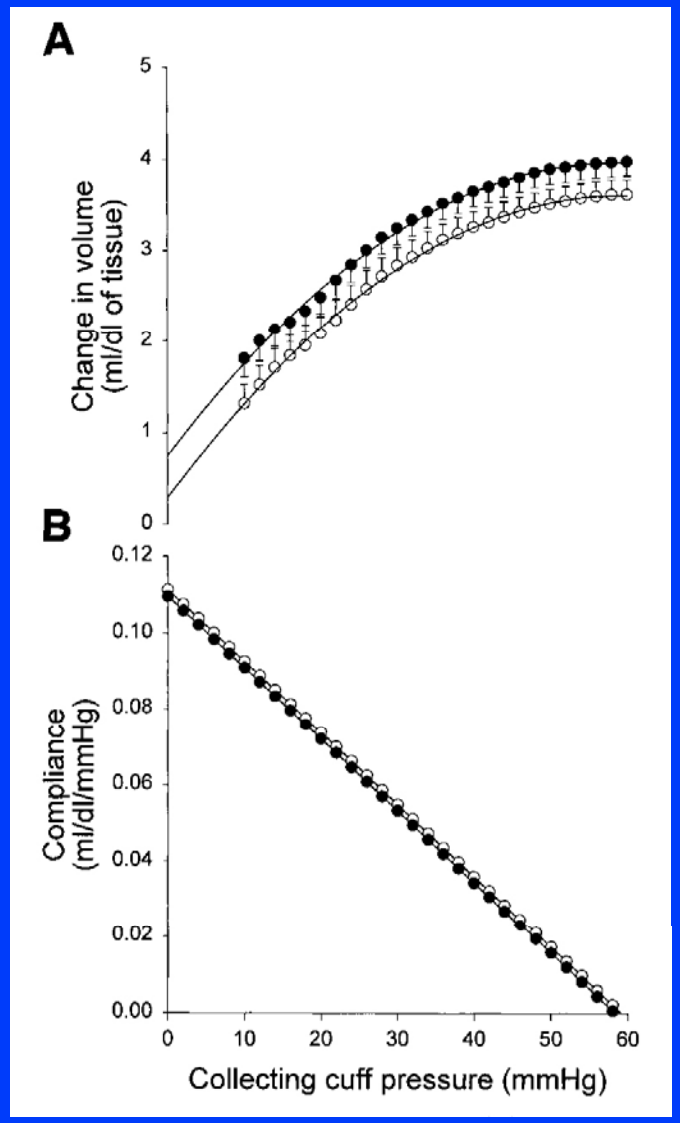
Lung Water Measurement: MRI



Caruthers SD, et al. *J Appl Physiol* 84:2143, 1998

Venous Capacitance Measurement

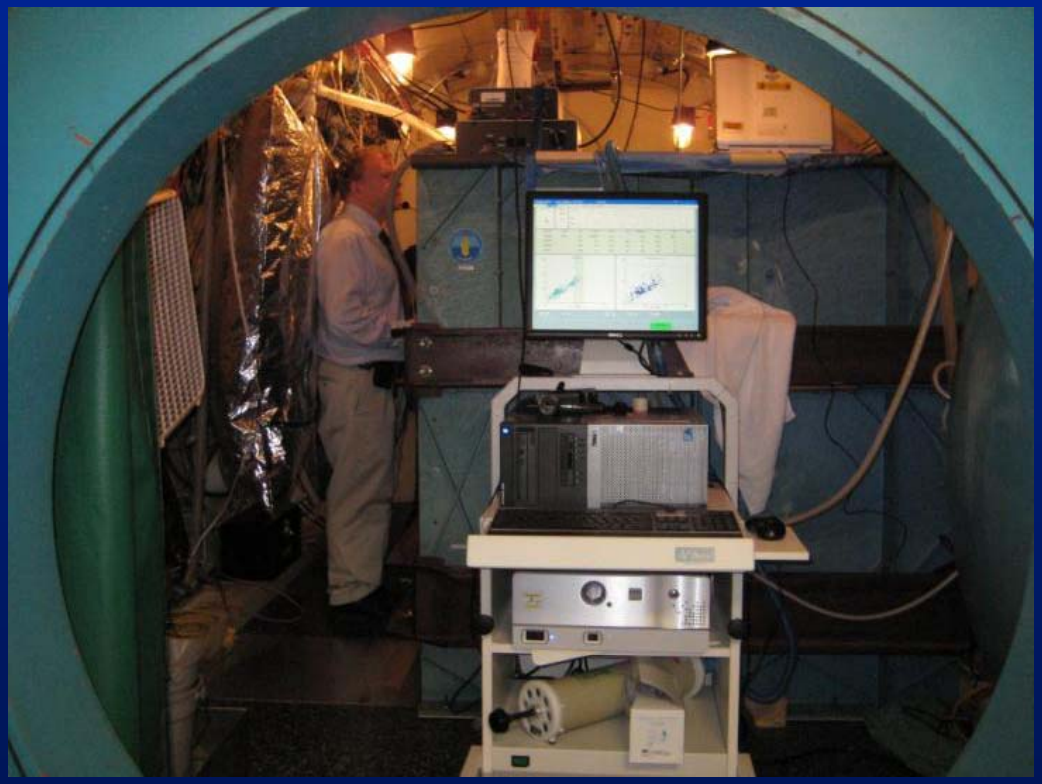


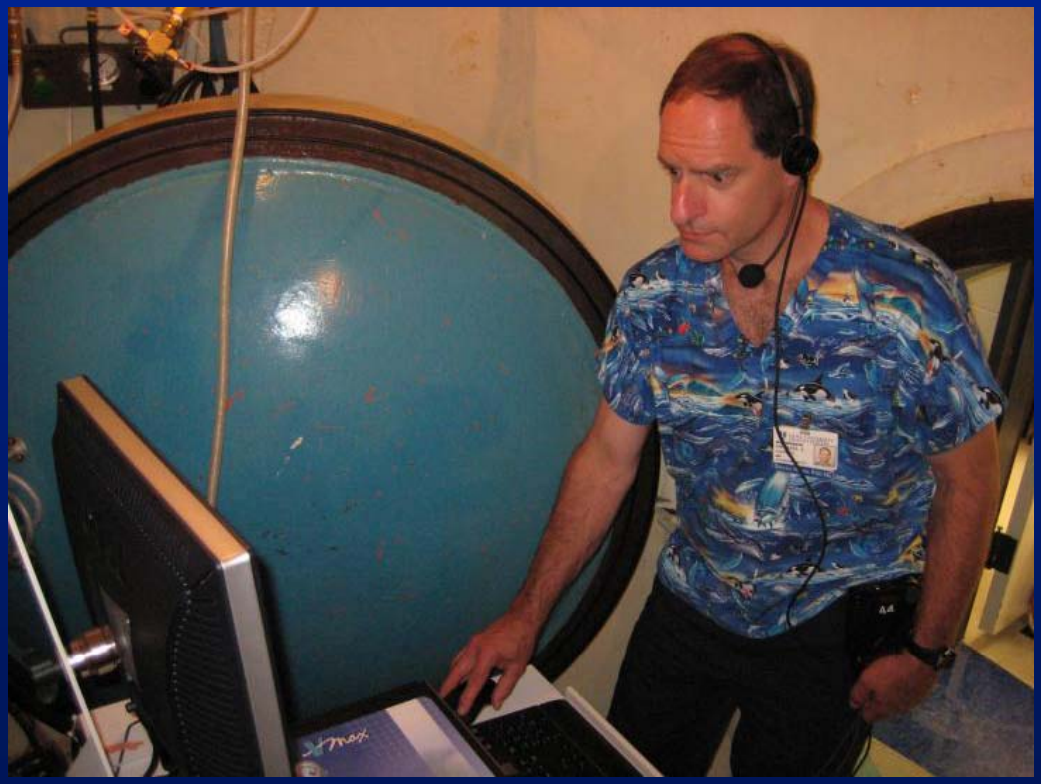


Halliwill JR, et al. *J Appl Physiol* 87: 1555, 1999

Immersed Cardiac Echo

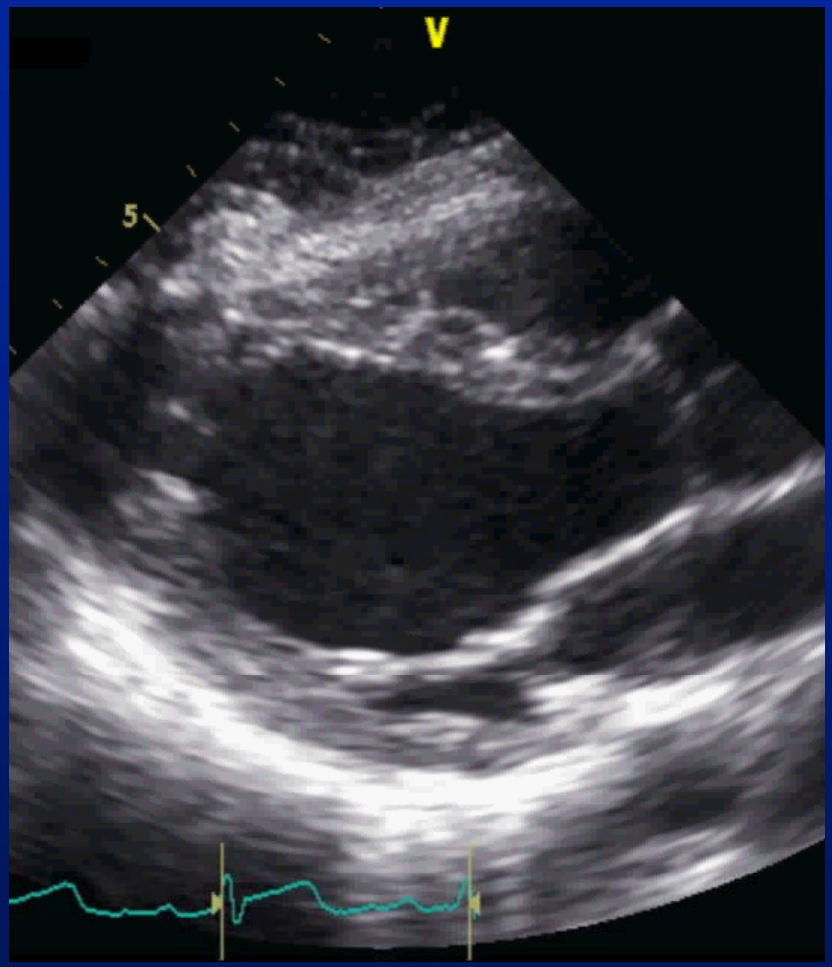
Immersed Cardiac Echo



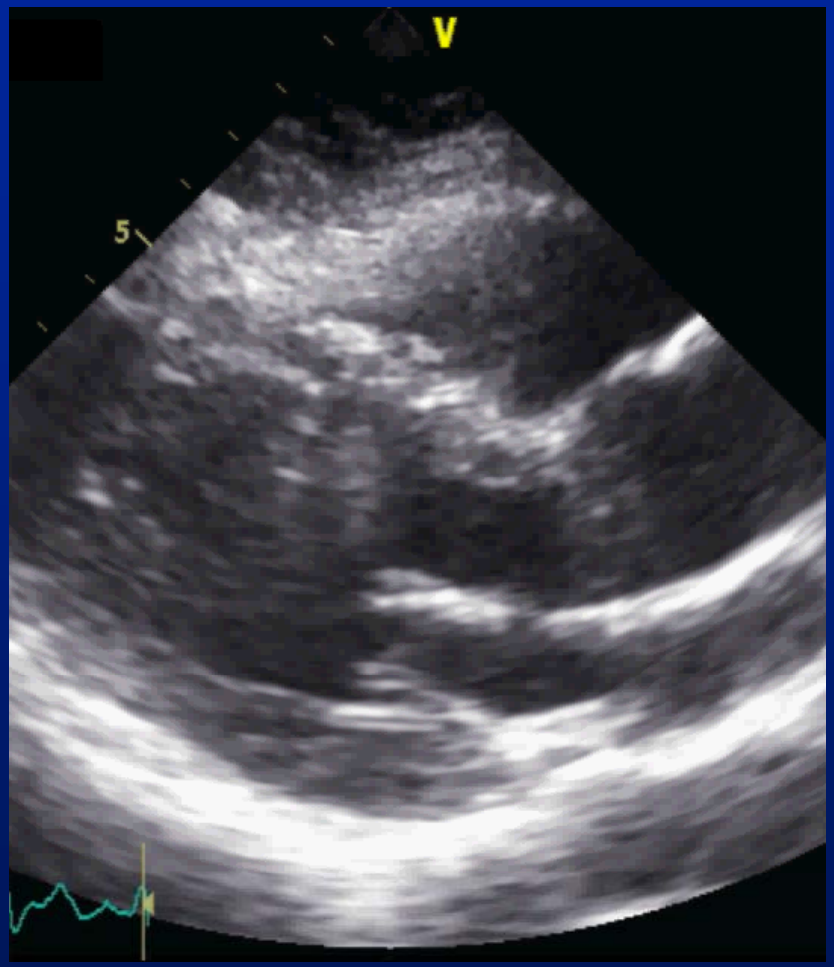


LV Long Axis

Subject JW



rest wet

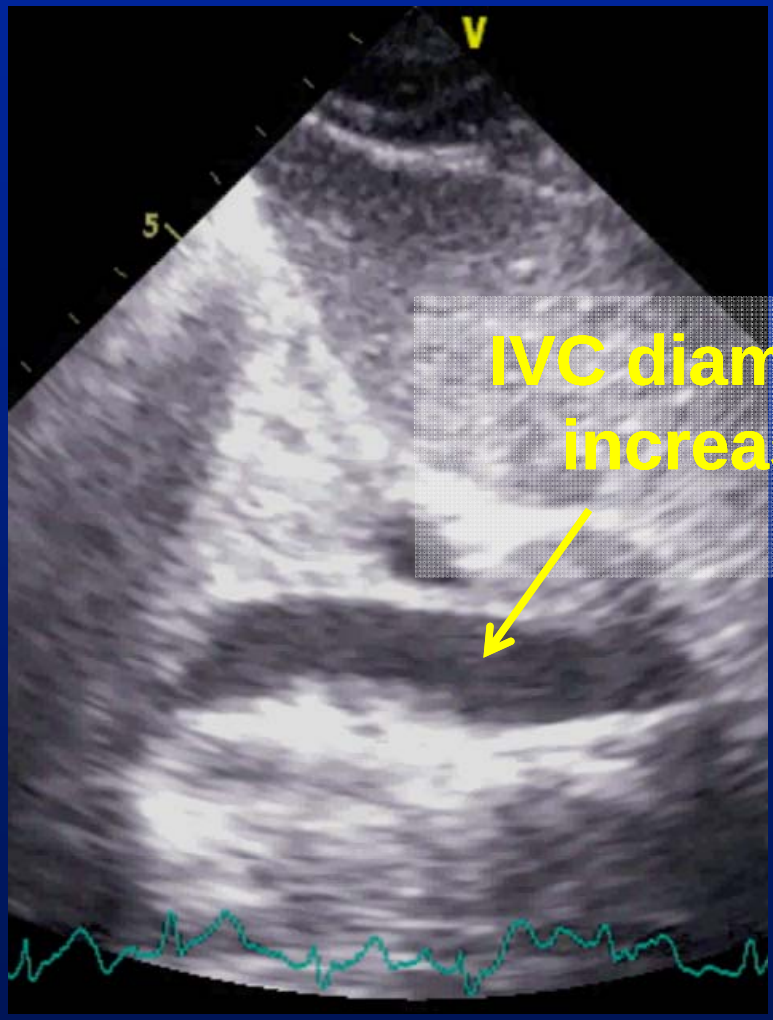


peak stress wet

IVC

Subject JW

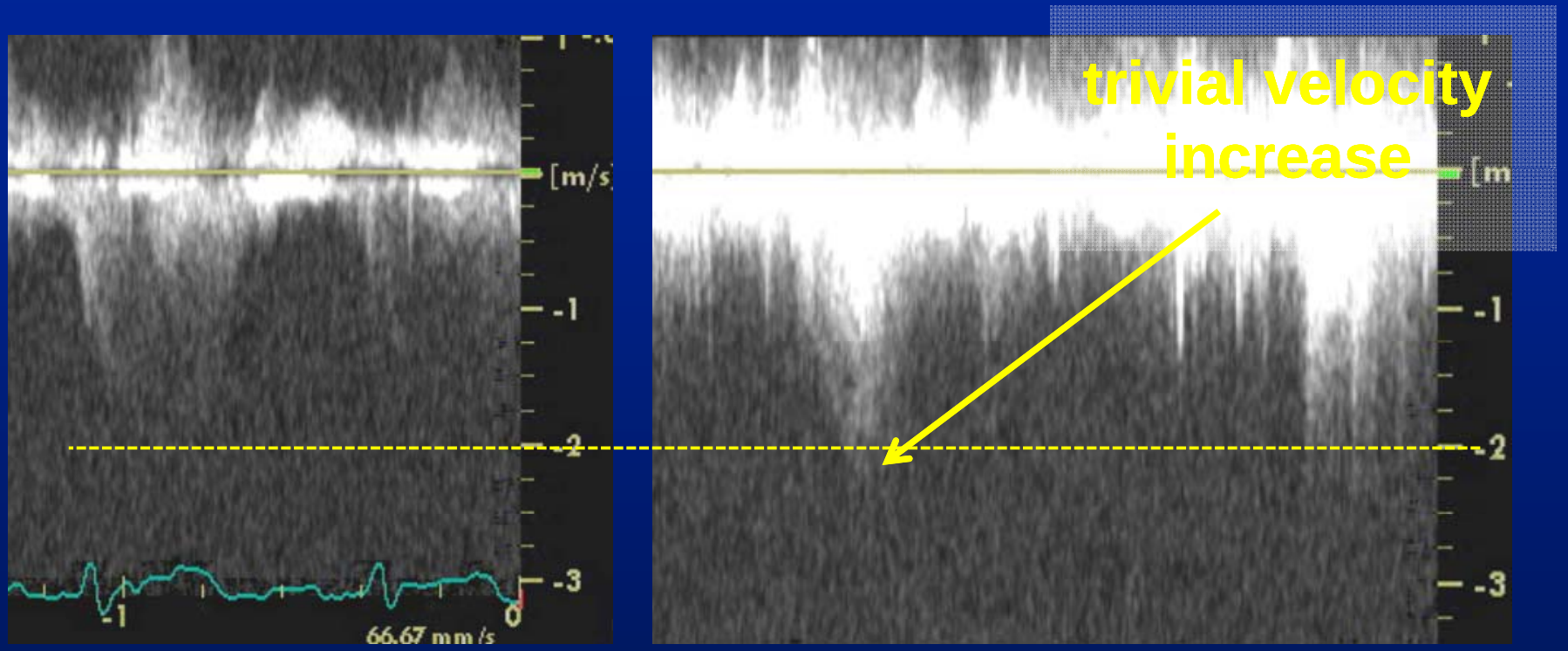
rest wet



peak stress wet

Tricuspid regurgitation

Subject JW



rest wet

peak stress wet

Products

- Physiological test to predict the risk of SIPE
- Specific genotypes that place an individual at increased risk of SIPE
- Best strategy for fluid consumption prior to immersed exercise

Conclusions

- A method by which lung water, venous capacitance and cardiac function can be assessed before and after head-out immersed exercise have been implemented, in order to test susceptibility to immersion pulmonary edema we have constructed
- Using this system, fluid administration strategies and genetic predisposition can be tested in a large cohort

Acknowledgment

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