



Hemodynamics of Immersion Pulmonary Edema Susceptibility and the Effect of Sildenafil

RE Moon, SD Martina, DF Peacher, AD Cherry, TE Wester,
JAV Fraser, MJ Natoli, EA Schinazi, D Kernagis, JJ Freiburger
Center for Hyperbaric Medicine and Environmental Physiology
Duke University Medical Center
Durham, NC, USA



Immersion Pulmonary Edema (IPE), Swimming-Induced Pulmonary Edema (SIPE)

■ Pulmonary edema occurring in divers, swimmers

■ Dyspnea	70	(100%)
■ Cough	67	(96%)
■ Hemoptysis	39	(56%)
■ Sputum production	63	(90%)
■ Chest pain	6	(9%)
■ Basal inspiratory crackles	64	(91%)
■ Wheezing	6	(9%)

**Adir Y, et al.
Chest 126:394, 2004**

- Most commonly reported in naval combat swimmers during training, triathletes. Prevalence in 2.4-3.6 km open sea swimming trials reported to be 1.8-60% (Shupak A, et al. Respir Physiol 2000;121:25-31; Adir Y, et al. Chest 2004;126:394-9)
- No cardiopulmonary pathology in majority of cases, especially among military
- Evidence supports a hemodynamic cause for SIPE

Immersion Pulmonary Edema

THE LANCET, JANUARY 14, 1989

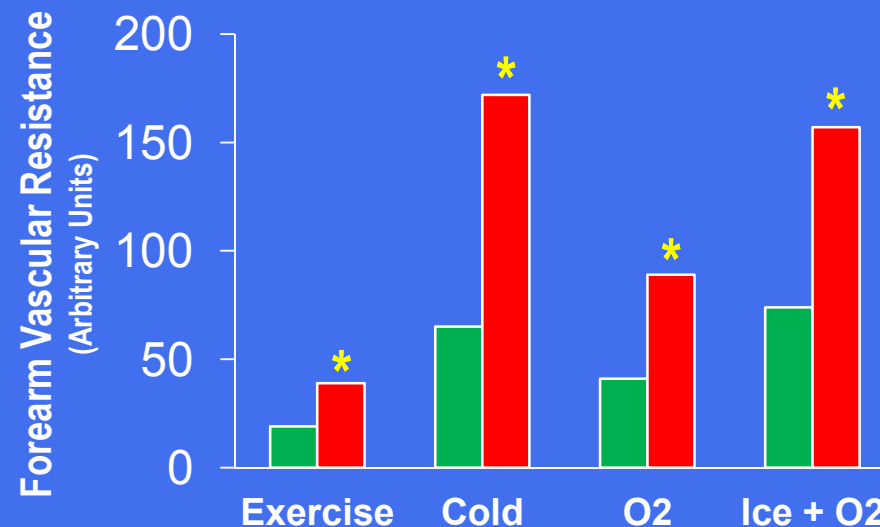
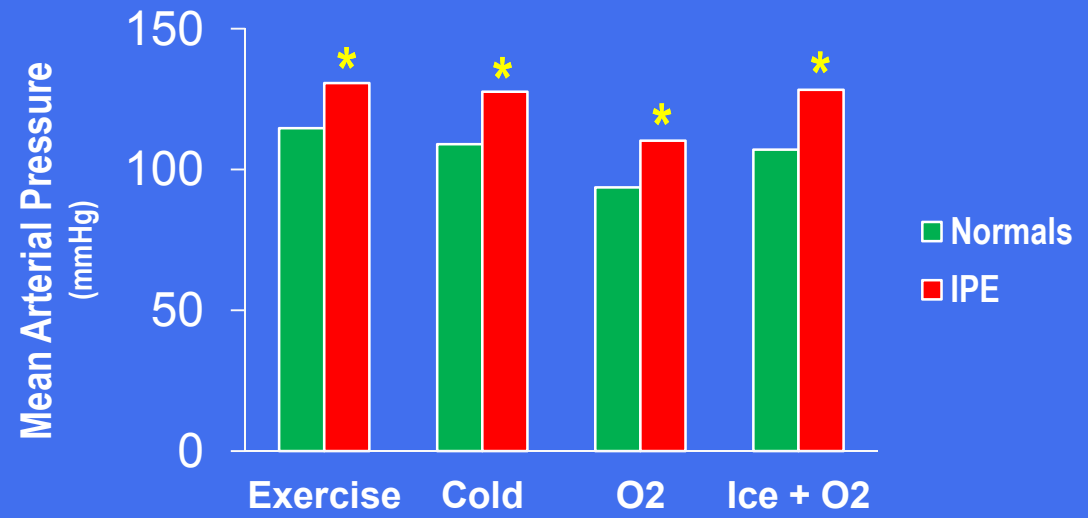
COLD-INDUCED PULMONARY OEDEMA IN SCUBA DIVERS AND SWIMMERS AND SUBSEQUENT DEVELOPMENT OF HYPERTENSION

P. T. WILMSHURST
A. CROWTHER

M. NURI*
M. M. WEBB-PEPLOE

*Department of Cardiology, St. Thomas' Hospital,
London SE1 7EH*

Summary The effect of cold and/or a raised partial pressure of oxygen was examined in eleven people with no demonstrable cardiac abnormality but who had pulmonary oedema when scuba diving or surface swimming, and in ten normal divers. These stimuli induced pathological vasoconstriction in the pulmonary oedema group, nine of whom also showed signs of cardiac decompensation when so stimulated. The pulmonary oedema patients have been followed-up for an average of 8 years. Seven have become hypertensive. Except for the onset of lone atrial fibrillation in one normotensive female diver and development of Raynaud's phenomenon in a normotensive man, there have been no cardiovascular events and no deaths.



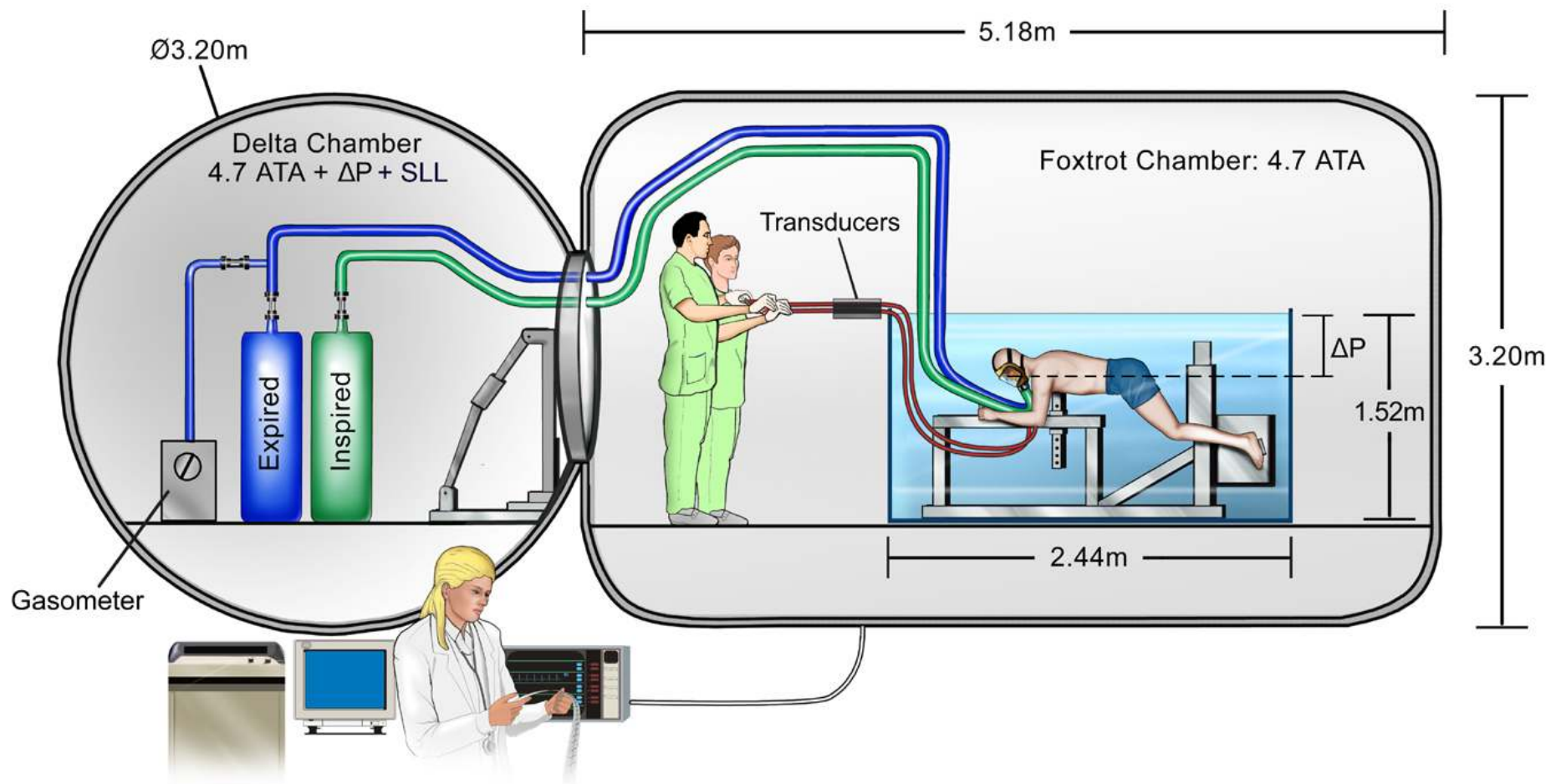
* P < 0.05 vs. Normals

Hypothesis

Individuals who are susceptible to SIPE have higher pulmonary artery and PA wedge pressures during exercise in cold water

Methods

- Approval by Duke IRB, informed consent
- Volunteers with SIPE history, controls
- All subjects instrumented with radial artery and pulmonary artery catheters
- 6 minutes of exercise fully immersed in 20°C water, no thermal protection
- Hemodynamics (MAP, PAP, PAWP, Fick CO)
- Ventilation, O₂ consumption, CO₂ elimination
- Exercise repeated on the same day 1-2 hours after oral sildenafil 50 mg



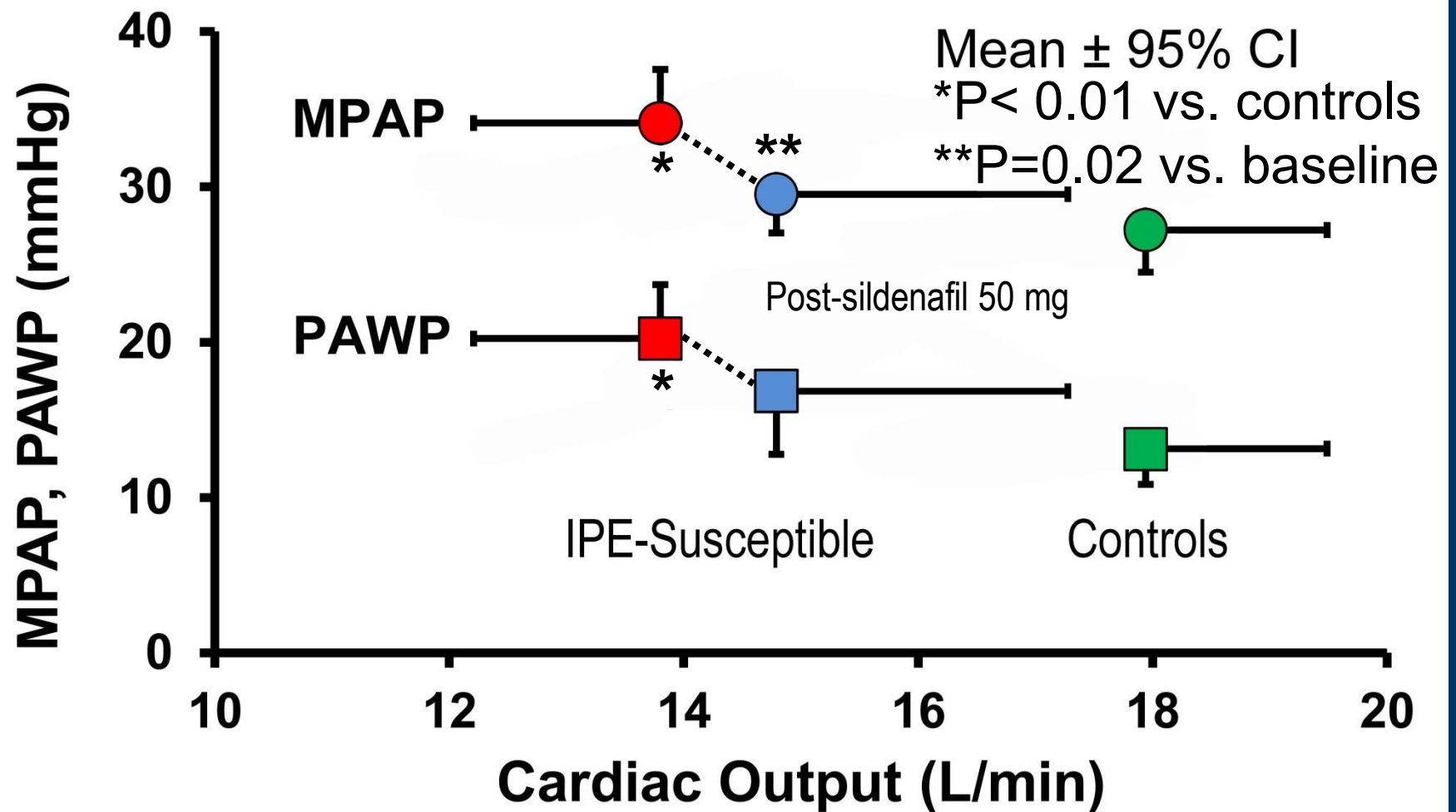


Demographics

	SIPE History (N=10)	Controls (N=20)
Age (Y)	41.6±7.8	36.2±8.3
Gender (M/F)	4/6*	18/2
BMI (kg/m ²)	25.7±3.9	26.0±2.2

*P=0.004

PAP and PAWP During Cold (20°C) Immersed Exercise



Conclusions

- SIPE-susceptible individuals have higher PAP, PAWP than controls during cold water exercise. This supports the notion that SIPE is hemodynamic pulmonary edema
- Sildenafil reduces PAP in SIPE-susceptible individuals and may be a useful preventive medication
- Possible causes for the augmented pulmonary vascular pressures include
 - Enhanced venoconstriction, causing increased central redistribution of blood during cold water immersion
 - Reduced diastolic LV compliance (“diastolic dysfunction”)



Bruce Derrick



Alicia Armour



Owen Doar



Aaron



Dionne



Eric Schinazi



Mike Natoli



Ivy Forkner



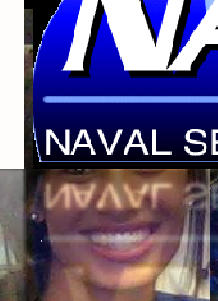
**Dr. Joe
Kisslo**



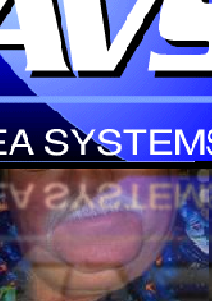
**Danny
Rivera**



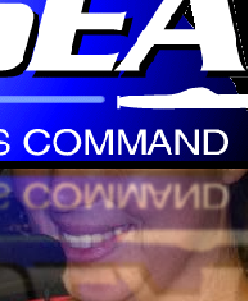
**Anne
Cherry**



**Claire
Otteni**



**Tommy
Edwards**



**Tracy
Wester**



**Jennifer
Fraser**



**Marty
Lynch**



Jim Logan



Rick Roller



Sonny Boso



**Stefanie
Martina**



Jenna Wiley



**Dawn
Kernagis**



Shelly Pecorella



Eric Alford