Knowledge Transfer from Space Medicine to Global Health on Earth

Prof. Thais Russomano, MD, MSc, PhD

Senior Lecturer & Deputy Director of the Master's Degree in Space Physiology and Health, CHAPS, KCL

Co-Founder & CEO, InnovaSpace Ltd, UK

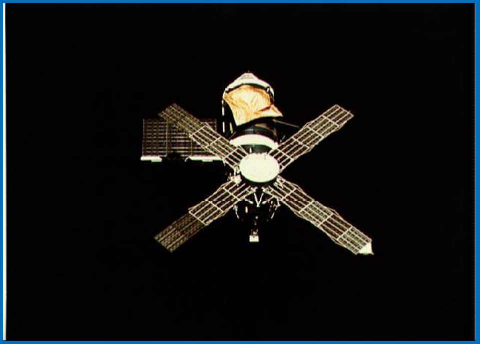
Co-Founder & CMO, ISMC (USA)

www.thaisrussomano.com - www.innovaspace.org

Spacecraft/Space Station and Spacesuit Environments

Mercury, Gemini and Apollo Projects: pressure 5 psi / 100% O_2

- cabin size and design of the life support system



Skylab Project: pressure 5 psi / 70% O_2 and 30% N_2

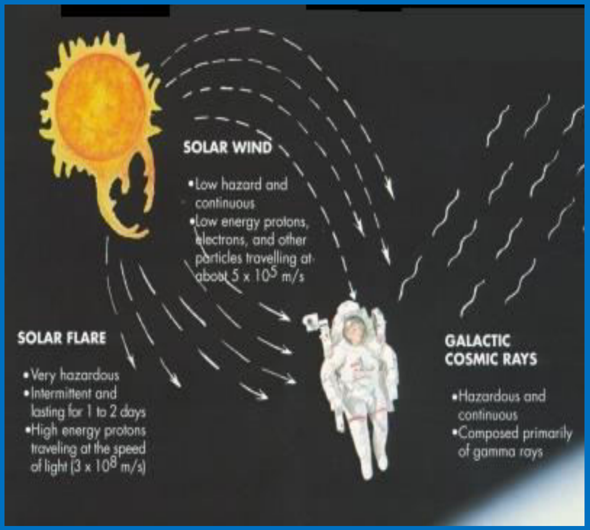
- safety and risk of lung atelectasia

Space Shuttle Program/ISS: pressure 14.7 psi (1 ATM, 760 mmHg), 20% O_2 and 80% N_2), temperature between 18 - 27 degrees Celsius, water vapour pressure 6.2 - 14 mmHg.

Space environment – Space Missions (LEO)

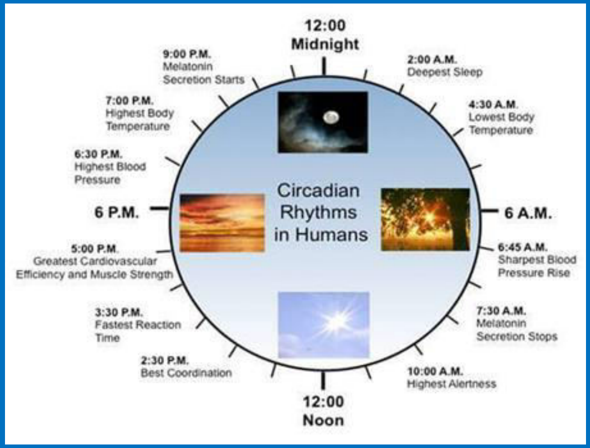
Microgravity

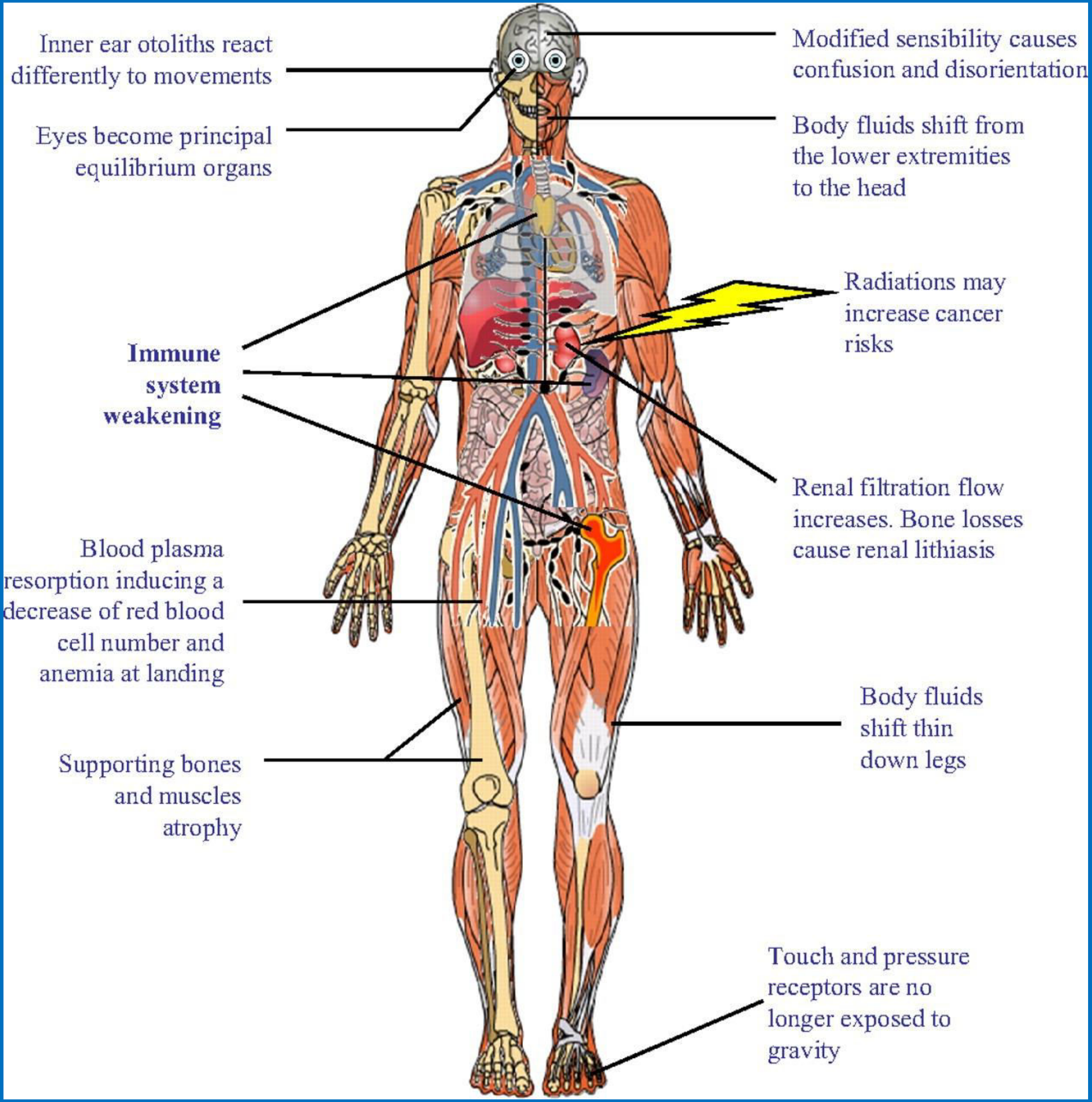
Radiation



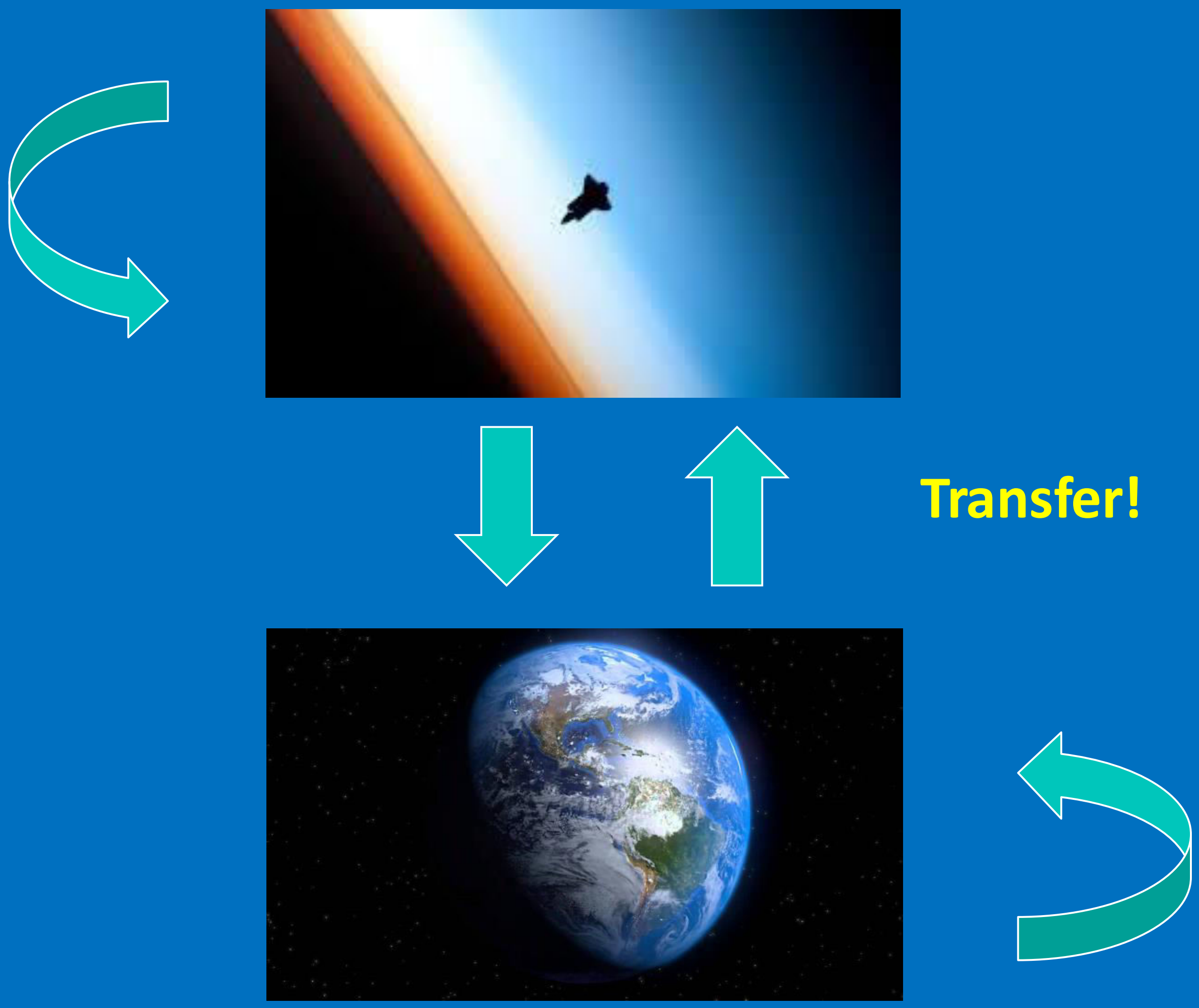
The Human Mind in Space

Circadian Rhythm



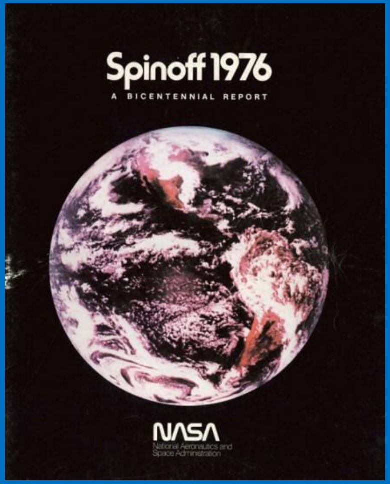

Inner ear otoliths react differently to movements
Eyes become principal equilibrium organs
Modified sensibility causes confusion and disorientation
Body fluids shift from the lower extremities to the head
Radiations may increase cancer risks
Immune system weakening
Renal filtration flow increases. Bone losses cause renal lithiasis
Blood plasma resorption inducing a decrease of red blood cell number and anemia at landing
Body fluids shift thin down legs
Supporting bones and muscles atrophy
Touch and pressure receptors are no longer exposed to gravity

Knwoledge, Products, Methods, Techniques, Processes



NASA SPINOFF

TECHNOLOGY TRANSFER PROGRAM



+40 years!!!!

Health and Medicine

Transportation

Public Safety

Consumer Goods

Energy and Environment

Information Technology

Industrial Productivity

Telemedicine & eHeatlh

Human Psychology, Physiology & Medicine

Development of Medical Equipment & Devices

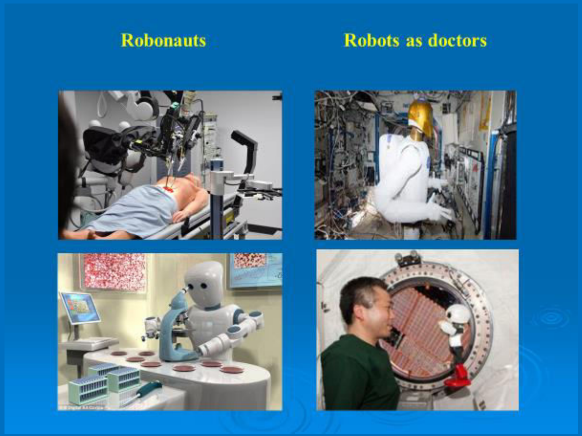
Software, XAI, VR, AR & Health applications

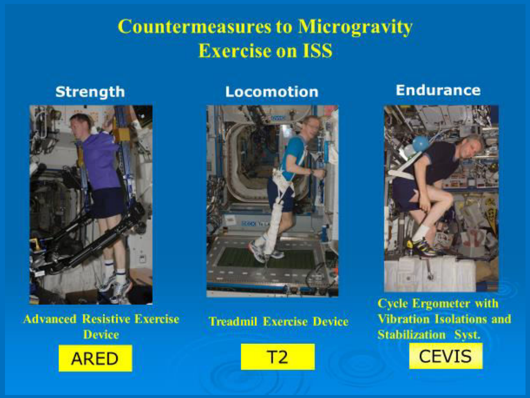
Disease Investigation & Treatment

Exercise & Space Countermeasures

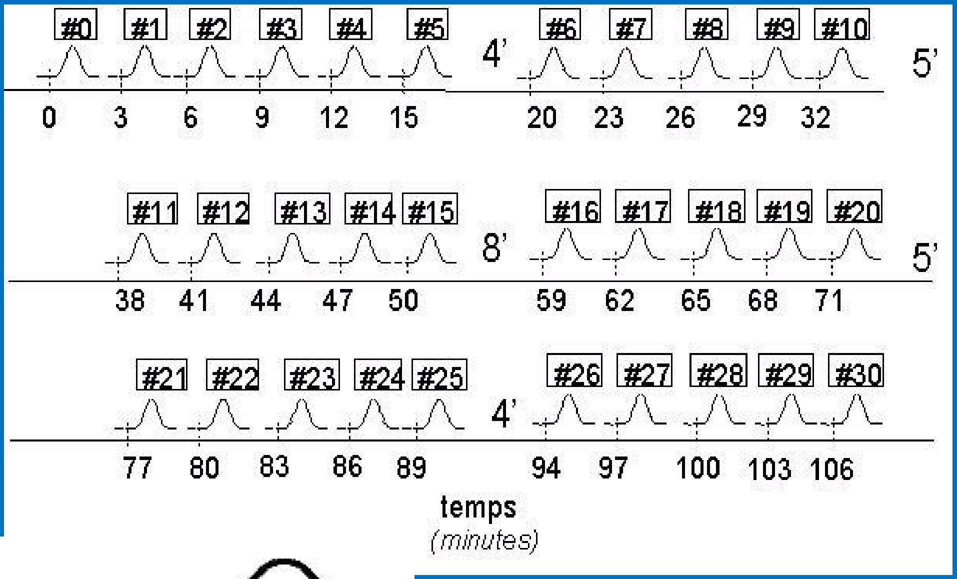
Genetics & Aging

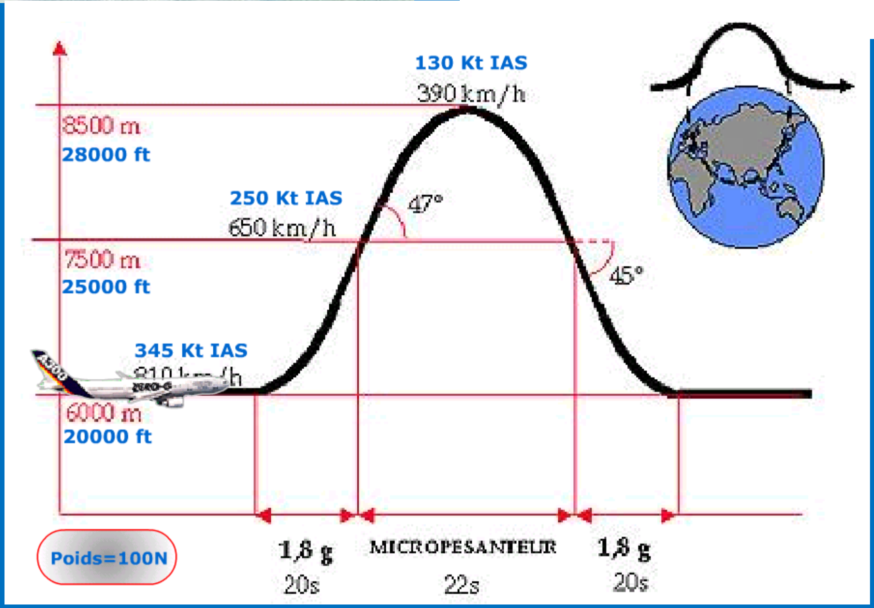
Robotics, Robonauts & Robots as Doctors





Parabolic flights – 20 seconds of microG

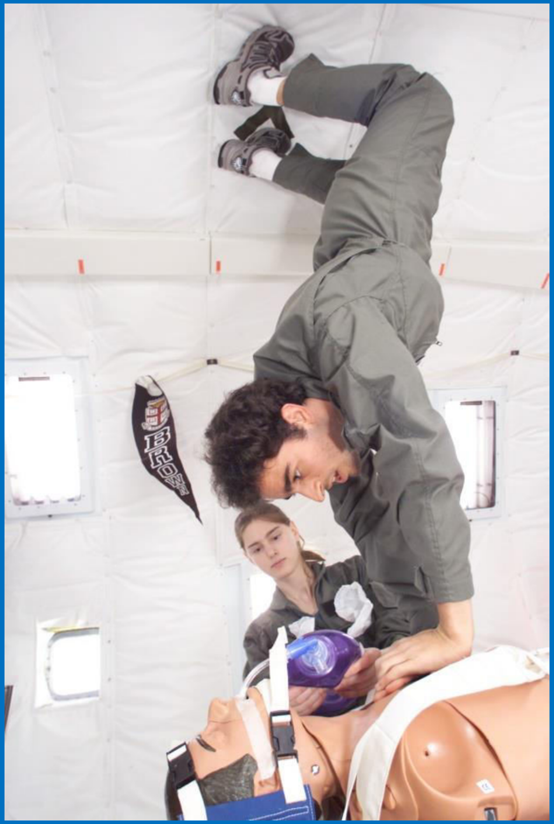




ESA 29th Parabolic Flight Campaign, Bordeaux, França, Nov - 2000

CPR in MicroG: 3 methods

Tests in parabolic flights



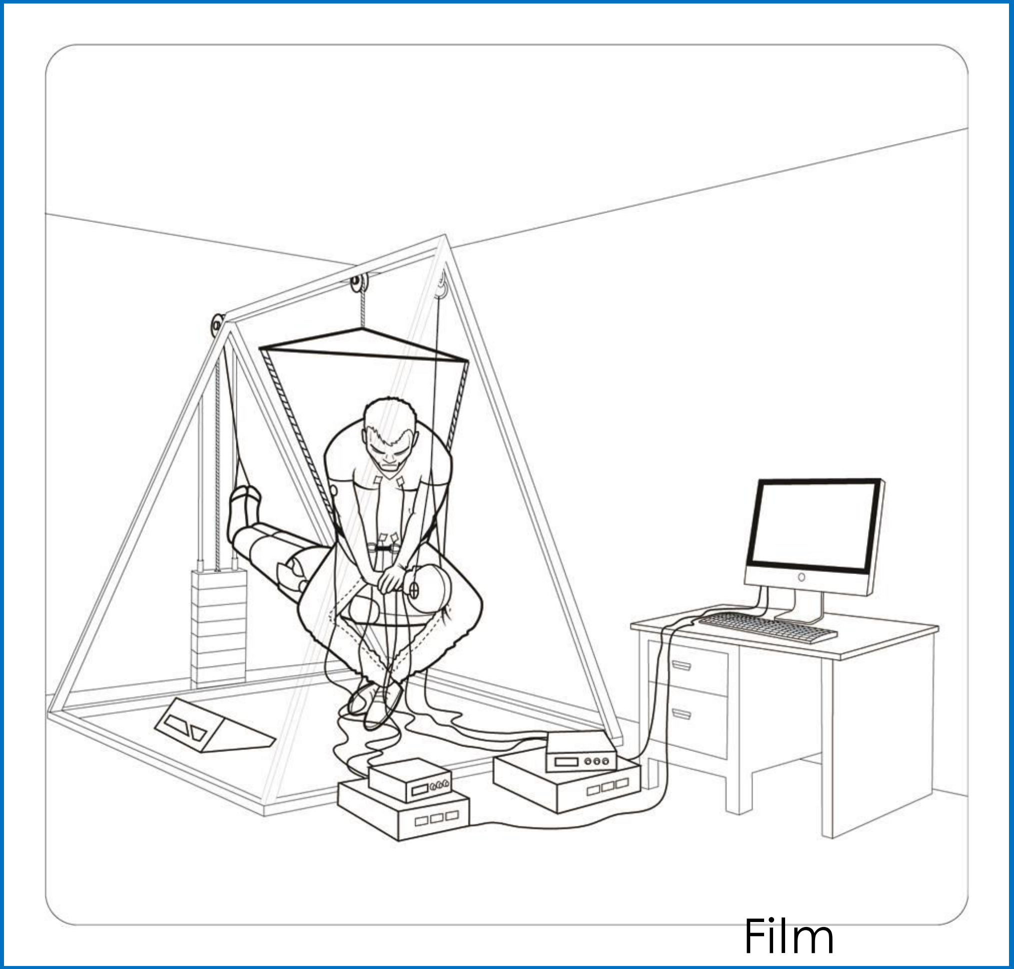
Hand stand

Reverse bear hug

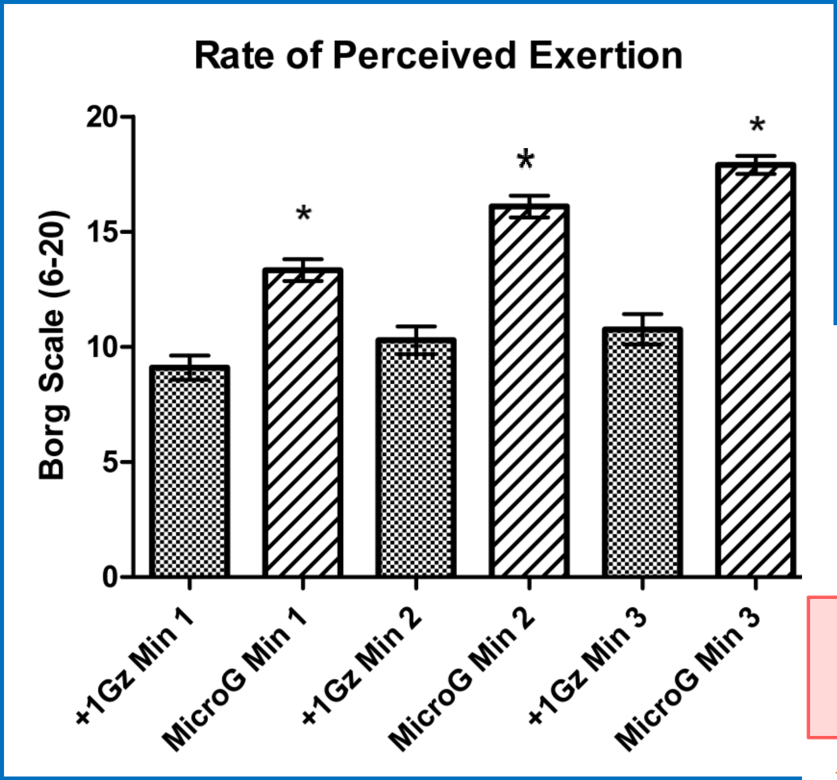
Evetts-Russomano

Movie

Evetts-Russomano MicroG CPR Method



Evetts-Russomano CPR Method – physically demanding

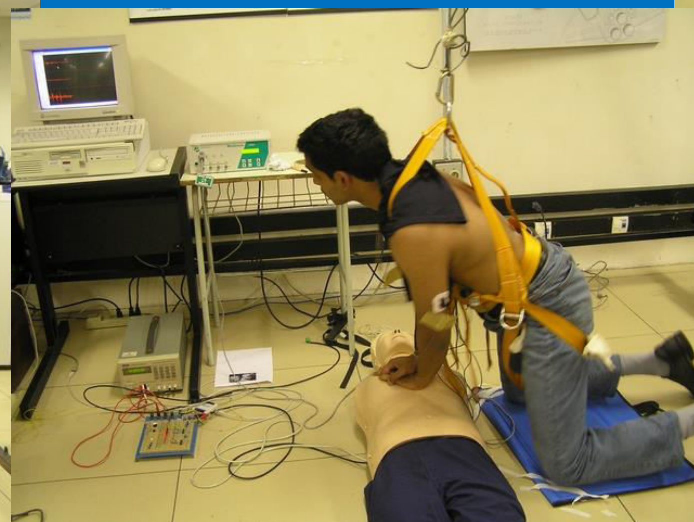


Mean ± SD * p < 0.001
MicroG vs 1G

	Time (minutes)		
	1	2	3
+1Gz			
Chest compression			
Depth (mm)	48.6 ± 0.48	48.4 ± 0.46	47.5 ± 0.40
Rate (compression. min^{-1})	103.7 ± 0.25	103.3 ± 0.24	102.2 ± 0.37
Massages per set (n)	30.3 ± 0.10	30.5 ± 0.14	31.1 ± 0.11
Borg Scale (6-20)	9.1 ± 0.53	10.3 ± 0.60	10.8 ± 0.66
Arm Flexion (°)			
Right	1.19 ± 0.20	1.23 ± 0.19	1.33 ± 0.22
Left	1.62 ± 0.19	1.47 ± 0.23	1.52 ± 0.22
Heart Rate (bpm)	110.9 ± 2.73	112.2 ± 3.57	114.8 ± 3.91
MicroG			
Chest compression			
Depth (mm)	45.7 ±0.53*	43.0 ±1.14**	41.4 ± 1.26**
Rate (compression. min^{-1})	104.5 ± 1.13	105.2 ± 0.99*	102.4 ± 1.43
Massages per set (n)	30.2 ± 0.32	30.2 ± 0.36	30.1 ± 0.54
Borg Scale	13.3 ± 0.47**	16.1 ± 0.47**	17.9 ±0.40**
Arm Flexion (°)			
Right	11.4 ± 1.85**	11.3 ± 1.86**	12.3 ± 1.76**
Left	14.6 ± 1.99**	14.8 ± 2.07**	14.7 ± 1.85**
Heart Rate (bpm)	153.9 ± 3.48**	168.2 ± 3.18**	174.5 ±2.79**

**Significantly different to +1Gz control at p<0.05, paired sample t-test*
***Significantly different to +1Gz control at p<0.001, paired sample t-test*

CPR in HypoG Simulation



Movie

CPR in Simulated HypoG – Female Data

n = 10

Female	Control		Planet X		Mars		Moon	
	1G	9.81m/s.s	0.7G	6.8m/s.s	0.38G	3.71m/s.s	0.16G	1.62m/s.s
	Mean	(±SD)	Mean	(±SD)	Mean	(±SD)	Mean	(±SD)
Mean DCC (mm)	44.6	2.2	42.0	4.5	36.2	5.8	31.1	6.4
Mean FCC (crp/min)	105.1	2.3	104.8	5.1	94.3	23.5	99.2	11.7
Angle Variation (º)	4.9	1.0	8.9	5.0	18.6	9.8	20.7	11.8
Load Variation (Kg)	0.0	0.0	13.4	2.0	20.4	3.7	23.6	6.3

CPR in Simulated HypoG – Male Data

n = 10

Male	Control		Planet X		Mars		Moon	
	1G	9.81m/s.s	0.7G	6.8m/s.s	0.38G	3.71m/s.s	0.16G	1.62m/s.s
	Mean	(±SD)	Mean	(±SD)	Mean	(±SD)	Mean	(±SD)
Mean DCC (mm)	47.3	0.8	45.8	2.1	45.3	1.4	44.6	1.2
Mean FCC (crp/min)	105.3	3.1	103.8	6.0	105.6	4.6	105.9	7.1
Angle Variation (º)	4.2	1.7	4.8	2.3	11.3	4.5	15.0	5.6
Load Variation (Kg)	0.0	0.0	13.1	5.0	25.0	9.9	30.9	5.3

A Preliminary Comparison Between Methods of Performing External Chest Compressions During Microgravity Simulation

MEHDI KORDI[1,2], RICARDO B. CARDOSO[1],
AND THAIS RUSSOMANO[1,2]

Aviation, Space, and Environmental Medicine • Vol. 82, No. 12 • December 2011

A comparison between the 2010 and 2005 basic life support guidelines during simulated hypogravity and microgravity

Extreme Physiology & Medicine

Thais Russomano[1,2*], Justin H Baers[1,2], Rochelle Velho[1], Ricardo B Cardoso[1], Alexandra Ashcroft[1,2],
Lucas Rehnberg[1], Rodrigo D Gehrke[1], Mariana K P Dias[1] and Rafael R Baptista[1]

Rehnberg L, Ashcroft A, Baers JH, Campos F, Cardoso RB, Velho R, Gehrke RD, Dias MKP, Baptista RR, Russomano T. *Three methods of manual external chest compressions during microgravity simulation.* Aviat Space Environ Med 2014; 85:687–93.

Journal of Exercise Physiologyonline

April 2016
Volume 19 Number 2

JEPonline

Official Research Journal of the American Society of Exercise Physiologists

ISSN 1097-9751

Is Weight a Pivotal Factor for the Performance of External Chest Compressions on Earth and in Space

Justin Baers[1], Rochelle Velho[1], Alexandra Ashcroft[1], Lucas Rehnberg[1], Rafael Baptista[1], Thais Russomano[1,2]

[1]MicrSgravity Center, Pontifical Catholic University of Rio Grande do Sul, Porto Alegre, Brazil, [2]Center of Human and Aerospace Physiological Sciences, School of Biomedical Sciences, Kings College London, London, United Kingdom

Contents lists available at ScienceDirect

Life Sciences in Space Research

journal homepage: www.elsevier.com/locate/lssr

A new method for the performance of external chest compressions during hypogravity simulation

Christina Mackaill[a,*], Gregori Sponchiado[b], Ana K. Leite[b], Paola Dias[b], Michele Da Rosa[f], Elliot J. Brown[d], Julio C.M. de Lima[c], Lucas Rehnberg[b,f], Thais Russomano[e,f]

Books Publish About News Contact

Author Panel Sign in Search

Open access peer reviewed chapter

Extraterrestrial CPR and Its Applications in Terrestrial Medicine

By Thais Russomano and Lucas Rehnberg

Submitted: December 12th 2016 Reviewed: June 27th 2017 Published: December 6th 2017
DOI: 10.5772/intechopen.70221

Home > Books > Resuscitation Aspects

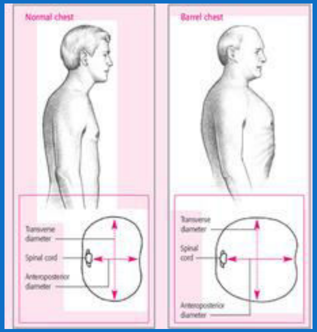
Free e-book linking to all the relevant literature on CPR in space and the terrestrial applications:

https://www.intechopen.com/books/resuscitation-aspects/extraterrestrial-cpr-and-its-applications-in-terrestrial-medicine

Spin-offs from Extraterrestrial CPR

- Small rescuer /weaker (child, female, old...) and a big patient

- Increased chest stiffness (diseases)



- Increased chest diameter (diseases, natural shape)

???

???

???

Van Gogh Project

Characteristic	Radial Artery Sample	Hyperemic Earlobe Sample
Discomfort	Painful	Pain Free
Potential Complications	Hematoma Hemorrhage Infection Wrist pain	Hemorrhage Cutaneous infection
Ease of Use	Requires trained medical personnel	Performed by non-medical personnel.
Potential Usage	Hospitals research	Hospitals, Private Clinics, Rural Centers, Aero medical Transport, ISS, Other space missions

Earlobe Arterialized Blood Collector (EABC)

PCT/BR2007/000157 (18/06/2007) / US12/665,433 (18/12/2009) - USA/ EP07719325.8 (08/01/2010) – Europe

The Earlobe Arterialized Blood Collector (EABC) was developed to enable collection of arterialized blood from the earlobe of astronauts by non-medically trained personnel, whilst minimizing risks of environmental contamination, infection and pain.

Method of Blood Collection with EABC

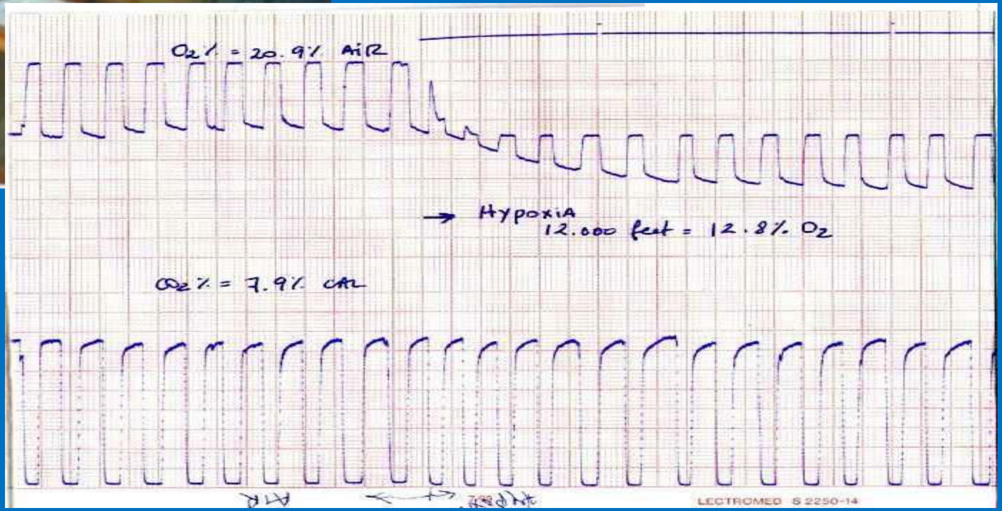
1. Arterialization

2. Cleaning

3. Collection

4. Analysis

Volunteers had samples from the radial artery and the earlobe arterialized blood collected simultaneously, after being in the HDT position and breathing for 15 min a 12.8% O_2 in N_2



Blood Collection

EABC vs Blood from the arterial side of the fistula

EABC

Fistula

Selected Publications - EABC

A Device for Sampling Arterialized Earlobe Blood in Austere Environments

Thais Russomano, Simon N. Evetts, Joao Castro, Marlise A. dos Santos, Jorge Gavillon, Dario F. G. Azevedo, John Whittle, Edward Coats, and John Ernsting

Aviation, Space, and Environmental Medicine • Vol. 77, No. 4 • April 2006

Assessment of an Earlobe Arterialized Blood Collector in Microgravity

T. Russomano[1,2], J. Whittle[2], G. Evetts[2], E. Coats[2], M. Vian[1], R. Cardoso[1], G. Dalmarco[1], R. Cambraia[1], and F. Falcao[1]

Aviation, Space, and Environmental Medicine • Vol. 80, No. 11 • November 2009

Clinical Validation of the Earlobe Arterialized Blood Collector

Felipe Falcão and Thais Russomano

Aviation, Space, and Environmental Medicine • Vol. 81, No. 11 • November 2010

Vaquer *et al. Extreme Physiology & Medicine* (2015) 4:5
DOI 10.1186/s13728-015-0025-x

Extreme Physiology & Medicine

RESEARCH Open Access

Operational evaluation of the earlobe arterialized blood collector in critically ill patients

Sergi Vaquer[1,5*], Jordi Masip[1], Gisela Gili[1], Gemma Gomà[1], Joan Carles Oliva[1], Alexandre Frechette[2], Simon Evetts[2], Thais Russomano[3,4] and Antonio Artigas[1]

Abstract

Background: The new Earlobe Arterialized Blood Collector (EABC®) is a minimally invasive prototype system able to perform capillary blood collection from the earlobe (EL) with minimal training and risk. This system could improve medical emergency management in extreme environments. Consequently, a prospective validation study was designed to evaluate operational performance of the EABC® in a cohort of critically ill patients.

Methods: Arterialized capillary blood was sampled from the EL of 55 invasively ventilated patients using the EABC® following a validated procedure. Operational characteristics such as the number of cuts and cartridges required, sampling failure/success ratio, bleeding complications, storage requirements and other auxiliary aspects were recorded. Result turnaround laboratory times (TAT) were compared with published references.

Vaquer *et al. Annals of Intensive Care* 2014, **4**:11
http://www.annalsofintensivecare.com/content/4/1/11

Annals of Intensive Care
a SpringerOpen Journal

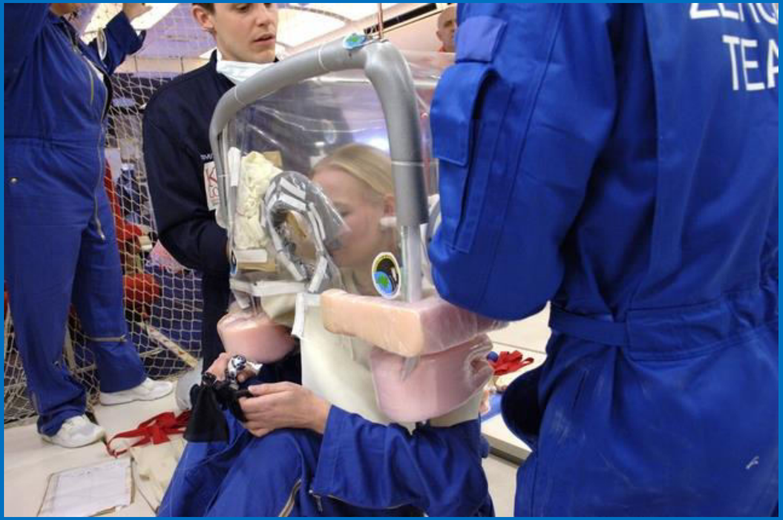
RESEARCH Open Access

Earlobe arterialized capillary blood gas analysis in the intensive care unit: a pilot study

Sergi Vaquer[1*], Jordi Masip[1], Gisela Gili[1], Gemma Gomà[1], Joan Carles Oliva[1], Alexandre Frechette[2], Simon Evetts[2], Thais Russomano[3] and Antonio Artigas[1]

Science Museum London - Exhibition

Van Gogh Project



Van Gogh Project

Video

Knowledge Transfer from Space Medicine to Global Health on Earth

Prof. Thais Russomano, MD, MSc, PhD

Senior Lecturer & Deputy Director of the Master's Degree in Space Physiology and Health, CHAPS, KCL

Co-Founder & CEO, InnovaSpace Ltd, UK

Co-Founder & CMO, ISMC (USA)

www.thaisrussomano.com - www.innovaspace.org

KING'S College LONDON

InnovaSpace
Space Without Borders