10TH ANNIVERSARY XTREME EVEREST

Ultimate team collaboration: Xtreme Everest 10 years on

Kay Mitchell

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CASE MEDICINE | INSTITUTE OF SPORT EXERCISE & HEALTH | CHiP University of Southampton Centre for Human Integrative Physiology | Duke University | University of Southampton | UCL

Introduction

- Introduction to Xtreme Everest
- Some views on teamwork in science and research
- Caudwell Xtreme Everest 2007 – a case study of critical care research teamwork
- What can we learn from Xtreme Everest ten years on

Introduction to Xtreme Everest

Xtreme Everest Oxygen Research Consortium – a collaboration between (founding partner) University College London, University of Southampton and Duke University, North Carolina, USA

CASE Medicine

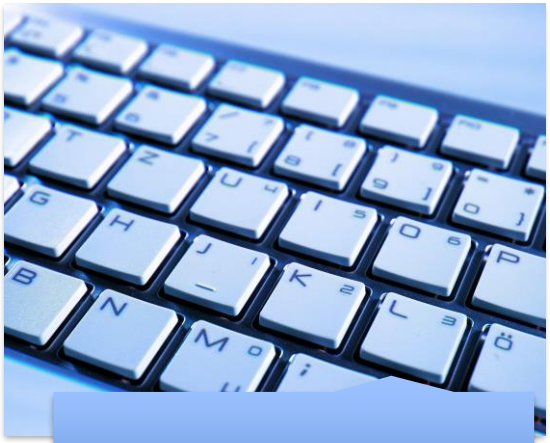
- UCL Centre for Altitude, Space and Extreme Environment Medicine
- Founded at the end of the nineties
- Clinicians and scientists with specialist interests and training in medicine and the physiology of extreme environments.
- Aimed to use the study of human systems exposed to these environments to increase our understanding of critically ill patients.

One approach to critical care research

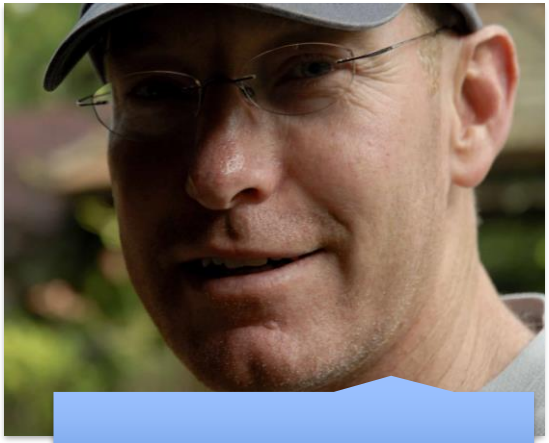
(Image shown with permission)

Use models

Laboratory



Computer

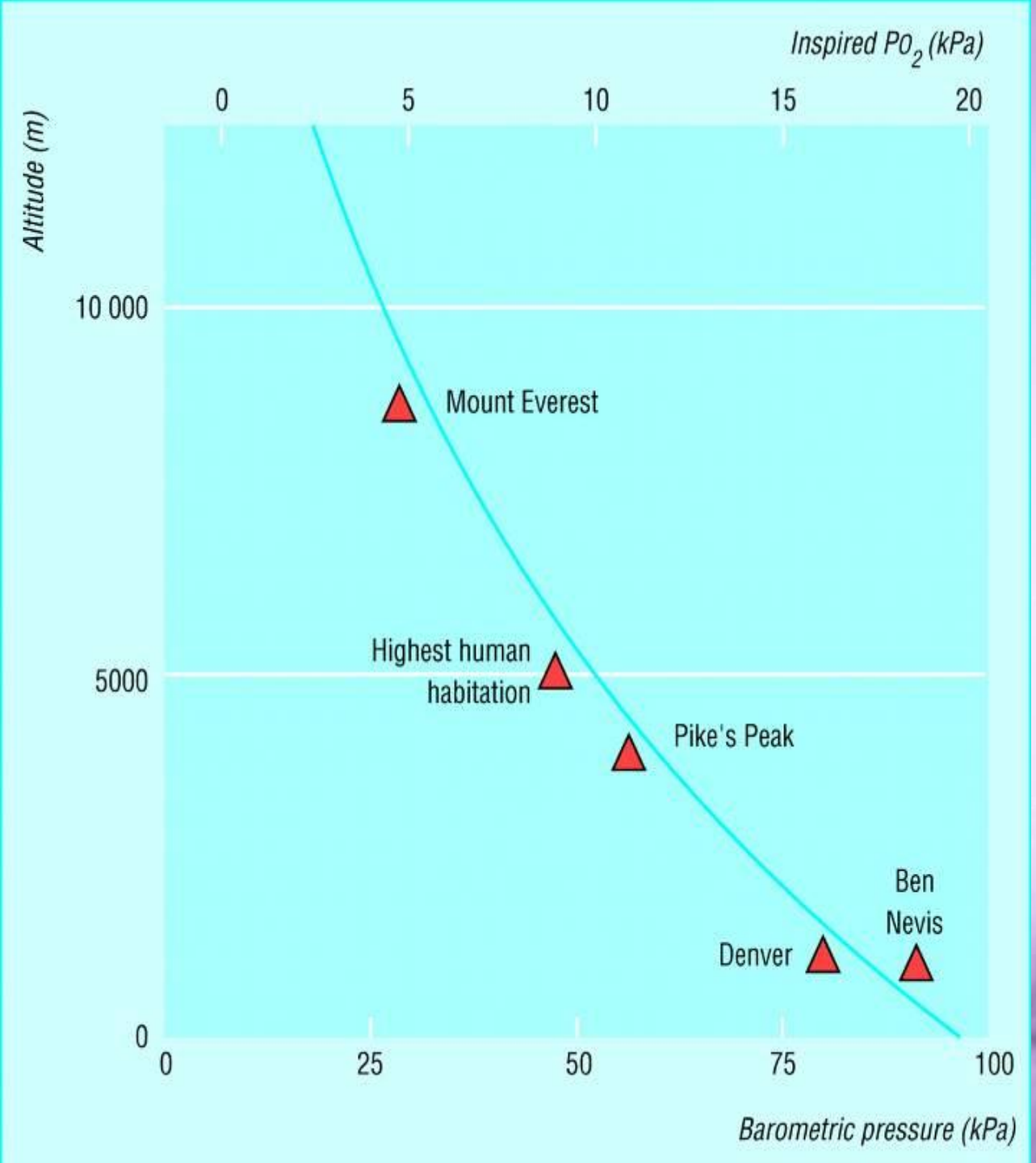


Healthy volunteers

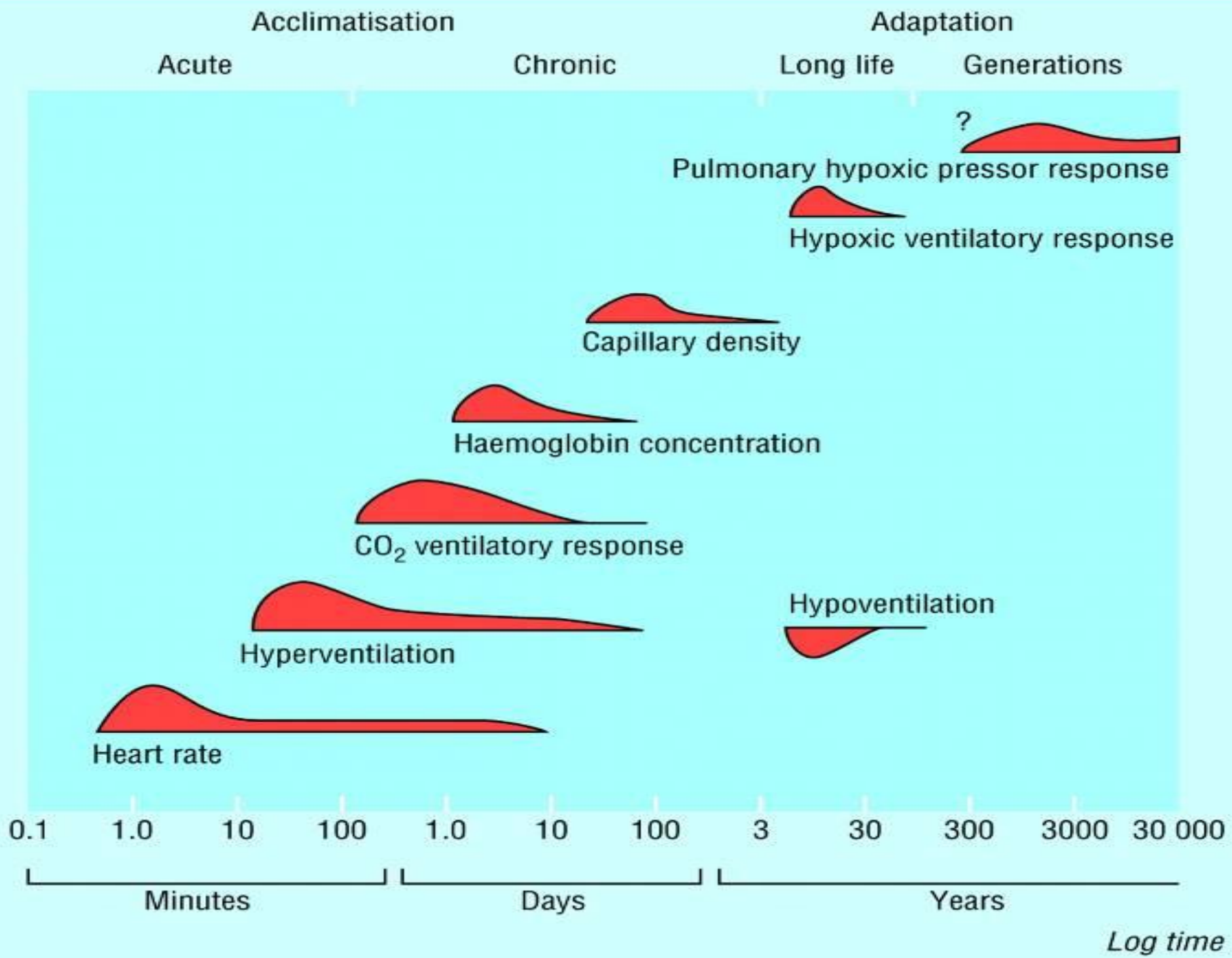

Lode

Why research at high altitude?

- Model for understanding critical illness
- Exercising volunteers at high altitude are experiencing similar physiological challenges to critically ill patients


Inspired PO_2 (kPa)
0
5
10
15
20
Altitude (m)
10 000
5000
0
Mount Everest
Highest human habitation
Pike's Peak
Ben Nevis
Denver
0
25
50
75
100
Barometric pressure (kPa)

Acute hypoxia

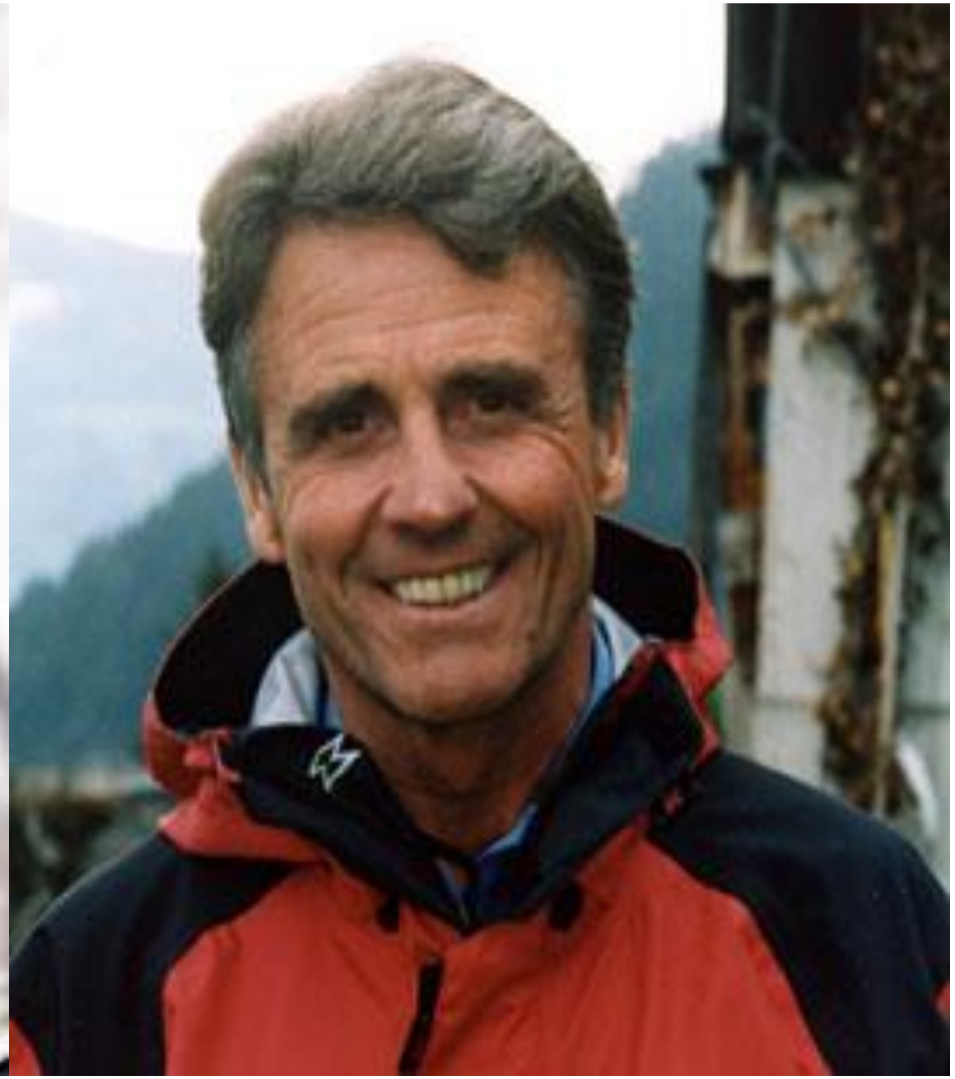

Acclimatisation
Adaptation
Acute
Chronic
Long life
Generations
?
Pulmonary hypoxic pressor response
Hypoxic ventilatory response
Capillary density
Haemoglobin concentration
CO_2 ventilatory response
Hypoventilation
Hyperventilation
Heart rate
0.1
1.0
10
100
1.0
10
100
3
30
300
3000
30 000
Minutes
Days
Years
Log time

Why Research on Everest?

- Traditional explanation of adaptation to altitude fails to explain differences in performance between individuals

Edmund Hillary and Tenzing Norgay

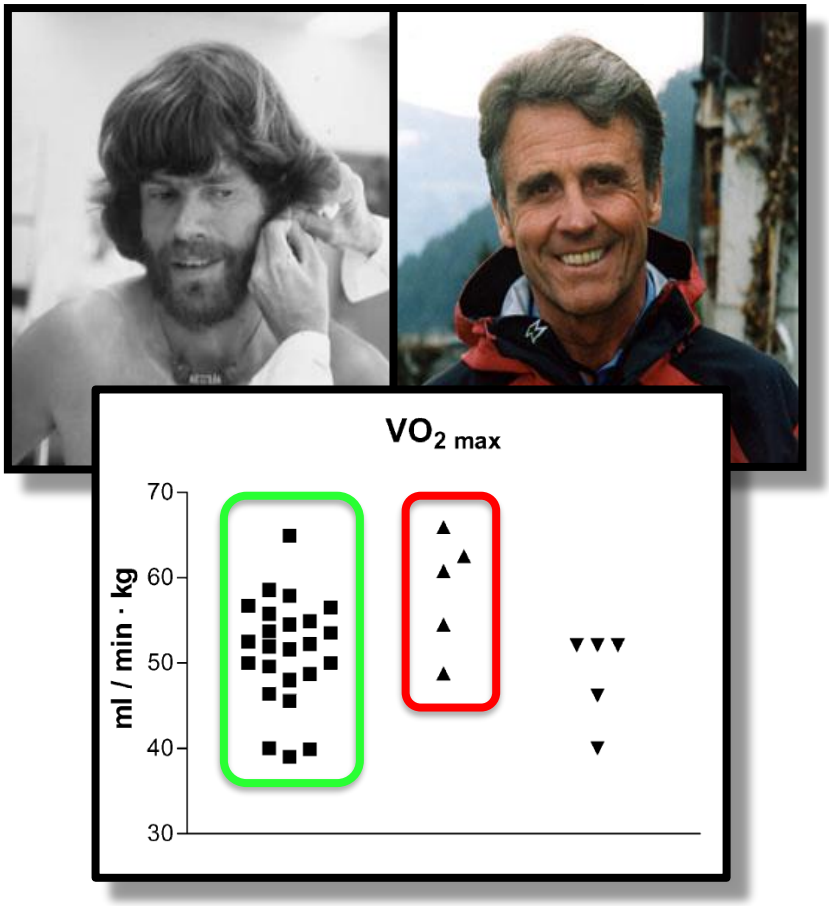
29th May 1953

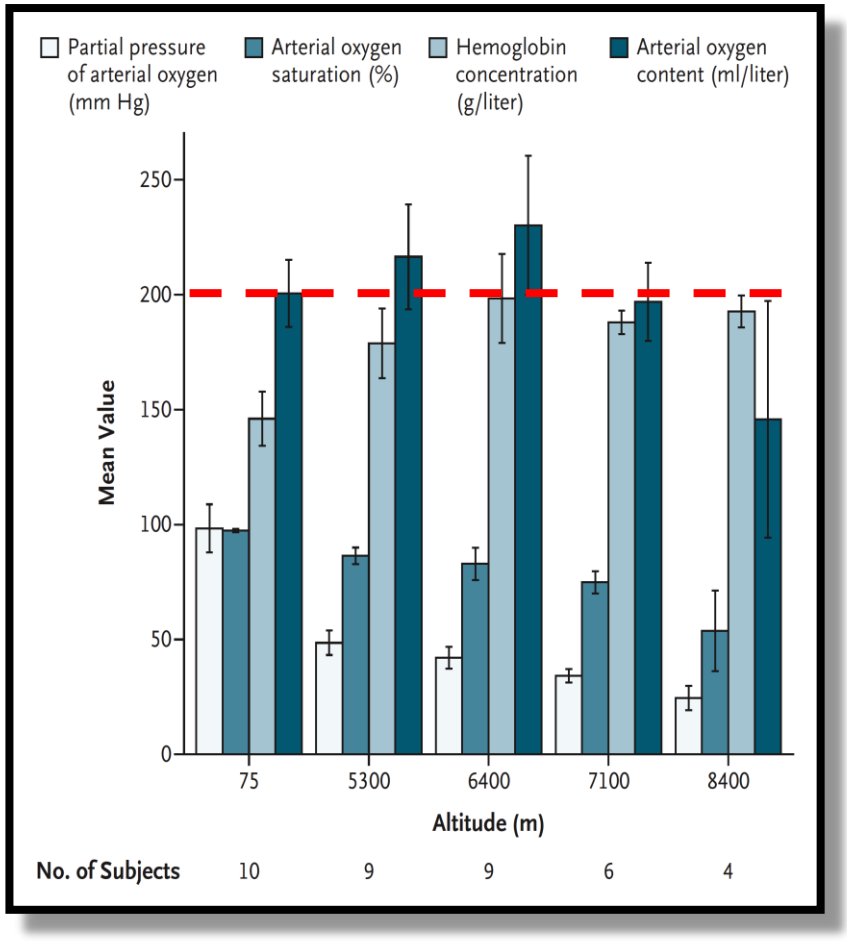


Reinhold Messner and
Peter Habeler

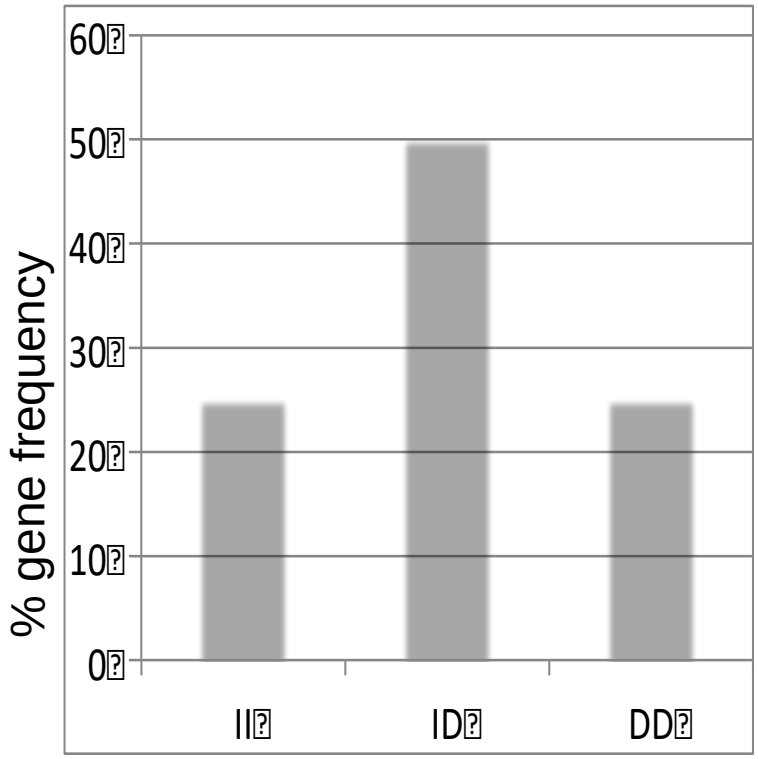
8th May 1978

Performance ≠ O_2 delivery

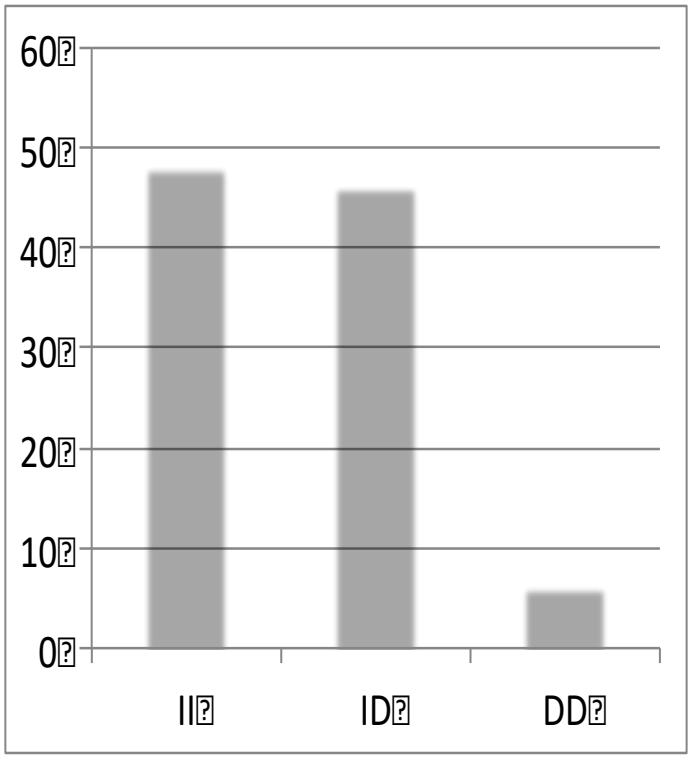




ACE gene



Normal distribution

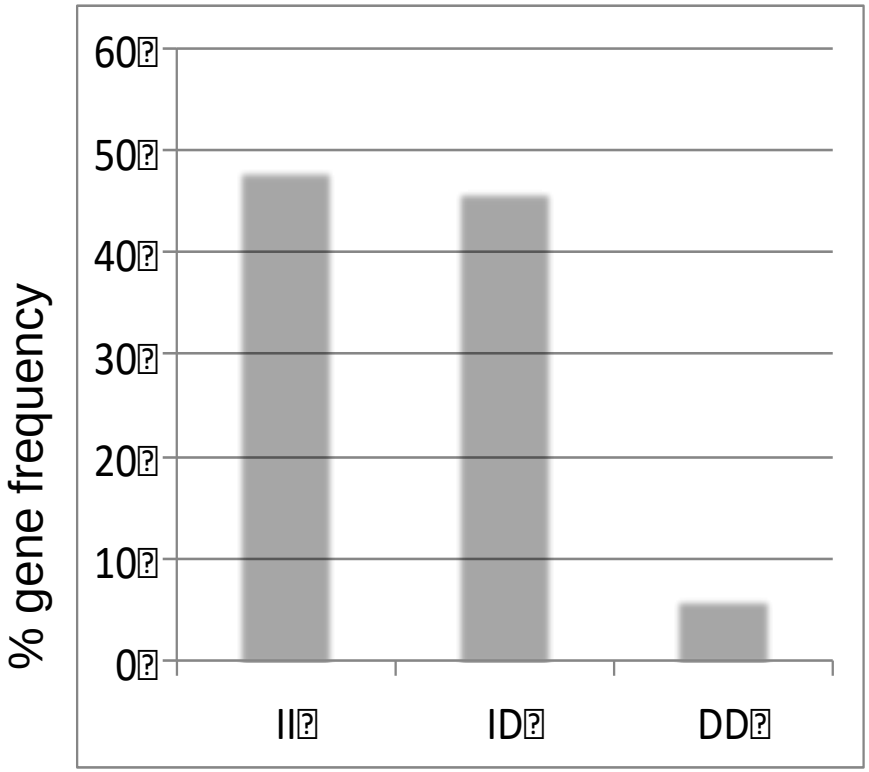


Elite High Altitude Climbers

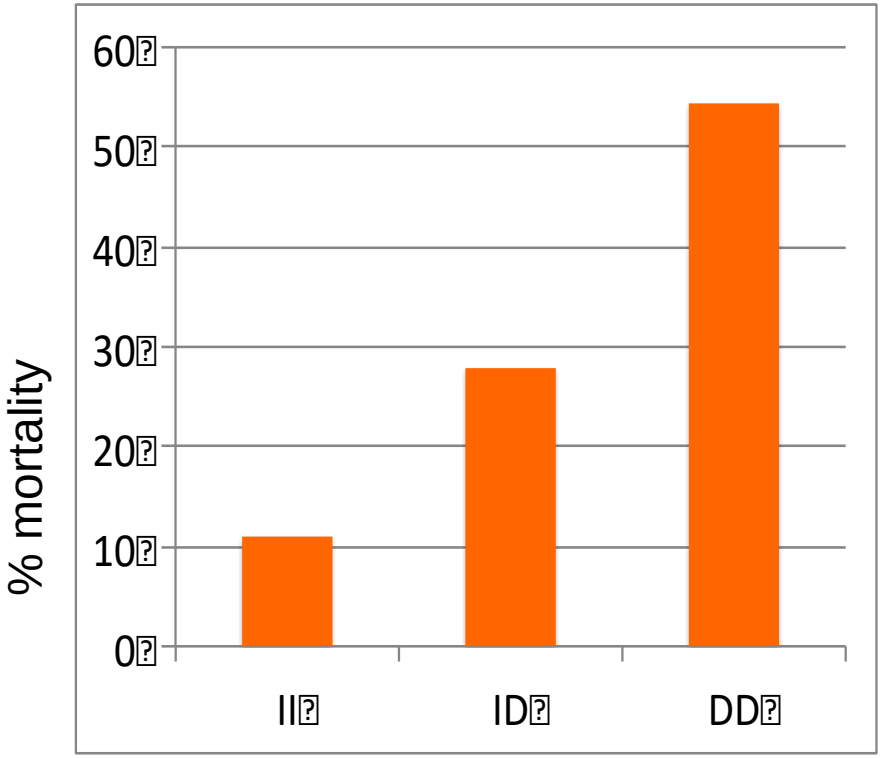
Montgomery *Nature* 1998

Marshall *AJRCCM* 2002

ACE gene



Elite High Altitude Climbers



Critically Ill Patients (ARDS)

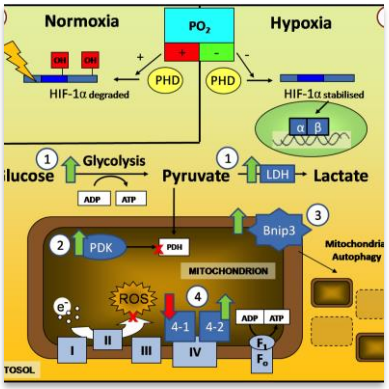
Montgomery *Nature* 1998
Marshall *AJRCCM* 2002

Areas for investigation

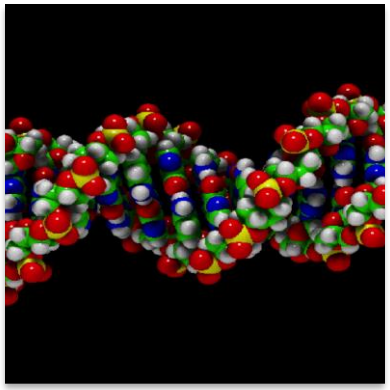
Metabolic function

Microcirculatory function

Mitochondrial function



Genetic differences



Some views on teamwork in science and research

Teamwork in healthcare

A systematic concept analysis in 2008 concluded teamwork to be "a dynamic process involving two or more healthcare professionals with complementary backgrounds and skills, sharing common health goals and exercising concerted physical and mental effort in assessing, planning, or evaluating patient care”

Xirychis et al 2008

“The Scientist”, Culotta 1993

- No single person is able to contribute all the necessary expertise to solve increasingly complex problems
- Research teams need a shared mission, a good organisational structure, and plenty of interpersonal interactions, says John Kutzbach
- Collaborations with an element of fun are most productive

Science of team science (SciTS)

- "Mapping a research agenda for the science of team science", Research Evaluation, 2011

- "An increase in cross-disciplinary, collaborative team science initiatives over the last few decades has spurred interest by multiple stakeholder groups in empirical research on scientific teams, giving rise to an emergent field referred to as the science of team science (SciTS)."

- NIHR and NIH supported

Improving teamwork in anaesthesia and critical care - BJA, Brindley 2014

"To create a high-performing team we must understand the reality of the multidisciplinary team, how human factors impact on their performance, and the nature of how the different disciplines work, interact, and train."

Five teamwork principles

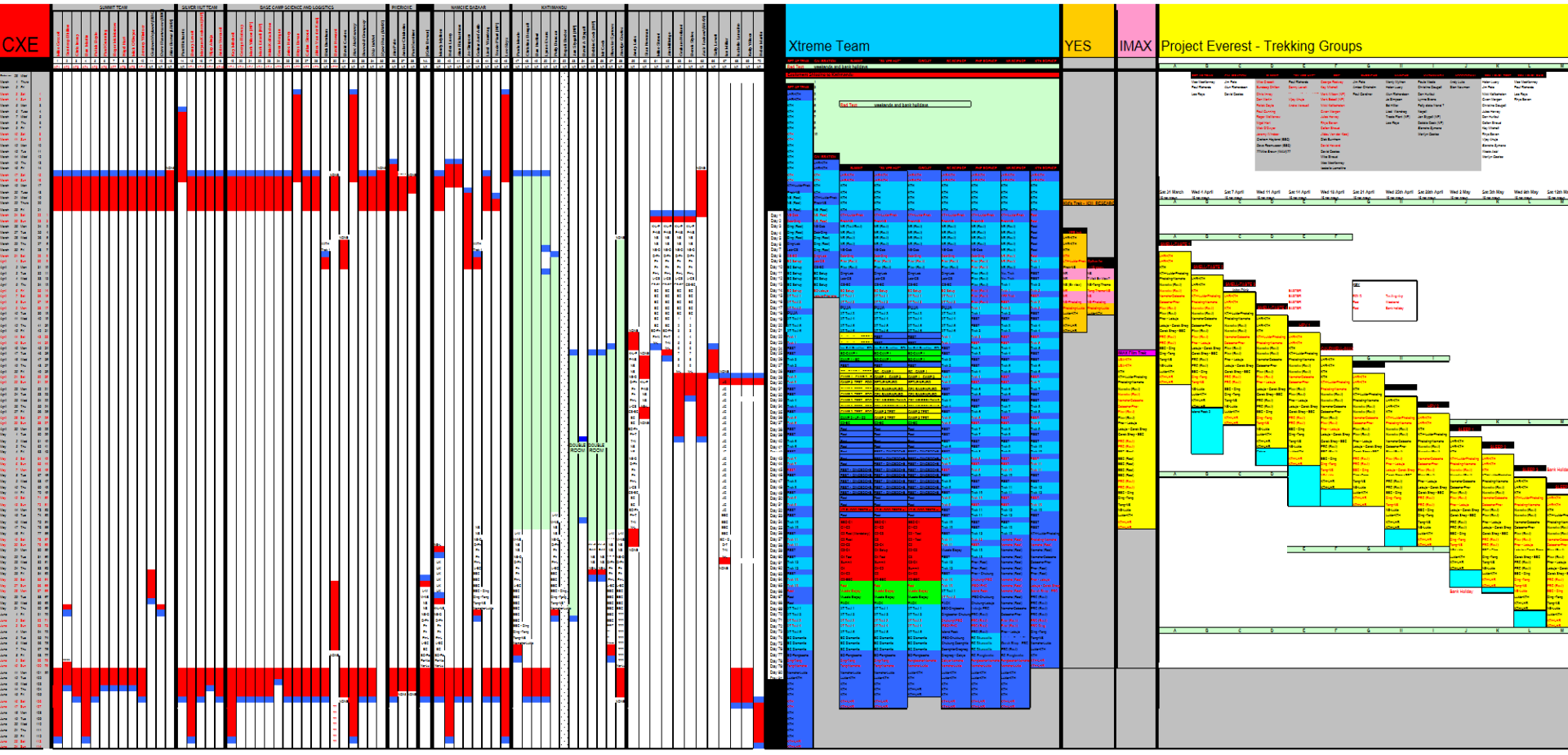
- Leadership
- Coordination
- Mutual support
- Situation monitoring
- Communication

Caudwell Xtreme Everest 2007 – a case study of critical care research teamwork

Using Brindley's five teamwork principles

Leadership

Coordination (Project Management)



Investigators – 45

- Medics, anaesthetists, surgeons and GPs
- Nurses, physiotherapists and dieticians
- Physiologists
- Research scientists
- Medical students
- Gap year students

Subjects – 222

- 24 investigators
- 198 trekkers included:

✓ Record producer

✓ Dry stone waller

✓ Retired fighter pilot

Sherpa colleagues

Climbing

Laboratory and trekking

Logistics team

Equipment

- >26 metric tonnes
- >1000 containers
- >1m items

Including

- Devices
- Disposables
- Medical kit
- Computers
- Generators and inverters
- Food treats


646
635

Power!


HONDA
EU 10i
HONDA
EU INVERTER 20i
Max. Power 2000W
HONDA

Mutual support

Situation Monitoring

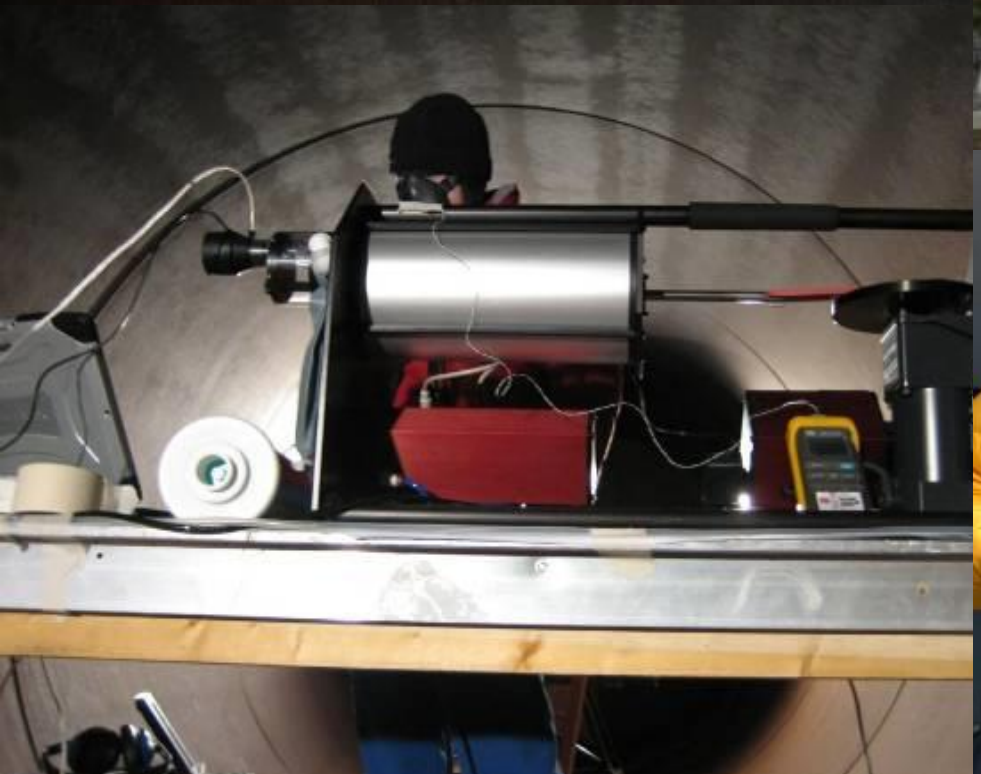
- Safety
- Science
- (Summit)
- Expedition Management Group
- +/- Climbing Management Group

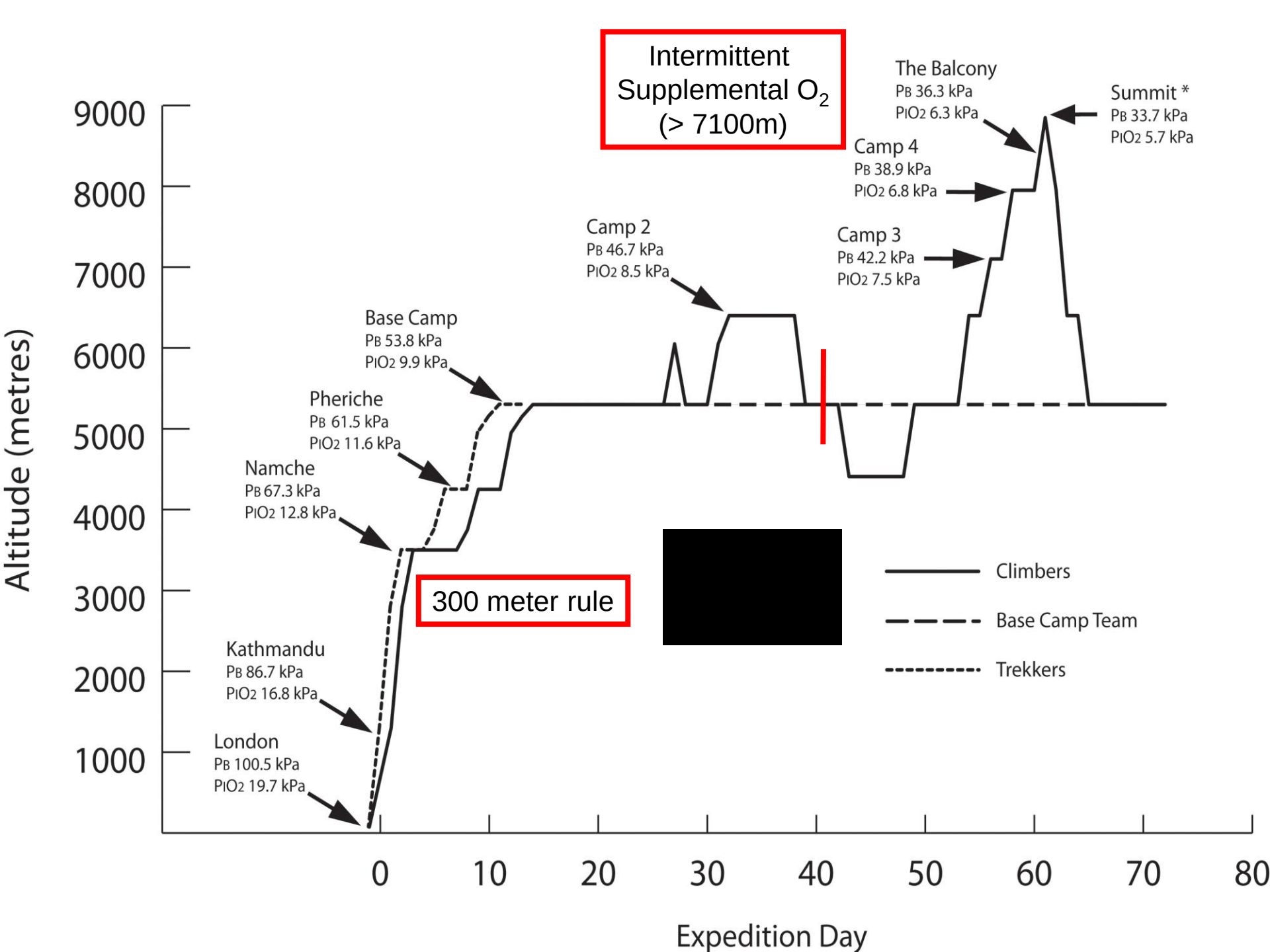
- Laboratory Management
- Medical management
- Publicity
- Use of photographs
- Scientific publications

Delivering robust data

- Feasibility
- Reliability
- Validation
  - Pilot data

- Sea-level studies
  - Physiology laboratory
  - Environmental chamber
  - Hypobaric Chamber
- Field studies
  - Alps 2005 & 2006
  - Cho Oyu 2005
  - Cho Oyu 2006




Intermittent Supplemental O_2 (> 7100m)
The Balcony
PB 36.3 kPa
PIO2 6.3 kPa
Summit *
PB 33.7 kPa
PIO2 5.7 kPa
Camp 4
PB 38.9 kPa
PIO2 6.8 kPa
Camp 2
PB 46.7 kPa
PIO2 8.5 kPa
Camp 3
PB 42.2 kPa
PIO2 7.5 kPa
Base Camp
PB 53.8 kPa
PIO2 9.9 kPa
Pheriche
PB 61.5 kPa
PIO2 11.6 kPa
Namche
PB 67.3 kPa
PIO2 12.8 kPa
300 meter rule
Kathmandu
PB 86.7 kPa
PIO2 16.8 kPa
London
PB 100.5 kPa
PIO2 19.7 kPa
Climbers
Base Camp Team
Trekkers
Altitude (metres)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
10
20
30
40
50
60
70
80
Expedition Day

Communication

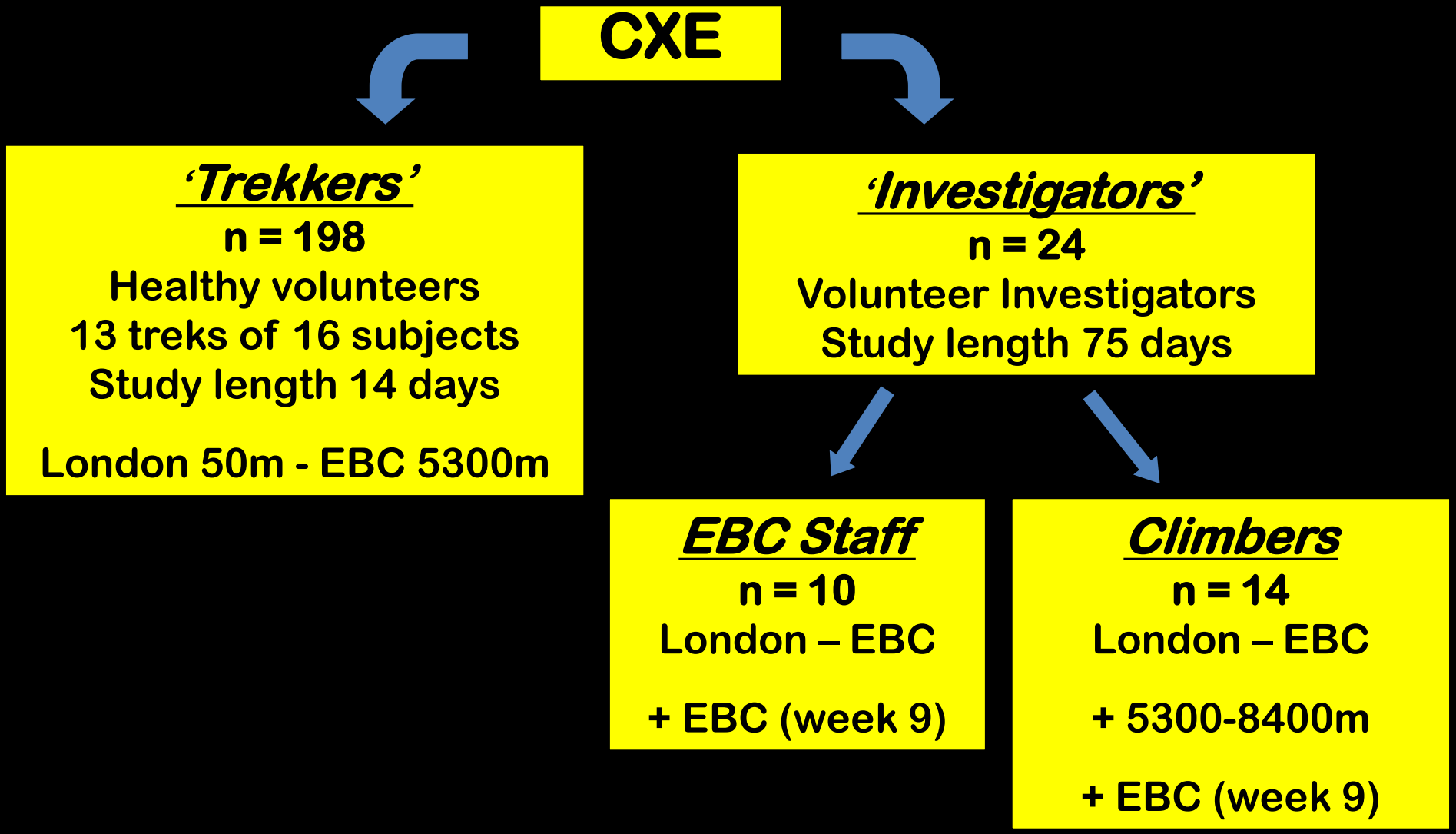
Internal

- Set up and project development
- Inter-laboratory communications –using satellite phones and two way radios
- Overcoming isolation from family and friends

External

- Website (using BGAN)
- Press and public relations
- Journal articles

Study groups



Phenotypic Variables

CXE

Trekkers (n = 198)

VO_2 max and AT
Oxygen efficiency
Hb and Hct
Inflammatory markers
Muscle NIRS
Brain NIRS
Spirometry
Neurocognitive testing
Weight change
Sleep studies
Smell and taste
Retinal Photography

[Pulmonary vascular response]

Investigators (n =24)

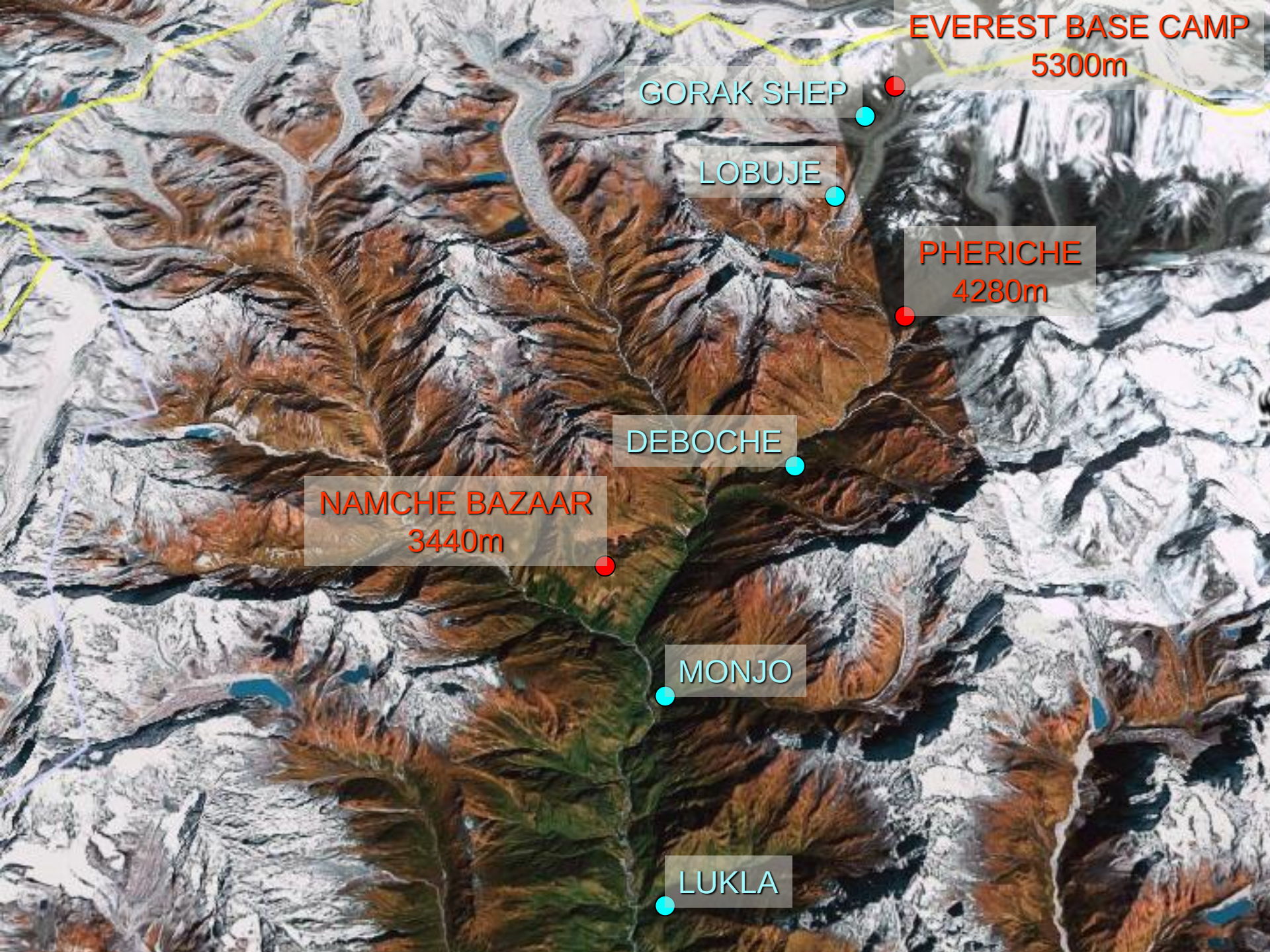
In addition…

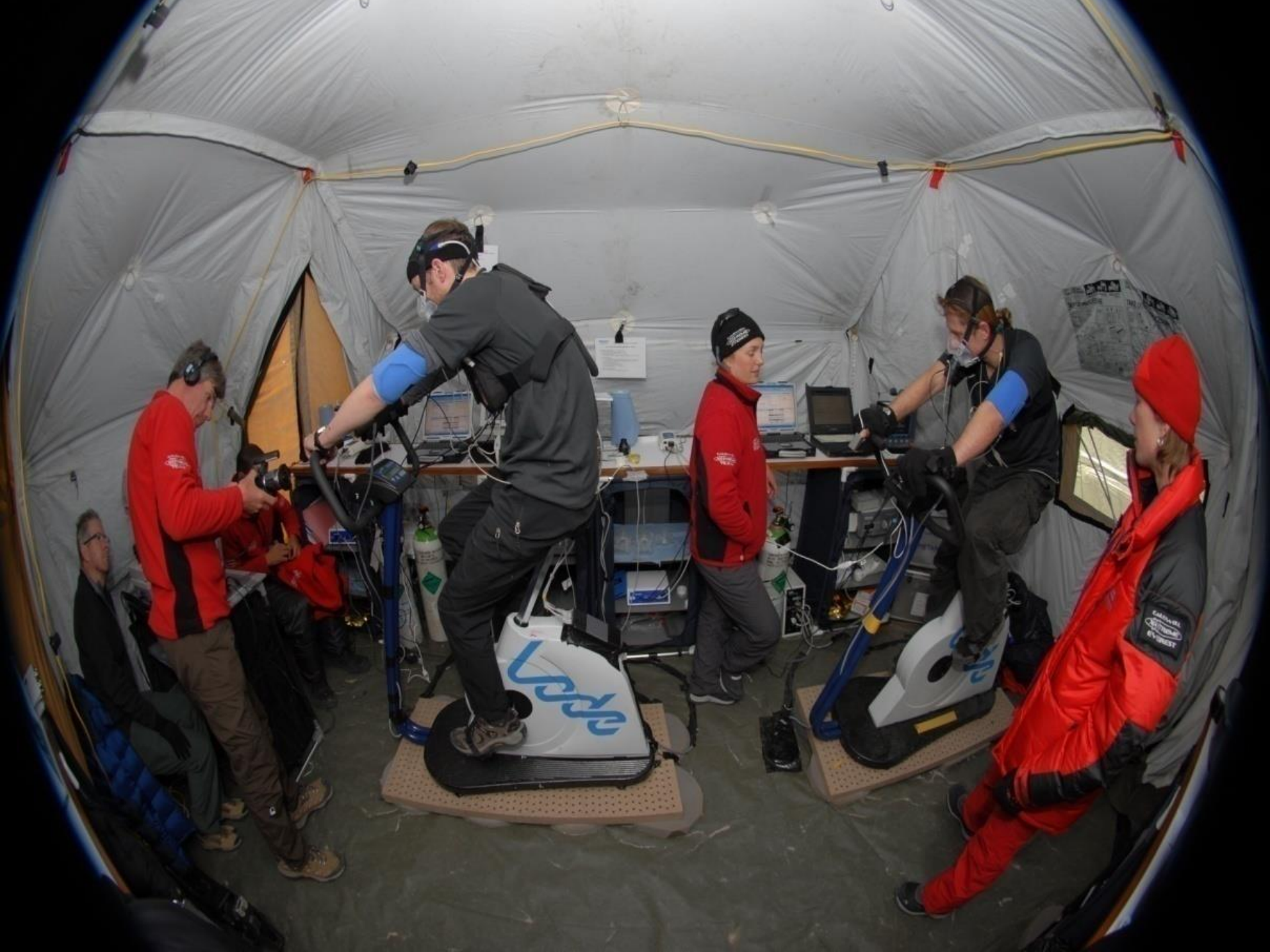
Arterial blood gases
Skeletal muscle biopsies
Sublingual microcirculation
Gastric tonometry / DO_2
Cerebral Doppler
Body composition change
Resting metabolic rate
Nutritional studies
Structural brain MRI
MR spectroscopy
Eye saccades
Laryngoscopy
Thromboelastography

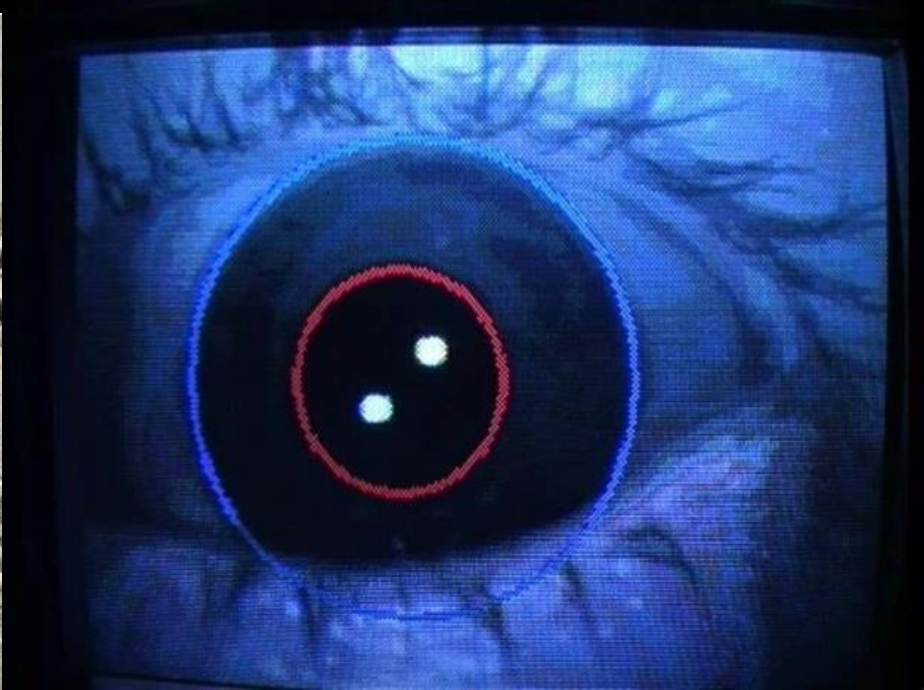
Research expedition model

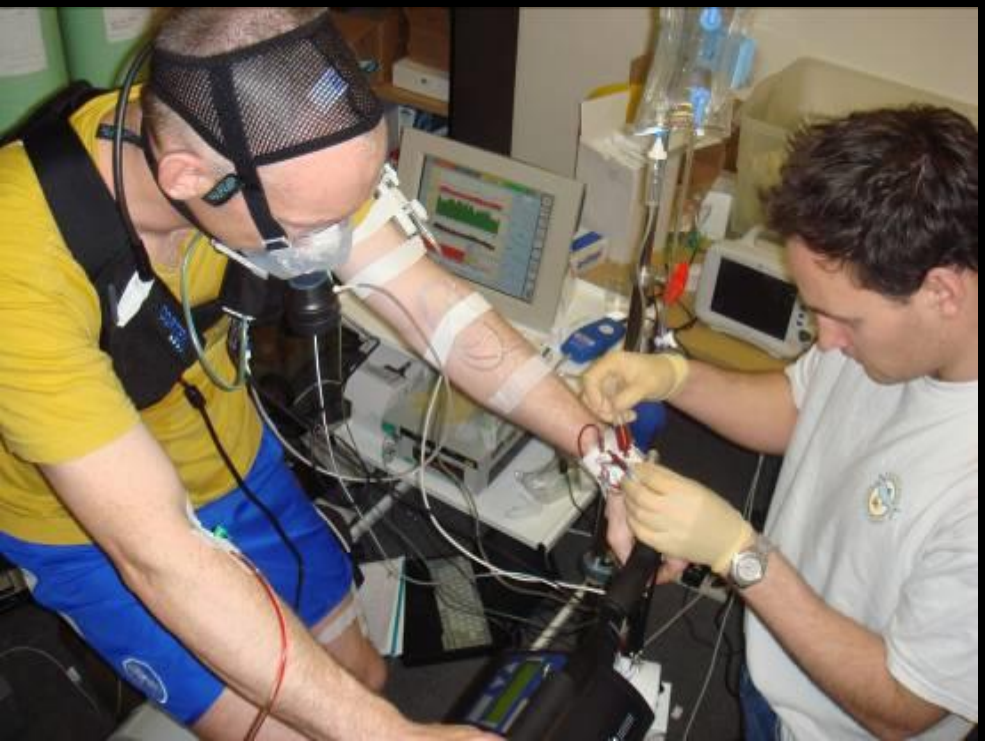
- Repeated measures of a core data set
- as environmental oxygen decreased
- on ascent to Everest Base Camp,
- and in sub group, to Summit


9N-AET
Yeti Airlines
9N-AET


EVEREST BASE CAMP
5300m
GORAK SHEP
LOBUJE
PHERICHE
4280m
DEBOCHE
NAMCHE BAZAAR
3440m
MONJO
LUKLA








SUMMIT
8848m
Balcony (8400m)
South Col (7950m)
CAMP 4
CAMP 3
Western Cwm (6400m)
CAMP 2
CAMP 1
EBC
Image © 2007 DigitalGlobe
Image © 2007 TerraMetrics
© 2007 Europa Technologies
©2007


Lode


nny Grocott
62
116


EXTREME
EVEREST


61
79.3


CAUDWELL
XTREME
EVEREST

Success?

- Safety
  - All significant illness evacuated safely with good outcome
  - 8 turned back, 4 evacuations
- Science
  - >93% of planned testing completed
  - Reliable and valid measurements
  - Largest controlled human physiology experiment at altitude
  - Highest measurements of several variables
- Climbing success
  - 190/198 trekkers to basecamp
  - 25 climbers to summit (8 doctors, 2 cameramen, 15 sherpas)

What can we learn from Xtreme Everest ten years on?

Xtreme Everest Oxygen Research Consortium

12 research studies

- Cho Oyu 2005
- Cho Oyu 2006
- Caudwell Xtreme Everest 2007
- Young Everest Study 2007
- CXE 2009
- Xtreme Alps 2010
- Bedford School 2012
- **Simulated Altitude Study 2012**
- **EMC2 2012/3**
- XE2 2013
- YES 2 2013
- XEX 2017

High-altitude physiology and pathophysiology: implications and relevance for intensive care medicine

Michael Grocott, Hugh Montgomery and Andre Vercueil

Centre for Altitude, Space and Extreme Environment Medicine (CASE Medicine), UCL Institute of Human Health and Performance, Ground Floor, Charterhouse Building, UCL Archway Campus, Highgate Hill, London, N19 5LW, UK

Corresponding author: Michael Grocott, mike.grocott@ucl.ac.uk

Published: 1 February 2007
This article is online at http://ccforum.com/content/11/1/203

Critical Care 2007, **11**:203 (doi:10.1186/cc5142)

Exp Physiol 95.3 pp 463–470

Experimental Physiology – *Review Article*

SUBJECT AREAS:
CHEMICAL BIOLOGY
MEDICAL RESEARCH
PHYSIOLOGY

OPEN

The role of nitrogen oxides in human adaptation to hypoxia

Denny Z. Levett[1]*, Bernadette O. Fernandez[2]*, Heather L. Riley[2], Daniel S. Martin[1], Kay Mitchell[1], Carl A Leckstrom[2], Can Ince[3], Brian J. Whipp[2], Monty G. Mythen[1], Hugh E. Montgomery[1], Mike P. Grocott[1]* & Martin Feelisch[2]*, for the Caudwell Extreme Everest Research Group

SCIENTIFIC REPORTS

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Arterial Blood Gases and Oxygen Content in Climbers on Mount Everest

Michael P.W. Grocott, M.B., B.S., Daniel S. Martin, M.B., Ch.B., Denny Z.H. Levett, B.M., B.Ch., Roger McMorrow, M.B., B.Ch., Jeremy Windsor, M.B., Ch.B., and Hugh E. Montgomery, M.B., B.S., M.D., for the Caudwell Xtreme Everest Research Group*

Variation in human performance in the hypoxic mountain environment

Daniel S. Martin, Denny Z. H. Levett, Mike P. W. Grocott and Hugh E. Montgomery

University College London Institute for Human Health and Performance, Charterhouse Building, UCL Archway Campus, Highgate Hill, Archway, London N19 5LW, UK

Caudwell Xtreme Everest: a field study of human adaptation to hypoxia

Mike Grocott[1], Alan Richardson[2], Hugh Montgomery[1] and Monty Mythen[1]

[1]Centre for Altitude, Space and Extreme Environment Medicine (CASE Medicine), UCL Institute of Human Health and Performance, Ground Floor, Charterhouse Building, UCL Archway Campus, Highgate Hill, London, N19 5LW, UK
[2]Chelsea School, University of Brighton, Hillbrow, Denton Road, Eastbourne BN20 7SR, UK

Corresponding author: Monty Mythen, montymythen@btinternet.com

Published: 1 August 2007
This article is online at http://ccforum.com/content/11/4/151

Critical Care 2007, **11**:151 (doi:10.1186/cc5921)

Anaesthesia
Journal of the Association of Anaesthetists of Great Britain and Ireland
Anaesthesia, 2011, 66, pages 348–353 doi:10.1111/j.1365-2044.2011.

ORIGINAL ARTICLE

A novel ambulatory closed circuit breathing system for during exercise

R. C. N. McMorrow,[1,2] J. S. Windsor,[3,4] M. G. Mythen,[5,6] M. P. W. Grocott[7,8] and the Caudwell Xtreme Everest Research Group*

Original article

The Young Everest Study: effects of hypoxia at high altitude on cardiorespiratory function and general well-being in healthy children

E Scrase,[1] A Laverty,[1] J C D Gavlak,[1] S Sonnappa,[2] D Z H Levett,[3] D Martin,[3] M P W Grocott,[3] J Stocks[2]

The FASEB Journal • Research Communication

Changes in sublingual microcirculatory flow index and vessel density on ascent to altitude

Daniel S. Martin[1], Peter Goedhart[2], Andre Vercueil[1,3], Can Ince[2], Denny Z. H. Levett[1] and Mike P. W. Grocott[1] for the Caudwell Xtreme Everest Research Group

[1]*UCL Centre for Altitude, Space and Extreme Environment Medicine (CASE Medicine), Portex Unit, Institute of Child Health, 30 Guilford Street, London WC1N 1EH, UK*
[2]*Department of Translational Physiology, Academic Medical Center, University of Amsterdam, Meibergdreef 9, 1105 AZ Amsterdam, The Netherlands*
[3]*King's College Hospital, Denmark Hill, London SE5 9RS, UK*

OPEN ACCESS Freely available online

PLoS one

Cardiac response to hypobaric hypoxia: persistent changes in cardiac mass, function, and energy metabolism after a trek to Mt. Everest Base Camp

Oliver J. Rider,[†] Denny Z. H. Levett,[‡] Damian J. Tyler,[*,†] Jane M. Francis,[†] Stefan Neubauer,[†] Michael P. W. Grocott,[‡] and Kieran Clarke,[*] for the Caudwell Xtreme Everest Research Group

[*]Department of Physiology, Anatomy, and Genetics and [†]The University of Oxford Centre for Clinical Magnetic Resonance Research, University of Oxford, Oxford, UK; and [‡]University College

The Effect of High-Altitude on Human Skeletal Muscle Energetics: ^{31}P-MRS Results from the Caudwell Xtreme Everest Expedition

Available online http://cctorum.com/content/13/S5/S7

Lindsay M. Edwards[1,2*¤a], Andrew J. Murray[1¤b], Damian J. Tyler[1,2], Graham J. Kemp[3], Cameron J. Holloway[2], Peter A. Robbins[1], Stefan Neubauer[2], Denny Levett[4], Hugh E. Montgomery[4,5], Mike P. Grocott[4], Kieran Clarke[1], Caudwell Xtreme Everest Research Group

rd, Oxford, Oxfordshire, United Kingdom, 2 The Oxford Centre for Clinical Magnetic Resonance , 3 School of Clinical Sciences, University of Liverpool, Liverpool, Merseyside, United Kingdom, rsity College London, London, United Kingdom, 5 Institute for Human Health and Performance,

Research

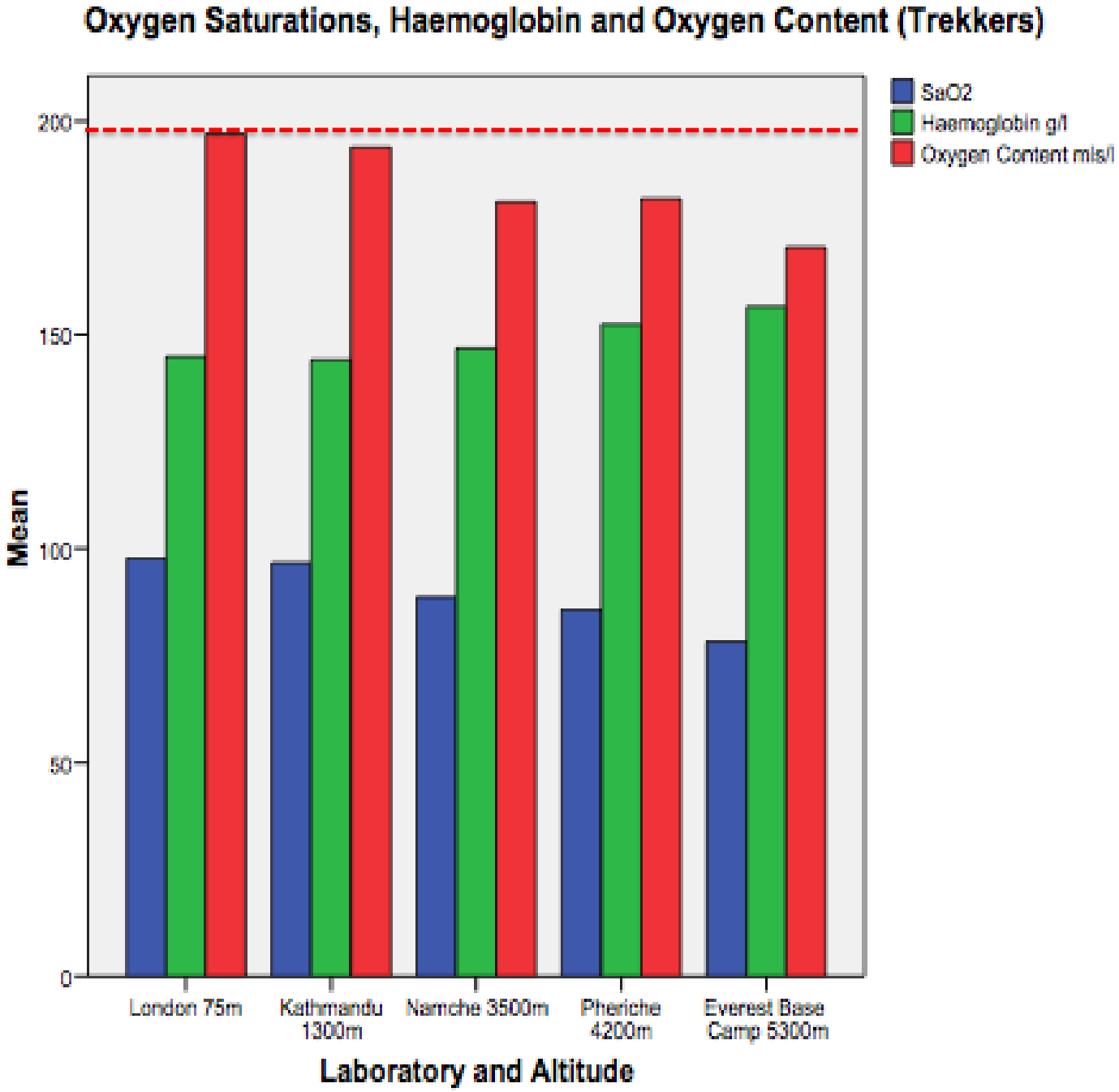
Changes in skeletal muscle oxygenation during exercise measured by near-infrared spectroscopy on ascent to altitude

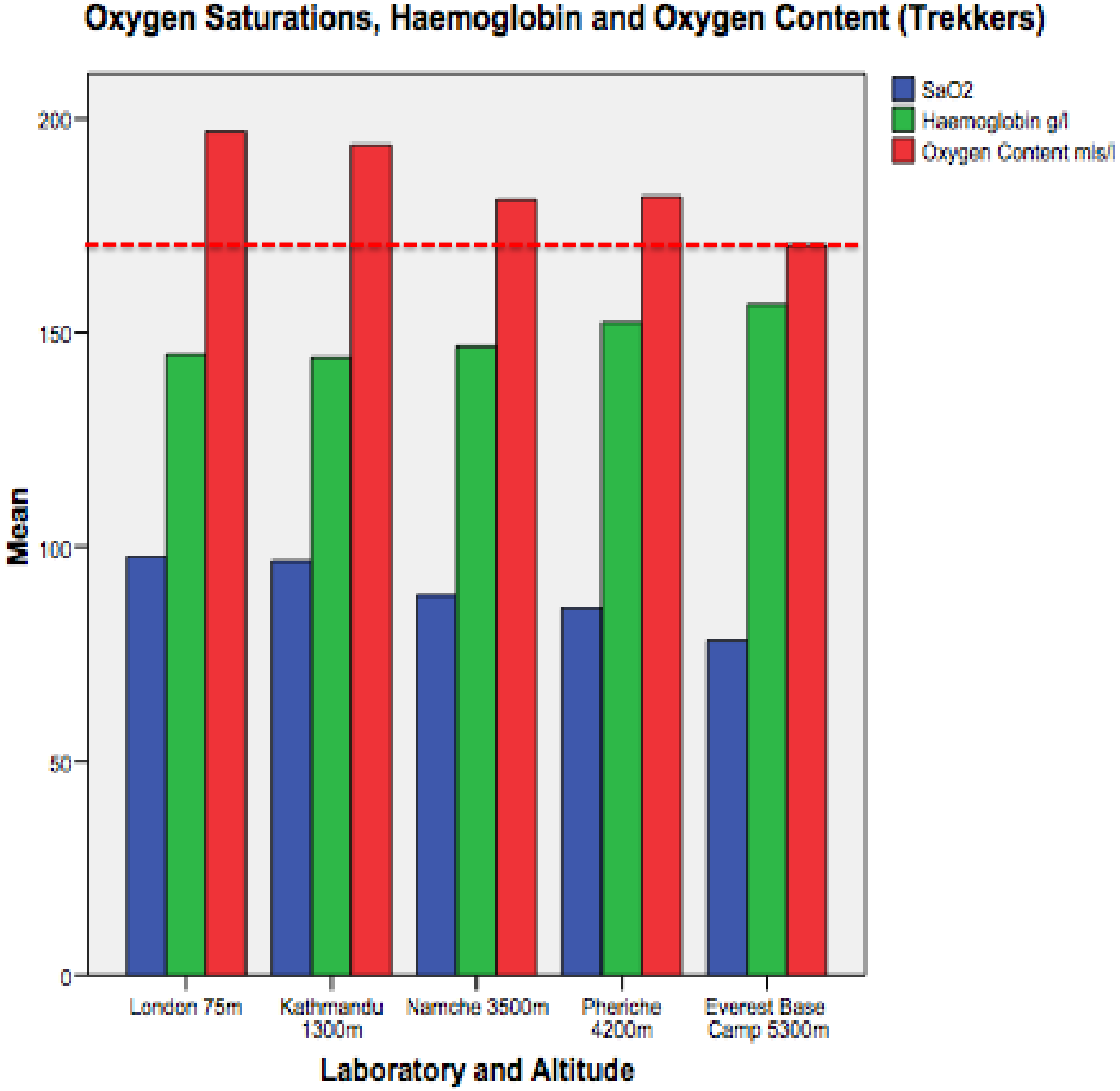
Daniel S Martin[1], Denny ZH Levett[1], Michael Mythen[1,2] and Mike PW Grocott[1], for the Caudwell Xtreme Everest Research Group

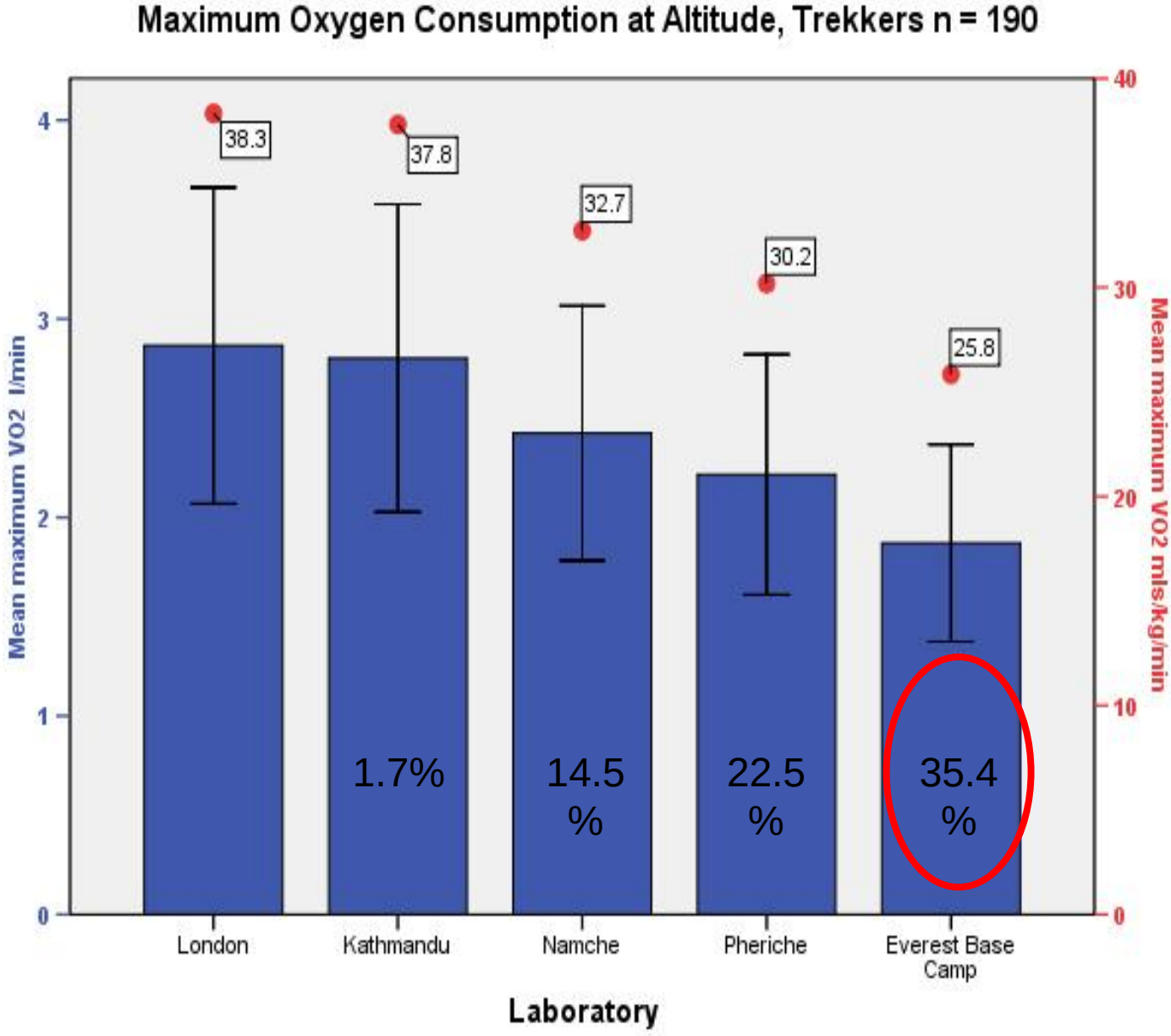
Pubmed search – 22nd May 2017

- 34 listed articles
  - Cho Oyu 2006 - 1
  - CXE - 26
  - CXE 2009 – 1
  - Xtreme Alps – 2
  - XE 2 – 3
  - Miscellaneous – 1

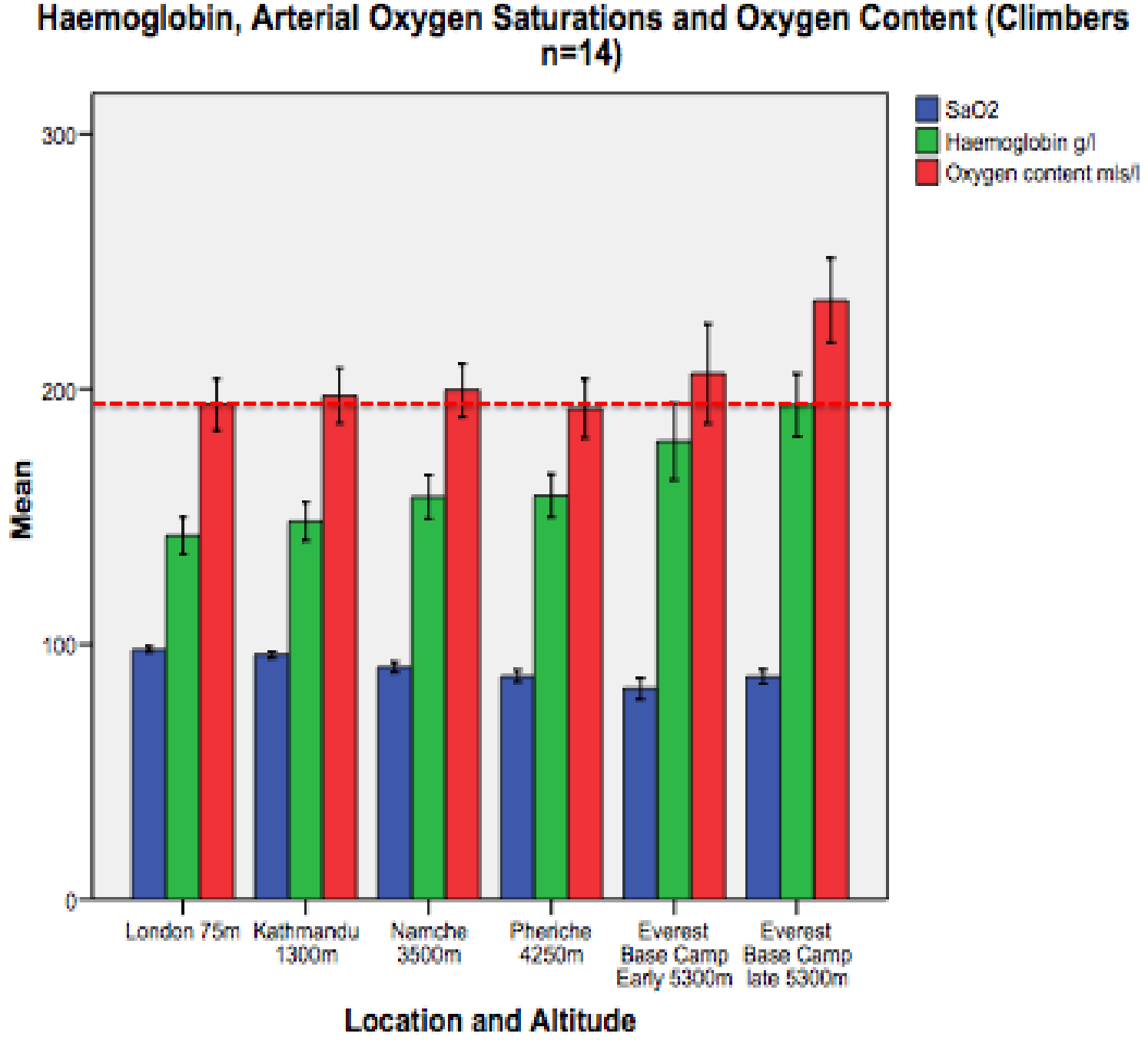
Does not include
numerous invited reviews

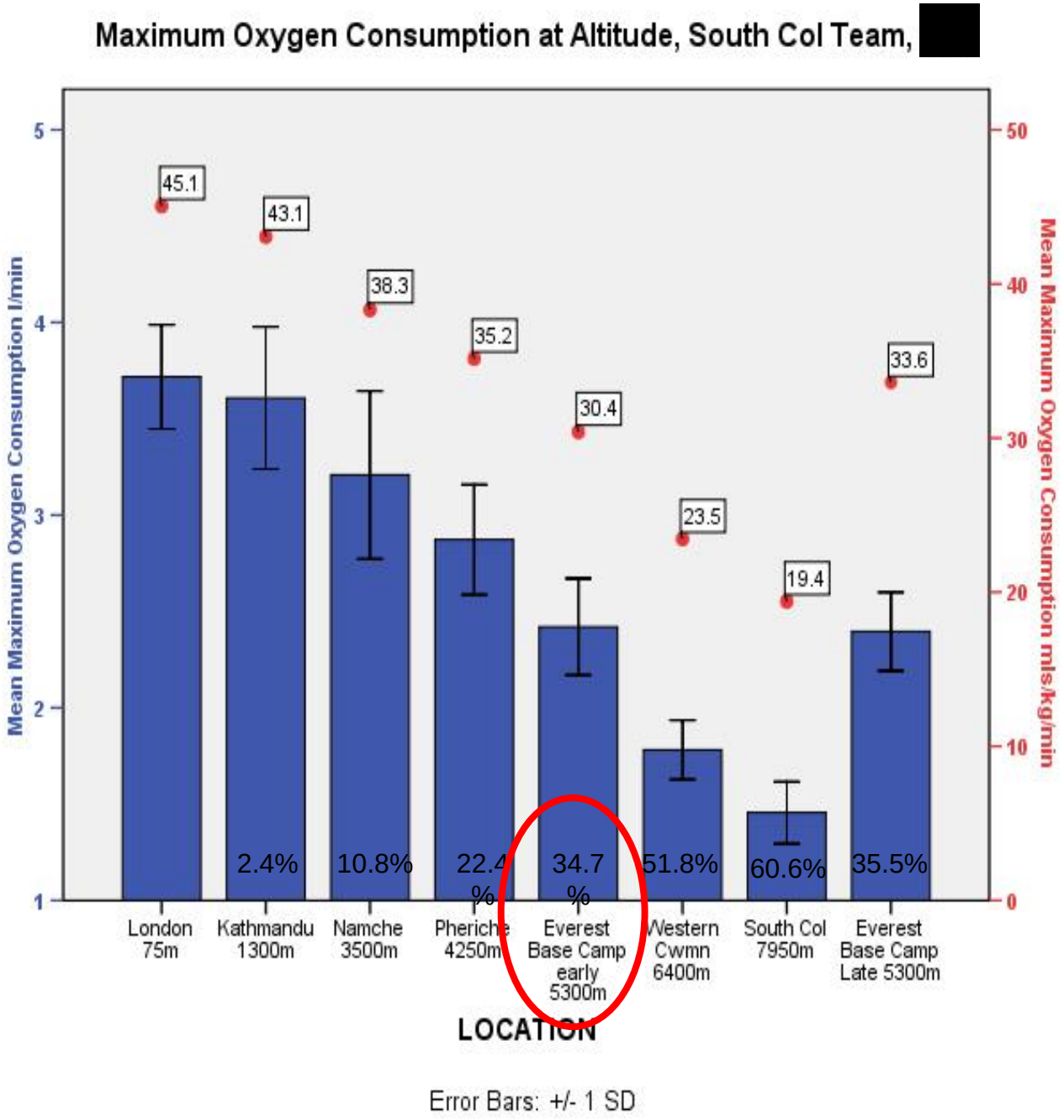

Oxygen Saturations, Haemoglobin and Oxygen Content (Trekkers)
SaO2
Haemoglobin g/l
Oxygen Content mls/l
Mean
200
150
100
50
0
London 75m
Kathmandu 1300m
Namche 3500m
Pheriche 4200m
Everest Base Camp 5300m
Laboratory and Altitude

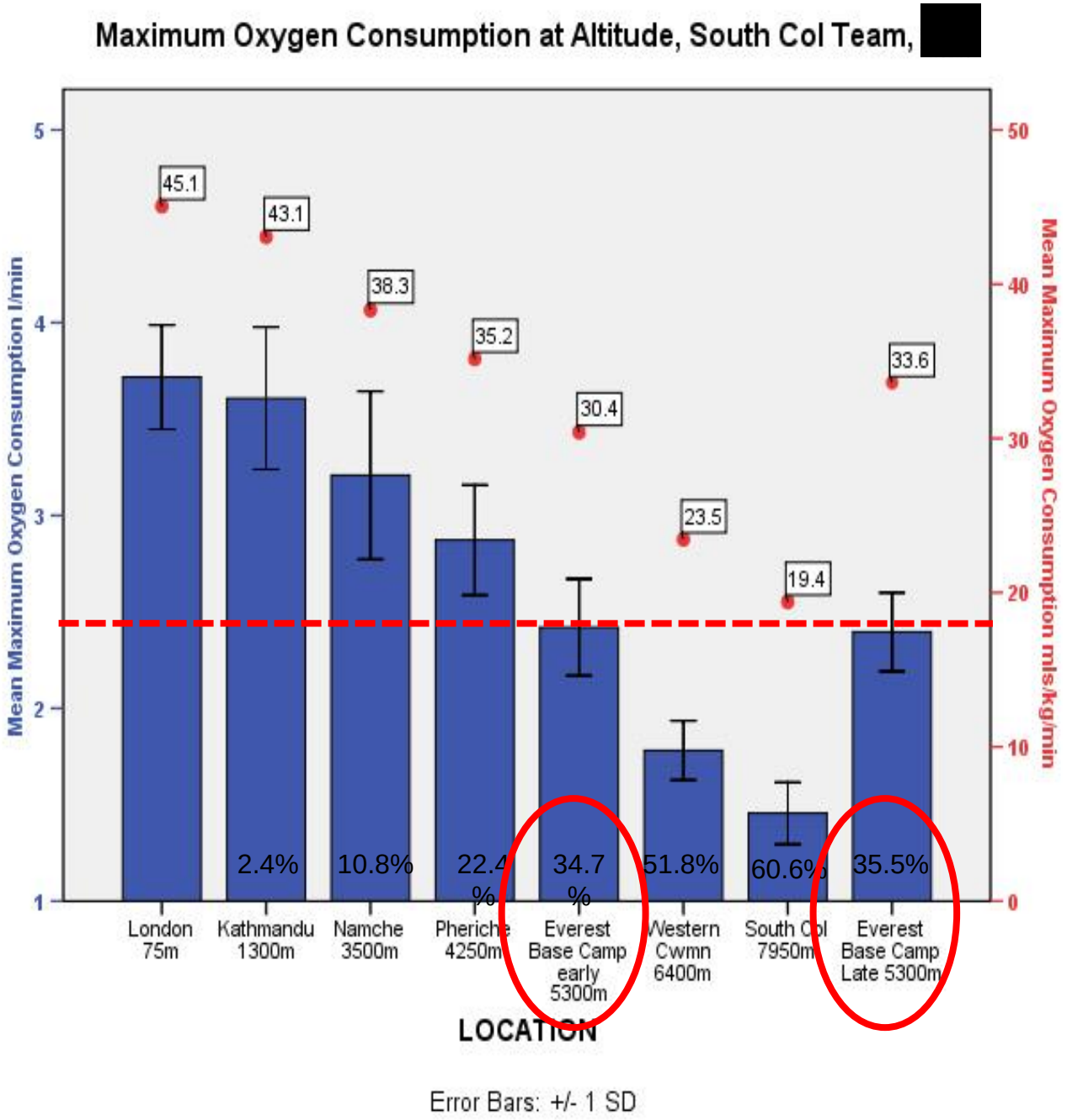

Oxygen Saturations, Haemoglobin and Oxygen Content (Trekkers)
SaO2
Haemoglobin g/l
Oxygen Content mls/l
Mean
200
150
100
50
0
London 75m
Kathmandu 1300m
Namche 3500m
Pheriche 4200m
Everest Base Camp 5300m
Laboratory and Altitude


Maximum Oxygen Consumption at Altitude, Trekkers n = 190
Mean maximum VO2 l/min
Mean maximum VO2 mls/kg/min
38.3
37.8
32.7
30.2
25.8
1.7%
14.5 %
22.5 %
35.4 %
London
Kathmandu
Namche
Pheriche
Everest Base Camp
Laboratory
Error Bars: +/- 1 SD

VO_2 max at 7950m


Haemoglobin, Arterial Oxygen Saturations and Oxygen Content (Climbers n=14)
SaO2
Haemoglobin g/l
Oxygen content mls/l
300
200
100
0
Mean
London 75m
Kathmandu 1300m
Namche 3500m
Pheriche 4250m
Everest Base Camp Early 5300m
Everest Base Camp late 5300m
Location and Altitude


Maximum Oxygen Consumption at Altitude, South Col Team, [redacted]
Mean Maximum Oxygen Consumption l/min
Mean Maximum Oxygen Consumption mls/kg/min
5
4
3
2
1
50
40
30
20
10
0
45.1
43.1
38.3
35.2
30.4
23.5
19.4
33.6
2.4%
10.8%
22.4 %
34.7 %
51.8%
60.6%
35.5%
London 75m
Kathmandu 1300m
Namche 3500m
Pheriche 4250m
Everest Base Camp early 5300m
Western Cwmn 6400m
South Col 7950m
Everest Base Camp Late 5300m
LOCATION
Error Bars: +/- 1 SD


Maximum Oxygen Consumption at Altitude, South Col Team, [redacted]
Mean Maximum Oxygen Consumption l/min
Mean Maximum Oxygen Consumption mls/kg/min
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1
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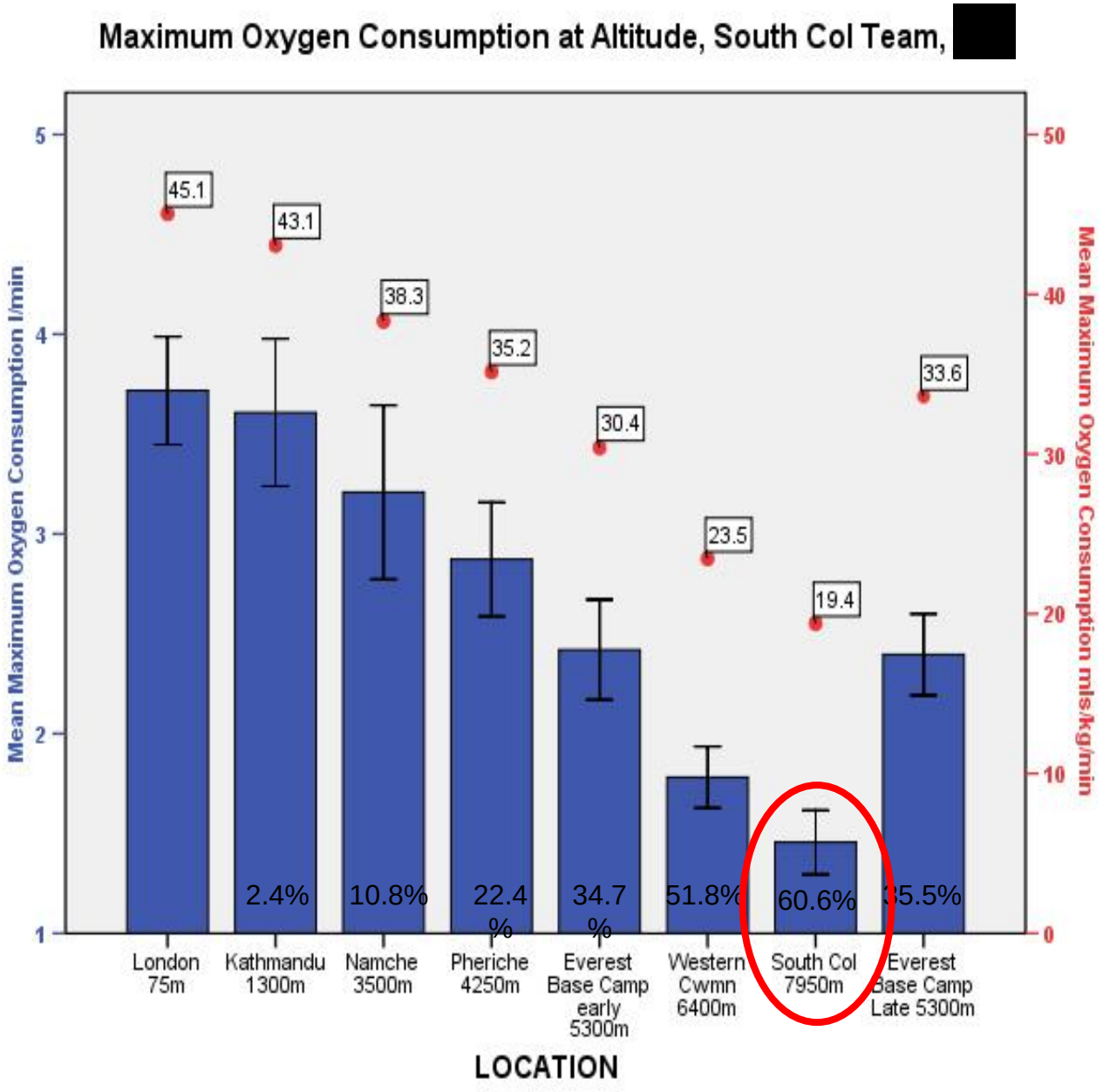
45.1
43.1
38.3
35.2
30.4
23.5
19.4
33.6
2.4%
10.8%
22.4 %
34.7 %
51.8%
60.6%
35.5%
London 75m
Kathmandu 1300m
Namche 3500m
Pheriche 4250m
Everest Base Camp early 5300m
Western Cwmn 6400m
South Col 7950m
Everest Base Camp Late 5300m
LOCATION
Error Bars: +/- 1 SD


Maximum Oxygen Consumption at Altitude, South Col Team, [redacted]
Mean Maximum Oxygen Consumption l/min
Mean Maximum Oxygen Consumption mls/kg/min
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45.1
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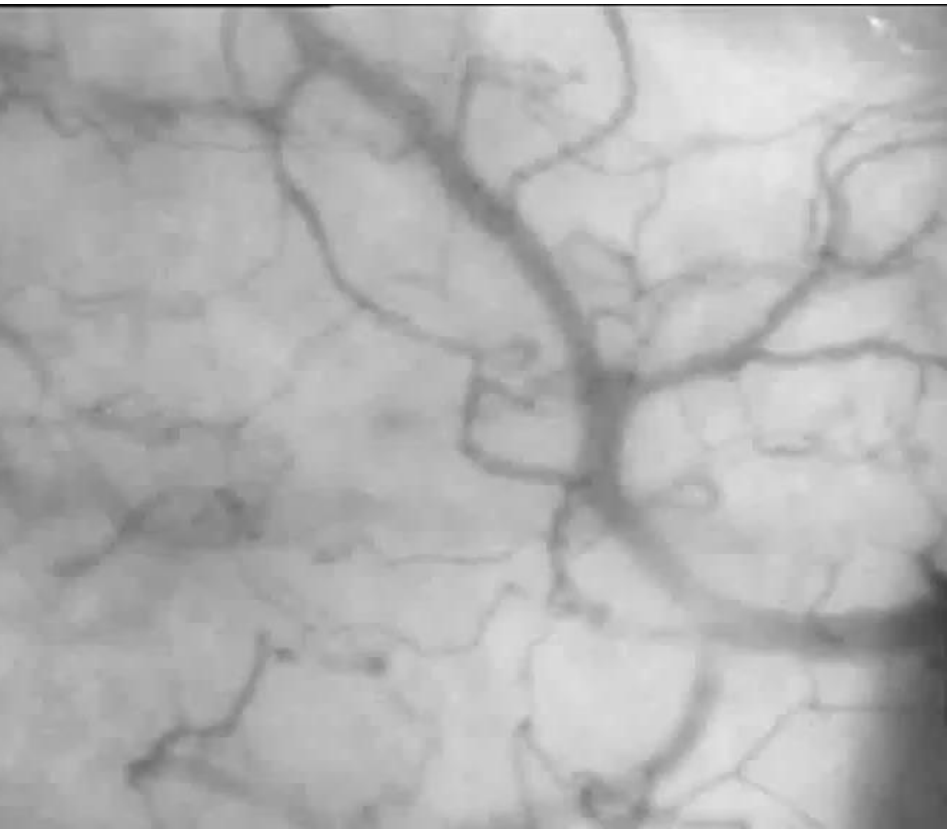
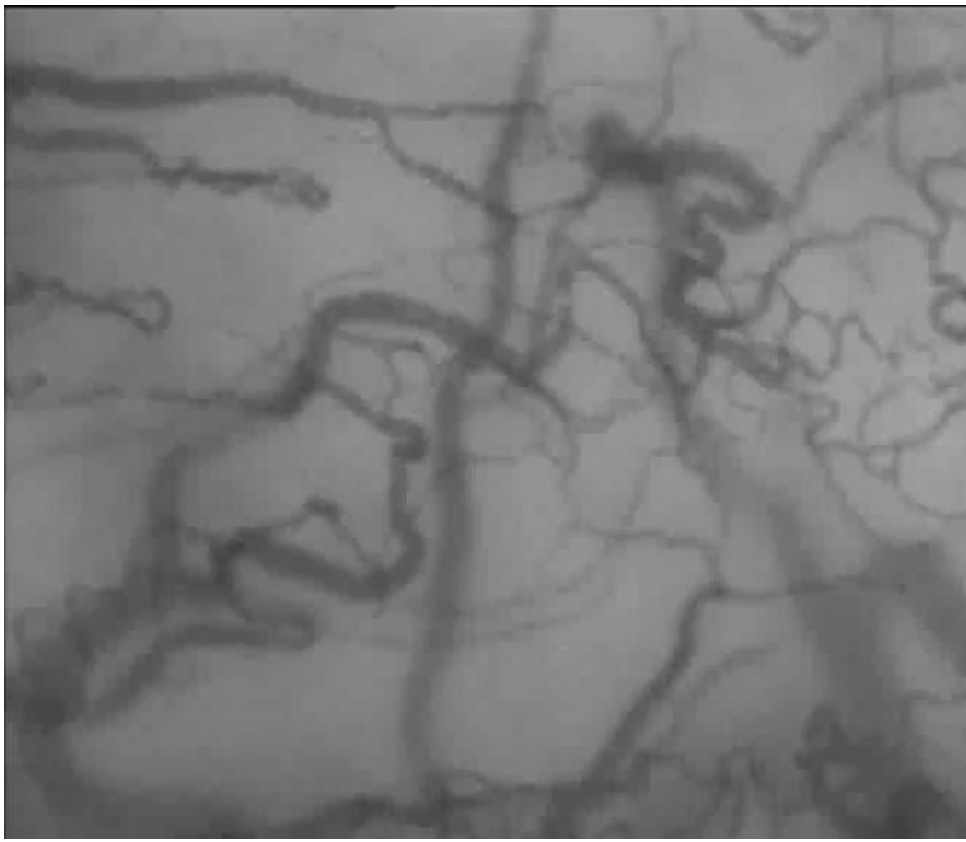
38.3
35.2
30.4
23.5
19.4
33.6
2.4%
10.8%
22.4 %
34.7 %
51.8%
60.6%
35.5%
London 75m
Kathmandu 1300m
Namche 3500m
Pheriche 4250m
Everest Base Camp early 5300m
Western Cwmn 6400m
South Col 7950m
Everest Base Camp Late 5300m
LOCATION
Error Bars: +/- 1 SD

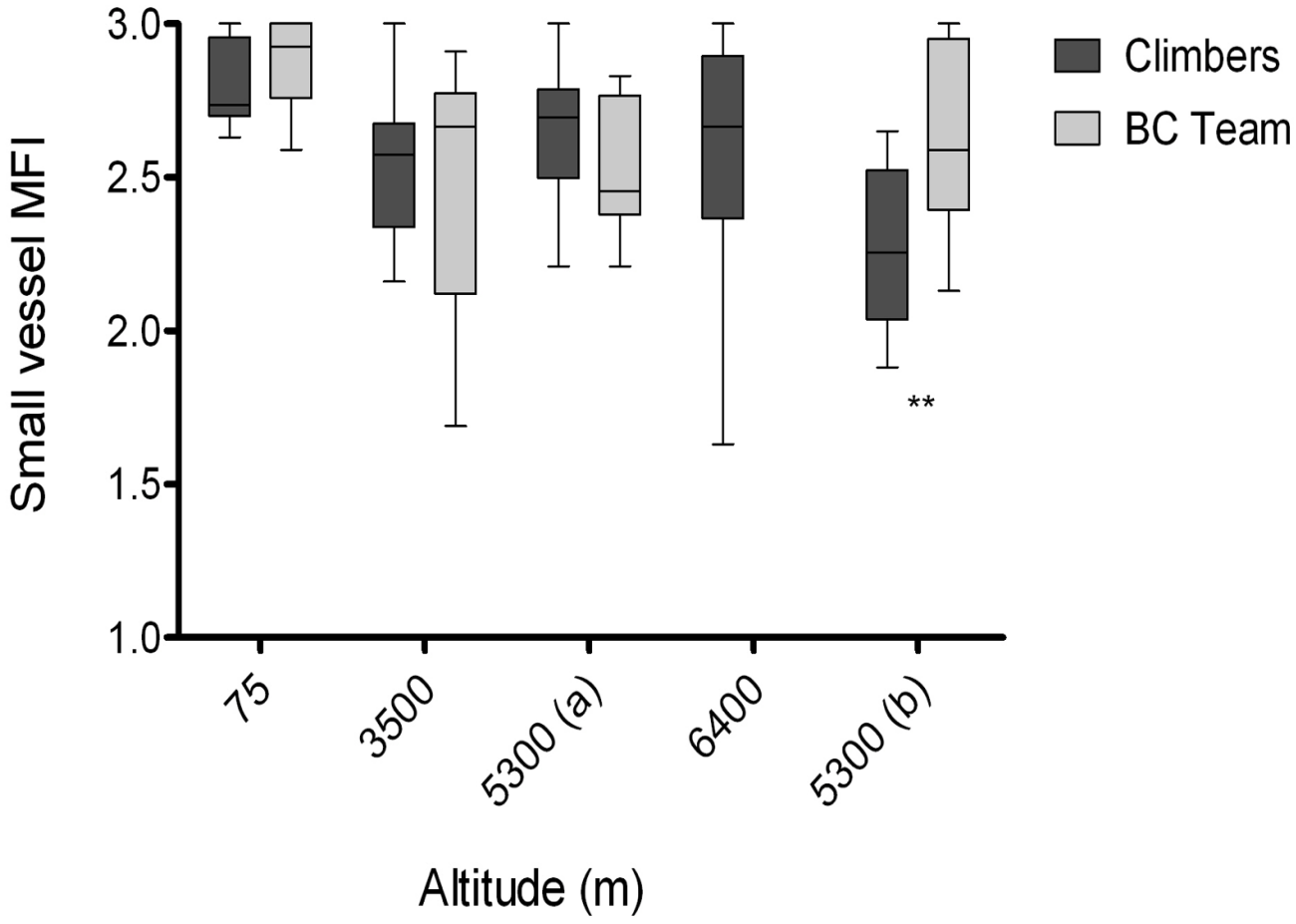
Microcirculatory dysfunction





Martin *EJAP* 2009

Microcirculation



Martin *Experimental Physiology* 2010

Metabolic basis to Sherpa altitude adaptation – Horscroft et al, 2017

- Himalayan Sherpas highly adapted to life in a low oxygen environment
- Does enhanced tissue oxygenation and delivery play a role?
- In Sherpa/Lowlander comparison, Sherpas showed lower capacity for fatty acid oxidation, enhanced efficiency of O_2 utilisation, improved muscled energetics, and protection against oxidative stress

CXE: A prospective study of the effects of environmental hypoxia on cognitive functioning – Griva et al, 2017

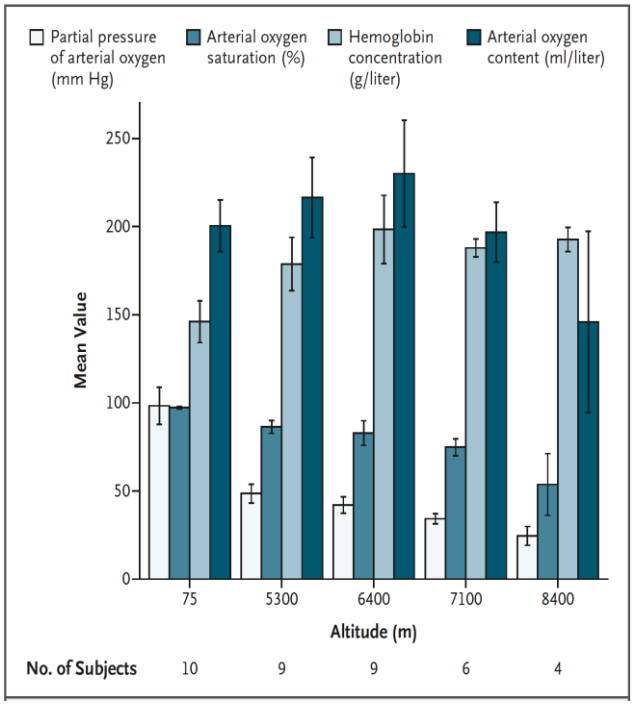
- Overall, attention, verbal ability and executive function declined in those exposed to hypoxia compared with controls
- Memory and psychomotor function showed decline at highest ascent only
- Considerable inter-individual variability in the response to sustained hypoxia
- Cognitive decline was greater amongst older people
- Not associated with mood, socio-demographic, or physiological variables

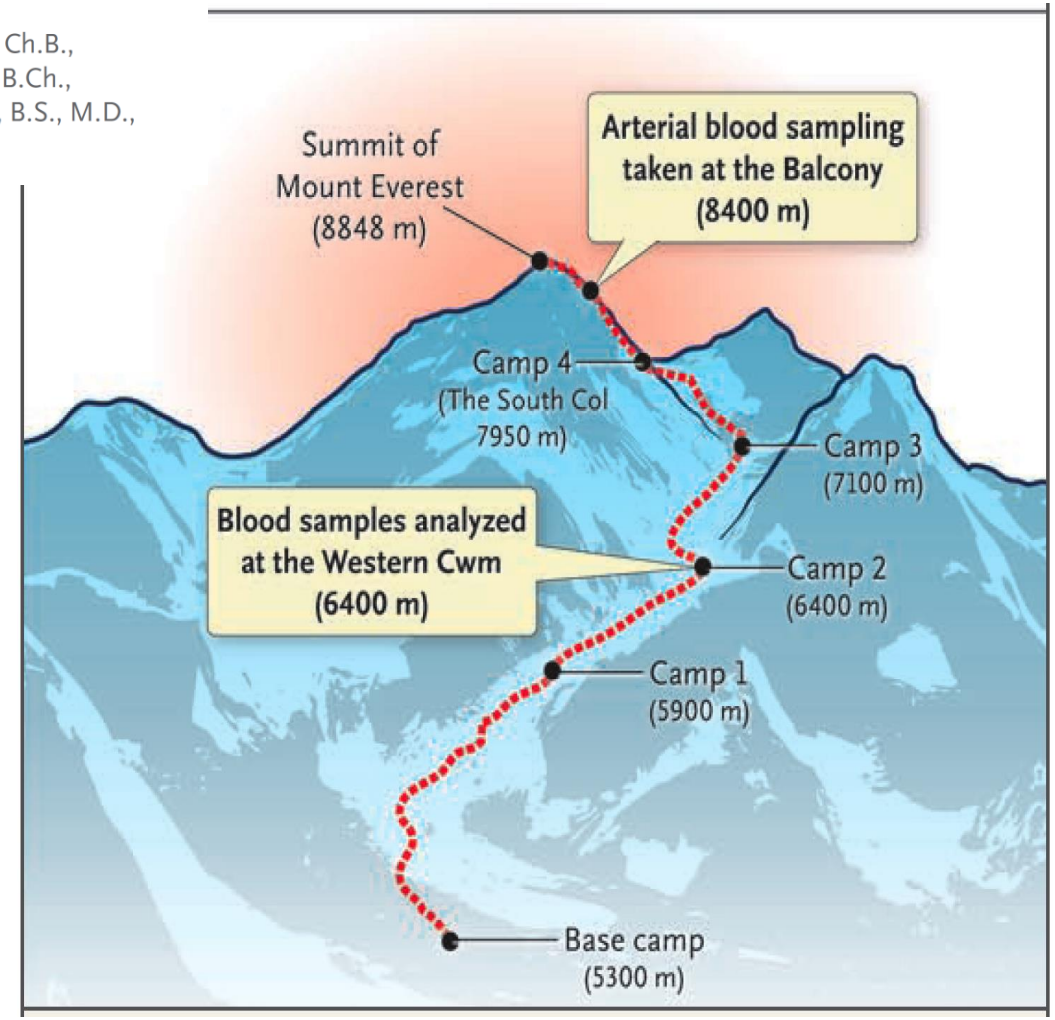
The NEW ENGLAND JOURNAL of MEDICINE

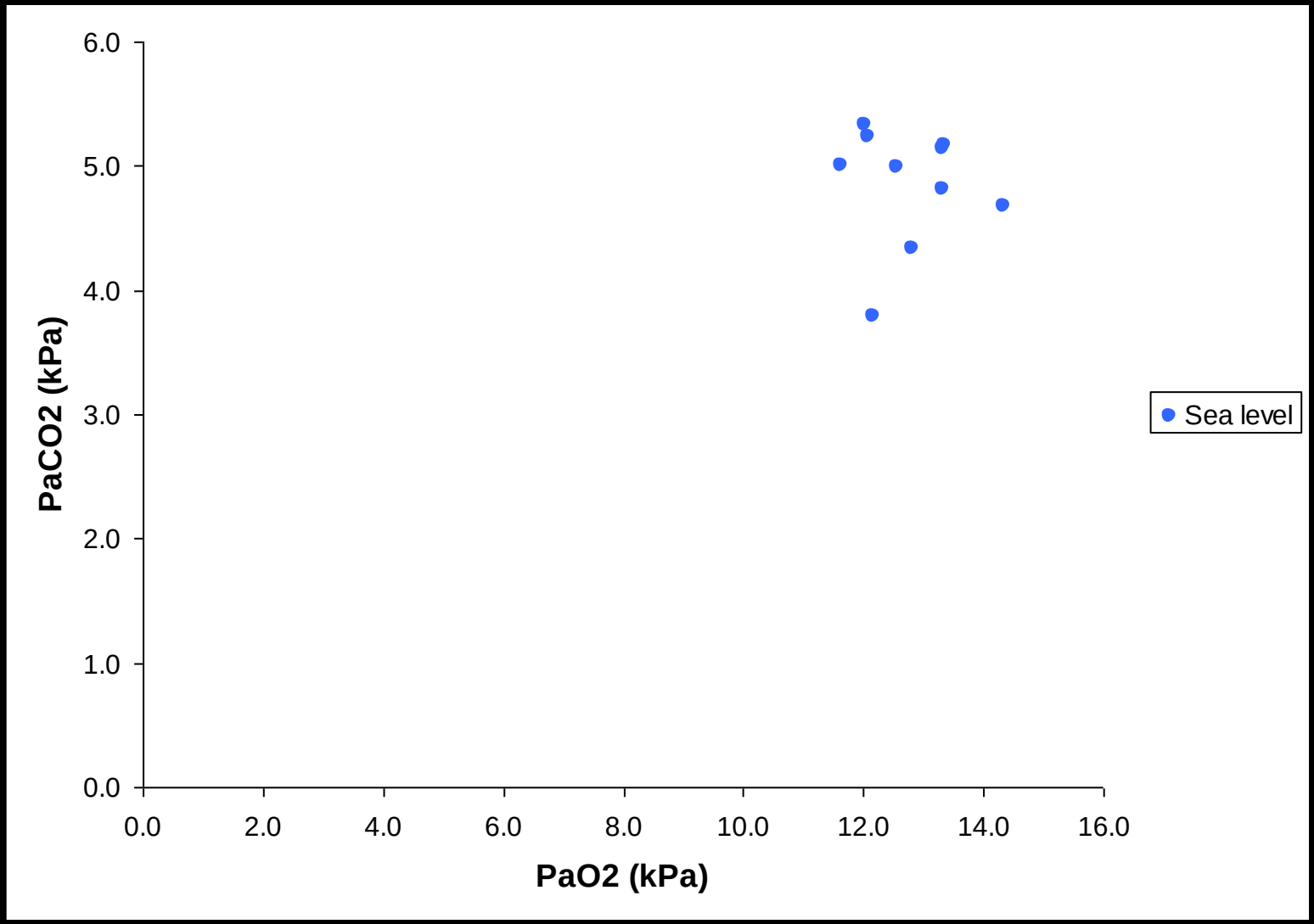
ORIGINAL ARTICLE

Arterial Blood Gases and Oxygen Content in Climbers on Mount Everest

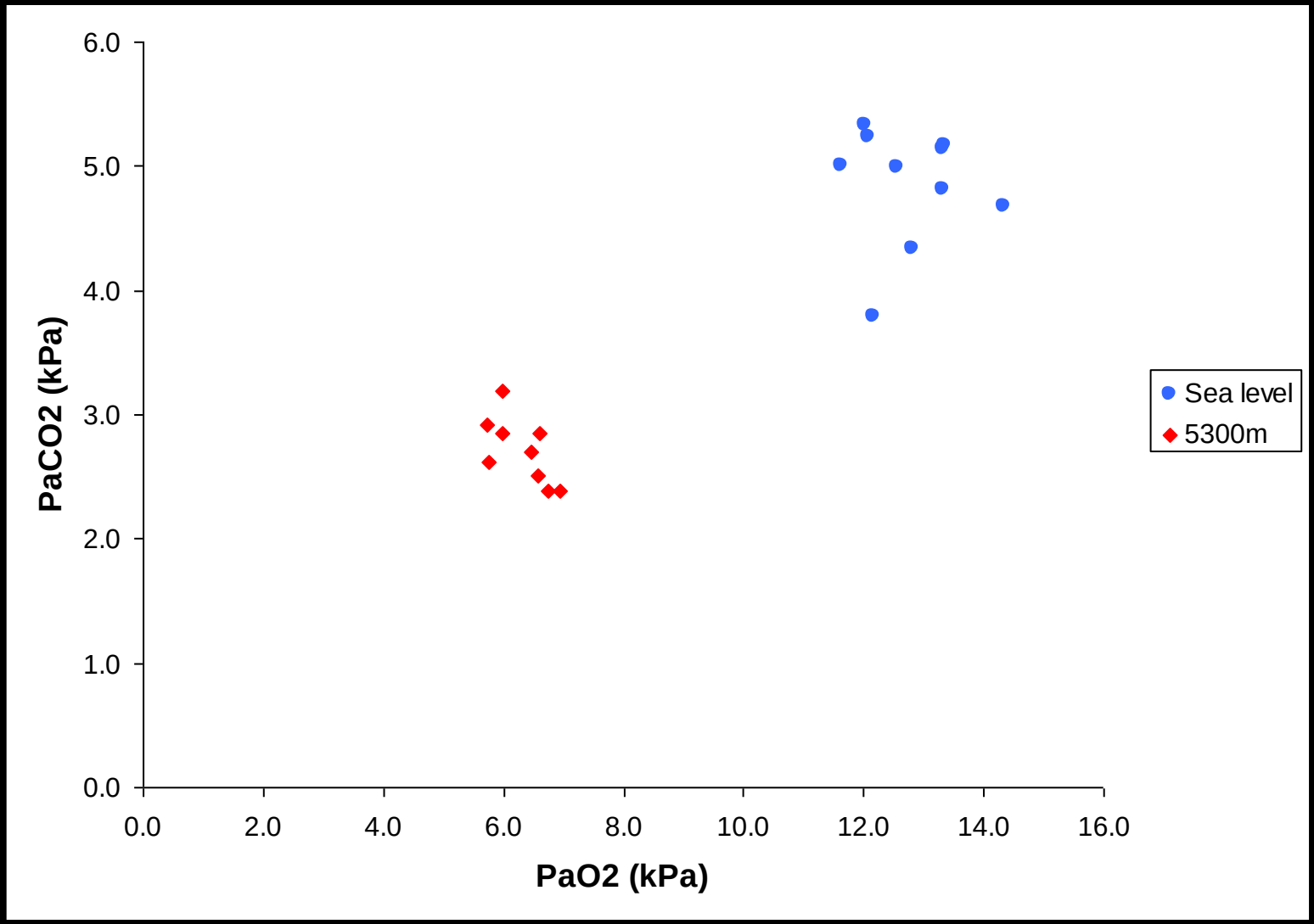
Michael P.W. Grocott, M.B., B.S., Daniel S. Martin, M.B., Ch.B., Denny Z.H. Levett, B.M., B.Ch., Roger McMorrow, M.B., B.Ch., Jeremy Windsor, M.B., Ch.B., and Hugh E. Montgomery, M.B., B.S., M.D., for the Caudwell Xtreme Everest Research Group*



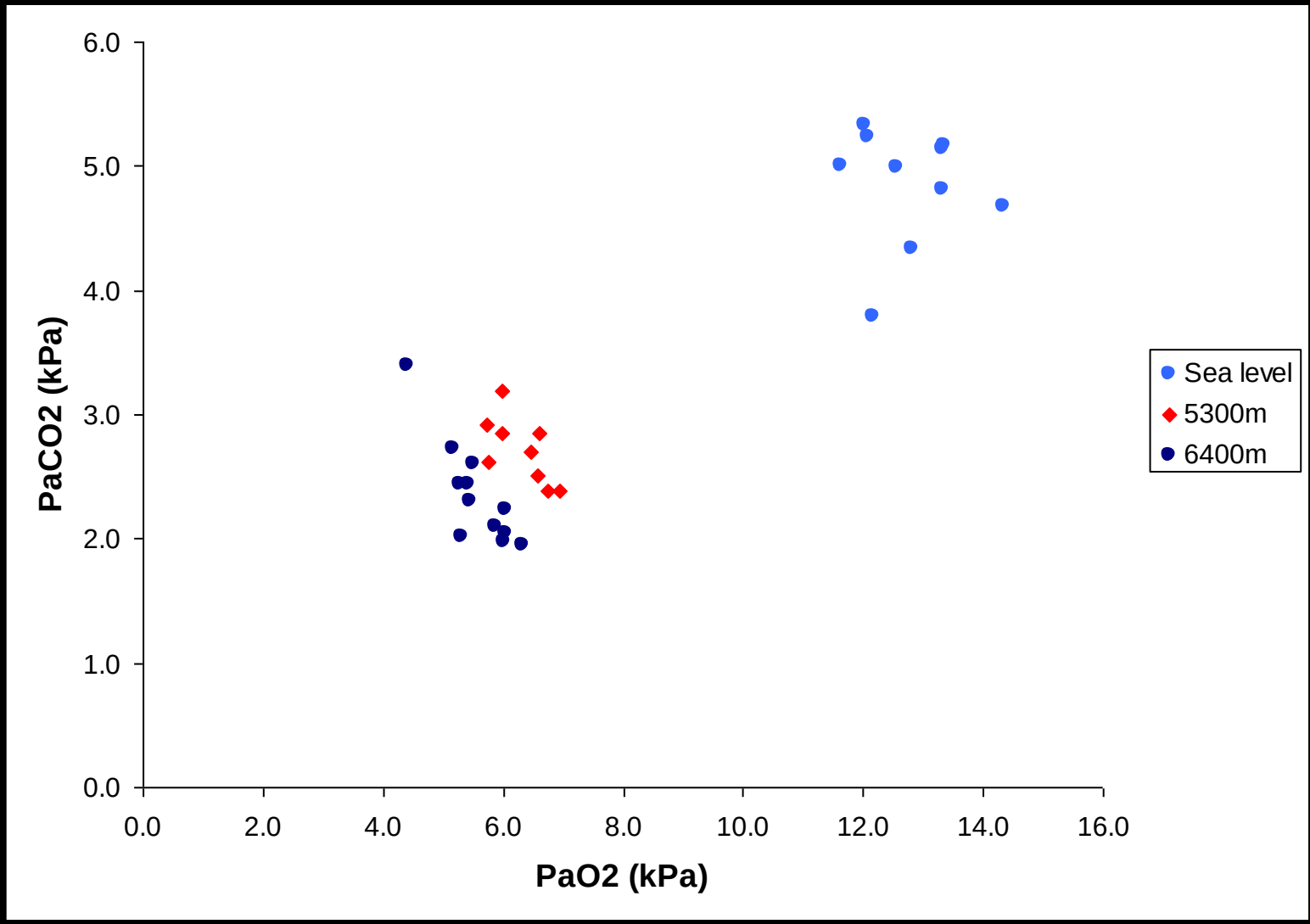



6.0
5.0
4.0
3.0
2.0
1.0
0.0
PaCO2 (kPa)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
PaO2 (kPa)
Sea level

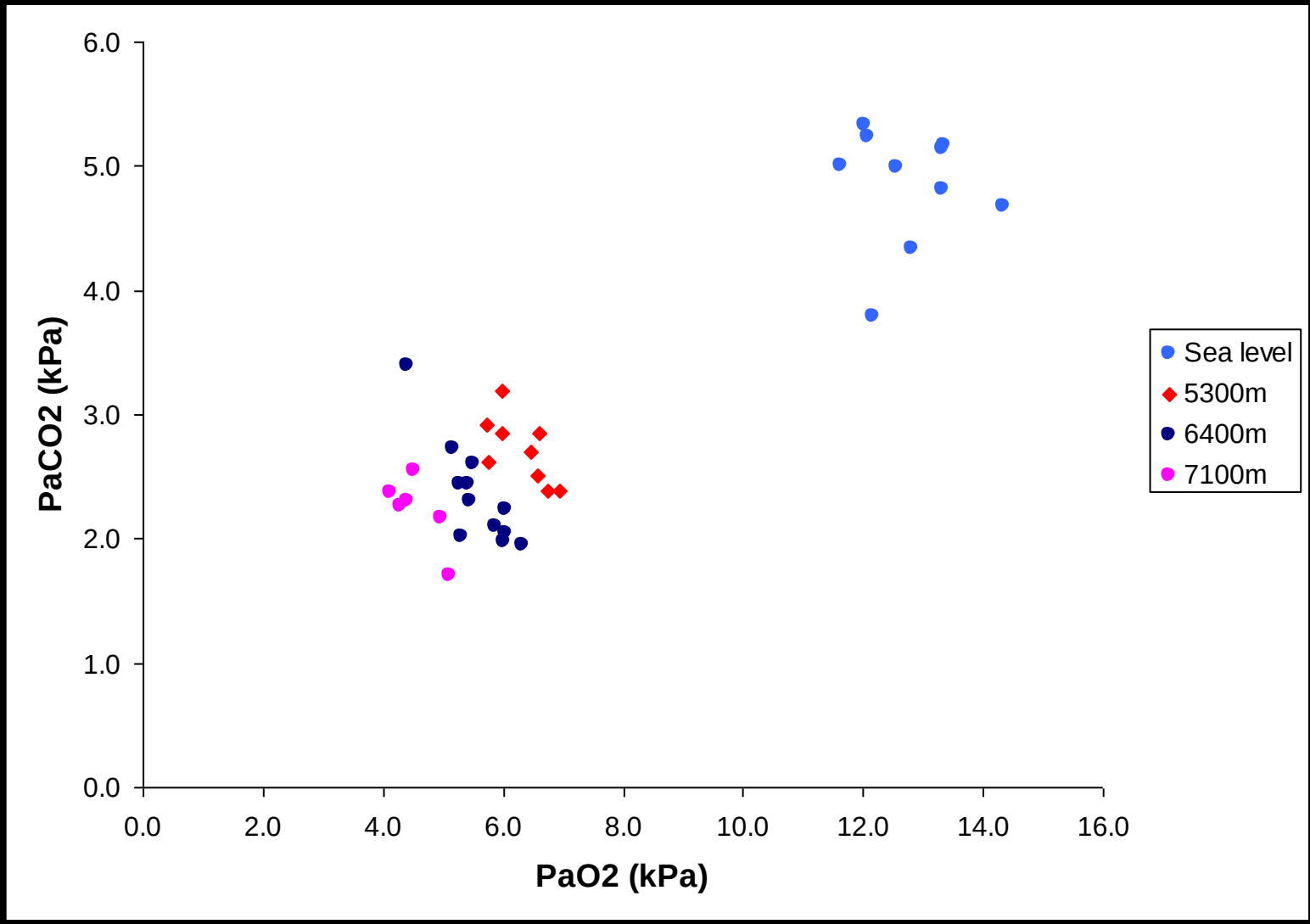
CXE data


6.0
5.0
4.0
3.0
2.0
1.0
0.0
PaCO2 (kPa)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
PaO2 (kPa)
Sea level
5300m

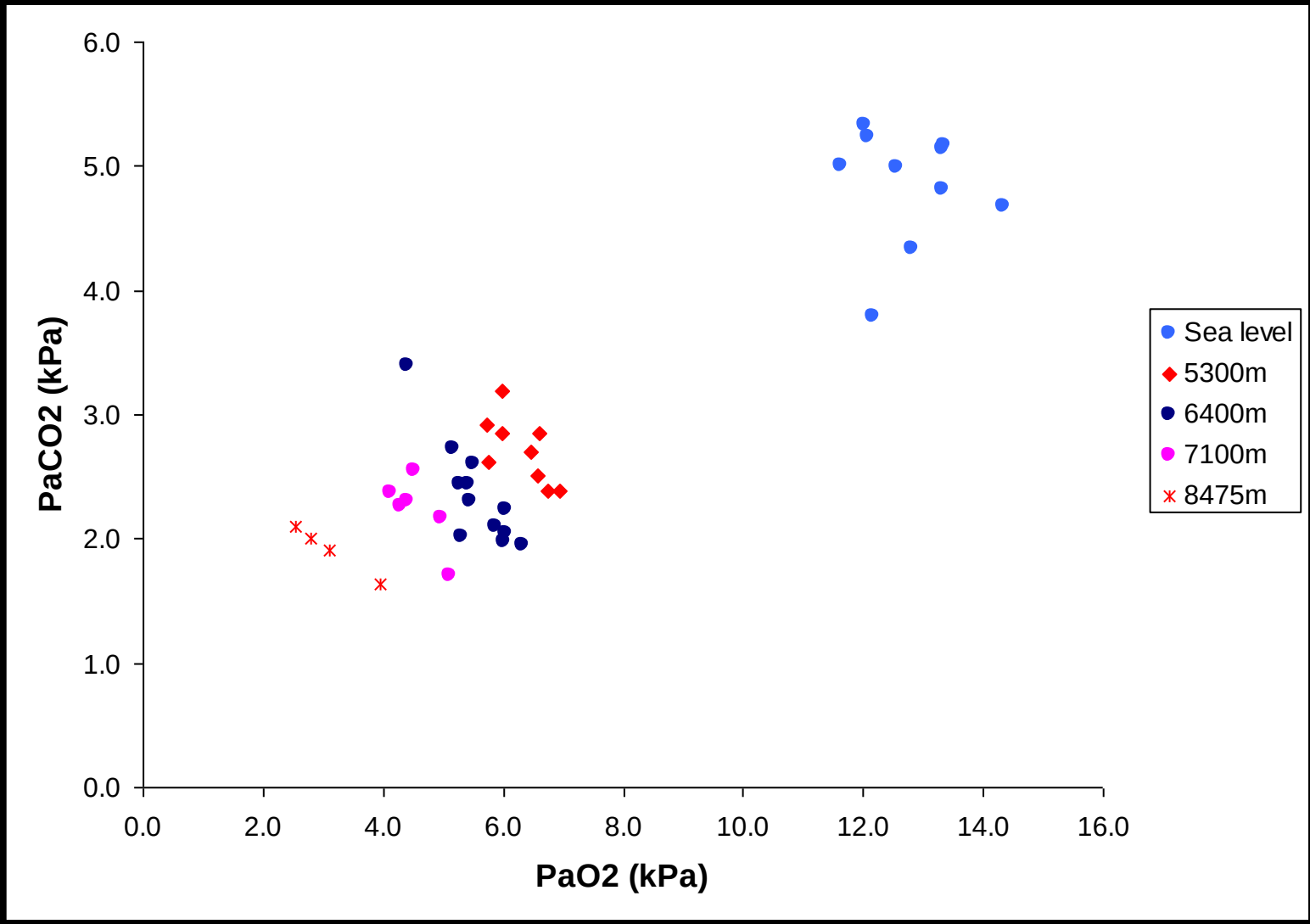
CXE data


6.0
5.0
4.0
3.0
2.0
1.0
0.0
PaCO2 (kPa)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
PaO2 (kPa)
Sea level
5300m
6400m

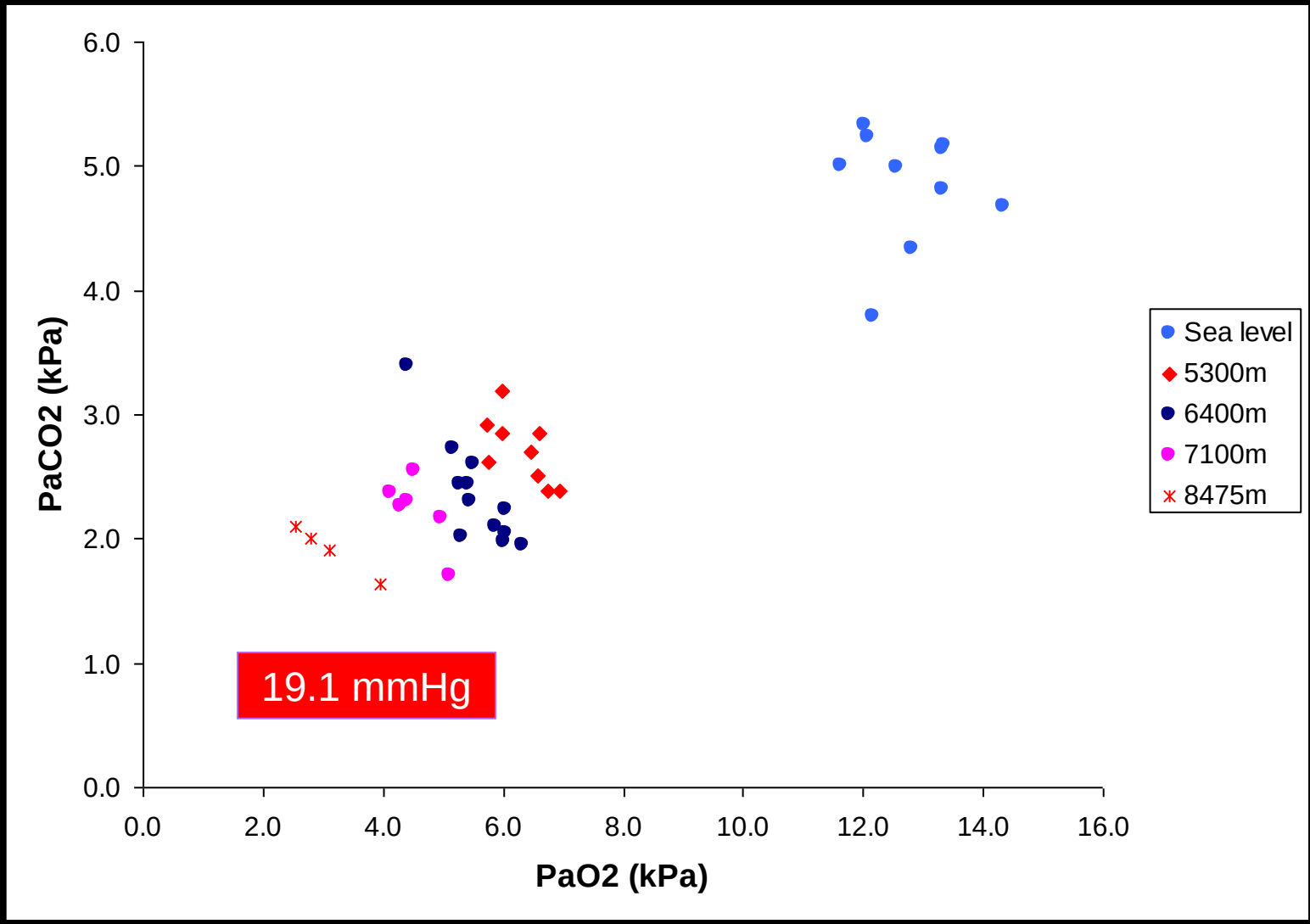
CXE data


6.0
5.0
4.0
3.0
2.0
1.0
0.0
PaCO2 (kPa)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
PaO2 (kPa)
Sea level
5300m
6400m
7100m

CXE data


6.0
5.0
4.0
3.0
2.0
1.0
0.0
PaCO2 (kPa)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
PaO2 (kPa)
Sea level
5300m
6400m
7100m
8475m

CXE data


6.0
5.0
4.0
3.0
2.0
1.0
0.0
PaCO2 (kPa)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
PaO2 (kPa)
Sea level
5300m
6400m
7100m
8475m
19.1 mmHg

CXE data

“Everest *in utero*”

PaO_2 ~ 2.5-3.0 kPa

- Foetus *in utero*
- Diving Seals
- Everest Climber

So what?

Implications for practice

- We can measure gross oxygen delivery
- More difficult to measure oxygen delivery at cellular level
- The two do not necessarily correlate
- Beware hyperoxia
- Good saturations do not always suggest adequate availability of oxygen at cellular level

Provide feedback (external link)

NB: The information displayed below does not replace the protocol. The latest protocol version should always be consulted before making clinical decisions.

Data cut: 06 March 2017

Search for a study

Tissue metabolism and blood flow in critically ill patients	IRAS ID
An observational study in critically ill patients of the relationship between tissue blood flow and metabolism and their severity of disease and outcomes	159977

Current Status	Open, With Recruitment
Planned Duration	04/03/2016 - 01/07/2017
Managing Specialty	Critical care
All Specialties	Critical care
Managing Specialty Primary Subspecialty	Critical Care
All SubSpecialties	Critical Care

CPMS ID	20087
ISRCTN	-
EudraCT	-
MREC No.	-

Geographical Scope	Single Site
Lead Country	England
Study Setting	Secondary Care
Portfolio eligibility route	Standard

Funder(s)	The Intensive Care Society, The Royal Free Charity
Sponsor(s)	ROYAL FREE LONDON NHS FOUNDATION TRUST

Research Summary

There remains much to be learnt regarding what determines favourable survival in critically ill patients. Traditional teaching of maintaining adequate delivery of oxygen to organs and tissues becomes ever less important as disease progresses. As our understanding of tissue metabolism and the interaction of complex cellular systems improves a concept has developed that may explain why measures of oxygen delivery frequently fail to differentiate those patients with good outcomes from those who ultimately fail to recover. The aim of our observational study of critically ill patients admitted to intensive care is to characterise three key physiological characteristics that we believe are likely to be closely interrelated and may have a significant influence on tissue oxygen balance. These mechanisms have been selected from our previous studies in which healthy volunteers were exposed to low levels of oxygen at high altitude. We aim to quantify: i) Nitric oxide activity a naturally occurring molecule that plays an important

Study Type	Observational
Intervention Detail	n/a
Phase(s)	N/A
Open to New Sites	No

England Sample Size	33
England Recruitment to Date	19
UK Sample Size	33
UK recruitment to Date	19

Chief Investigator	Dr Daniel Martin
Contact Details	Dr Helen McKenna htmckenna@gmail.com

Main Inclusion Criteria

i) Patients aged 18 years and over ii) Unplanned admissions to ICU who are expected to remain there for > 5 days

Main Exclusion Criteria

i) Severe coagulopathy ii) Therapeutic immunosuppression iii) Primary neuromuscular pathology iv) Disseminated cancer vi) Lack of permission from patient's Consultee

TOXYC

- RfPB funded study
- Two sites recruiting
- Royal Free Hospital, London
- University Hospital Southampton
- Tight oxygen control


HIGHLAND SHERPA RESORT
Pangboche 3985 mt. ft.
Facilites
• Attached bathroom
• Common room
• Western woodfire stove
• Warm Dining & Good View
• Organic & Hygienic Food
• Camping Ground
• Horse Rent
• Heli Rescue
• Oxygen Service
• Wifi Service
exodus
24 HOUR
WiFi
ZONE


SPORT
CAMP

Sponsors and supporters

Caudwell Xtreme Everest

- BOC Medical
- Ei Lilley
- The London Clinic
- Smiths Medical
- Deltex Medical
- The Rolex Foundation
- AAGBI
- Intensive Care Foundation
- Sir Halley Stewart Trust
- NIHR UCLH BRC

Xtreme Everest 2

- Smiths Medical
- UCLH Charity
- Deltex Medical
- Royal Free Charity
- London Clinic
- University Hospital Southampton
- Rhinology and Laryngology Fund
- Atlantic Customer Solutions
- Physiological society

All grants were unrestricted

Ultimate team collaboration: Xtreme Everest 10 years on

- No single person is able to contribute all the necessary expertise to solve increasingly complex problems
- Research teams need a shared mission, a good organisational structure, and plenty of interpersonal interactions
- Collaborations with an element of fun are most productive

"The Scientist", Culotta 1993

www.xtreme-everest.co.uk

@XtremeEverest