2nd International Congress

New Advances in Mountain Medicine and Emergency

photo by Francesca Agosta Tipress Ag. Fotografica (Tris Rotondo 2012 – CAS Ticino)

in collaboration with

UNIVERSITAS STUDIORUM INSUBRIAE

EURAC research

INSTITUTE OF MOUNTAIN EMERGENCY MEDICINE

Varese – 19 April 2013 – Atahotel – Via F. Albani, 73 – Varese, Italy

18th April 2013

Atahotel – Via F. Albani, 73 – Varese, Italy

PRESIDENT: LUIGI FESTI

Morning

CONFERENCE OF MEDICAL COMMISSION CLUB ALPINO ITALIANO (CAI)

DIRECTOR OF CAI MEDICAL COMMISSION *A. Rinaldi*

PROGRAM

Doctors expedition *Urs Hefti*

Solar irradiation and eye pathology at High Altitude *Paolo Conci*

Conference of SiMeM (Italian Society of Mountain Medicine)

Heart and Brain at High Altitude

Director of Congress SIMEM *Guido Giardini*

Lingua ufficiale: Italiano

Conference presentation

Main Lecture: Heart and Brain at High Altitude, state of the art *Corrado Angelini* *introduced by* *Andrea Ponchia*

Research at high altitude – laboratory data – Chairs *Corrado Angelini – Andrea Ponchia*

Studying the high altitude on Monte Bianco: Resamont2 project

General placement and neurological aspects *Guido Giardini*

Cardiological aspects *Lorenza Pratali*

The role of genetics *Sandro Malacrida*

The Ortles project: a standardized methodology for a non-invasive study on hypoxia effects *Giacomo Strapazzon, Piergiorgo Lochner*

Discussion and Conclusions

National SIMEM meeting with Buddha Basnyat, ISMM President

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Morning

8.30 Authorities Greetings and Presentation of Conference

8.45 Microhemorrhages in lungs and brain
P. Bärtsch

9.05 The rational use of medications at high altitude: treatment, prevention and doping
P. Hackett

9.25 International Frostbite Register
E. Cauchy

9.45 Altitude Cough: Psychophisiology and treatment
B. Basnyat

10.05 World perspectives in mountain rescue
J. Ellerton

10.25 How can the International Hypothermia Registry improve triage and outcome of accidental hypothermia victims?
B. Walpoth

10.45 Expedition Doctor-Myths and Realities
U. Hefti

11.00 In-Hospital Decision Making in Accidental Hypothermia: the Bernese Hypothermia Algorithm
M. Brodmann Maeder

11.15 Management of multiple trauma in the mountains
F. Elsensohn

11.30 Accidental Hypothermia, out-of-hospital triage and transport decisions
H. Brugger

11.50 Pulmonary circulation at high altitude, effects of sympaticus and parasympaticus blocade
M. Maggiorini

12.10 Advances in Mountain Medicine Education: The UIAA/IKAR/ISMM Diploma of Mountain Medicine
D. Hillebrandt

12.30 Ultrasound diagnoses at high altitude and in mountain emergency medicine
G. Strapazzon

12.50 Communication of Agusta Westland
Agusta Westland

1.00-2.00 pm Light lunch

Afternoon

2.00 Lung adaptation at high altitude
A. Cogo

2.15 Chronic hypoxia and adaptation to very high altitude in Tibetan highlanders
G. Ge Ri-Li

2.30 Thoracic trauma in practice mountaineering
A. Imperatori

2.45 Essential equipment and aid packs in time of climbing: how do I use? View of the border service surgeon
K. Yusif-zade

3.00 On-site treatment in difficult sites of accident Longline-Helicopter rescue missions
B. Durrer

3.15 Perspectives of nutrition in mountaineering
E. Arcelli

3.30 In the footsteps of the killer: the traumatic pneumothorax (minithoracotomy)
A. Rinaldi

3.45 Going altitude with neurological problems
G. Giardini

4.00 Acclimatization Practices of High-Altitude Recreationalists
L. Rozier

4.10 Mind and performance at high altitude
P. Trabucchi

4.25 Cardiovascular effects at high altitude
G. Parati

4.40 Break

5.00 **Round-table discussion:**
The Future in Mountain Medicine

6.00 ISMM meeting (International Society for Mountain Medicine)

Faculty

Arcelli Enrico
Until 2010 (retired) Professor, Sport Science, Nutrition and Health, Milan University, Italy

Bärtsch Peter
Universitatsklinikum Heidelberg Medizinische Klinik Innere Medizin VII

Basnyat Buddha
Director of Nepal International Clinic, Katmandu, Nepal

Brodmann Maeder Monika
Head of Education and Wilderness Medicine, Bern University Hospital, Department of Emergency Medicine

Brugger Hermann
Institute of Mountain Emergency Medicine, EURAC research, Bolzano, Innsbruck Medical University

Cauchy Emmanuel
Médecine Polyvalente Urgence, Hôpitaux du Mont-Blanc. Président de l'IFREMMONT

Cogo Annalisa
Head of Centro Studi Biomedici applicati allo Sport, University of Ferrara

Durrer Bruno
Dr.med., General Internal Medicine FMH, Emergency Medicine SGNOR, Sports-Medicine SGSM

Ellerton John
Family Doctor in the Lake District, United Kingdom for over 20 years. He has combined this with emergency medicine and particularly Mountain Rescue

Elsensohn Fidel
Chairman Medical Board of Austrian Mountain Rescue Service. President of ICAR-MEDCOM

Festi Luigi
Deputy Chief Thoracic Surgery, Ospedale di Circolo Varese, Italy. Director of International Master Course in Mountain Medicine

Ge Ri-Li Gao
Vice President of Qinghai University, Director and Professor, Research Center for High Altitude Medicine, Qinghai University, China

Giardini Guido
Director Mountain Medicine Center Aosta Valley Regional Hospital. President of Italian Society of Mountain Medicine

Hackett Peter
Director Institute for Altitude Medicine, Telluride Clinical Professor of Emergency Medicine, University of Colorado

Hefti Urs
Head of the orthopedic and trauma department, County Hospital Münsingen, Switzerland

Hillebrandt David
President of UIAA Medcom, Hon Medical advisor to BMC and Family doctor

Imperatori Andrea
Department of Surgical Sciences of the University of Insubria, Varese. Thoracic Surgery, Ospedale di Circolo di Varese, Italy

Maggiorini Marco
Medical Intensive Care Unit, University Hospital, Zürich

Parati Gianfranco
Professor of Cardiovascular Medicine, Dept of Health Sciences, University of Milano-Bicocca. Head, Dept of Cardiovascular, Neural and Metabolic Sciences, S.Luca Hospital, Istituto Auxologico Italiano, Milano, Italy

Rinaldi Adriano
Department of Anesthesia and Intensive Care, University of Trieste

Rozier Leslie
Family Nurse Practitioner, Pinedale, Wyoming, USA

Strapazzon Giacomo
Institute of Mountain Emergency Medicine, EURAC research, Bolzano, Italy

Trabucchi Pietro
Sports performance Psychologist. Full Professor, University of Verona, Italy

Walpoth Beat
Director, Cardiovascular Research, Geneva University Hospital

Yusif-zade Kenan
Head of Military Hospital of State Border Service of Azerbaijan Republic

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BALMELLI SPORT
LUGANO

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B|BRAUN
SHARING EXPERTISE

LÉKAŘ NA EXPEDICI: EXPEDIČNÍ DOKTOR MÝTY A REALITA

Urs Hefti, MD

Orthopedic and Trauma and General Surgeon

Bord Member Swiss Society of Mountain Medicine

Leader High Altitude Medical Expedition
2001, 2005, 2009, 2013

Himalayan Rescue Association

Emergency Physician Swiss Air Ambulance

Head of the Orthopedic and trauma department,
County Hospital Langenthal, Switzerland

Činnost v jiném kulturním prostředí

Extrémní počasí

Silný chlad

Velká výška

Vědomí a připravenost

- rizika situací
- schopnost zabránit nepředvídaným událostem
- fungovat ve stressu chladu, hypoxie a únavy
- Spousta stressových psychologických faktorů

Schopnost provádět rutinní lékařské úkony

Personal statement

CHRISTMAS 2008: SPORT

Mortality on Mount Everest, 1921-2006: descriptive study

Paul G Firth, anaesthetist,[1] Hui Zheng, statistician,[2] Jeremy S Windsor, specialist registrar in anaesthetics and intensive care,[1] Andrew I Sutherland, Wellcome research training fellow,[1] Christopher H Imray, vascular surgeon,[1] G W K Moore, professor,[3] John L Semple, professor,[1] Robert C Roach, associate professor,[4] Richard A Salisbury, computer analyst[1]

Results The mortality rate among mountaineers above base camp was 1.3%. Deaths could be classified as involving trauma (objective hazards or falls, n=113), as non-traumatic (high altitude illness, hypothermia, or sudden death, n=52), or as a disappearance (body never found, n=27). During the spring climbing seasons from 1982 to 2006, 82.3% of deaths of climbers occurred during an attempt at reaching the summit. The death rate during all descents via standard routes was

VOM častěji ve vyšší výšce než VOP

VOM 7x v 8276 (±791) m

VOP 5x v 6229 (±104) m P=0,001

NAMME, Varese 2013

Hefti U, 2013

Úmrtí na Everestu v jarní sezóně 1982-2006

Population characteristics of mountaineers on Everest, 1921-2006. Values are numbers (percentages) unless stated otherwise

Variables	Climbers (n=8030)	Sherpas (n=6108)	Total
Male	7404 (92.2)	6106 (99.9)	13 510
Female	626 (7.8)	2 (0.1)	628
Mean (SD) age (years) (range)	36.5 (8.9) (12-74)	—*	—
Overall total	8030	6108	14 138

Úmrtí na Everestu v jarní sezóně 1982-2006

Population characteristics of mountaineers on Everest, 1921-2006. Values are numbers (percentages) unless stated otherwise

Variables	Climbers (n=8030)	Sherpas (n=6108)	Total
Summit ascents:			
1953-81 (all)	94 (5.3)	23 (1.8)	117 (3.8)
1982-2006:			
S-spring	663 (37.5)	661(51.2)	1324 (43.3)
N-spring	732 (41.4)	484 (37.5)	1216 (39.8)
Other†	279 (15.8)	122 (9.4)	401 (13.1)
Total	1768	1290	3058

CHRISTMAS 2008: SPORT

Mortality on Mount Everest, 1921-2006: descriptive study

Nad BC umírali horolezci častěji ve vyšší výšce než Šerpové

Horolezci 103x v 7854 m (±918 m)

Šerpové 44x v 6927 m (±116 m) P<0,001

Úmrtnost při sestupech z vrcholu klasickými cestami (tj. přes Jižní nebo Severní sedlo

častější u horolezců 2,7% (43/1585)

než u Šerpů 0,4% (5/1231) P<0,001.

Mechanismy smrtelných nehod v horách

INCIDENTE

Nepal, morti quattro alpinisti Rimane un disperso sull'Everest

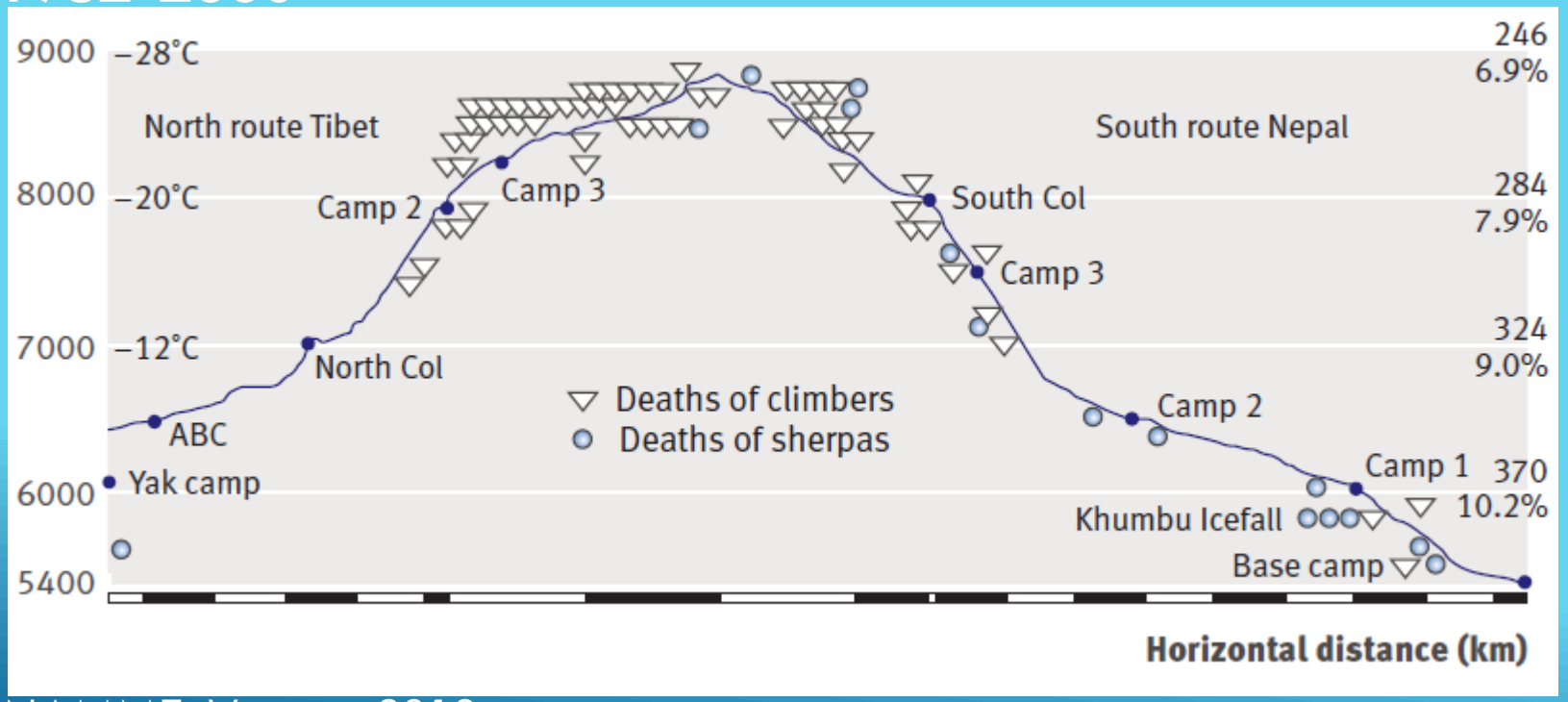
Una bufera di vento improvvisa ha ucciso gli scalatori. Erano di nazionalità canadese, tedesca, coreana e cinese. Proseguono le ricerche per recuperare l'altro uomo disperso, una guida nepalese

Lo leggo dopo

KATMANDU - Morti quattro alpinisti che stavano tornando da un'escursione sull'Everest, mentre una guida nepalese risulta ancora dispersa. Lo confermano le autorità nepalesi, precisando che le vittime erano di nazionalità tedesca, canadese, coreana e cinese. I quattro hanno perso la vita sabato sera, mentre scendevano dalla montagna alta circa 8.850 metri.

Sebbene le condizioni meteorologiche fossero

Úmrtí na Everestu v jarní sezóně (duben – červen) 1982-2006



- Úrazy
  - mnohočetná tupá zranění hlavy, hrudníku, břicha, převážně po pádu
- Výšková zranění
- Chladová poranění
- Náhlá srdeční smrt

Hefti U, 2013

INCIDENTE

Nepal, morti quattro alpinisti
Rimane un disperso sull'Everest

Una bufera di vento improvvisa ha ucciso gli scalatori. Erano di nazionalità canadese, tedesca, coreana e cinese. Proseguono le ricerche per recuperare l'altro uomo disperso, una guida nepalese

Lo leggo dopo

KATMANDU - Morti quattro alpinisti che stavano tornando da un'escursione sull'Everest, mentre una

Úmrtí na Everestu v jarní sezóně (duben – červen) 1982-2006

9000 −28°C
8000 −20°C
7000 −12°C
6000
5400

North route Tibet
South route Nepal

Yak camp
ABC
North Col
Camp 2
Camp 3
South Col
Camp 3
Camp 2
Camp 1
Khumbu Icefall
Base camp

246
6.9%
284
7.9%
324
9.0%
370
10.2%

Deaths of climbers
Deaths of sherpas

BMJ | 20-27 december 2008 | Volume 337

Horizontal distance (km)

NAMME, Varese 2013 Hefti U, 2013

Mechanismy smrtelných nehod v horách

Úmrtí na Everestu v jarní sezóně (duben – červen) 1982-2006

Route	Mountaineers	Death rate during descent from summit (%)	P value*
North	Climbers	3.4	0.0001
	Sherpas	‹0.2	
South	Climbers	1.7	0.02
	Sherpas	0.4	
Combined north and south	Climbers	2.5	0.0001
	Sherpas	0.2	
North	Mountaineers	2.0	0.1
South	Mountaineers	1.1	

Mortality on Mount Everest, 1921-2006: descriptive study

Paul G Firth,[1] Hui Zheng,[2] Jeremy S Windsor,[3] Andrew I Sutherland,[4] Christopher H Imray,[5] G W K Moore,[6] John L Semple,[7] Robert C Roach,[8] Richard A Salisbury[9]

WHAT IS ALREADY KNOWN ON THIS TOPIC

What is already known on this topic

The death rate on Mount Everest is greater than that of lower mountains attempted by similar populations of climbers

The death rate among climbers is higher than that among sherpas

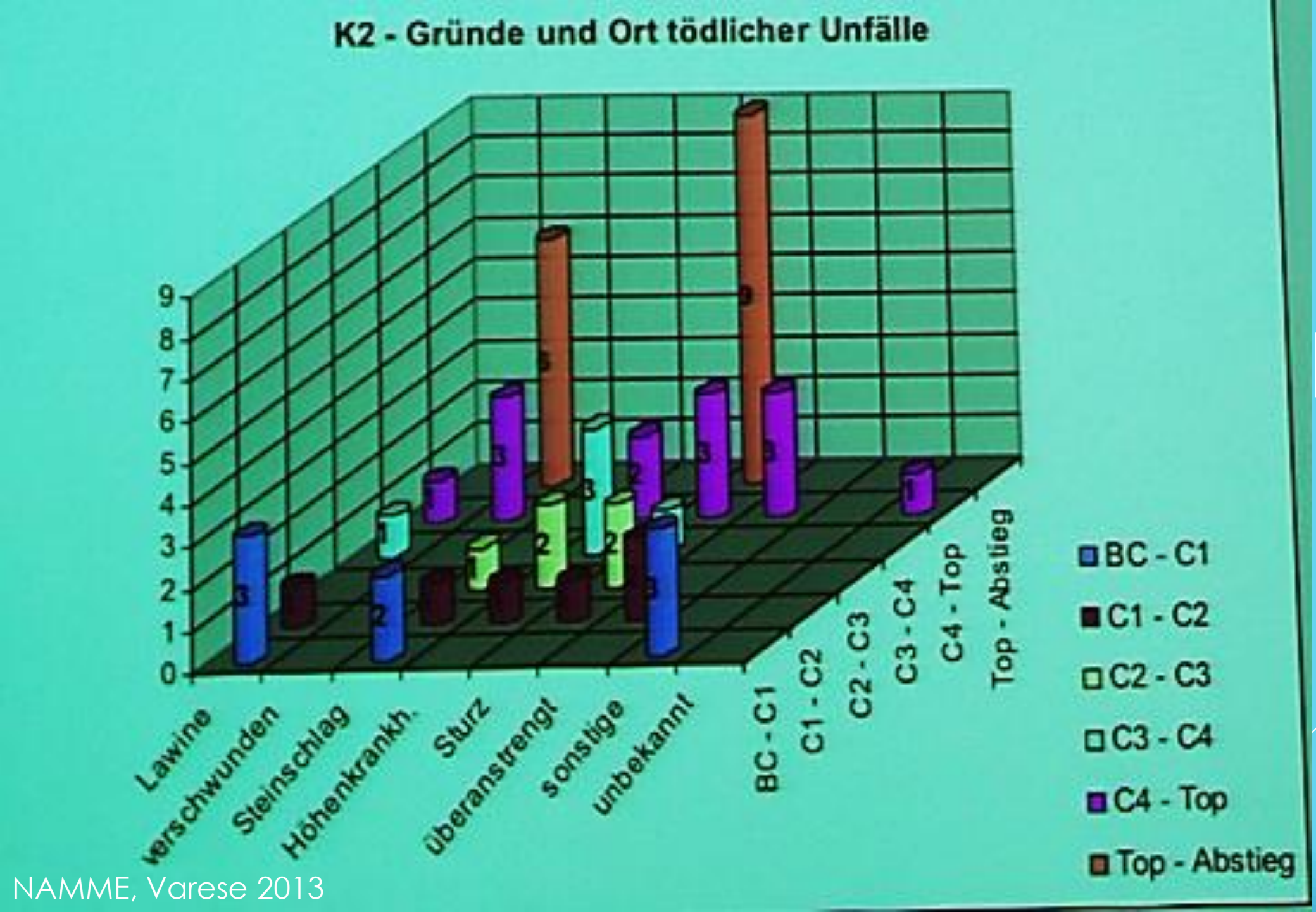
BMJ 2008;337:a2654

WHAT THIS STUDY ADDS

Most climbers on Mount Everst die above 8000 m, usually during descent from the summit

Cognitive impairment and ataxia, symptoms of cerebral oedema, are often present

Profound fatigue and late summit times are early features of non-survivors



K2

Příčina a Místo úrazu

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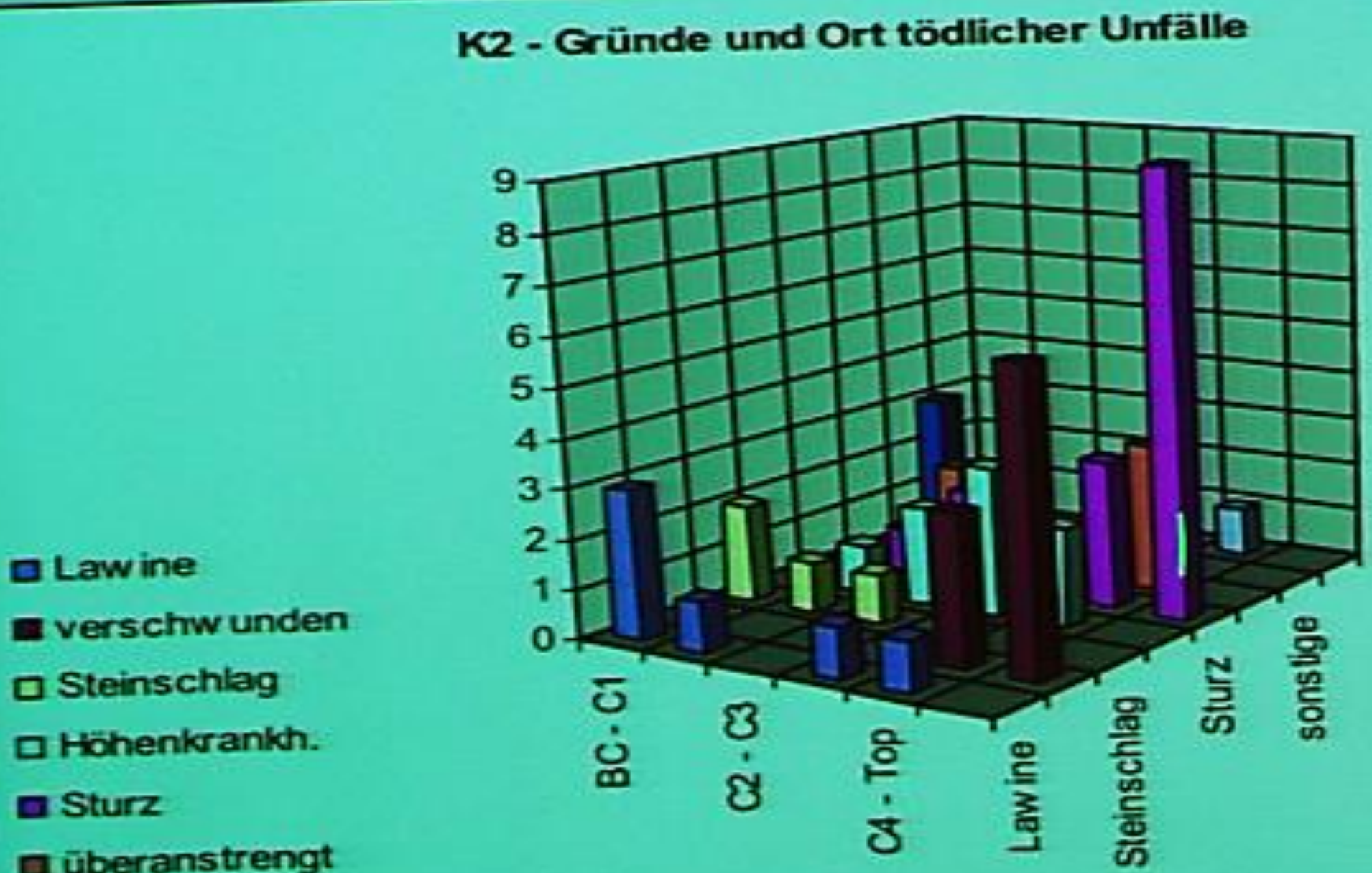
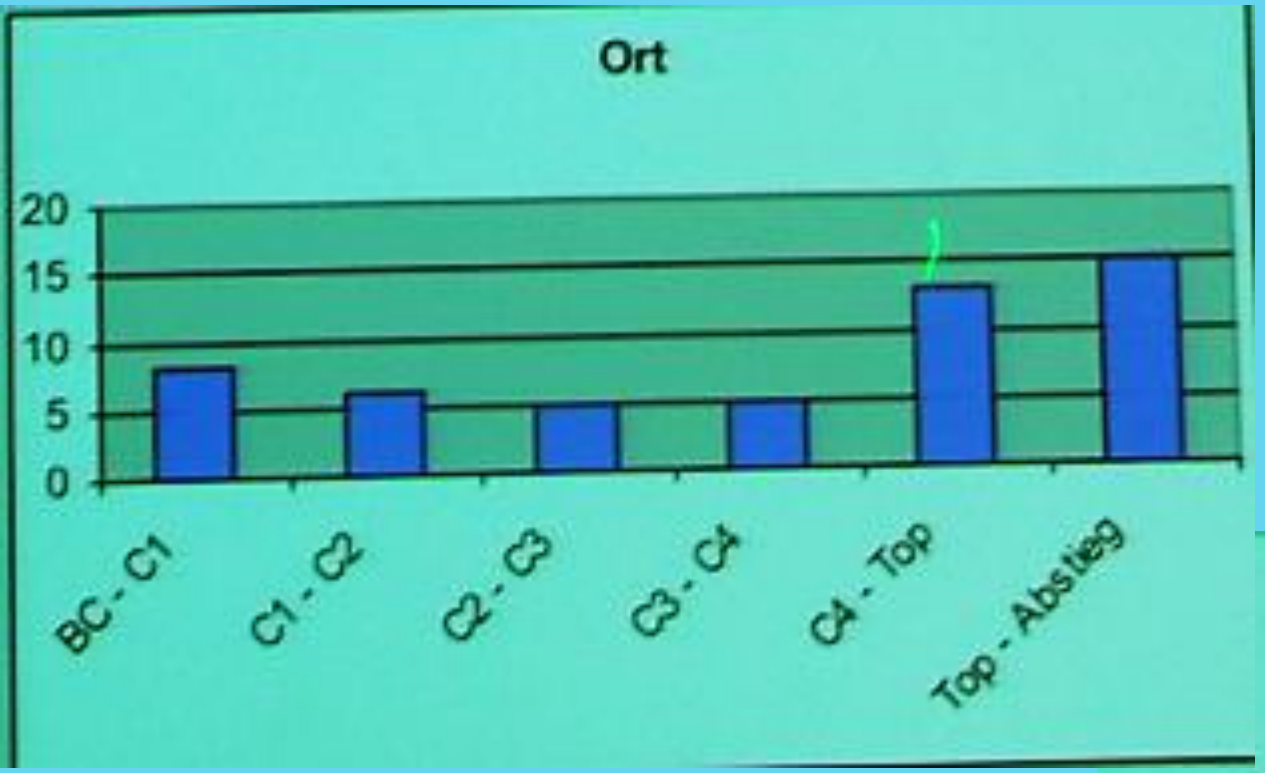
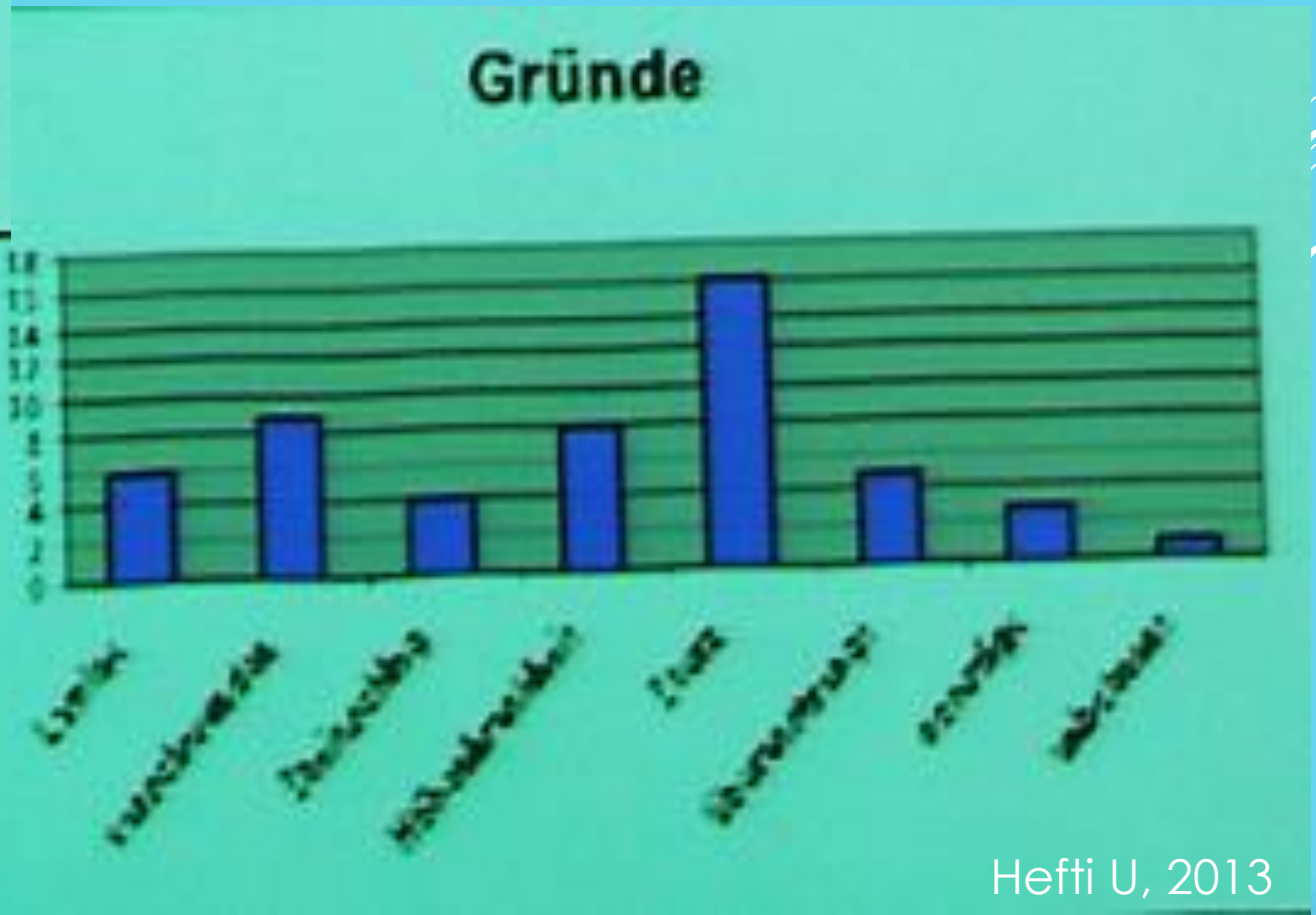
Hefti U, 2013

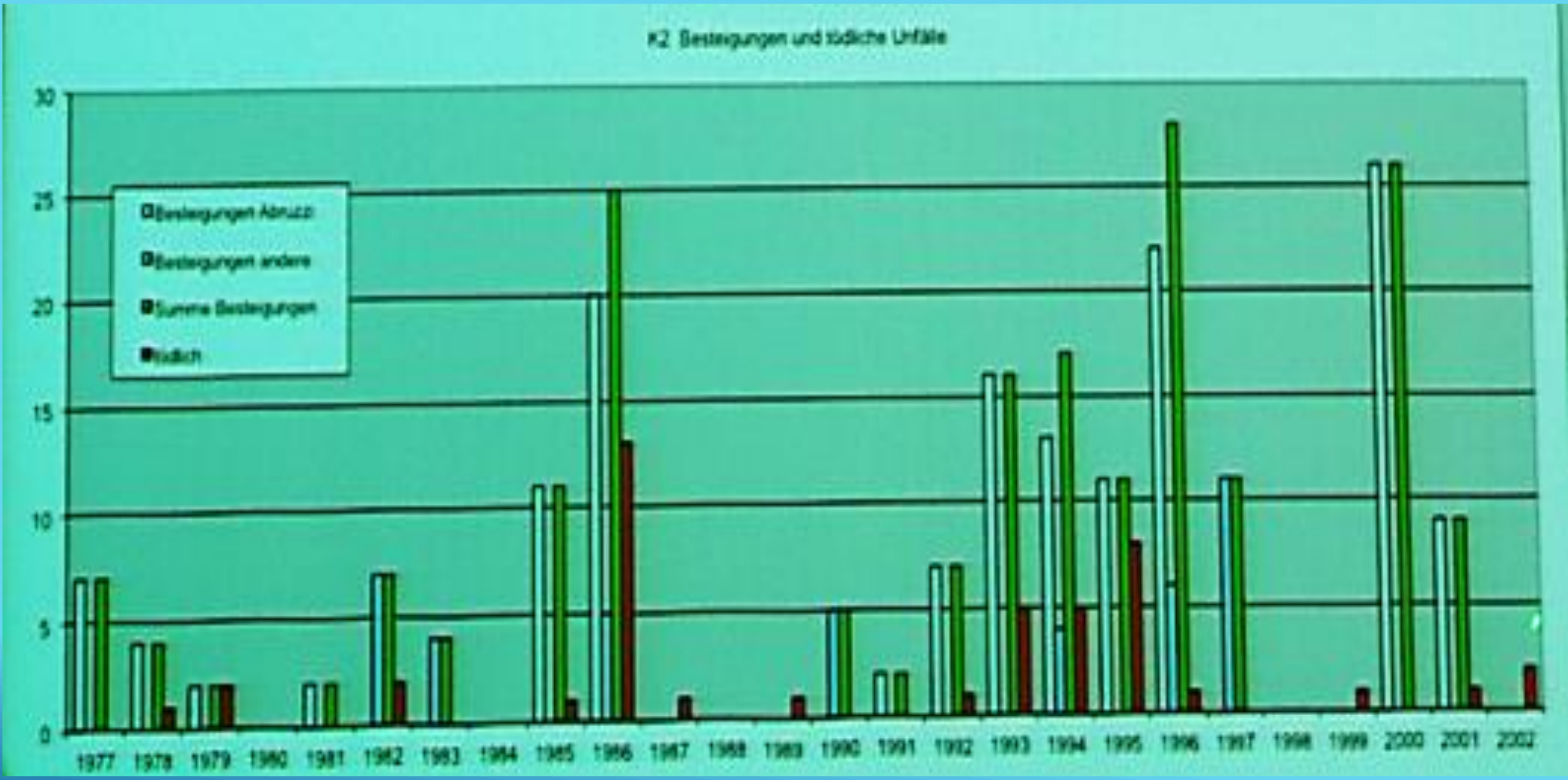
K2

Příčina a Místo úrazu




Ort
20
15
10
5
0
BC - C1
C1 - C2
C2 - C3
C3 - C4
C4 - Top
Top - Abstieg


Gründe


#2 Bestegungen und tödliche Unfälle
Bestegungen Abruzzi
Bestegungen andere
Summe Bestegungen
tödlich
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1977
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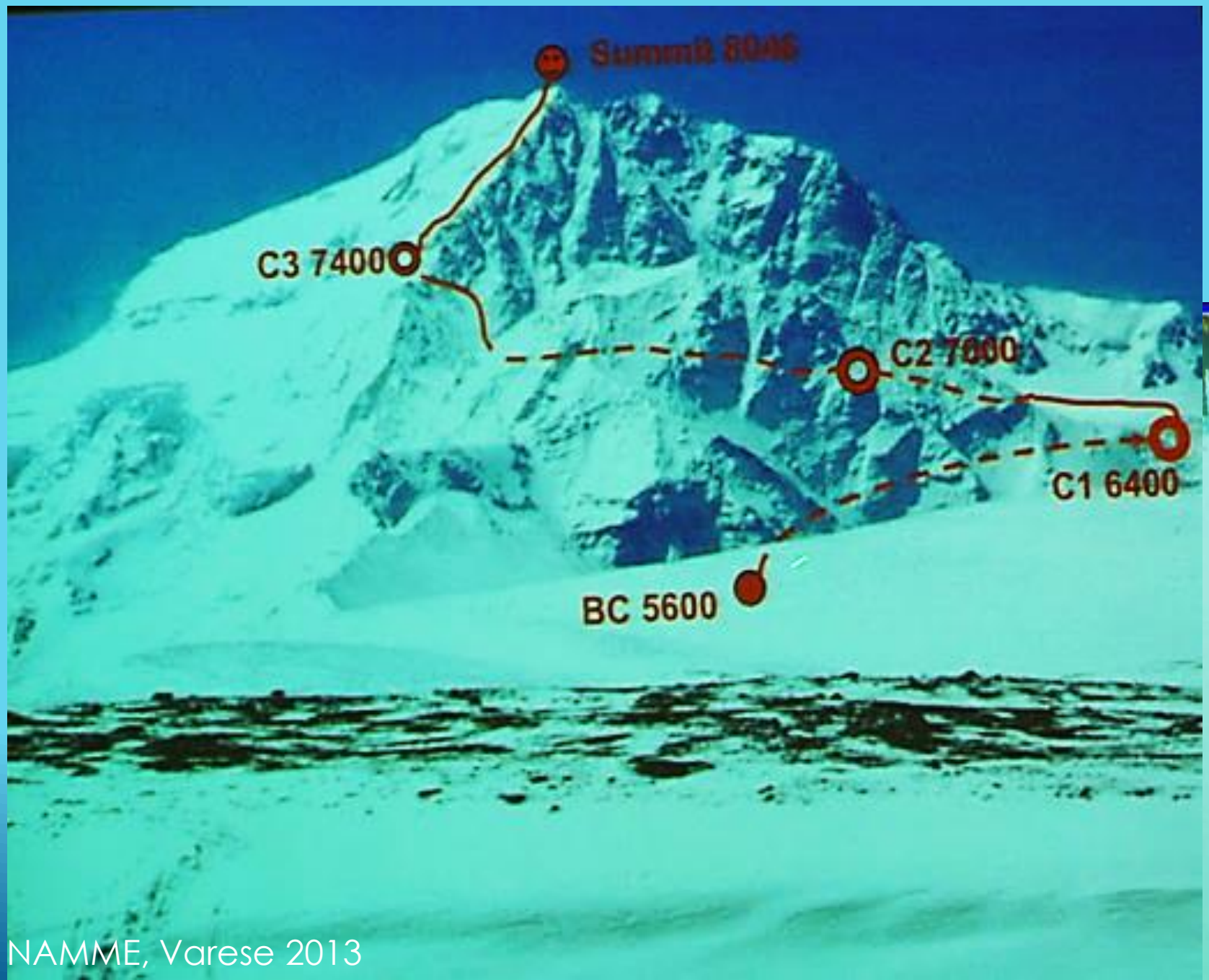
High Altitude illness

Cho-Oyu: první pokus vystoupit do tábora II



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The causes of death among trekkers in Nepal.

Shlim DR, Gallie J

Himalayan Rescue Association, Kathmandu, Nepal.

International Journal of Sports Medicine [1992, 13 Suppl 1:S74-6]

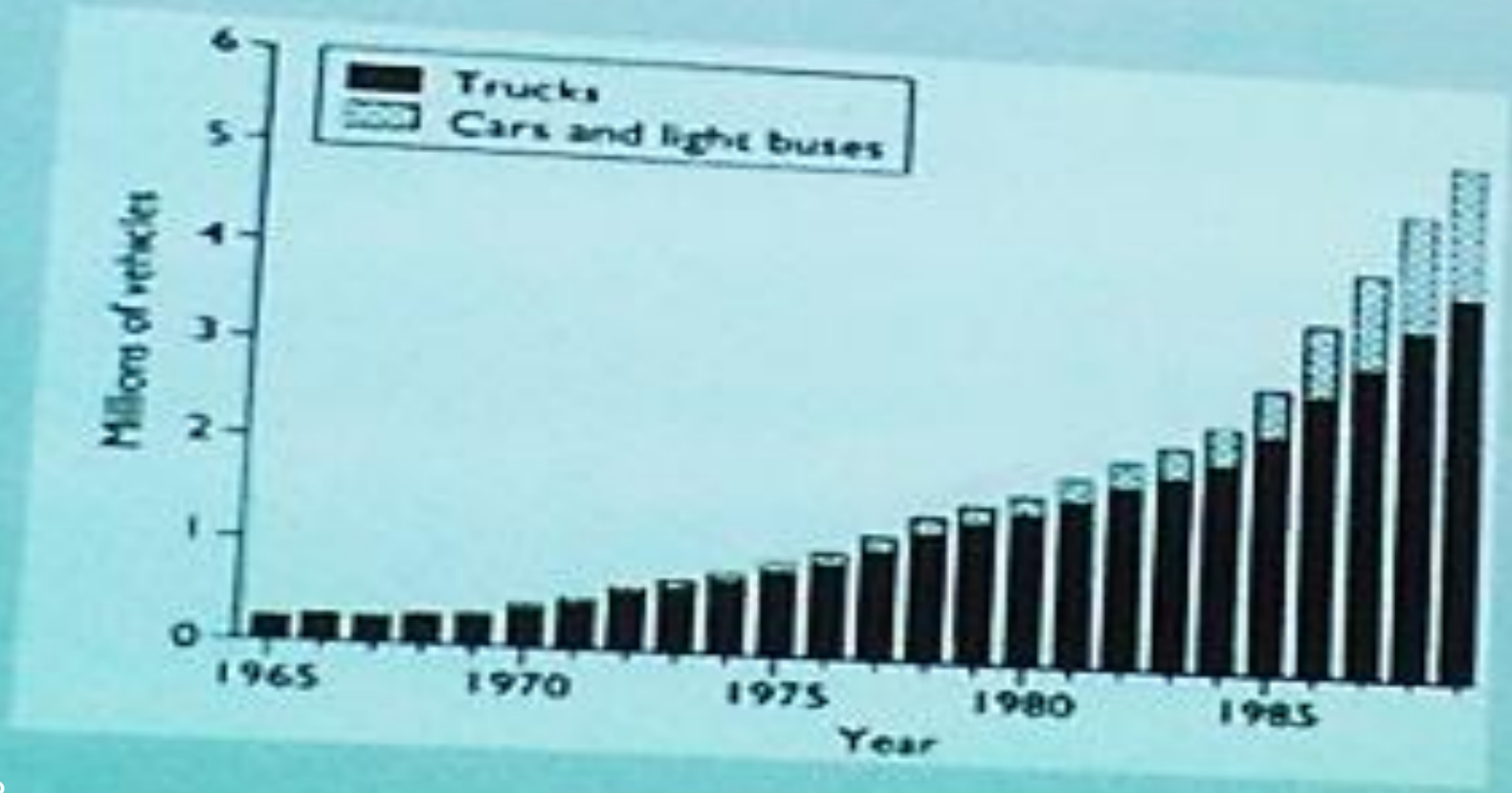
TREKKING

A review of trekking deaths from 1984 to mid-1987 showed a death rate of 15/100,000 trekkers. Altitude sickness deaths accounted for 3/23 (13%) of these deaths. Recently, we followed up on our original study by compiling the number and causes of trekking deaths in Nepal from mid-1987 through 1991. The overall number of deaths was 40, out of 275,950 trekkers (death rate 14/100,000). Illness accounted for 14 deaths, trauma was the cause of 12 deaths, altitude sickness was the cause of 10 deaths, 3 people were found dead after being reported missing, and one person is still missing and presumed dead. Eight out of 10 altitude sickness deaths occurred in organized trekking groups, even though only 40% of trekkers trek in organized groups. Four people were reported to have died from heart attacks, and 3 people died from apparent diabetic ketoacidosis above 4000 meters in altitude. Trekking in Nepal is a relatively safe holiday that currently attracts more than 60,000 people each year. Monitoring the causes of death among trekkers can help generate advice that could make trekking even safer.

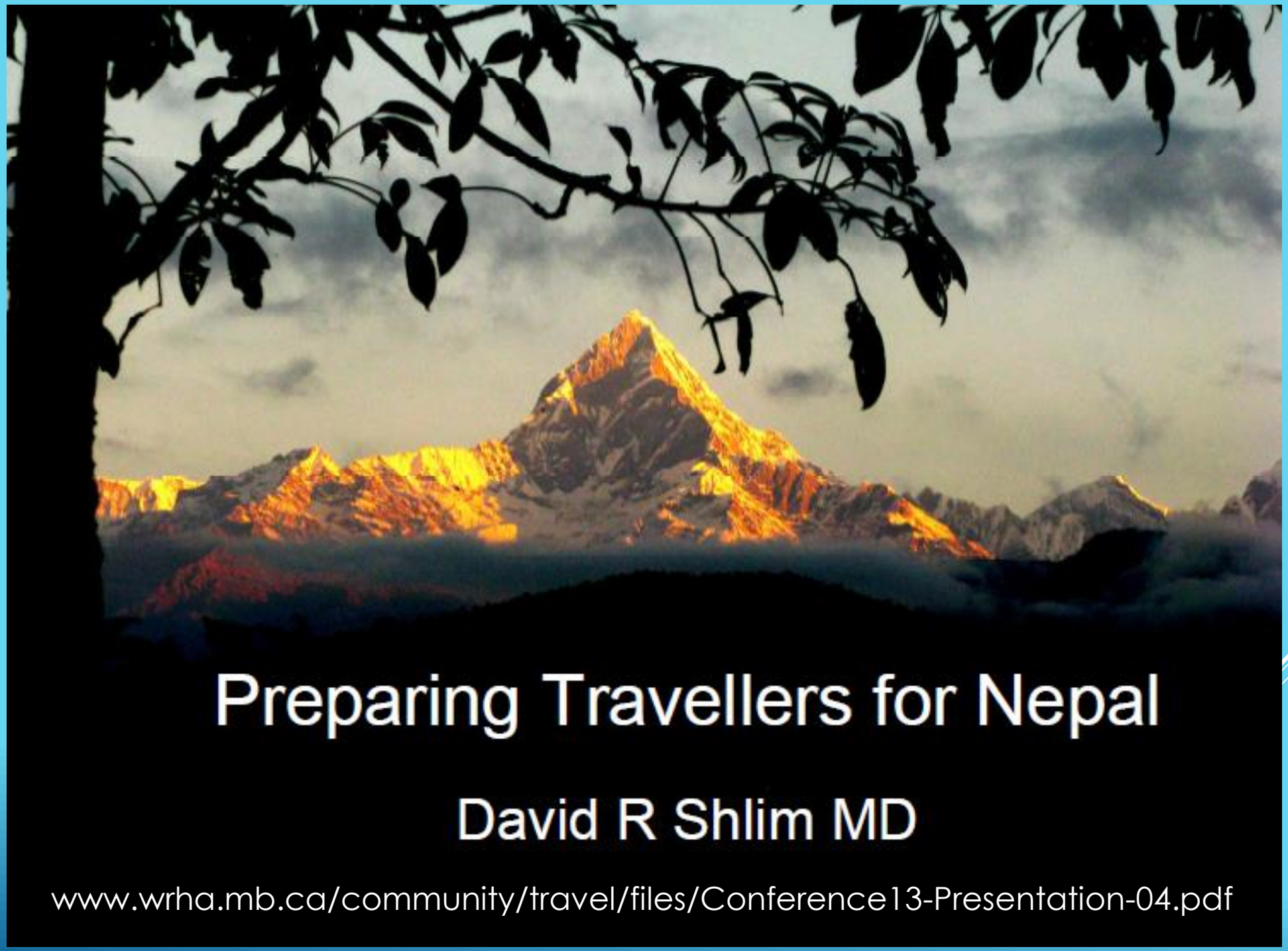
... The overall number of deaths was 40, out of 275,950 trekkers (death rate 14/100,000). Illness accounted for 14 deaths, **trauma was the cause of 12 deaths**, altitude sickness was the cause of 10 deaths, 3 people were found dead after being reported missing, and one person is still missing and presumed dead. ... Trekking in Nepal is a relatively safe holiday that currently attracts more than 60,000 people each year. Monitoring the causes of death among trekkers can help generate advice that could make trekking even safer.

Accidents, injuries and violence

Travellers are more likely to be killed or injured in accidents or through violence than to be struck down by an exotic infectious disease. Traffic accidents are the most frequent cause of death among travellers. ..... It is estimated that more than 1 million people were killed in traffic accidents worldwide in 1998 and a further 10 million were injured.



WHO 2002



www.wrha.mb.ca/community/travel/files/Conference13-Presentation-04.pdf

NAMME, Varese 2013

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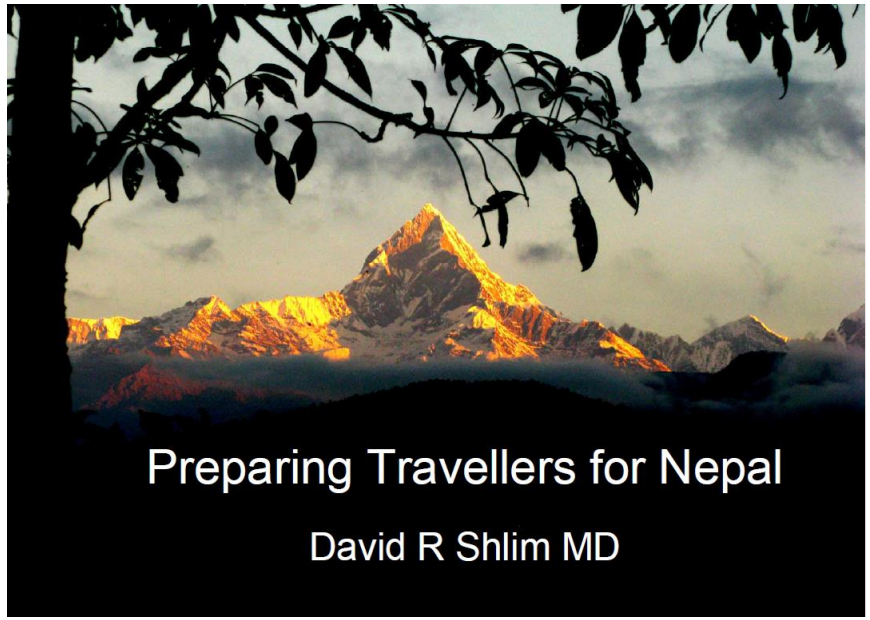
Trekking versus Himalayan Mountaineering



15/100,000

2900/100,000

Deaths per 100,000 people

Wilderness and Environmental Medicine, **8**, 78–81 (1997)

ORIGINAL ARTICLE

Medical problems of porters and trekkers in the Nepal Himalaya

BUDDHA BASNYAT, MD*, AND JAMES A. LITCH, MD

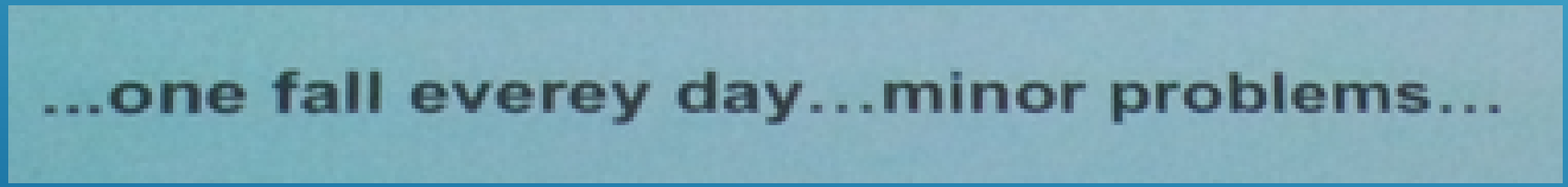
Himalayan Rescue Association and Nepal International Clinic, Katmandu, Nepal

...22-day trekking
102 Nepali porters, 31 Nepali trek staff, 22 Western trekkers
45 % with medical problems
Incidence: porters 52%, trekkers 55%, staff 13%

Bronchitis/Pharyngitis: 12%
AMS: 8%
GE: 6%
Minor problems: 3%

Wanderstöcke und Sturzhäufigkeit

Urs Hefti ,
Himalayan Rescue Association, Nepal; Kantonsspittal Aarau, Chirurgie
Schweizerische Zeitschrift für Sportmedizin und Sporttraumatologie 49 (2), 82–83, 2001



Omrzliny

4.Stupeň postihuje celou tlouštku kůže, i svaly a kosti, gangréna

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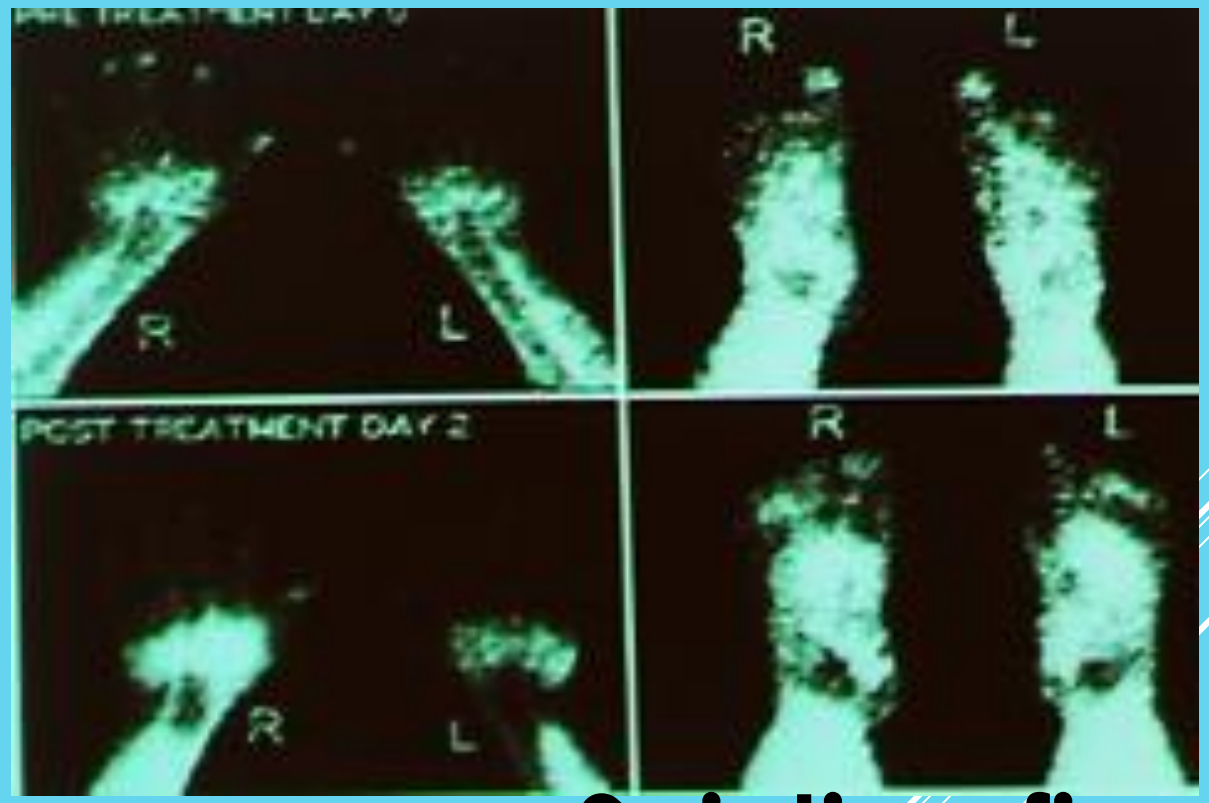
DIAGNOSTIKA



- **Scintigrafie**
- **CT**
- **MRI**

Bhatnagar A.,European J of Nuclear Medicine 2002
Cauchy E, Marsigny B, Allamel G, Verhellen R, Chetaille E.
The value of technetium 99 scintigraphy in the prognosis of amputation in severe frostbite injuries of the extremities: a retrospective study of 92 severe frostbite injuries. J Hand Surg Am 2000;25:969-78

Hefti U, 2013

Management & Therapy ?

Doctor on Expedition

Reduction of the Incidence of Amputation in Frostbite Injury With Thrombolytic Therapy FREE

Kevin J. Bruen, MD; James R. Ballard, BS; Stephen E. Morris, MD; Amalia Cochran, MD; Linda S. Edelman, MPhil, BSN; Jeffrey R. Saffle, MD

Arch Surg. 2007;142(6):546-553. doi:10.1001/archsurg.142.6.546.

Text Size: A A A

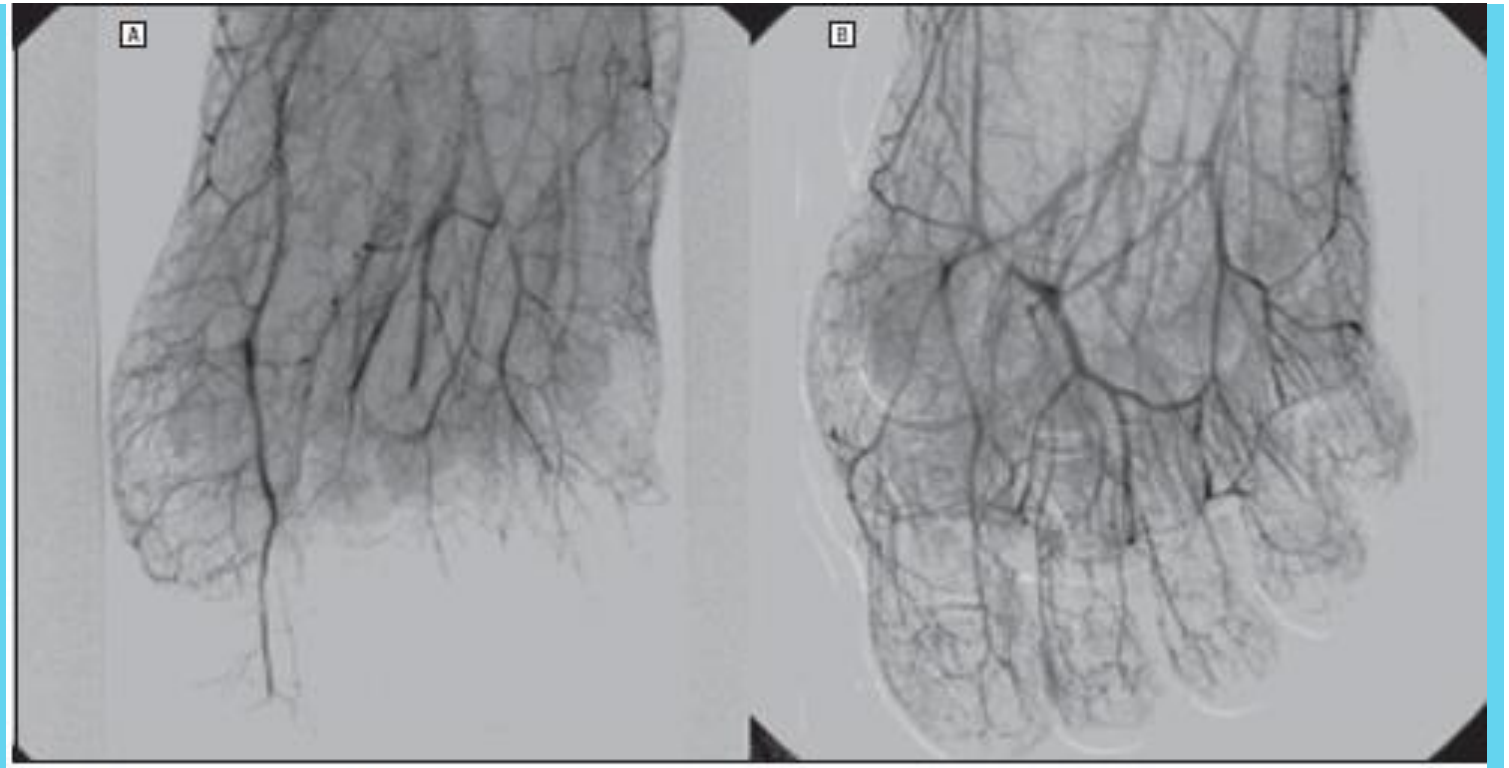


Figure 2. Digital angiography of a 19-year-old woman who sustained bilateral lower extremity frostbite following vehicle breakdown. A, The image demonstrates poor distal perfusion to the left toes. B, Following administration of tissue plasminogen activator via bilateral femoral catheters, angiography demonstrates return of perfusion. All 10 of her toes were saved.

t-PA do 24 h sníží procento amputace prstů ze 41 na 10

NAMME, Varese 2013 Hefti U, 2013

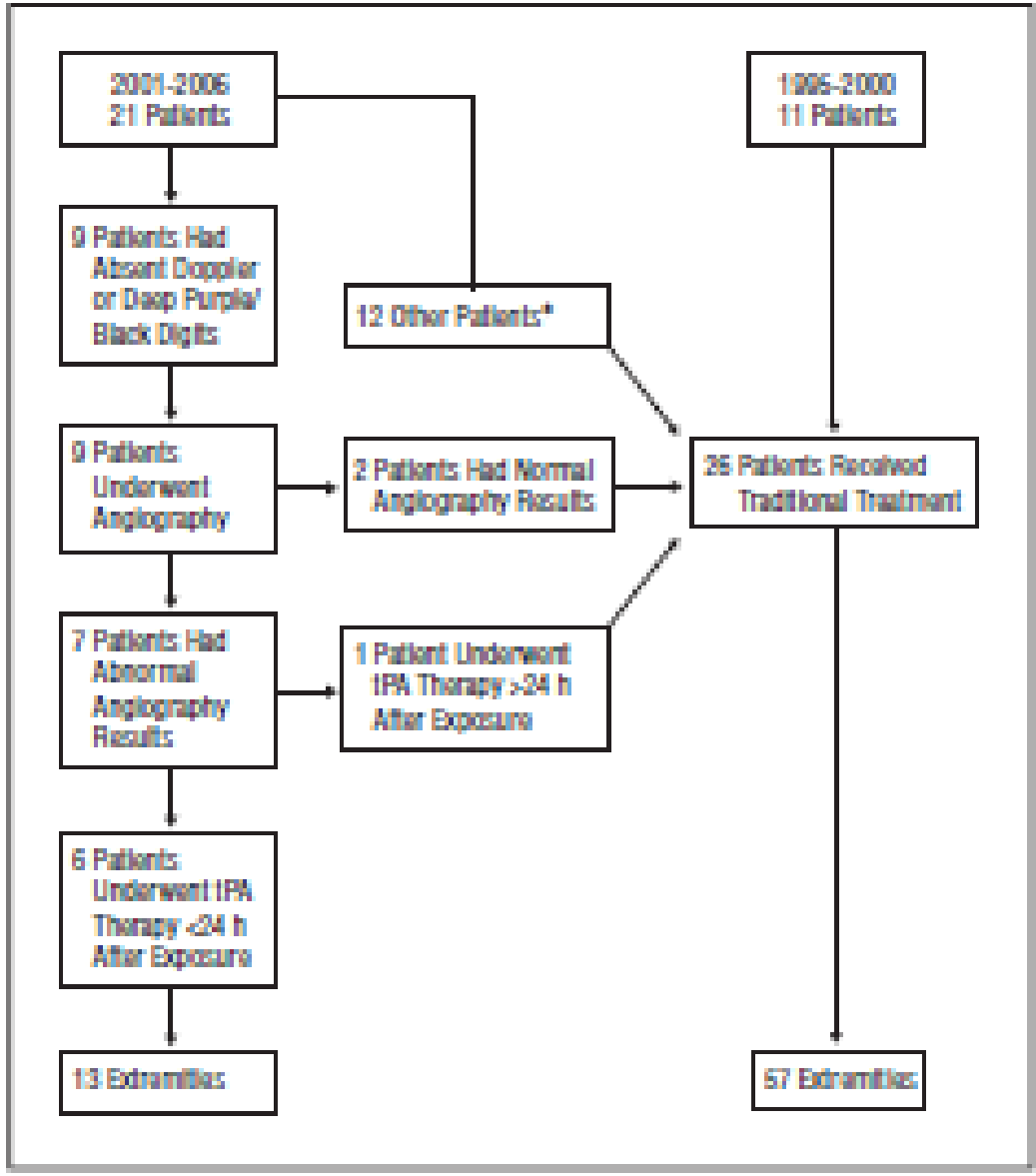


Figure 1. Evaluation and treatment groups of all patients with frostbite at the University of Utah admitted from 1996 to 2006. Asterisk indicates present Doppler/clinical findings were limited to bullae without significant discoloration or a delay in presentation. tPA indicates tissue plasminogen activator.

J R Army Med Corps. 2011 Mar;157(1):73-8.

A clinical review of the management of frostbite.

Grieve AW, Davis P, Dhillon S, Richards P, Hillebrandt D, Imray CH.

Friarage Hospital, Northallerton.

Abstract

Frostbite is a thermal injury that can occur when temperatures drop low enough for tissue to freeze. On rewarming the tissues, an inflammatory process develops which is often associated with tissue loss. The extent of the tissue loss reflects the severity of the cold exposure and includes factors such as temperature, duration, wind chill, altitude, and systemic hypothermia. This review discusses the epidemiology, the pathophysiological processes involved, and the clinical management of frostbite injuries. Practical advice is given on both the field and hospital management and how to seek expert advice from remote situations. The review also discusses newer developments in frostbite treatment such as intra-vascular thrombolysis

CORRESPONDENCE

A Controlled Trial of a Prostacyclin and rt-PA in the Treatment of Severe Frostbite

N Engl J Med 2011; 364:189-190 | January 13, 2011 | DOI: 10.1056/NEJMc1000538

One group received 250 mg of aspirin and buflomedil (400 mg for 1 hour per day), the second received 250 mg of aspirin plus a prostacyclin (0.5 to 2 ng of iloprost per kilogram of body weight per minute for 6 hours per day), and the third received 250 mg of aspirin, iloprost (2 ng per kilogram per minute for 6 hours per day), and fibrinolysis (100 mg of recombinant tissue plasminogen activator [rt-PA] for the first day only)

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our results do not rule out a possible additive effect of rt-PA in selected patients. In addition, there were no significant differences according to frostbite localization, with 183 frozen fingers leading to 22 amputations (buflomedil, 49%; prostacyclin, 0%; prostacyclin plus rt-PA, 2%) and 224 frozen toes leading to 25 amputations (buflomedil, 34%; buflomedil, 0%; prostacyclin plus rt-PA, 4%). The only adverse reactions were minor (hot flushes in 55% of the patients, nausea in 25%, palpitation in 15%, and vomiting in 5%). None of these reactions led to discontinuation of the study medication.

CORRESPONDENCE

A Controlled Trial of a Prostacyclin and rt-PA in the Treatment of Severe Frostbite

N Engl J Med 2011; 364:189-190 | January 13, 2011 | DOI: 10.1056/NEJMc1000538

ASS+Buflomedil = amputace 60%

ASS+iloprost= 0%

ASS+PGD+rt-PA = 19%

Table 1. Number of Amputated Digits (Fingers or Toes) According to Treatment, Severity of Frostbite, and Time to Treatment.*

Treatment Group	No. of Patients	All Stages of Frostbite		All Stages, ≤12 Hr to Treatment		All Stages, >12 Hr to Treatment		Stage 2		Stage 3		Stage 4 or Higher	
		Digits with Frostbite	Digits Amputated	Digits with Frostbite	Digits Amputated	Digits with Frostbite	Digits Amputated	Digits with Frostbite	Digits Amputated	Digits with Frostbite	Digits Amputated	Digits with Frostbite	Digits Amputated
		no.	*no. (%)*	*no.*	*no. (%)*	*no.*	*no. (%)*	*no.*	*no. (%)*	*no.*	*no. (%)*	*no.*	*no. (%)*
All groups	47	407	47 (11.5)	271	13 (4.8)	136	34 (25.0)	155	4 (2.6)	215	31 (14.4)	37	12 (32.4)
Buflomedil	15	106	42 (39.6)	48	11 (22.9)	58	31 (53.4)	31	2 (6.5)	66	31 (47.0)	9	9 (100.0)
Iloprost	16	142	0	79	0	63	0	64	0	75	0	3	0
Iloprost plus rt-PA	16	159	5 (3.1)	144	2 (1.4)	15	3 (20.0)	60	2 (3.3)	74	0	25	3 (12.0)

* Stage 2 frostbite was defined as having at least one digit (finger or toe) with frostbite, with the lesion confined to the distal phalanx; stage 3 as having at least one digit with frostbite, with the lesion extending just past the proximal phalanx; and stage 4 as having at least one digit with frostbite, with the lesion extending proximal to the metacarpal or metatarsal joint.

our results do not rule out a possible additive effect of rt-PA in selected patients. In addition, there were no significant differences according to frostbite localization, with 183 frozen fingers leading to 22 amputations (buflomedil, 49%; prostacyclin, 0%; prostacyclin plus rt-PA, 2%) and 224 frozen toes leading to 25 amputations (buflomedil, 34%; buflomedil, 0%; prostacyclin plus rt-PA, 4%). The only adverse reactions were minor (hot flushes in 55% of the patients, nausea in 25%, palpitation in 15%, and vomiting in 5%). None of these reactions led to discontinuation of the study medication.

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On the basis of these results, we recommend that in the treatment of severe frostbite (stage 3 or above), after rapid rewarming, a combination of aspirin and prostacyclin should be used. The addition of rt-PA should be considered on a case-by-case basis, depending on the severity of injury (at least stage 4 frostbite), the presence of trauma (especially head trauma), any medical contraindications, and the amount of time passed since rewarming.

HIGH ALTITUDE MEDICINE & BIOLOGY
Volume 13, Number 1, 2012
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DOI: 10.1089/ham.2011.1072

Letter to the Editor

Pre-Hospital Wrist Block for Digital Frostbite Injuries

Mathieu Pasquier,[1] Gregoire Zen Ruffinen,[2] Hermann Brugger,[3] and Peter Paal[4]

Pain in both hands was completely relieved within 10 min. Hyperemia in both hands developed, following both water bath re-warming and wrist blocks.

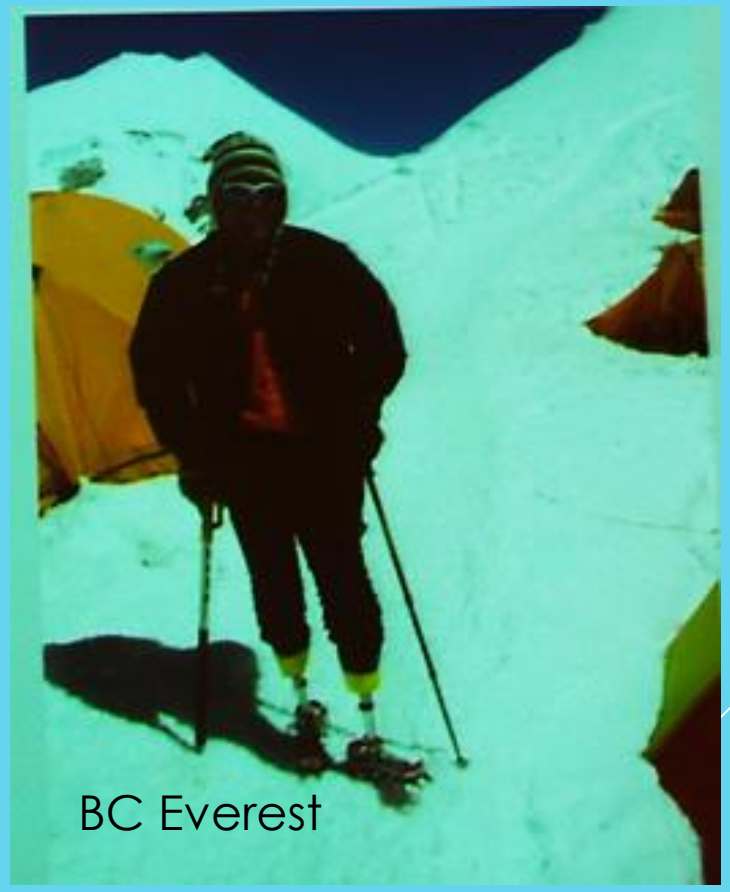
After transient loss of a nail and superficial skin, the fingers recovered within 8 weeks. A mild cold intolerance persisted.

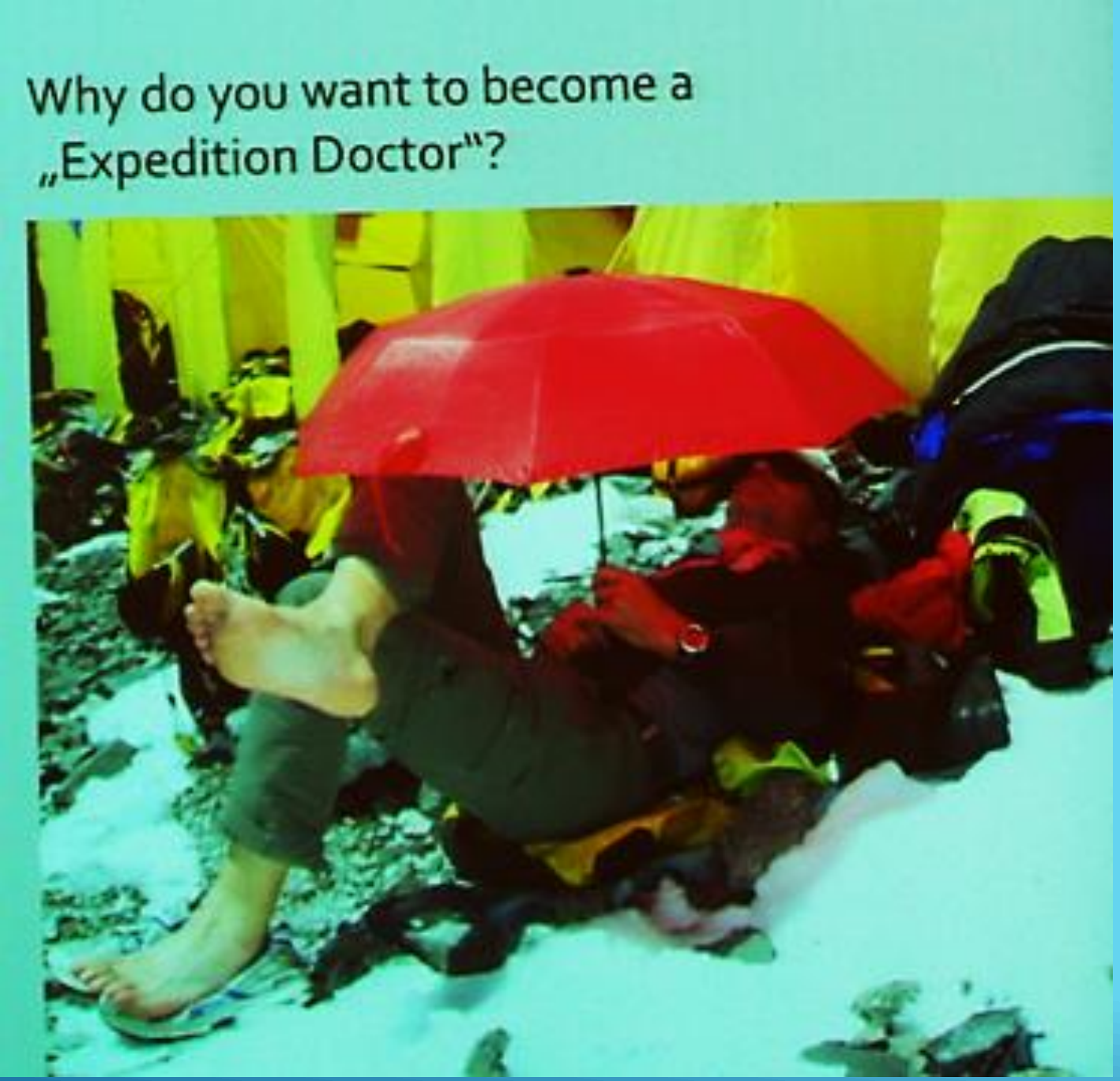
In conclusion, we report the pre-hospital management of frostbite injuries of both distal digital phalanges with warm water bathing and wrist blocks. With frostbite injuries to the hands, a pre-hospital wrist block may be a useful adjunct because it achieves fast and complete pain control and enhances peripheral vasodilation; its role in influencing outcome remains to be determined.

Omrzliny - chirurgie

Obnovené prokrvení ischemických tkání může být provázeno otokem, zvýšený tlak může vést ke vzniku compartment syndromu a vyžádá si fasciotomii

Prevence, časné rozehřátí, časné podání léků a odklad chirurgických zákroků (amputací) zůstávají základními kameny léčení omrzlin
Prof. Buddha Basnyat, Nepál


BC Everest



Proč expedičním lékařem?

Ego?

Dobrodružství?

Lékařská výzva?

Doctor on Expedition and at High Altitude

1. Decision making
2. Team
3. Mountain / work place
4. Myself
5. Information
6. Preparation
7. Trip

Doctor on Expedition and at High Altitude

1. Decision making

„informed consent“

- Manželka / manžel /přítelkyně /…
- Matka / otec / bratr a sestra /…
- Zaměstnavatel
- přátelé

2. Team

- Znalost organizátora, vedoucího
- Znalost všech členů (a jejich problémů)
- Informace o místních partnerech a týmu
- Počet osob, za které má odpovědnost
- Předpokládané problémy (je možné je zmenšit)
- Práva a povinnosti
- Odměna za práci (sleva)

Být kritický

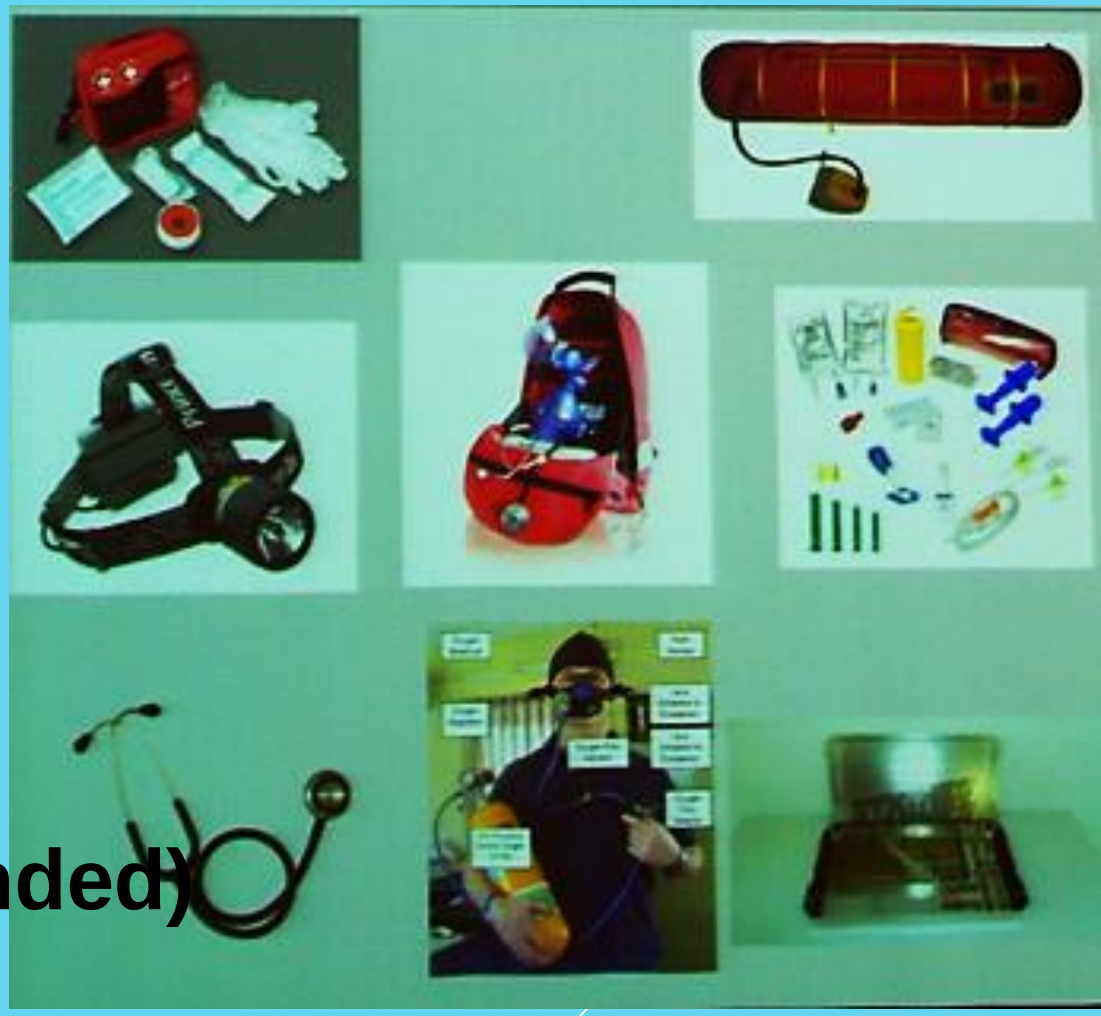
3. V horách, na místě činnosti

- Cesta
- Délka
- Co je v blízkosti základního tábora
- Nouzový východ
- Lezecký profil
- Kolik lidí poleze
- Počet lidí, za které má odpovědnost
- Člen lezeckého týmu nebo více manažer v základním táboře
- Počet pacientů
- Infrastruktura

Doctor on Expedition and at High Altitude

4. Vlastní osoba

- Ego
- Schopnosti, dovednosti
- Nedostatky
- Plánování (time management)
- Zdatnost
- Mít otevřenou mysl (Be open minded)
- Osobní vybavení
- Právní aspekty! (Legal consideration!)



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Doctor on Expedition and at High Altitude

5. Informace

- Získat všechny důležité informace
- Informovat o svých názorech a úmyslech
- Informace o pojištění
- Informace z Internetu
- Informace o osobních lékárničkách
- Znalost všech osobních informací o účastnících
- Informovaný souhlas jak a kdy informovat média

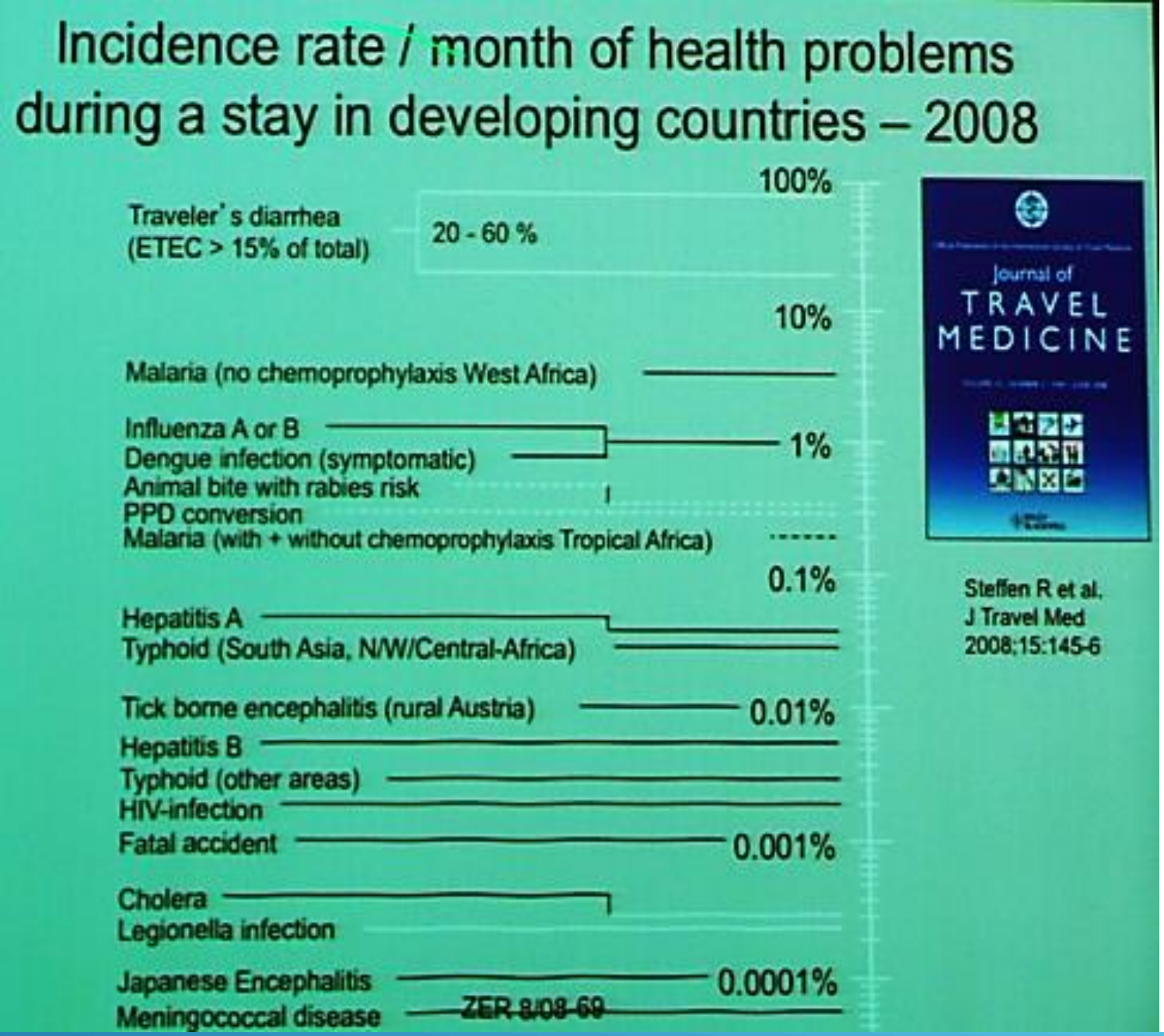
6. Příprava – Lékařské vybavení pro velké výšky

- Osobní výběr a znalosti
- Cíl cesty
- Trvání expedice
- Počet členů expedice
- Zdravotnictví (Medical)
- Očekávání
- Anamnéza
- Rozměry, hmotnost a cena

7. Cesta

- Cestovní medicína!!! (boil it, cook it or leave...)
- Dohled nad skupinou
- V nutnosti zahajovat léčení agresívněji
- Kontrola lékařského vybavení a umístění
- Informace o nemocnicích, ústupových cestách
- Dohled nad aklimatizací skupiny
- Hovory s účastníky (Talk and stay informed)
- Rádio / osobní lékařské vybavení
- Dokumentace

Incidence rate / month of health problems during a stay in developing countries – 2008



Steffen R et al.
J Travel Med
2008;15:145-6

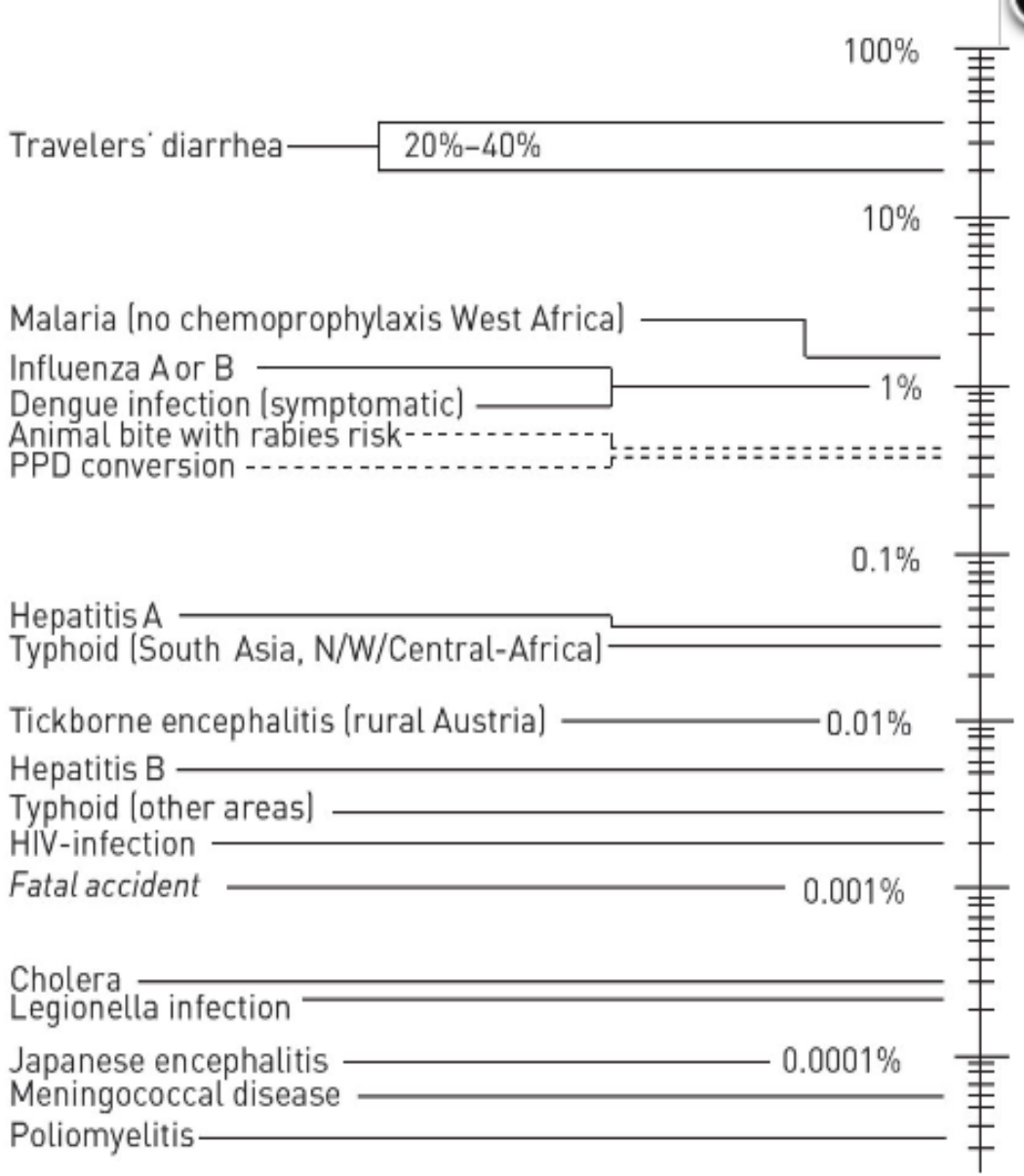
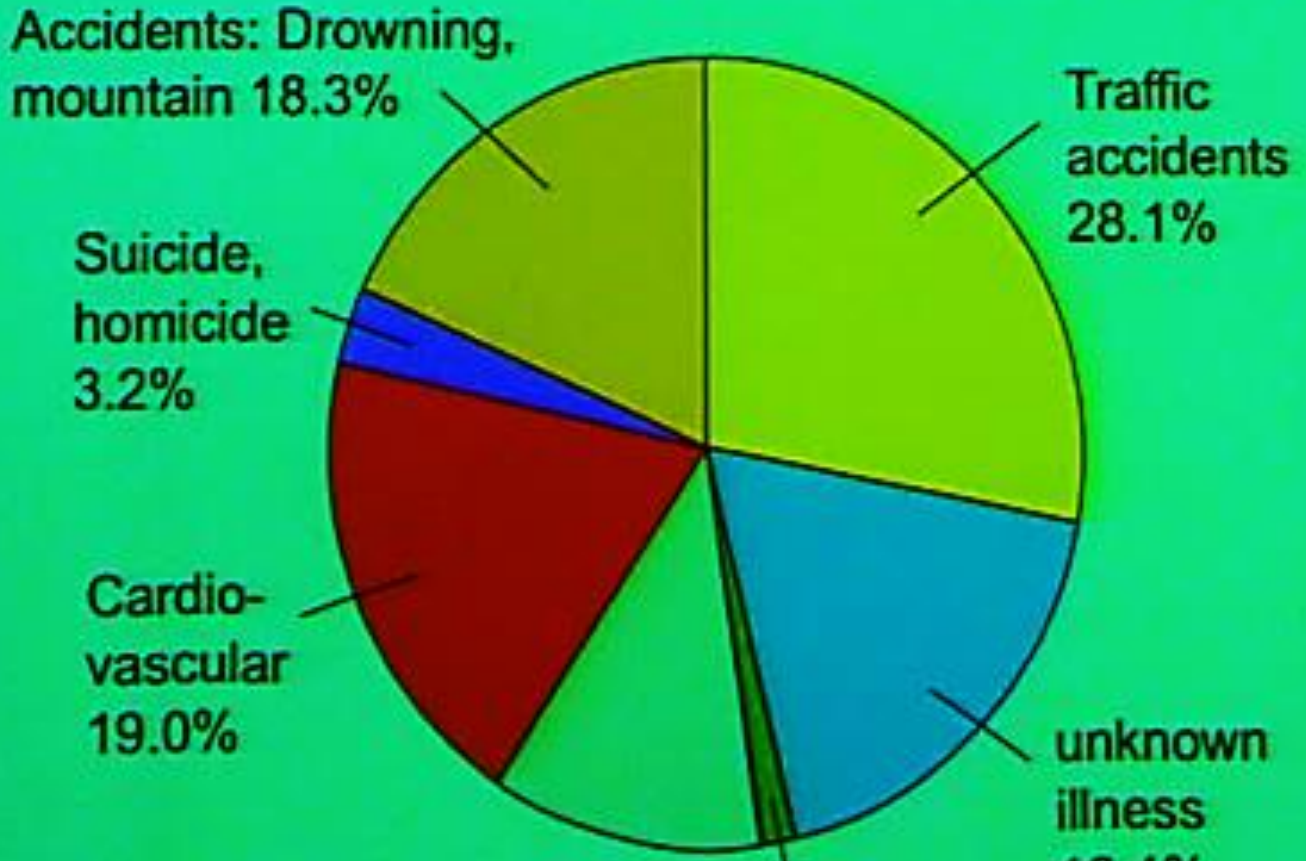


Figure 1-01. Estimated incidence rate per month of infections and fatal accidents among travelers in developing countries, 2010

Fatalities among French abroad 2000 - 2004



Jeannel D et al. BEH 2006/no 23-24/p166-8

ZER 8/08- 70

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Cestovní průjem a podávání tekutin

I když je orální rehydratace vysoce účinná při normalizaci dehydratace a jejích závažných důsledků, nesníží závažnost a nezkrátí trvání průjmu

WHO/CDD/CMT/86.1 Rev. 1 (1988)

Lékařský výzkum

Eur J Appl Physiol. 2013 Aug;113(8):2025-37. doi: 10.1007/s00421-013-2635-6. Epub 2013 Apr 6.

Cognitive performance in high-altitude climbers: a comparative study of saccadic eye movements and neuropsychological tests.

Merz TM, Bosch MM, Barthelmes D, Pichler J, Hefti U, Schmitt KU, Bloch KE, Schoch OD, Hess T, Turk AJ, Schwarz U.

Department of Intensive Care Medicine, Bern University Hospital and University of Bern, Bern, Switzerland, tobias.merz@insel.ch.

32 mountaineers participating in an expedition to Muztagh Ata (7,546 m).

Our data indicates that acclimatized climbers do not seem to suffer from significant cognitive deficits during or after climbs to altitudes above 7,500 m. We demonstrated that investigation of EMs is feasible during high-altitude expeditions

We conclude that severe hypobaric hypoxia is well tolerated in healthy high-altitude climbers, without any indication of acute or long-term impairment of cognitive functions. Furthermore, we demonstrated that the investigation of eye movements is feasible during high-altitude expeditions and could represent a valuable tool for the study of human cognitive function under a variety of environmental conditions.

BRIEF REPORT (WEM 18, 312-316 (2007)

New-Onset Anxiety Disorders at High Altitude

Peter J. Fagenholz, MD; Alice F. Murray, MBChB; Jonathan A. Gutman, MD; John K. Findley, MD;
N. Stuart Harris MD, MFA

RESULTS:

Six of 76 foreign patients and none of the 224 Nepalis seen during the season had anxiety-related primary diagnoses. None of the 6 patients had a history of psychiatric disorders or anxiety-related problems at low altitude. Three of the 6 patients were seen after hours, and all 6 required multiple visits. We describe 3 types of anxiety-related disorders: limited-symptom panic attacks induced by nocturnal periodic breathing, excessive health-related anxiety, and excessive emotionality.

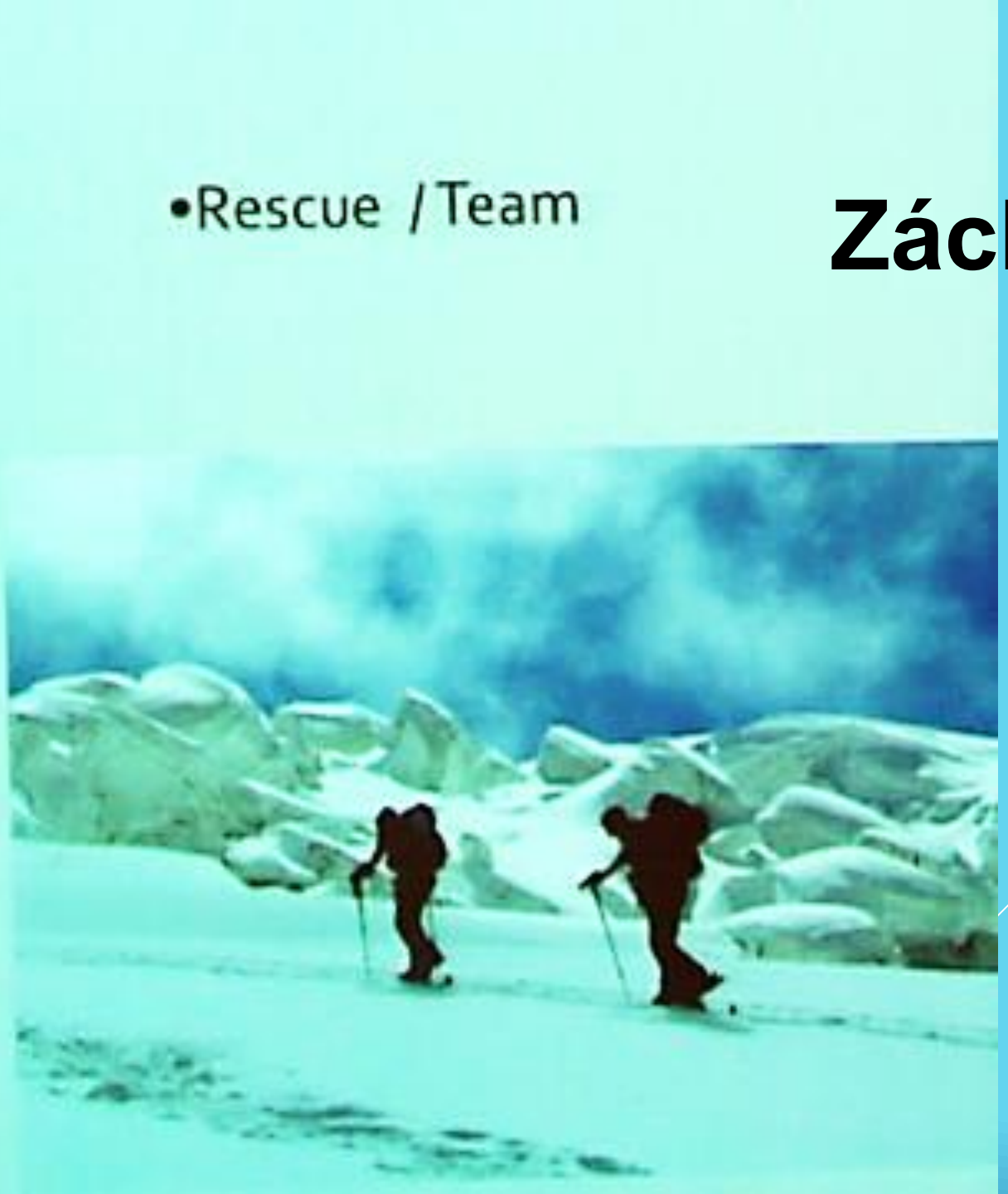
CONCLUSIONS:

Anxiety-related illness requires significant use of medical resources by high-altitude travelers. Further research is needed to define the epidemiology of anxiety-related disorders at high altitude, to quantify the contributions of various etiologic factors, and to identify safe, effective treatments.

Local Team-don‘t forget it!

Local Team - don´t forget it!

Záchrana



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Personal statement

Keep it simple !

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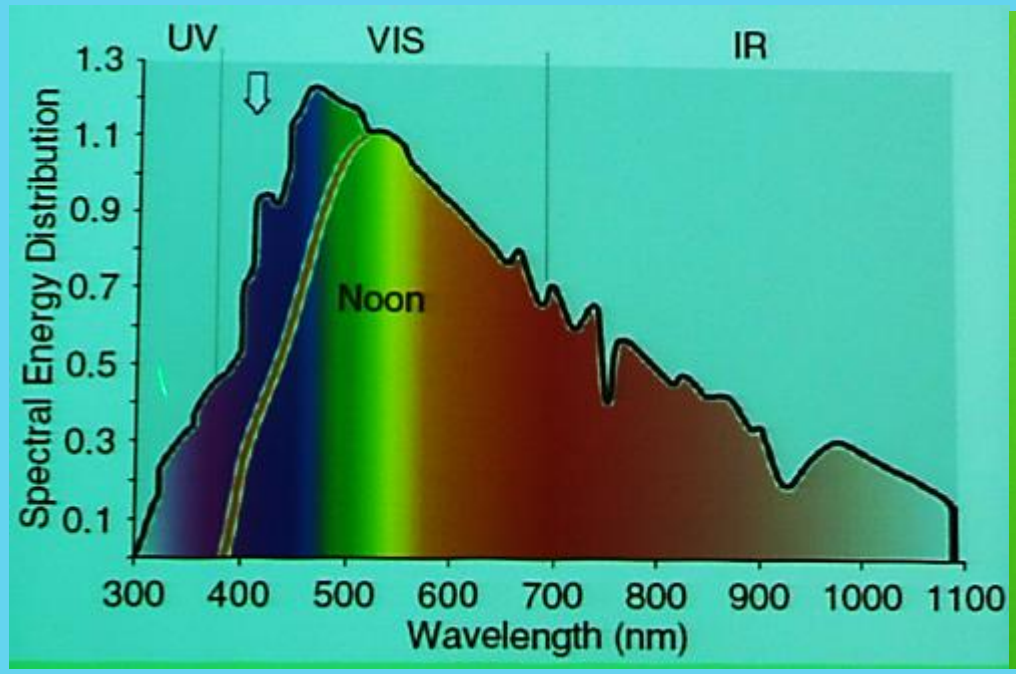
Doctor on Expedition

SLUNEČNÍ ZÁŘENÍ A OČNÍ PATOLOGIE VE VELKÝCH VÝŠKÁCH

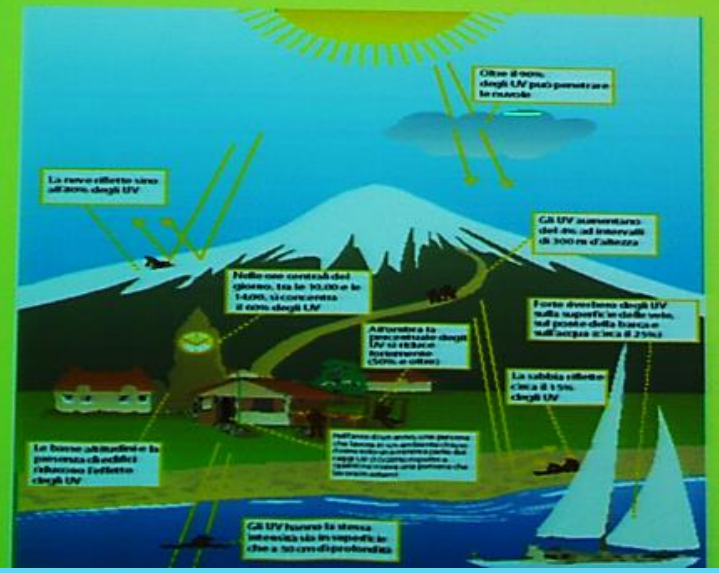
Irradiazione solare e patologia oculari ad alta quota

Paolo M. Conci

NAMME, Varese 2013



FATTORI DI RADIAZIONE UV



Ogni 300 metri di incremento di quota, i raggi UV aumentano del 4%....quindi a 3000 metri la irradiazione UV sarà del 20% maggiore che a 1500

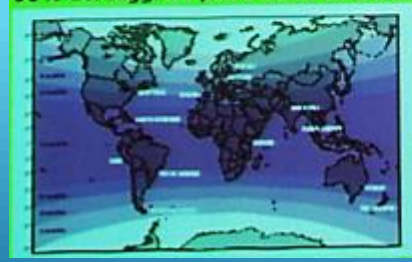
4500 m → +40%

6000 m → +60%

FATTORI DI RADIAZIONE UV

COME?

Le radiazioni dirette dipendono da:
Latitudine: le radiazioni UV sulla terra dipendono dall' angolo di incidenza dei raggi UV nell' atmosfera: ai tropici (latitudine 0° o in prossimità dell' equatore), le radiazioni UV sono più intense.
Altitudine: l' intensità degli UV aumenta in funzione dell' altitudine. Più il livello dal mare è elevato,più l' atmosfera, che assorbe una parte dei raggi UV, è rarefatta.
Radiazioni indirette
Riverbero sul suolo: gli UV aumentano in diversa maniera a seconda della superficie di contatto.
Attenzione alle nuvole! In condizioni di cielo limpido le radiazioni UV sono alla loro massima intensità. In condizioni di forte nuvolosità, il passaggio si riduce ma più del 90% dei raggi UV può ancora filtrare.

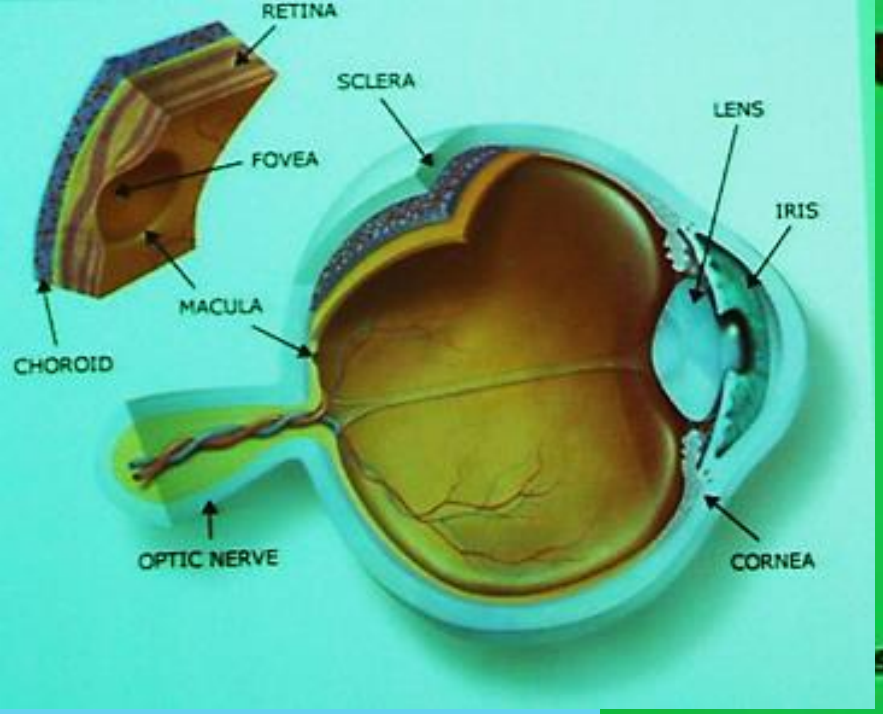


Sintesi

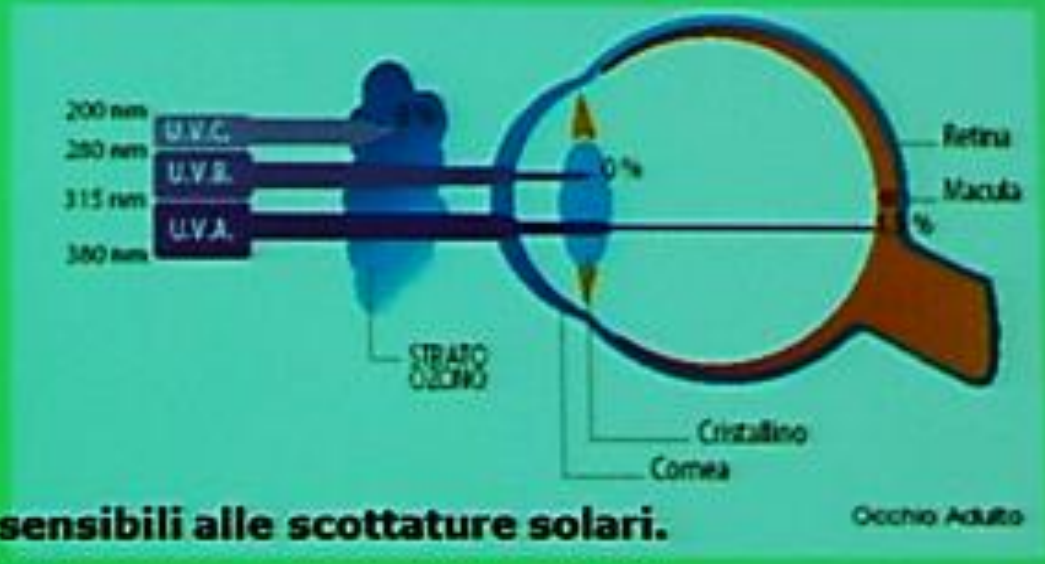
I mezzi oculari assorbono UV, Visibile, IR

- UV è sempre pericoloso
- Del visibile la radiazione blu determina una diminuzione dell'acuità visiva e del contrasto => opportuna una filtratura
- IR pericoloso soltanto se associato ad alta temperatura

LA NEVE RIFLETTE FINO AL 80% DEGLI UVB



FESA NATURALE DAI RAGGI SOLARI



sono particolarmente sensibili alle scottature solari.

Mucose: la superficie interna delle palpebre e la parte bianca dell' occhio (sclera) possono essere soggette ad infiammazioni.

Cornea: primo filtro naturale dell' occhio. L' esposizione solare per una o due ore senza protezione, può determinare arrossamento e/o bruciore (cheratite).

Cristallino: i raggi UV possono originare la formazione precoce di cataratta, caratterizzata da una opacità del cristallino. Prima dei 18/20 anni, il cristallino non ha ancora completamente formato la sua funzione di filtro fisiologico dell ' occhio. Per questo motivo, i giovani devono essere i primi ad essere interessati alla protezione.

Retina: i raggi UV e HEV (luce blu) possono colpire la retina provocando reazioni fototossiche, causa potenziale di degenerazione maculare senile.

LA PROTEZIONE INCOMINCIA SIN DALL'INFANZIA

Contrariamente a quanto si possa pensare, i bambini non sono immuni ai rischi di lesioni oculari dovute alle radiazioni UV.
Nei neonati il cristallino è trasparente e particolarmente sensibile ai raggi UV.

- Sino ad 1 anno di età, il 90% dei raggi UVA e più del 50% dei raggi UVB colpiscono la retina.

- Tra i 10 ed i 13 anni, il 60% delle radiazioni UVA e il 25% delle radiazioni UVB colpiscono la retina.

- Verso i 18-20 anni, la difesa naturale è completamente sviluppata, ma persiste la necessità di un'ulteriore protezione. Gli eventuali danni provocati alla retina dalle radiazioni solari si accumulano con il passare degli anni.

- Nel corso della vita, circa l'80% delle esposizioni avviene prima dei vent'anni.

Rispetto agli adulti, i bambini trascorrono molto più tempo all'aperto, soprattutto durante i mesi estivi quando i raggi sono più intensi.

Un'esposizione prolungata merita un'adeguata protezione dal sole al fine di ridurre i rischi di affezioni.Quanto prima viene adottata questa protezione, quanto più la vista sarà preservata nel tempo.

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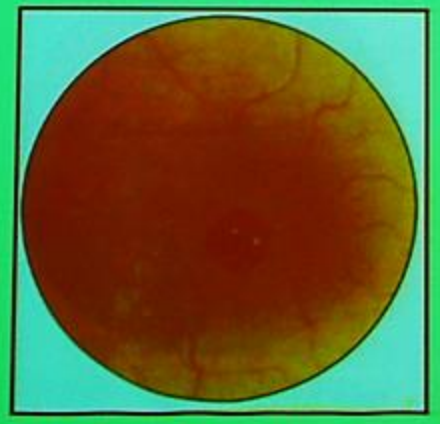
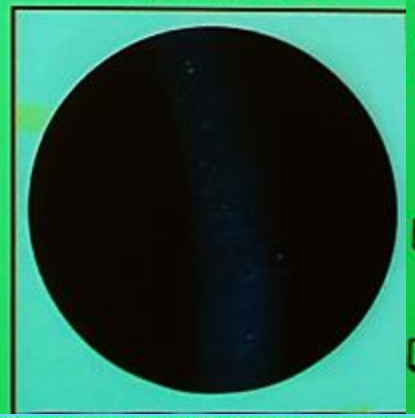
Patologie

Nuove prospettive in Medicina ed Emergenza in Montagna Varese 18-19 aprile 2013
Paolo M. Conci



Retinopatia solare

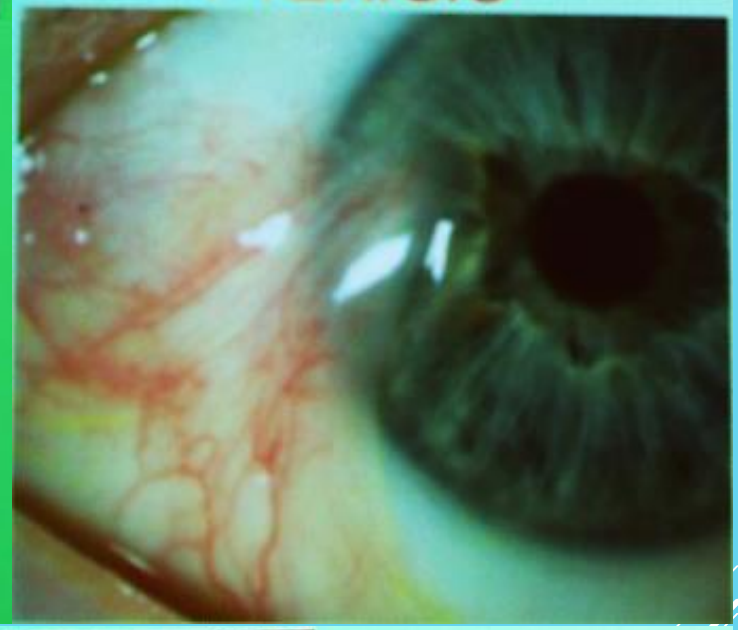
Fotokeratite



Patologie oculari di alta quota non legate all' irradiazione solare complicanti AMS

- Edema retinico (edema cerebrale)
- Deficit del campo visivo da edema cerebrale o da emorragie retiniche
- Emorragie retiniche (sintomatiche e non)
- Complicanze di cheratotomia radiale

PTERIGIO

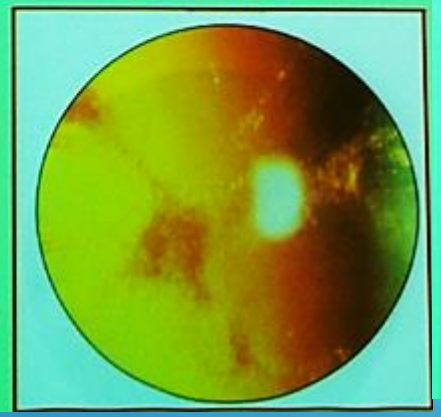


Patologie

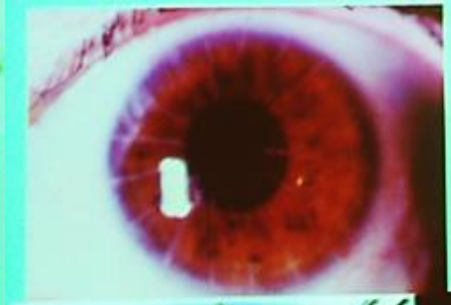
Nuove prospettive in Medicina ed Emergenza in Montagna Varese 18-19 aprile 2013
Paolo M. Conci

Degenerazione maculare senile

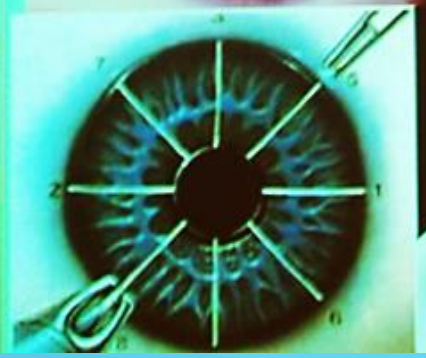
Cataratta

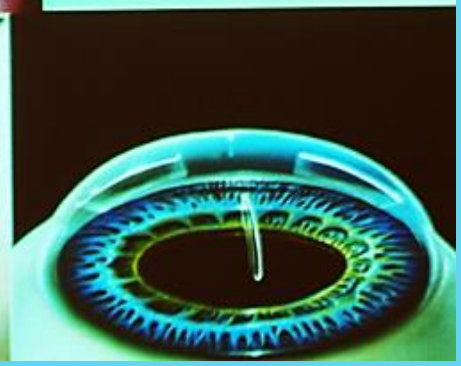


EMORRAGIA RETINICA



CHERATOTOMIA





Cosa fare

- Interrompere l'ascensione
- Sospendere l'eventuale somministrazione di aspirina
- Somministrare acetozolamide

Possiamo considerare la prevenzione (primaria) come quel sistema di norme e regole che disciplinano un esercizio sportivo cercando di ridurne i rischi per i praticanti

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Conci, 2013

Caratteristiche delle lenti filtranti

I fenomeni che interessano la radiazione che incide su di una lente:

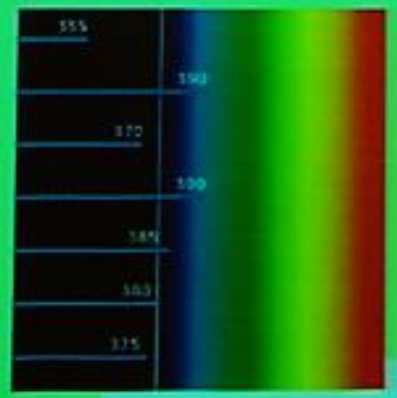
Diffusione (abbagliamento)

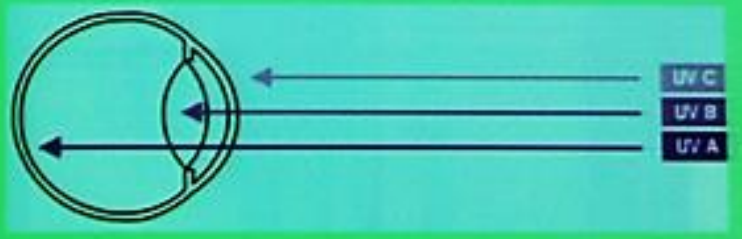
Assorbimento (filtro dell' occhiale da sole)

Riflessione (specchiatura)

Trasmissione (ciò che arriva all' occhio)

100% protezione UVB e UVA





ATTENUAZIONE DELLA LUCE BLU

L' occhio fatica a focalizzare la luce blu che diffonde e tende ad attenuare il contrasto cromatico.

Limitare la luce blu significa aumentare il conforto della visione e l' accentuazione dei contrasti cromatici (colore rosso marrone)

FATTORE COMFORT

Un filtro confortevole viene utilizzato per tempi più lunghi diminuendo l' esposizione ai danni della luce.

Il miglior occhiale da sole deve essere il più possibile protettivo e il più possibile confortevole.

NAMME, Varese 2013

Conci, 2013

TONALITÀ SCURE

RIDUZIONE DELL' INTENSITÀ LUMINOSA

Le categorie 3 e 4 sono considerate tinte solari in quanto proteggono da forti intensità luminose.

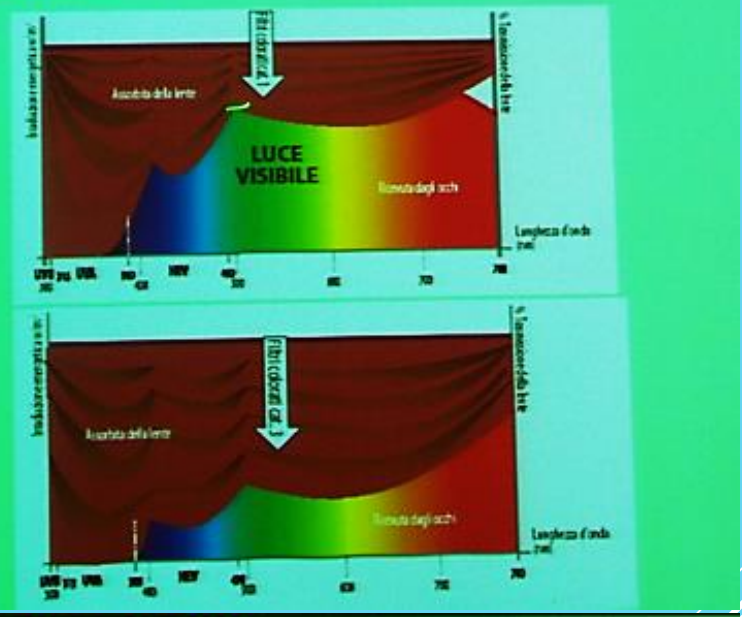
Protezione dagli UV al 100%

In origine, le tonalità scure non furono concepite allo scopo di bloccare al 100% i raggi UV. La scoperta che i raggi solari potessero provocare danni, ha orientato la produzione verso lenti scure in grado di proteggere gli occhi secondo la norma ISO.

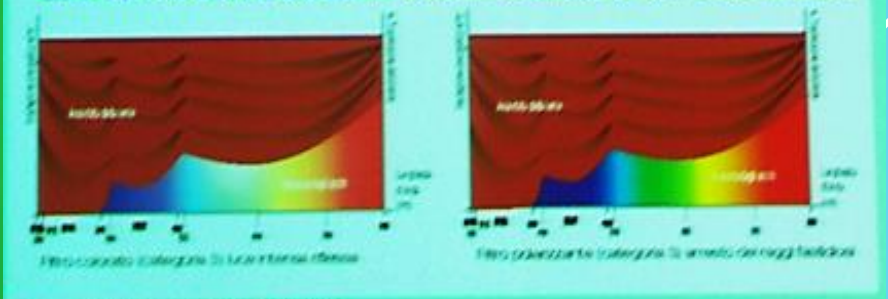
Colori scuri

E' comunemente condiviso il concetto che alcuni colori presentino proprietà particolari,ma non è così determinante da condizionare la scelta personale di ogni individuo.

I FILTRI COLORATI RIDUCONO L' INTENSITÀ LUMINOSA



FILTRI POLARIZZANTI: ELIMINAZIONE DELL' ABBAGLIAMENTO DA RIVERBERO



Quando la luce naturale (onde oscillanti in tutte le direzioni) colpisce una superficie riflettente in un determinato angolo, si polarizza (le onde oscillano orizzontalmente)
La luce polarizzata orizzontalmente provoca un effetto di abbagliamento da riverbero.
Il filtro polarizzante contiene dei cristalli di iodio, allineati in file verticali parallele che bloccano la luce orizzontale, eliminandone i riflessi intensi

TRATTAMENTO ANTIRIFLESSO SULLA SUPERFICIE INTERNA DELLA LENTE

RIDUZIONE DEI RIFLESSI INDESIDERATI

Senza trattamento antiriflesso sulla superficie interna

I raggi che non passano attraverso le lenti ma arrivano di lato e dietro di noi, penetrano direttamente negli occhi e disturbano la visione.

Con trattamento antiriflesso sulla superficie interna

I riflessi fastidiosi sono attenuati e la visione è più confortevole.

TRATTAMENTO SPECCHIATO

LENTI ALLA MELANINA

(pigmento naturale che assorbe la luce UV, viola e blu)

LENTI FOTOCROMATICHE

TRATTAMENTO FOTOSELETTIVO

con filtri equalizzatori

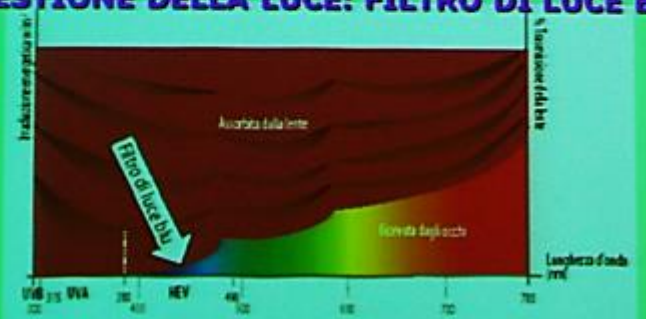
AUMENTO DEL CONTRASTO CROMATICO

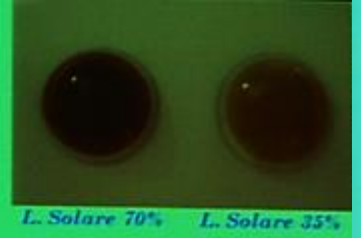
FILTRI EQUALIZZATORI SULLE ZONE DI SOVRAPPOSIZIONE CROMATICA TRA BLU GIALLO E ROSSO.

MIGLIORANO IL CONTRASTO, RIDUCONO L'ABBAGLIAMENTO E I TEMPI DI REAZIONE CON SIGNIFICATIVI MIGLIORAMENTI DELLE PRESTAZIONI SPORTIVE.

I FILTRI CHE ARRESTANO IN MODO SPECIFICO I RAGGI UV

SISTEMA DI GESTIONE DELLA LUCE: FILTRO DI LUCE BLU

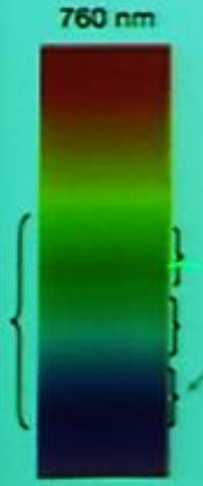




EFFETTO SELETTIVO SU IRIDE CHIARA

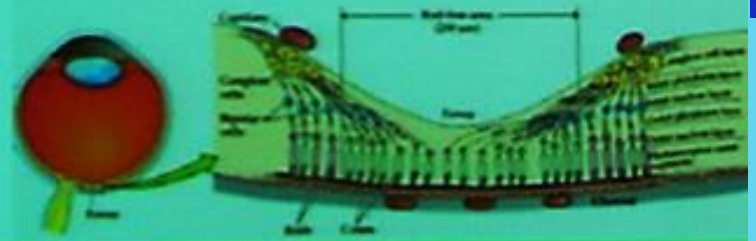
Funzione di un filtro fotoselettivo

Modulatore di energia



Operano un taglio e /o una riduzione di energia che arriva sul sistema oculare.

Esempio => Assorbono la luce blu (445 nm)

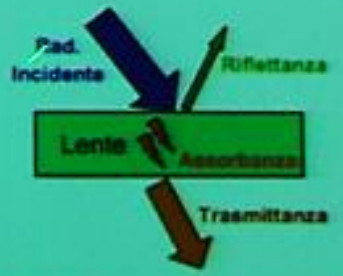


PROTEZIONE OCULARE MEDIANTE MONTATURE PROTETTIVE

(MASCHERE DA SCI, MONTATURE AVVOLGENTI)

Filtri Fotoselettivi

Caratteristiche dei filtri

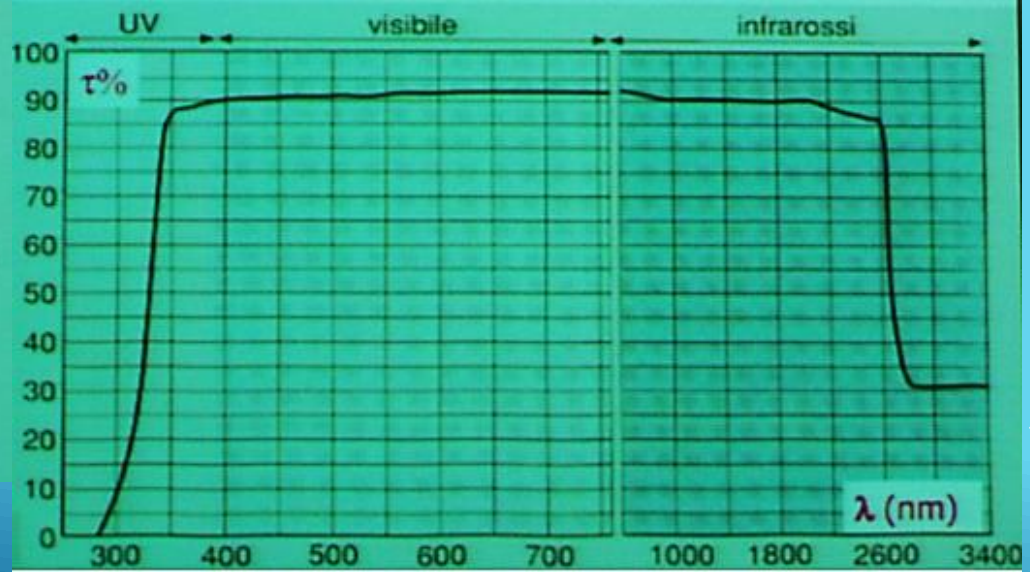


I fenomeni che interessano la radiazione che incide su di una lente sono:

Diffusione	Assorbimento
Riflessione	Trasmissione

Curva di trasmittanza

Andamento di τ% al variare di λ della radiazione incidente



LENTI AVVOLGENTI

La forma ergonomica delle lenti solari avvolgenti, permette di praticare sport estremi in tutta libertà.

I vantaggi sono:

- **massima protezione dai raggi solari visibili e dagli UV**
- **visione panoramica grazie alla particolare curvatura**
- **protezione laterale dai raggi e riduzione dei riflessi che colpiscono la superficie interna della lente**
- **difesa da vento e polvere**
- **design attuale**

Protezione oculare mediante colliri

- L'actinoquinolo è un derivato chinolinico ad attività antisettica che possiede attività di filtro UV. Associato a colliri lubrificanti può aumentare la difesa in condizioni di alta irradiazione.

Conci, 2013

ALCUNE INDICAZIONI DI MASSIMA CHE POSSONO AIUTARE NELLA SCELTA DEI FILTRI

GIALLO

VISIONE IDEALE IN CONDIZIONE DI NEBBIA,GIORNATE CON NEVE CADENTE.

ESALTA I CONTRASTI E LE PROFONDITA' : EFFETTO SCHIARENTE.

ASSORBIMENTO : 13 – 14 % (ATTRAVERSO IL FILTRO " PASSA " UN 86 – 87% DI LUMINOSITA').

FATTORE DI PROTEZIONE CONTRO LA LUMINOSITA' : 0

VERDE

PROTEZIONE IN GIORNATE DI SOLE.

(IPERMETROPIA)

ARANCIO

MIGLIORA LA VISIONE IN CASO DI NEBBIA.

(miopia)

IL GIUSTO COLORE DEI FILTRI

(COME SCEGLIERLO IN FUNZIONE DELLE PROPRIE ESIGENZE VISIVE)

Riduzione dell' acuità visiva, sensazione di sforzo,mal di testa persino nausea e vertigine possono essere gli effetti di colori dei filtri protettivi non adatti alle proprie esigenze visive

POLARIZZANTI

FILTRI CONTRO I RIFLESSI DISTURBANTI (ACQUA,NEVE,...)

ASSORBIMENTO : 90 %

SPECCHIATO

PROTEZIONE IN GIORNATE FORTEMENTE SOLEGGIATE E CON LUCE INTENSA

SUL GHIACCIAIO

PROTEZIONE CON LUMINOSITA' MASSIMA

PER UN BUON ACQUISTO OCCORRE QUINDI VALUTARE :

- CHE IL GRADO DI PROTEZIONE DAI RAGGI NOCIVI UVA E UVB SIA TOTALE;
- CHE IL COLORE E IL GRADO DI ASSORBIMENTO DELLA LUCE VISIBILE DA PARTE DEI FILTRI SOLARI DEVE TENER PRINCIPALMENTE CONTO DELLA SENSIBILITA' PERSONALE ALLA LUCE INTENSA (CHI HA DIFETTI VISIVI E' PIU' SENSIBILE ALLA LUCE) E DELL'USO CHE SI DEVE FARE DEGLI OCCHIALI DA SOLE;

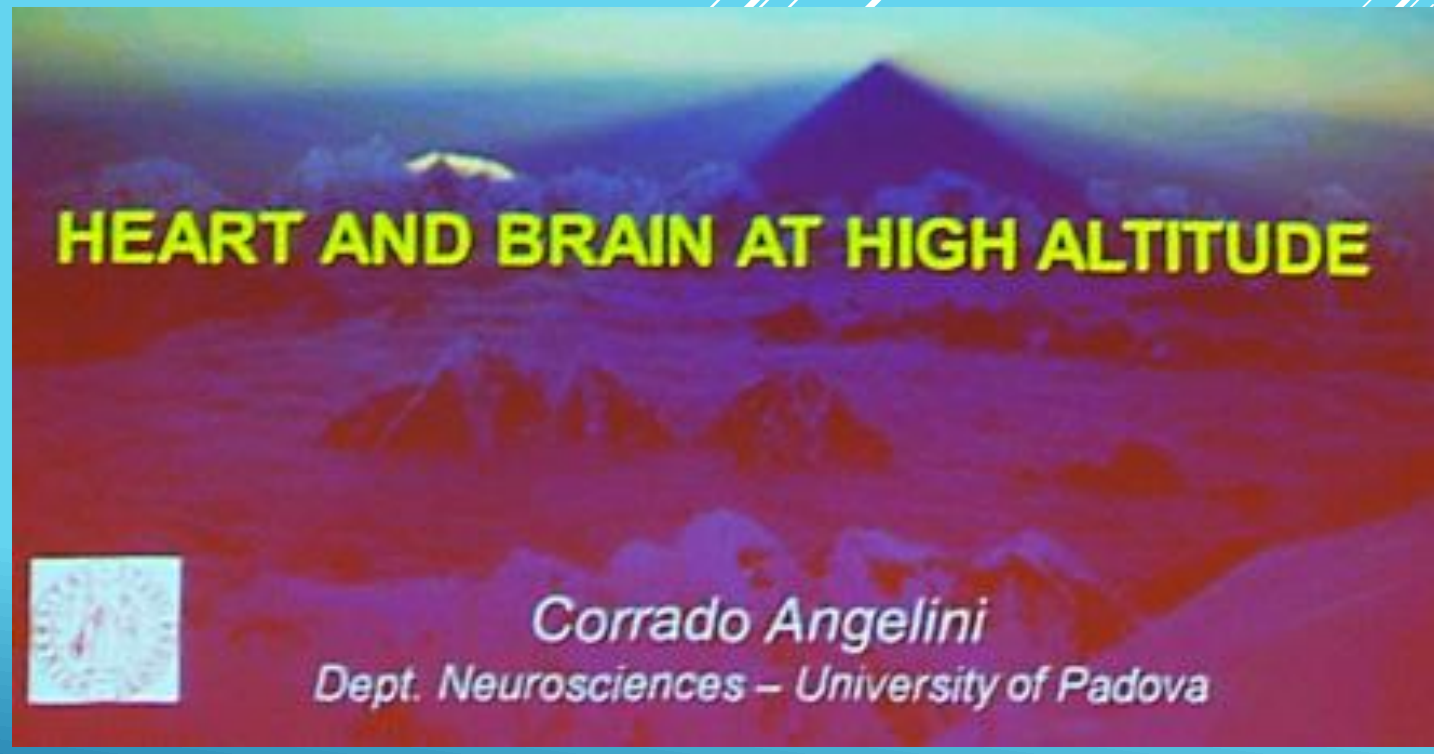
CONCLUSIONI

PER OTTENERE IL MASSIMO GRADO DI PROTEZIONE DA UN FILTRO SOLARE OCCORRE:

- ELIMINARE LA RADIAZIONE ULTRAVIOLETTA FINO A 400 NM
- PROTEGGERE DALLA LUCE BLU SALVAGUARDANDO LA NATURALE PERCEZIONE DEI COLORI
- SCEGLIERE MONTATURE AMPIE ED AVVOLGENTI O CON ADEGUATE PROTEZIONI LATERALI

SRDCE A MOZEK VE VELKÉ VÝŠCE - NA ÚROVNI DOBY

Heart and Brain at High Altitude - State of the ArtC



Prof. Corrado Angelini

Dept. Neurosciences

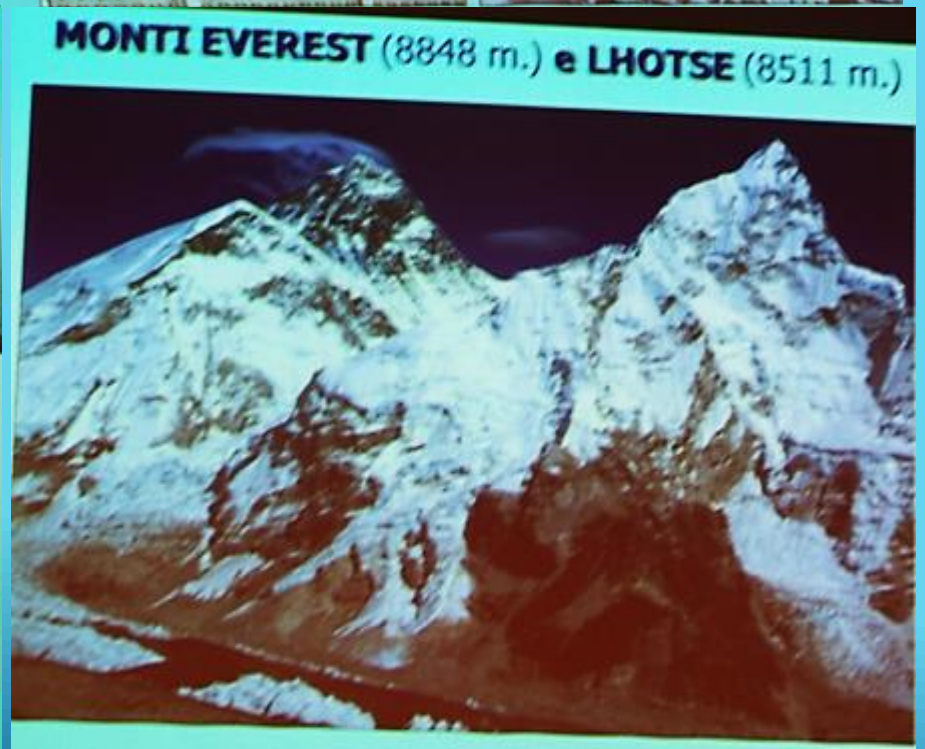
University of Padova

NAMME, Varese 2013

LABORATORIO CAPANNA REGINA MARGHERITA
Beno Bizzozero misura al fratello di Mosso a Capanna Margherita la quantità di acido carbonico eliminato
Soldato Sarteur mentre fa esercizi con manubri a Capanna Margherita
Polmonite sviluppatasi e guarita sul Monte Rosa (soldato Ramella)
Beno Bizzozero

LABORATORIO CAPANNA REGINA MARGHERITA
(Punta Gnifetti, Monte Rosa, 4560 m)
Costruzione della Capanna
La Capanna nel 1911

LABORATORIO CAPANNA REGINA MARGHERITA
Punta Gnifetti prima della costruzione
1890: inizio dei lavori
4 Settembre 1893
1897: lavori di ampliamento

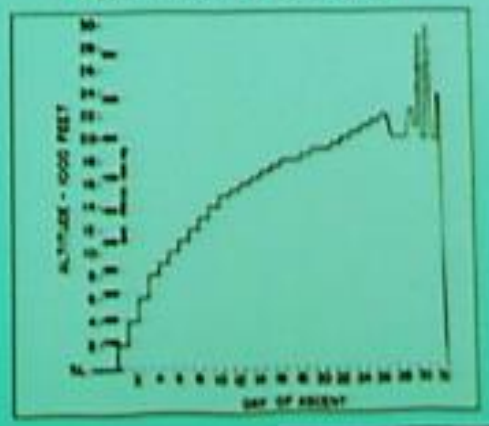

MONTI EVEREST (8848 m.) e LHOTSE (8511 m.)

Historie

OPERAZIONE EVEREST-I (1944) E ASPETTI TEORICI

Charly Houston usando la camera di decompressione, prova che la montagna si può ascendere anche senza ossigeno, inviando 4 soggetti a 9400 m nella Operazione Everest-I

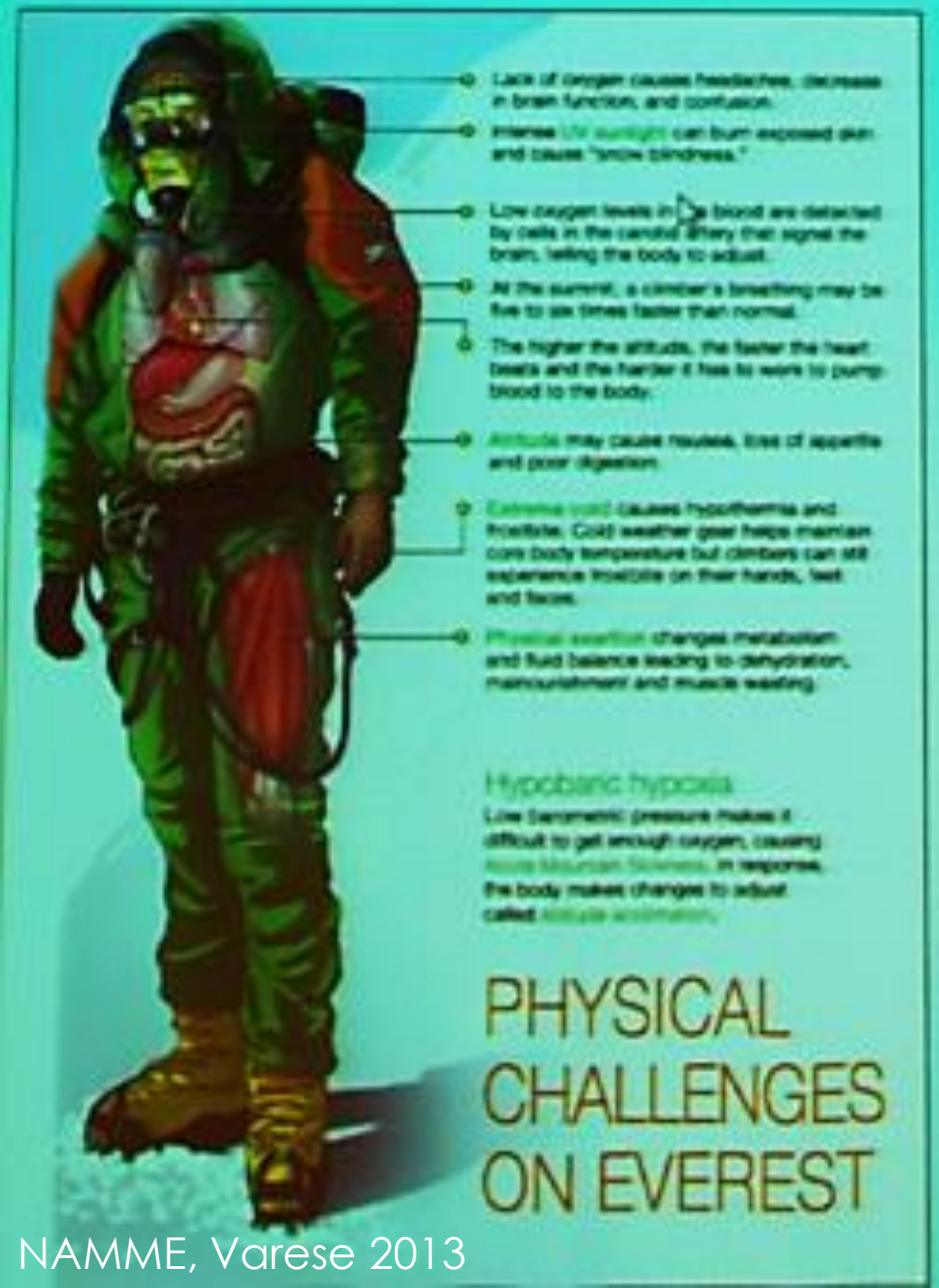
C. Houston e R.L. Riley misurano l'ossigeno durante l'Operazione Everest 1.



Lewis Pugh (1909-1994). Nel 1951 studia i problemi fisiologici della ascensione all'Everest.

PRIMA ASCENSIONE AL MONTE EVEREST (8848 m) NEL 1953 UTILIZZANDO OSSIGENO

Sir Edmund Percival Hillary (1919-2008) e sherpa ***Dawa Tenzing***



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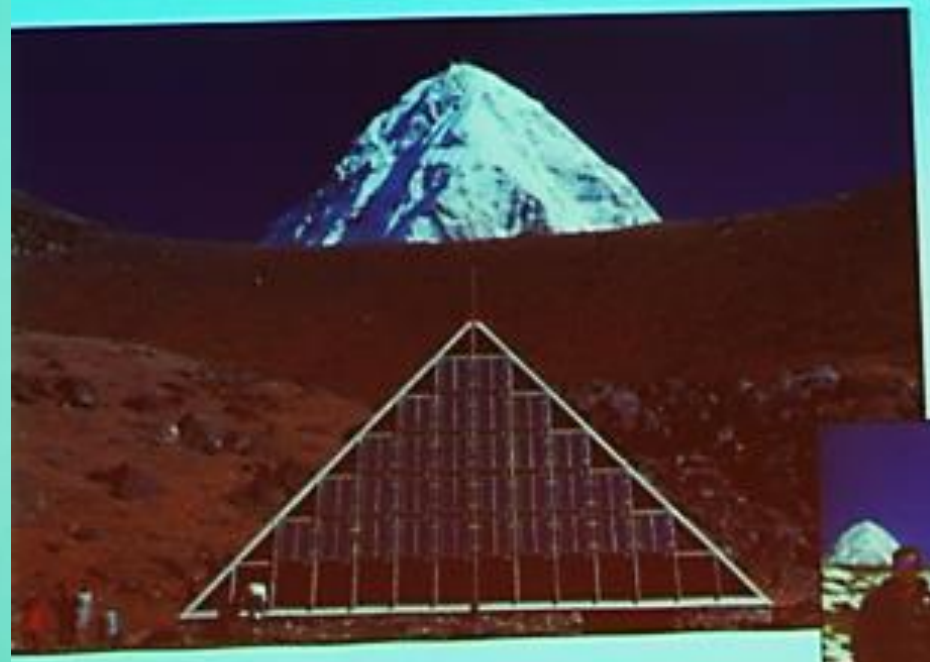
Brain and heart interaction at high altitude

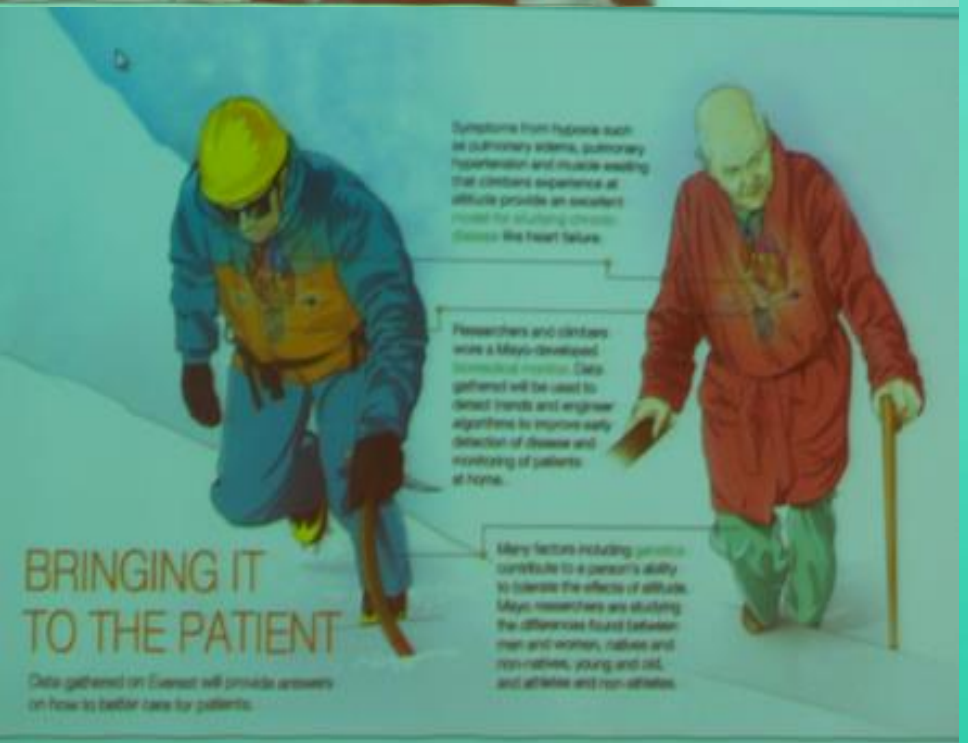
LABORATORIO PIRAMIDE (5050 m)
AL CAMPO BASE IN NEPAL, INAUGURATA NEL 1990



Ev-K²-CNR

Angelini, 2013

Climbers scale the Khumbu Icefall using brain and heart



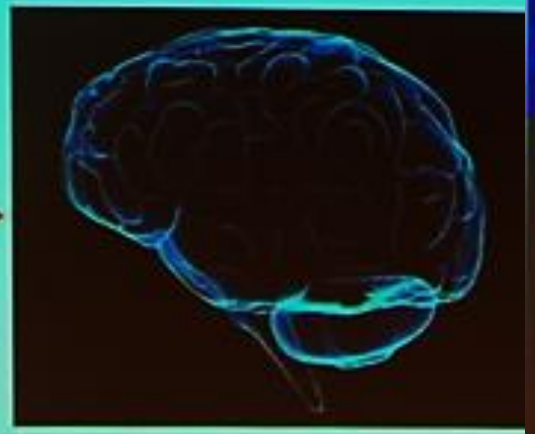
Data gathered on Everest will provide answers of how to better care for patients

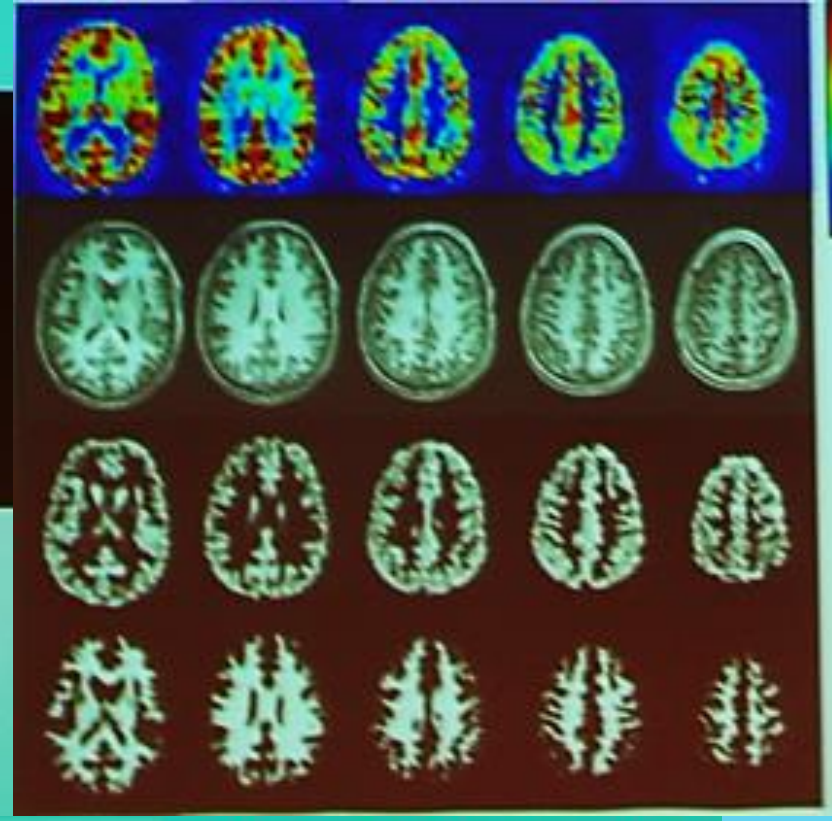
Many post-cardiac arrest patients received therapeutic hypothermia and continuous EEG monitoring to unravel the puzzle of who is more likley to survive. Patients with seizures or status epilepticus have poorer outcome

HYPOTHERMIA THERAPY: Cooling is induced with two liters of chilled saline at 4 degrees C; ice bags are placed on the groin and under the armpits, and cooling wraps are used around the chest and legs. Some hospitals cool the body from the inside out with cooling solutions in intravascular catheters. Patients remain cooled at 33 degrees C. for 24 hours and then are slowly rewarmed.

NAMME, Varese 2013 Resuscitation 2012 Angelini, 2013

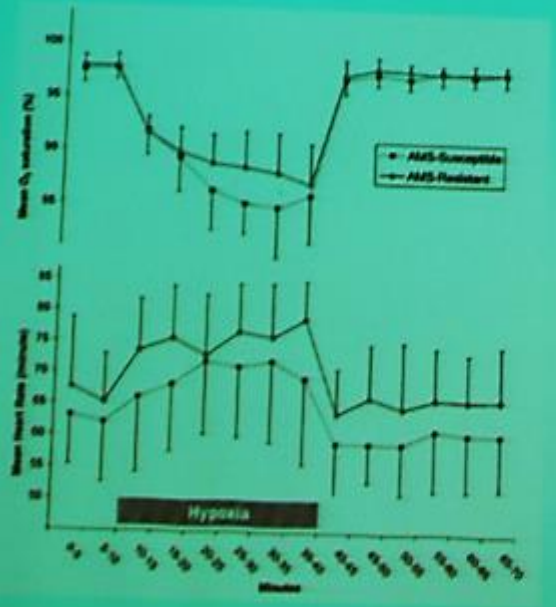
HEART-BRAIN INTERACTION



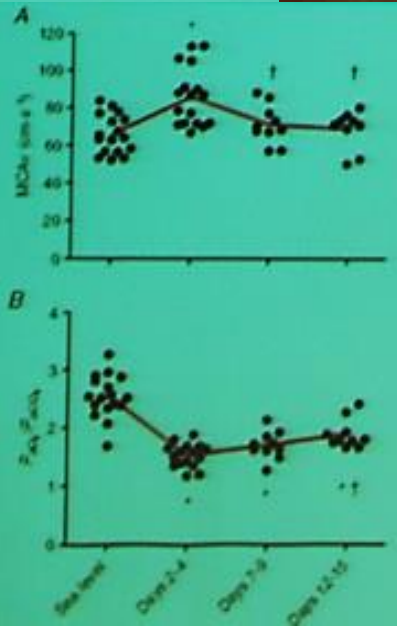


Dyer et al. 2008 showed by brain MRI an increased CBF during acute hypoxia that was greater in white matter than gray matter

Increased glucose uptake
Increased beta-adrenergic stimulation
Increased Q-T



Dyer et al. 2008 examined during 30 minutes of hypoxia (12.5% O2) the SaO2 and heart rate in AMS susceptible and AMS resistant cases

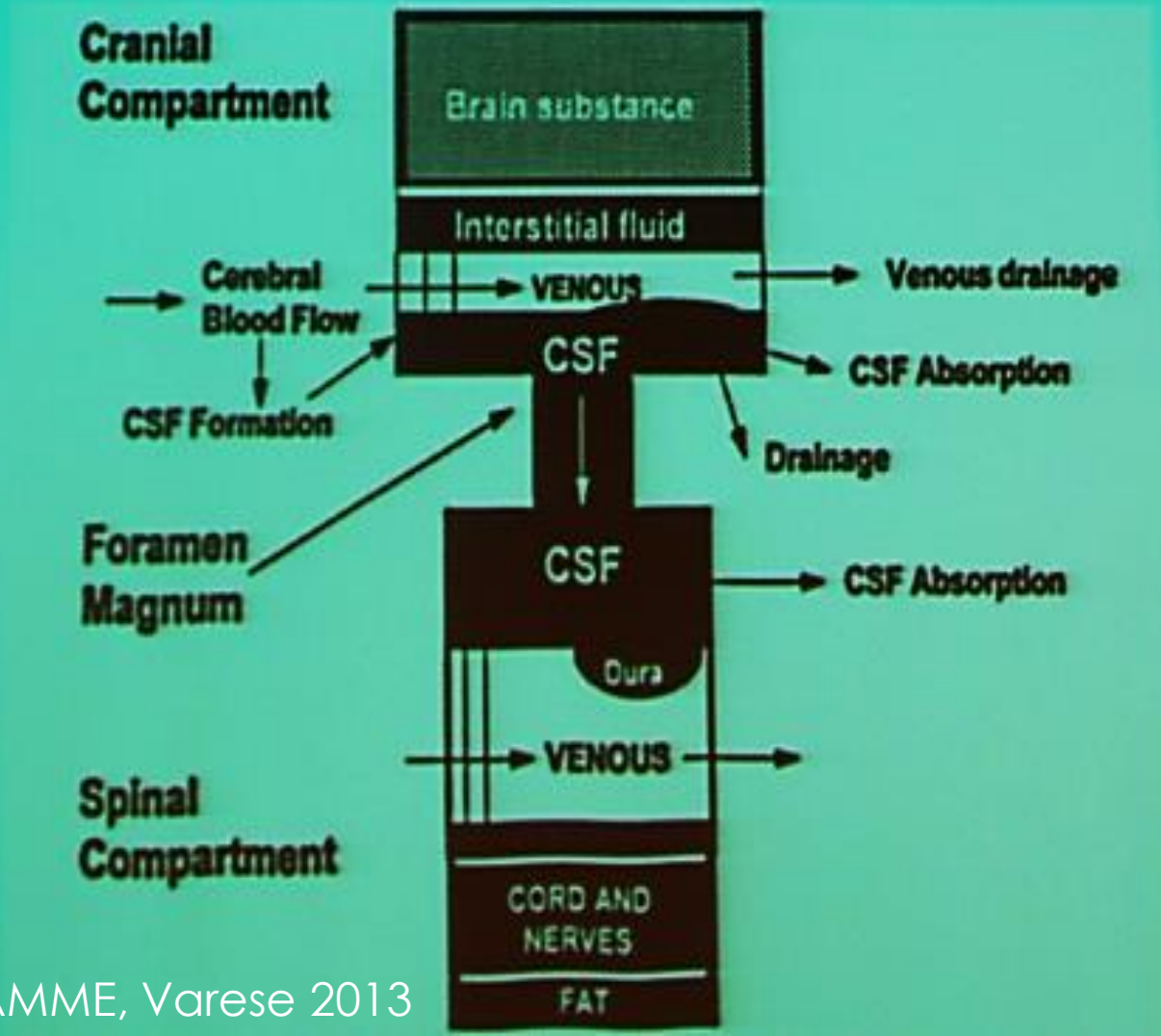


Lucas et al. 2011 showed that brain blood flow increases during the first week at high altitude. The balance between O2 and Co2 pressure in arterial blood explains the difference upon arrival at high altitude (5050 mt.)

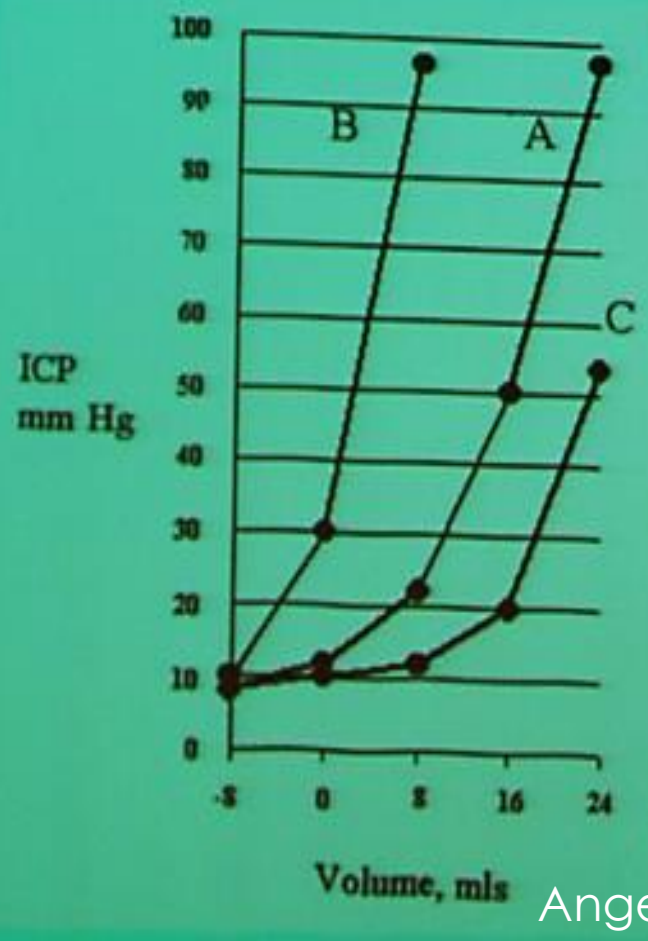
NAMME, Varese 2013 Angelini, 2013

BRAIN: PATHOPHYSIOLOGY OF CEREBRO SPINAL FLUID (CSF)

BRAIN AND CSF IN RIGID CRANIAL COMPARTMENT



RELATION BETWWEN BRAIN VOLUME AND CSF PRESSURE (ICP) IN NORMAL (A), CEREBRAL OEDEMA (B) AND DEHYDRATED BRAIN (C)



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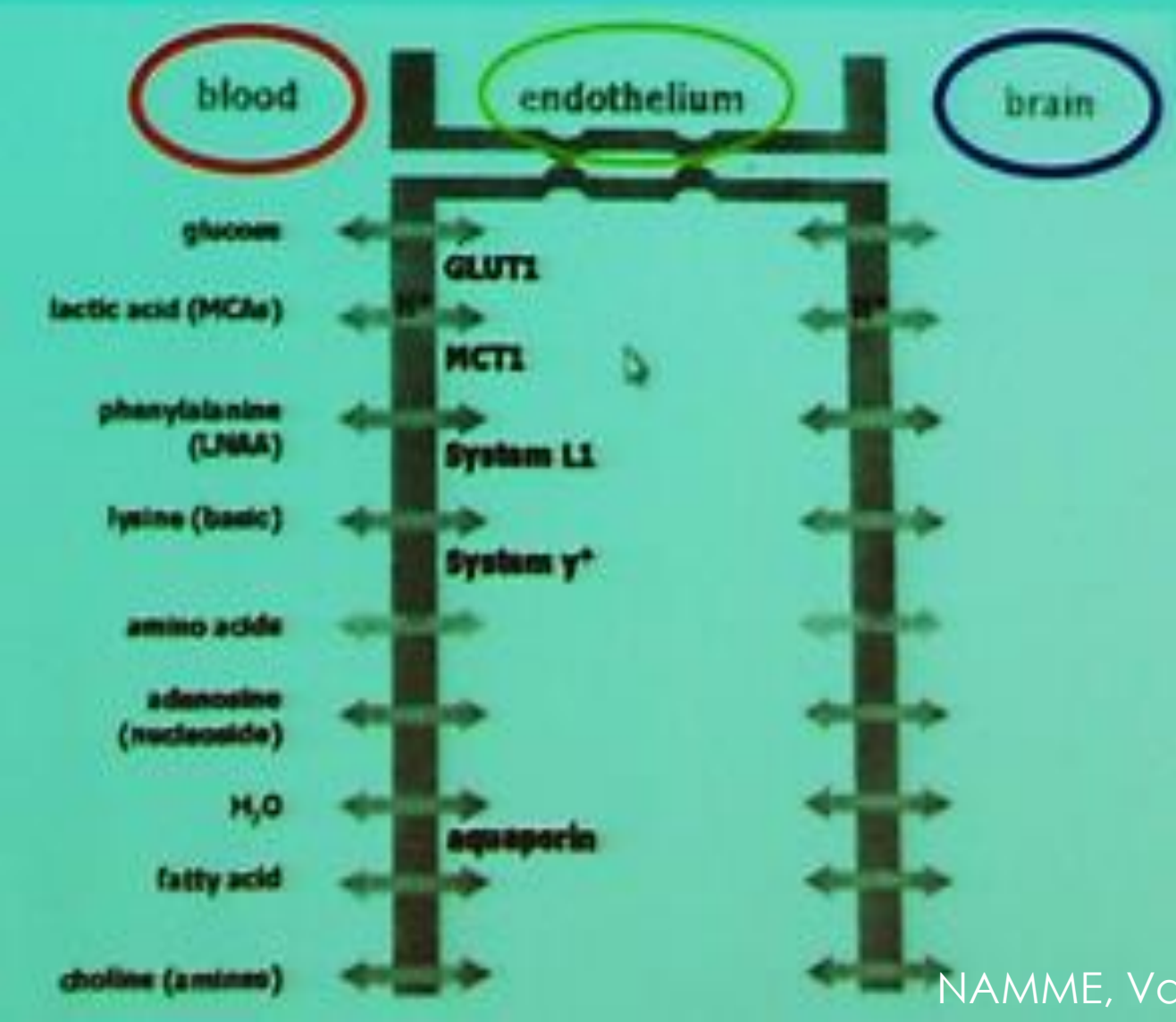
TRANSPORT SYSTEM IN THE BLOOD-BRAIN BARRIER



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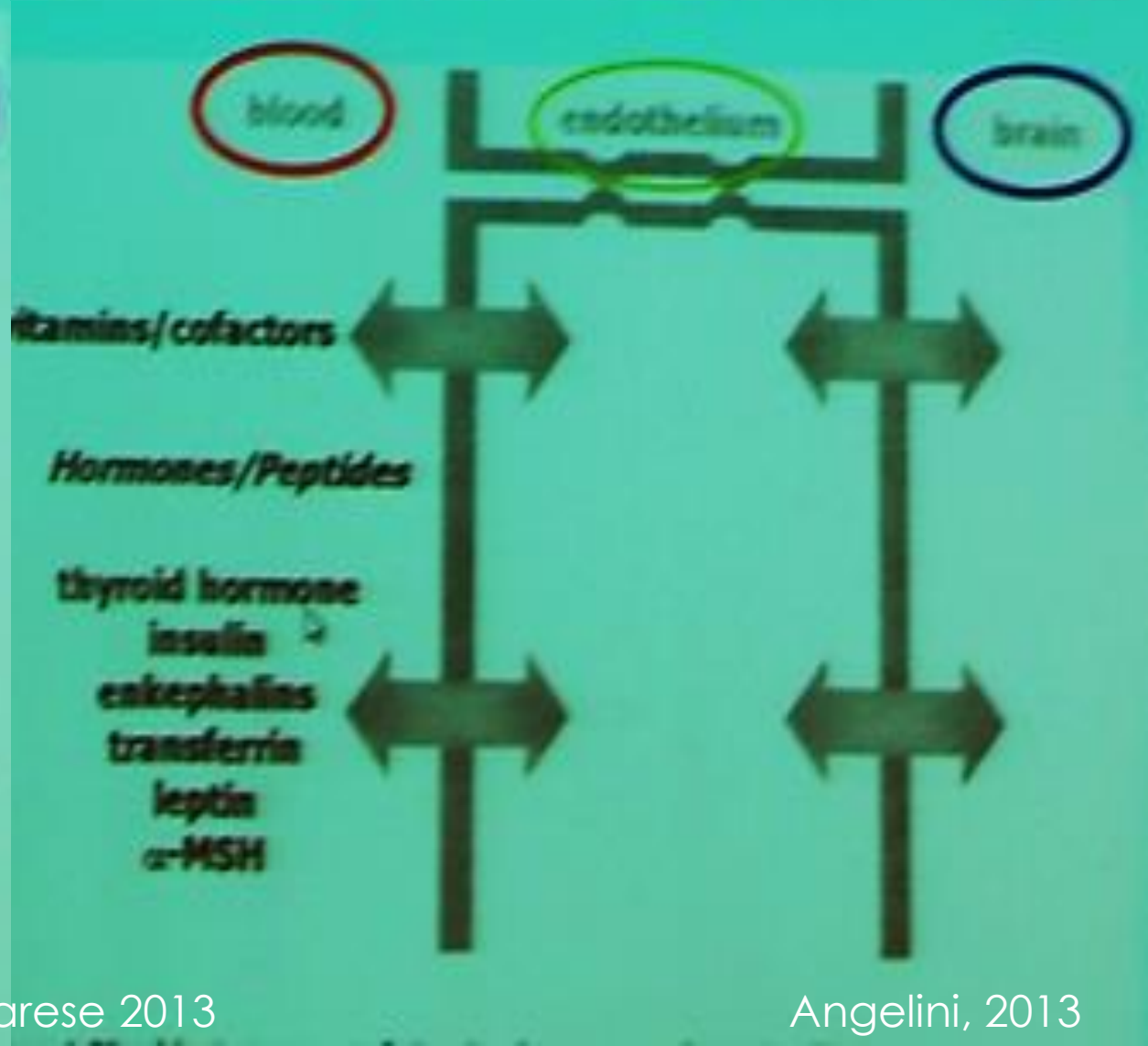
VITAMINS, HORMONS, PROTEINS



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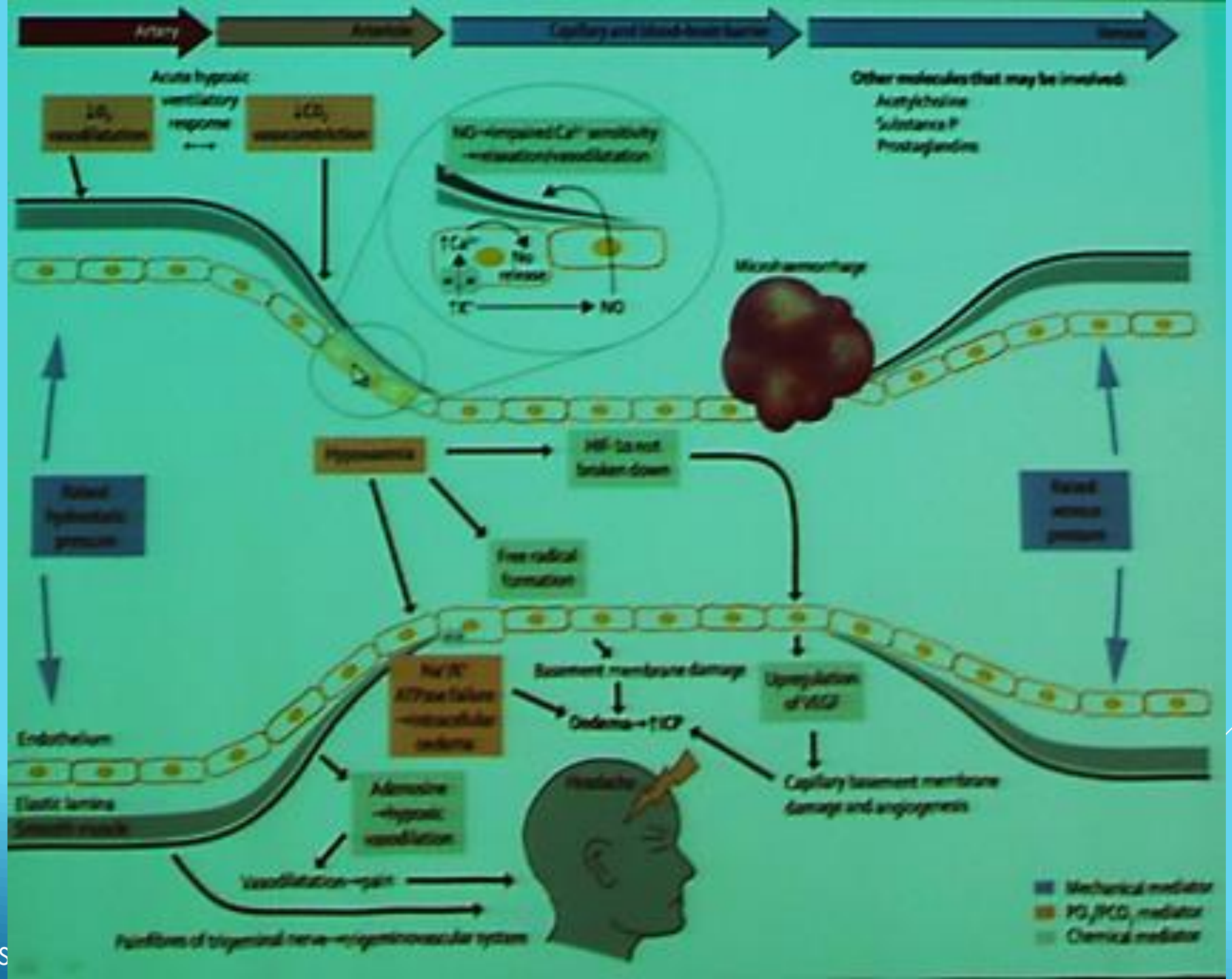

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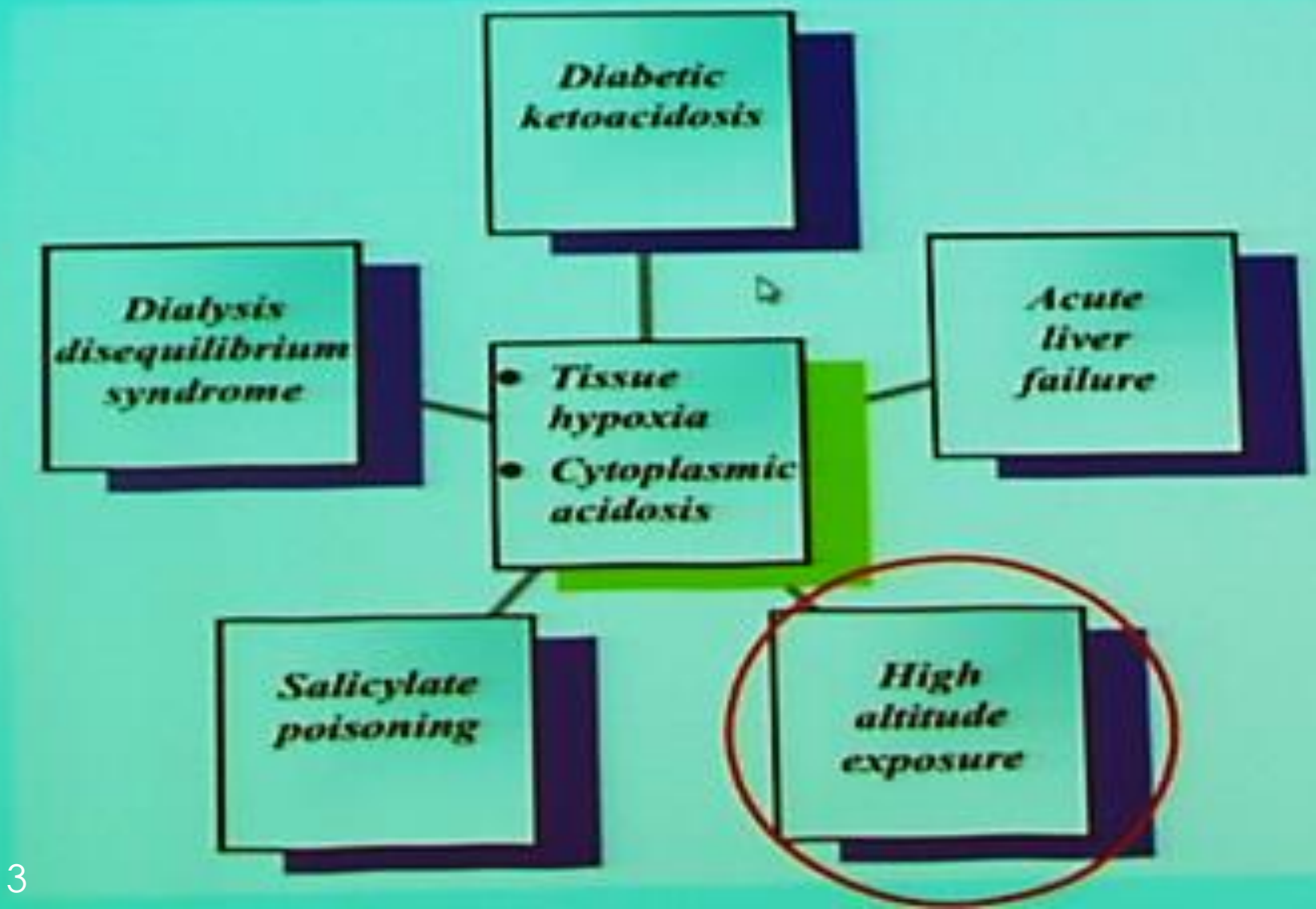
CONDITIONS LEADING TO BRAIN OEDEMA SHARE HYPOXIA OF TISSUES AND INTRACELLULAR ACIDOSIS



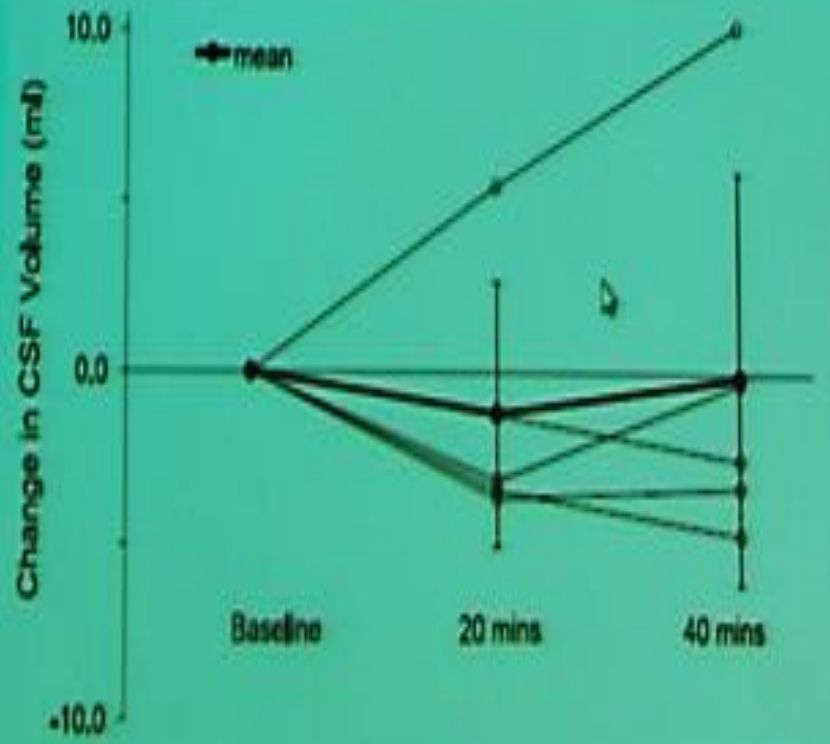
BRAIN SWELLING IN ACUTE HYPOXIA

Dubowitz et al. J.Appl.Physiol. 2009

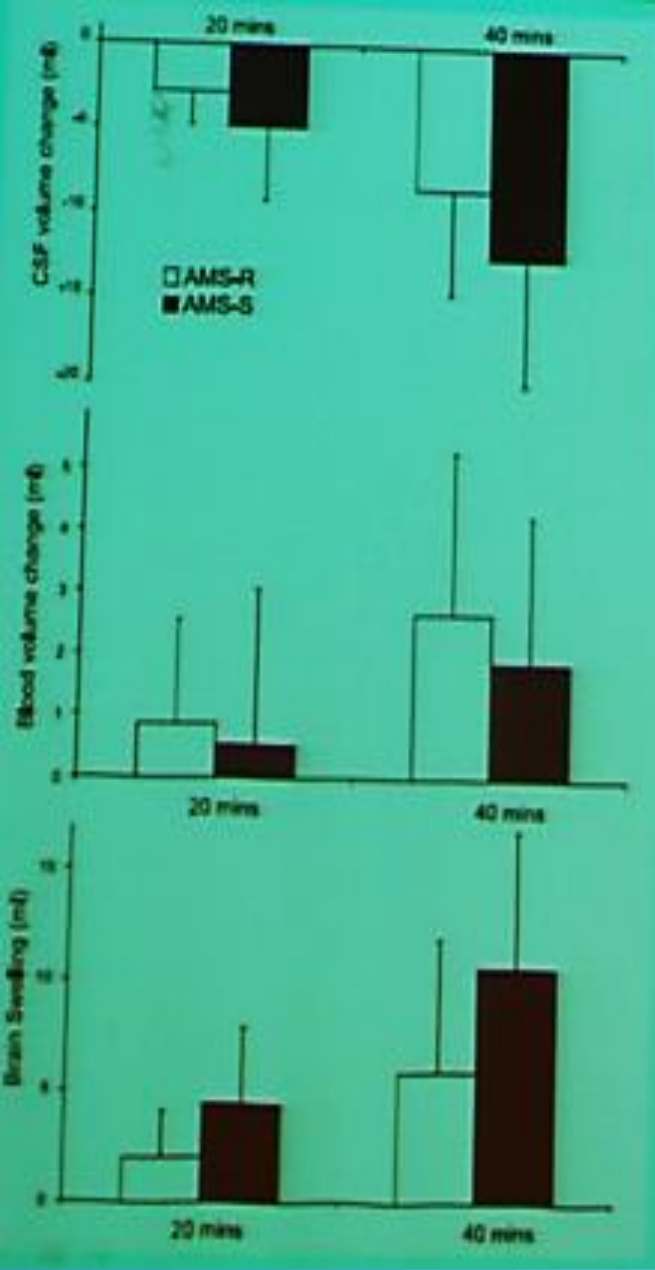
Volumetric measurement on MRI to determine brain blood flux and the volume of CSF during 40 minuts of hypoxia

Brain mask

Images in T1 (A) and T2 (B) to quantify CSF volume.
A: brain volume up to forame magnum.
B: measurement of CFS which appears white



Variations of CSF volume (in milliliters) show a decrease in the first 20 minutes, which is independent from inspired oxygen



Decrease of CSF intracranial volume during hypoxia and corresponding increase of volume of intracranial blood.

Higher panel: CSF volume

Middle panel: blood volume

Lower panel: brain volume showing a rapid swelling

BRAIN MRI SHOWS ABNORMALITIES OF WHITE MATTER DUE TO OEDEMA AND ITS RESOLUTION AFTER TREATMENT

Figure 5.—Axial T_2-weighted magnetic resonance image of patient 8 showing markedly increased signal in splenium and centrum semiovale.

P. Hackett, JAMA, 1998

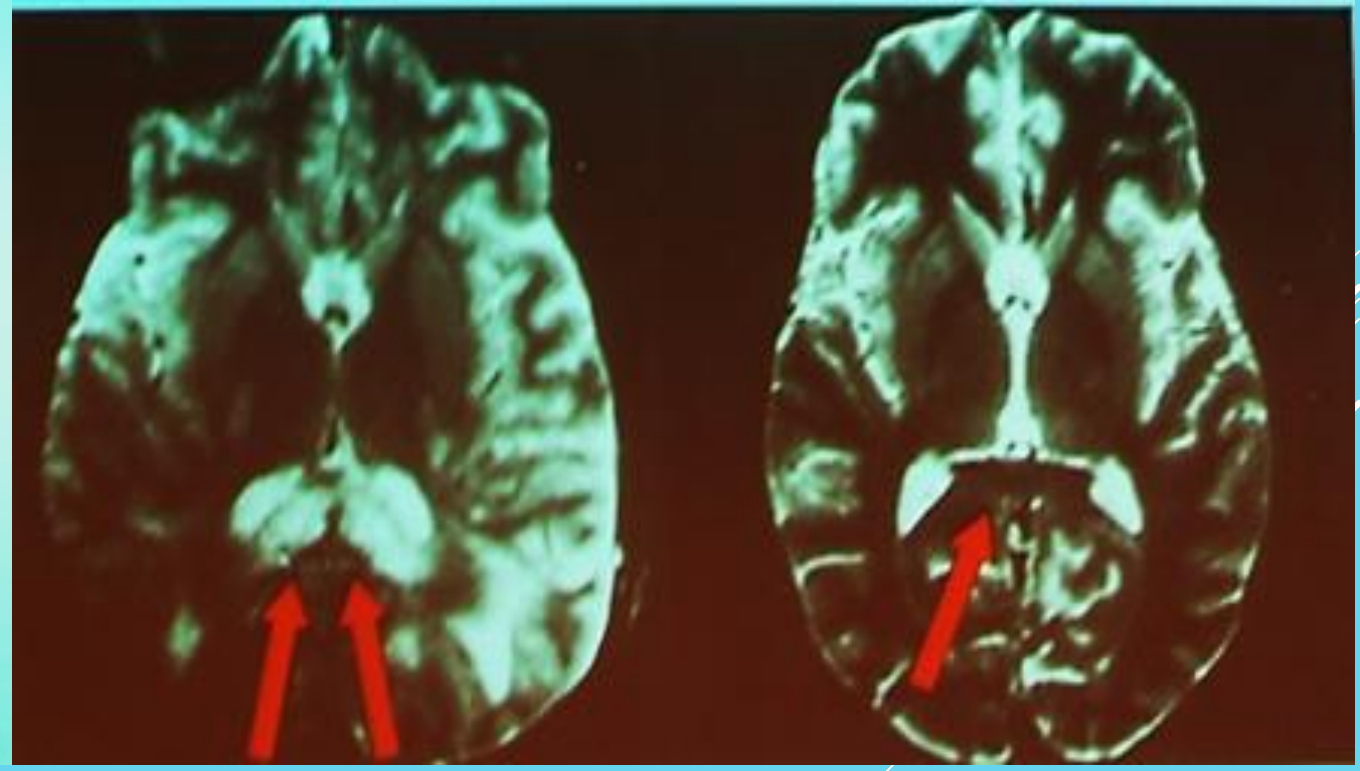
BRAIN MRI SHOWS ABNORMALITIES OF WHITE MATTER DUE TO OEDEMA AND ITS RESOLUTION WITH TIME

Figure 6.—Left, Axial T_2 weighted magnetic resonance image of patient 9 demonstrating high signal in splenium and mild increased signal in centrum semiovale. Right, Axial T_2 weighted magnetic resonance image of the same patient demonstrating complete resolution of abnormal signals 11 months later.

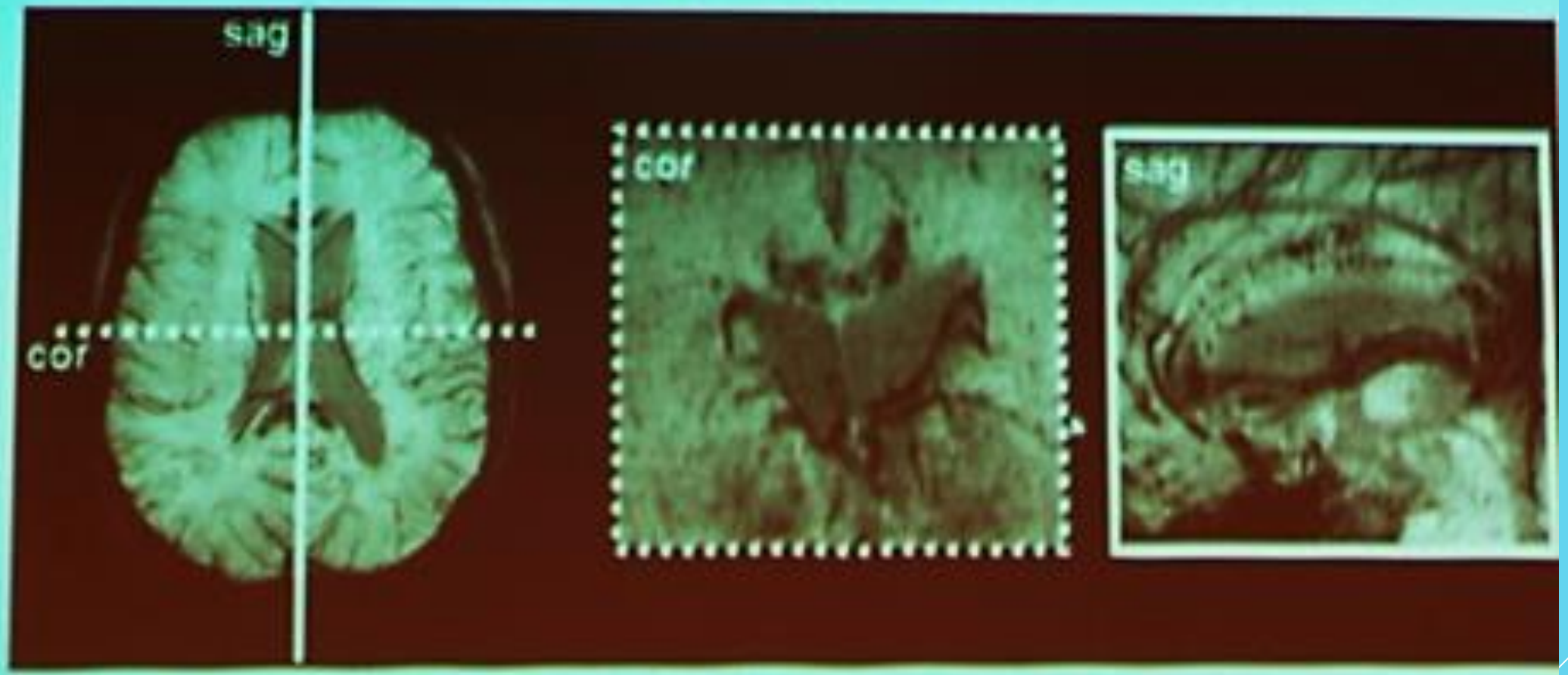
P Hackett, JAMA, 1998

BRAIN MRI SHOWS ABNORMALITIES OF THE SPLENIUM AND ITS RESOLUTION AFTER 1 MONTH

P Hackett, JAMA, 1998



BRAIN MICROHEMORRAGES IN INDIVIDUALS WITH HACE IN THE SPLENIUM AND CORPUS CALLOSUM



The multiplanar reconstruction shows the predilection for the corpus callosum and also shows that the genu, splenium, and corpus are mainly affected

CASE REPORT

Male, 20 years, first onset of seizures during travel to Pordoi (2200 m.)

Diagnostic hypothesis:

Acute mountain sickness?
Sympromatic epilepsy due to altitude exposure?

Diagnosis: epilepsy due to brain cancer in temporal region (RMN)

The patient was treated with Carbamazepine and underwent surgery abroad

Brain MRI

PHYSIOLOGY OF SLEEP

Polygraphic studies demonstrated that sleep is constituted of two alternative states:

Slow sleep, also called **non-REM**, characterized by slow EEG in 4 phases:

- *phase 1*: alpha activity replaced by theta activity
- *phase 2* dominant theta activity, paroxistic complex K (delta waves of high voltage) and spindles
- *phase 3:* delta activity < 50% of EEG
- *phase 4:* delta activity > 50% of EEG

Rapid sleep, also called ***REM (rapid eye movement),*** characterized by EEG with frequency similar to awake. REM mental activity is typical of dreaming, vegetative alterations of blood pressure, erection in males.

INTERCONNECTION BETWEEN HEART AND BRAIN

Heart Rate Variability (HRV) is an index of adaptability of the organism: Subjects showing high levels of HRV perform better under stressful conditions. Reductions in HRV have been found in depression, anxiety and post-traumatic stress disorders (Thayer 2002, 2010; Cohen 1999)

VAGAL NERVE STIMULATION
Signals from the heart to the brain are used for treatment of depression
Cameron 2009

CENTRAL NERVOUS SYSTEM
↓
AUTONOMIC NERVOUS SYSTEM
↓
HEART
↓
HEART RATE VARIABILITY → HRV is an important peripheral index of the integrative actions of the brain when involved in cognitive or emotional controls

Cognitive and Emotional Control

VAGAL AFFERENCES EXERT ACTIONS UNRELATED TO THE CARDIOVASCULAR CONTROL SINCE THEY AFFECT BRAIN COGNITIVE AND EMOTIONAL CONTROL, HENCE EUDEMONIA (Thayer and Lane 2009; Cameron 2009)

SUMMING UP:

1. HEART ACTIVITY CAN MODULATE BRAIN FUNCTION VIA
   - ARTERIAL BLOOD PRESSURE WAVES
   - HORMONES
   - VAGAL AFFERENCES
2. BRAIN AND HEART ARE BOTH INVOLVED IN THE PSYCHIC HOMEOSTASIS, i.e., IN EUDEMONIA

Vagal stimulation is important to control cognitive and emotional functions

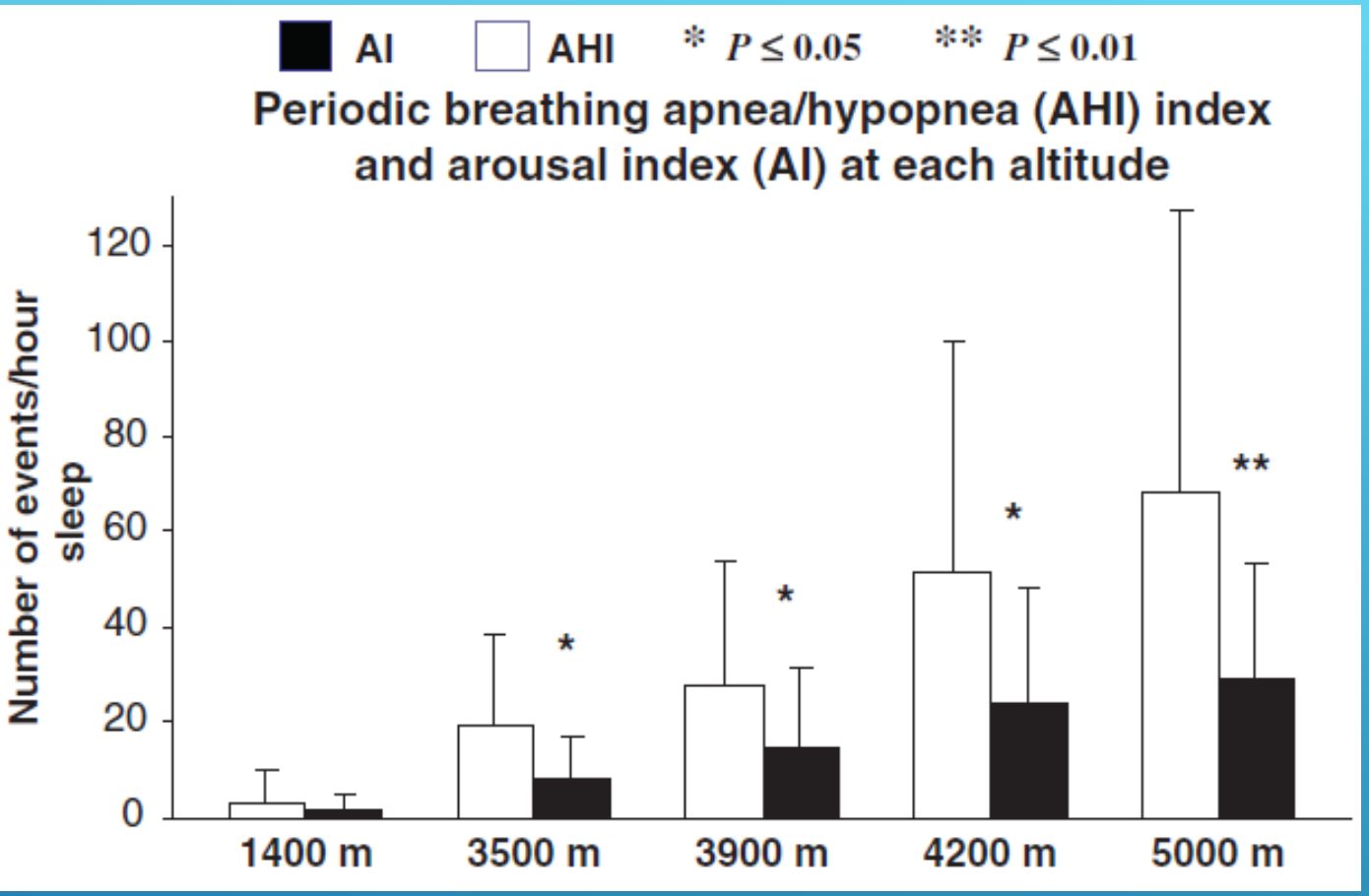
J Sleep Res. 2010 Mar;19(1 Pt 2):148-56. doi: 10.1111/j.1365-2869.2009.00745.x. Epub 2009 Aug 3.

Sleep architecture changes during a trek from 1400 to 5000 m in the Nepal Himalaya.

Johnson PL, Edwards N, Burgess KR, Sullivan CE.

David Read Laboratory, Department of Medicine, University of Sydney, Sydney, NSW 2006, Australia. pamelaj@med.usyd.edu.au

sleep architecture was affected by increasing altitude. While time spent in Stage 1 non-rapid eye movement sleep increased at 3500 m and higher ($P < 0.001$), time spent in slow-wave sleep (SWS) decreased as altitude increased. Time spent in rapid eye movement (REM) sleep was well preserved. In subjects who developed periodic breathing during sleep at one or more altitudes (16 of 19), arousals because of periodic breathing predominated, contributing to an increase in the total arousal index. However, there were no differences in sleep architecture or sleeping oxyhaemoglobin saturation between subjects who developed periodic breathing and those who did not. As altitude increased, sleep architecture became progressively more disturbed, with Stage 1 and SWS being affected from 3500 m, while REM sleep was well preserved. Periodic breathing was commonplace at all altitudes, and while associated with increases in arousal indices, did not have any apparent effect on sleep architecture.



the PB AI 14 ± 17 h)1, at 4200 m the PB AHI was 52 ± 49 h)1 and the PB AI 25 ± 23 h)1, at 5000 m the PB AHI was 68 ± 59 h)1 and the PB AI 29 ± 24 h)1. *P £ 0.05; **P £ 0.01.

http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2869.2009.00745.x/pdf

NAMME, Varese 2013 Angelini, 2013

There was a wide range of periodic breathing (PB) indices in the 19 subjects; three did not develop PB at any altitude and three had low levels of PB at one altitude only. Periodic breathing did not always result in arousal from sleep. The PB apnoea/hypopnoea index (AHI) (central apnoea/hypopnoeas per hour of sleep) was at least twice as high as arousals that were caused by these repetitive cessations in breathing. Periodic breathing developed in two subjects at 1400 m, thus the PB indices were compared for altitudes of 3500 m and higher.

The PB AHI at 3500 m was 20 ± 19 h)1 and the PB Arousal Index (AI) 9 ± 8 h)1, at 3900 m the PB AHI was 28 ± 2 h)1 and

SYMPTOMS DURING TREKKING TO GOKYO (4790 mt.), GORAK SHEP (5130 mt.) AND PIRAMIDE (5550 mt.)

18 subjects (9 male, 9 female) participating to the II Course of Mountain Medicine (as teachers or students). Nepal, october 2008.

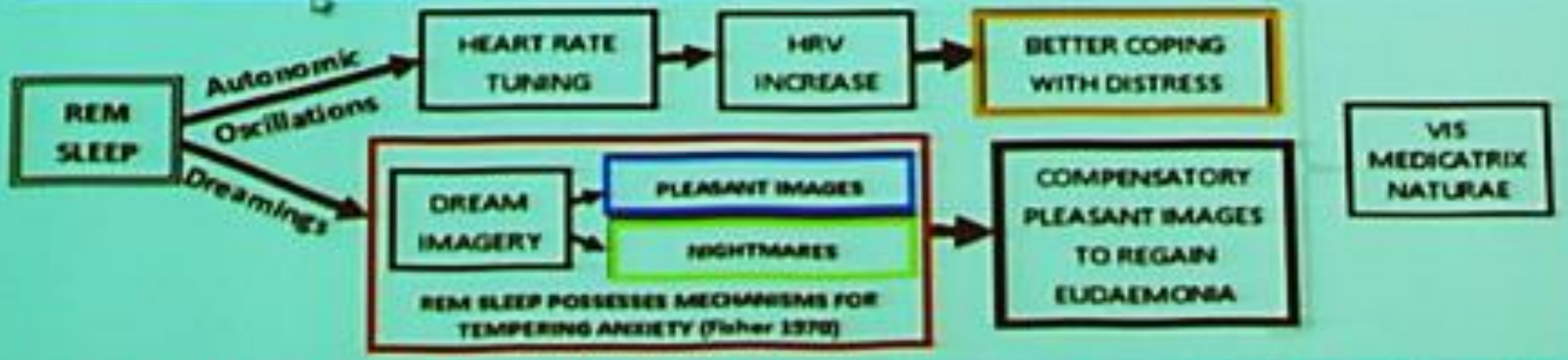
- Sleep disturbances in 9 cases (50%)
- Headache in 10 cases (55%)
- Fatigability in 8 cases(44%)
- Gastrointestinal disturbance in 6 cases (33%)
- Dizziness in 6 cases (33%)
- Peripheral oedema in 3 cases (16%)
- Ataxia in 1 case (5.5%)
- Mental alteration in 1 case with nightmares (5.5%)

REM SLEEP and DREAMING are part of the VIS MEDICATRIX NATURAE (Healing Power of Nature). They are aimed at the maintenance of PREDICTIVE PSYCHIC HOMEOSTASIS due to their involvement in:

1. **FLUCTUATIONS OF THE AUTONOMIC CONTROL DURING REM SLEEP , which could lead to an INCREASE OF HEART RATE VARIABILITY (HRV). Hence, REM sleep may play role in increasing the ABILITY OF THE SUBJECT TO COPE WITH DISTRESS (Cameron 2009; Lane and Wager 2009)**

2. **NIGHTMARISH DREAMS , which can be thought as an AUTO-FLOODING PSYCHOTHERAPY. Flooding is a technique in which the patient receives abrupt and intense exposures to fear-producing situations in order to REDUCE THE PATIENT'S ANXIETY VIA ACCELERATED DESENSITISATION**

3. **DREAMING PLEASANT IMAGES , which can be thought as a SUPPORT PSYCHOTHERAPY.**
***"In ancient times, before going to sleep, people customarily prayed to Mercury to have pleasant dreams"* (Leopardi 1826)**



Sleep and dreams are required for psychic homeostasis and therefore they are able to control mental stress and daily anxiety, and to prepare the mind for the next day activity

The relative high incidence of disturbances during trekking might be explained by physical requirements during ascent and by the need of psychic homeostasis.

CONCLUSIONS

During acute hypoxia, a cerebral swelling occurs early with shift of CSF after 40 minutes of hypoxia.

These changes occur in all subjects independently from their susceptibility to acute mountain sickness.

Sleep alteration and its relation with periodic breathing increase with altitude.

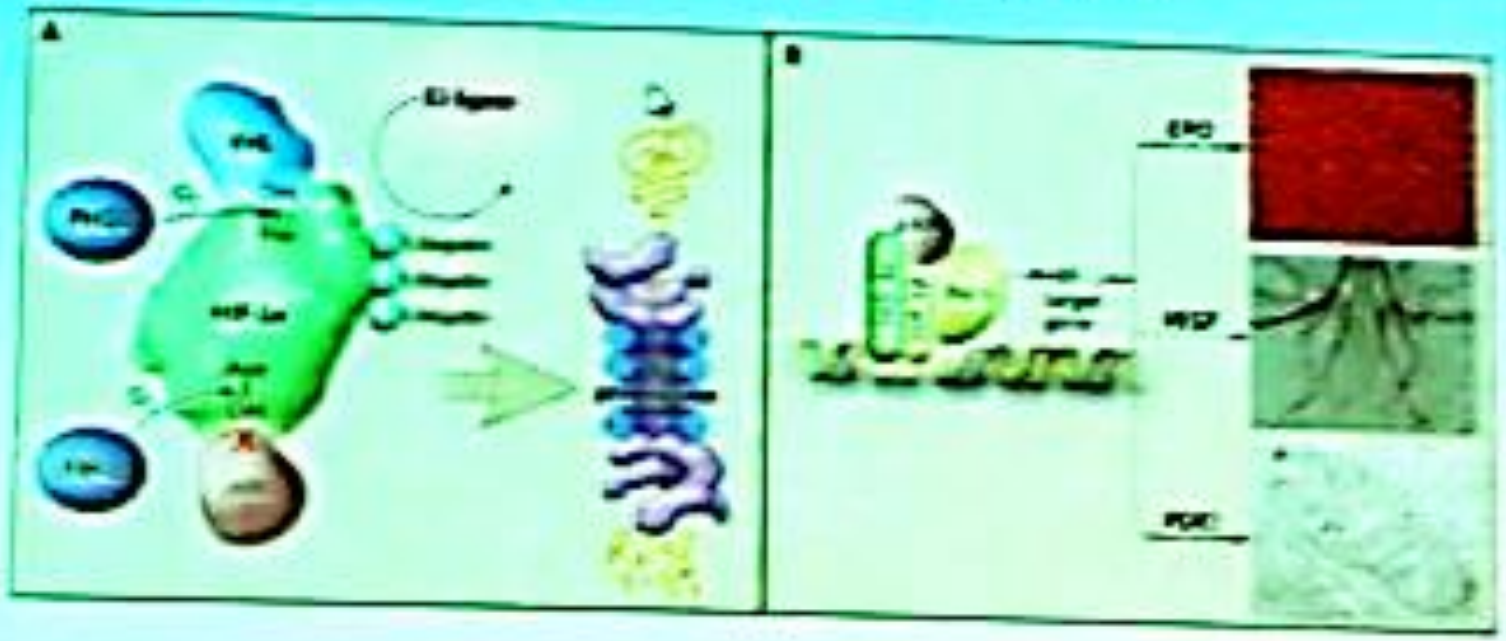
Sleep architecture becomes progressively more disturbed and periodic breathing more frequent, while REM sleep is preserved.

Both dreams and nightmares contribute to psychic homeostasis.

Mozek ve velké výšce – závěry

- při akutní hypoxii během 40 minut k přesuny mozkomíšního moku a otoku mozku
- u všech osob bez ohledu na jejich náchylnost k AHN
- změny spánku a jejich vztah k periodickému dýchání stoupá
- spánková architektura se progresívně zhoršuje
- periodické dýchání je stále častější
- REM spánek je zachován
- sny a noční můry ovlivňují psychiku ve výšce

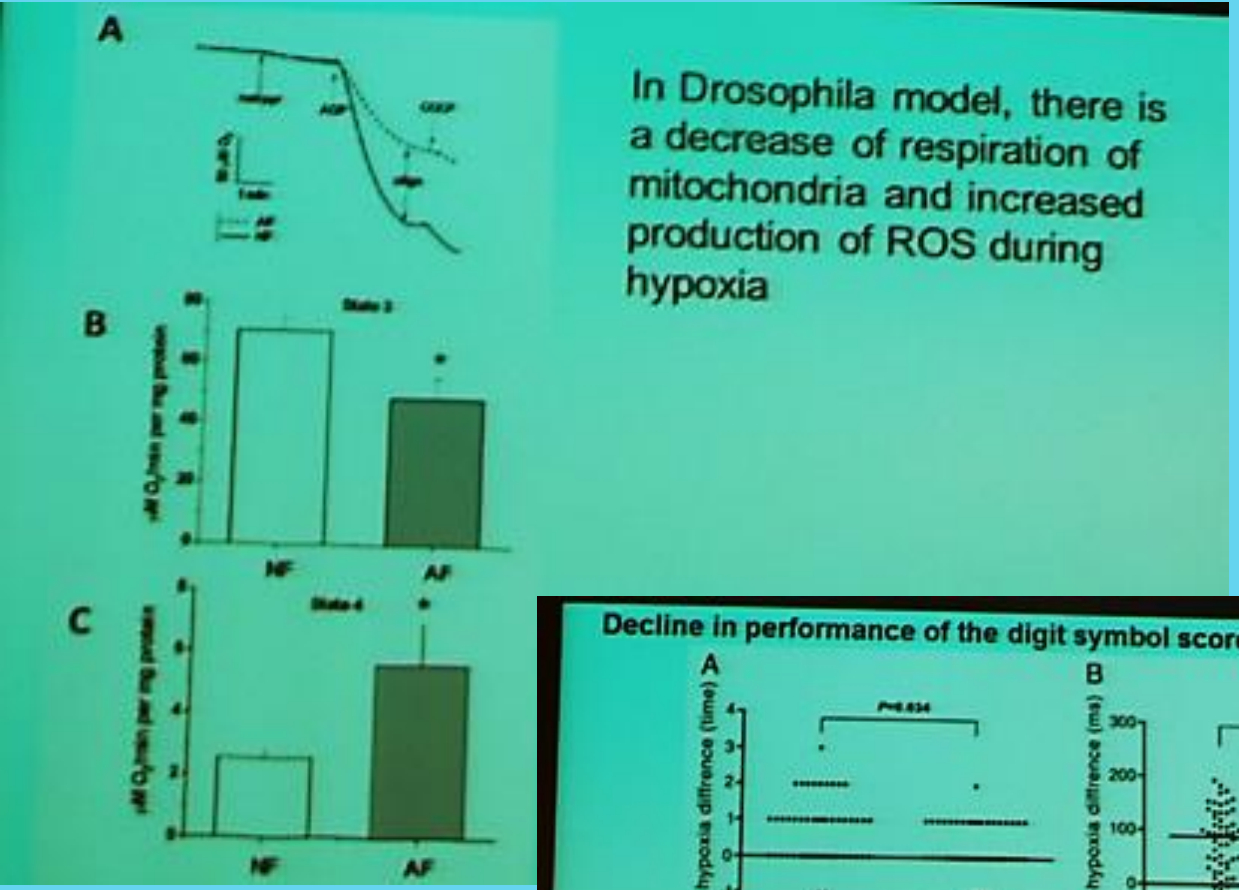
STUDI MOLECOLARI SULLA IPOSSIA

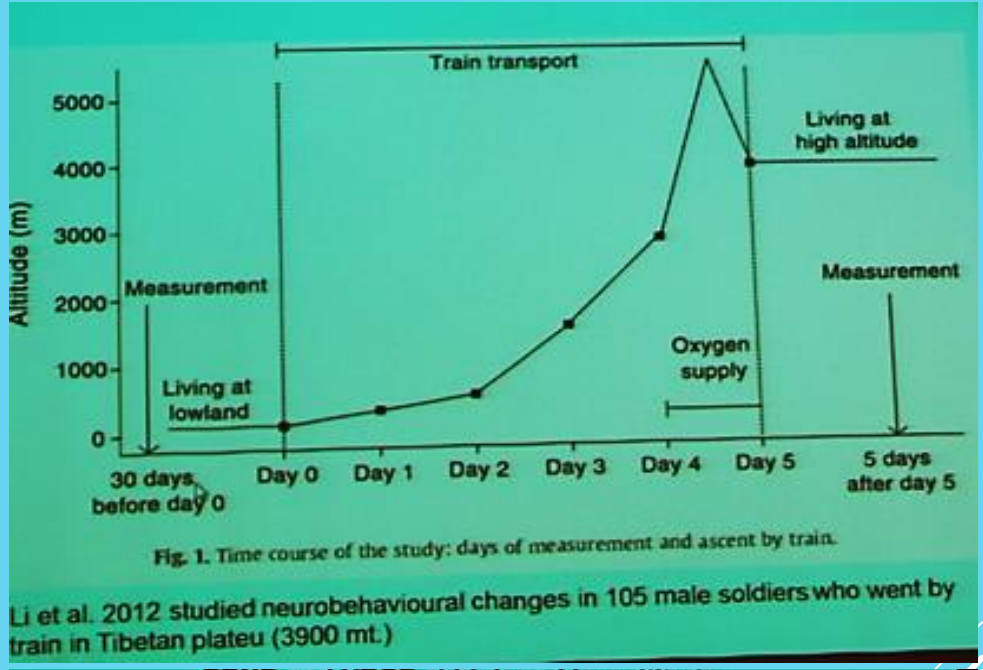


Gregg Semenza ha recentemente scoperto il gene HIF-1, che regola tramite segnali nucleari, l'adattamento all'ipossia, stimola la glicolisi, l'EPO e induce cambiamenti molecolari multipli. Questo gene è a sua volta regolato da una cascata di altri geni.

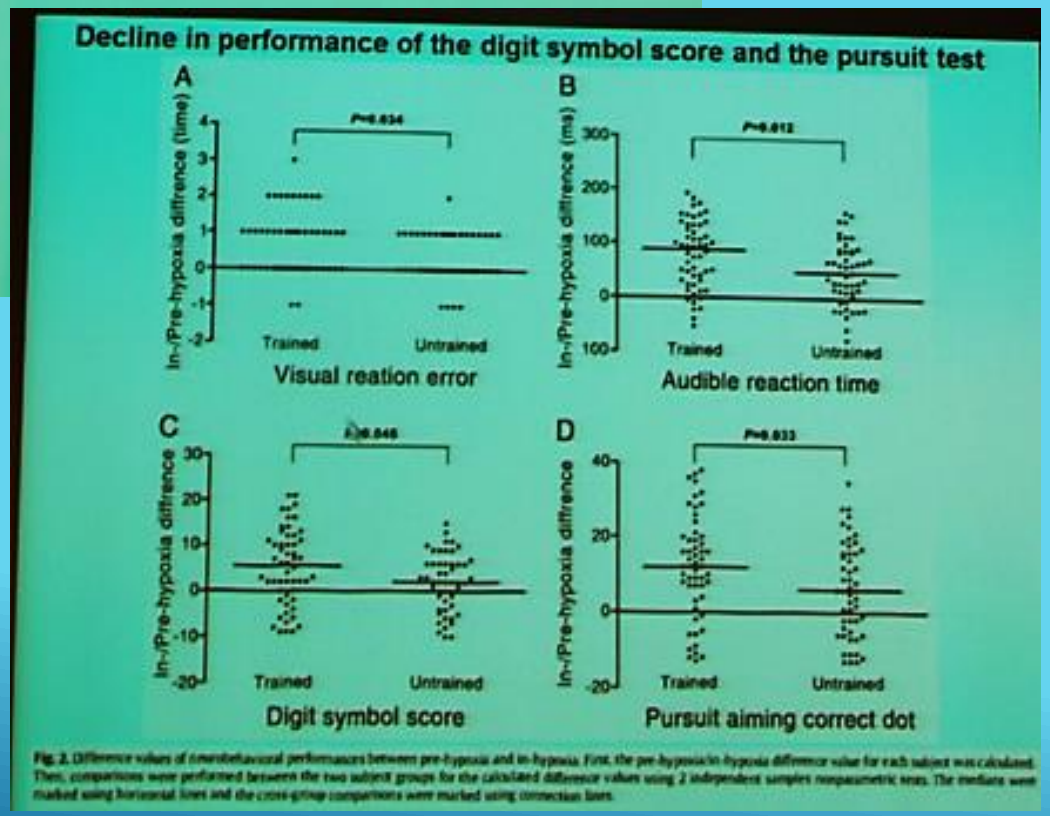
GENE HIF-2α

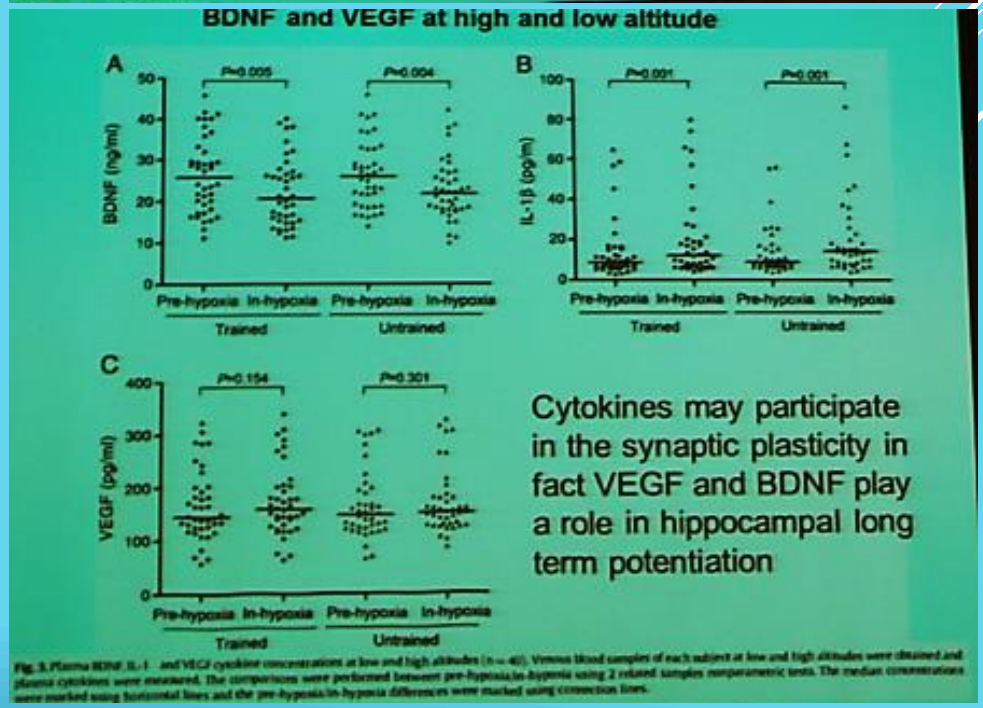
Di recente sono stati identificati dei loci su cui è avvenuta la selezione genetica nelle popolazioni Tibetane di alta quota rispetto a quelle di bassa quota.
In particolare, ciò si è verificato per il gene HIF-2a, ma anche per PHD2 e per i target di HIF-1 (Simonson et al. 2010; Yi et al. 2010; Beal et al. 2010).





Li et al. 2012 studied neurobehavioural changes in 105 male soldiers who went by train in Tibetan plateau (3900 mt.)





NAMME, Varese 2013

Angelini, 2013

Am J Cardiol. 1996 May 1;77(11):1021.

High altitude-related neurocardiogenic syncope.

Freitas J, Costa O, Carvalho MJ, Falcão de Freitas A.

Centro de Estudos da Função Autonómica, Oporto, Portugal.

Snížení ortostatické tolerance

High Altitude-Related Neurocardiogenic Syncope

João Freitas, MD, Ovídio Costa, PhD, Mário J. Carvalho, MD, and A. Falcão de Freitas, PhD

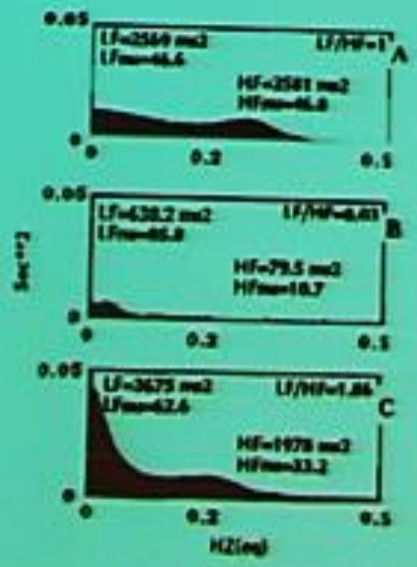


FIGURE 1. *A*, spectral analysis of heart rate variability (autoregressive model) in the supine position with normal age-related pattern. *B*, marked increase in low- to high-frequency ratio (LF/HF) in the first minutes after 70° tilt before the induction of syncope. *C*, after β-blocker therapy, the tilt induced an increase in total variability and a normalization of low- to high-frequency ratio (LF/HF).

A 22-year old woman presented syncope when she climbed higher than 2000 mt. She had a positive tilt test, treated with 50 mg atenolol, she had no more syncope

Am.J.Cardiol. 199(

NAMME, Varese 2013

CONSEQUENCES FOR THE PATIENTS

- Sleep apnea with periodic breathing
- Reductuion of orthostatic tolerance in hypoxia (syncope)
- Breathing instability
- Decrease in work performance in aircraft pilots, large machine operators, train drivers, engeneering builders, military soldiers
- Decrease of cognitive training advantage at high altitude

Angelini, 2013

DROBNÁ KRVÁCENÍ V PLICÍCH A MOZKU

Microhemorrhages in Brain and Lung

Prof. Dr. med Peter Bärtsch

Höhenmedizinische Beratung in Bern
www.swiss-sportclinic.ch
Swiss Sport Clinic AG, Wankdorfstadion, Bern

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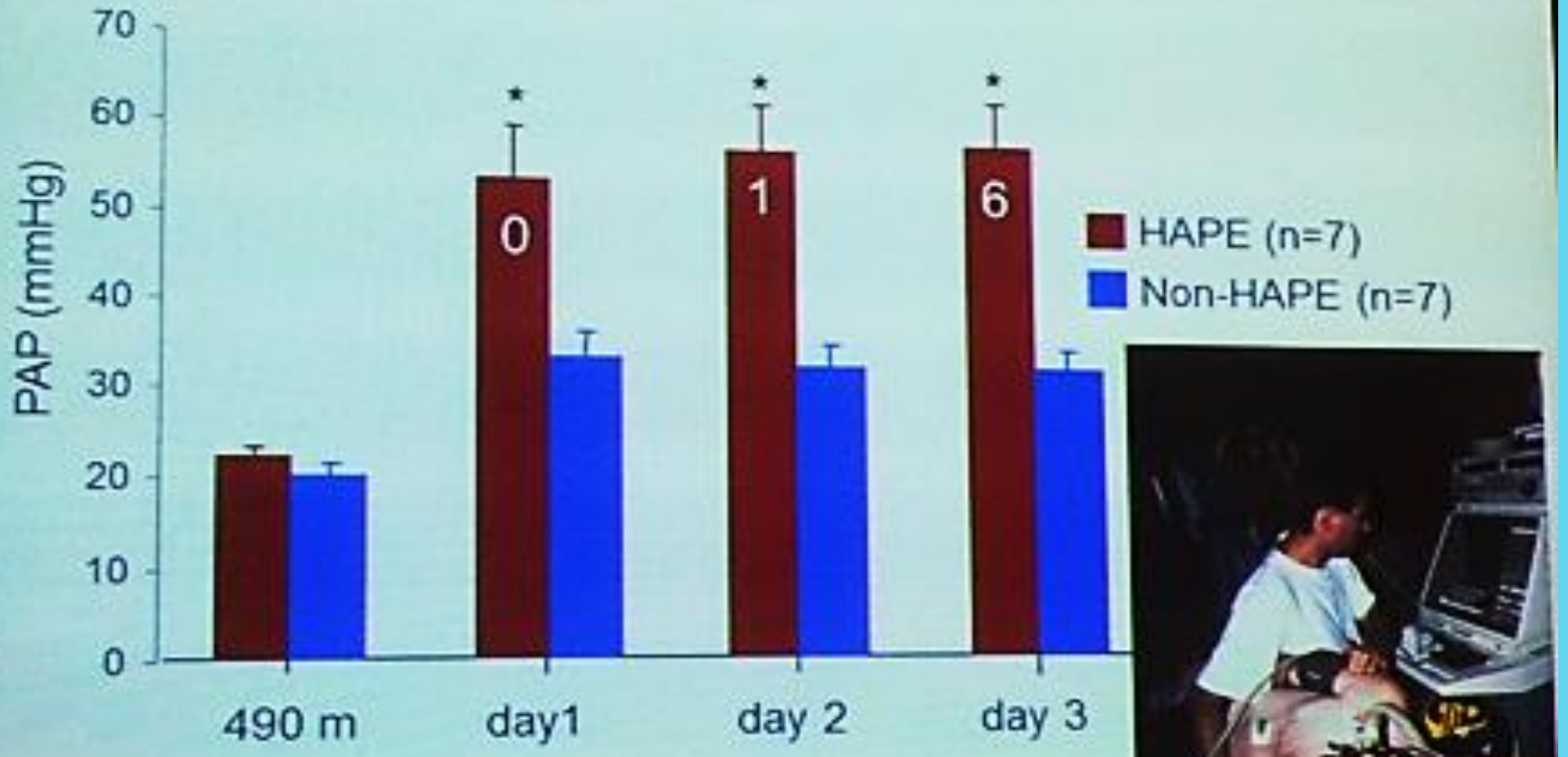
Systolic Pulmonary Artery Pressure at 4559 m

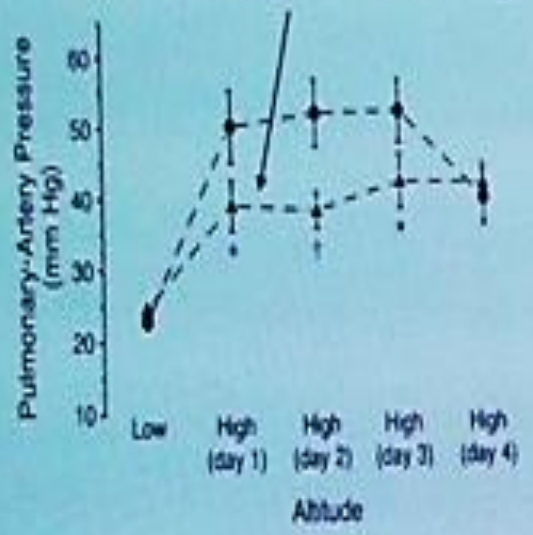


Bärtsch, N Engl J Med 1991

Bärtsch, 2013

Prevention of HAPE by Pulmonary Vasodilators

Nifedipine 3x20 mg

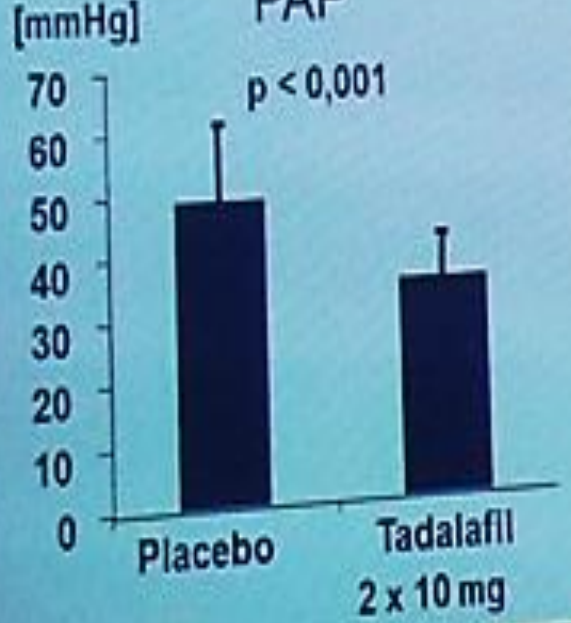


Radiographic endpoint: HAPE

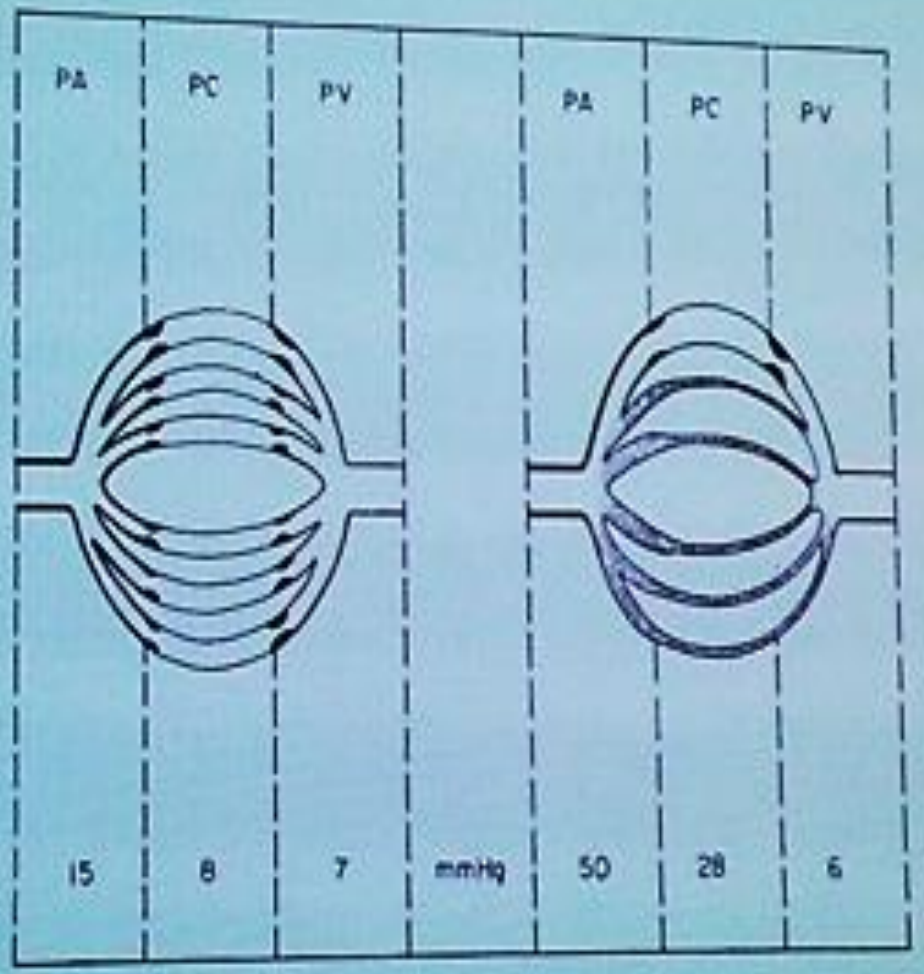
Nifedipine	1 of 10 (= 10%)
Placebo	7 of 11 (= 64%)

Bärtsch, N Engl J Med 1991

PAP



Inhomogenous Vasoconstriction



ultgren, in: Lung Water and Solute Exchange (Lenfant Series, vol. 7, Marcel Dekker, Inc., New York, 1978)

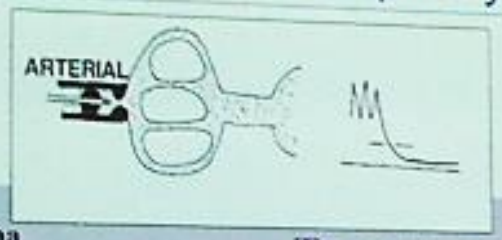
Bärtsch, 2013

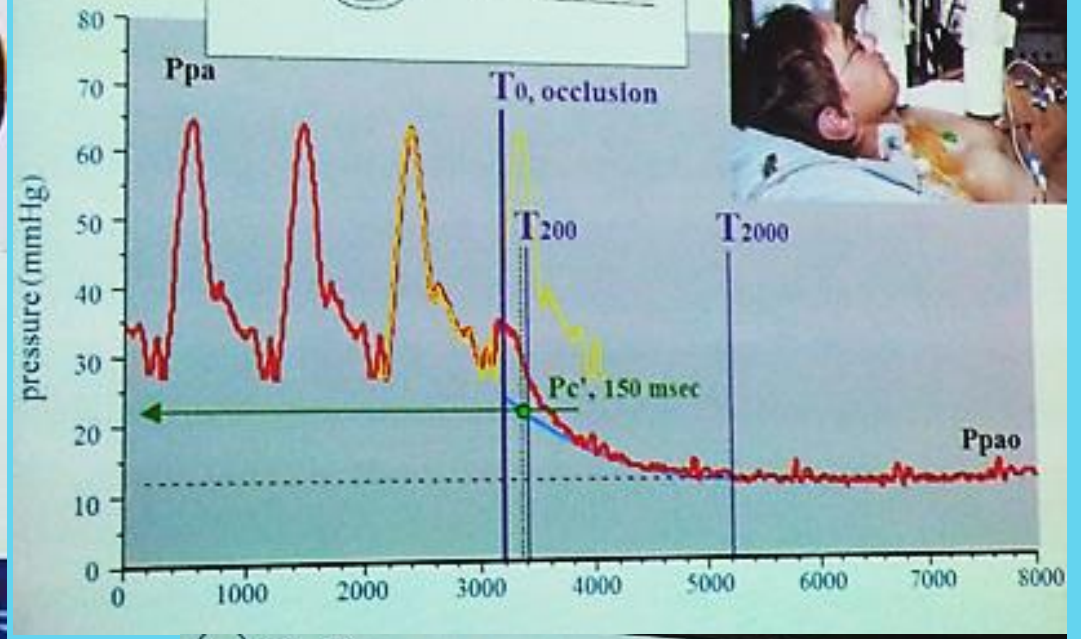
Inhomogeneity of HPV in HAPE

Radiographic appearance

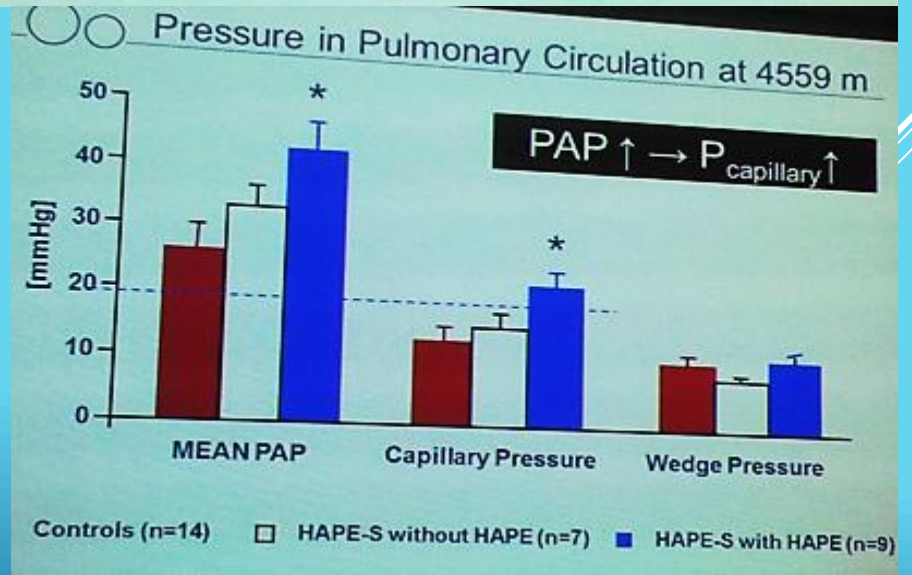
Hopkins, et al., AJRCCM 2005
Dehnert et al., AJRCCM 2006

Increased Capillary Pressure?





Pressure in Pulmonary Circulation at 4559 m



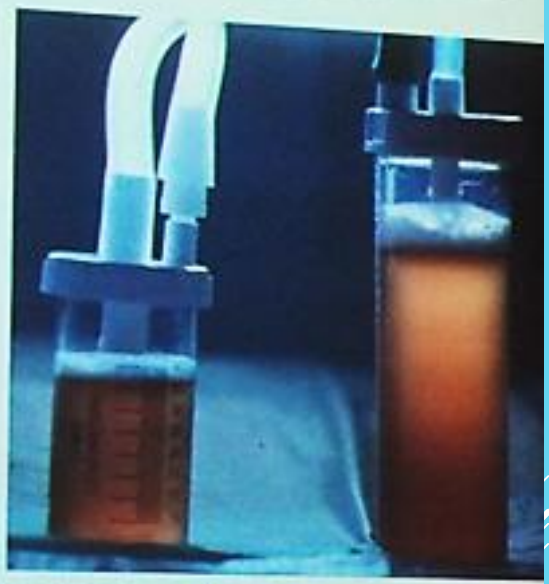
BAL in HAPE:
Cytokines and arachidonate metabolites

		Low altitude (490 m)		High altitude (4559 m)		
		CONT (n=8)	HAPE-S (n=9)	CONT (n=8)	HAPE-S well (n=6)	HAPE-S ill (n=3)
IL-1	(pg/ml)	ND	ND	ND	ND	ND
IL-6	(pg/ml)	ND	ND	ND	ND	176*
IL-8	(pg/ml)	0.1	0.1	0.2	0.2	0.2
TNF-α	(pg/ml)	ND	ND	ND	ND	ND
LTB_4	(pg/ml)	547	521	499	537	512
PGE-2	(pg/ml)	13	14	13	19	18
Thromboxane	(pg/ml)	24	14	43	28	51

ND not detectable

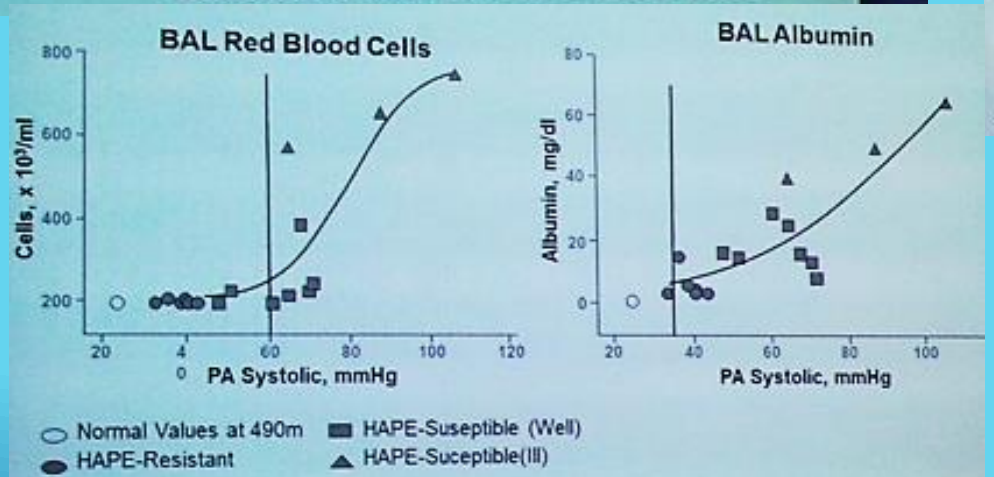
Swenson, JAMA 287: 2228-2235, 2002

BAL at 4559 m in Early HAPE



→ HAPE is a hydrostatic pulmonary edema with normal Wedge-pressure

Swenson, JAMA 2002



The leak for RBC and albumin is pressure-dependent

Swenson, JAMA 287: 2228-2235, 2002

NAMME, Varese

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Bronchoalveolar Lavage at 4400 m

	Control n=4	AMS n=4	HAPE n=6
Leucozytes	0.7 ± 0.6	0.9 ± 0.4	3.5 ± 2.3*
AM/GC/LY (%)	94/3/3	94/2/4	65/25/7*
TxB_2 (pg/ml)	43 ± 6	38 ± 2	342 ± 201*
LTB_4 (pg/ml)	-	-	810 ± 374
Protein	12 ± 3	10 ± 8	619 ± 329*

Schoene, JAP 1988

- BAL fluid analysis (Japan)

  (Kubo, Thorax 1996 & Respir Physiol 1998)

- Urinary LTE_4 excretion in HAPE (Colorado)

  (Kaminsky, Chest 1996)

Inflammation, VEGF and ROS in HAPE

Inflammation in HAPE: prospective studies are negative

- No evidence of activated blood coagulation (Bärtsch, JAP 1987 and 1989)
- Plasma levels of TNF-α, IL-1β, 2, and 8 unchanged (Kleger, JAP 1996)
- Urinary LTE_4 excretion unchanged (Bärtsch, Chest 2000)
- No increase of exhaled NO (Duplain)

VEGF (vascular endothelial growth factor)

No evidence from measurements in BAL fluid and pulmonary capillary blood (Walter, EJAP 2001, Hanaoka, JAP 2003, Schommer HAMB 2009)

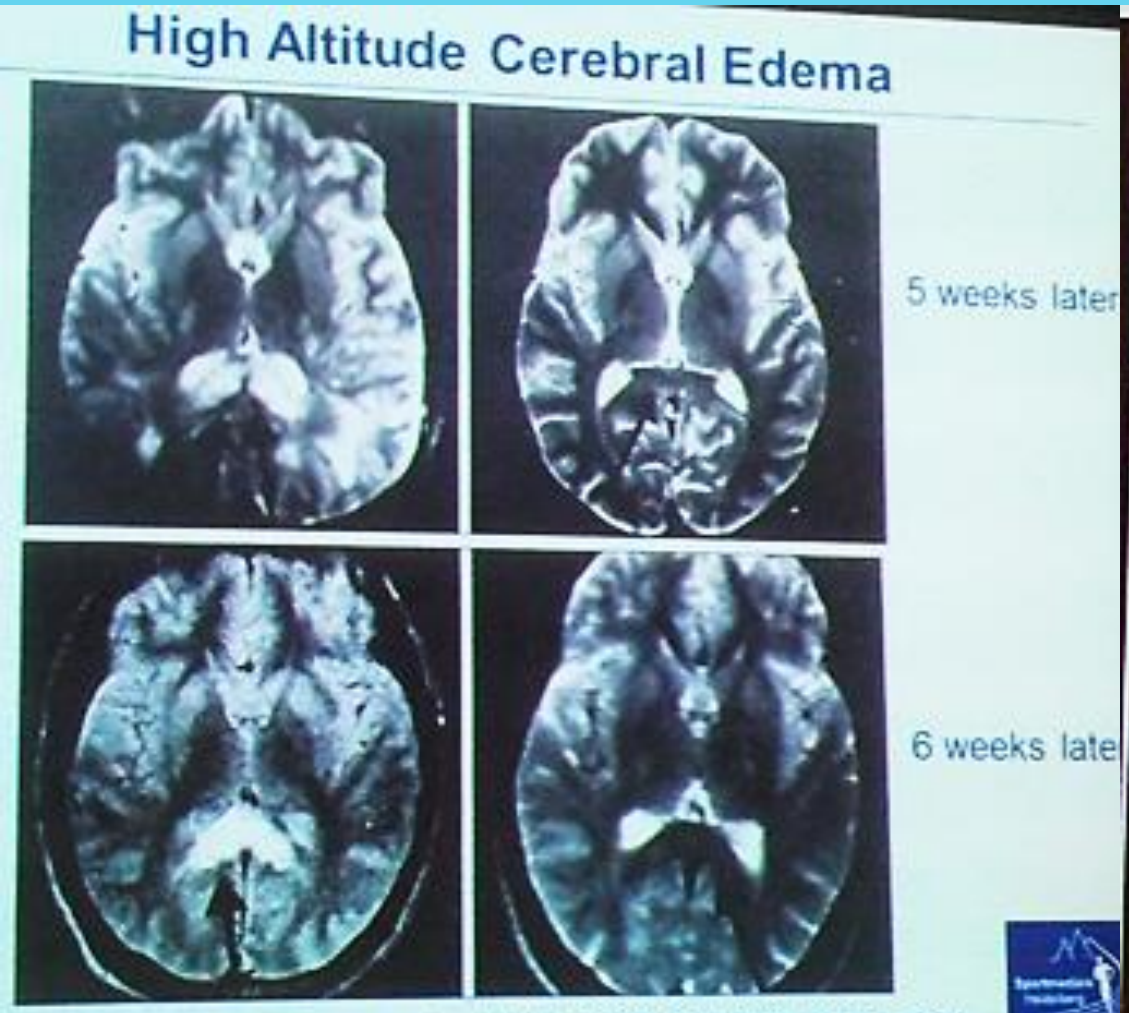
ROS (reactive oxygen species)

Transpulmonary increase at high altitude that correlates with increase in PAP (Bailey, J Physiol 2010)

Intermin Summary on HAPE

- Early HAPE is characterized by a non-selective leak of red cells and plasma proteins without activation of inflammatory or chemotactic mediators and without neutrophil recruitment.
- HAPE is a hydrostatic pulmonary edema
- Contribution of ROS and VEGF possible
- Inflammation may occur as a consequence of edema formation

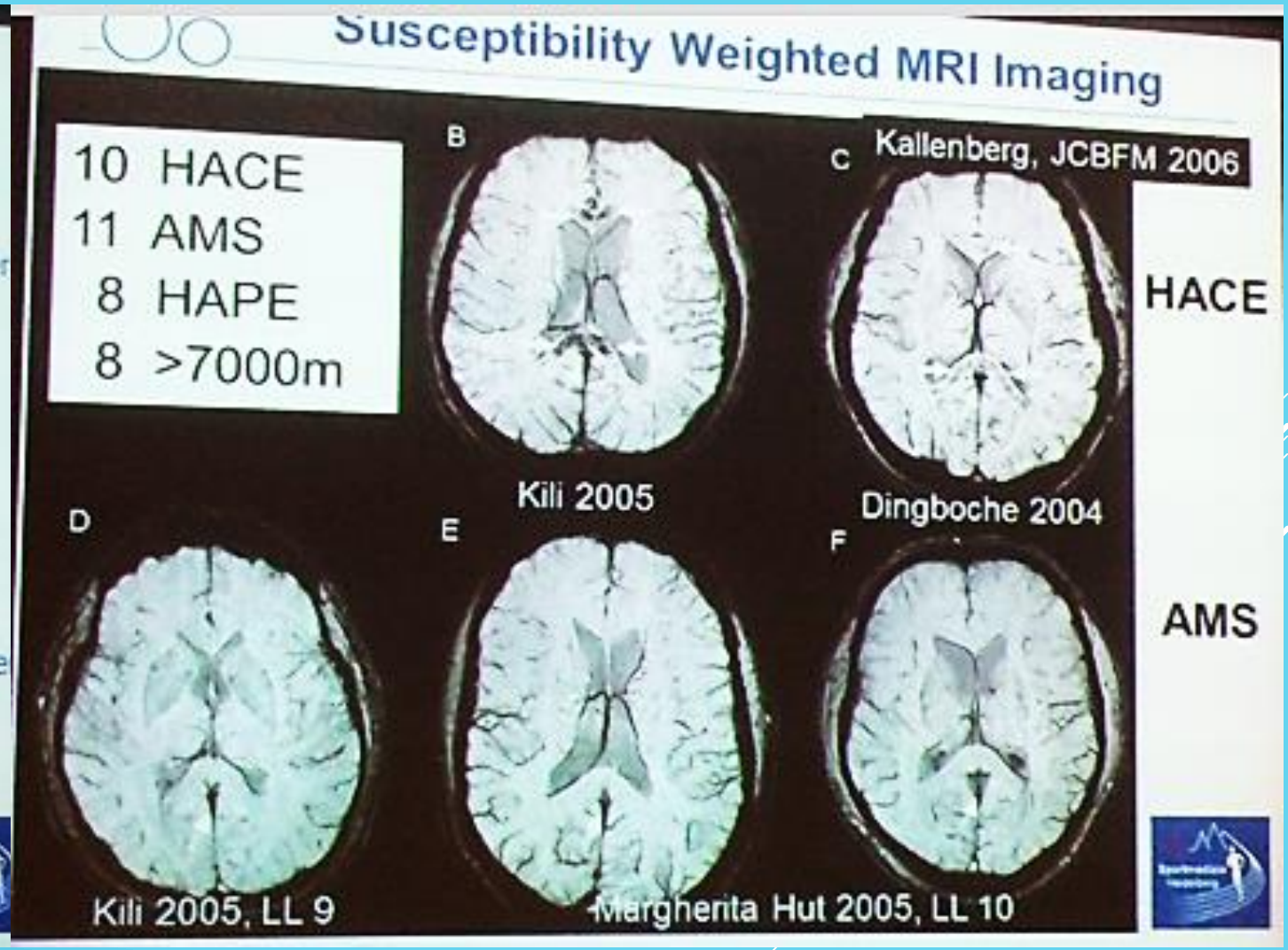
High Altitude Cerebral Edema



Hacket et al., JAMA 1998, 280(22):1923-1924

Susceptibility Weighted MRI Imaging

10 HACE
11 AMS
8 HAPE
8 >7000m



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Cerebral Microhemorrhages in Mountaineers

yes (≥ 2 MH, typical localization)

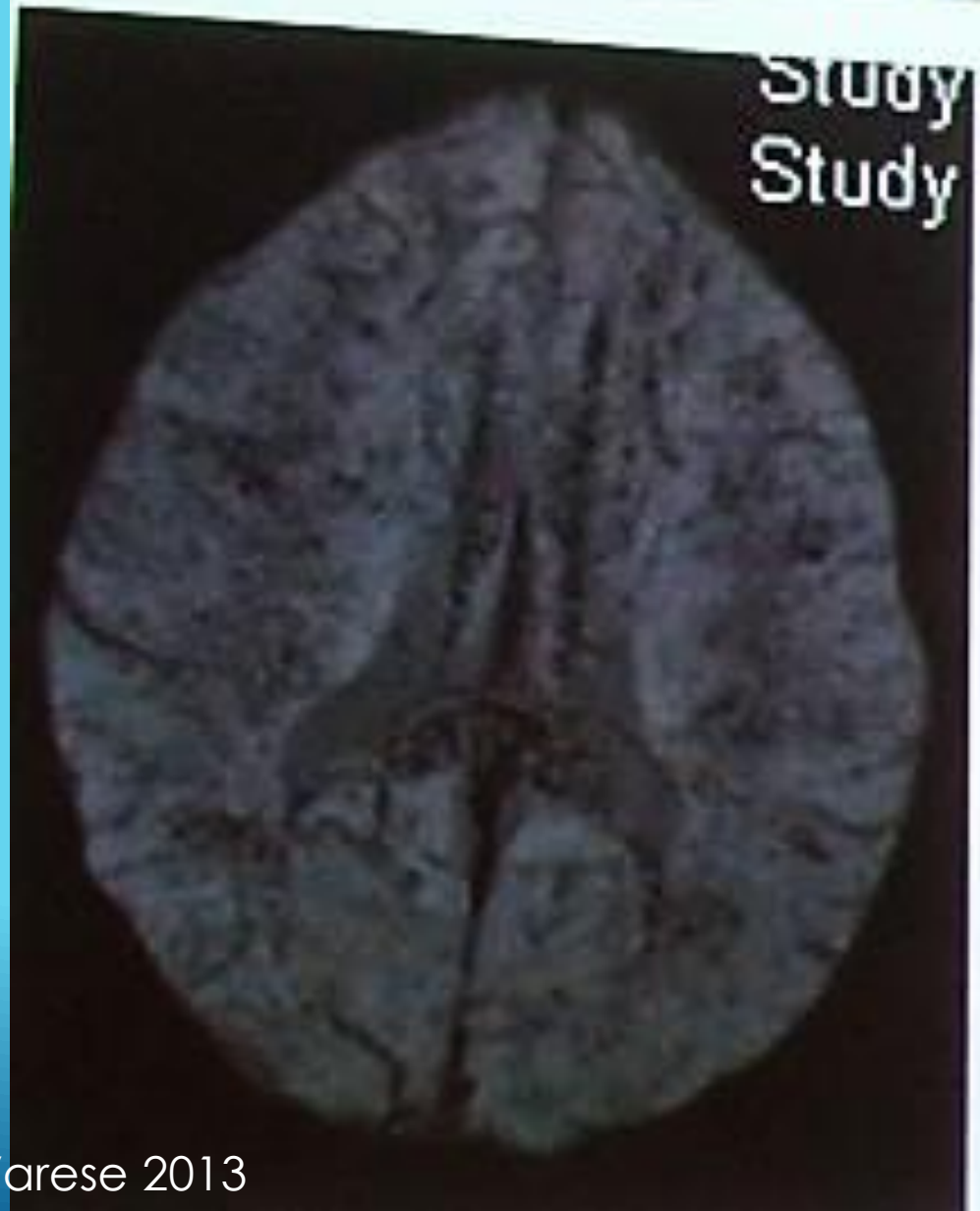
no (no MH)

questionable (1 MH in typical or 2 MB in atypical l.)

		microhemorrhages		
		yes	no	?
	n	n	n	n
HACE	10	8	-	2
severe AMS	11	1	10	-
HAPE	8	-	7	1
Climbers > 7000 m	8	-	6	2

Bärtsch, 2013

MRI of HACE: 10 Days and 1 Year after Onset



- No abnormal neurological findings
- Only two retinal hemaorrhages
- Neuropsychological testing normal
- ECG normal

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MRI of HACE: 10 Days and 1 Year after Onset

NAMME, Varese 2013

Bürtsch, 2013

Leak of Blood Brain Barrier in Hypoxia

- VEGF
  - increased mRNA and protein in hypoxic mouse brain at 6 – 9% oxygen (Xu, JAP 1998)
  - prevention of hypoxic brain edema in mice by VEGF-neutralizing antibodies at 8% oxygen (Schoch, Brain 2002)
  - not increased in human CSF at 12 % oxygen (Bailey, JCBFM 2006)
- Inflammation ?
- Membrane damage by ROS ?
- Hemodynamics ?

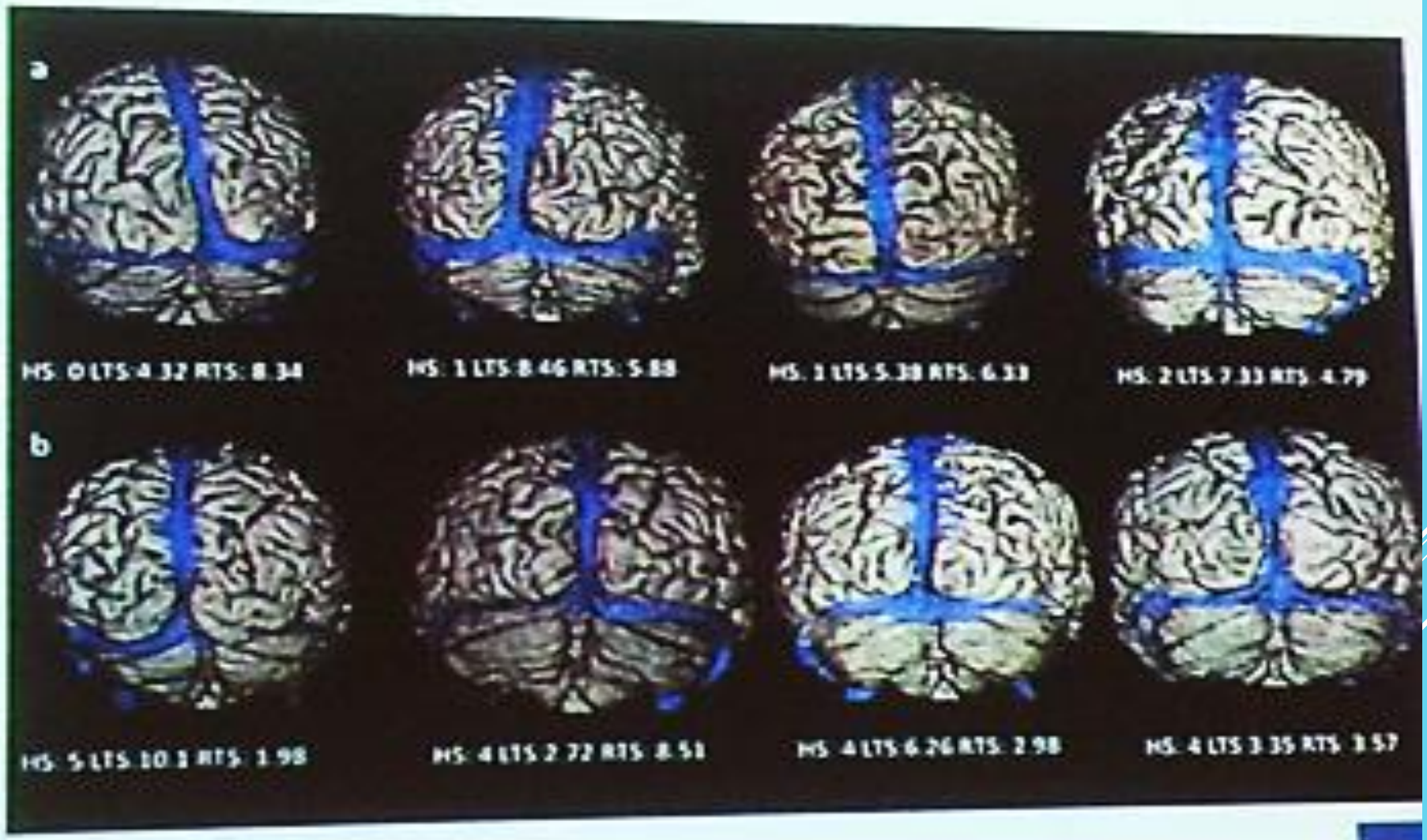
AMS ----------> HACE

Bärtsch, 2013

Impaired Venous Return in AMS ?

AMS -

AMS +



Wilson MH, Ann Neurol 2012, in press

NAMME, Varese 2013

Bärtsch, 2013

Summary Speculations

- Microbleeding is found in HAPE and HACE. This might point to a similar underlying pathophysiology
- Prospective examinations in HAPE demonstrate a non-inflammatory hemodynamic leak in the lung
- Hemodynamic stress in cerebral vessels could be due to an imbalance between increased inflow and the outflow capacity
- In addition integrity or resistance of alveolo-capillary barrier and blood-brain barrier might be weakened in hypoxia by increased production of VEGF and/or ROS

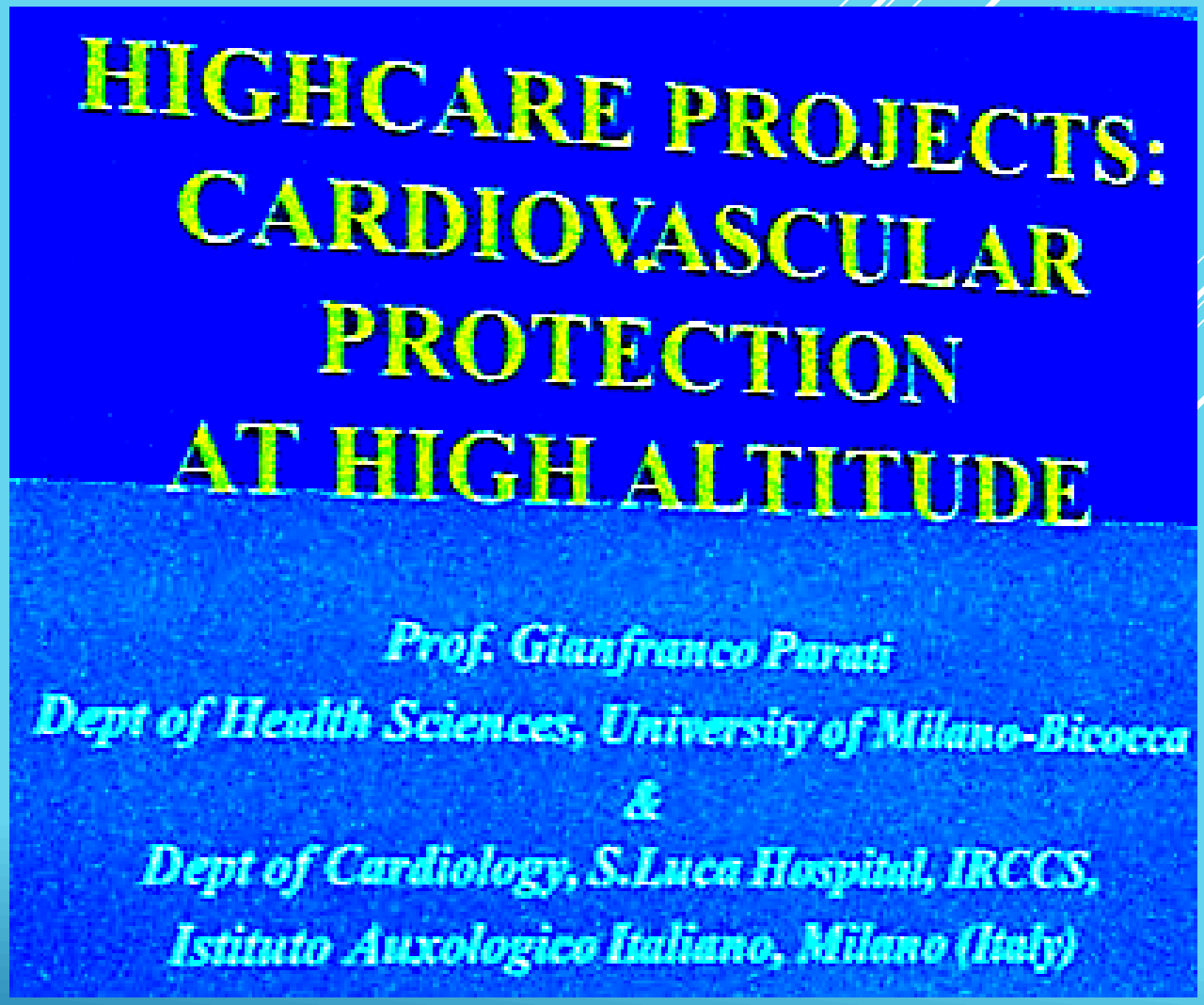
NAMME, Varese 2013 **Bärtsch, 2013**

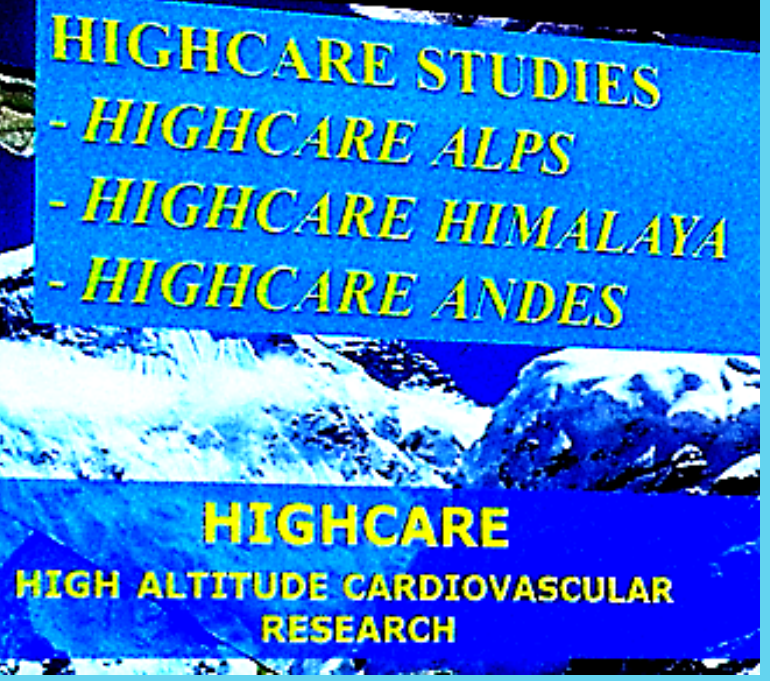
ÚČINKY VELKÉ VÝŠKY NA SRDCE A OBĚH - PROJEKT HIGHCARE

Cardiovascular Effects at High Altitude

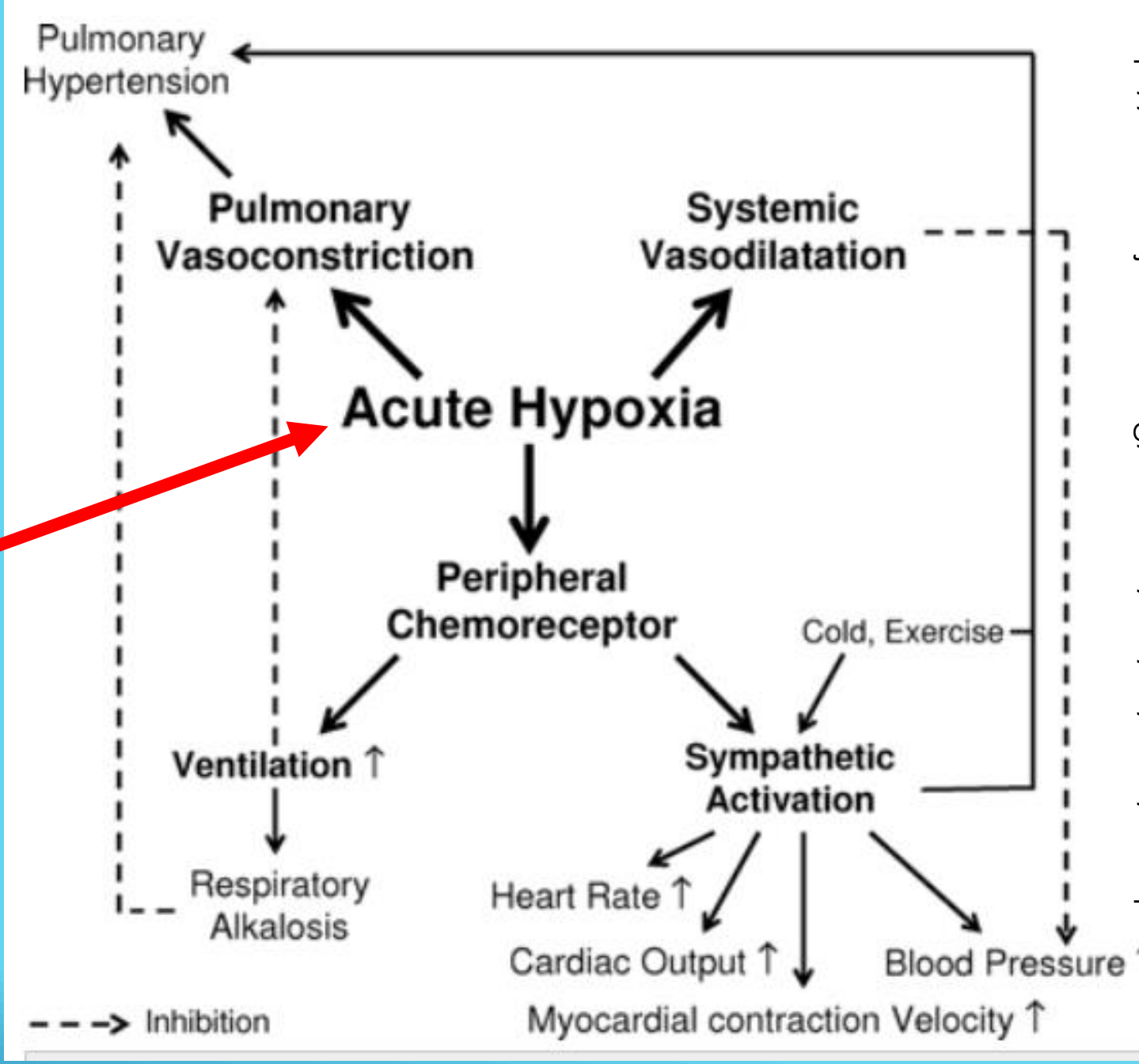
HighCare Projects: Cardiovascular Protection at High Altitude

Prof. Gianfranco Parati
Department of Health Sciences
University of Milano-Biococca





Inzulinová resistence
Zvýšení kortisolu



http://circ.ahajournals.org/content/116/19/2191/F1.expansion.html

Systemic Blood Pressure during acute exposure to HAHH

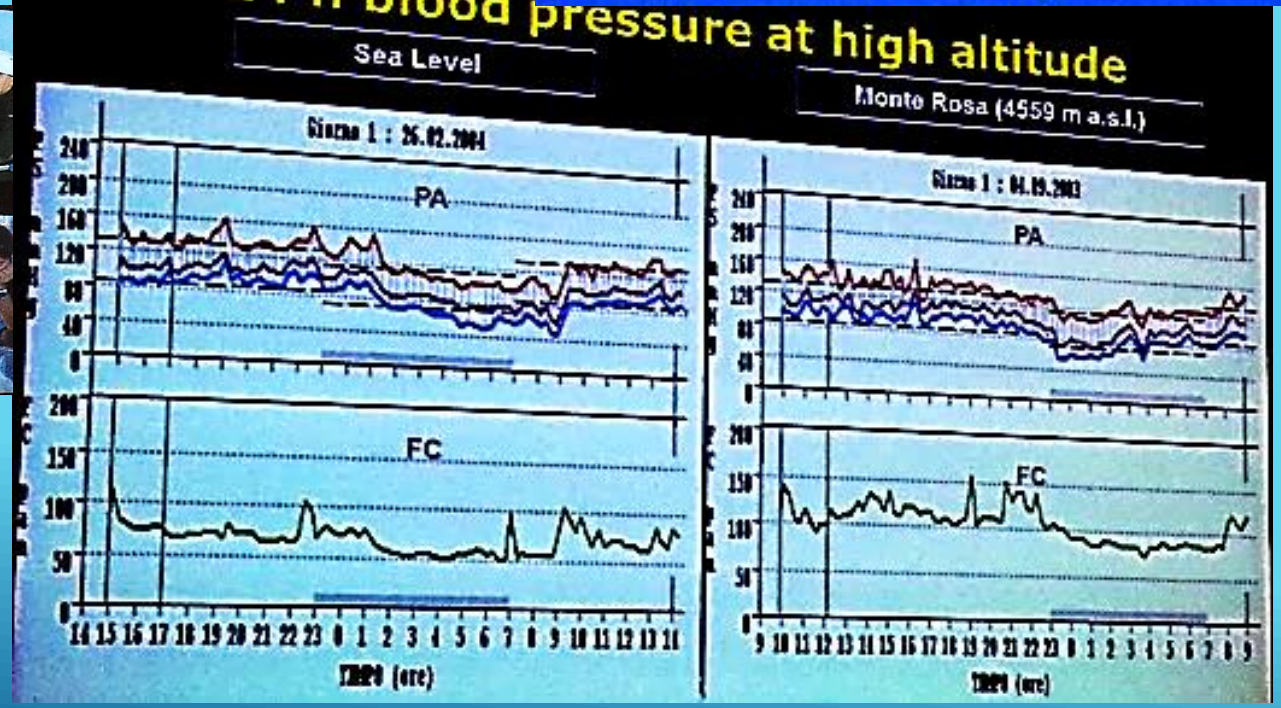
- Occasional Reports
- No systematic studies so far
- Conventional BP measurements with different techniques
- Limited use of 24 h ABPM

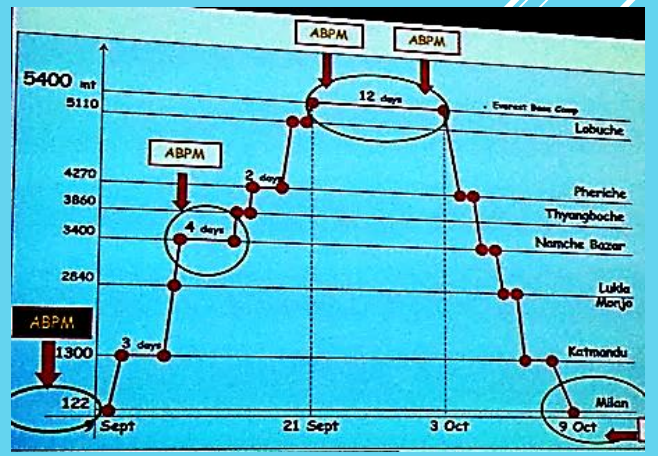
HIGHCARE

AN INTEGRATED PROJECT ON ACUTE AND PROLONGED EFFECTS OF HYPOBARIC HYOPOXIA AT ALTITUDE in HIMALAYA

49 Healthy volunteers: randomized (double blind) to placebo or Telmisartan 80 mg

24 h blood pressure at high altitude





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Parati 2013

So far seven expeditions have taken place:

- **five on the Italian Alps -HIGHCARE – ALPS in 2003, 2004, 2005, 2006, 2010)**
- **one in the Himalaya (HIGHCARE – HIMALAYA in 2008, on the south Nepal slopes of Mount Everest, and**
- **the last was located in the Peruvian Andes HIGHCARE – ANDES 2012**

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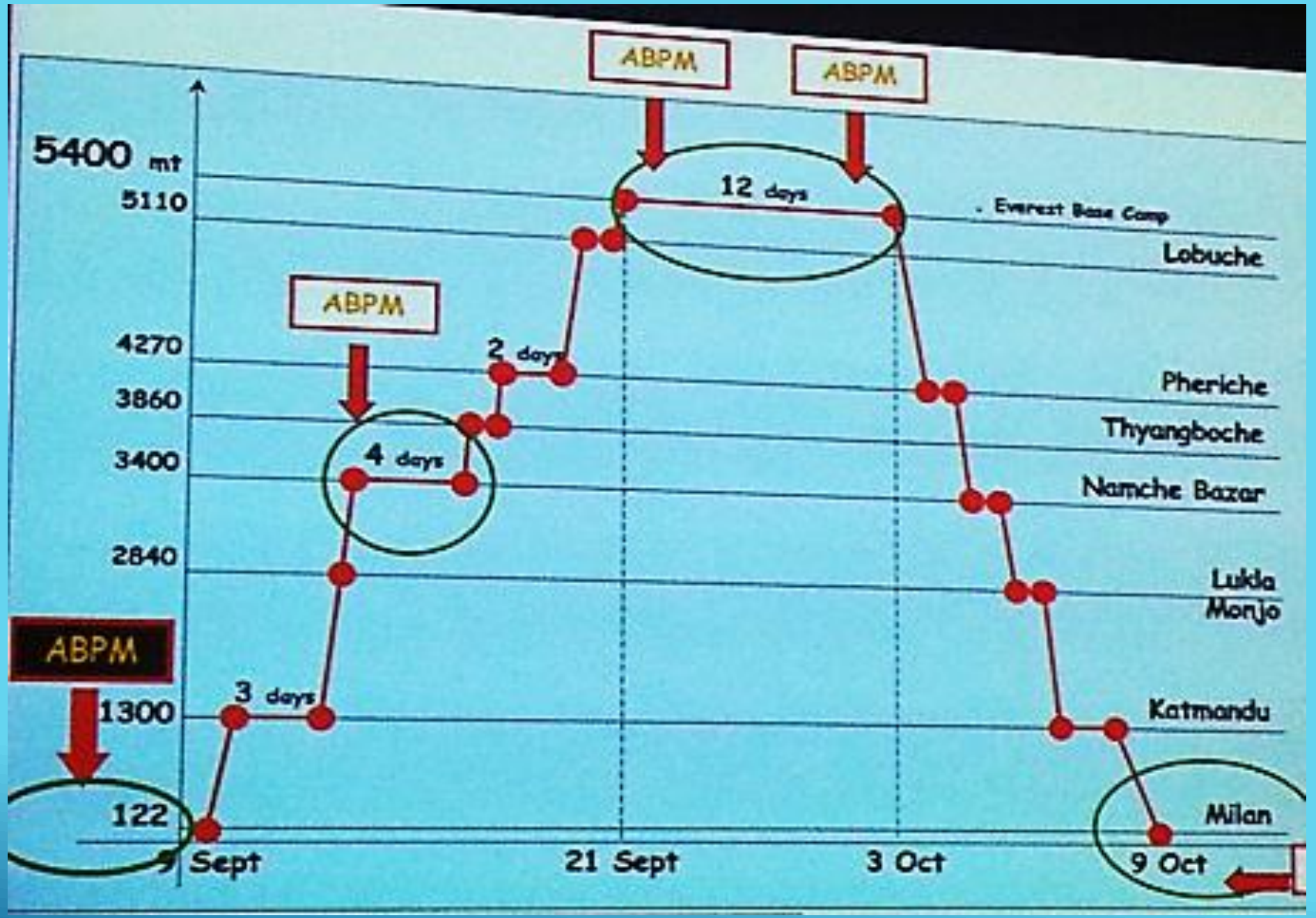
ABPM
ABPM
5400 mt
5110
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Pheriche
Thyangboche
3400
4 days
Namche Bazar
2840
Lukla
Monjo
ABPM
3 days
1300
Katmandu
122
Milan
Sept
21 Sept
3 Oct
9 Oct

EFFECTS OF ACETAZOLAMIDE ON BLOOD PRESSURE AND PULSE WAVEFORM CHANGES INDUCED BY HIGH ALTITUDE EXPOSURE

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[3] University of Milano-Bicocca and Istituto Auxologico Italiano, Milan-Italy; [4] Dept. Clinical Medicine and Prevention, University of Milano-Bicocca, Milan-Italy

Background

- Exposure to high altitude (HA) may induce mountain sickness and increase blood pressure (BP) but little is known on the effects of this condition on arterial properties.
- Acetazolamide (AC), antagonizing chemoreflex activation effects, has been proposed to prevent and treat mountain sickness, but no information is available on its effects on cardiovascular parameters at HA.

Aim

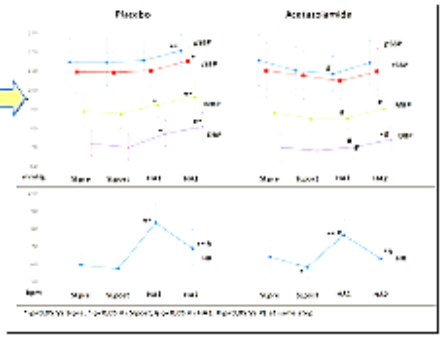
Aim of our study was to assess these issues in a group of healthy volunteers acutely exposed to very HA (Capanna Margherita, Mount Rosa, Italian-Swiss Alps, [illegible] m a.s.l.)

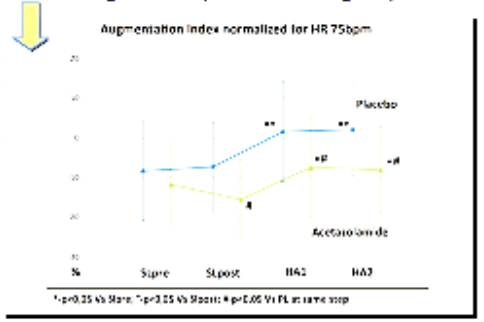
Methods

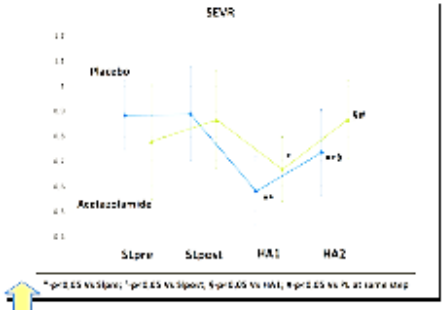
- 42 healthy volunteers were randomized to receive AC 250 mg bid or placebo (PL) both at sea level (SL) and HA.
- A *tonometric evaluation of arterial properties* (PulsePen, DiaTecne, Milan) by assessing carotid-femoral and carotid-radial PWV (CF-PWV, CR-PWV) and pulse wave analysis (augmentation index, AIx and subendocardial viability ratio, SEVR, i.e. the ratio between diastolic and systolic area under the pulse pressure curve) was performed in the following conditions:
  - at baseline (SL pre)
  - after 2 days of randomized treatment at SL (SL post)
  - within 6 hours from arrival at HA (HA1)
  - and on 3rd full day of exposure to HA (HA2)
- Systolic (S) and diastolic (D)BP were measured by a validated oscillometric device (AND UA 767-PC). Heart rate (HR) was derived from an ECG signal. Mean arterial pressure (MAP) was calculated by PulsePen software. Data are shown as means ± SD.

Results

- No difference in terms of anthropometric characteristics were found between the two groups.
- Acute exposure to HA significantly increased SBP, DBP, MAP and HR. Subjects in AC group, compared to PL group, showed however significantly lower values of these parameters at HA1. DBP and MAP were significantly lower with AC also at HA2.
- In all subjects CF-PWV and CR-PWV did not change, while AIx (adjusted for HR = 75 bpm) increased compared with SLpost both at HA1 and HA2. Its values were significantly lower in AC group.







- SEVR significantly decreased from SL to HA1 in both groups, with a smaller reduction in the AC group. At HA2 SEVR was significantly lower in PL compared to AC.

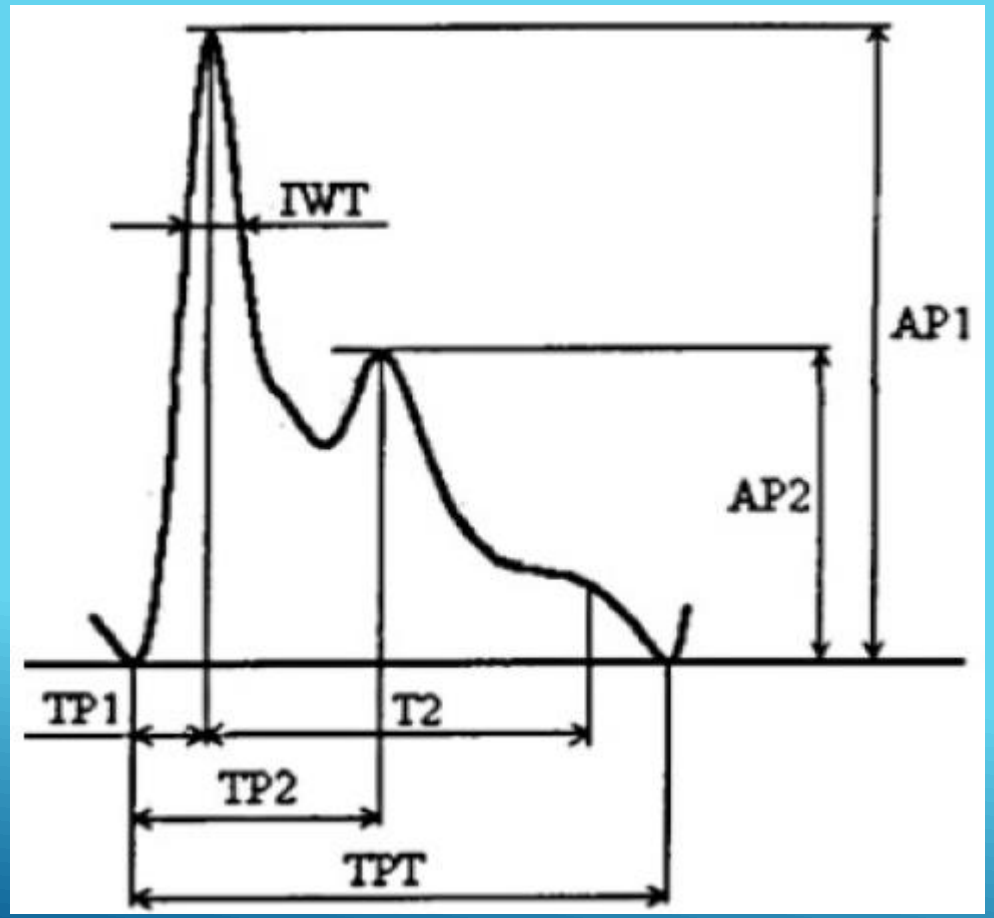
Conclusions

- Our study shows for the first time that acute exposure to HA induces both a BP rise and changes in vascular function, whose magnitude is partly counteracted by treatment with AC.
- The effects of AC on the haemodynamic changes induced by hypobaric hypoxia may contribute to the beneficial role of this drug in subjects prone to mountain sickness.
- Based on these findings, also the possible clinical usefulness of AC in patients with diseases associated to hypoxemia might deserve to be re-assessed.

http://spo.escardio.org/eslides/view.aspx?eevtid=48&fp=P5713

Peripheral Pulse Wave Analysis

Pulzová vlna vzniká během srdeční revoluce, kdy dochází za systoly k vypuzeni krve z levé komory do velkého oběhu. Arteriální systém se s tímto rychle vypuzeným objemem vyrovnává svou elasticitou, tedy schopnosti krátkodobého zvětšeni průřezu arterie

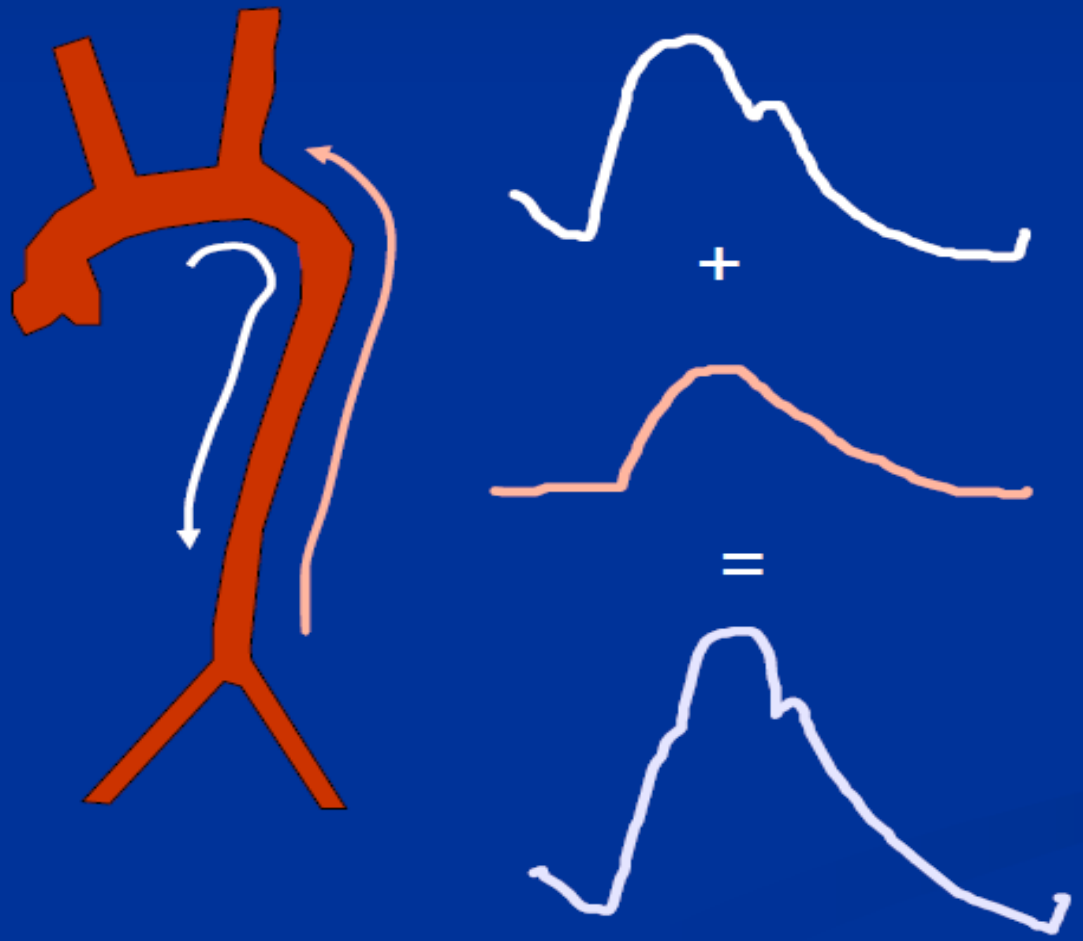


- Pulsový čas TPT Total Pulse Time (ms)
- Vrcholový čas CT Crest Time (80-100 ms)
- Relativní vrcholový čas RCT (CT/TPT)
- Meziraménková vzdálenost IWT Inter Wave Time (ms)
- Vrcholový čas diastolické vlny TP2 (ms)
- Relativní vrcholový čas diastol.vlny RTP2
- Systolická amplituda (A) (V,Pa)
- Radiální augmentační index Aixr %
- Vrcholový čas rozštěpu TPS Time of Peak Split

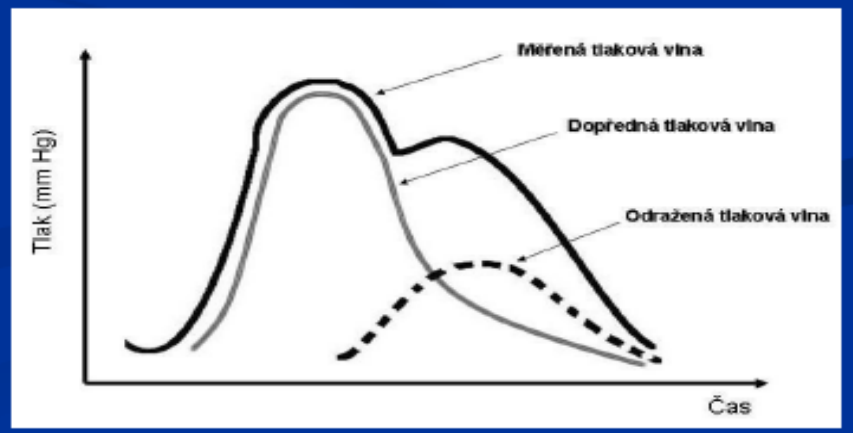
http://www.chirurg.cz/navratk/mereni_bolesti/autoreferat-disertace-dr_navratil.pdf

Pulzní (tlaková) vlna

Činností levé komory je generována primární (dopředná) tlaková vlna, která se šíří podél velkých tepen do periferie, kde se odráží a navrací zpět jako sekundární (odražená) tlaková vlna. Jako místo odrazu se předpokládá počátek rezistenčního řečiště, kde dochází k největšímu větvení tepen.



Vlastnosti primární tlakové vlny jsou závislé na funkci levé komory a následně na vlastnostech centrálních elastických tepen, zatímco sekundární vlna je dána především rychlostí šíření tlakové vlny a místem odrazu



http://int3.lf1.cuni.cz/Data/files/3.intern%C3%AD/ppt/petrak_16_11_2010.pdf

Pulzní (tlaková) vlna

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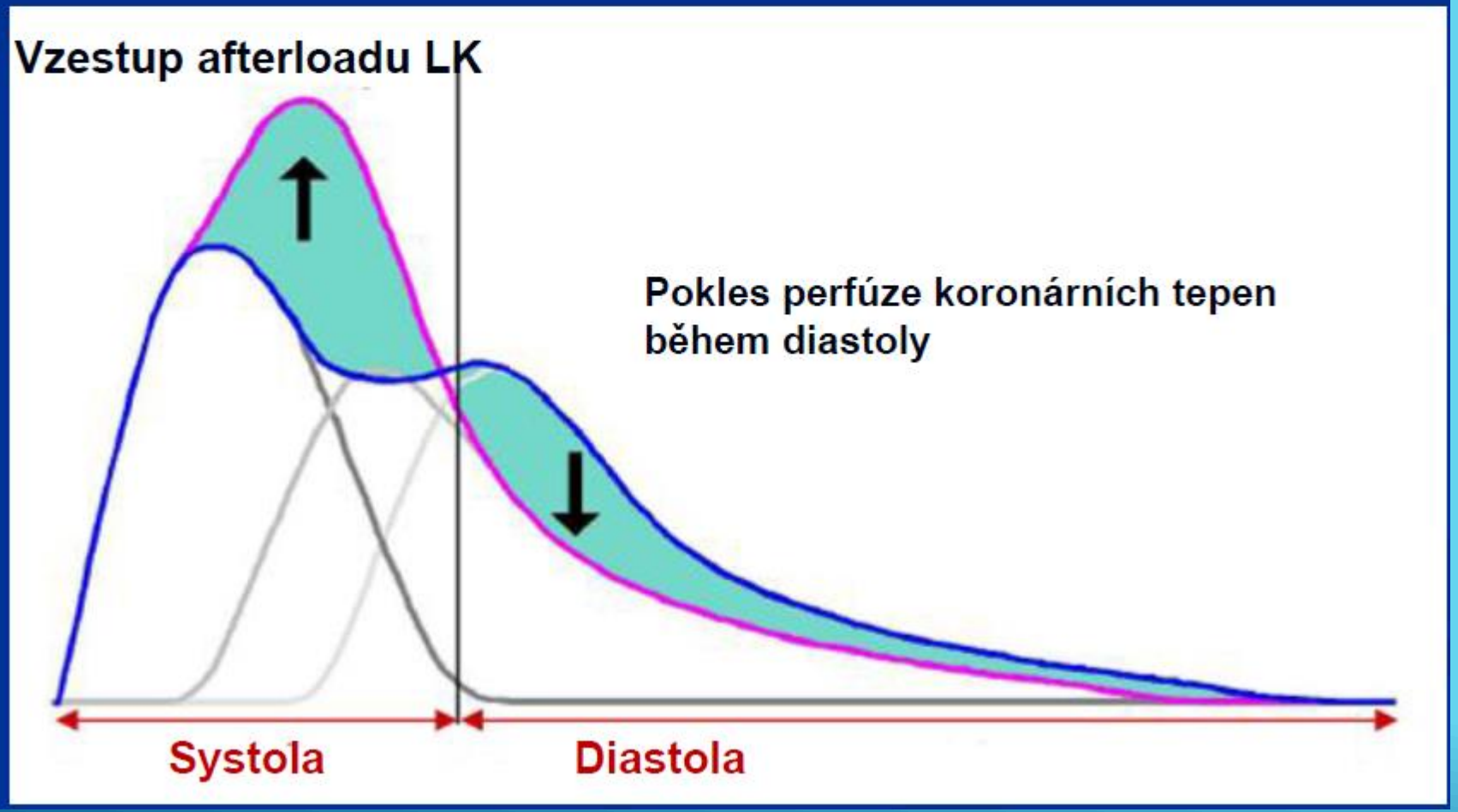
Změny důsledkem remodelace

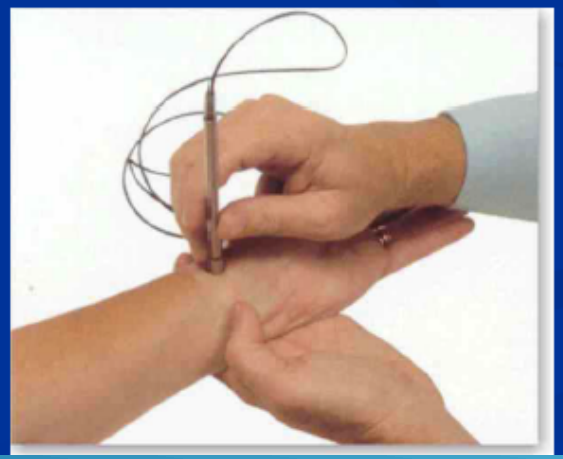


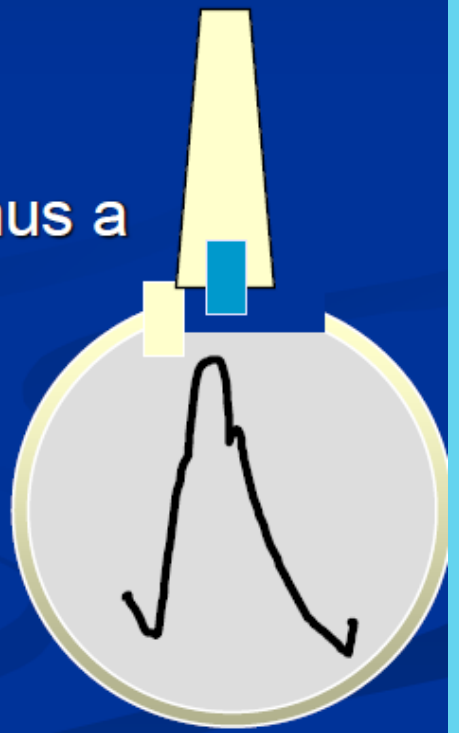
SphygmoCor (AtCor Medical, USA)
princip metody

Komprese tepny mezi senzorem a okolní strukturou:
intraarteriální tlak

Závisí od:

- viskoelastických vlastností stěny - svalový tonus a struktura (elastin / kolagen)
- viskozity krve
- wave dispersion
- wave reflection





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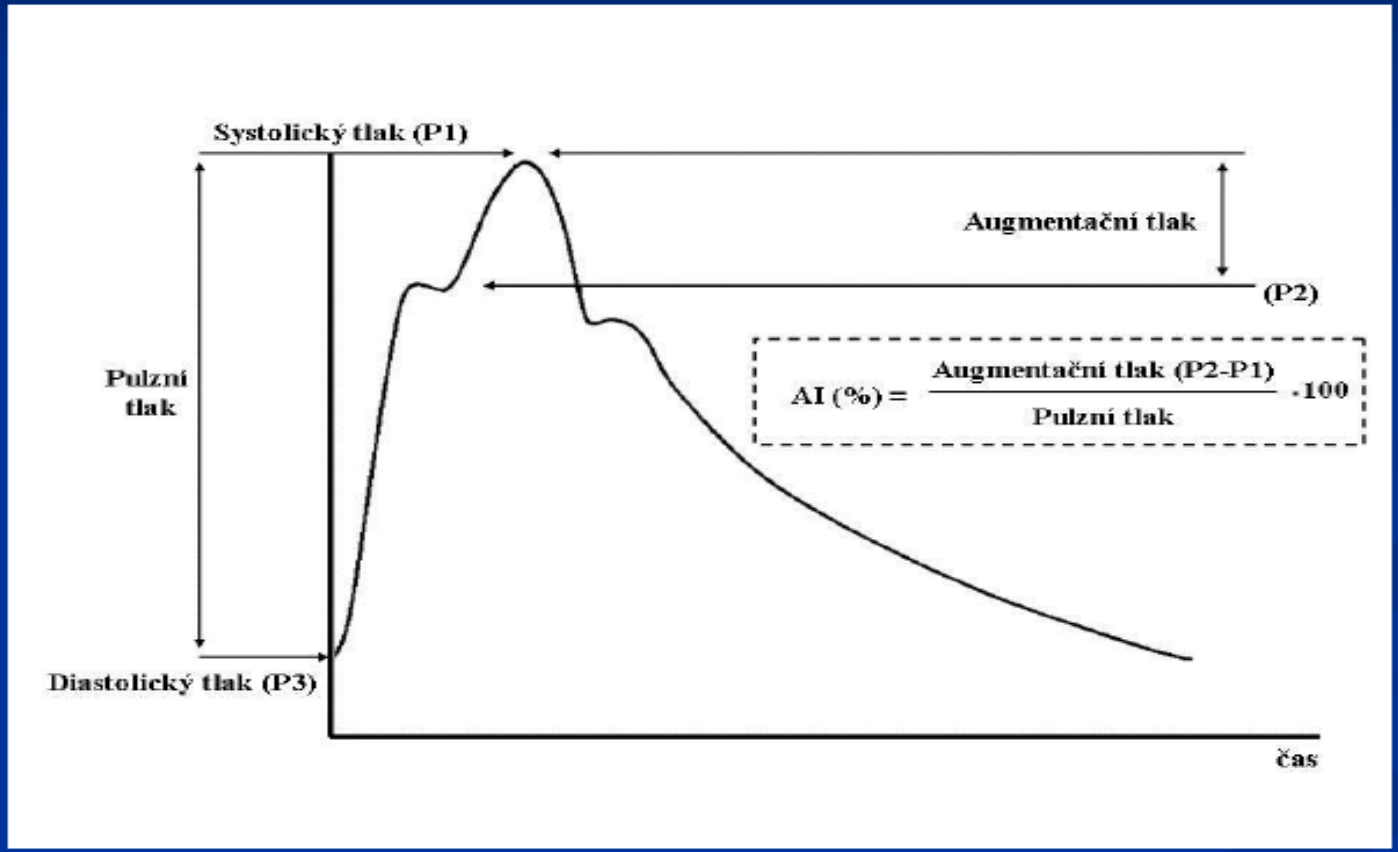
Co měříme?

Pulse Wave Analysis – analýza pulzní vlny

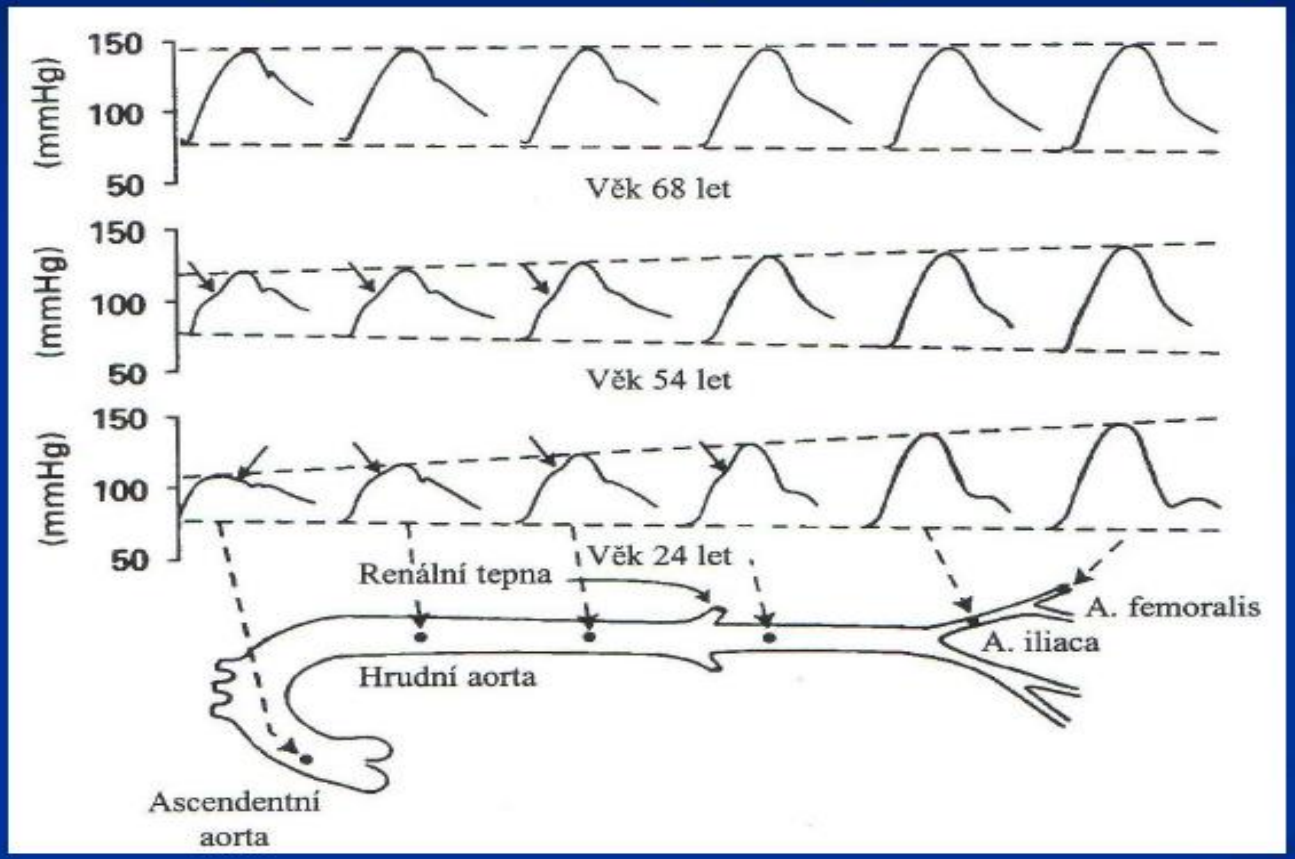


Záznam ukazuje navýšení systolického tlaku důsledkem časného návratu odražené vlny. Rozdíl tlaků mezi odraženou (sekundární) vlnou a dopřednou (primární) vlnou se označuje jako augmentační tlak. Poměr augmentačního tlaku k pulznímu tlaku se označuje jako augmentační index (AI).

http://int3.lf1.cuni.cz/Data/files/3.intern%C3%AD/ppt/petrak_16_11_2010.pdf

Co měříme?

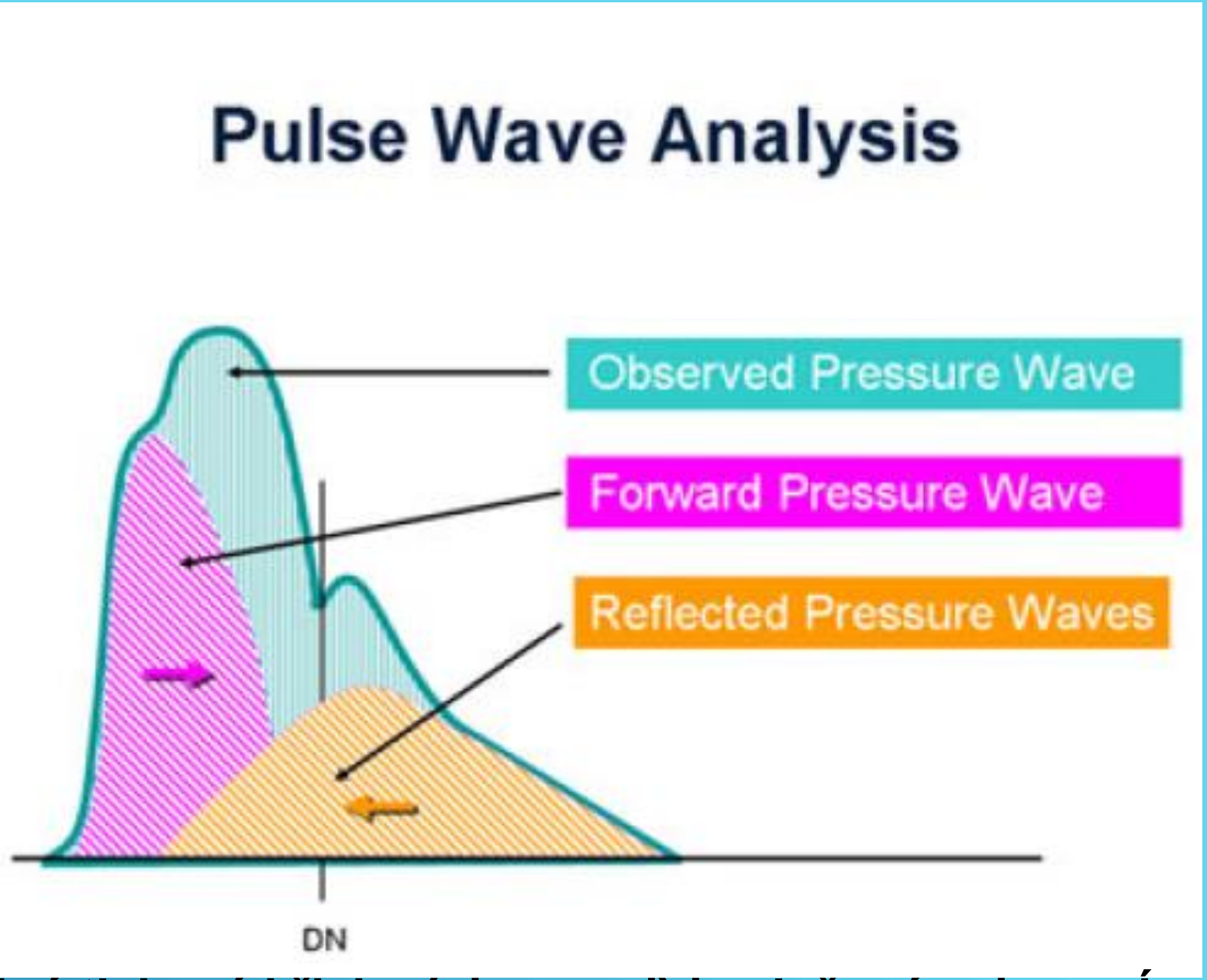
Pulse Wave Analysis – analýza pulzní vlny



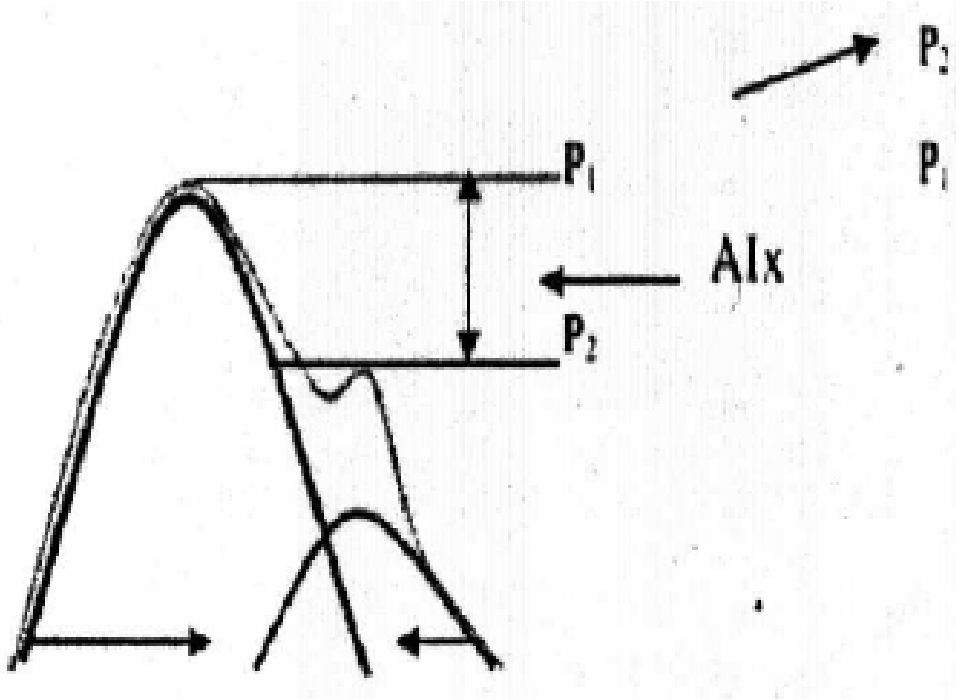
Jak tlaková vlna postupuje krevním řečištěm, dochází ke změnám pulzního tlaku, zatímco střední tlak zůstává neměnný. Zvětšuje se amplituda pulzního tlaku, převážně zvyšováním systolického krevního tlaku. Tento jev se nazývá amplifikace krevního tlaku a bývá vyjádřen u mladých jedinců.

http://int3.lf1.cuni.cz/Data/files/3.intern%C3%AD/ppt/petrak_16_11_2010.pdf

http://www.ehealth.sk/files/hypertenzia/Vysetrovanie_arterialnej_tuhosti.pdf



Výsledná tlaková křivka (observed) je složená z dvou vĺn: dopředná (forward) a odražená (reflected pressure wave).



http://www.ehealth.sk/files/hypertenzia/Vysetrovanie_arterialnej_tuhosti.pdf

Obr. 3. Výpočet augmentácie (P2-P1) pre výpočet Aix.

Tab.1. Kategórie PWV a AIx	AIx	PWV
Optimálny	menej ako -30%	menej ako 7 m/s
Normálny	-30% až -10%	7m/s až 9.7 m/s
Zvýšený	-10% až 10%	9.7 m/s až 12m/s
Abnormálny	viac ako 10%	viac ako 12m/s

A *tonometric evaluation of arterial properties* (PulsePen, DiaTecne, Milan) by assessing carotid-femoral and carotid-radial PWV (CF-PWV, CR-PWV) and pulse wave analysis (augmentation index, AIx and subendocardial viability ratio, SEVR, i.e. the ratio between diastolic and systolic area under the pulse pressure curve) was performed in the following conditions:

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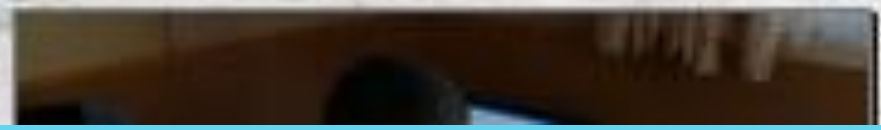
- within 6 hours from arrival at HA (HA1)
- and on 3rd full day of exposure to HA (HA2)

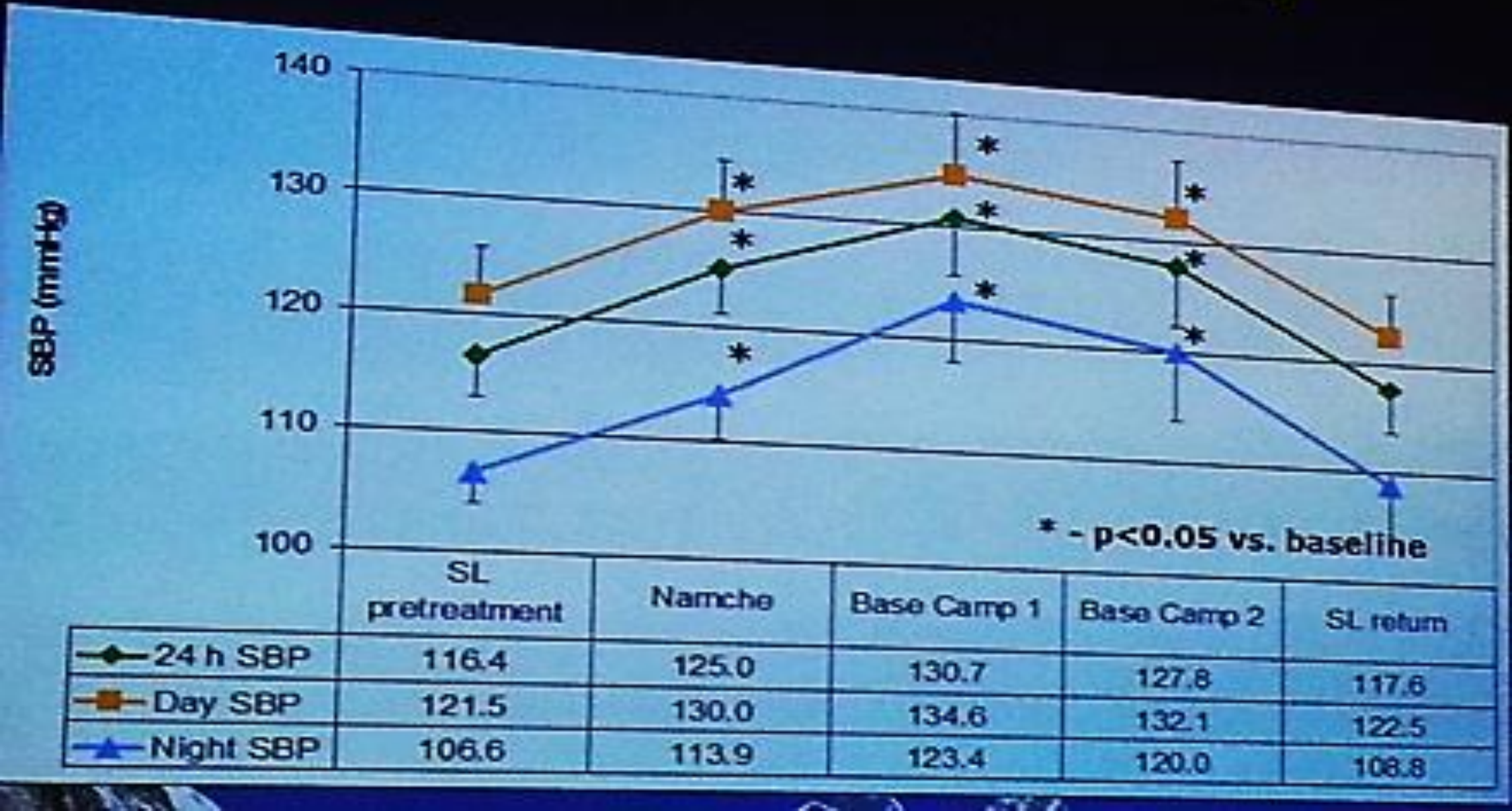


Acetazolamid zmírnil vzestup TKs, TKd, Tkmean a SF

Conclusions

- Our study shows for the first time that acute exposure to HA induces both a BP rise and changes in vascular function, whose magnitude is partly counteracted by treatment with AC.
- The effects of AC on the haemodynamic changes induced by hypobaric hypoxia may contribute to the beneficial role of this drug in subjects prone to mountain sickness.
- Based on these findings, also the possible clinical usefulness of AC in patients with diseases associated to hypoxemia might deserve to be re-assessed.

RESULTS: Systolic BP means

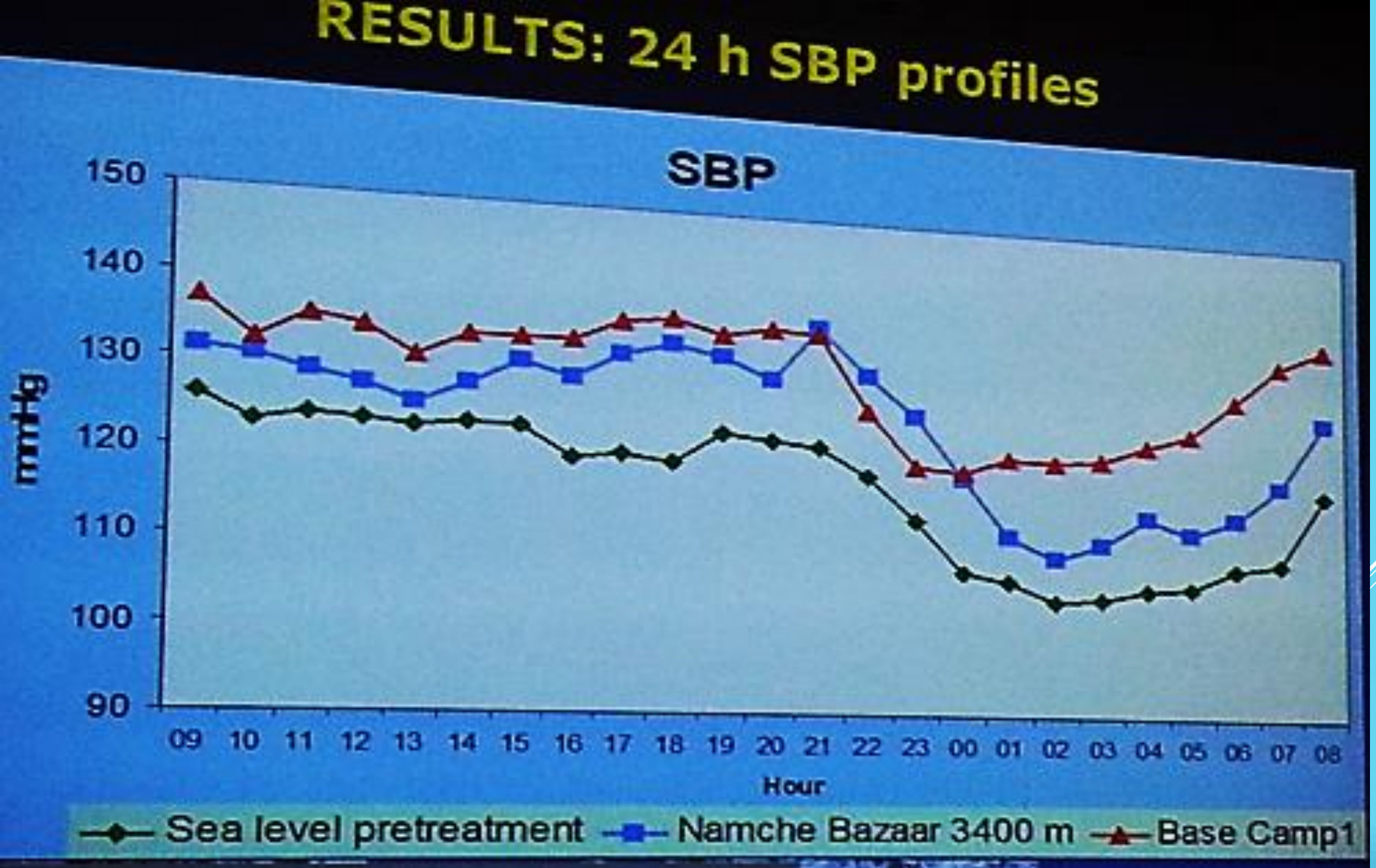


	SL pretreatment	Namche	Base Camp 1	Base Camp 2	SL return
24 h SBP	116.4	125.0	130.7	127.8	117.6
Day SBP	121.5	130.0	134.6	132.1	122.5
Night SBP	106.6	113.9	123.4	120.0	108.8

NAMME, Varese 2013

Parati 2013

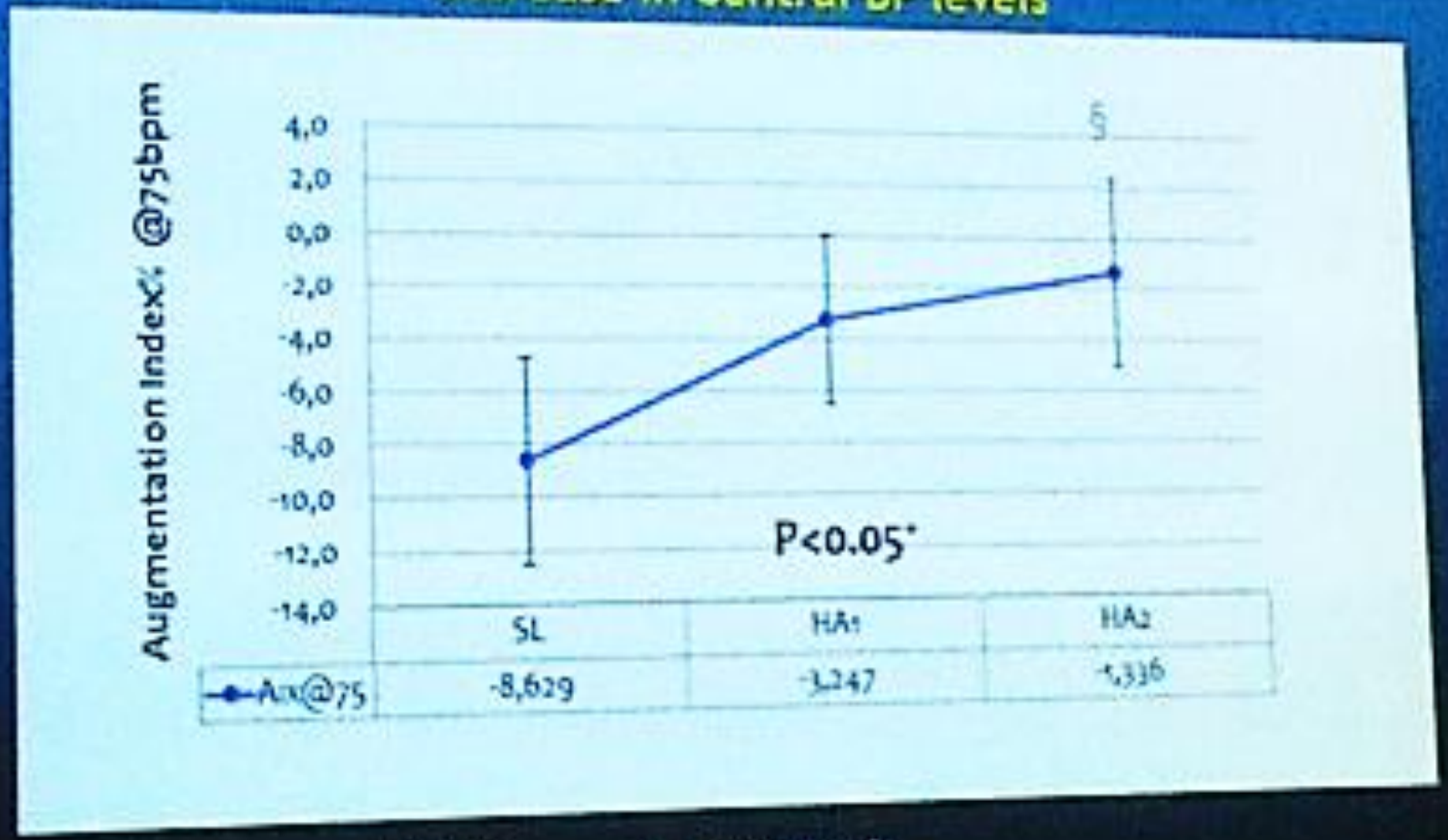
RESULTS: 24 h SBP profiles

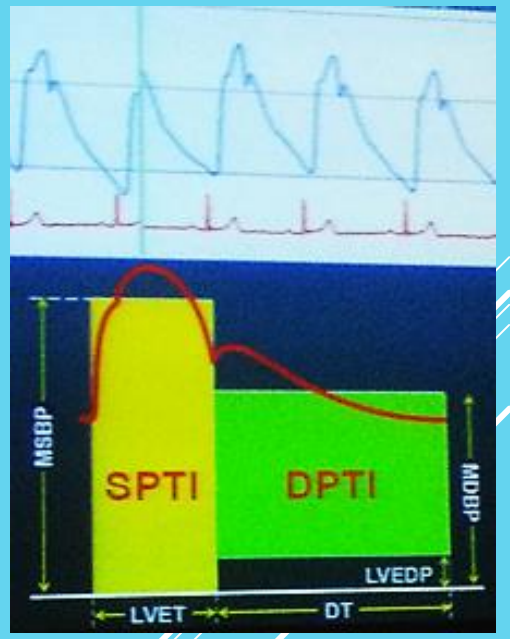


Central BP levels, PWA and Arterial Wall Properties with hyposia

Augmentation Index during acute exposure at high and very high altitude

Increase in Central BP levels



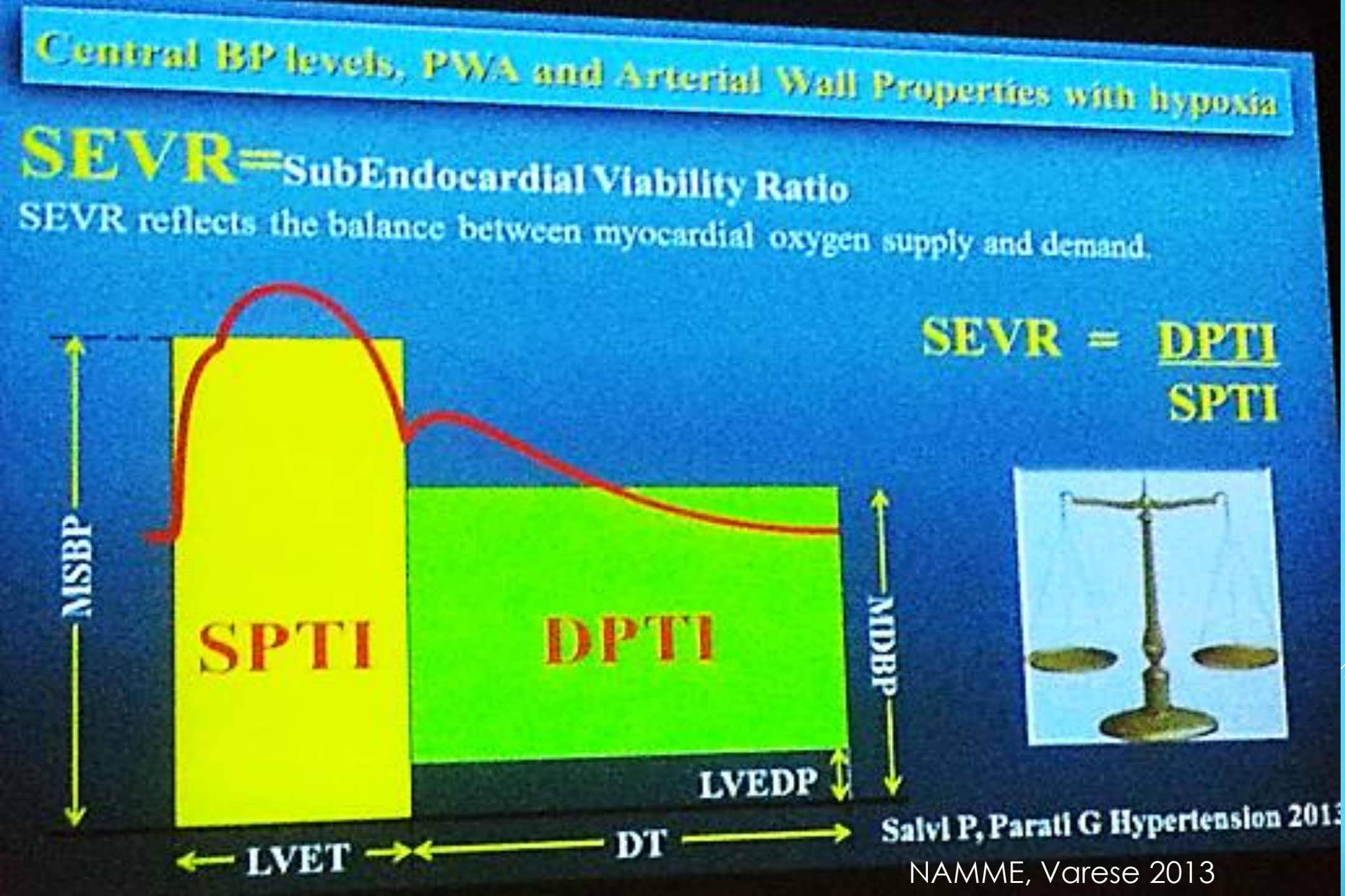


NAMME, Varese 2013

*ANOVA

§ p=0.05 Vs SL

Parati 2013

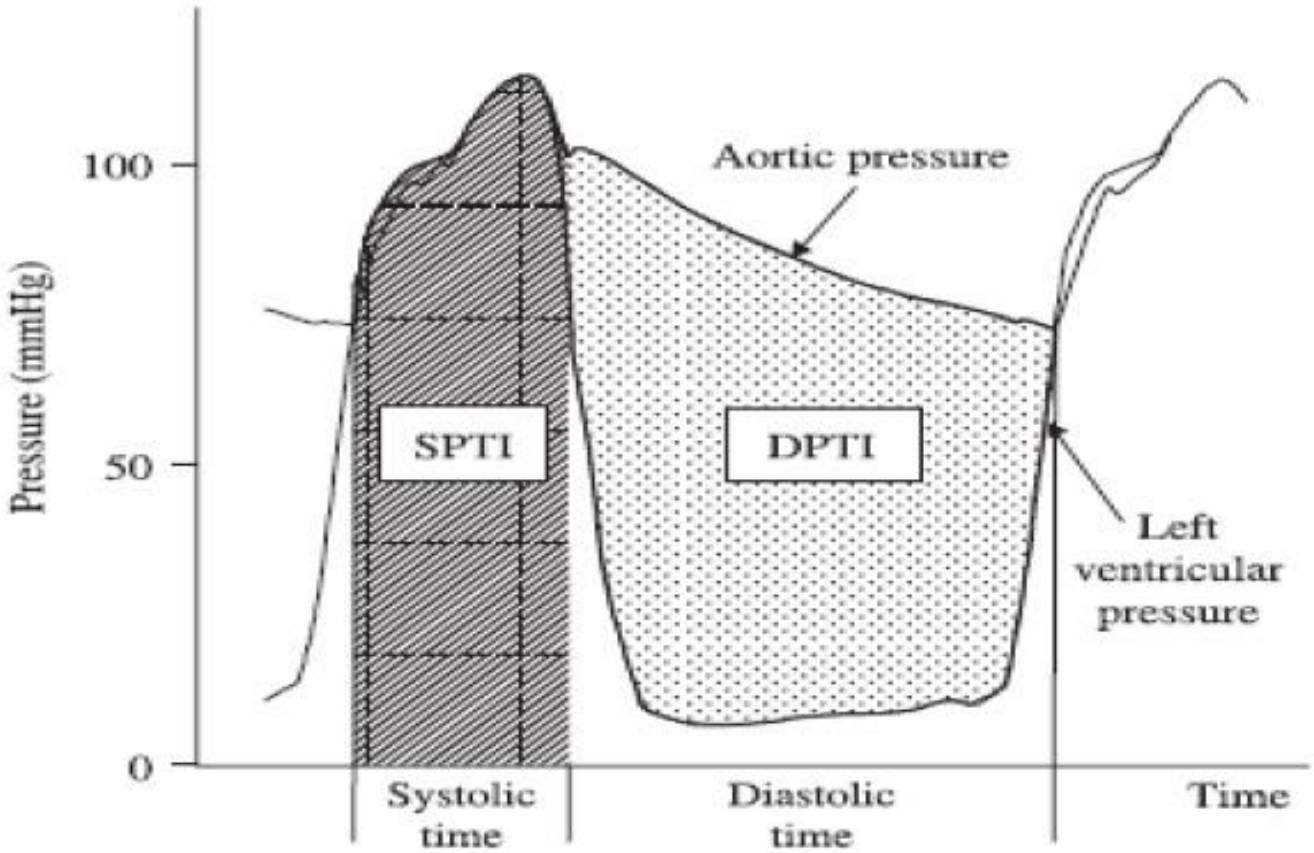


Parati 2013

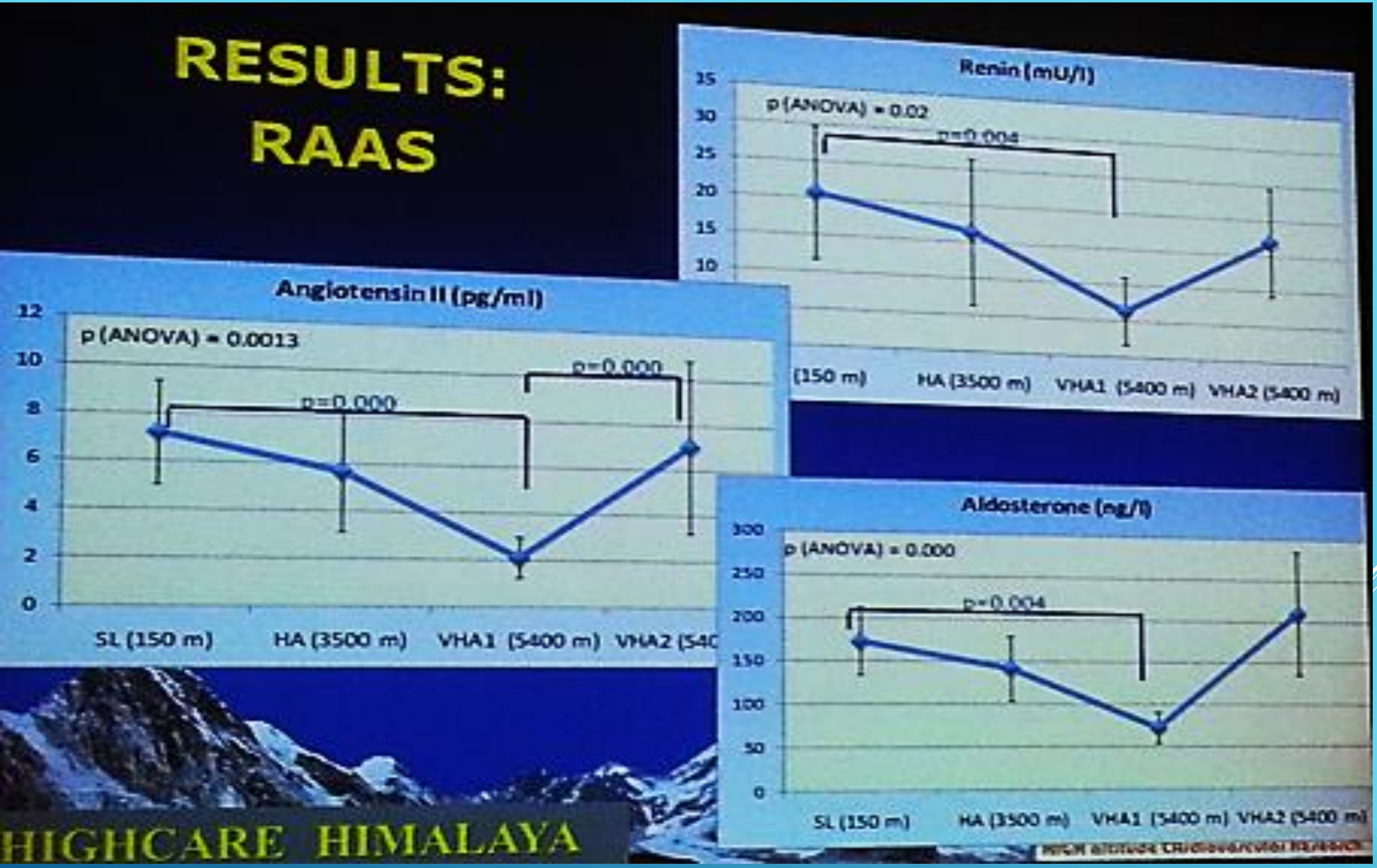
NAMME, Varese 2013

Subendocardial viability ratio (SEVR) as an index of impaired coronary microcirculation, calculated through pulse wave analysis, is an index of myocardial supply and demand

Schematic representation of the measurements of the SEVR, systolic time (ST) and diastolic time (DT). SPTI, systolic pressure–time integral; DPTI, diastolic pressure–time interval. SVI is calculated as DPTI/SPTI



RESULTS: RAAS

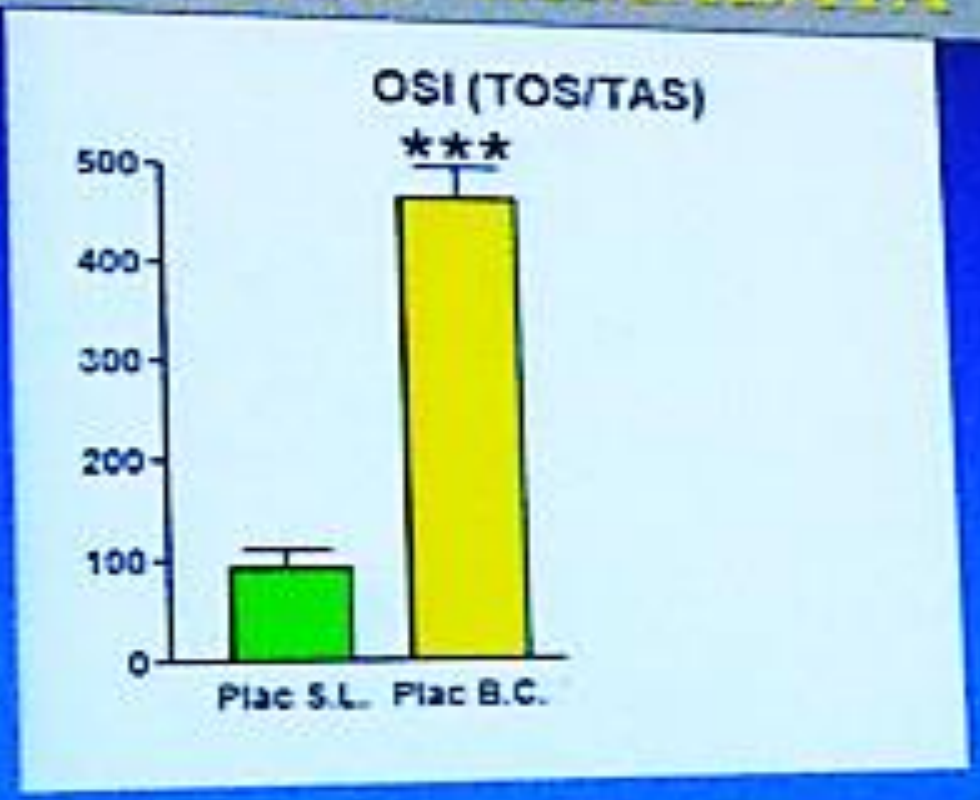


NAMME, Varese 2013

Parati 2013

Results: Oxidative Stress Index

HIGHCARE HIMALAYA



***p<0.001 placebo base camp vs placebo sea level

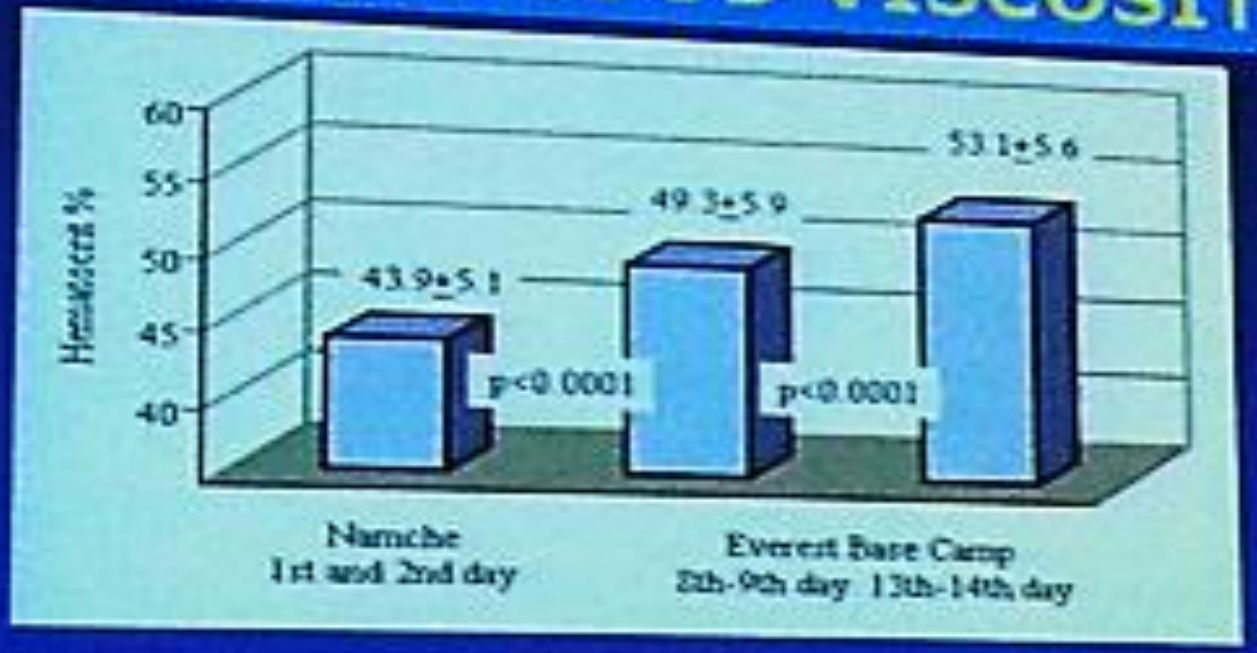
Kashina E, Parati G et al

NAMME, Varese 2013

Parati 2013

Blood Rheology during chronic exposure to HAHH

INCREASED BLOOD VISCOSITY



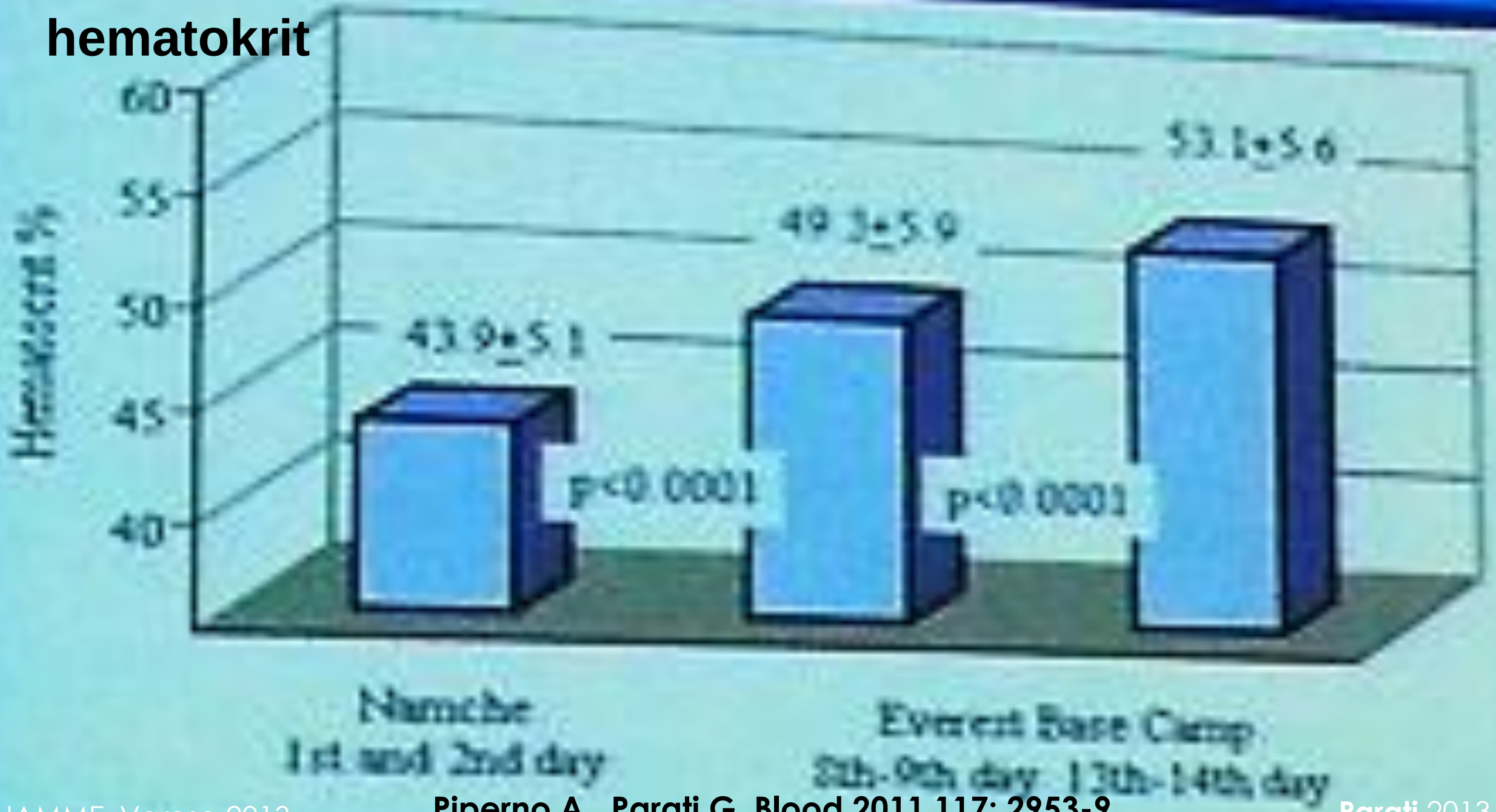
HIGHCARE HIMALAYA

Piperno A, Parati G BLOOD 2011 117: 2953-2959

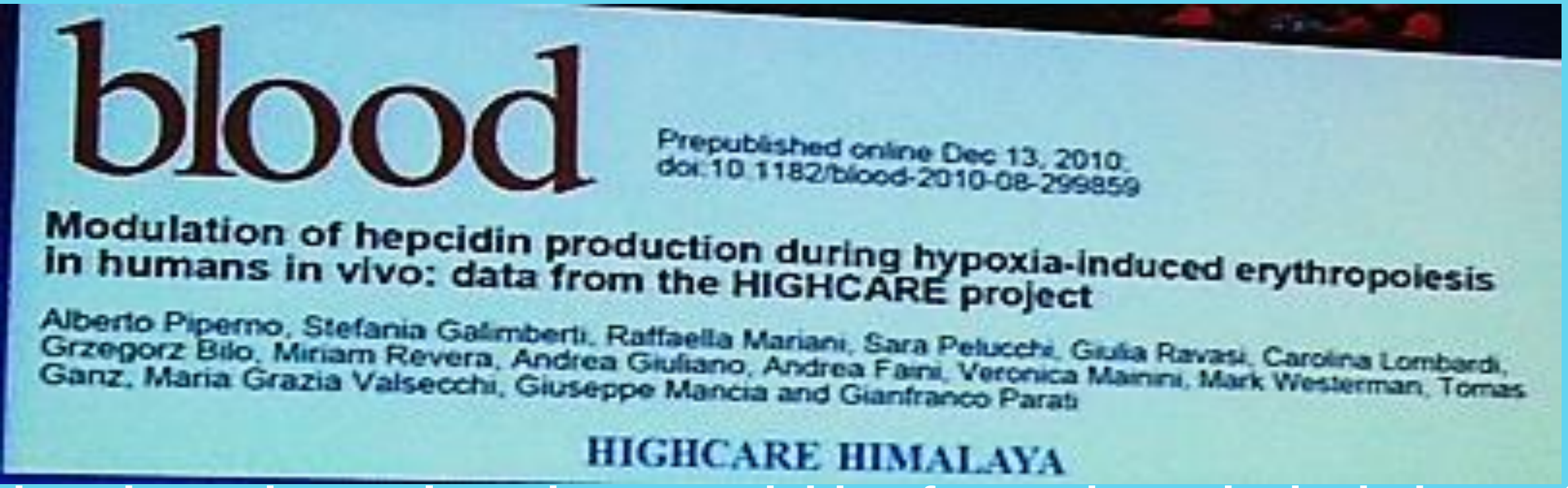
NAMME, Varese 2013

Parati 2013

hematokrit



Piperno A., Parati G. Blood 2011 117: 2953-9



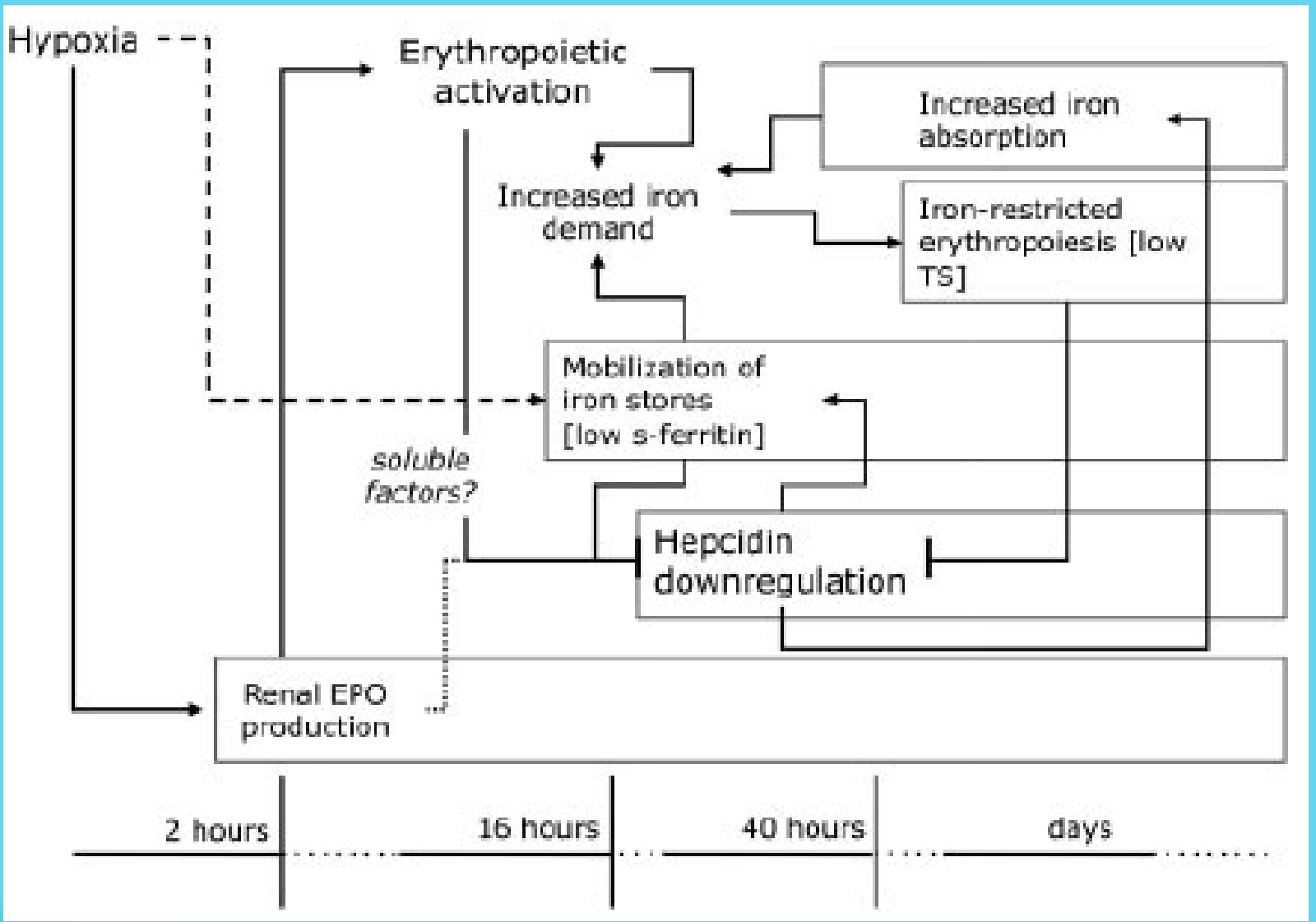
how hypoxia regulates iron acquisition for erythropoiesis in humans
Suppression of hepcidin

Modulation of hepcidin production during hypoxia-induced erythropoiesis in humans in vivo: data from the HIGHCARE project (*Blood*. 2011; 117(10):2953-2959)

Jaterní peptid hepcidin (codified by *HAMP*) je klíčovým regulátorem homeostázy železa. Inhibuje vstřebávání železa ve střevě. Tvorba hepcidinu je regulována různými faktory včetně cytokinů, erytropoetické aktivity, anemie, hypoxie hlavně na úrovni transkripce

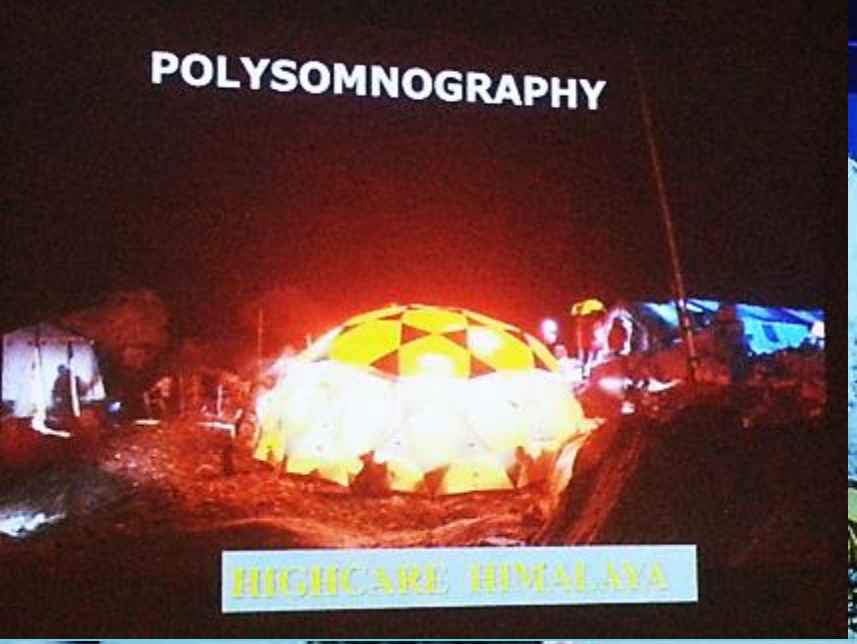
Anémie může zprostředkovat supresi hepcidinu mnoha mechanismy včetně vzestupu EPO, erytropoetickou aktivitou, zvýšenou potřebou železa nebo hypoxií jater.

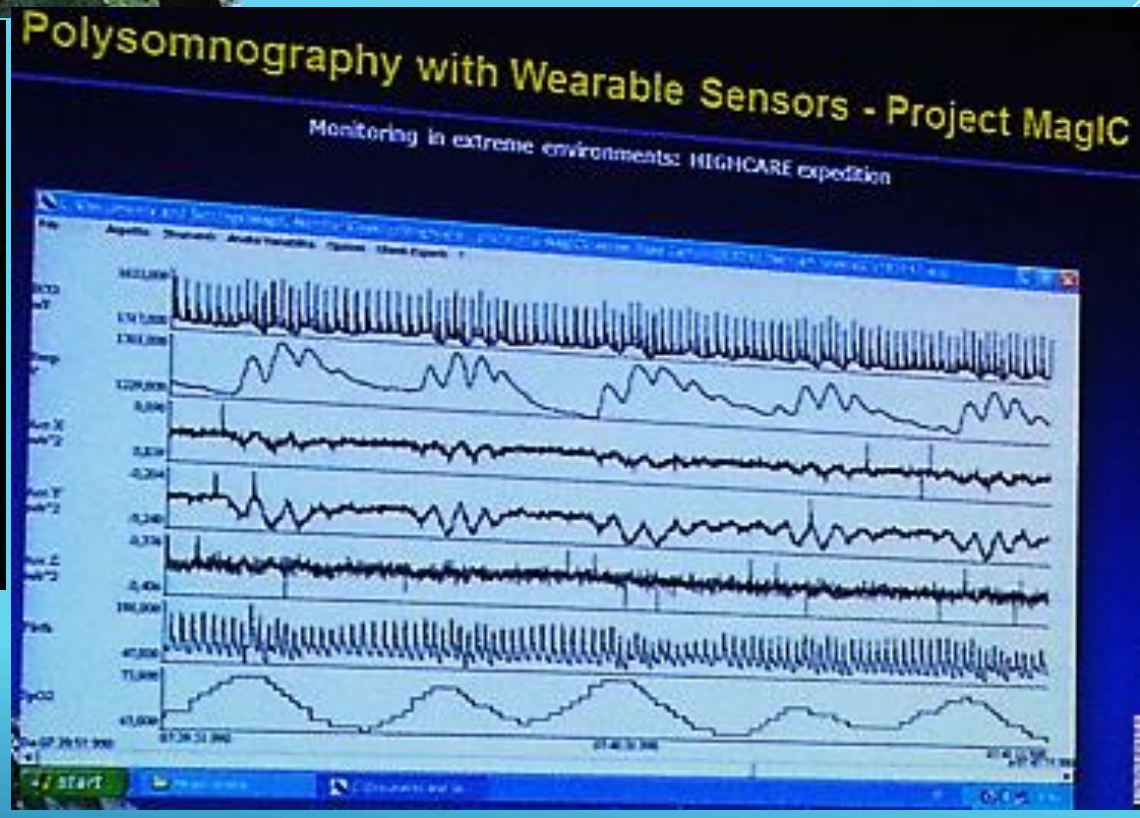
Erythropoetický regulátor hepcidinu není dosud popsán, může zahrnovat proteiny uvolňované při aktivní krvetvorbě. Jeden z těchto regulátorů, GDF15, odlišný člen rodiny růstového faktoru byl identifikován jako transcript reagující na hypoxii



Hypoxia-induced modifications of iron homeostasis. Erythropoietin (EPO) activation is the first event occurring after acute hypoxia exposure, inducing erythropoietic expansion, which requires more iron for red blood cell hemoglobinization.
Hepcidin down-regulation is central for this function: it begins within 16 to 40 hours and peaks within a few days of exposure, and thereafter persists for a long time. Iron and erythroid signals cooperate in hepcidin suppression, increasing intestinal iron absorption and cellular iron release. Iron mobilization from stores occurs early, possibly involving a hypoxia-mediated event. Erythroid signal probably requires soluble mediators from bone marrow to the liver. Transferrin saturation (TS) decreased only in the phase of expansion of the erythropoietic mass contributing to hepcidin suppression.

(*Blood*. 2011; 117(10):2953-2959)

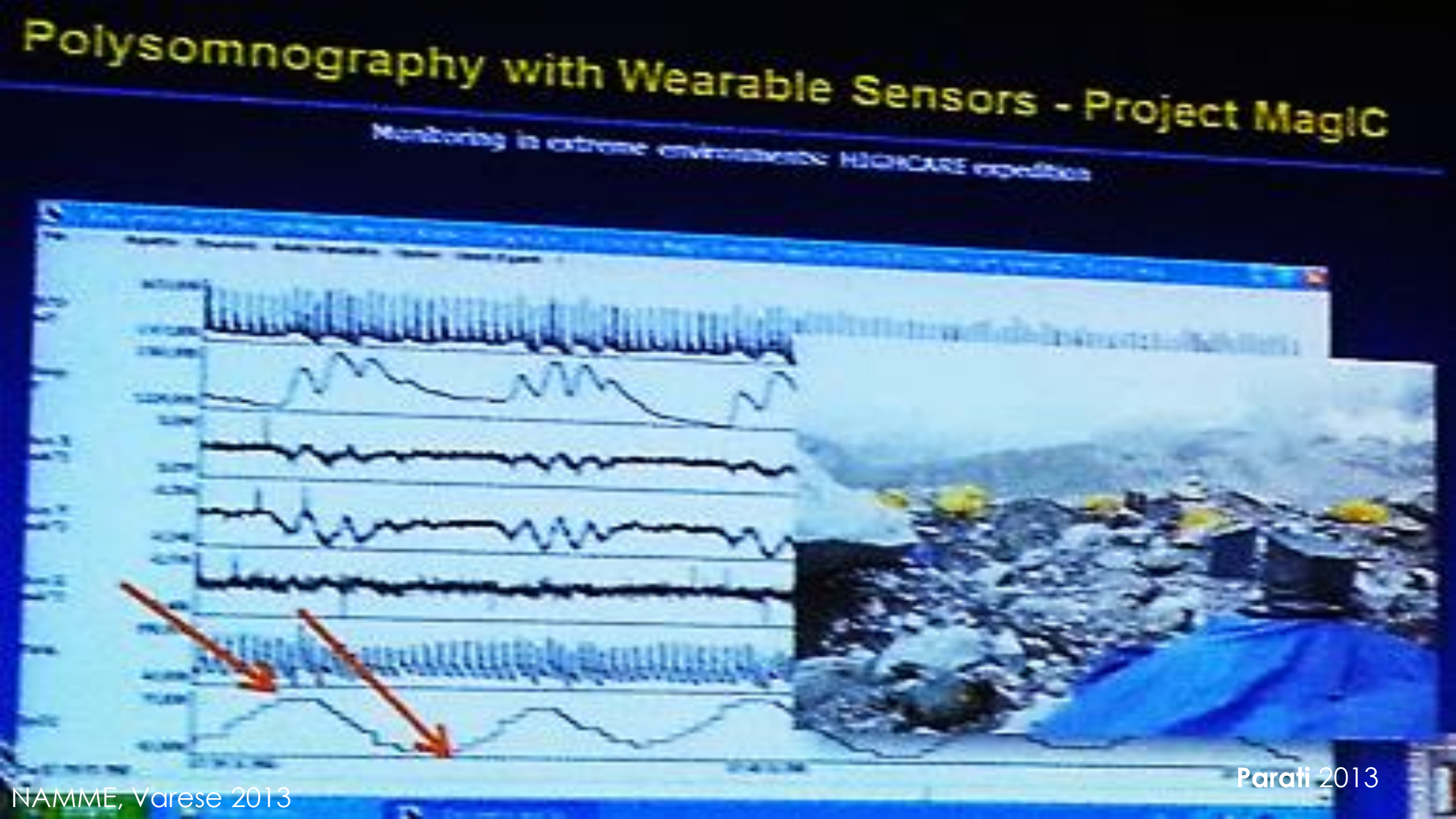




NAMME, Varese 2013

Parati 2013

Polysomnography with Wearable Sensors - Project MagIC



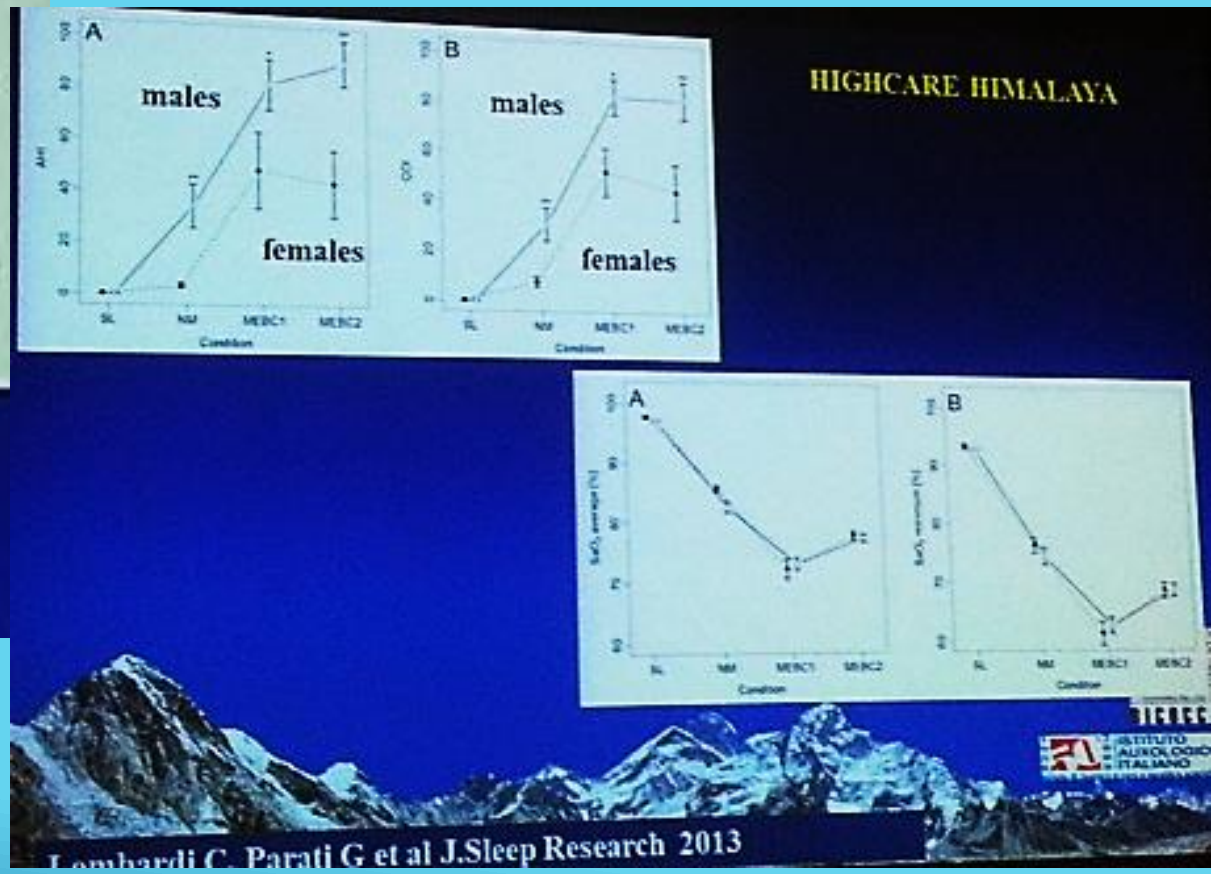
J Sleep Res. (2013)

Regular Research Paper

High-altitude hypoxia and periodic breathing during sleep: gender-related differences

CAROLINA LOMBARDI[1], PAOLO MERIGGI[2], PIERGIUSEPPE AGOSTONI[3,4], ANDREA FAINI[1], GRZEGORZ BILO[1,6], MIRIAM REVERA[1,6], GIANLUCA CALDARA[1], MARCO DI RIENZO[2], PAOLO CASTIGLIONI[2], BUSSOTTI MAURIZIO[7], FRANCESCA GREGORINI[1], GIUSEPPE MANCIA[1,6], GIANFRANCO PARATI[1,6] and ON BEHALF OF THE HIGHCARE INVESTIGATORS

DOI: 10.1111/jsr.12012

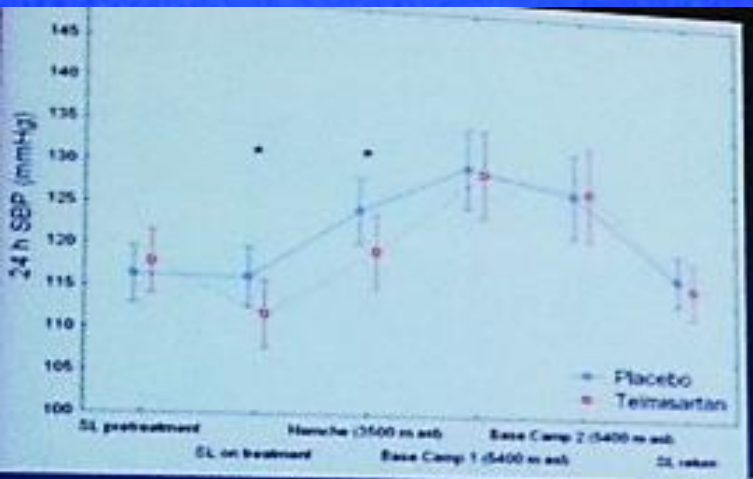


Parati 2013

HIGHCARE PROJECTS. Cardiovascular Protection at High ALtitude

HIGH ALTITUDE HYPOBARIC HYPOXIA

- **Interventions to Achieve Protection**

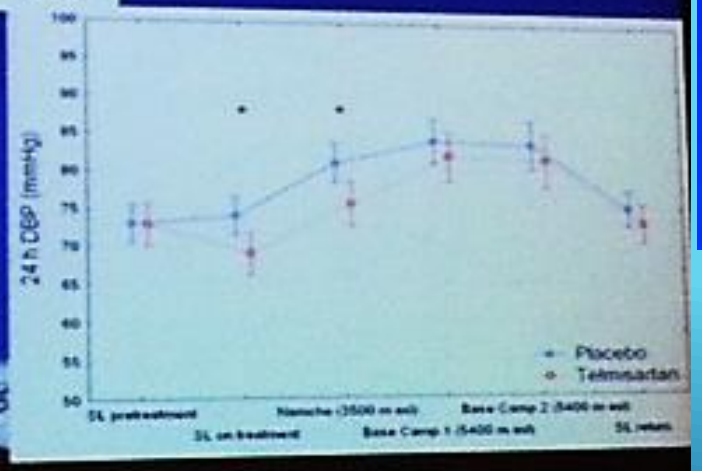


Effects of Telmisartan on

24 h SBP and DBP:

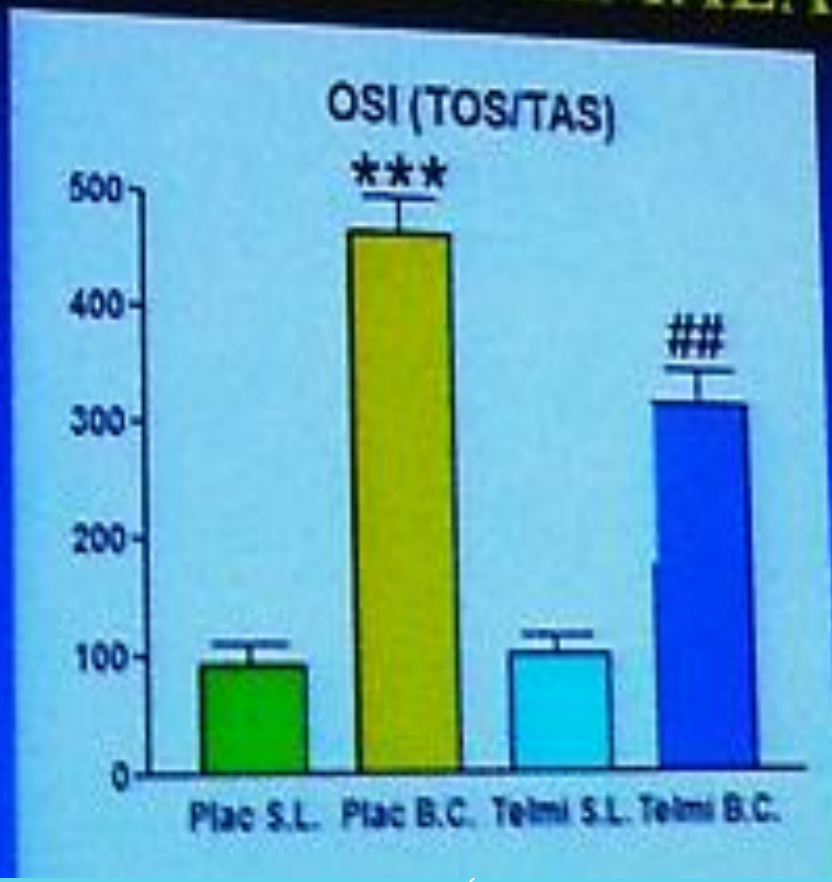
Protection up to altitudes usually reached by tourists

* - p < 0.05 for TEL vs. PL



Results: Oxidative Stress Index

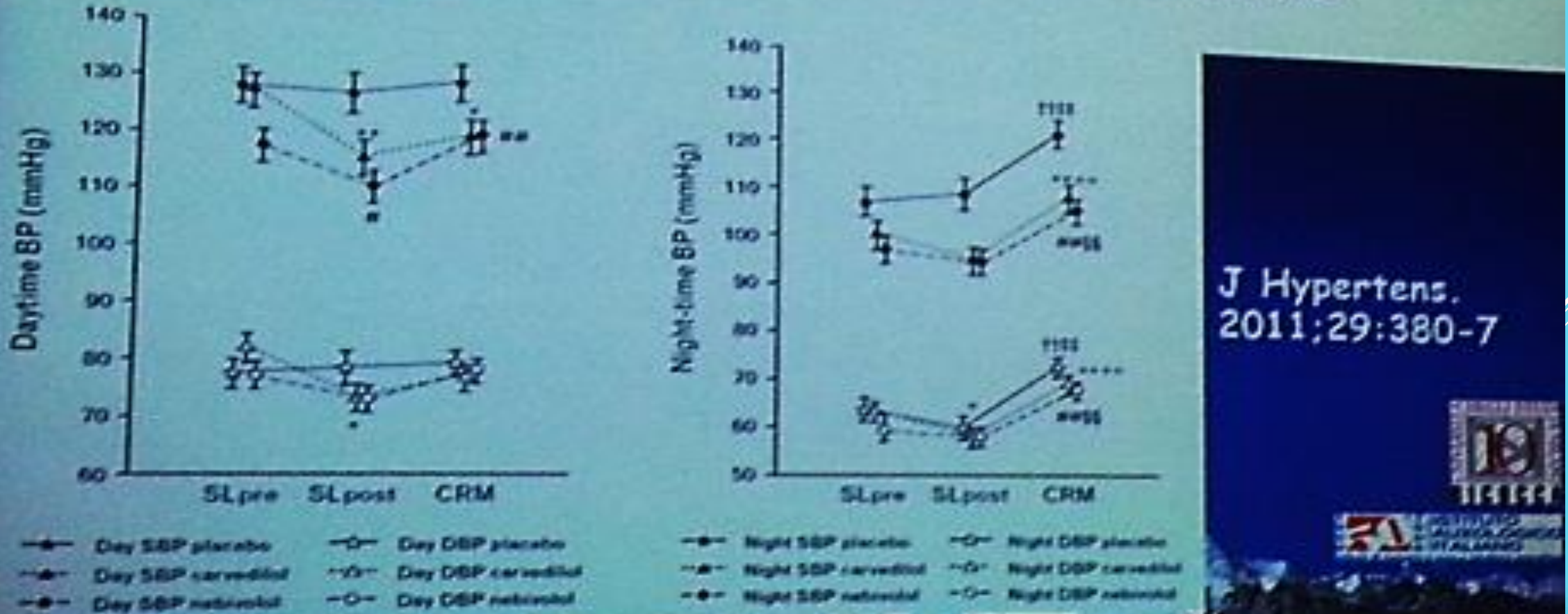
HIGHCARE HIMALAYA



Parati 2013

Effects of selective and nonselective beta-blockade on 24-h ambulatory blood pressure under hypobaric hypoxia at altitude

Grzegorz Bilo[a], Gianluca Caldara[a], Katarzyna Styczkiewicz[c], Miriam Revera[a], Carolina Lombardi[a], Alessia Giglio[a], Antonella Zambon[d], Giovanni Corrao[d], Andrea Faini[a], Mariaconsuelo Valentini[a], Giuseppe Mancia[b] and Gianfranco Parati[a,b]



J Hypertens.
2011;29:380-7

NAMME, Varese 2013

Parati 2013

European Heart Journal Advance Access published June 17, 2012

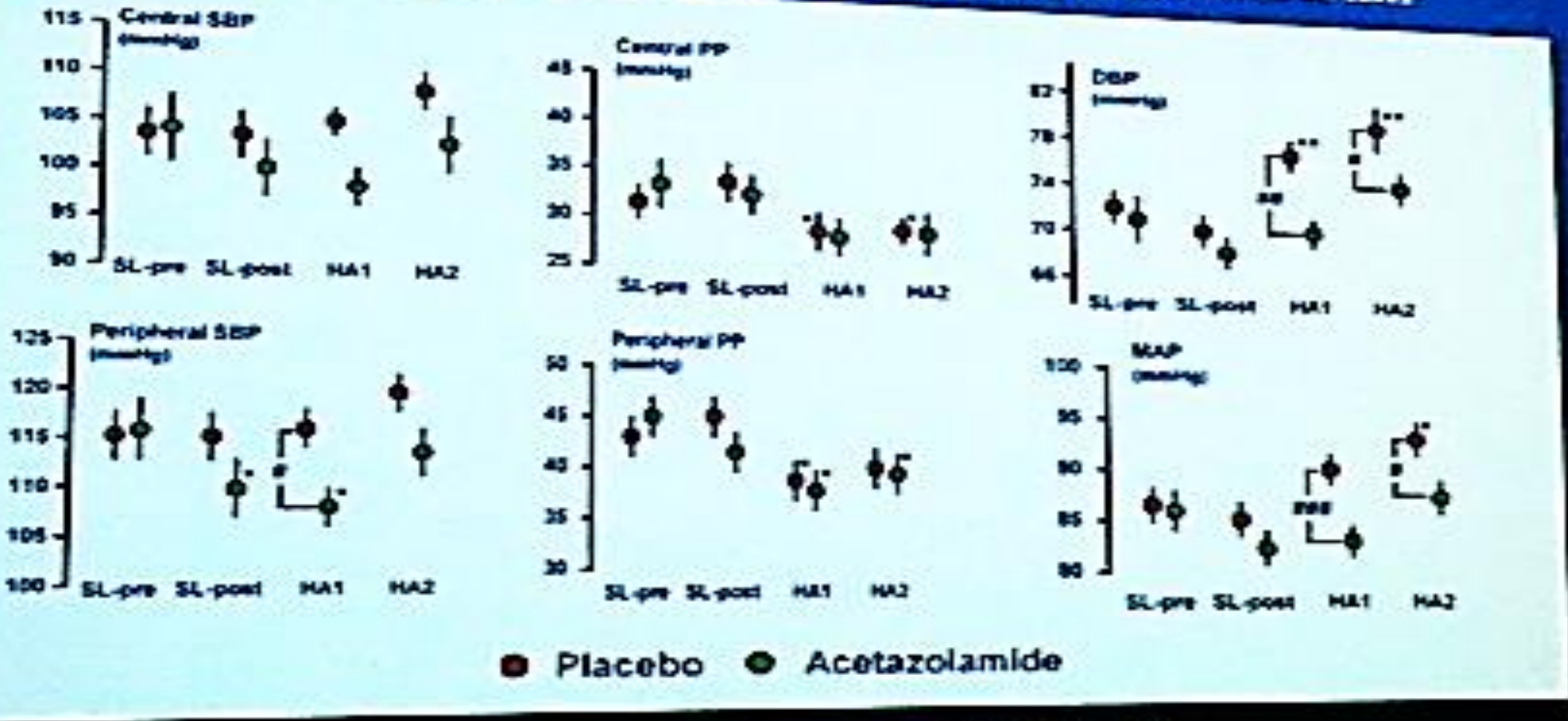
CLINICAL RESEARCH

Effects of acetazolamide on central blood pressure, peripheral blood pressure, and arterial distensibility at acute high altitude exposure

Gianfranco Parati[1,2]*, Miriam Revera[1], Andrea Giuliano[1,2], Andrea Faini[1], Grzegorz Bilo[1], Francesca Gregorini[1], Elisabetta Lisi[1,2], Sabrina Salerno[1,2], Carolina Lombardi[1], Carlos G. Ramos Becerra[1], Giuseppe Mancia[1,2], and Paolo Salvi[1]

Central BP levels, PWA and Arterial Wall Properties with hypoxia

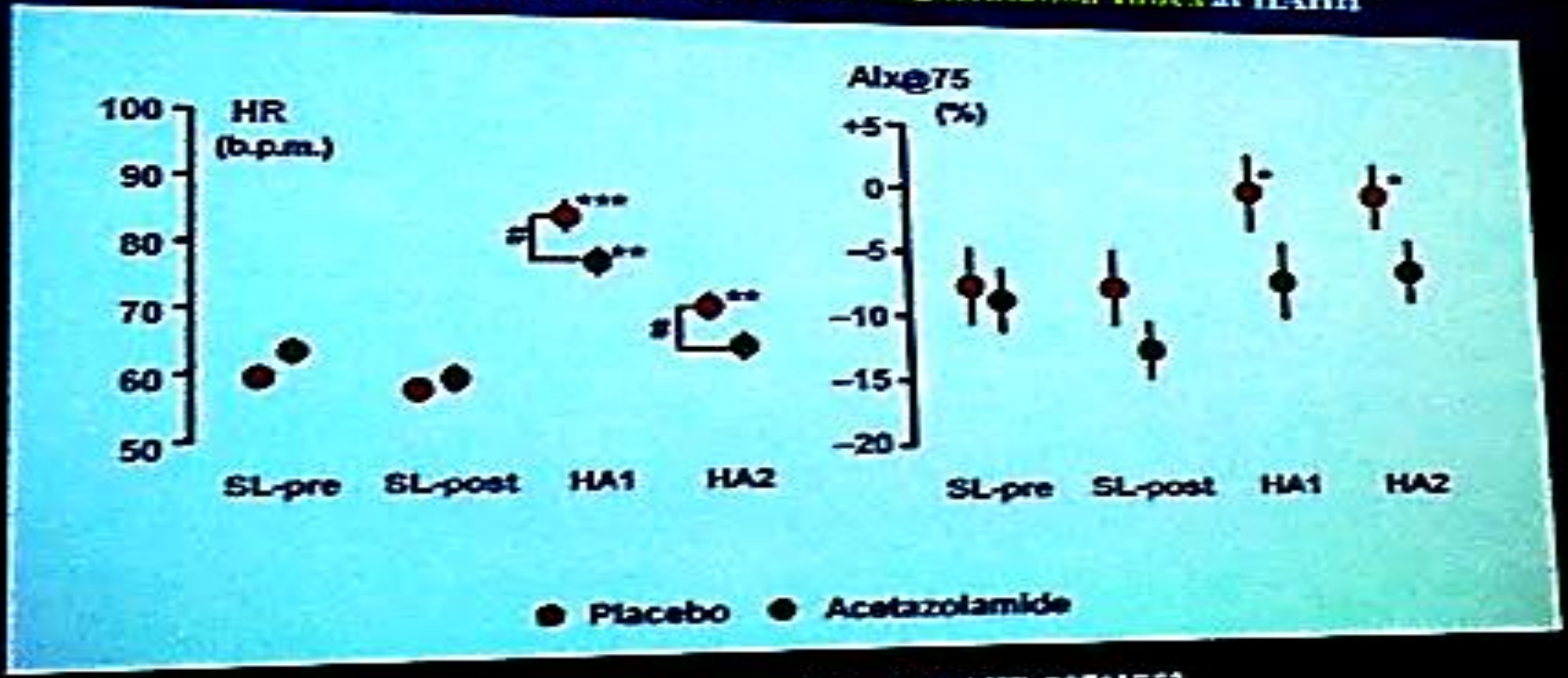
Effects of acetazolamide on central and peripheral BP levels at HABH



Parati G. et al. Eur Heart J. 2012 Jun 17[Epub ahead of print]PMID:22711752

Central BP levels, PWA and Arterial Wall Properties with hypoxia

Effects of acetazolamide on HR and Augmentation Index at HAHH



Parati G. et al. Eur Heart J. 2012 Jun 17[Epub ahead of print]PMID:22711752

Hypertension

Journal of the American Heart Association.

Changes in Subendocardial Viability Ratio With Acute High-Altitude Exposure and Protective Role of Acetazolamide

Paolo Salvi, Miriam Revera, Andrea Faini, Andrea Giuliano, Francesca Gregorini, Pierguiseppe Agostoni, Carlos G. Ramos Becerra, Grzegorz Bilo, Carolina Lombardi, Michael F. O'Rourke, Giuseppe Mancia and Gianfranco Parati

Hypertension. 2013;61:793-799; originally published online February 25, 2013;
doi: 10.1161/HYPERTENSIONAHA.111.00707

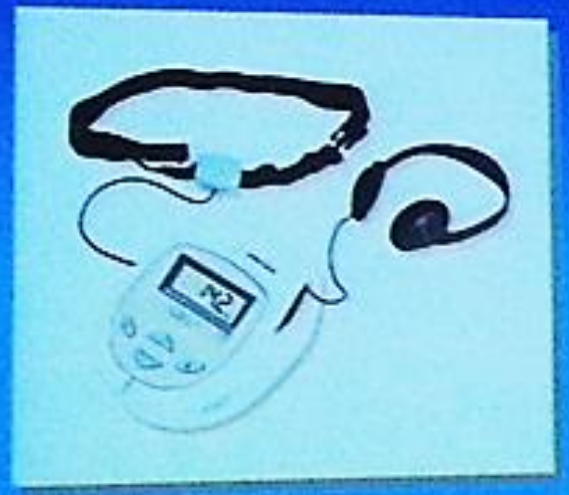
OPEN ACCESS Freely available online

PLOS ONE

Effects of Slow Deep Breathing at High Altitude on Oxygen Saturation, Pulmonary and Systemic Hemodynamics

Grzegorz Bilo[1], Miriam Revera[1], Maurizio Bussotti[2], Daniele Bonacina[3], Katarzyna Styczkiewicz[4], Gianluca Caldara[1], Alessia Giglio[1], Andrea Faini[1], Andrea Giuliano[1,3], Carolina Lombardi[1], Kalina Kawecka-Jaszcz[4], Giuseppe Mancia[1], Piergiuseppe Agostoni[1,*], Gianfranco Parati[1,3]

Device Guied Slow Breathing



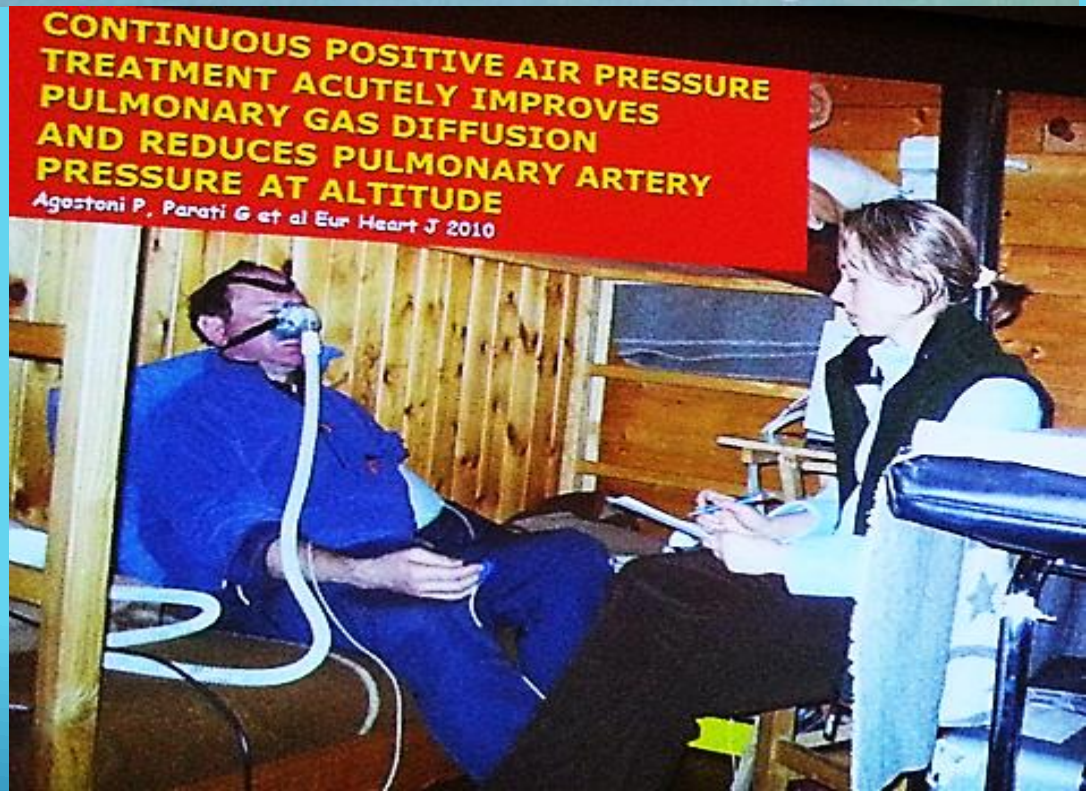
SLOW BREATHING IMPROVES PULMONARY GAS EXCHANGE AND REDUCES BP AT HIGH ALTITUDE

European Heart Journal (2010) 31, 457–463
doi:10.1093/eurheartj/ehp472

CLINICAL RESEARCH
Congenital heart disease

Continuous positive airway pressure increases haemoglobin O_2 saturation after acute but not prolonged altitude exposure

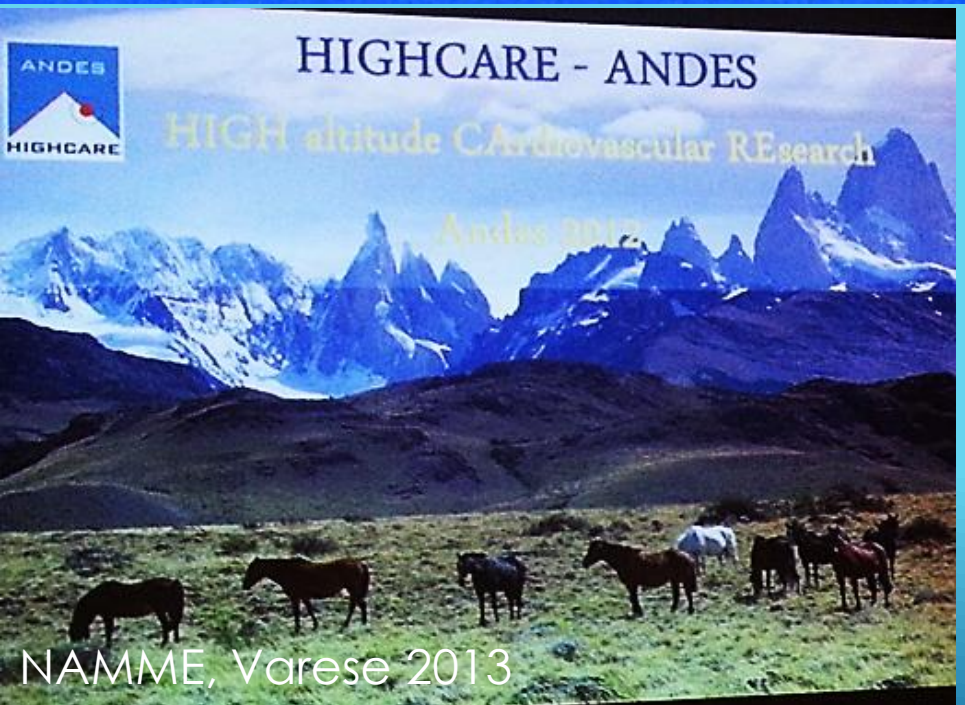
Piergiuseppe Agostoni[1,2*], Gianluca Caldara[3], Maurizio Bussotti[1], Miriam Revera[3,4], Mariaconsuelo Valentini[3,4], Francesca Gregorini[3], Andrea Faini[3], Carolina Lombardi[3,4], Gregorz Bilo[3], Andrea Giuliano[3], Fabrizio Veglia[1], Giulio Savia[3], Pietro A. Modesti[5], Giuseppe Mancia[3,4], and Gianfranco Parati[3,4] on behalf of the HIGHCARE Investigators



HIGHCARE PROJECTS. Cardiovascular Protection at High ALtitude

HIGH ALTITUDE HYPOBARIC HYPOXIA

- Cardiovascular Effects in Hypertensive patients and implications for treatment



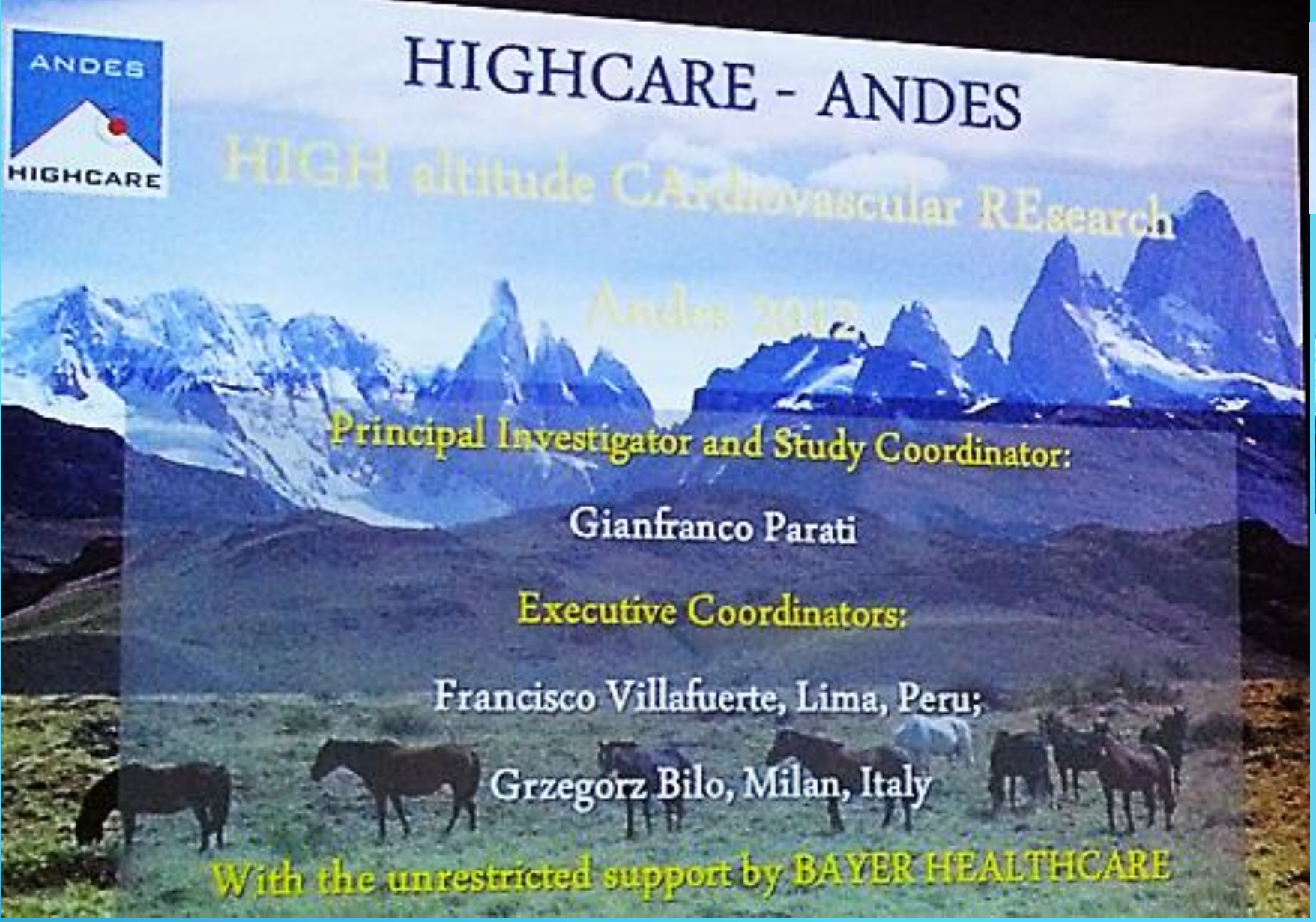
NAMME, Varese 2013

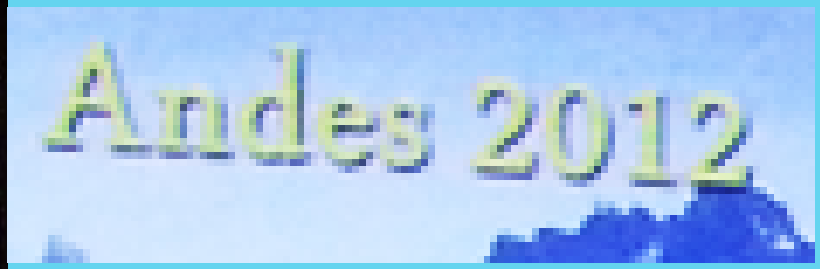
High altitude: pending issues:

1. What is the BP increase at high altitude in subjects already affected by hypertension ?

2. How should antihypertensive therapy be managed to face the BP effects of High Altitude in hypertensive patients ?

Parati 2013


ANDES
HIGHCARE
HIGHCARE - ANDES
HIGH altitude CArdiovascular REsearch
Andes 2012
Principal Investigator and Study Coordinator:
Gianfranco Parati
Executive Coordinators:
Francisco Villafuerte, Lima, Peru;
Grzegorz Bilo, Milan, Italy
With the unrestricted support by BAYER HEALTHCARE


Andes 2012

LOWLANDERS STUDY
HIGHLANDERS STUDY

NAMME, Varese 2013

Parati 2013

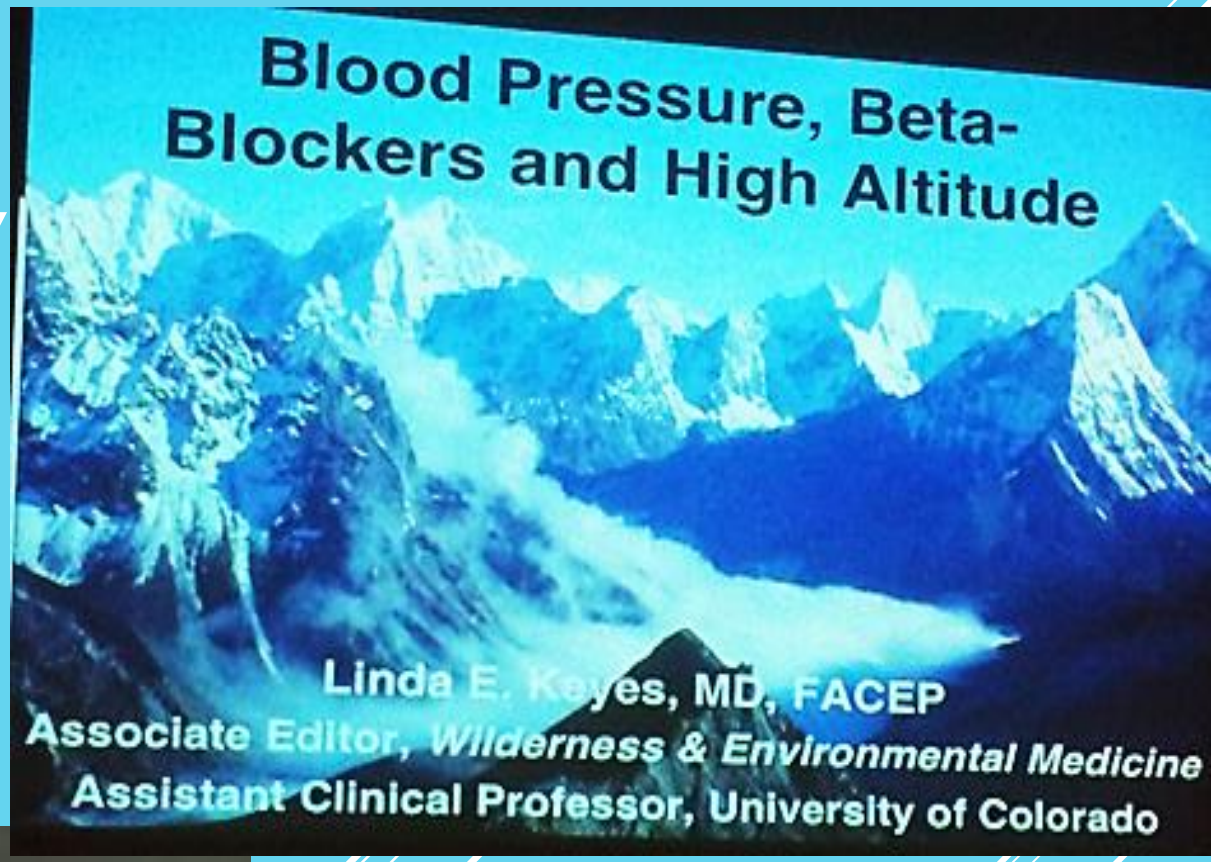
KREVNÍ TLAK A BETABLOKÁTORY VE VELKÉ VÝŠCE

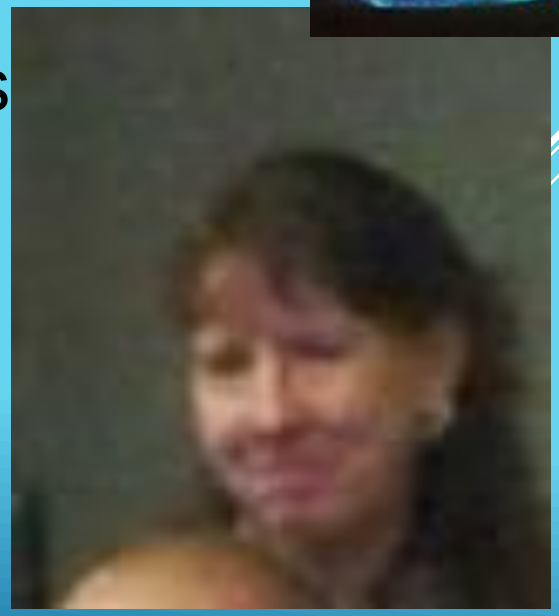
Blood Pressure and Betablockers and High Altitude

Linda E. Keyes, MD, FACEP

Associated Editor, Wilderness & Environmental Medicine

Assistant Clinical Professor, University of Colorado





NAMME, Varese 2013

Blood Pressure and Altitude

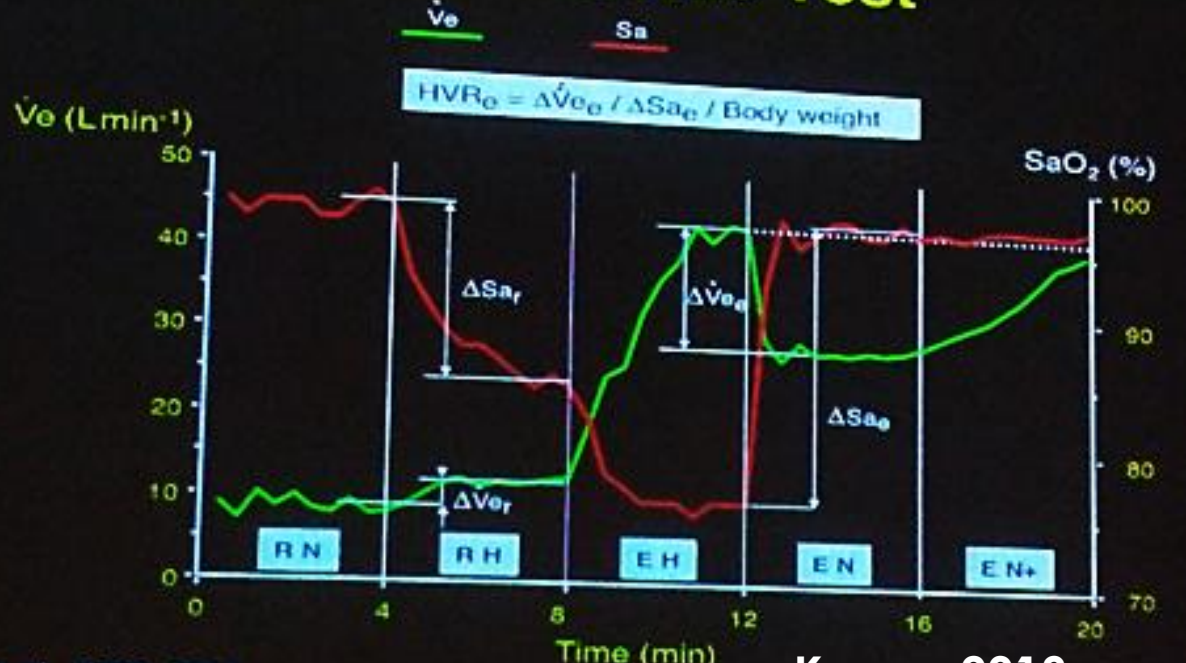
- Reports vary ↑, ↔, ↓
- Within a study, individual responses highly variable
- ↑ with exercise

NAMME, Varese 2013

Hypertension at High Altitude

- Pre-existing HTN is common in HA visitors
- As in normotensives BP response is variable
  - May change with time at HA
  - Some HTN subjects have an exaggerated BP response to HA

Hypoxic Exercise Test



Richalet et al., 1988; 2012

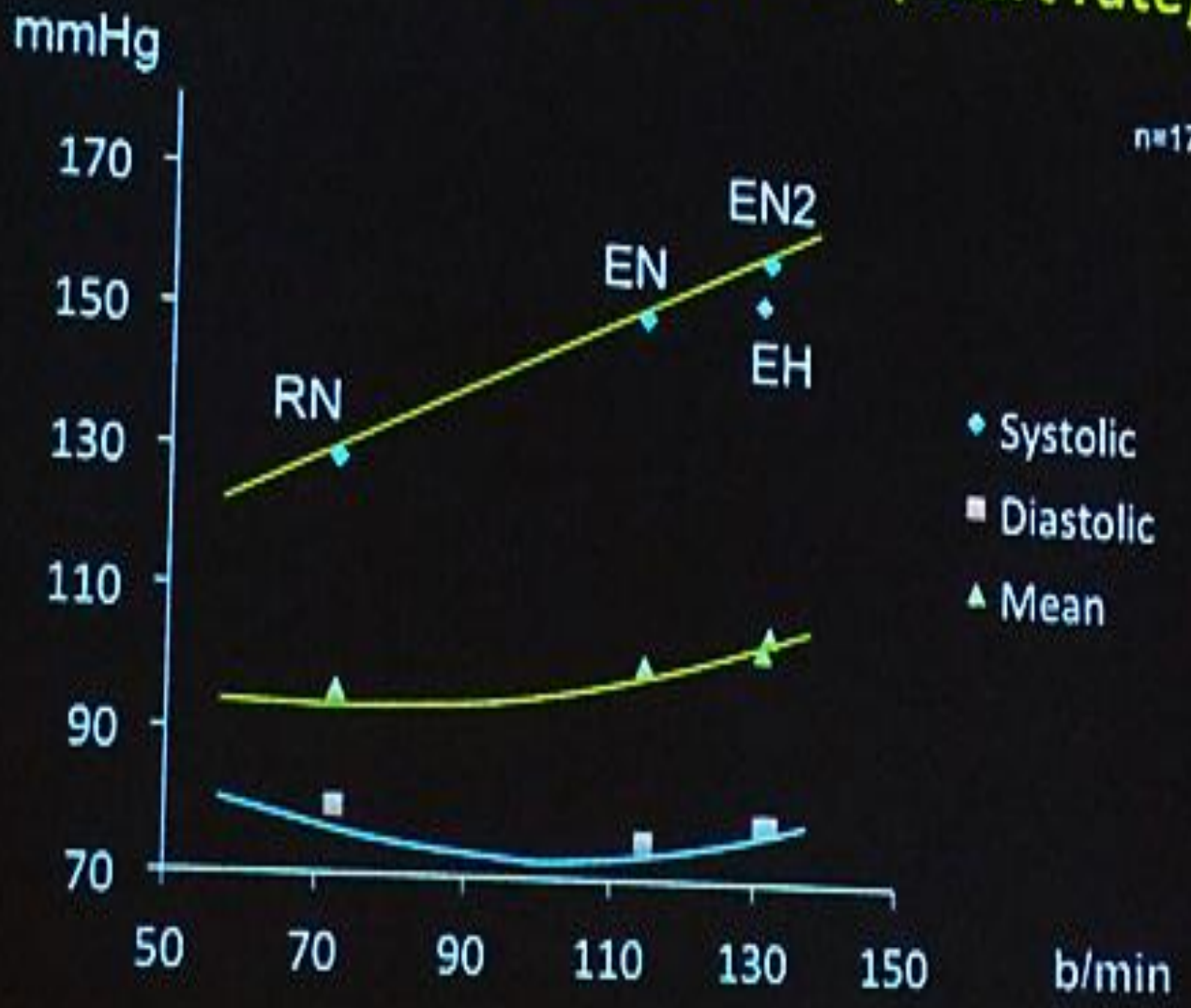
Keyes, 2013

Systémový krevní tlak v průběhu hypoxického zátěžového testu

	KLID NORMOXIE	ZÁTĚŽ NORMOXIE	ZÁTĚŽ NORMOXIE2	ZÁTĚŽ HYPOXIE
SAP mmHg	129.0±14.5	151.5±22.6	160.7±23.9*	154.2±21.8*$
DAP mmHg	79.4±8.8	75.4±13.1	78.2±13.3*	78.2±14.0*
MAP mmHg	95.9±9.9	100.7±14.7	105.7±15.0*	103.5±14.8*$
HR b/min	72.5±11.1	114.6±15.7	132.1±15.4*	131.3±15.0*

Keyes, 2013

Systemic arterial pressure = f (heart rate)



Does chronic beta-blocker use alter response to hypoxia?

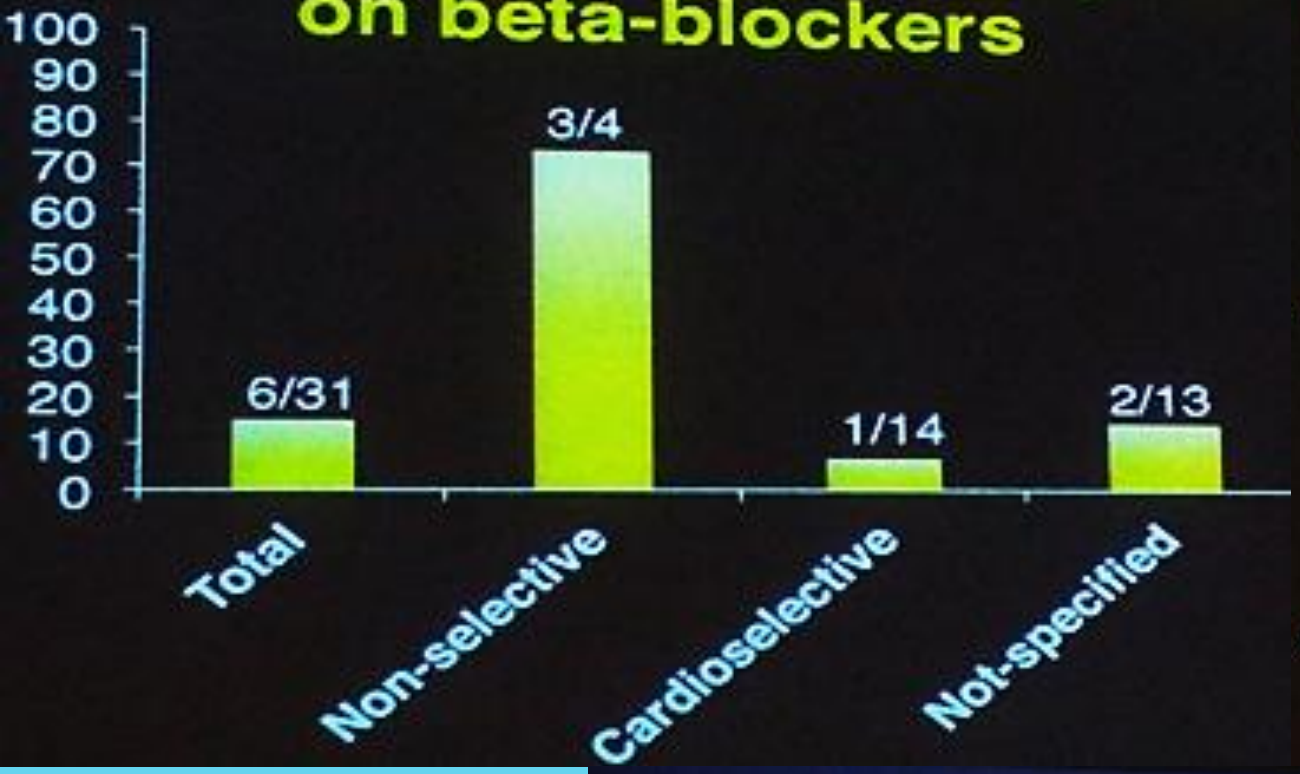
- Hypertension is not a risk factor for AMS
- Beta-Blocker use is common at HA
- Sympathetic activation occurs at high altitude
- Prior studies all in young, healthy subjects

Keyes, 2013

Response to Hypoxic Exercise Test

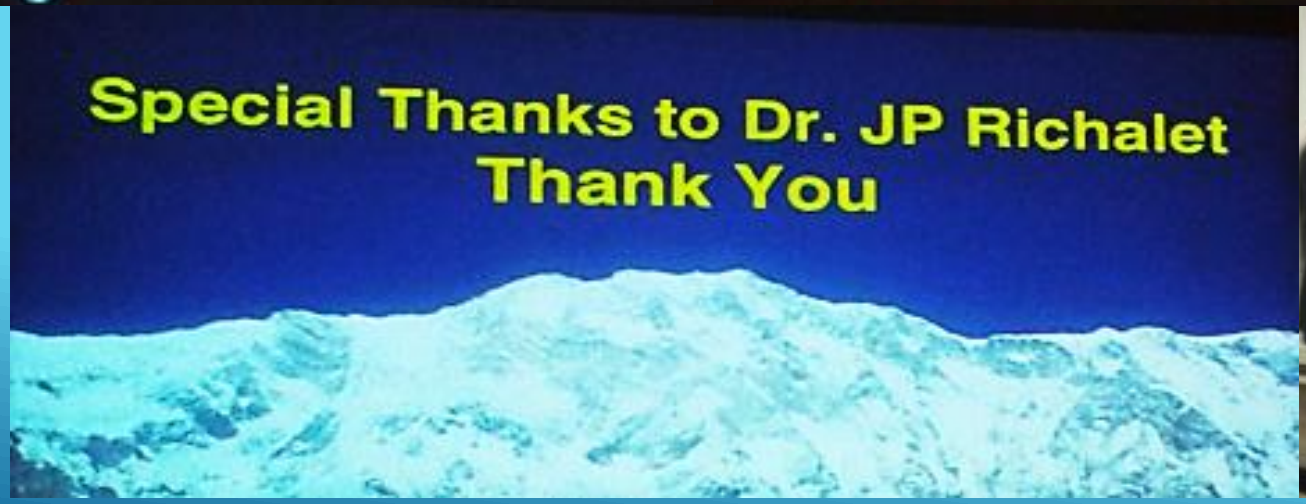
	Control		β-blocker	
	Men	Women	Men	Women
BMI (cm/kg)	24.6±2.7	22.6±3	26.2±3.5	22.9±2.9
HCR (b/min/%)	0.72±0.28	0.65±0.32	0.55±0.26*	0.46±0.29*
HVR (l/min/kg)	0.78±0.35	0.68±0.33	0.81±0.32	0.64±0.32
ΔSaO_2 hypoxic exercise (%)	23±5	23±5	22±5	22±6
AMS (%)	24		23	

Incidence of AMS in subjects on beta-blockers



Conclusions

- BP response to altitude is a function of HR
- For the same HR, BP is lower at HA
  - Response in HTN remains to be seen
- Beta-blockers in general do not increase risk of AMS
  - Non-selective Beta- ↓ HVRe and ↑ desaturation with exercise
- Further study regarding non-selective beta-blockers is warranted



Keyes, 2013

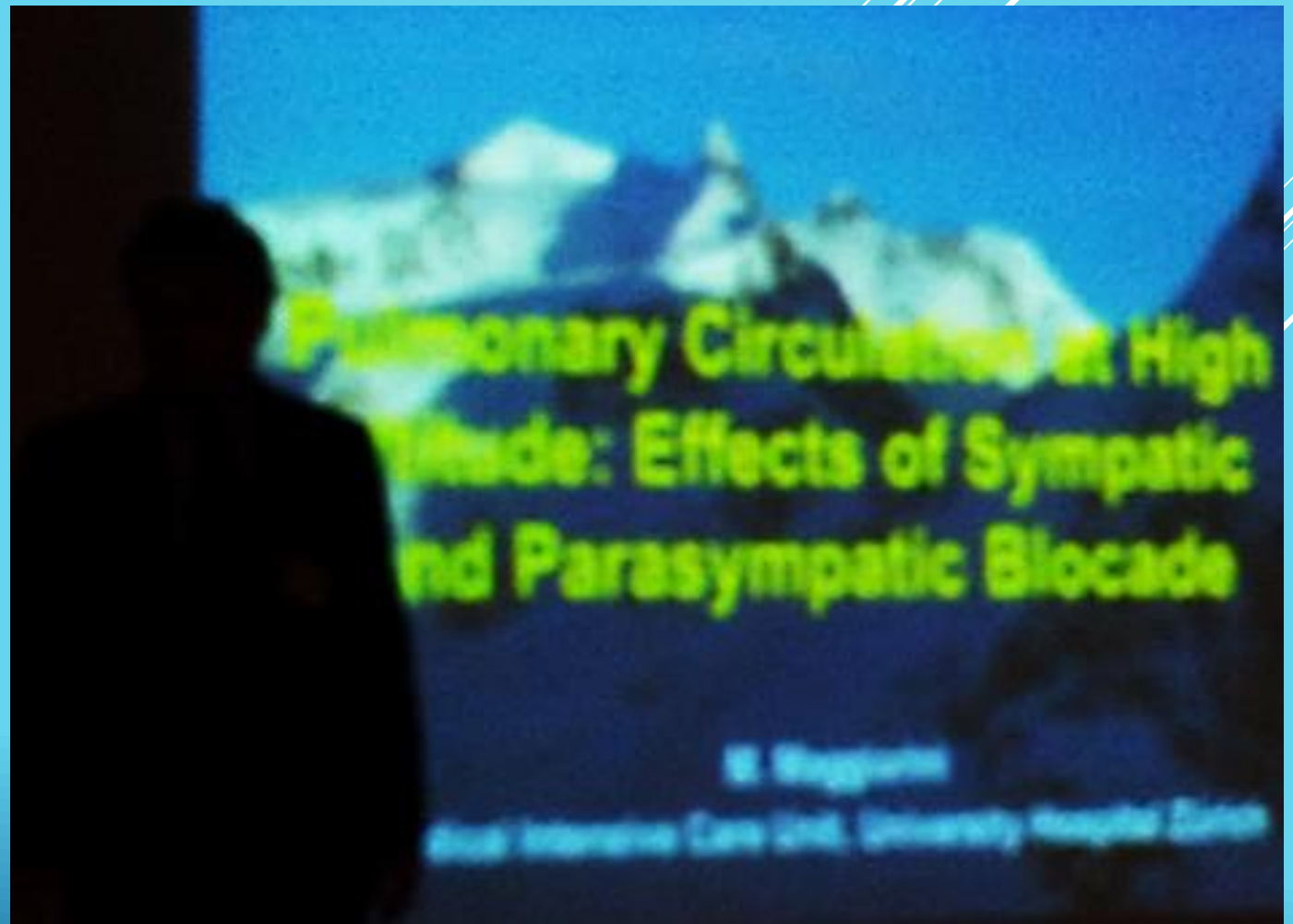
NAMME, Varese 2013

PLICNÍ OBĚH VE VELKÉ VÝŠCE – ÚČINKY BLOKÁDY SYMPATIKU A PARASYMPATIKU

Pulmonary Circulation at High Altitude - Effects of Sympaticus and Parasympaticus Blocade

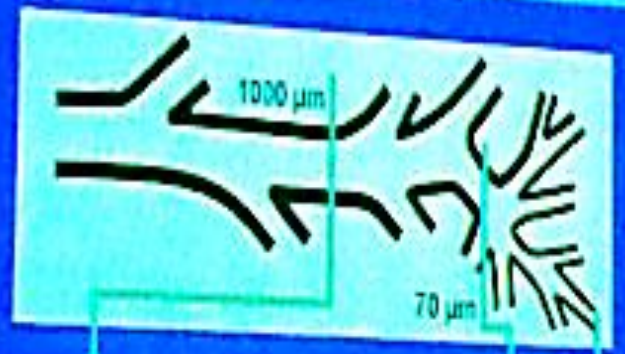
Marco Maggiorini

Medical Intensive Care Unit
University Hospital Zürich

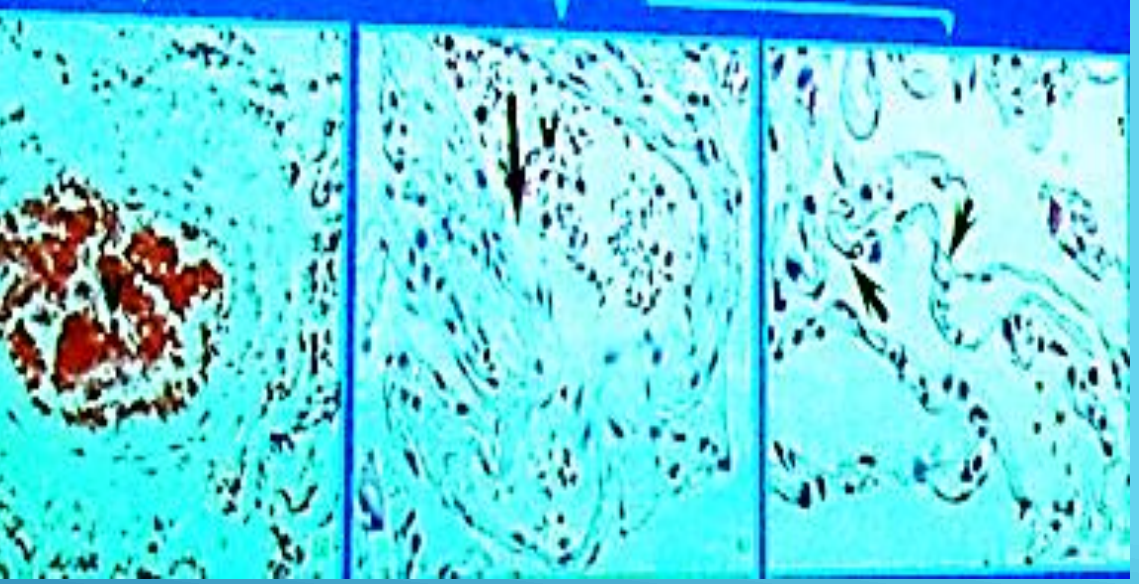


NAMME, Varese 2013

Structural characteristics of the pulmonary vessels

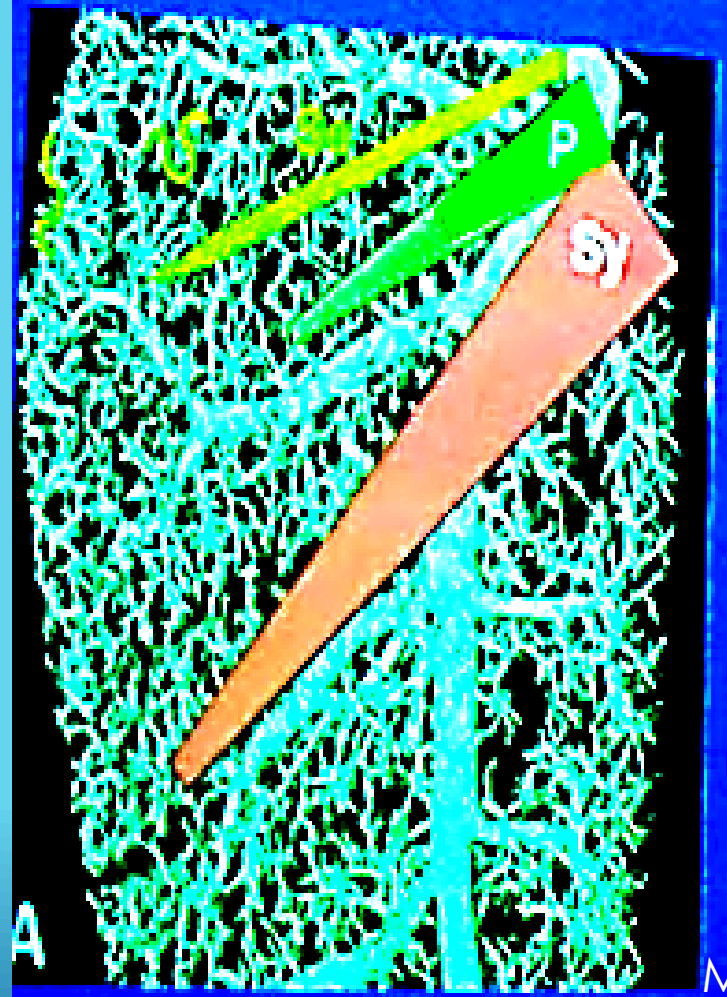


Resistance pulmonary vessels (small arteries) are between 1000µm and 70µm of diameter



NAMME, Varese 2013

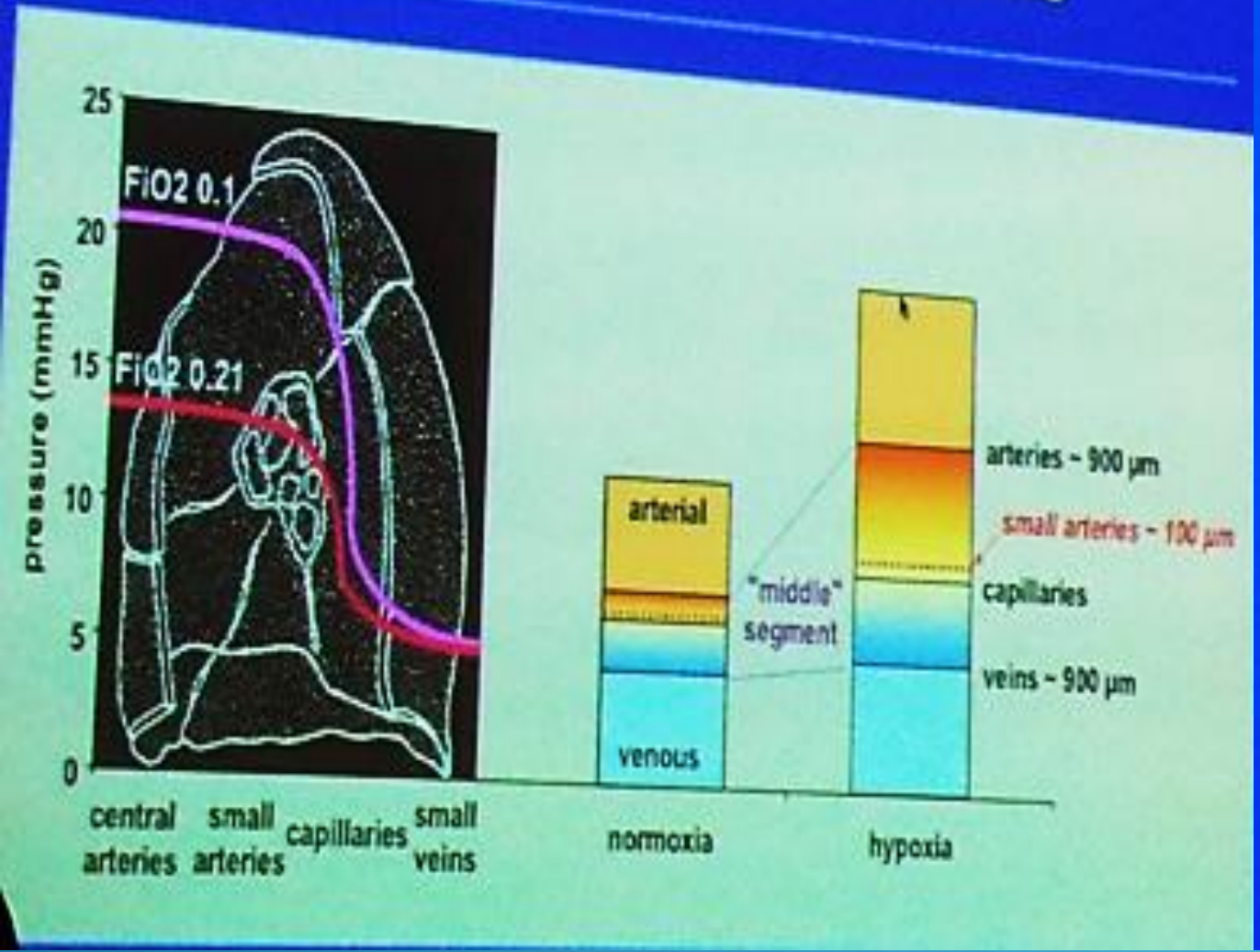
Schematic representation of the distribution of sympathetic and parasympathetic nerve fibers along the pulmonary vascular tree



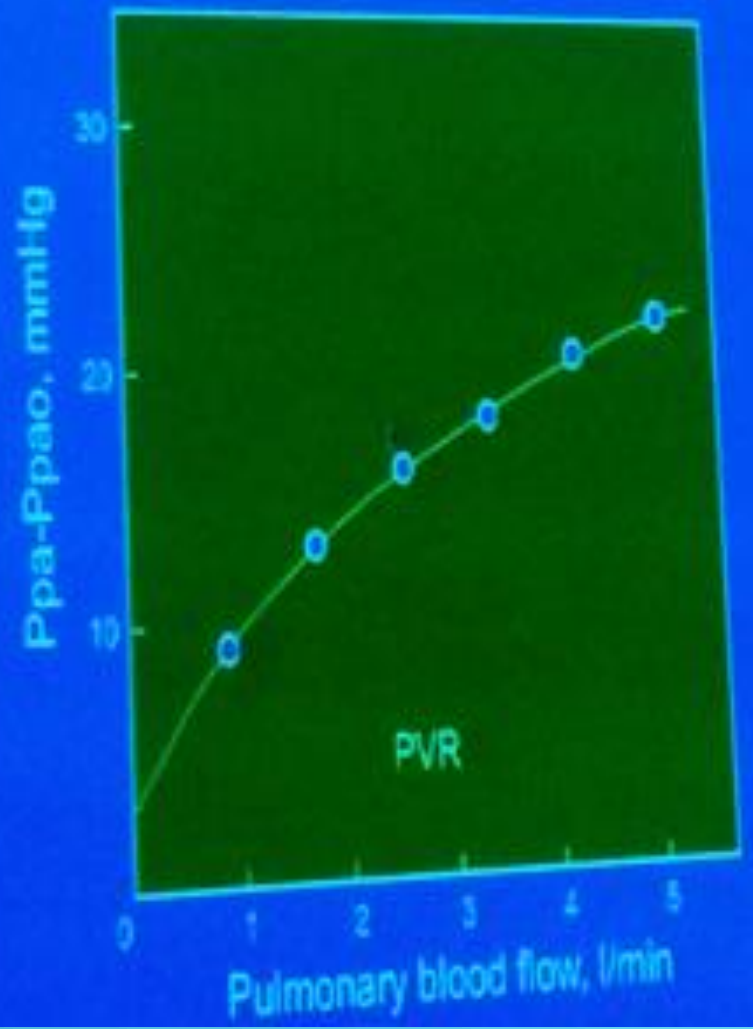
- Projection onto a micro-computed tomography (CT) image of the arterial tree of a mouse lung.
  - sympathetic (Sy; red) nerve fibers
  - parasympathetic (P; light green: cholinergic, dark green: NOS and VIP) nerve fibers
  - sensory (Se; yellow)
- Situation similar in guinea pig, rabbit, sheep, cat, dog and human.

Maggiorini, 2013

Hypoxia leads to the contraction of small pulmonary arteries and veins

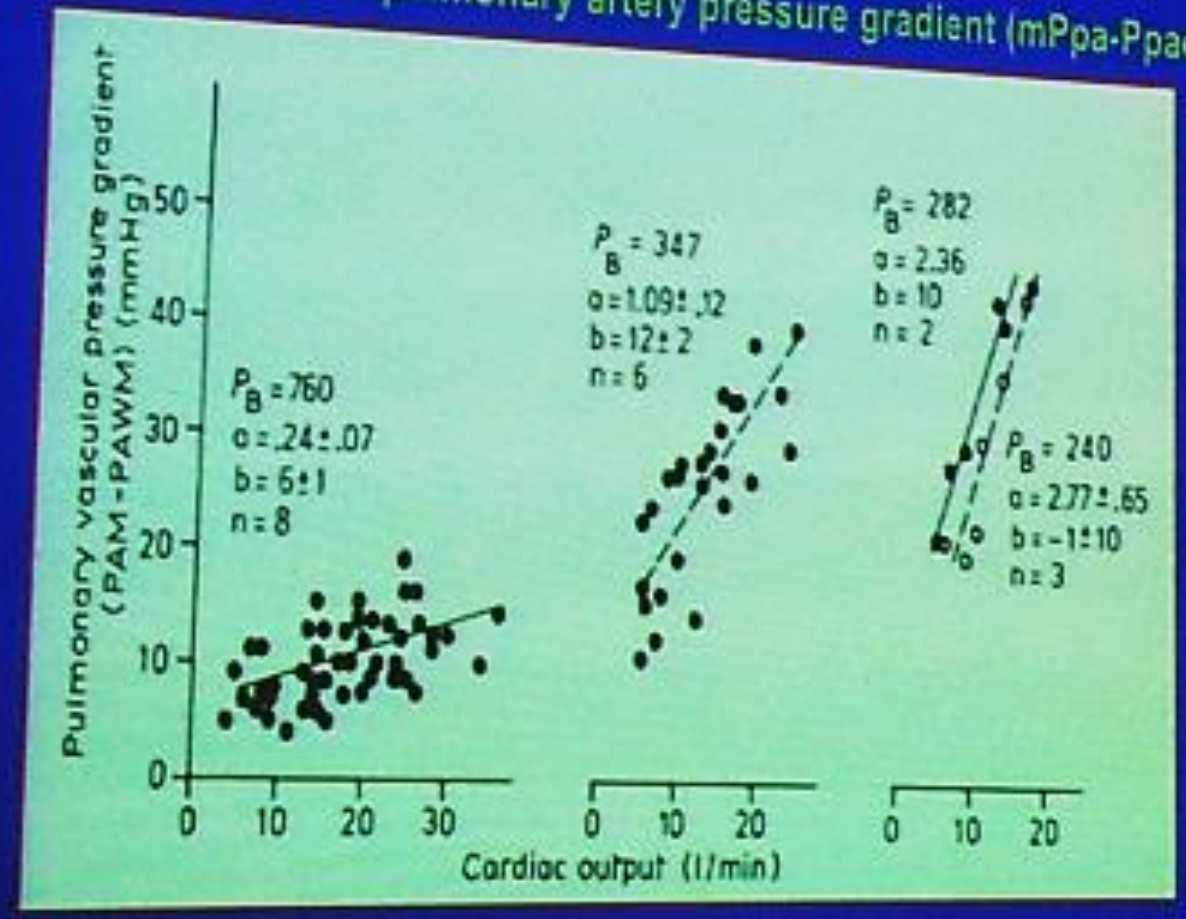


Pulmonary arterial resistance and the pressure-flow relationship



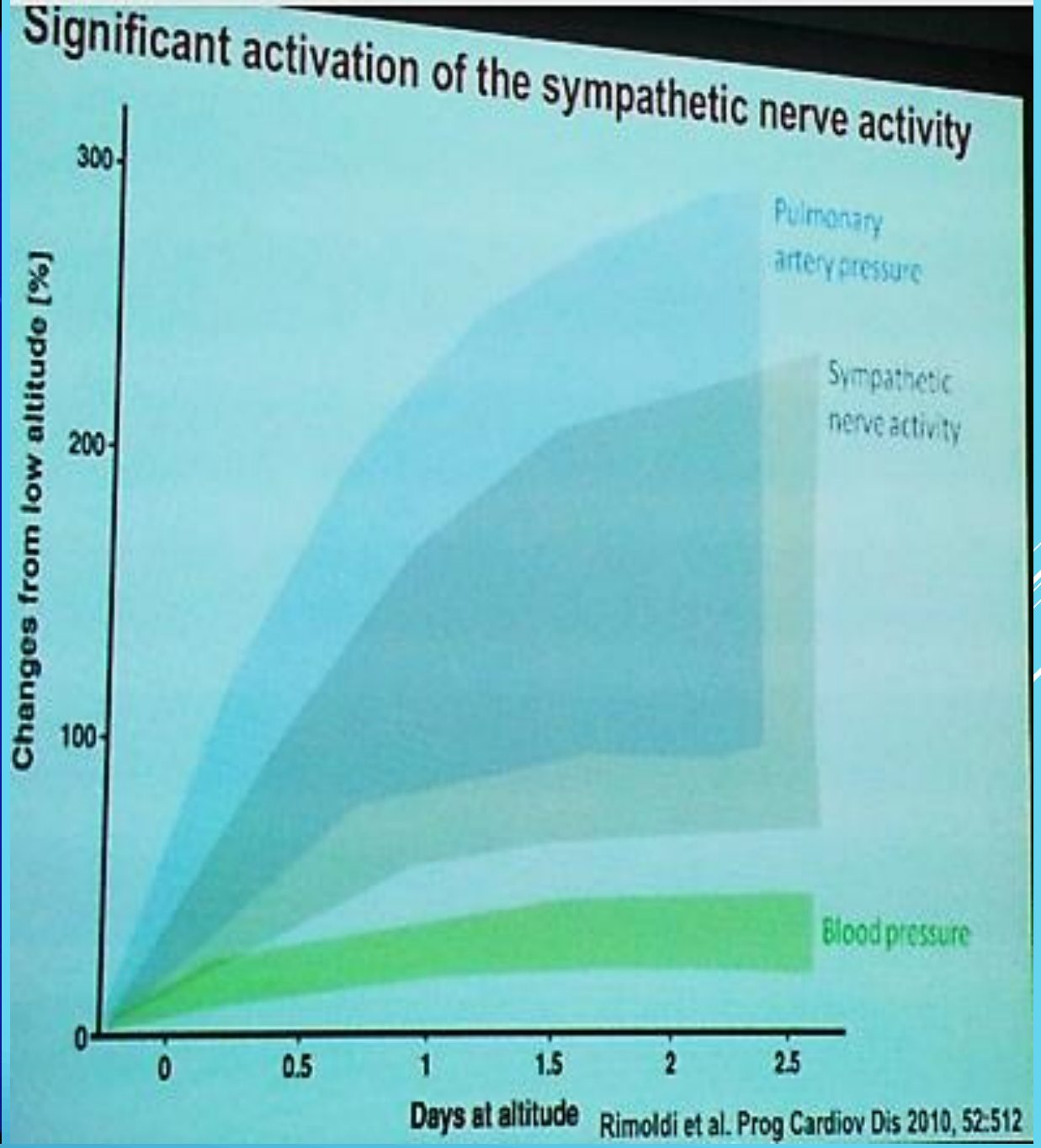
Hemodynamics during exercise at different altitudes

Operation Everest II: pulmonary artery pressure gradient (mPpa-Ppao)



Groves et al. J Appl Physiol 1987, 63:521

Significant activation of the sympathetic nerve activity



Rimoldi et al. Prog Cardiov Dis 2010, 52:512

Excessively Elevated Pulmonary Artery Pressure in High Altitude Pulmonary Edema

Vasoconstrictors

Vasodilators

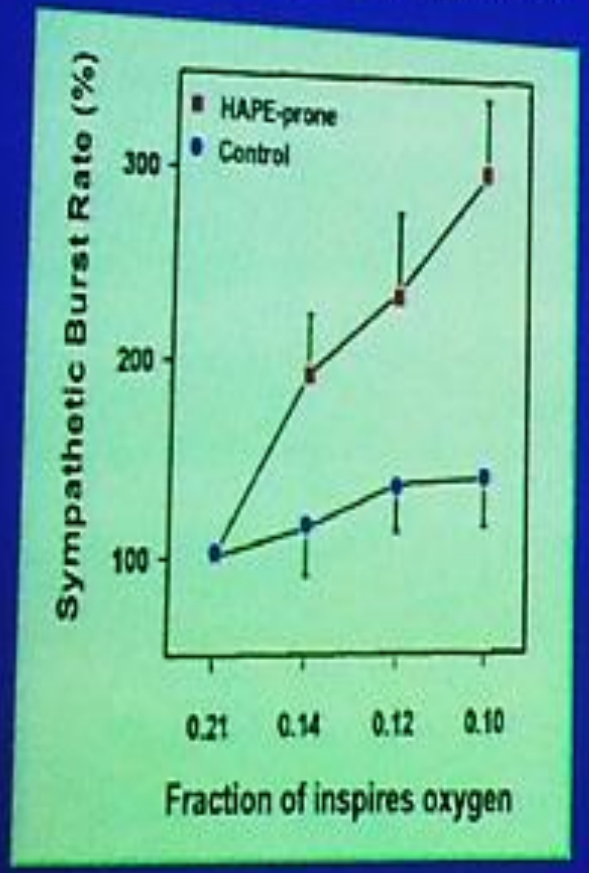
↑ Endothelin synthesis
↑ Sympathetic activity

↓ Nitric oxide availability
↓ Prostaglandin synthesis

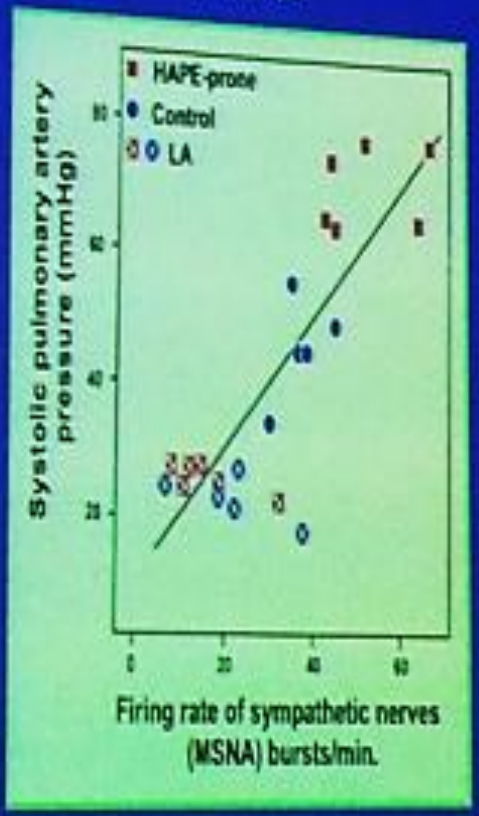
NAMME, Varese 2013

Pathophysiology of high altitude pulmonary edema: Enhanced sympathetic activity?

Sympathetic activity in HAPE-prone subjects



Relationship between sym-pathetic activity and systolic Ppa

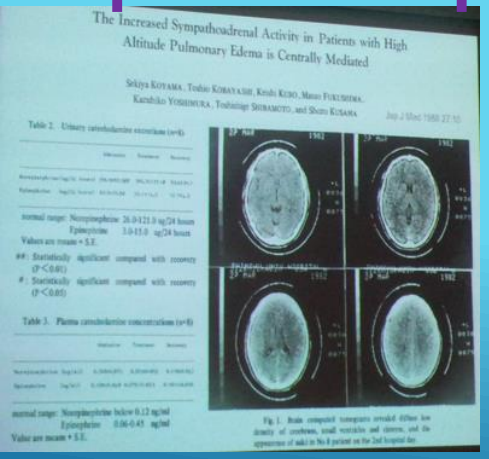


Duplin et al Circ. 1999, 99:1713

Maggiorini, 2013

The Increased Sympathoadrenal Activity in Patients with High Altitude Pulmonary Edema is Centrally Mediated
S. Koyama et al., Jap J Med 1988

Zvýšená sympatikoadrenální aktivita u pacientů s otokem mozku má vztah k tíži otoku, spíše než k pouhé expozici hypoxii

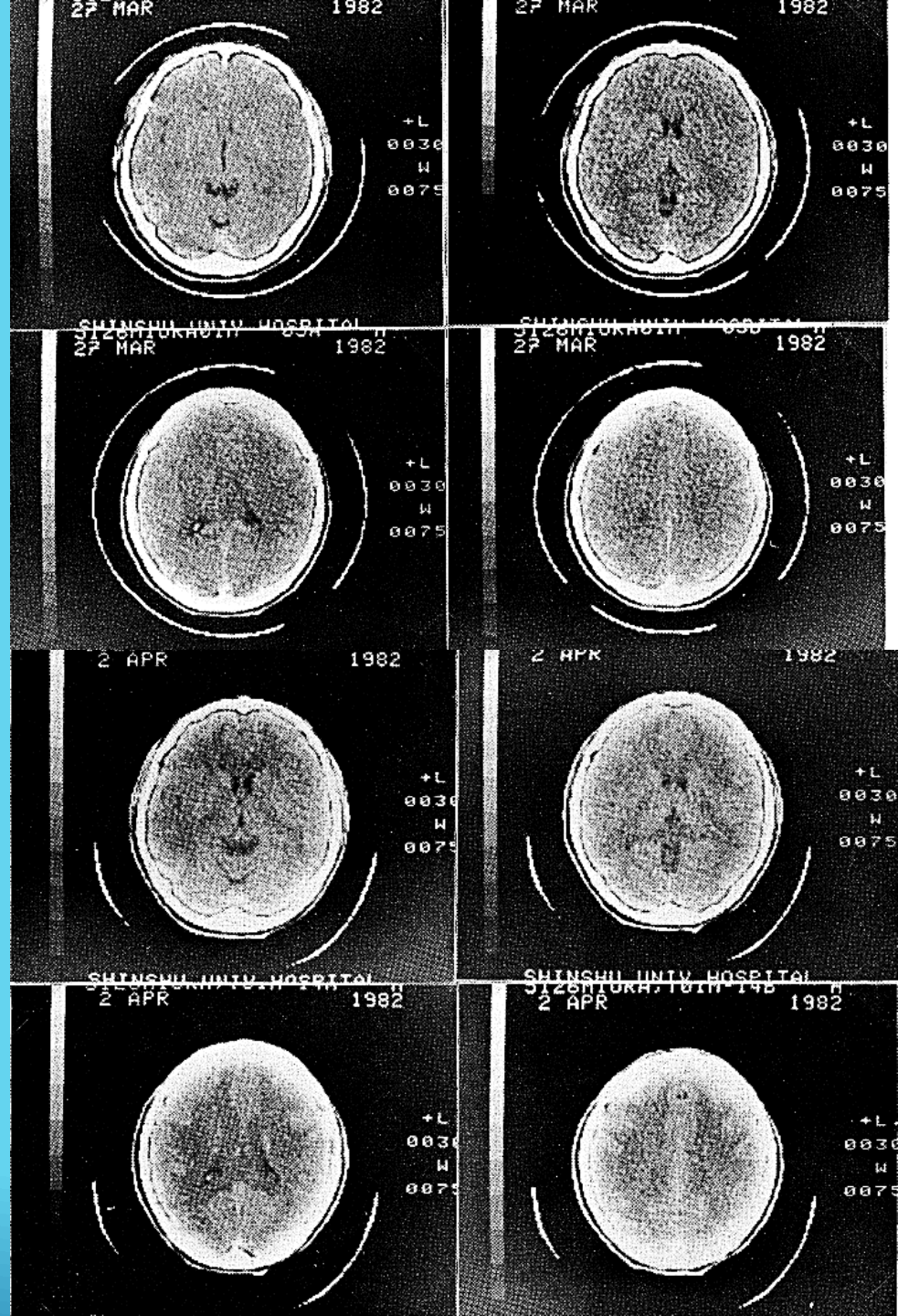

The Increased Sympathoadrenal Activity in Patients with High Altitude Pulmonary Edema is Centrally Mediated

Seikya KOYAMA, Toshio KOBAYASHI, Kenji KUBO, Mitsu FUKUSHIMA, Kanehiko YOSHIMURA, Toshitsugu SHIRAMOTO, and Shozo KUSAMA

hospitalizace
2. den
difúzně nízká denzita mozku, malé komory a cisterny, vymizení sulků

HACE

8. Den
difúzně nízká denzita bílé hmoty



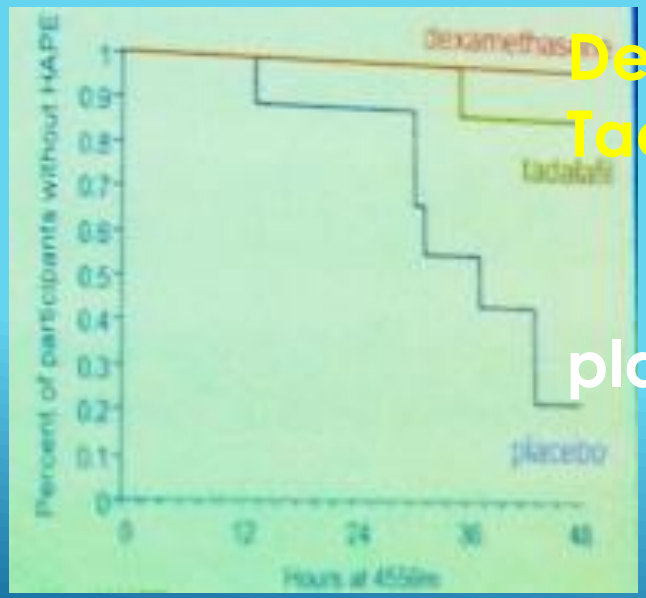
NAMME, Varese 2013 Maggiorini, 2013

Both Tadalafil and Dexamethasone May Reduce the Incidence of High-Altitude Pulmonary Edema: A Randomized Trial

M. Maggiorini et al., Ann Intern Med 2006, 145(7):497-506

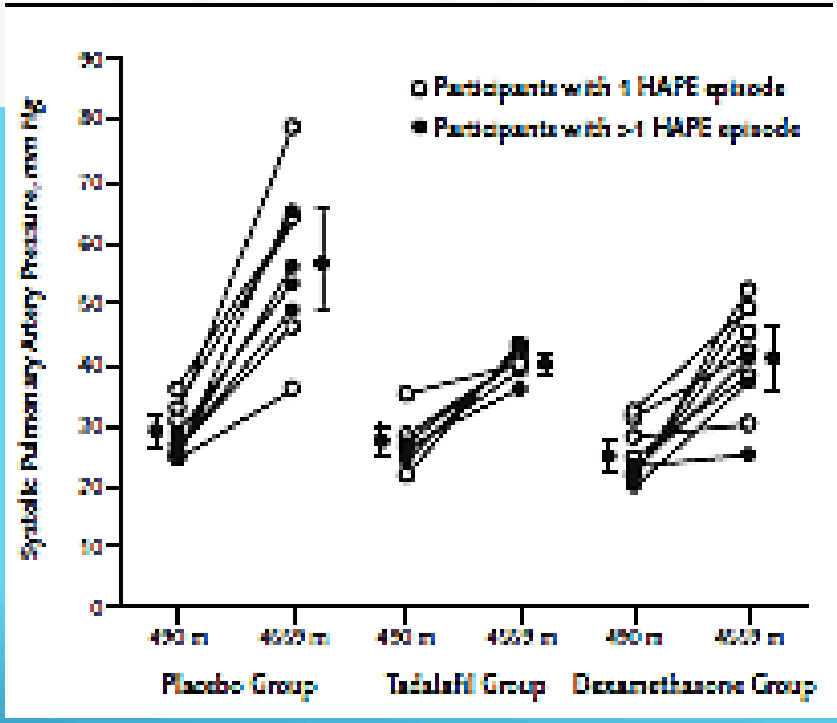
When treatment was given 24 hours before rapid ascent to 4559 m, both tadalafil and dexamethasone reduced the incidence of HAPE after arrival at high altitude in persons with 1 or more previous episodes of HAPE. Moreover, dexamethasone prevented the excessive increase in systolic pulmonary artery pressure; its vasodilatory effect was comparable to that of the selective pulmonary vasodilator tadalafil (a phosphodiesterase-5 inhibitor). Dexamethasone, but not tadalafil, decreased the incidence of AMS in these HAPE-susceptible adults.

% bez HAPE
4559 m
0-48 h



Dexamethazon
Tadalafil

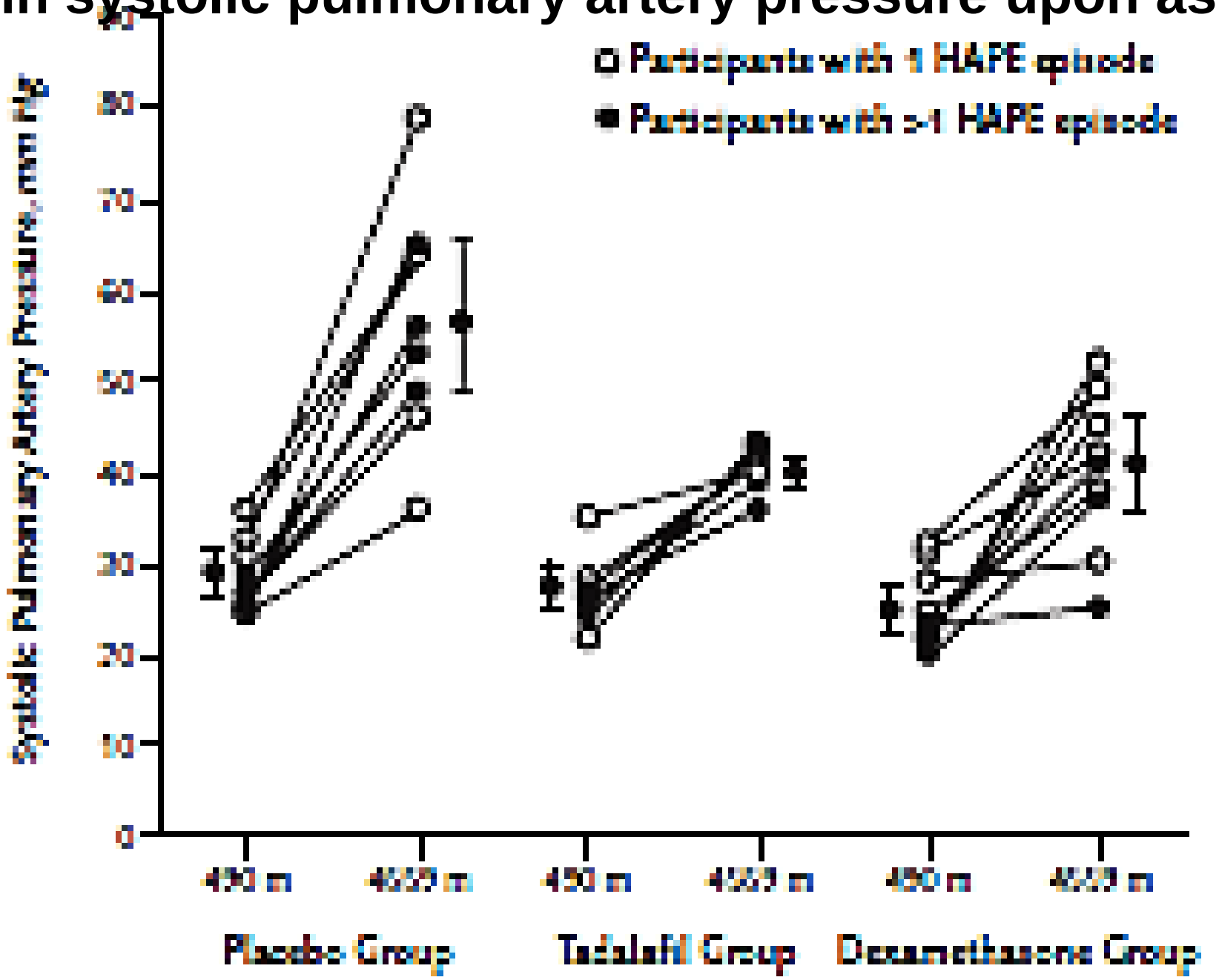
placebo



NAMME, Varese 2013

Maggiorini, 2013

Increase in systolic pulmonary artery pressure upon ascent to 4559 m.



NAMME, Varese 2013

Maggiorini, 2013

Sympathico-vagal balance: LF/HF at rest

NAMME, Varese 2013

Maggiorini, 2013

Plicní oběh a aktivita sympatiku v akutní hypoxii

- Akutní expozice výškové hypoxii je spojena s významným vzestupem aktivity sympatiku a ↑ SF
- U osob náchylných ke vzniku HAPE je aktivita sympatiku vyšší než u osob odolných. Intenzita aktivity sympatiku koreluje s tlakem v plicnici
- Dexamethason příznivě ovliňuje rovnováhu mezi sympatikem a parasympatikem a byl účinný v prevenci HAPE
- Avšak propranolol zvýšil tlak v plicnici, a tak se zdá, že aktivace sympatiku v akutní hypoxii má spíše protektivní účinek

NAMME, Varese 2013

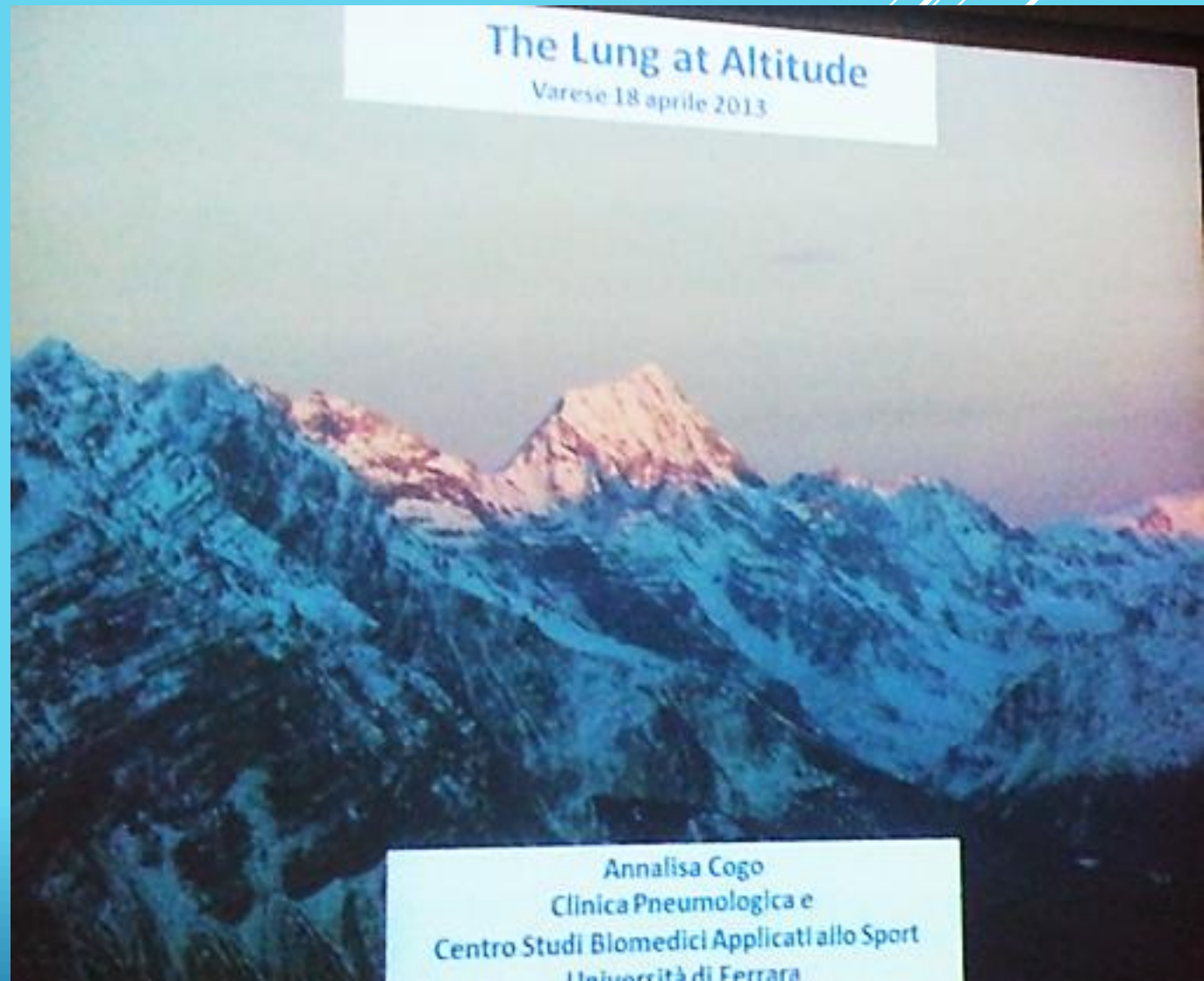
Maggiorini, 2013

PLÍCE A VÝŠKA - ADAPTACE PLIC NA VELKOU VÝŠKU

Lung Adaptation at High Altitude

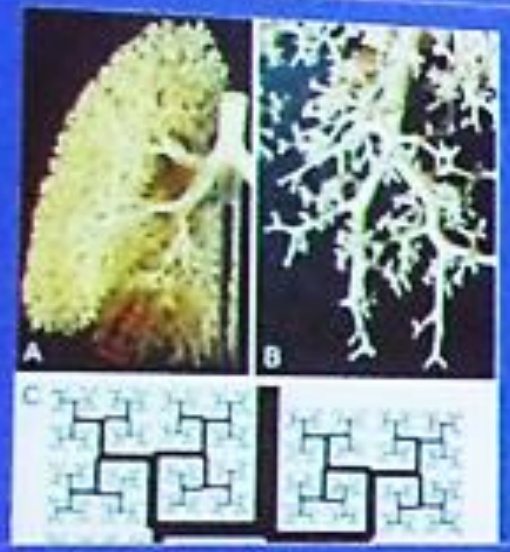
Annalisa Cogo

Head of Centro Studi Biomedici applicati allo Sport
University of Ferrara



To Tolerate Hypoxic Conditions
is required the functional integration of lung's structures to make an efficient gas exchanger

Epithelial and endothelial cells forming the lining of airways and vessels, smooth muscle cells and myfibroblasts, secretory cells.....



Weibel, ER
AmJRespirCritCareMed, 2013

Optimal Ventilatory Response: rib cage and abdominal movement, respiratory muscles function

Adequate Pulmonary Function: airway calibre

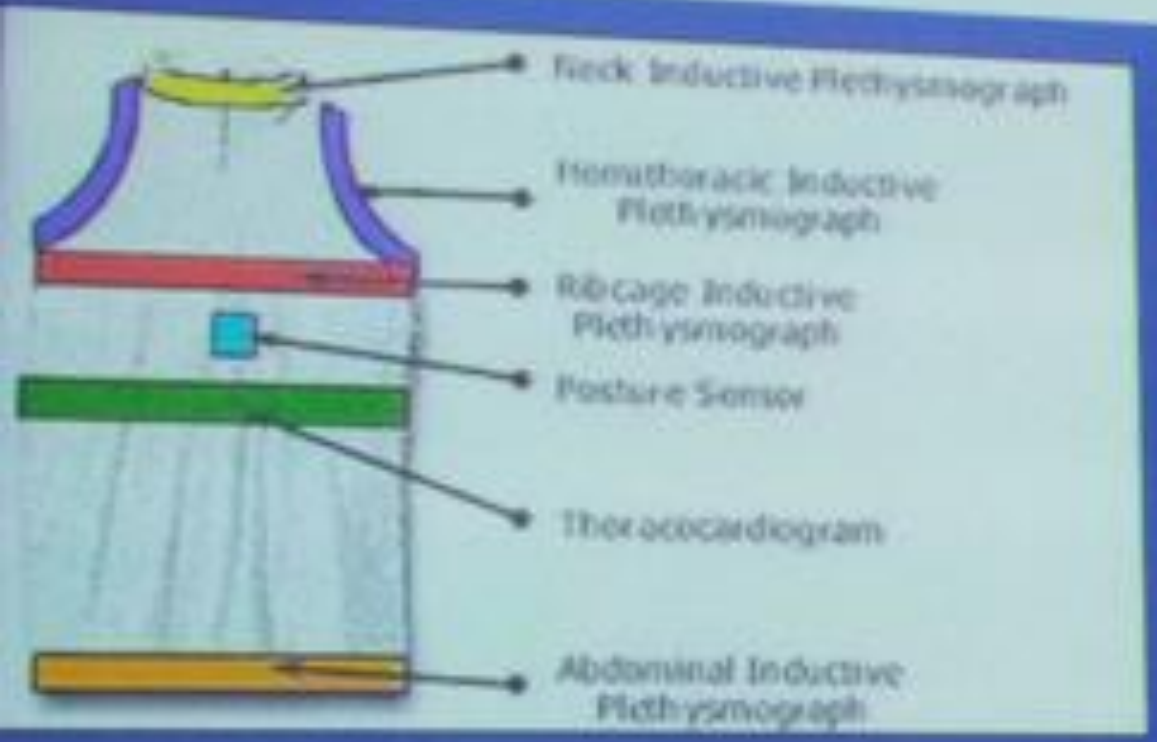
Adequate Gas Exchange: diffusion capacity

Ventilation and Ventilatory Pattern

A deeper and slower ventilation (yoga derived breathing) is more efficient in terms of gas exchange and has been reported

- to improve resting gas exchange in heart failure patients *(Bernardi L, 1998)*
- to improve gas exchange and thoraco-abdominal coordination in COPD *(Pomidori L, 2009)*
- to maintain a satisfactory oxygenation during hypoxic exposure *(Bernardi L, 2001, 2007)*

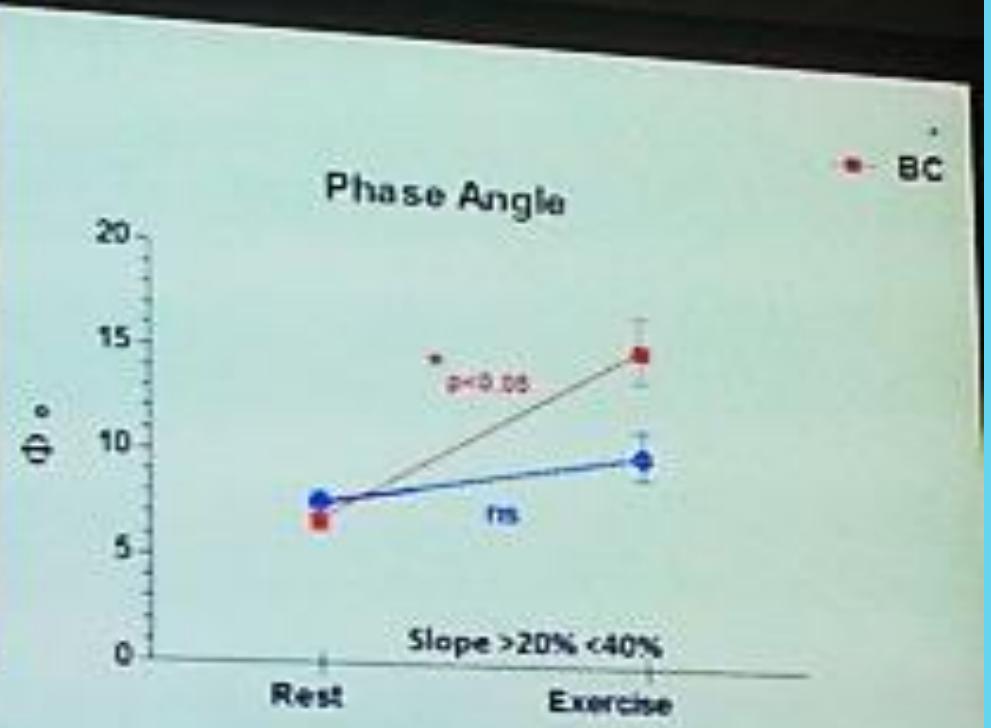
Lifeshirt system (VivoMetrics, CA, USA)

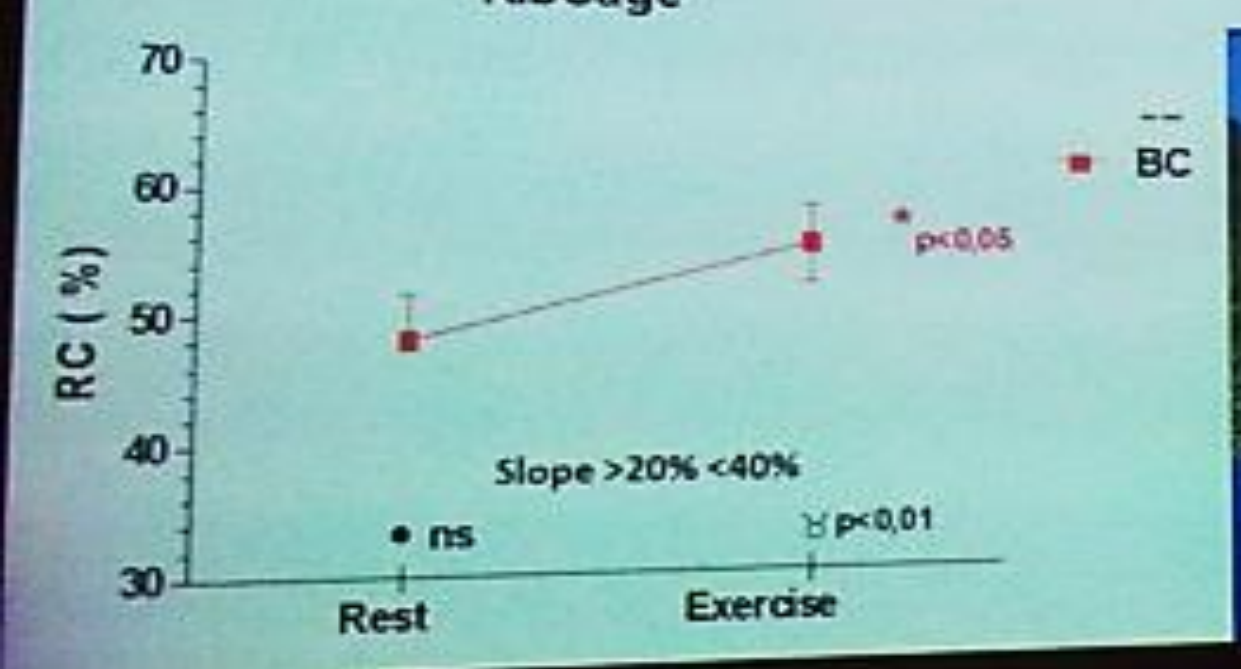


O2 saturation
ECG
Sensors on Rib cage and Abdomen → VE, ventilatory pattern and time, Thoraco abdominal coordination

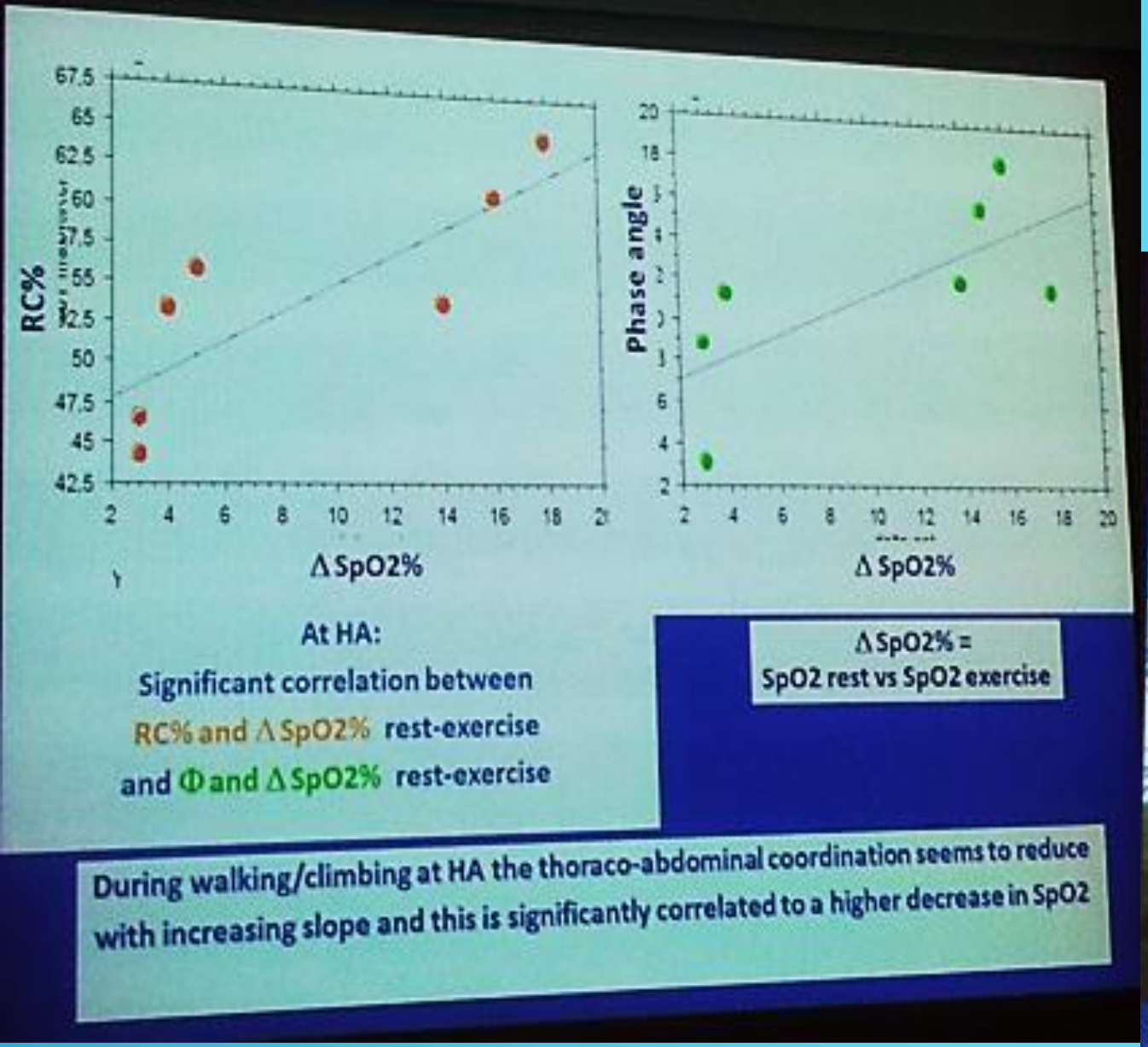
Cogo, 2013

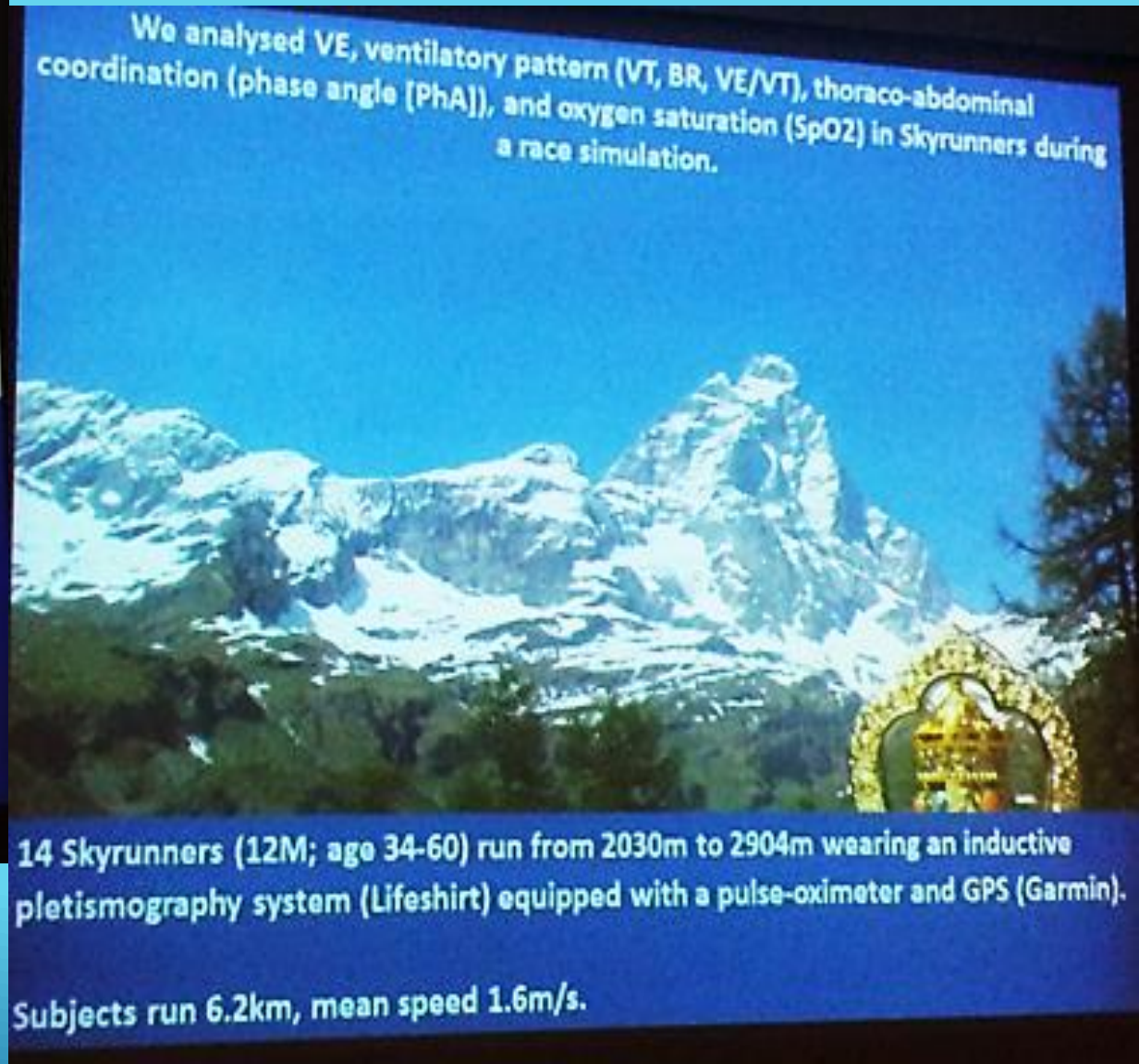
7 élite climbers (M age32-52)
1° day at the Everest North base Camp 5300m
They hiked along a standardized trail around the base camp. The speed, the slope and the difference in height were monitored by means of a GPS



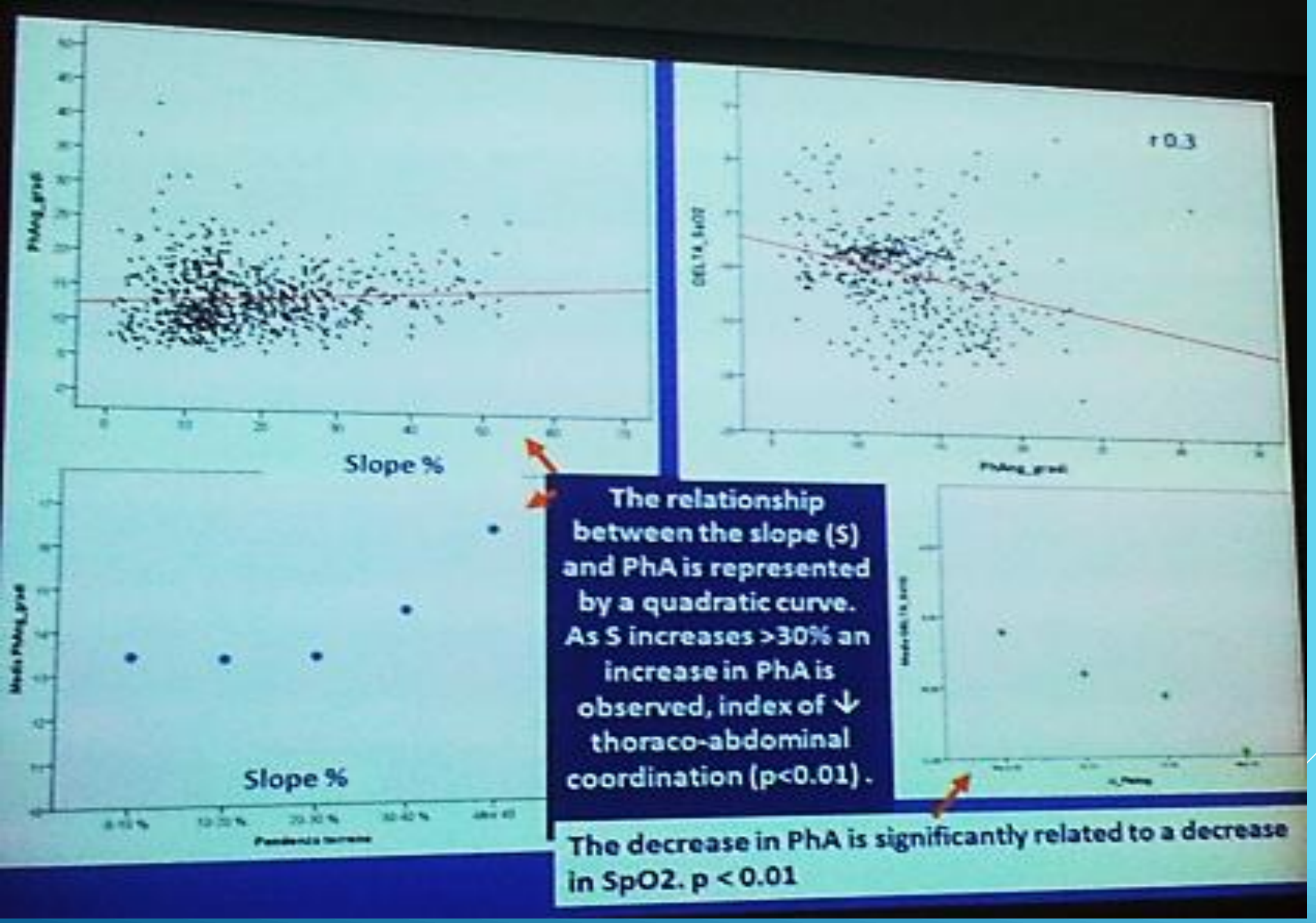


Pomidori L, Cogo A, work in progress

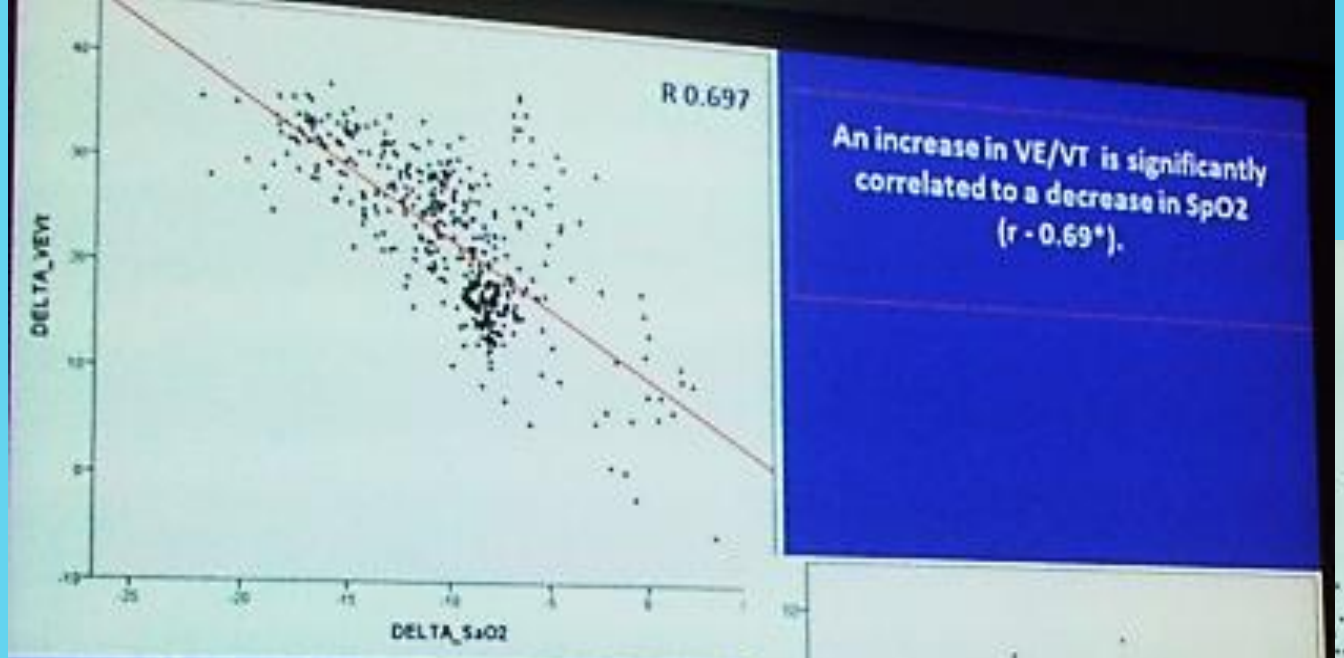




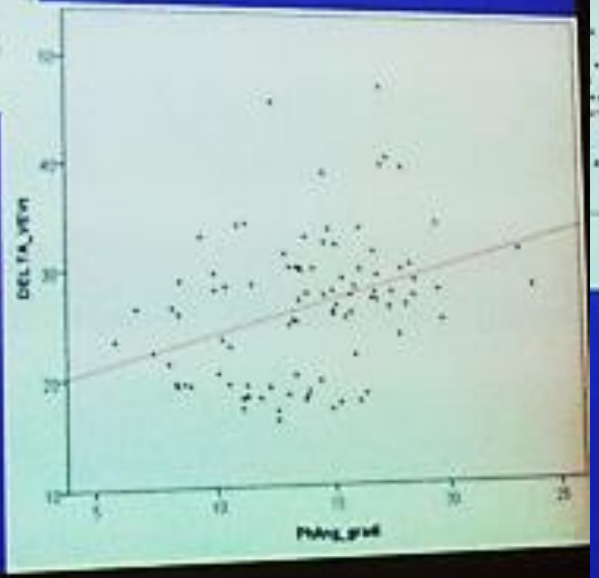
NAMME, Varese 2013 Cogo, 2013


Slope %
r 0.3
Slope %
The relationship between the slope (S) and PhA is represented by a quadratic curve. As S increases >30% an increase in PhA is observed, index of ↓ thoraco-abdominal coordination (p<0.01) .
The decrease in PhA is significantly related to a decrease in SpO2. p < 0.01

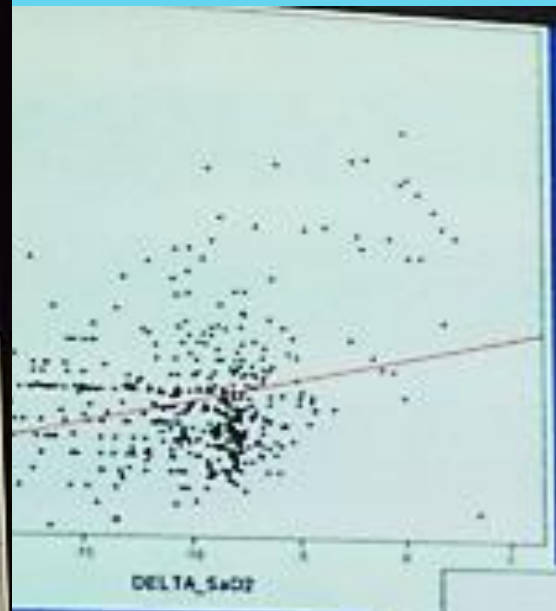
Cogo, 2013



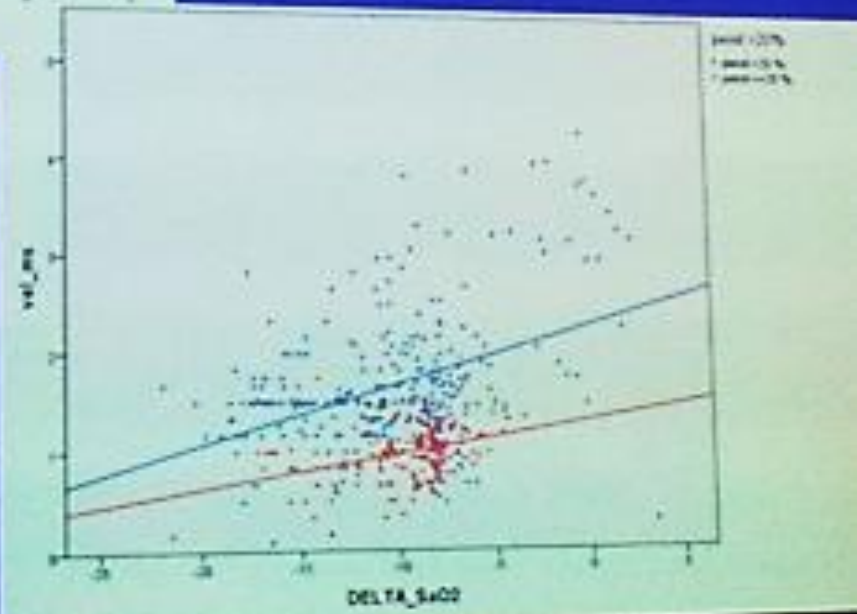
An increase in VE/VT is significantly correlated to a decrease in SpO2 (r - 0.69*).



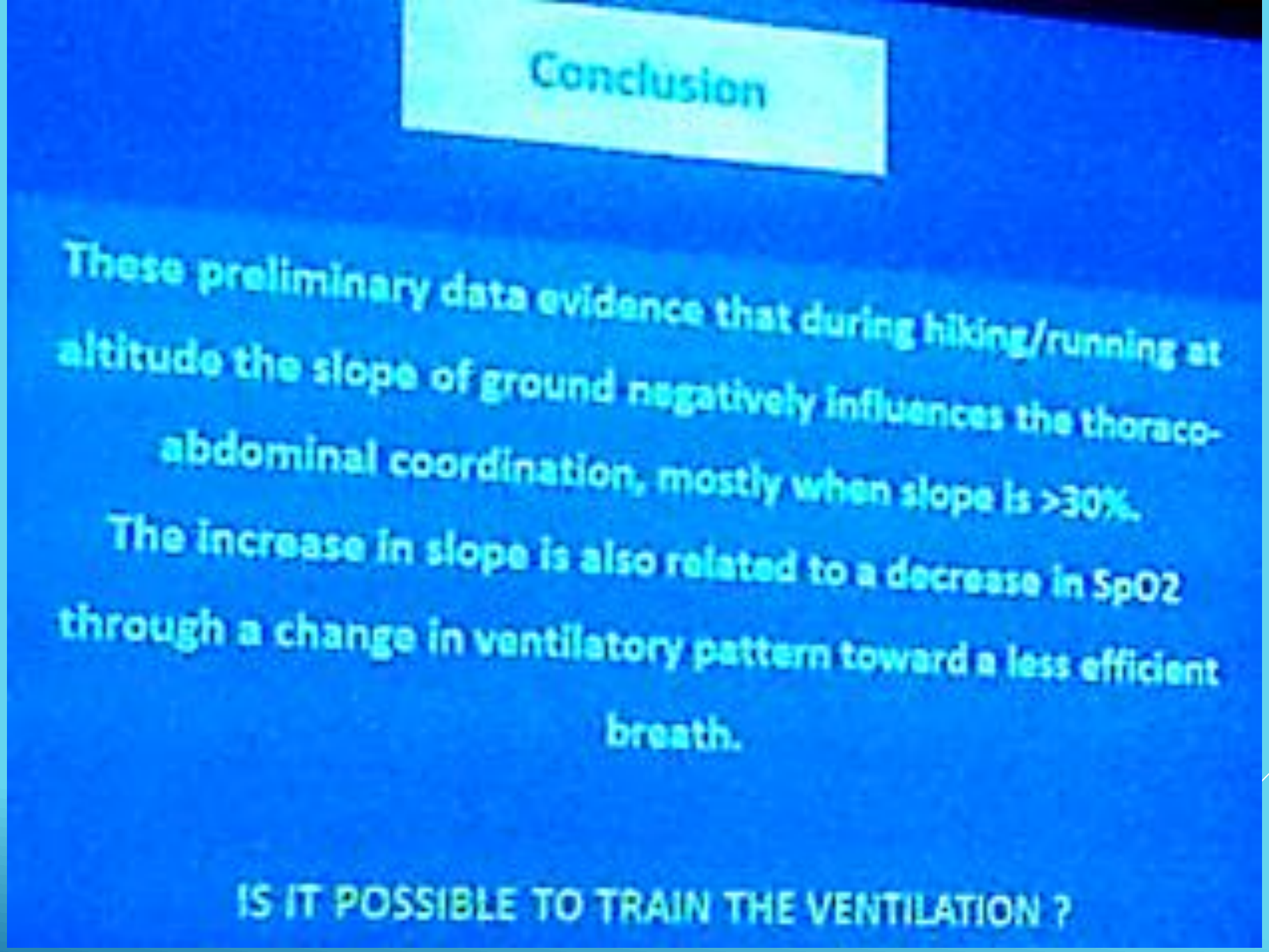
The increase in PhAng is significantly correlated to an increase in VE/VT (r - 0.35*).



The lower SpO2 is associated to a lower race speed (r 0.33*), more evident when the slope is > 20%.
*p<0.01



NAMME, Varese 2013 Cogo, 2013


Conclusion
These preliminary data evidence that during hiking/running at altitude the slope of ground negatively influences the thoraco-abdominal coordination, mostly when slope is >30%.
The increase in slope is also related to a decrease in SpO2 through a change in ventilatory pattern toward a less efficient breath.
IS IT POSSIBLE TO TRAIN THE VENTILATION ?

Cogo, 2013

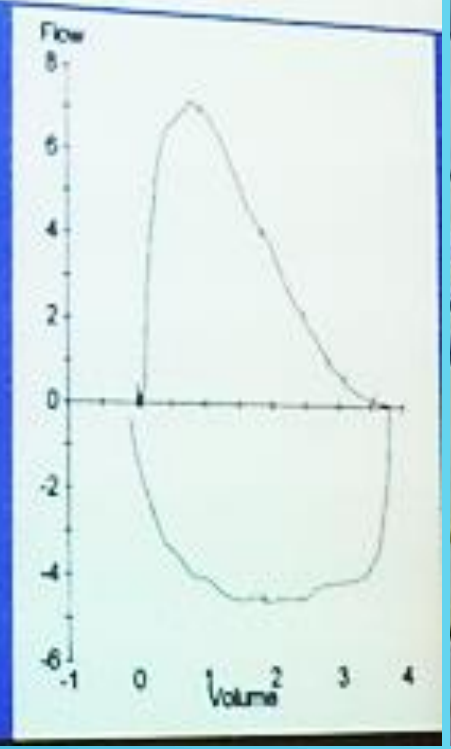
Interstitial Edema

SL---

HA ---

Flow Volume curve at SL e HA

At altitude, the reduced density of the air induces an ↑ in flows and a ↓ in airway resistance.

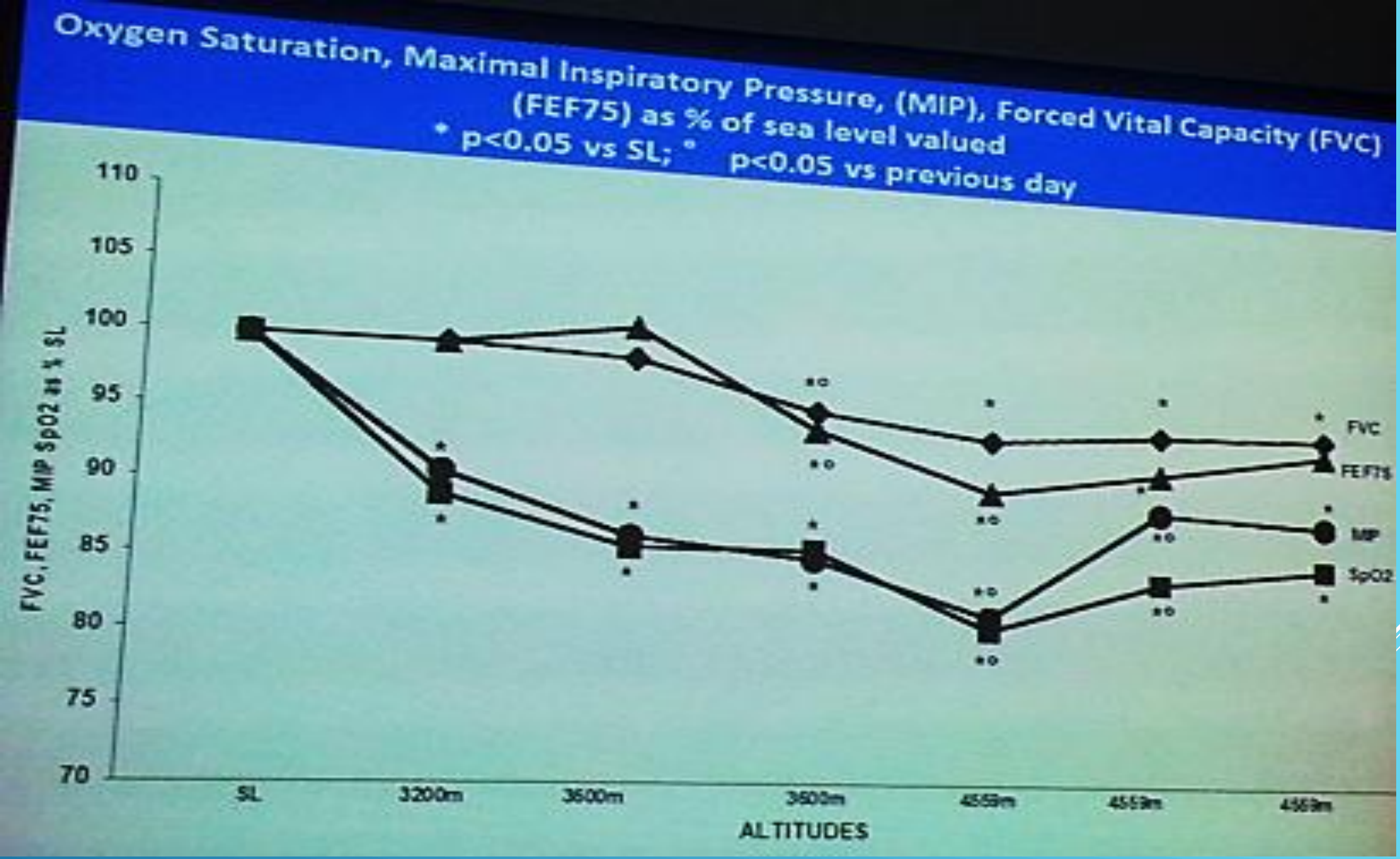


Capanna Regina Margherita 4559m, Mt.Rosa, Italian Alps

Many papers reported the ↓ in FVC and in Flows at the last part of FVC at HA (*Mosso A, 1897 ..... Jaeger JAP 1979, Gautier JAP 1982, Welsh CH, AmRevRespirDis, 1993, Cogo Respiration 1997, Mason HAM&B 2000, Wilson Thorax 2002.....*)

Potential explanation for reduced FVC and VC:

- ↑ in pulmonary blood volume
- Development of lung interstitial oedema
- Respiratory muscles weakness (*Deboeck Med Sci Sports Exerc 2005, Fasano Int J Sport Med 2007*)

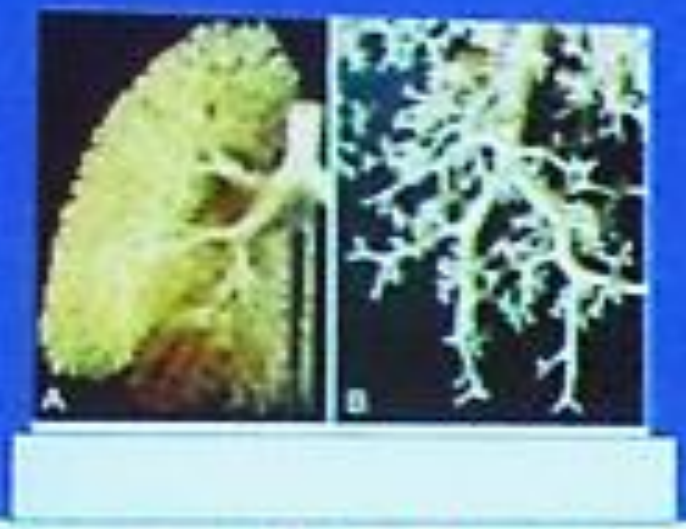

Oxygen Saturation, Maximal Inspiratory Pressure, (MIP), Forced Vital Capacity (FVC)
(FEF75) as % of sea level valued
* p<0.05 vs SL; ° p<0.05 vs previous day
FVC, FEF75, MIP SpO2 as % SL
110
105
100
95
90
85
80
75
70
SL
3200m
3600m
3600m
4559m
4559m
4559m
ALTITUDES
FVC
FEF75
MIP
SpO2

Cogo, 2013

The interstitial fluid accumulation reduces the lung compliance and induces a premature closure of peripheral air spaces.

The gold standard to assess extravascular lung water is the imaging technique.

And functional measurement?



Cogo A, Miserocchi G. Pro: most climbers develop subclinical pulmonary interstitial edema. High Alt Med Biol. 2011 Summer;12(2):121-4.

Swenson ER. Con: rebuttal. High Alt Med Biol. 2011 Summer;12(2):131-2.

Cogo, 2013

NAMME, Varese 2013

Imaging

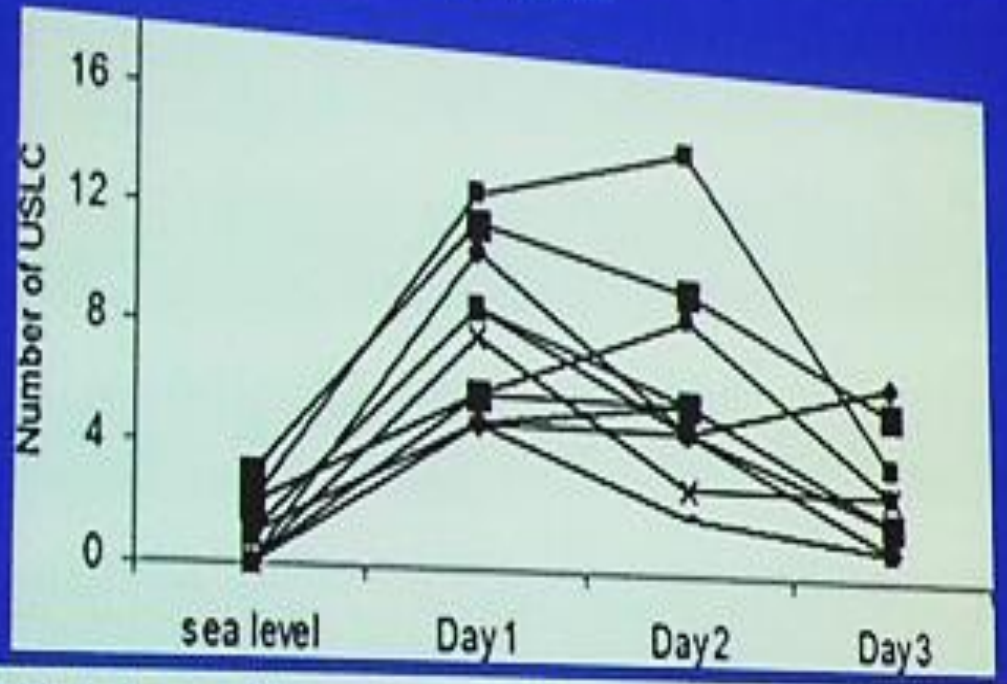
Recently a new method to assess extravascular lung water has been developed using lung echocardiography --> the appearance of the so called B-lines (" lung comets")

18 subjects monitored at different altitudes during the trek to the South Everest Base camp

an increase in extravascular lung water in 83% of otherwise healthy climbers at 3440m and in 100% at 4790.

Data have shown a negative correlation with oxygen saturation but no correlation with the contextually measured pulmonary artery systolic pressure. (*Pratali, Crit Care Med 2010; 38: 1818 –1823*)

7 subjects transported to 43500m by helicopter



Individual ultrasound lung comets (USLC) time course at sea level, first (D1), second (D2) and third (D3) days at 4350<ce:hsp sp="0.25"/> m.

P. Bouzat et al. Time course of asymptomatic interstitial pulmonary edema at high Altitude. Respir Physiol Neurobiol 2013

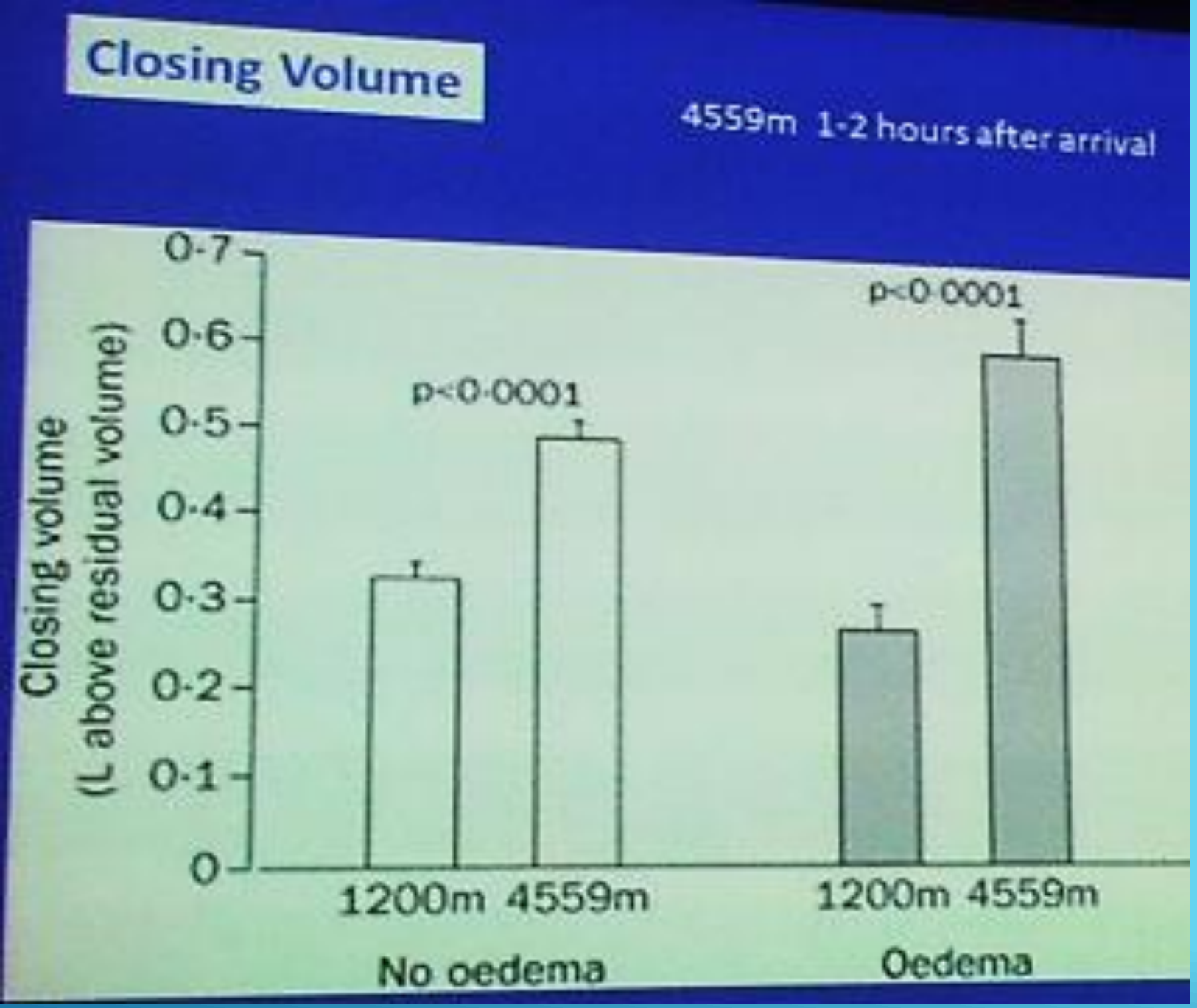
Functional Diagnosis

Small airways are more difficult to assess than central airways and the functional diagnosis of peripheral airways involvement continues to be a challenge.

The two recommended test are

the nitrogen single breath → increase in closing volume reflecting early closure of small airways *(Macklem 1988)*

impulse oscillometry (IOS), measures changes in airway resistance during tidal breathing: by varying the frequency, different districts of the bronchial tree can be assessed, and *low oscillation frequencies (5 Hz)* are supposed to measures resistance at the level of small airways *(Contoli 2010, Johnson MK 2005)* *Reactance (Xrs)*, which mainly reflects the elastic properties of the tissues or the presence of closure or choke points in peripheral airways and is very sensitive to the development of interstitial lung oedema. *(Dallaca 2008)*



Cremona et al.,
Lancet 2002

Cogo, 2013

NAMME, Varese 2013

Do changes in Lung Function Predict High-Altitude Pulmonary Edema at an Early Stage?

26 unacclimatized subjects studied at 4559m after the arrival and 24 hours later

	N	Baseline at 490 m	Day 1 at 4559 m	Day 2 at 4559 m
IVC (L)	24	→ 4.75 ± 0.78	4.46 ± 0.79*	4.45 ± 0.81*
(% predicted)		102 ± 8	96 ± 8*	96 ± 8*
FVC (L)	24	4.67 ± 0.75	4.37 ± 0.83*	4.34 ± 0.84*
(% predicted)		103 ± 9	96 ± 10*	96 ± 10*
FEV1 (L)	24	3.81 ± 0.61	3.64 ± 0.67*	3.59 ± 0.66*
(% predicted)		99 ± 10	94 ± 10*	93 ± 10*
FEV1/FVC (%)	24	→ 82 ± 6	84 ± 8*	84 ± 8*
Closing volume (L above RV)	21	→ 0.35 ± 0.14	0.44 ± 0.11*	0.42 ± 0.15
(% predicted IVC)		8 ± 3	10 ± 2*	9 ± 3

These alterations of pulmonary function are consistent with interstitial fluid accumulation,
Do not indicate a subsequent progression to clinical HAPE,

Their extent, the time course, and the underlying mechanisms may vary according to individual susceptibility and other unknown factors

Senn O et al Med.Sci.Sports Exerc 2006

Cogo, 2013

NAMME, Varese 2013

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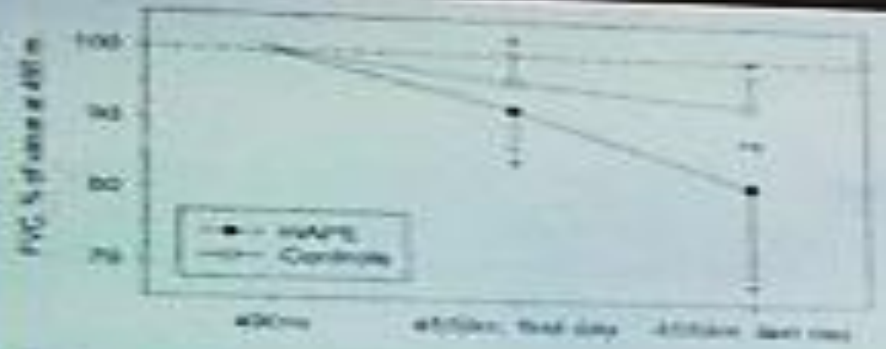
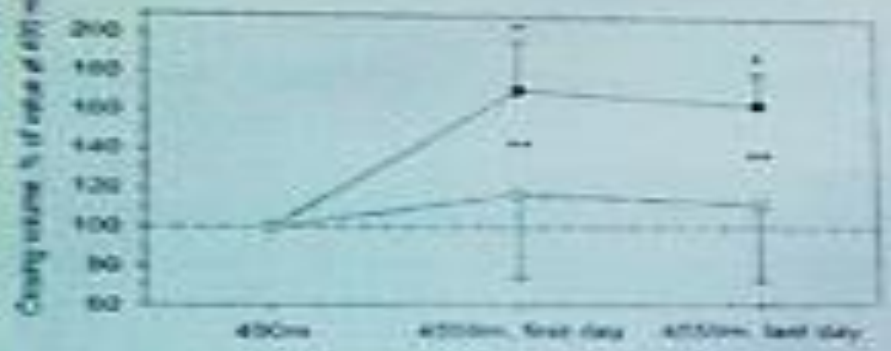
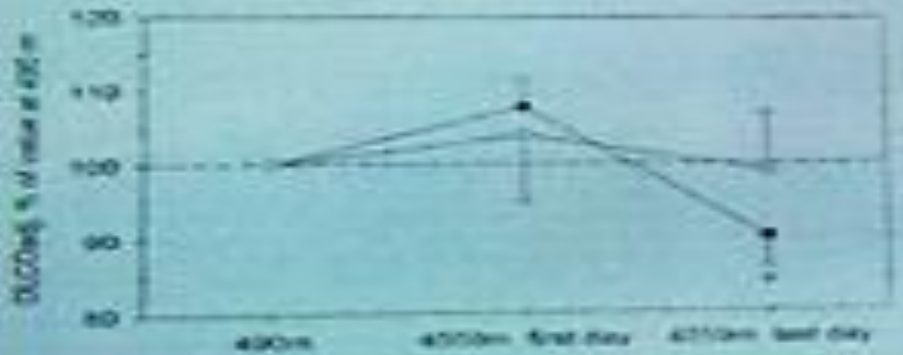
Senn O et al Med.Sci.Sports Exerc 2006

Cogo, 2013

NAMME, Varese 2013







18 mounbtaineers
8 developed HAPE

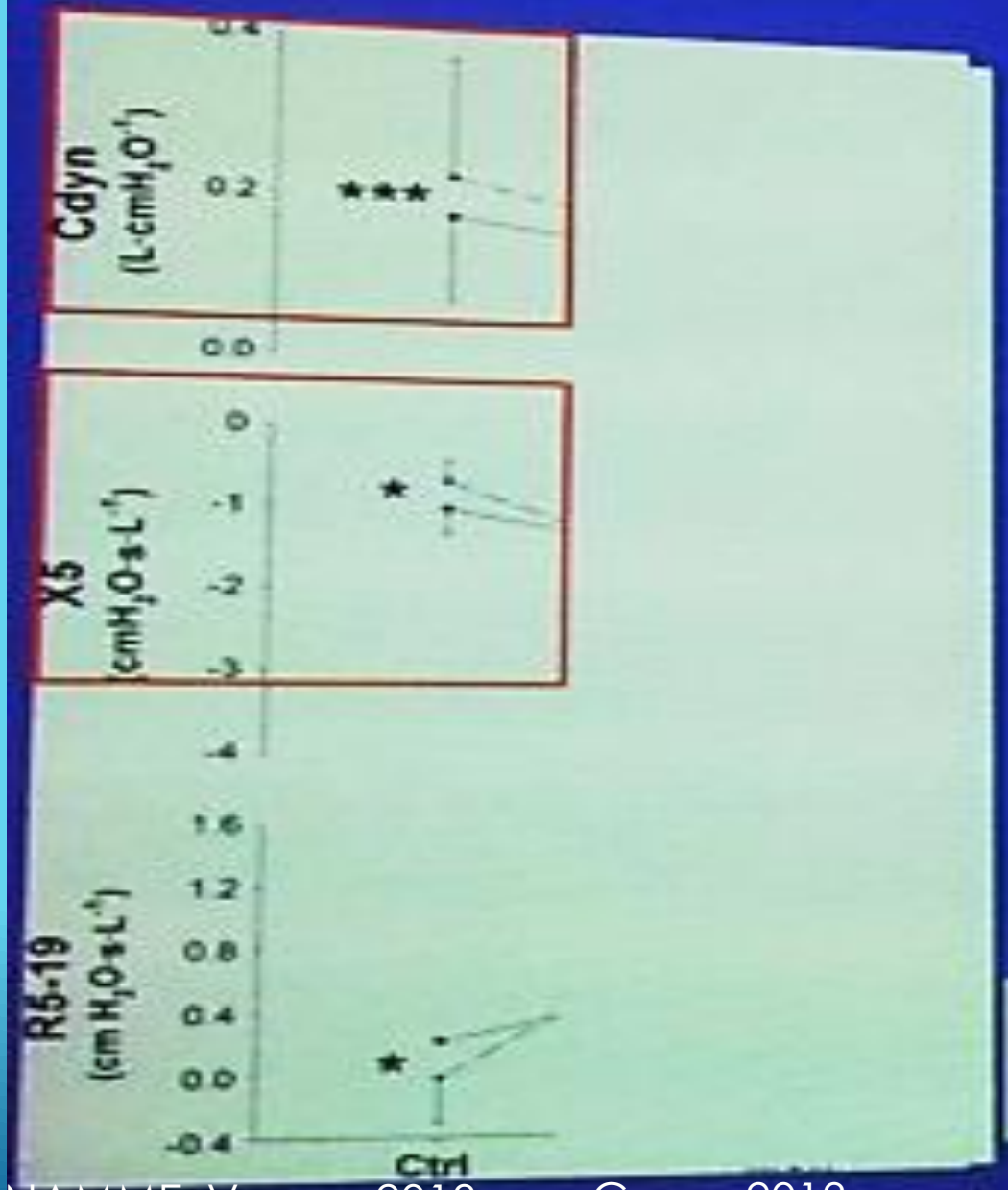
Clinically overt HAPE is preceded by a pattern of alterations in pulmonary mechanics and gas exchange that are consistent with reduced compliance and respiratory muscle strength, uneven distribution of ventilation and gas exchange impairments that are caused by interstitial fluid accumulation.

Lung Function and Breathing Pattern in Subjects Developing High Altitude Pulmonary Edema
C.Clarenbach et al. PLoS ONE 2012

Cogo, 2013

NAMME, Varese 2013

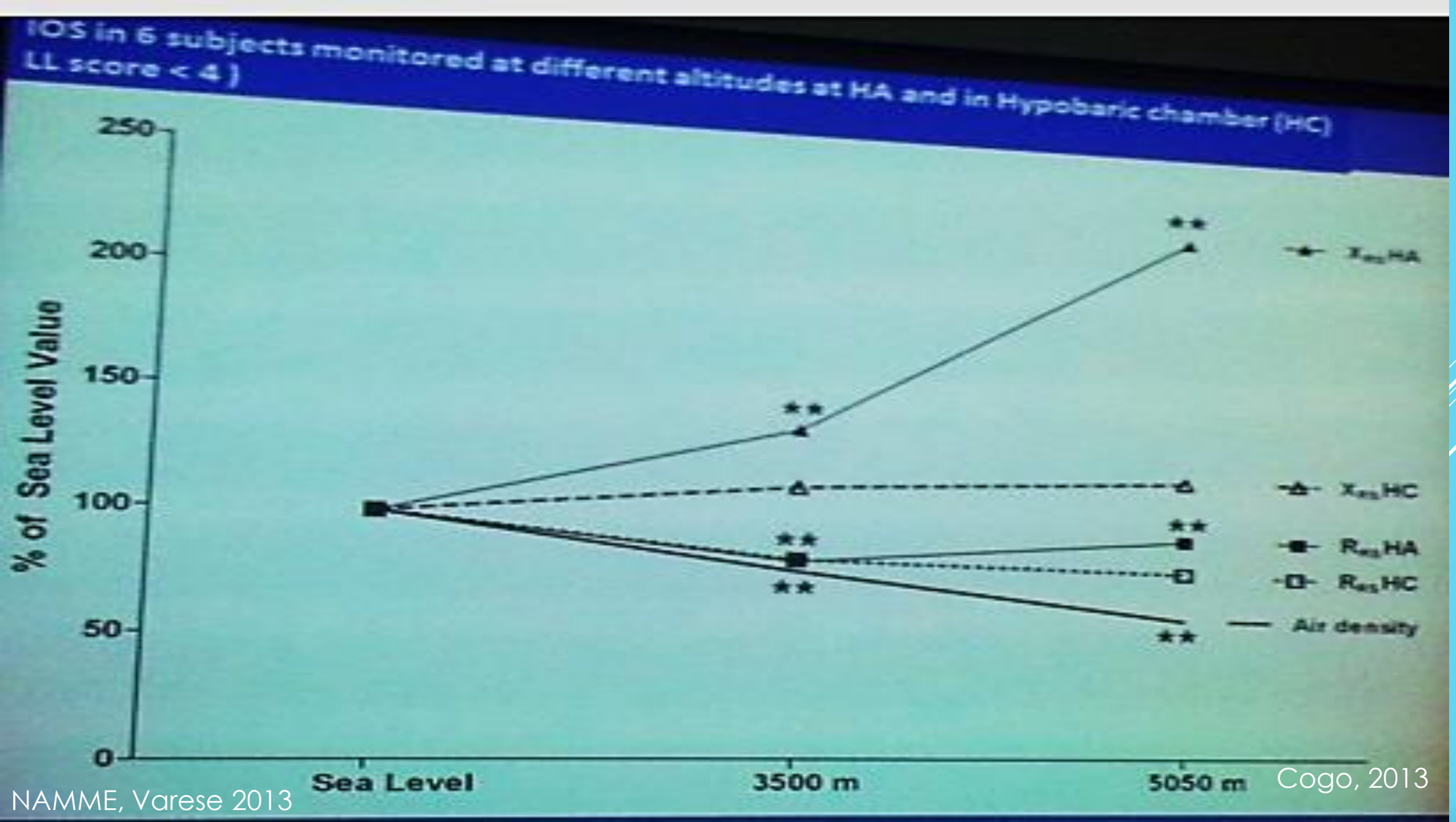
IOS



As regard IOS, Pellegrino reported a decrease in reactance in subjects during exposure at 4559m together with a significantly decrease of compliance. Also in this study, high standard deviation suggests a high inter-individual variability.

Cdyn, respiratory reactance at 5 Hz (X5), and difference in respiratory resistance between 5 and 19 Hz (R5-19) and .....

Pellegrino, R. et al. J Appl Physiol 108: 256-265 2010



NAMME, Varese 2013

Cogo, 2013

CONCLUSION

At HA the lung is on the narrow ridge between physiology and pathology.

Hypoxic exposure induces significant changes in lung mechanics and imaging which can indicate the presence of interstitial oedema.

These changes do not seem to surely indicate a subsequent progression to clinical HAPE, and their extent and the time course are variable probably due to the individual susceptibility and the ascent profile (i.e acclimatization)

More studies are needed to screen a larger sample of subjects to look for a cut-off value indicating the progression to HAPE and to understand what mechanisms push the lung down from the ridge.

NAMME, Varese 2013

Cogo, 2013

JAK VÝŠKOVÁ NEMOC ROZHODLA O VÝSLEDKU INDICKO-ČÍNSKÉ VÁLKY V ROCE 1962

How Altitude Sickness Determined the Outcome of the India-China War of 1962

Buddha Basnyat

International Society for Mountain Medicine, president

NAMME, Varese 2013

Čínsko-indická válka byla krátká válka, ke které došlo v roce 1962 mezi Čínskou lidovou republikou a Indií. Hlavní příčinou války byly neshody o podobě himalájské hranice mezi státy, ale byly zde i další motivy. Indie například po Tibetském národním povstání poskytla azyl dalajlámovi, což Čína vnímala jako zásah do svých zájmů. Indie při hlídání svých hranic překračovala McMahonovu linii, východní část linie aktuální kontroly vyhlášené v roce 1959 čínským premiérem Čouem En-lajem za hranici Číny.
Válka začala útokem čínských vojsk zároveň v Aksai Činu v Ladaku na západě a v Arunáčalpradéši na východě dne 20. října 1962, tedy v době Karibské krize. Čínské jednotky postupovaly úspěšně, ovšem posléze Čína vyhlásila 20. listopadu příměří a stáhla se ze sporného území zpět.
Bojovalo se v drsných vysokohorských podmínkách a zemřelo přes třináct set indických vojáků a přes sedm set čínských.

http://cs.wikipedia.org/wiki/%C4%8C%C3%ADnsko-indick%C3%A1_v%C3%A1lka

Altitude Sickness

- Acute Mountain Sickness
- High Altitude Pulmonary Edema
- High Altitude Cerebral Edema

The Jesuits (the Society of Jesus).

- Fr. Joseph de Acosta (1540—1600) travelled to Peru and ascended the Andes.
- The book was first published in 1590 and translated to English in 1604.
- "The air is thin and not proportionate with breathing".
- Robert Boyle was familiar with this book.

Historical Lines start fights

- The W. H. Johnson line (1865, Survey of India) in the West (Ladakh).
- The Henry McMahon line (1913, The British Indian Government) in the East (Arunachal Pradesh)

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Altitude Sickness and the India China war, 1962

- Inder Singh et al, NEJM, Jan 23, 1969.

Almost 2000 soldiers with severe altitude sickness were studied. Troops going suddenly from sea level to 5500m.

This study will never be repeated.

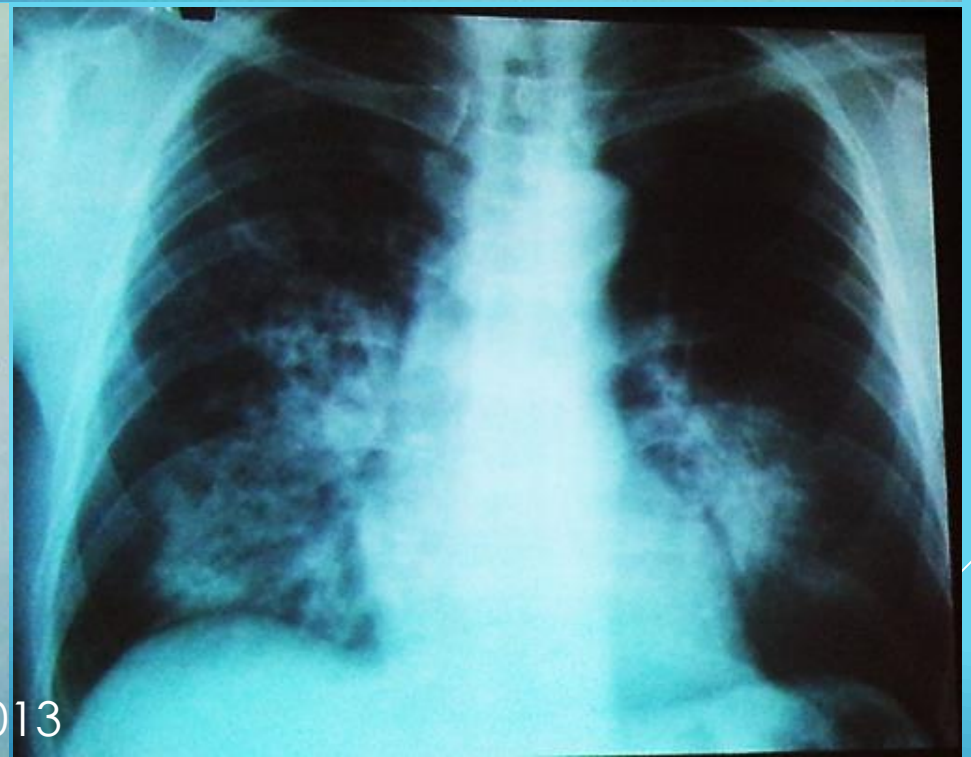
The 1962, India-China War

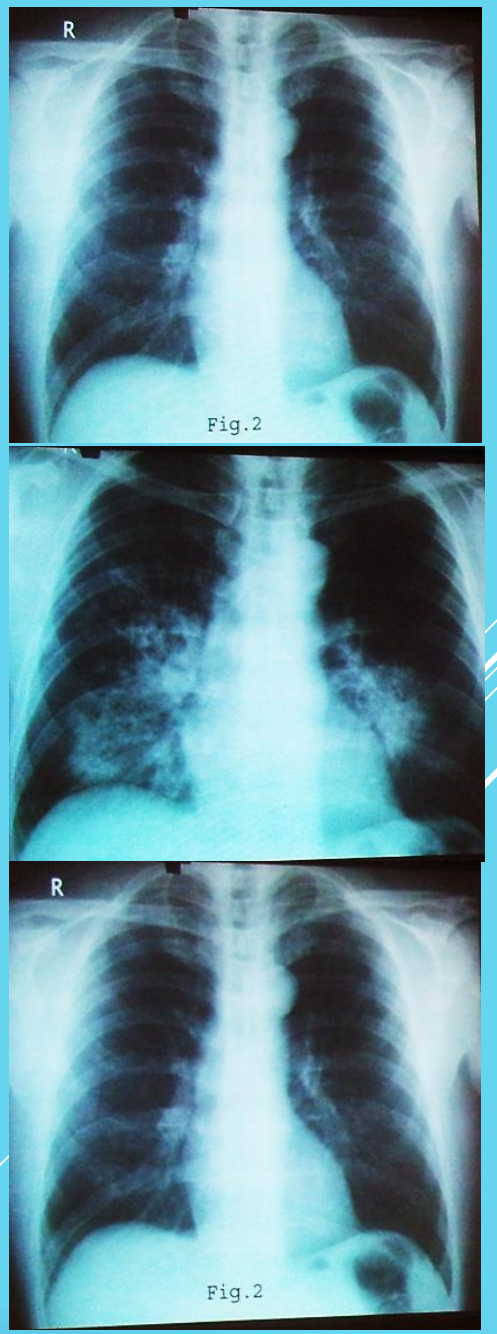
- Inder Singh et al. High Altitude Pulmonary Edema. The Lancet Jan 30, 1965.
- Prior to this article most of the HAPE cases were reported from South America except for one case reported in a skier by Charlie Houston from the US.
- Inder Singh's article noted: no role of left ventricular failure.

Findings from the NEJM study

- No relationship between altitude (3000m to 5500m) and severity of illness.
- Periodic breathing , pulmonary congestion, and antidiuresis was noted.
- Acute mountain sickness was ascribed to:

Hypoxia, pulmonary congestion, increased cerebral blood flow, increased csf pressure, and cerebral edema.





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ACUTE MOUNTAIN SICKNESS*

INDER SINGH, M.B. (RANGOON), F.R.C.P.E., F.R.C.P. (GLASG.), F.A.M.S.,
P. K. KHANNA, M.D. (POONA), D.M. CARDIOLOGY (A.I.I.M.S.), M. C. SRIVASTAVA, M.D. (POONA),
MADAN LAL, M.D. (POONA), SUJOY B. ROY, M.B. (RANGOON), F.R.C.P.E.,
AND C. S. V. SUBRAMANYAM, M.D. (POONA)

Abstract Observations on acute mountain sickness occurring between 11,000 and 18,000 feet, in 1925 men, 18, to 53 years old, showed no direct relation between altitude and severity of illness; mild, moderate and severe cases occurred at all altitudes. A time lag of six to 96 hours between arrival and onset of symptoms ruled out any direct relation between hypoxia and acute mountain sickness. During this period there was clinical evidence of respiratory dysfunction with slow, irregular or Cheyne-Stokes breathing, pulmonary congestion and antidiuresis. In one biopsy and two autopsy studies there was evidence of cerebral edema. Diuresis induced with furosemide provided effective routine therapy. Morphine and betamethasone were used as additional aids in severe cases. Clinical features of acute mountain sickness were ascribed to hypoxia, pulmonary congestion, increased cerebral blood flow, increased cerebrospinal-fluid pressure and cerebral edema.

BECAUSE of our commitments in the Himalayan region our troops shuttle frequently between sea level and 18,000 feet. Hence, acute mountain sickness is a constant challenge to us. The following is an account of our observations in 1925 patients who were incapacitated with the illness.

CLINICAL FINDINGS

The exposed population consisted of physically fit men between the ages of 18 and 53. The incidence of acute mountain sickness in large groups of men arriving at altitudes between 11,000 feet and 18,000 feet, under identical circumstances, varied from 1.01 to 83.33 per 1000. Also anyone predisposed to acute mountain sickness invariably suffered from the illness on every trip to the altitude. The severity, however, varied each time. No correlation between diuresis, whereas immune persons passed urine freely. Thus, under identical conditions of arrival at altitude, bed rest and composition, caloric value and sodium content of the diet, the effective diuresis (fluid intake minus fluid output) in 118 known predisposed test subjects on the first day of their arrival at high altitude was −1100 ml to +437 ml against 930 ml to 4700 ml in 46 absolutely immune men. Improvement in symptoms was preceded by diuresis, which continued for two to 10 days after recovery.

The Respiratory System

On arrival at 11,500 feet by air, under resting conditions, the mean respiratory rates were 23.28 on the first and 22.34 on the second day in symptomatic and 23.58 on the first and 21.64 on the second day in asymptomatic persons. Thus, comparisons

Abstract Observations on acute mountain sickness occurring between 11,000 and 18,000 feet, in 1925 men, 18, to 53 years old, showed no direct relation between altitude and severity of illness; mild, moderate and severe cases occurred at all altitudes. A time lag of six to 96 hours between arrival and onset of symptoms ruled out any direct relation between hypoxia and acute mountain sickness. During this period there was clinical evidence of respiratory dysfunction with slow, irregular or Cheyne—Stokes breathing, pulmonary congestion and antidiuresis. In one biopsy and two autopsy studies there was evidence of cerebral edema. Diuresis induced with furosemide provided effective routine therapy. Morphine and betamethasone were used as additional aids in severe cases. Clinical features of acute mountain sickness were ascribed to hypoxia, pulmonary congestion, increased cerebral blood flow, increased cerebrospinal-fluid pressure and cerebral edema.

The 1962, India-China War

- High Altitude Pulmonary Edema by Dr N D Menon in the July 8, 1965 edition of NEJM. Only in late 1962, this disease was fully recognized in this war.
- It was treated as bronchopneumonia with antibiotics until then.
- Bed rest and high flow oxygen became important measures.

Fred et al. Circulation, 25: 1962.

- The earliest case report to show (again in a skier with HAPE) after cardiac catheterization that there was pulmonary hypertension and normal left atrial pressures after the catheter tip by chance passed through a patent foramen ovale.
- So the left ventricle was intact.

Drugs for altitude illness

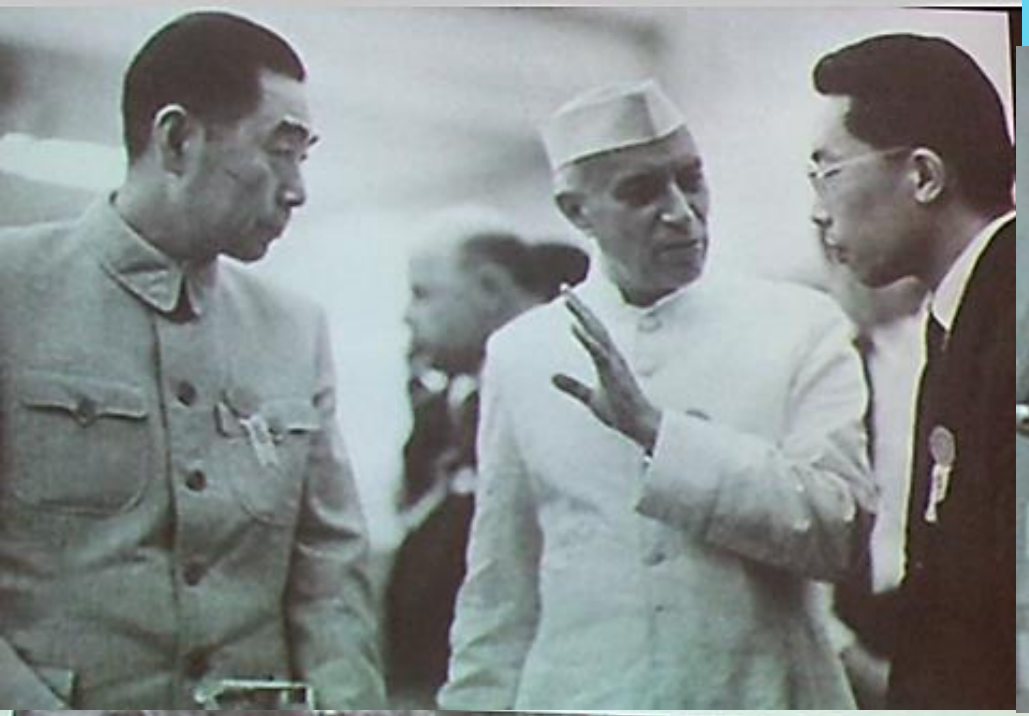
- Antibiotics, oxygen (high flow rates vs low flow rates)
- Digoxin
- Lasix
- Morphine
- Atropine
- Aminophylline
- Steroids

Prelude to the war

- In 1959 India granted asylum to the Dalai Lama.
- Nehru's Forward Policy: Putting up outposts north of McMahon Line. Aggressive stance in disputed areas.

India China War

- Lack of acclimatization.
- Chinese were well rested and did not exert themselves excessively in the first few days of arrival at high altitude unlike the Indian soldiers.
- Indians were dressed in summer uniforms and were more prone to hypothermia. The Chinese wore well padded uniforms.



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India China War

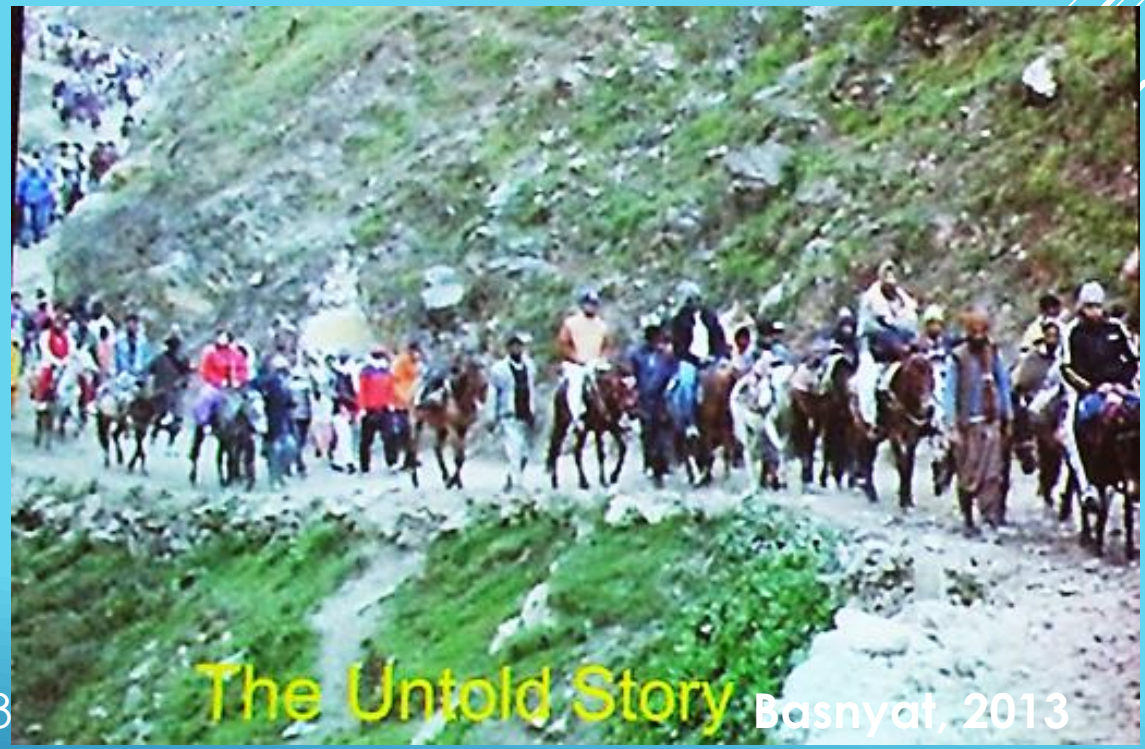
Medical reasons for the Indian defeat:

- Lack of alpine warfare experience unlike the Chinese who had been fighting with the Tibetans.
- No acclimatization: Too high too fast.
- Hypothermia.
- Lack of knowledge about altitude sickness.
- Poor, un coordinated medical treatment.

The Classified Report

- The government of India's Henderson Brooks-P. S. Bhagat Report written by two Indian army generals in 1962 is very critical of the Indian handling of the war.

- When declassified, this report is supposed to shed light.



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CHRONICKÁ HYPOXIE A ADAPTACE NA VELKOU VÝŠKU U TIBEŤANŮ

Chronic Adaptation to High Altitude in Tibetan Highlanders

Ge Ri-Li Gao

Research Center for High Altitude Medicine, Qinghai University, China

Populations in Tibetan plateau

15 million people at >2500m
New comers 2 million/year
15%- 20% of CMS
50-70% of AMS

Tibetan

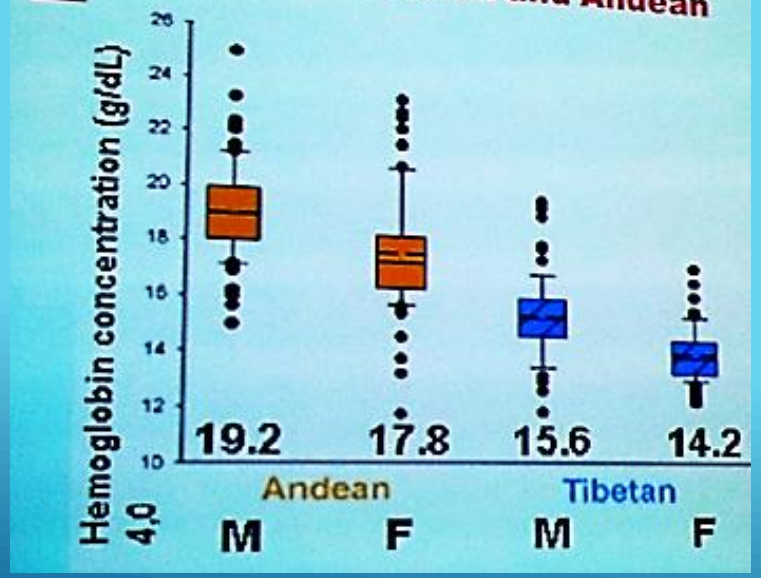
Andean

Tibetan have lived at an altitude about 25,000, and Andeans are 9000 years

Phenotypes in Tibetans

Lower Hb concentration
Lower mPPA
Higher NO production
Lower incidence of CMS

Hemoglobin in Tibetan and Andean



Science AAAS Recent Publications

1. Simonson and Ge *et al.*, *(2010)* Genetic Evidence for High-Altitude Adaptation in Tibet. *Science*

2. Yi Xi and Wang *et al.*, (2010). Sequencing of 50 Human Exomes Reveals Adaptation to High Altitude. *Science.*

3. Beall and Zeng *et al.*, (2010). Natural selection on EPAS1 associated with low hemoglobin concentration in Tibetan highlanders. *Proc. Natl. Acad. Sci.*

Ri-Li, 2013

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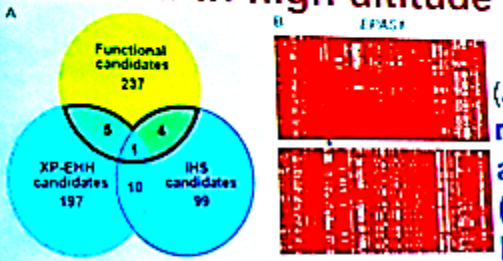
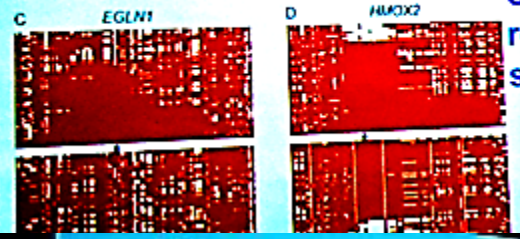
Overlap of selection genes likely involved in high-altitude adaptation





(A) List of genes related to high altitude adaptation. (B to D) Comparison between Tibetan and CHB-JPT genomic regions identified in selection scans.

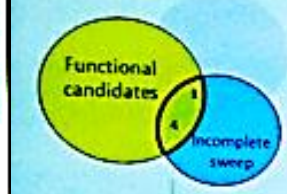
Ten genes associated with high altitude adaptation in Tibetan

- *EPAS1 (HIF2α)* Endothelial PAS domain protein 1
- *CYP2E1* Cytochrome P450, family 2, subfamily E, polypeptide 1
- *CAMK2D* Calcium/calmodulin-dependent protein kinase II delta
- *EDNRA* Endothelin receptor type A
- *ANGPTL4* Angiopoietin-like 4
- *EGLN1 (PHD2)* Egl nine homolog 1
- *CYP17A1* Cytochrome P450, family 17, subfamily A, polypeptide 1
- *PPARA* Peroxisome proliferator-activated receptor alpha
- *PTEN* Phosphatase and tensin homolog
- *HMOX2* Heme oxygenase (decycling) 2

Selection events that are fixed or nearly fixed in the population

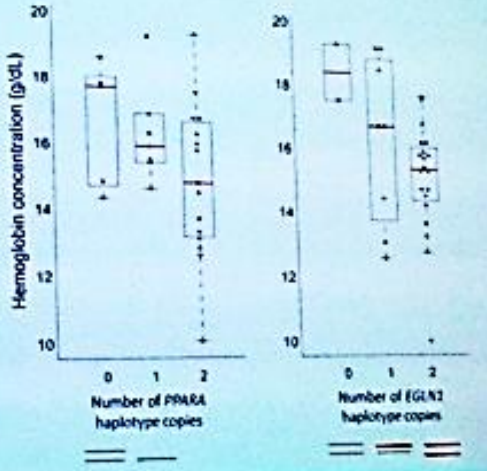
Selection events that are incomplete, polymorphic in the population

Two genes correlated with the decreased Hb

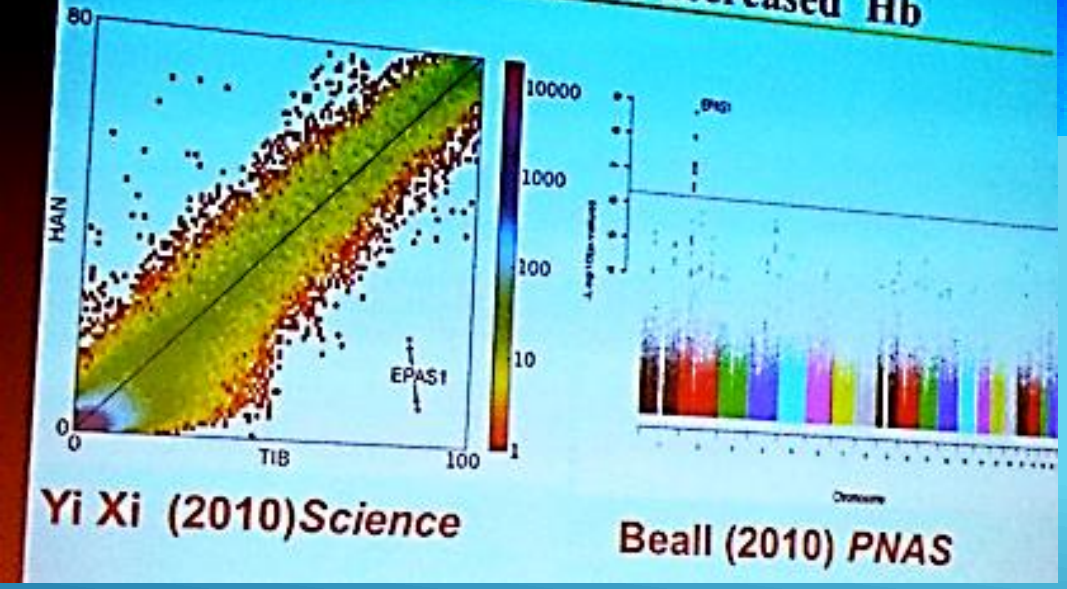


PPARA ($p = 0.009$)
EGLN1 ($p = 0.002$)

Simonson and Ge (2010)*Science*



EPAS1 associated with decreased Hb



Yi Xi (2010)*Science*

Beall (2010) *PNAS*

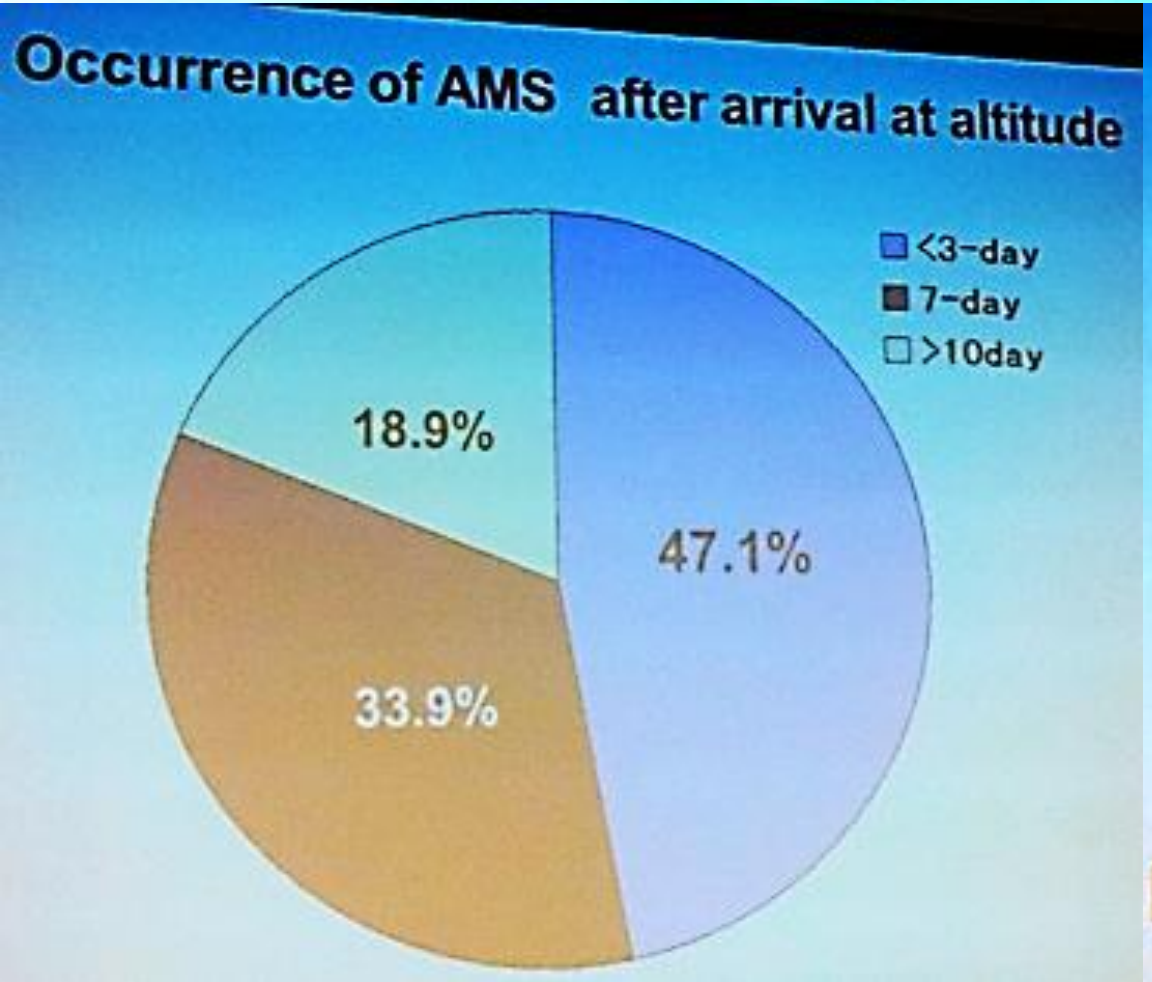
Adaptation to Altitude in Tibetans

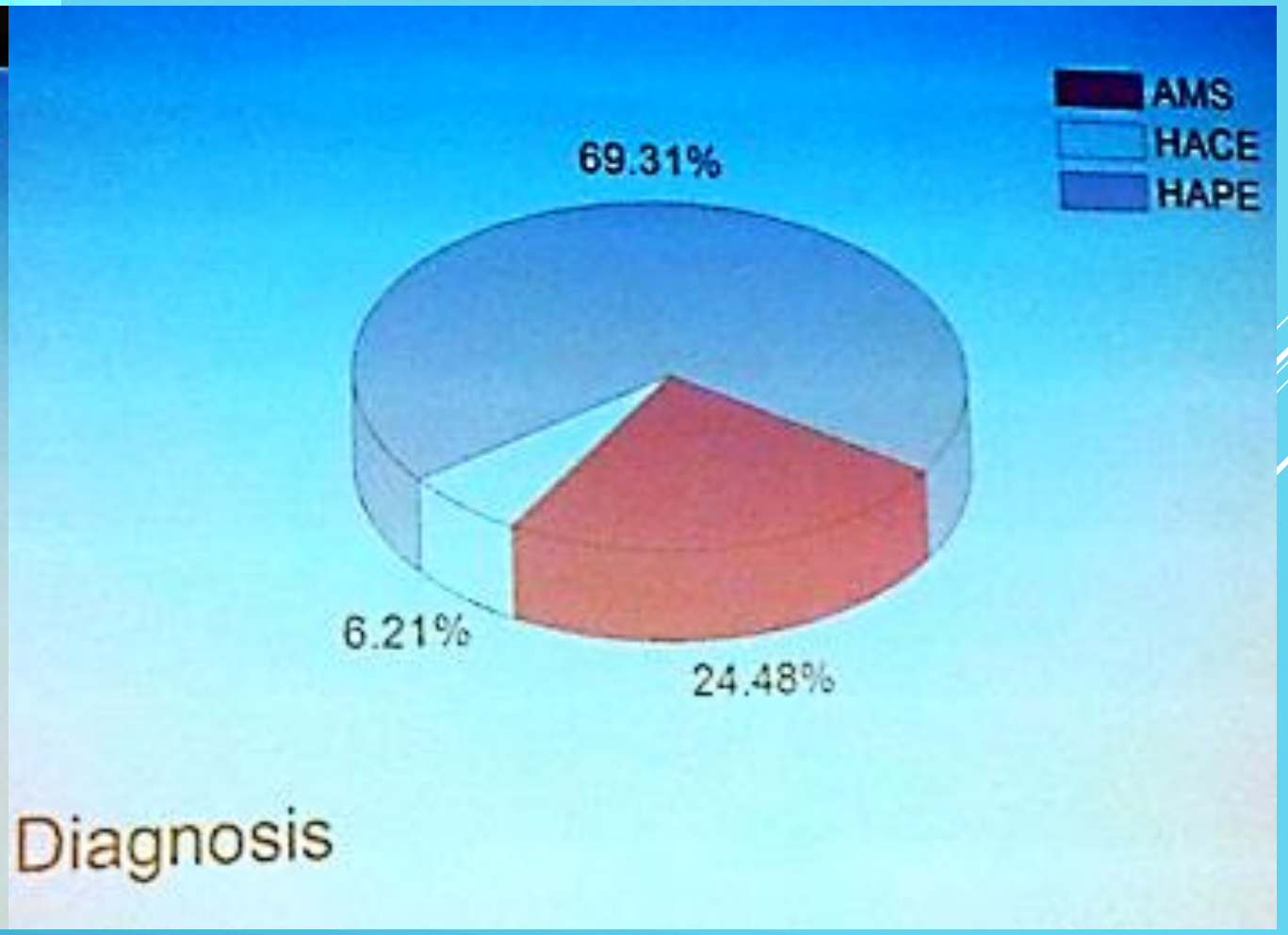
The PPARA haplotype was significantly associated with elevated

Conclusions

Multiple genes associated with high-altitude adaptation, three associated with [Hb] , and various HIF-related genes. Identification of these genes provides evidence for natural selection in Tibetan

Clinical characteristics of 280 cases of AMS from 2010.7 to 2012.7 in Yushu area (3870m-4350m)





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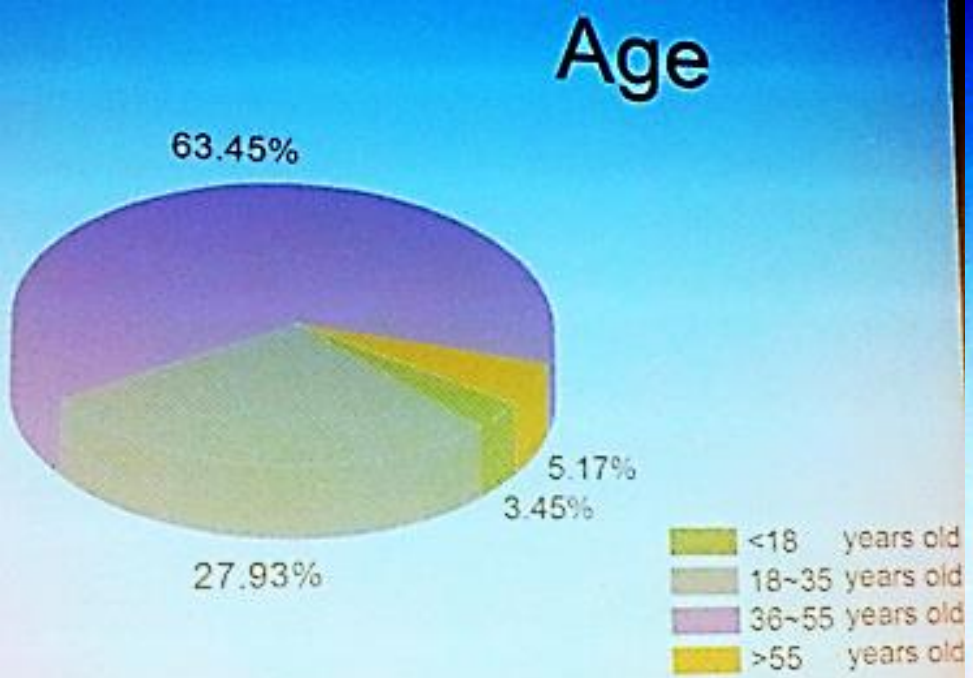
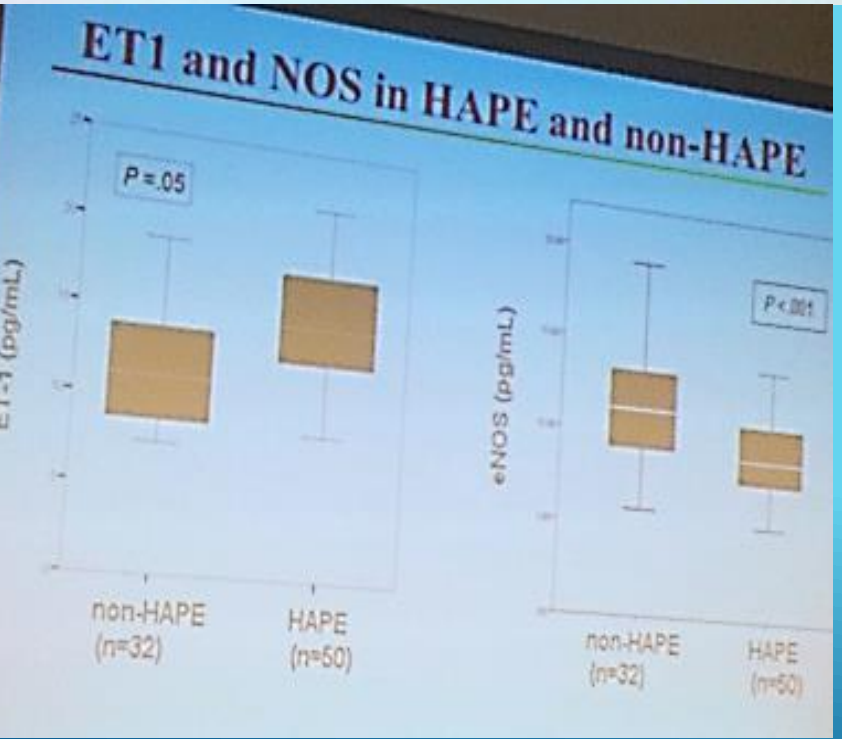
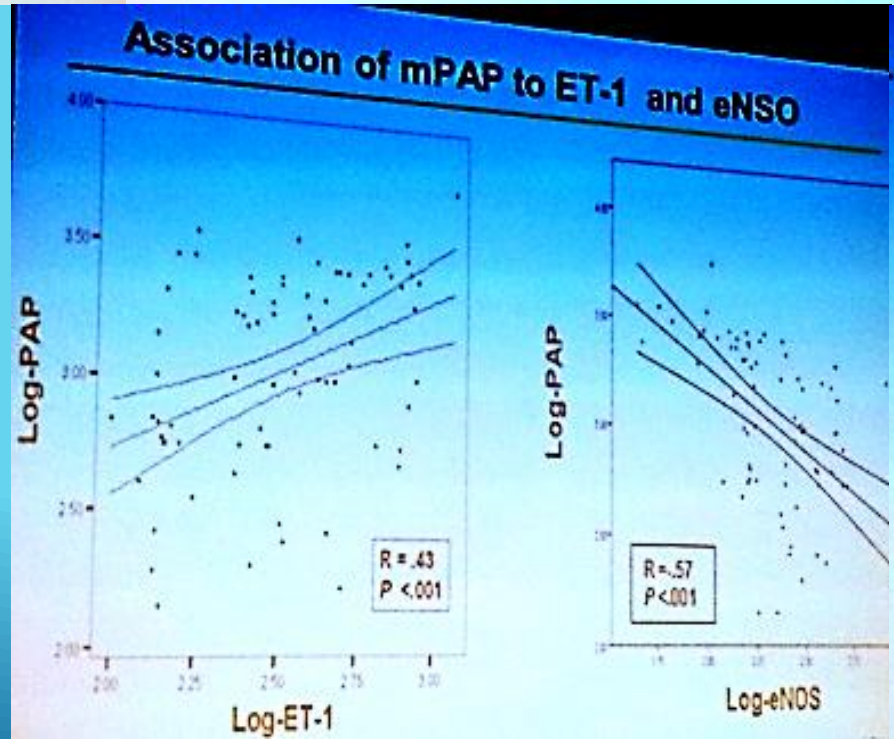
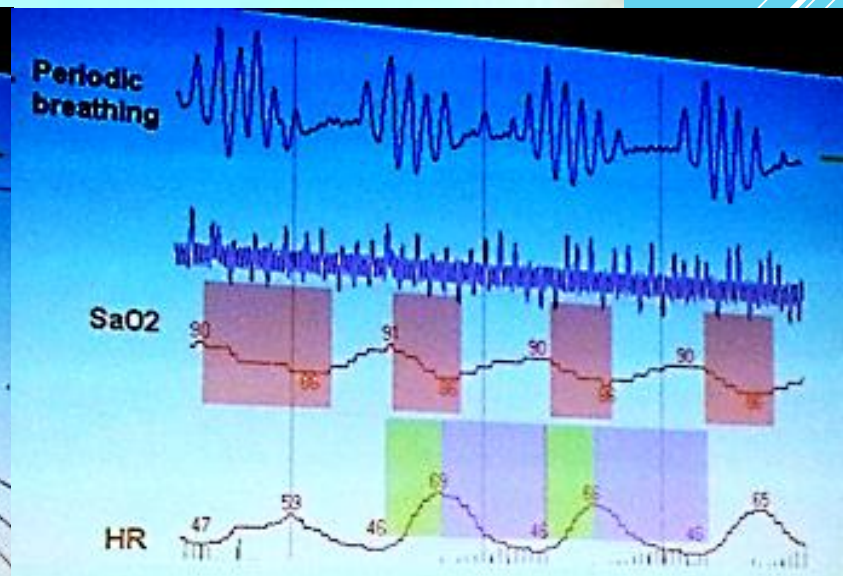


Blood gases analysis

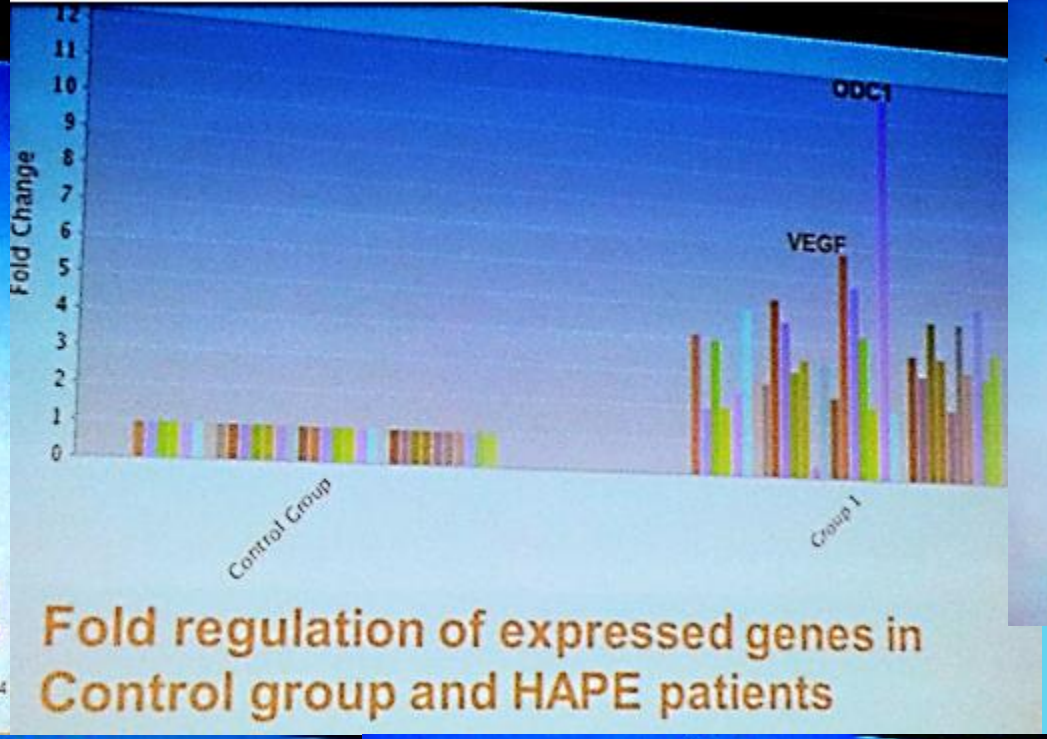
	HAPE (n=50)	non-HAPE (n=32)
pH	7.454±0.071	7.354±0.021**
PaCO2(mmHg)	30.64±6.02	35.7±5.8*
PaO2 (mmHg)	37.41±9.22	59.6±6.9**
HR (beats/min)	111.9±14.8	87.6 ± 13.9 **
WBC	10.85±4.71	7.24 ± 5.9*
RBC	5.43±1.02	6.53± 4.7
Hct (%)	54.16± 5.7	58.1± 3.8
PAP (mmHg)	40.87±7.47	27.4±6.7**

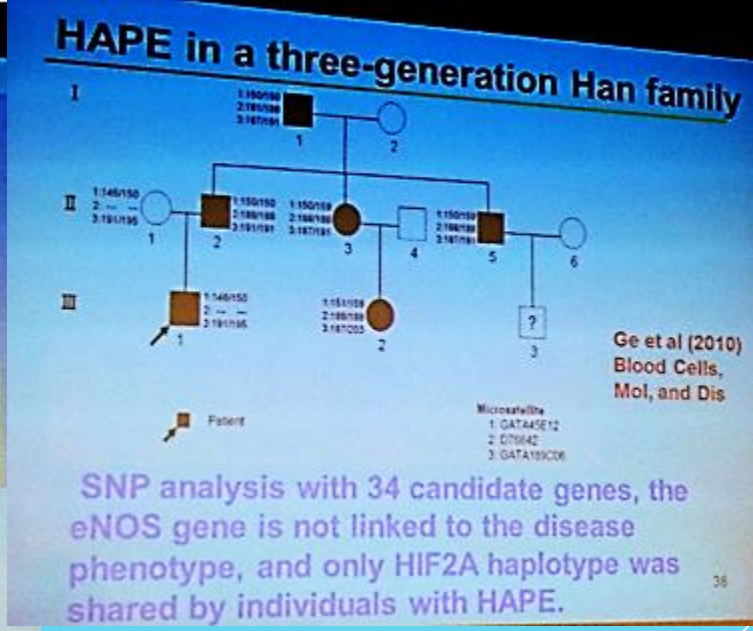


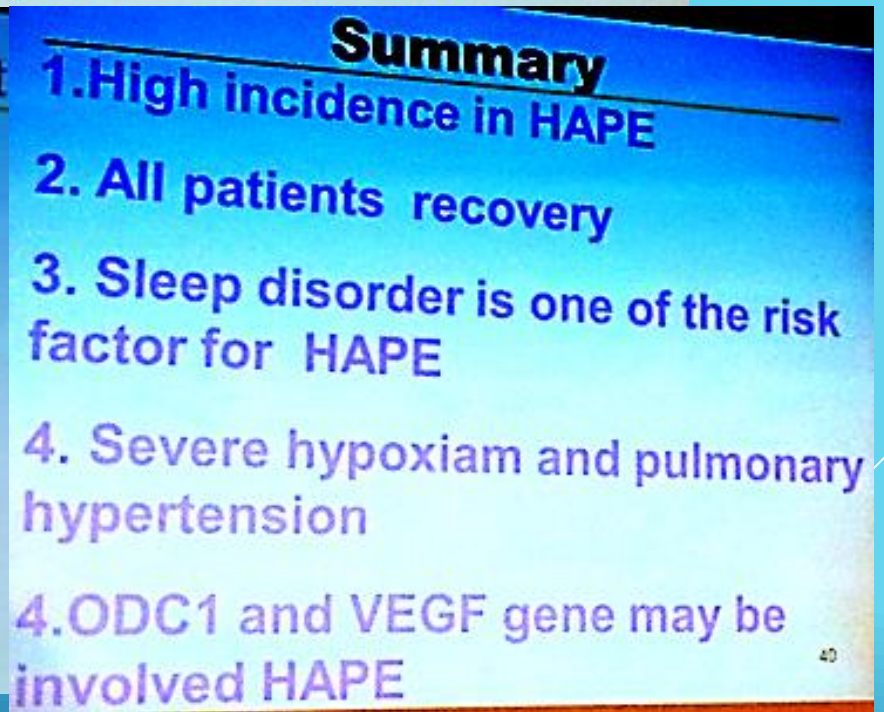




A 28-year-old male subject at 4300m, and sleep study indicated that periodic breathing with nocturnal desaturation.







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Research Center for High Altitude Medicine, Qinghai University, China

Main research areas:

1、Human adaptation to high altitude

2、Animal Adaptation to high altitude

3、Tibetan Medicine and High Altitude

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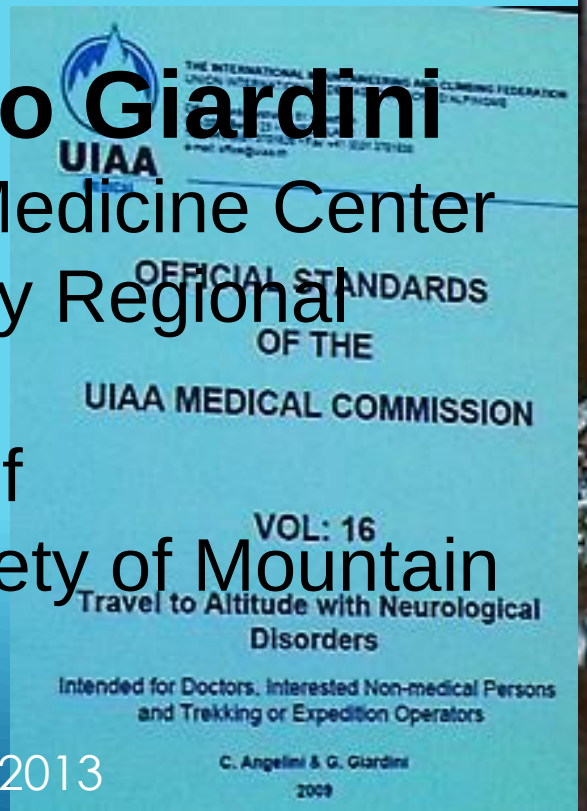
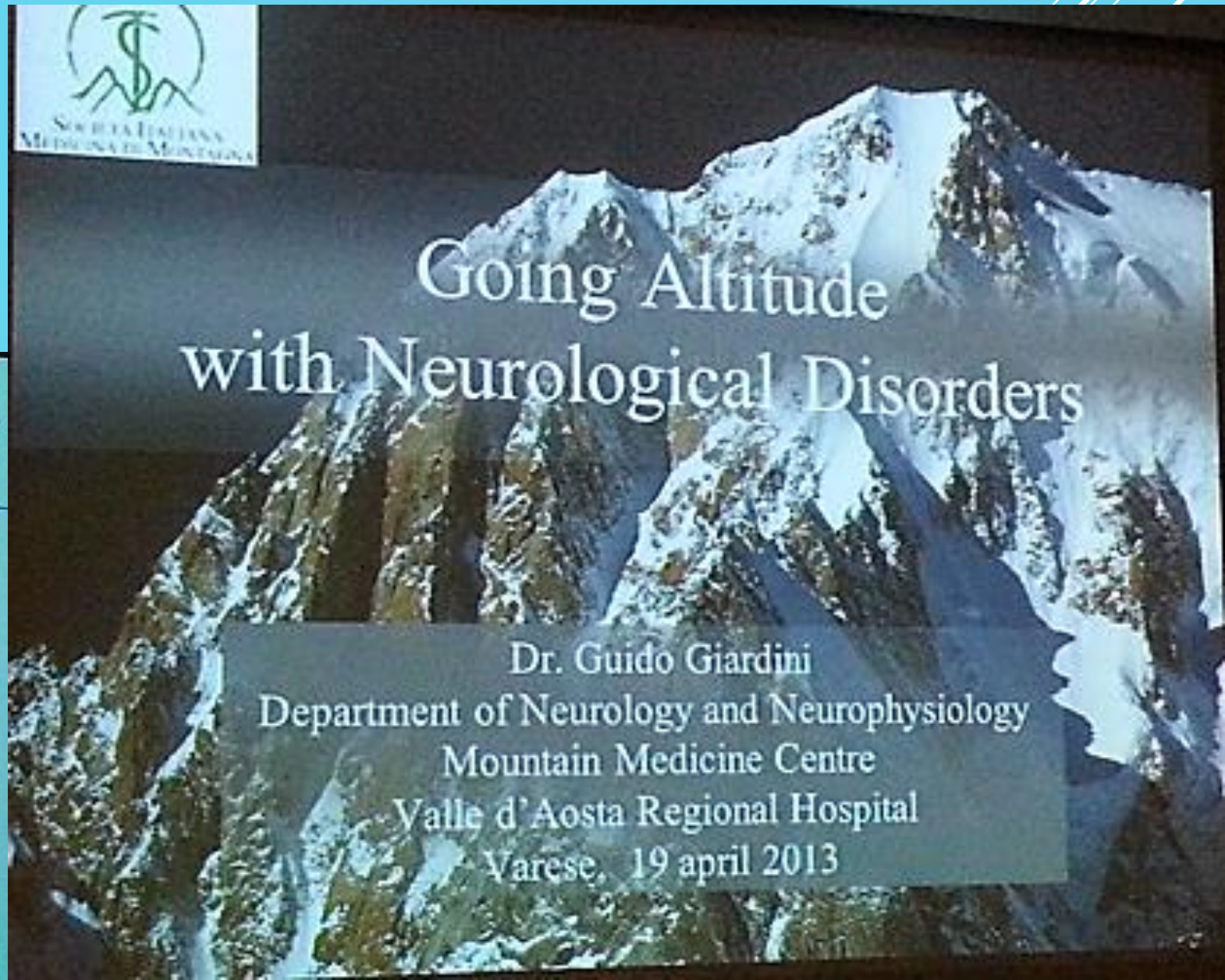
NEUROLOGICKÝ PACIENT VE VELKÉ VÝŠCE

Going Altitude with Neurological Problems



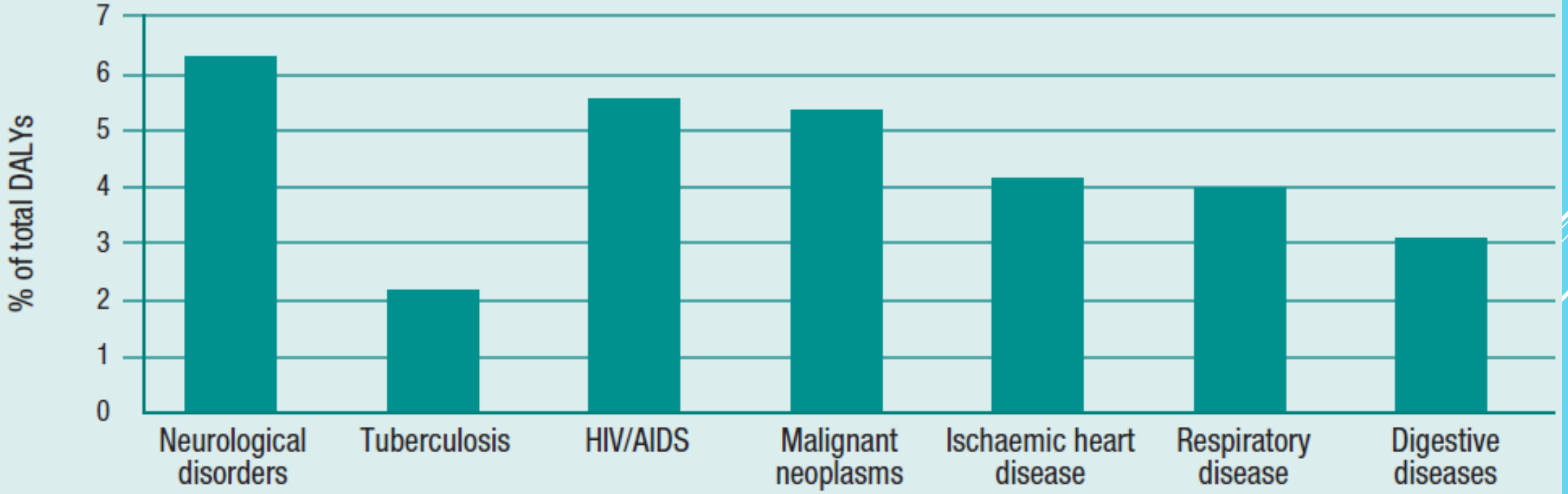
Dr. Guido Giardini
Mountain Medicine Center
Aosta Valley Regional Hospital
President of
Italian Society of Mountain Medicine



global burden of neurological disorders estimates and projections

disability-adjusted life year (DALY) overall disease burden number of years lost due to ill-health, disability or early death

Figure 2.1 Percentage of total DALYs for selected diseases[a] and neurological disorders[b]



[a] GBD cause categories
[b] Neuropsychiatric plus other categories

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global burden of neurological disorders
estimates and projections

Figure 2.2 DALYs for individual neurological disorders as percentage of total neurological disorders

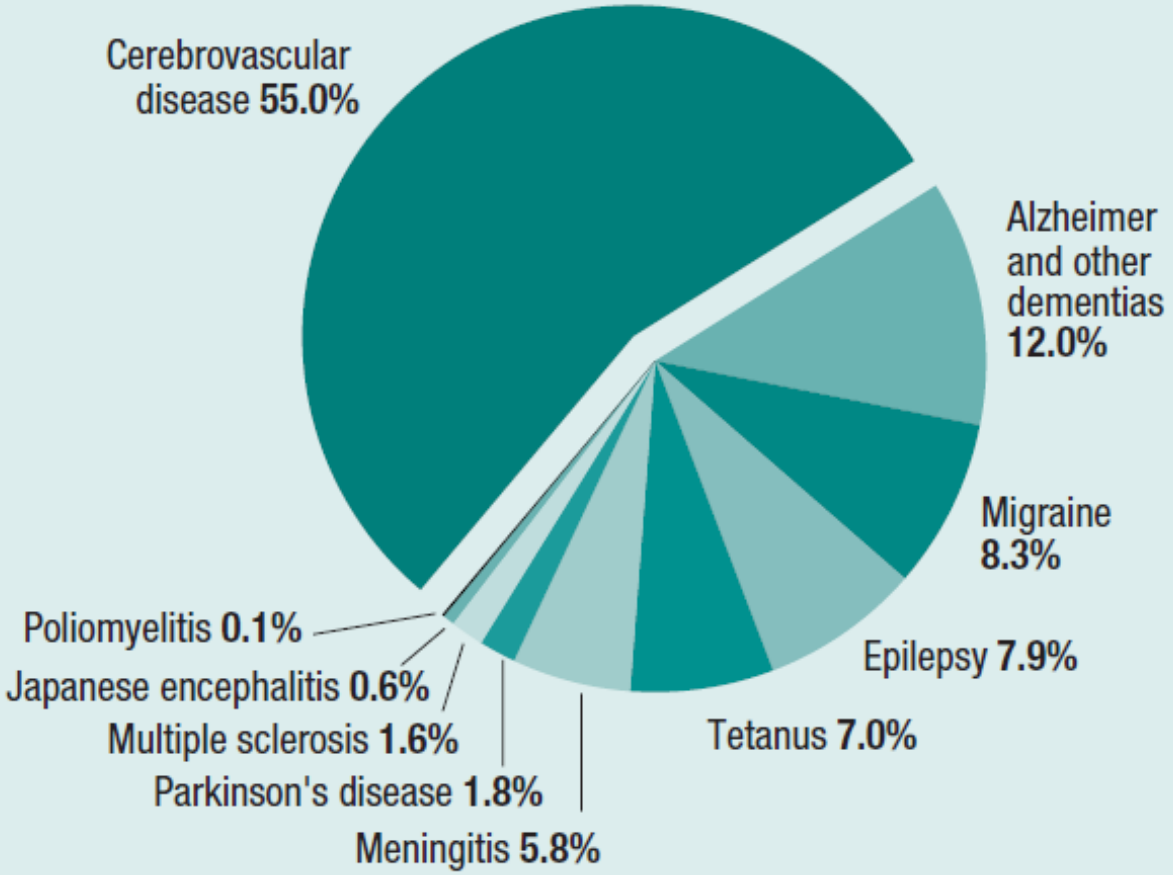
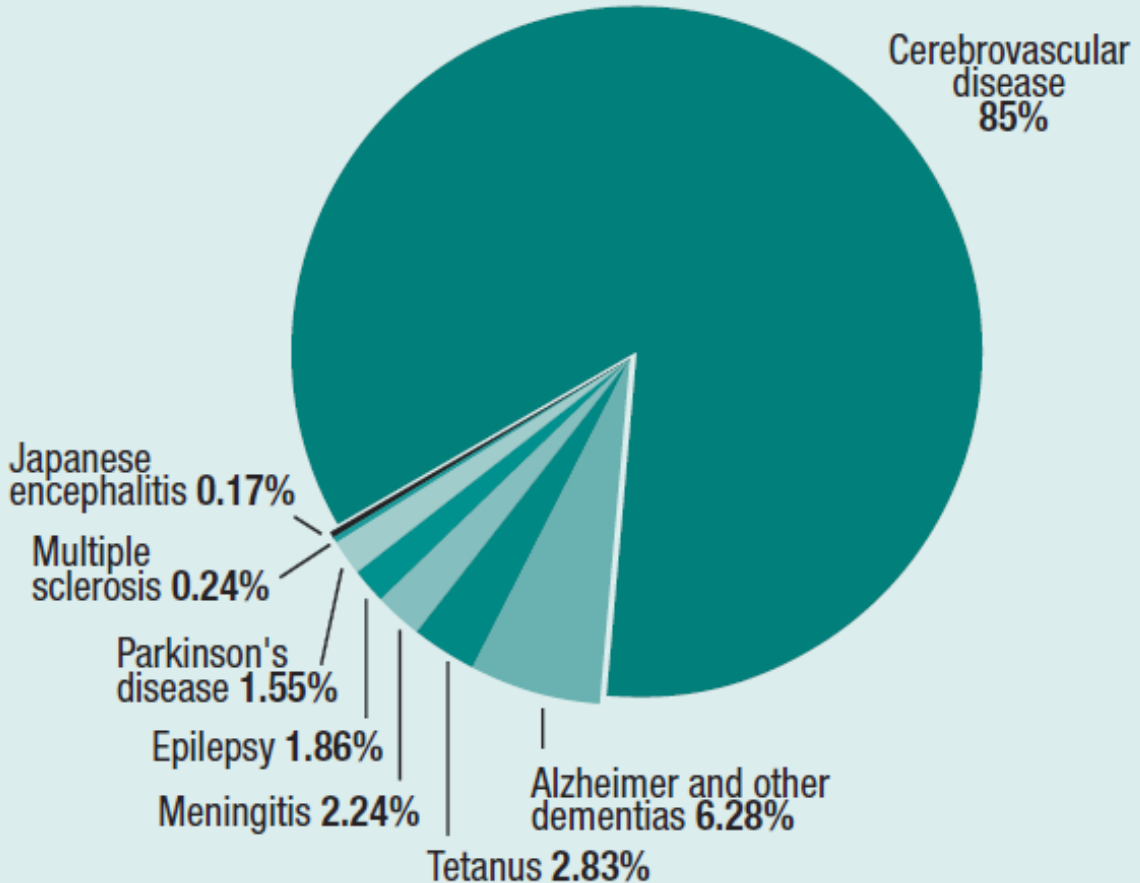
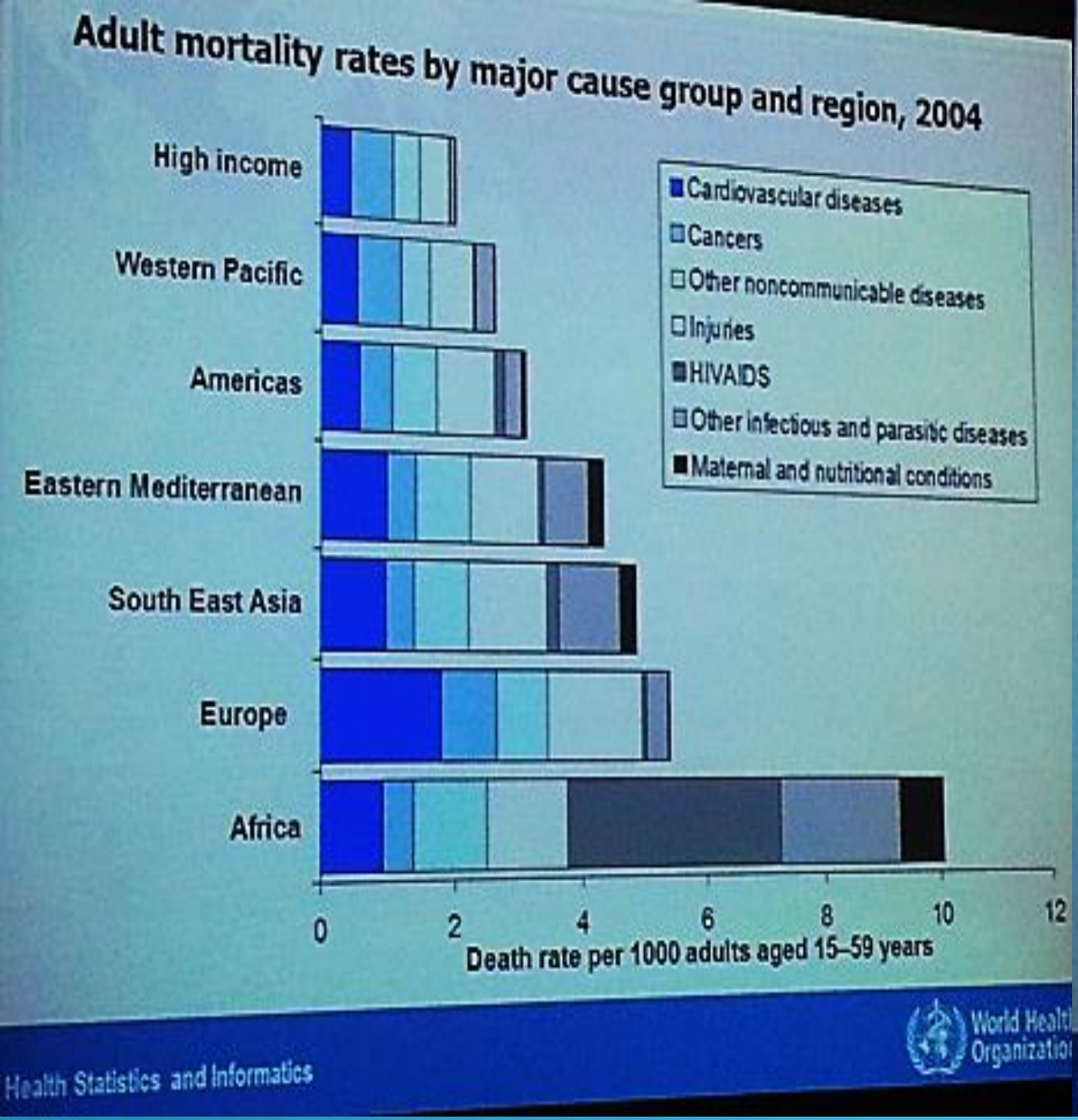
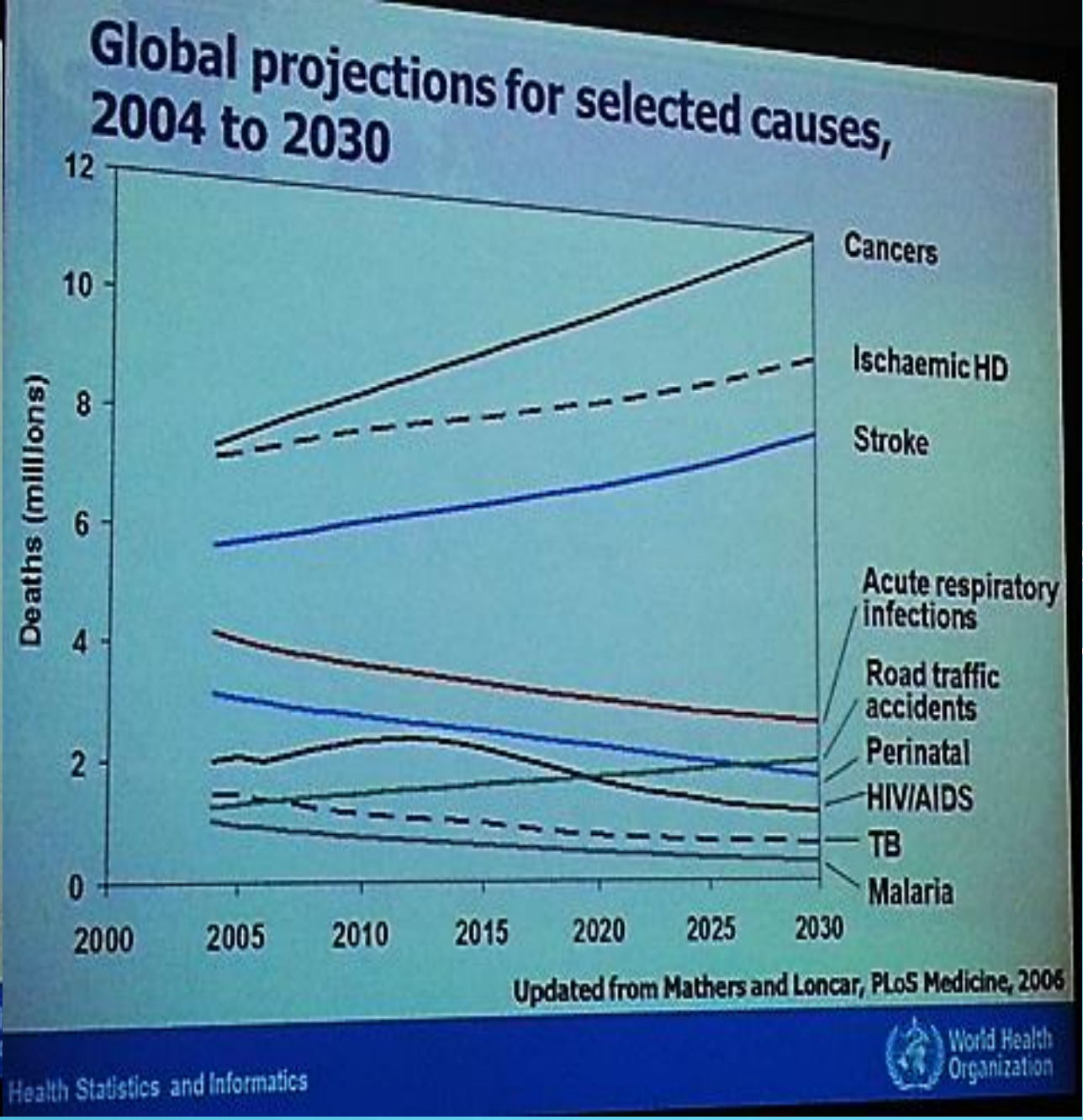


Figure 2.5 Deaths from selected neurological disorders as percentage of total neurological disorders



2013


Adult mortality rates by major cause group and region, 2004
High income
Western Pacific
Americas
Eastern Mediterranean
South East Asia
Europe
Africa
Cardiovascular diseases
Cancers
Other noncommunicable diseases
Injuries
HIV/AIDS
Other infectious and parasitic diseases
Maternal and nutritional conditions
0
2
4
6
8
10
12
Death rate per 1000 adults aged 15–59 years
Health Statistics and Informatics


Global projections for selected causes, 2004 to 2030
Deaths (millions)
0
2
4
6
8
10
12
2000
2005
2010
2015
2020
2025
2030
Cancers
Ischaemic HD
Stroke
Acute respiratory infections
Road traffic accidents
Perinatal
HIV/AIDS
TB
Malaria
Updated from Mathers and Loncar, PLoS Medicine, 2006
Health Statistics and Informatics

Neurological Diseases

- Epilepsy
- Space occupying lesions
- Migraine
- Cerebrovascular diseases
- Multiple sclerosis
- Neuromuscular disorders
- Neurodegenerative diseases
- Psychiatric disorders

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Epilepsy

The word Epilepsy is derived from ancient greek "ἐπιλαμβάνομαι" (epilambanomai) that means "to be attacked by surprise "

We distinguish:

- Partial or generalized epilepsy
- Idiopathic or symptomatic epilepsy

The prevalence in general population is about 5-7%

The incidence of isolated seizure 10%

Epilepsy and altitude

High altitude may cause epileptic seizures

Hypoxia can decreases epileptic threshold

In persons without history of epilepsy the altitude can trigger the first seizure

In those with epilepsy seizures may occur mostly if there's poor compliance for AE treatment.

What drug i can choose?

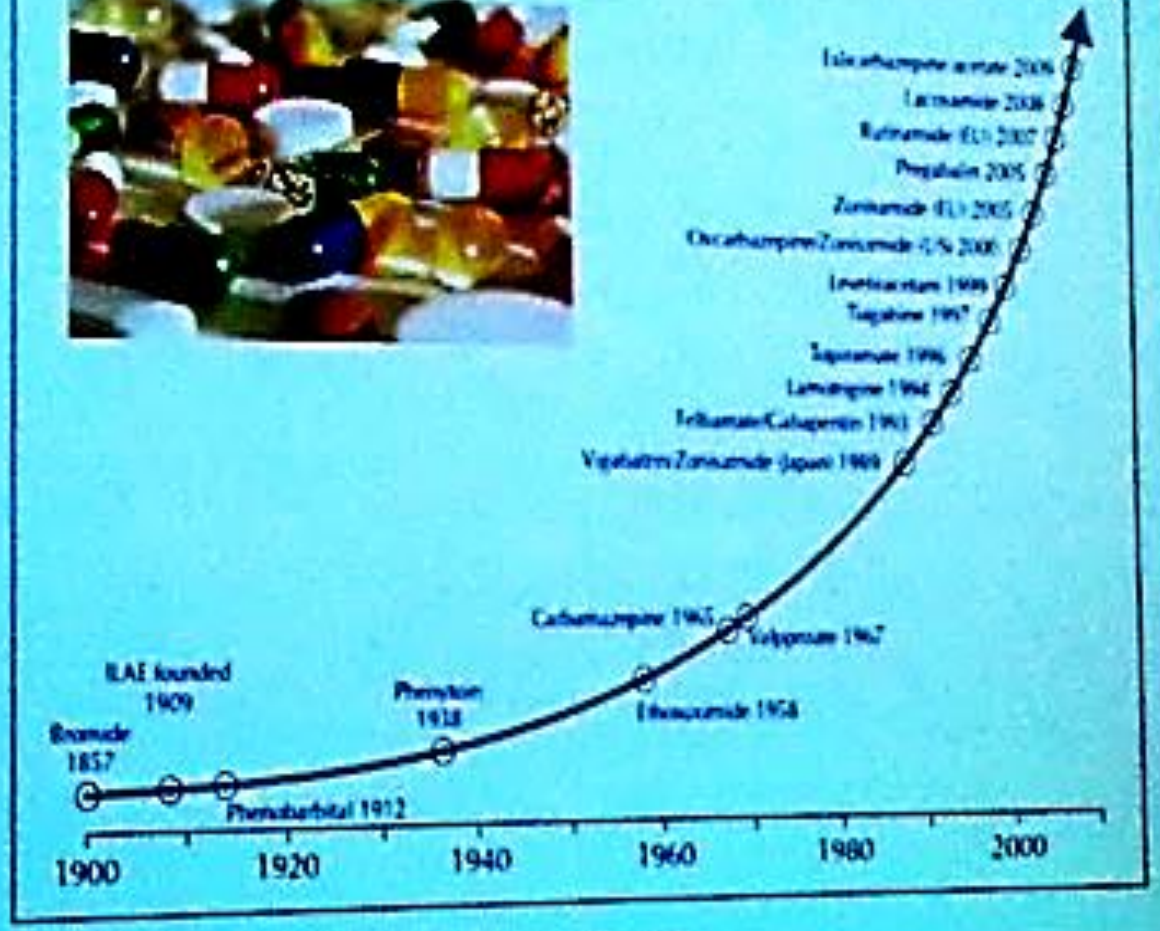

Figure 2. Timeline for antiepileptic drug development over the past 100 years.

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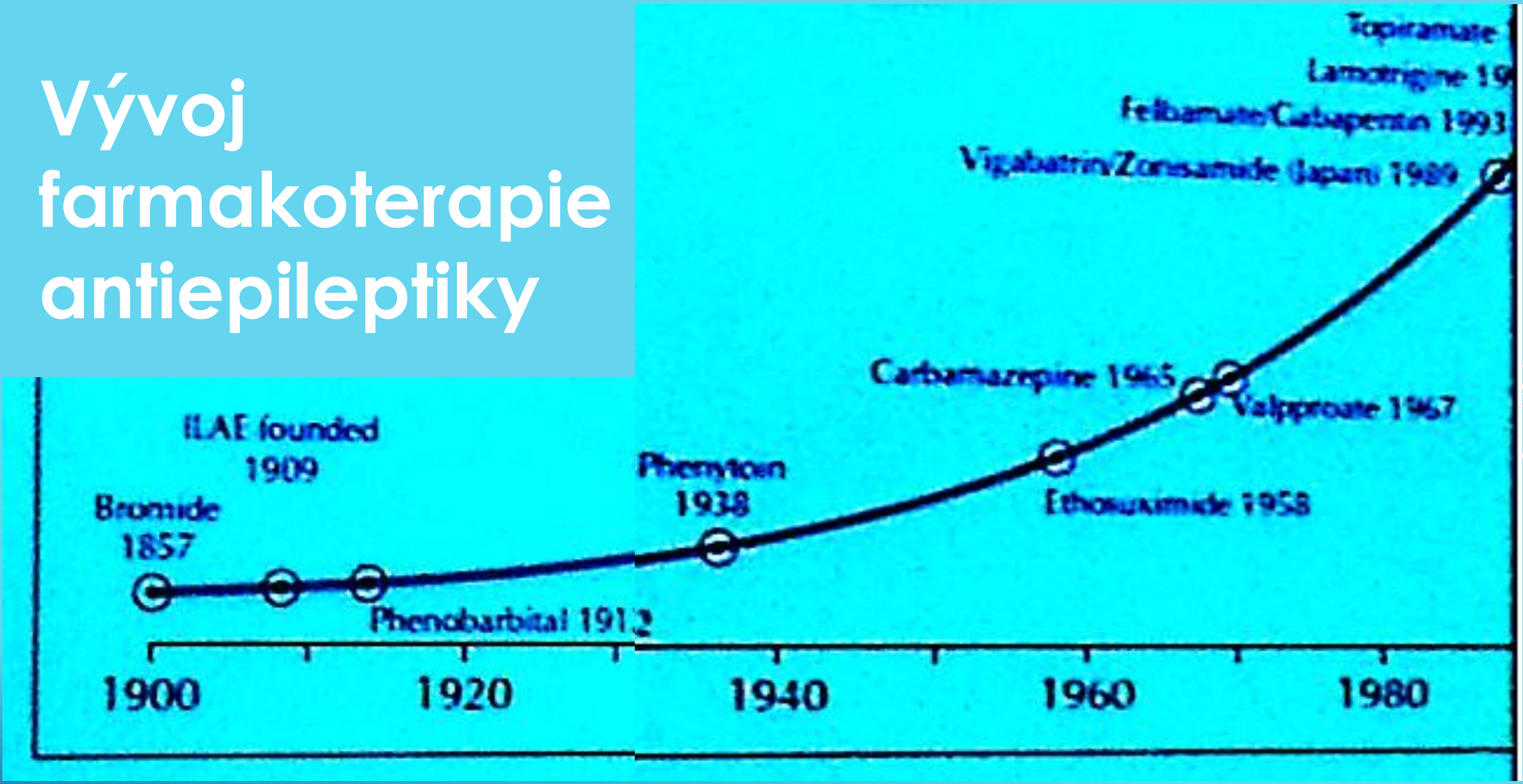
Vývoj farmakoterapie antiepileptiky



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464 THE NEW ENGLAND JOURNAL OF MEDICINE Mar. 2, 1972

1972

MEDICAL INTELLIGENCE

DRUG THERAPY

Drug Treatment of Convulsive Disorders

J. GORDON MILLICHAP, M.D., F.R.C.P.

SEIZURE PATTERN	ELECTROENCEPHALOGRAPHIC CORRELATES	MOST SPECIFIC THERAPIES
Grand mal & focal motor	Spikes, spike-&-wave & sharp waves	Phenobarbital, diphenylhydantoin & primidone
Petit mal	3/sec spike-&-wave	Acetazolamide, ethosuximide & trimethadione
Psychomotor	Temporal-lobe spikes & sharp waves	Primidone & methsuximide
Minor myoclonic & akinetic	Polyspike-&-wave & 2/sec slow spike-&-wave	Diazepam & primidone
Infantile myoclonic	Hypsarrhythmia	ACTH & diazepam

Giardini, 2013

NAMME, Varese 2013

Epilepsy ADVICE

- Avoid altitude if epilepsy is not stable (last seizure <6 months)
- Before departure to check AED level
- Don't stop or change their therapy before leaving
- To take acetazolamide (mostly with history of single seizure)
- If i must choose drugs: topiramate or zonisamide
- Avoid alcohol intake
- Sleep deprivation may be dangerous (AMS)
- Remember risk of trauma
- In many remote areas mountain rescue is very difficult if not impossible

NAMME, Varese 2013 **Giardini**, 2013

Intracranial space occuping lesions

Cerebral tumors or arachnoid cyst

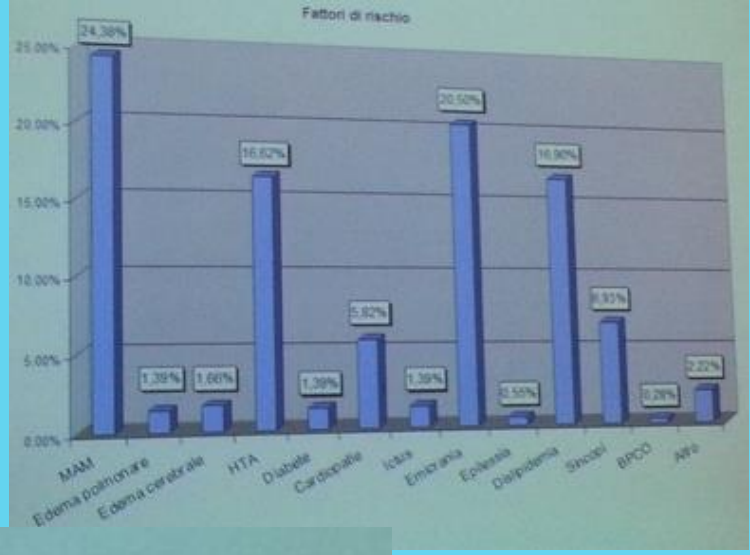
Symptomatic: AVOID altitude
Asymptomatic: CAUTION at altitude
In some case altitude can unmask lesion:
- increased volume
- peripheral edema
- decreased epileptic threshold

NAMME, Varese 2013

Giardini, 2013

Migraine

- The first cause of headache
- One of the leading causes of disability
- Prevalence in general population 12%
- 2 tipes of migraine
  - without aura
  - with aura



Migraine and AMS

	MAM+	MAM-
EMICRANIA+	18	39
EMICRANIA-	44	317

RR	2,59
OR	3,32
p	<0,0001

Giardini, 2013

Migraine ADVICE

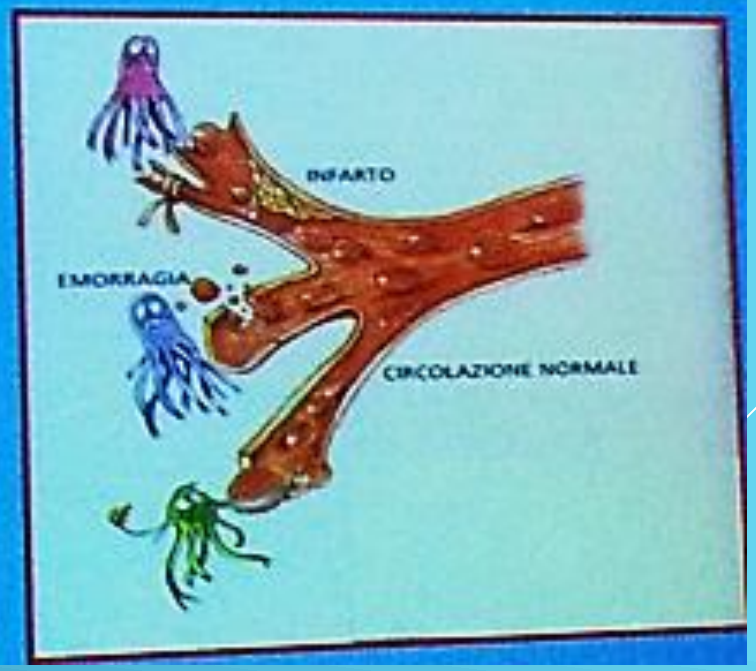
- A definite migraine diagnosis performed from a neurologist with experience in headache treatment is needed before leaving
- Every patient with migraine must be informed that his headache at altitude m worsen in frequency and/or intensity (hypoxia is a trigger factor)
- It's better to have in the backpack his own effective drug (aspirine, NSAIDs or triptans) and a second drug to take for eventual prevention treatment (e.g. flunarizine or topiramate)
- Recent data showed safety of triptans at altitude (also for AMS)
- Acetazolamide in people with migraine?

Migraine with aura ADVICE

- in case of migraine with aura we recommend before leaving:
  - Brain MRI with diffusion weighted study to disclose recent embolic subclinical strokes
  - Blood analisys to study prothrombotic state
  - Transcranial doppler monitoring to disclose a right to left shunt due to patent foramen ovale (also possible triggering of HAPE)
- Not only at altitude but also at sea level:
  - To stop smoke cigarettes
  - To stop take oral contraceptives
  - In case of PFO to take aspirine (100 mg/die) and to move legs frequently in very long flights (possible risk of deep vein thrombosis and the paradoxical embolism)

Cerebrovascular Diseases

- Stroke is the third cause of death and the first of disability
- Is defined as “a focal neurological deficit lasting more than 24 h”
- 2 types of stroke:
  - ischemic
  - hemorragic



ULTRAZVUKOVÁ DIAGNOSTIKA VE VELKÉ VÝŠCE A V HORSKÉ AKUTNÍ MEDICÍNĚ

Ultrasound Diagnoses at High Altitude and in Mountain Emergency Medicine

Giacomo Strapazzon

Institute of Mountain Emergency Medicine
Eurac Research
Bolzano

NAMME, Varese 2013

FAST ultrasonography

Point-of-care ultrasonography
in acute care medicine

Royse et al., Anesth Analg 2012

"The use of ultrasound in the acute care specialties of anesthesiology, intensive care, emergency medicine, and surgery has evolved from discrete, office-based [...] examinations to the real-time or point-of-care clinical assessment and interventions."

Dunham et al. Curr Ther Trauma Crit Care 2008

Focused Assessment with Sonography in Trauma

UPLATNĚNÍ SONOGRAFIE

"FAST" is an acronym for Focused Assessment with Sonography in Trauma and has become synonymous with beside ultrasound in trauma

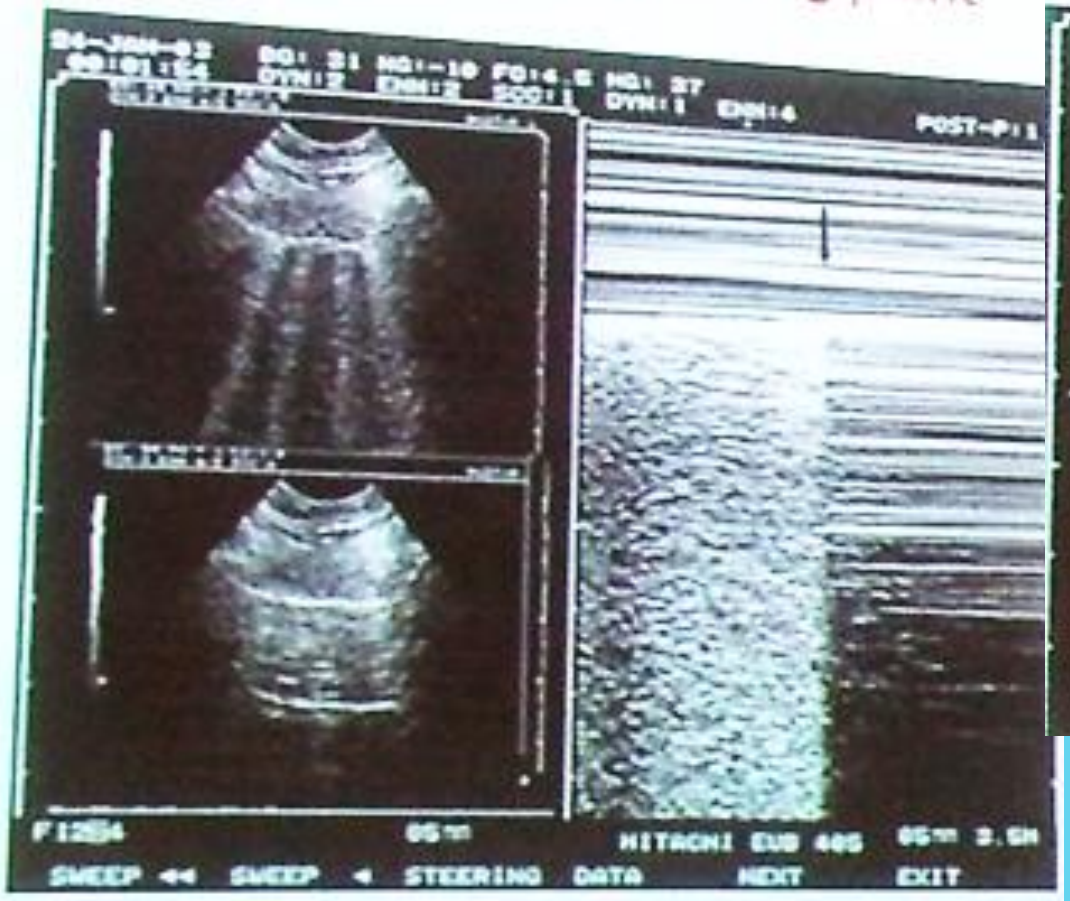
it is nearly perfect for recognizing intraperitoneal bleeding in hypotensive patients who need an emergent laparotomy and for diagnosing cardiac injuries from penetrating trauma

www.sonoguide.com/FAST.html

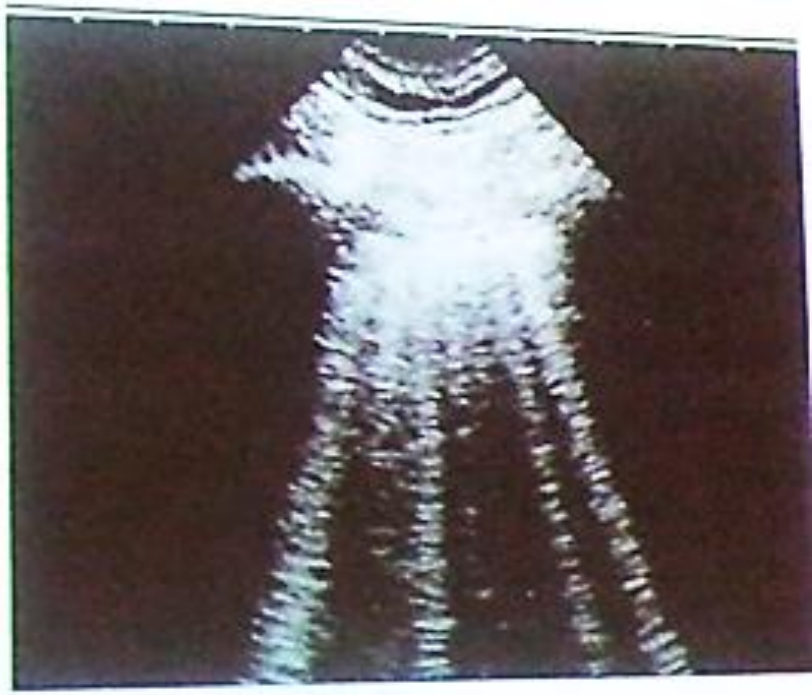
Ukázky

1.Hemodynamically unstable patients, when the cause of hypotension is unclear.
2.Patients who need an emergent bedside procedure.
3.Patients at a community hospital who require transfer to a trauma center. Consider pericardiocentesis if a pericardial effusion is found, consider early blood transfusion for significant hemoperitoneum, and consider a chest tube if a hemothorax or pneumothorax is discovered, especially if aeromedical transport is planned
4.Intoxicated patients who can be observed and re-examined.
5.Patients with penetrating trauma with multiple wounds or unclear trajectory, especially with wounds in upper abdomen or lower chest
6.Patients with a concerning mechanism of injury but no indication for CT. Consider a period of observation and serial FAST exams.

Lung ultrasound: the lung point



Lung ultrasound: the comet tail



Lichtestein, Crit Care Med 2007

NAMME, Varese 2013

Strapazzon, 2013

Lung ultrasonography

Agricola et al., Chest 2005

ULC is an accurate, non-invasive method to monitor extravascular lung water with a sensitivity of 87% and a specificity of 90%

ONSD ultrasonography

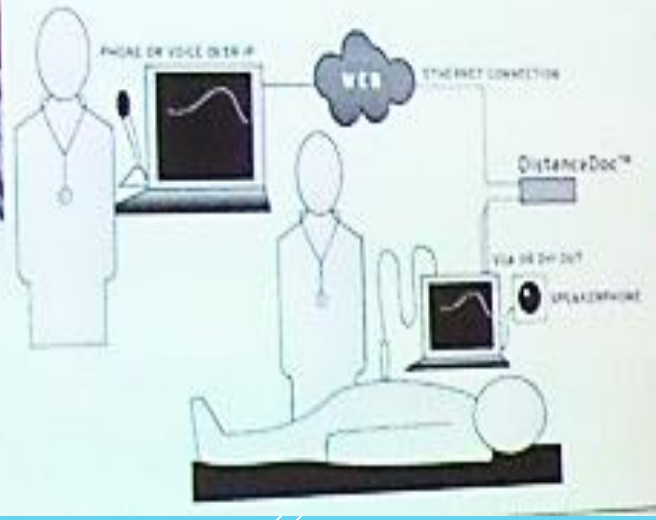
Geeraerts et al, Inr Care Med 2008

ONSD is an accurate, non-invasive method to monitor and acutely identify increased ICP with a sensitivity of 96% (95% CI 91-99%) and a specificity of 94% (95% CI 92-96%) for ICP >20 mm Hg

Cost-Effective Remote iPhone-Teathered Telementored Trauma Telesonography

McBeth et al., J Trauma 2010

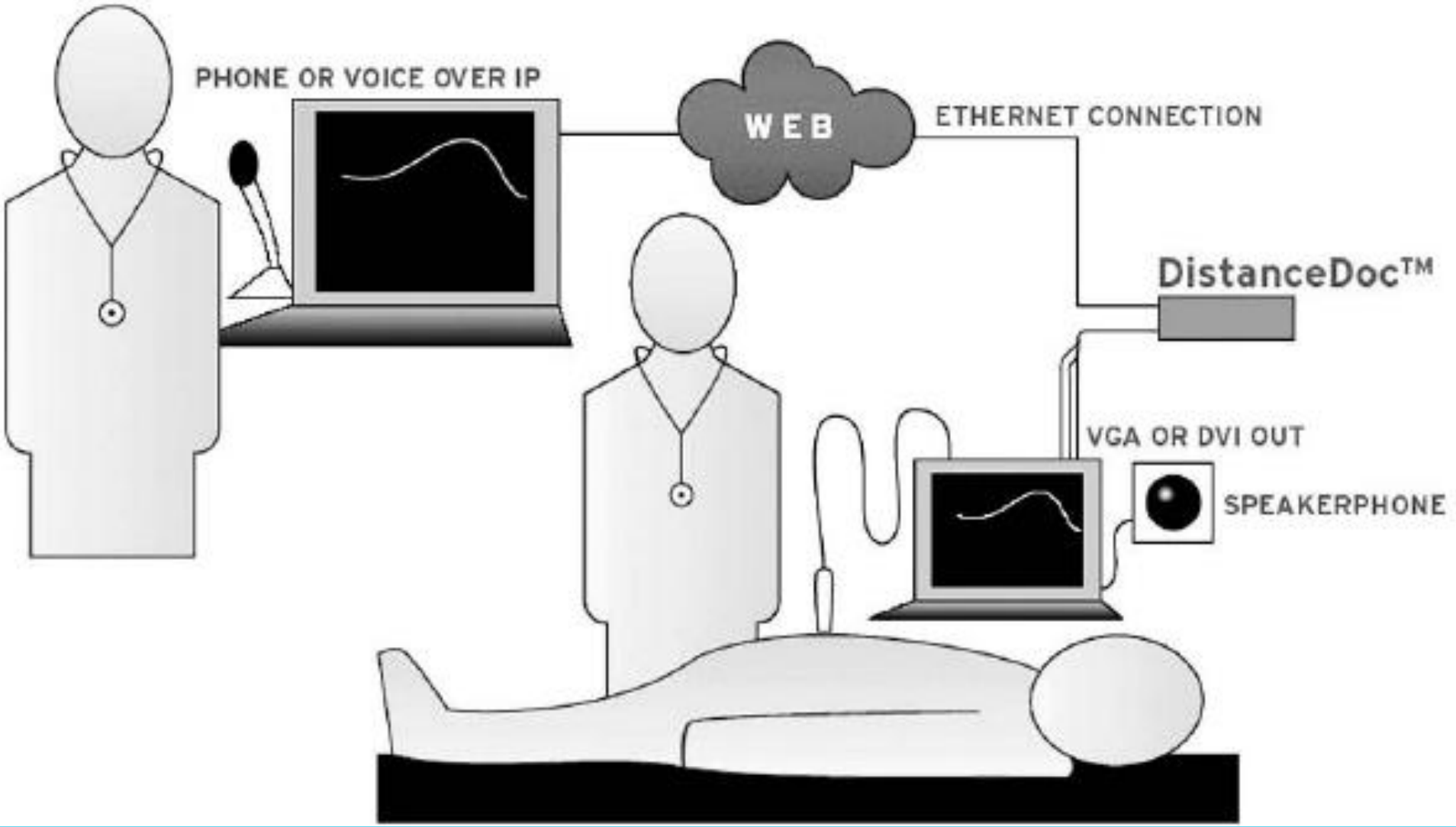
Into Thin Air: Extreme Ultrasound on Mt Everest



Otto et al., WEM 2008

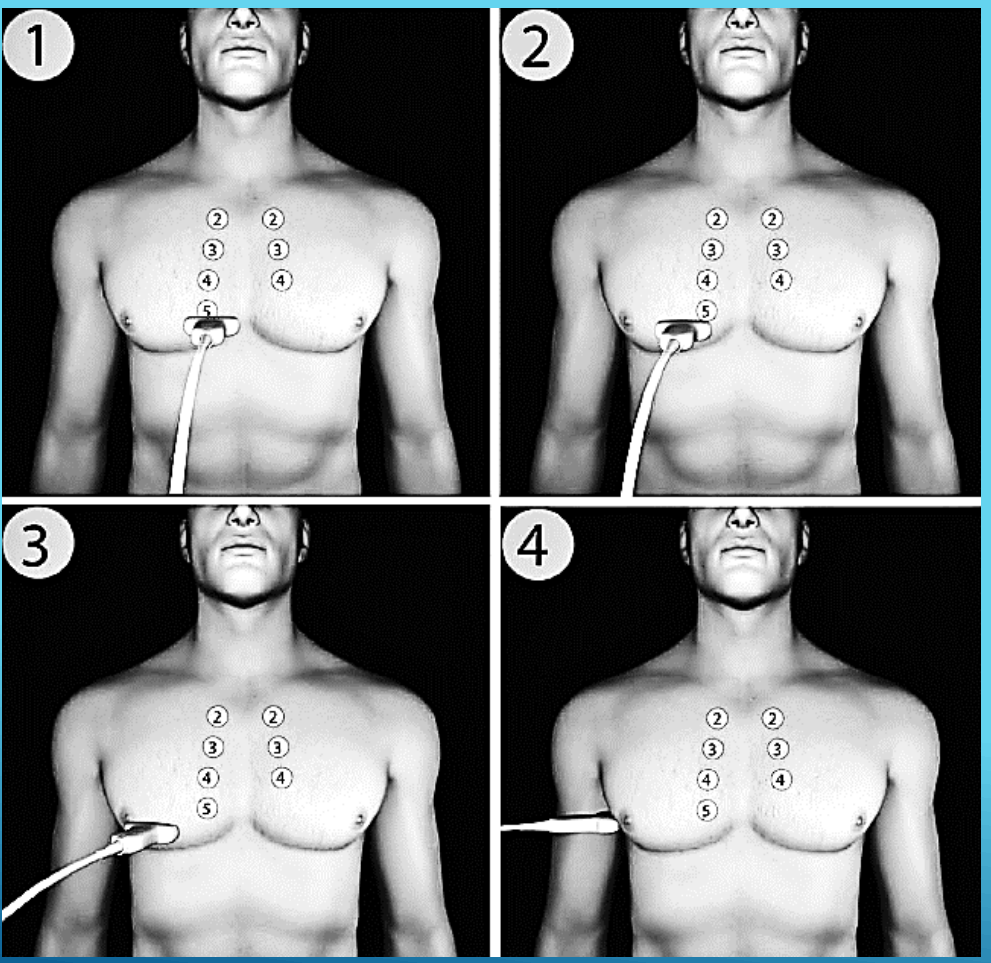
A nonexpert operator is performing a thoracic ultrasound examination on a fellow climber in a tent at Advanced Base Camp. The remote expert is seen on the computer screen in the background directing the examination.

Otto et al. Wilderness and Environmental Medicine, 20, 283–289 (2009)



Otto et al. Wilderness and Environmental Medicine, 20, 283–289 (2009)

Remote expert guidance of thoracic ultrasound examinations was done over the Internet using a satellite phone connection. The video output of the ultrasound device was compressed with a streaming device (DistanceDoc; Mediphan, Ottawa, Ontario) for real-time viewing by the remote expert.



A cue card was developed to help the operators perform the thoracic ultrasound examination.

The cue card used a color coded keyboard guide and external probe position starting points to streamline remote commands to the on-site operator.

Otto et al. Wilderness and Environmental Medicine, 20, 283–289 (2009)

ULTRAZVUK A TELEMEDICÍNA V DIVOČINĚ

Výhody ultrazvuku

- Přenosnost, nízká hmotnost, pohotovost
- Bezpečnost, bez ozařování, lze libovolně opakovat
- Relativně laciné
- Okamžitá data
- Snadná zvládnutelnost, a/nebo „přítel na telefonu“
- Možnost vyšetření více orgánů
- Vynikající pružnost pro aplikaci ve výzkumu i v klinice
- Možnost nových výzkumných studií

Omezení ultrazvuku

- Elektronické vybavení je choulostivé na chlad, prach, otřesy
- Zdroj energie (nebo dostatek baterií pro pobyt v terénu)
- Vyžaduje kvalifikaci resp. operátora on-line

NAMME, Varese 2013

Strapazzon, 2013

Ultrasound and telemedicine in the wilderness

Probe Type	Ideal Uses
Low-frequency (2-5 MHz) curved array (Excellent *depth* of imaging)	FAST examination Thoracic evaluation (for pulmonary edema) Cardiac views
High-frequency (8-10 Mhz) linear array (Excellent *resolution*, limited depth)	Foreign body location Thoracic assessment (for pneumothorax) Eye evaluation, optic nerve sheath assays Fractures

Auerbach, Wilderness Medicine 2012

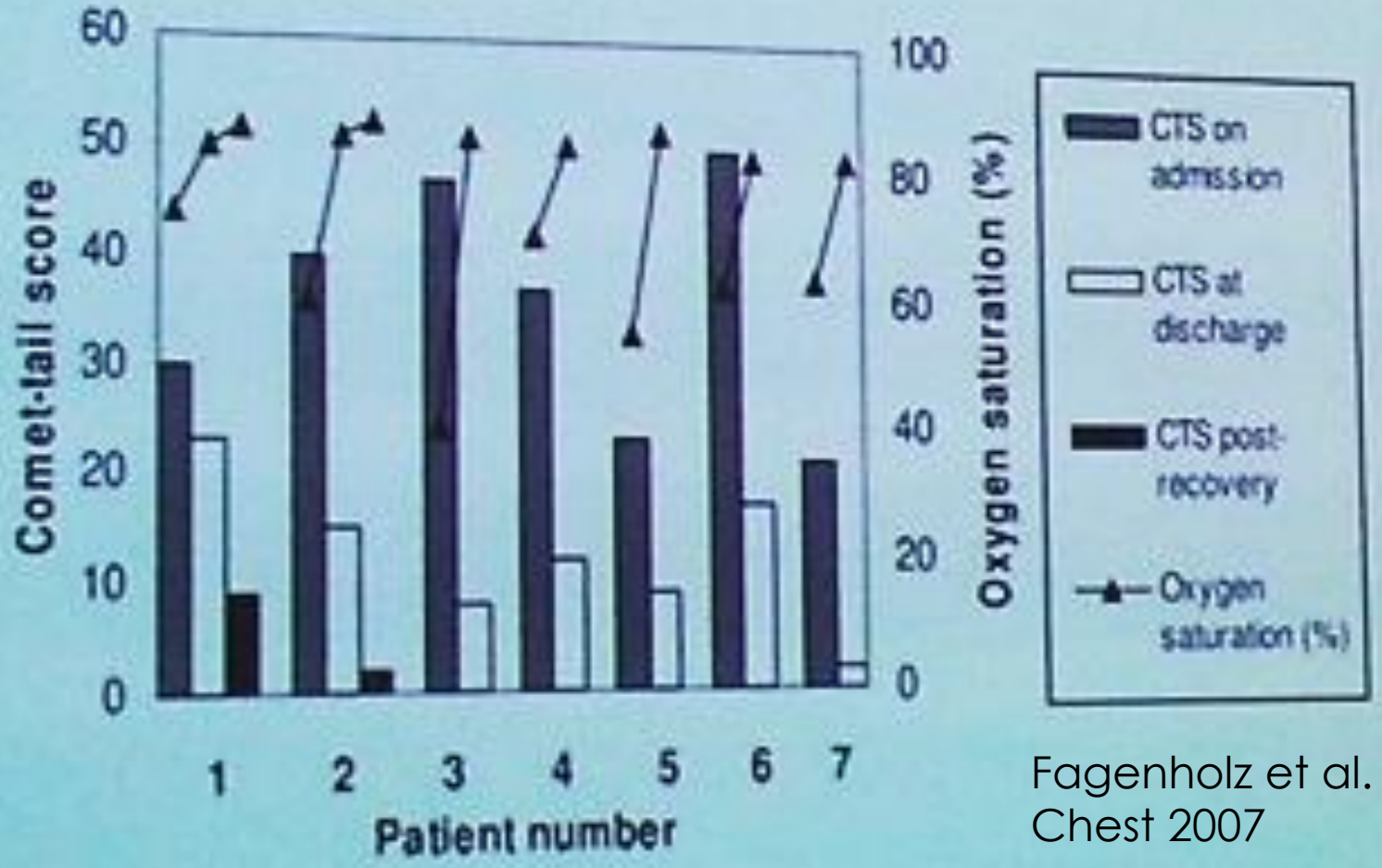
Selected ultrasound tecniques for high altitude research

Technique	Parameter evaluated	Specific machine capabilities	Transducer*	Time to perform	Ease to learn	References	Comment
B-line	Pulmonary edema	B-mode	1-5 MHz	3-5 min	Easy	Pratali 2010, Fagenholz 2007, Agricola 2005, Jambrick 2004	New, not extensively validated at altitude
Optic nerve sheath	Intracranial pressure	B-mode	7-10 MHz	3-5 min	Moderate	Fagenholz, 2009, Tayal 2007, Hansen 1997	High interobserver variability, technique still being refined
Transcranial Doppler	Cerebral blood flow†	Spectral and color Doppler	2 MHz	5 min	Moderate	Poulin 1996	Image cannot be acquired in many people
Transthoracic echocardiography	PFO sPAP†	PFO-second harmonic imaging sPAP- color Doppler	1-5 MHz for both	15-30 min for each	Difficult	PFO- Trevelyan 2006, sPAP-Alleman 2000	Requires extensive training
Venous compression	Lower extremity DVT	B-mode	7-10 MHz	5-10 min	Easy	Jang 2004	Good literature support in clinical settings for proximal DVT
Peripheral Doppler	Blood flow indices† Clot	Spectral and color Doppler	7-10 MHz or 1-5 MHz depending on site	5-10 min	Moderate	Polack 1998, Lewis 1998	Specific considerations depend on site being imaged
Inferior vena cava volume estimation	Central venous pressure	B-mode, M-mode	1-5MHz	3-5 min	Moderate	Kircher 1990, Lyon 2005, Tayal 2003	Stratifies subjects by CVP: <5, 5-10, 11-15, 16-20, >20 mmHg

PFO = patent foramen ovale; sPAP = systolic pulmonary artery pressure; DVT = deep venous thrombosis; CVP = central venous pressure.
* Specific frequency ranges vary by manufacturer.
† Specific software packages to perform all calculations of interest may need to be acquired separately for these applications.

Fagenholz et al. *US in Med & Biol* 2012

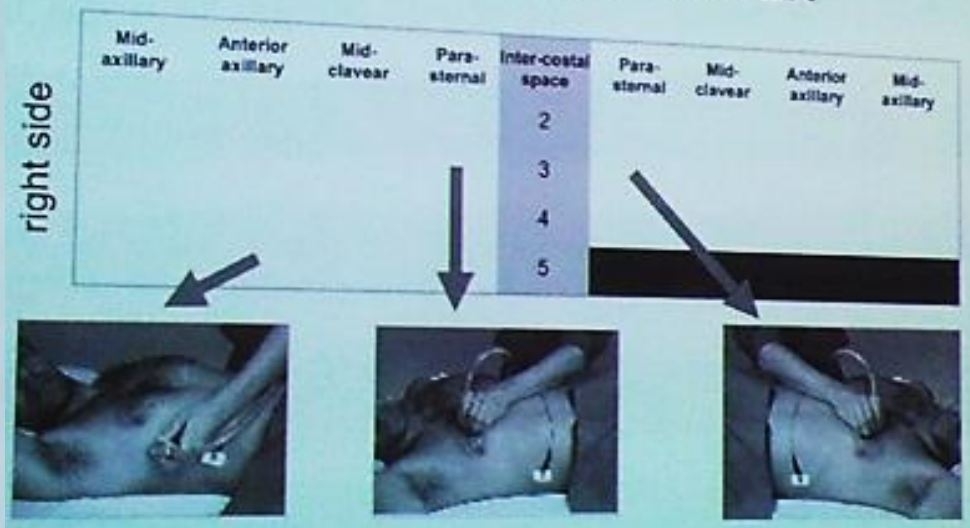
Chest Ultrasonography for the Diagnosis and Monitoring of High-Altitude Pulmonary Edema



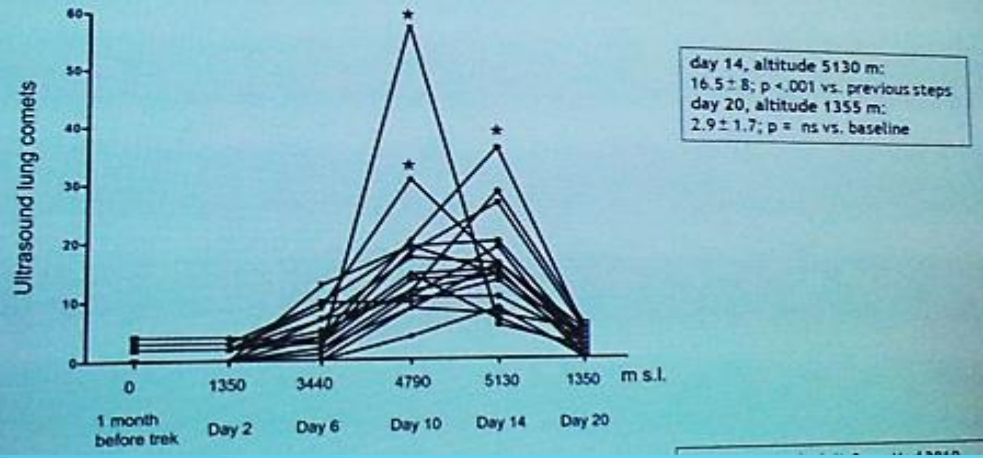
Fagenholz et al. Chest 2007

Lung ultrasonography

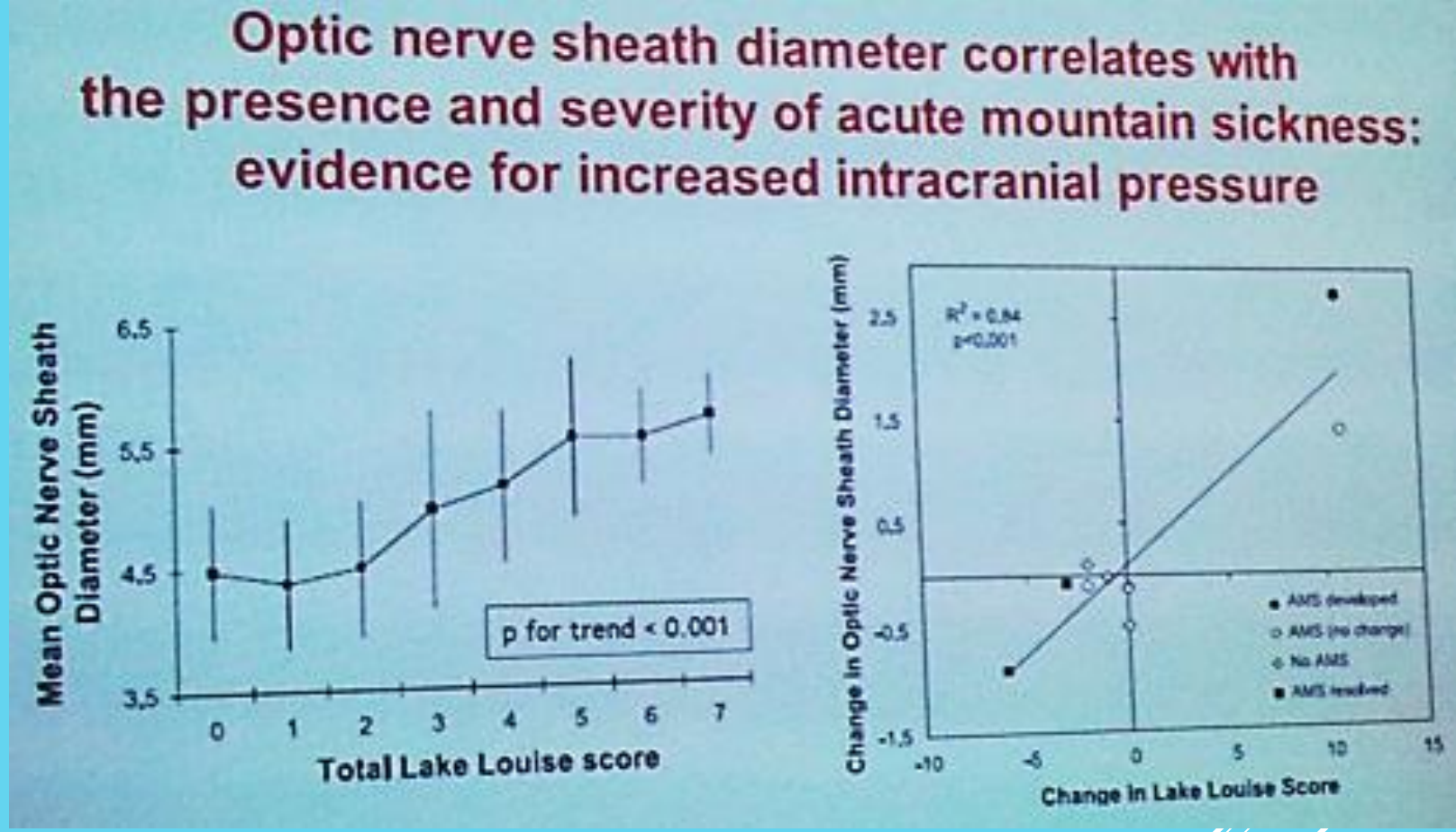
Anterior-lateral thorax



Frequent subclinical high-altitude pulmonary edema detected by chest sonography as ultrasound lung comets in recreational climbers



Pratali et al., Crit Care Med 2010



Fagenholz et al., HAMB 2007, J Appl Physiol 2009

Optic nerve sheat diameter

NAMME, Varese 2013

Strapazzon, 2013

Pre-hospital early diagnosis, monitoring and treatment from pathophysiology

Lung ultrasonography

HIGH ALTITUDE MEDICINE & BIOLOGY
Volume 12, Number 2, 2011
© Mary Ann Liebert, Inc.
DOI: 10.1089/ham.2011.0004

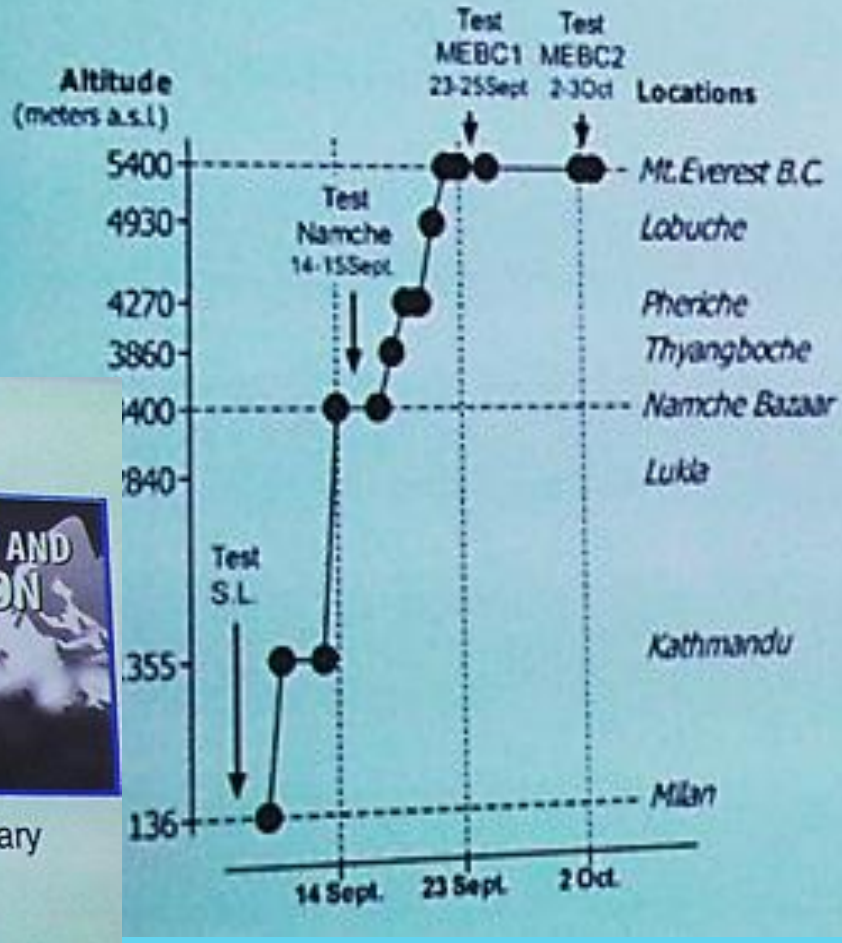
Pro: Most Climbers Develop Subclinical Pulmonary Interstitial Edema

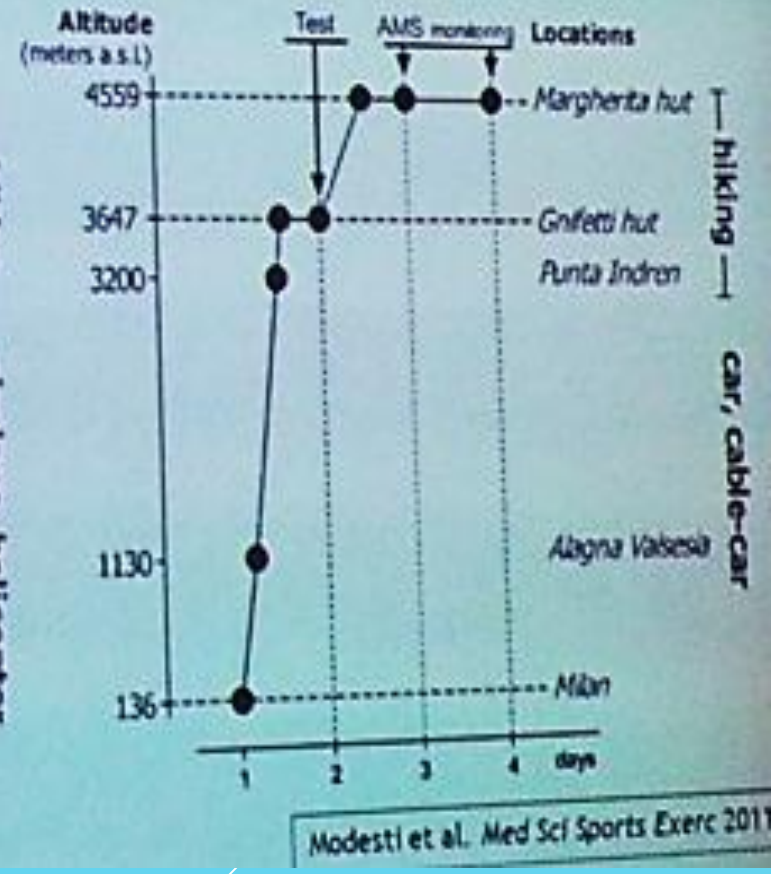
Annalisa Cogo[1] and Giuseppe Miserocchi[2]

CON: Most Climbers Do Not Develop Subclinical Interstitial Pulmonary Edema

NAMME, Varese 2013

Problems in data collection at high altitude: altitude exposure profile and physical effort

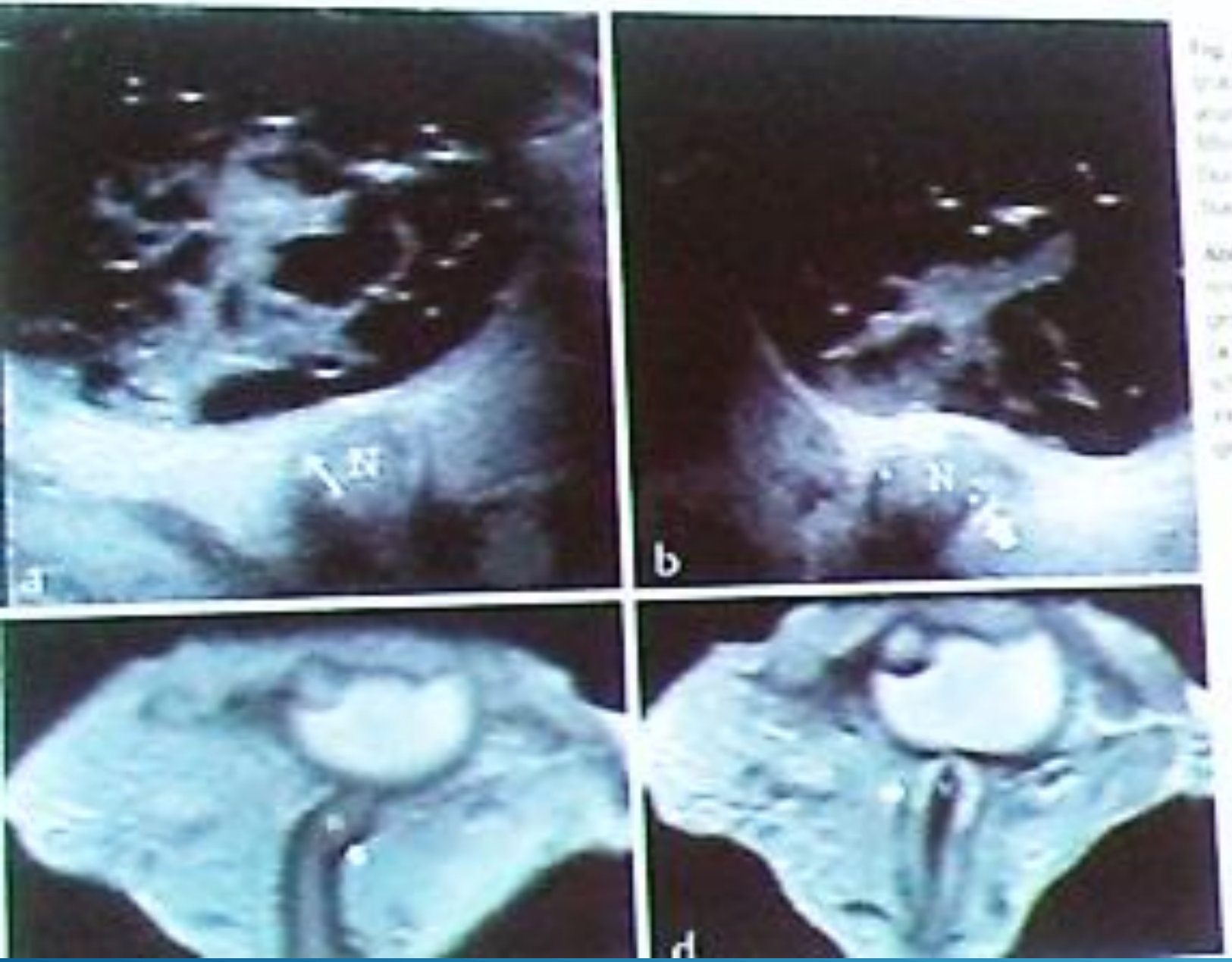




Modesti et al., Med Sci Sports Exerc 2011

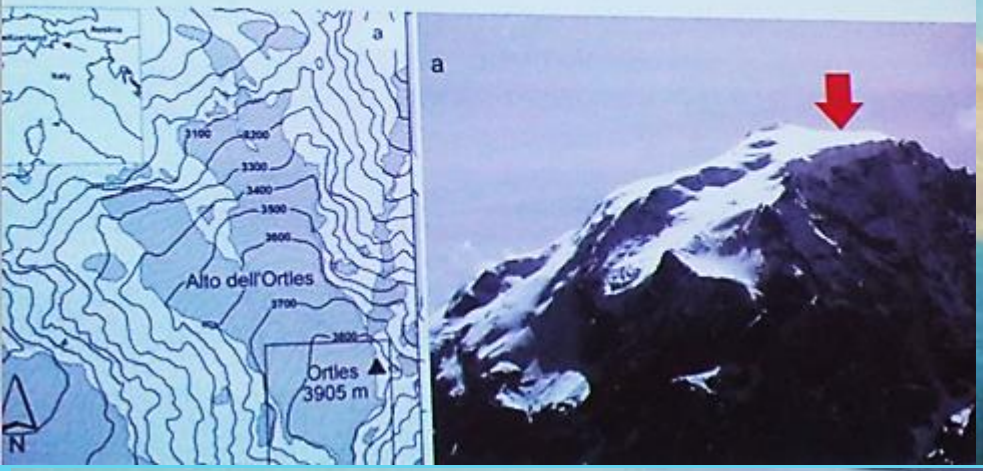
Strapazzon, 2013

ONSD ultrasonography

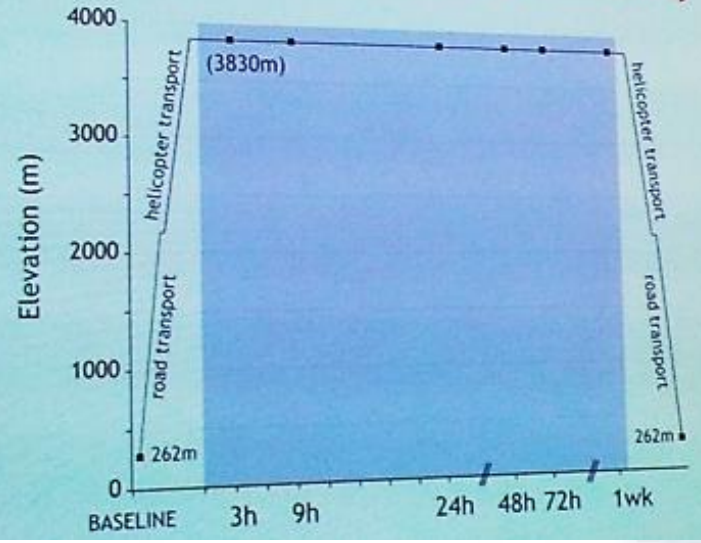


Steinborn et al., Ultraschall in Med 2011

Place: Mt. Ortles at 3830 m



A prospective design of the study, the control for confounding factors and the reproducibility



The course of SpO_2 during HA exposure

Strapazzon et al 2013

Lung ultrasonography

NAMME, Varese 2013

Lung ultrasonography

(18 subjects)

Time	Mean ULC	SD	p-value
0	2,1	4,3	
9 hours	8,0	9,1	0,016
24 hours	9,1	11,9	0,012
48 hours	6,0	7,1	0,008
72 hours	10,9	16,8	0,007
1 wk	8,2	8,0	0,043

Lung ultrasonography

rest vs.physical effort

Rest	N	Mean ULC 24h	SD	p-value
No	25	5,1	5,7	0,278
Yes	19	9,1	11,6	

Time course of asymptomatic interstitial pulmonary oedema at high altitude

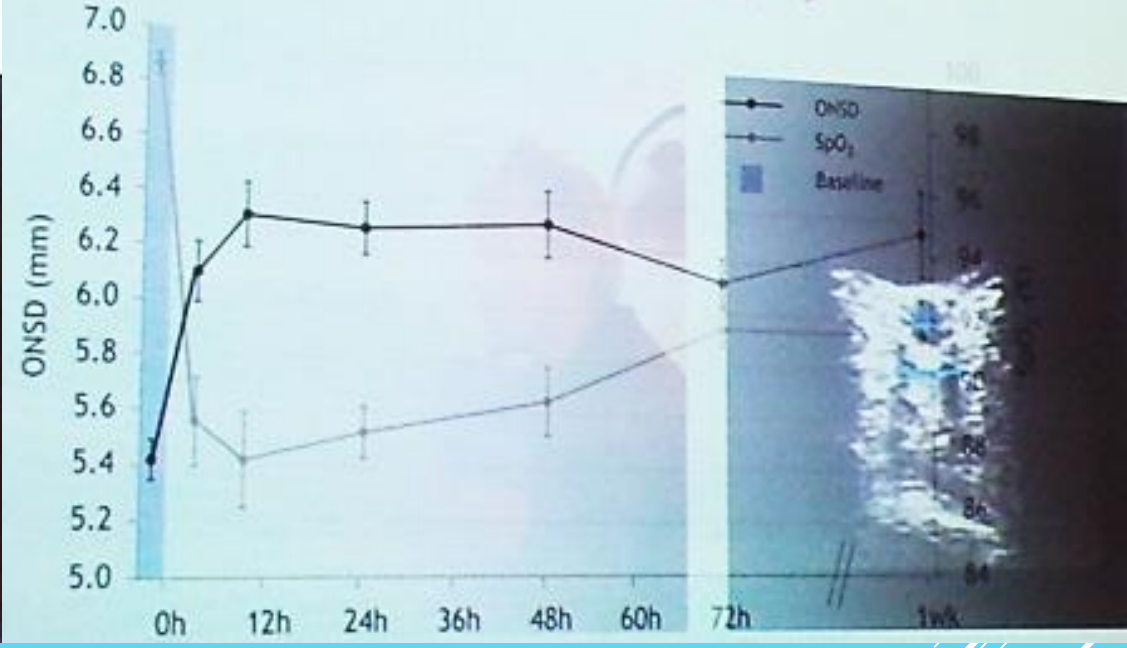
Bouzat et al.,
Respir Physiol Neurobiol 2013

All subjects had a significant increase in the number of USLC on day 1 (n=8±3), day 2 (n=7±4) and day 3 (n=3±2) compared to sea level (n=1±1) ($P<0.01$).

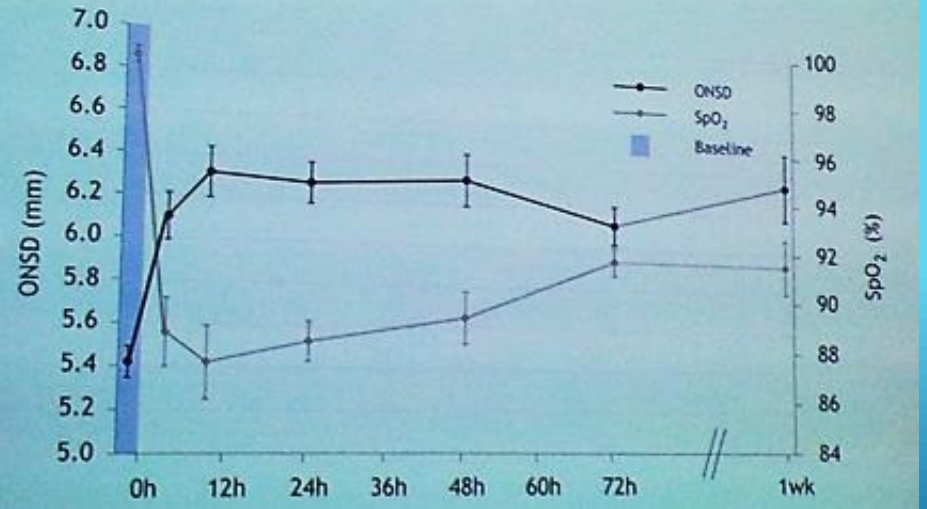
Although left ventricle diastolic function and systolic tricuspid regurgitation gradient were significantly different at altitude compared to sea level, they did not correlate with the number of USLC ($P>0.05$).

ONSD ultrasonography

ONSD and SpO_2 over 72h and 1 week at HA

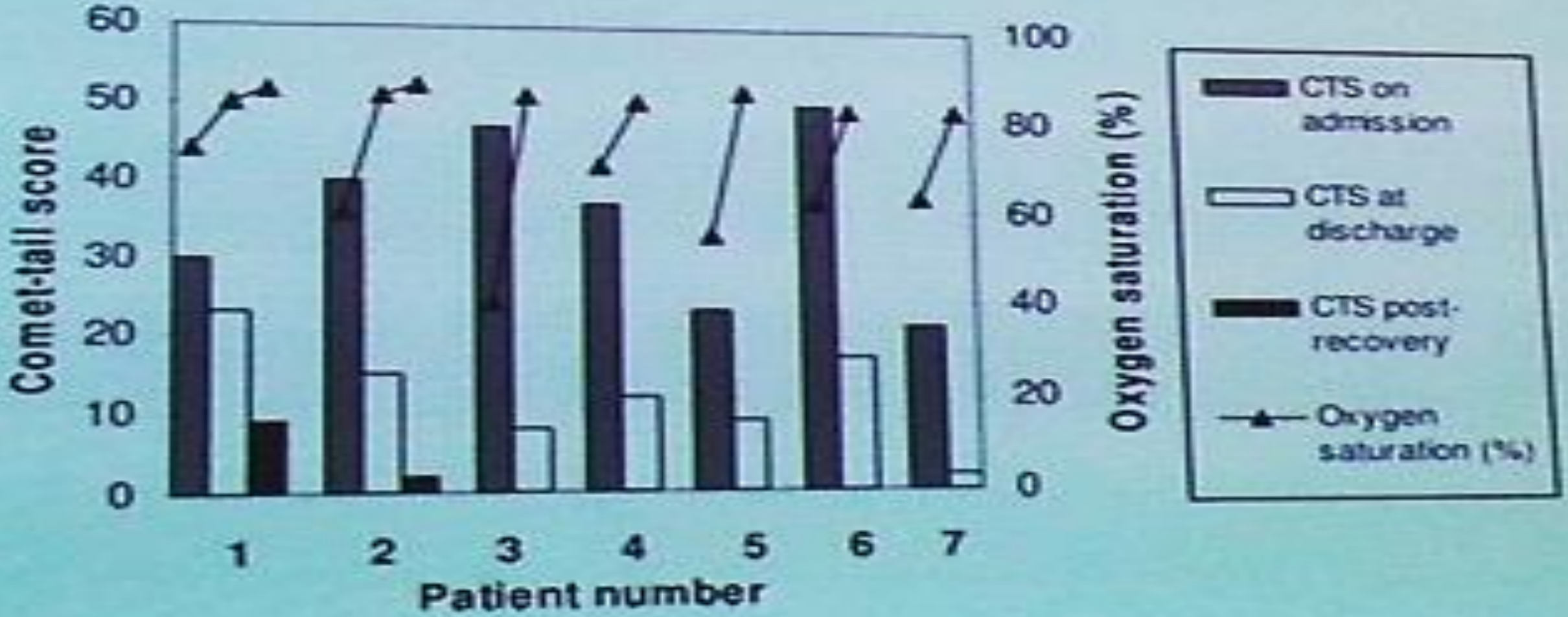


ONSD and SpO_2 over 72h and 1 week at HA



Strapazzon, 2013

Chest Ultrasonography for the Diagnosis and Monitoring of High-Altitude Pulmonary Edema



NAMME, Varese 2013 Fagenholz et al., Chest 2007 **Strapazzon**, 2013

A way to monitor therapy?

Variable	*Baseline*	*Arrival 4300 m*	*18 hours at 4300 m or too ill to continue*
Total n	57		
Male n (%)	29 (51)		
Age (years)	24 (range 18–70)		
Peripheral O_2 saturation (%)		81 (80.5–81.5)	85 (84.6–85.4)
LLS	0.4 (0.35–0.45)	1.7 (1.6–1.8)	2.2 (2.0–2.4)
LLS (median [IQR])	0 (0–1)	2 (1–2)	2 (0–3)
AMS n (%)			29 (51)
ONSD all subjects (cm)	0.40 (0.38–0.42)		0.42 (0.40–0.44)
ONSD well (cm)	0.41 (0.38–0.44)		0.40 (0.37–0.43)
ONSD well after 30 min of O_2 (cm)	0.41 (0.35–0.46)		0.40 (0.38–0.42)
ONSD AMS+ (cm)	0.40 (0.38–0.42)		0.43 (0.41–0.45)*
ONSD AMS+ after 30 min of O_2 (cm)	0.37 (0.34–0.40)		0.41 (0.39–0.43)†

AMS, acute mountain sickness; IQR, interquartile range; LLS, Lake Louise Score; ONSD, optic nerve sheath diameter.

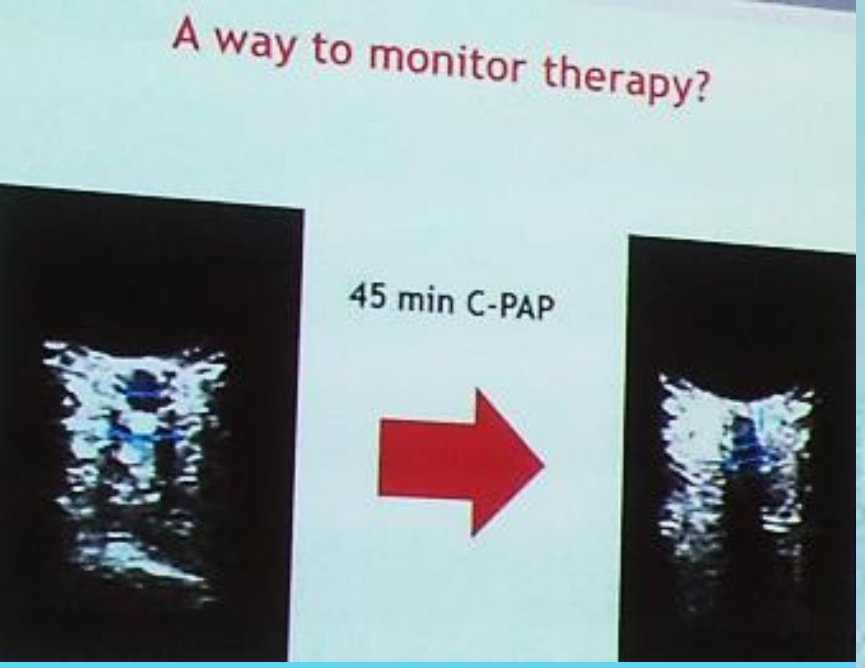
* $P < .05$ compared with well subjects at high altitude.

† $P < .05$ compared with AMS subjects before oxygen treatment at high altitude.

Keyes et al., WEM 2013

NAMME, Varese 2013

Strapazzon, 2013



Conclusions

Point-of-care ultrasonography at high altitude and in mountain emergency medicine represents a great promise next to classical clinical approach.

Dedicated research on significance and EBM-recommendations should be developed.

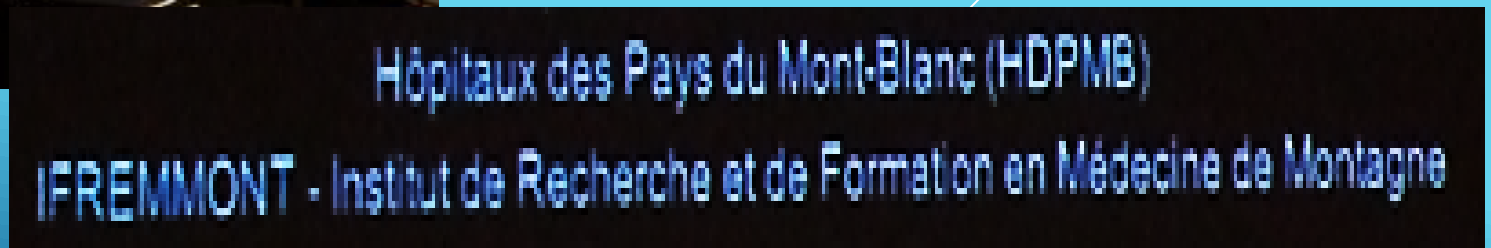
Strapazzon, 2013

NAMME, Varese 2013

OMRZLINY A PODCHLAZENÍ
NOVINKY
KASUISTIKA

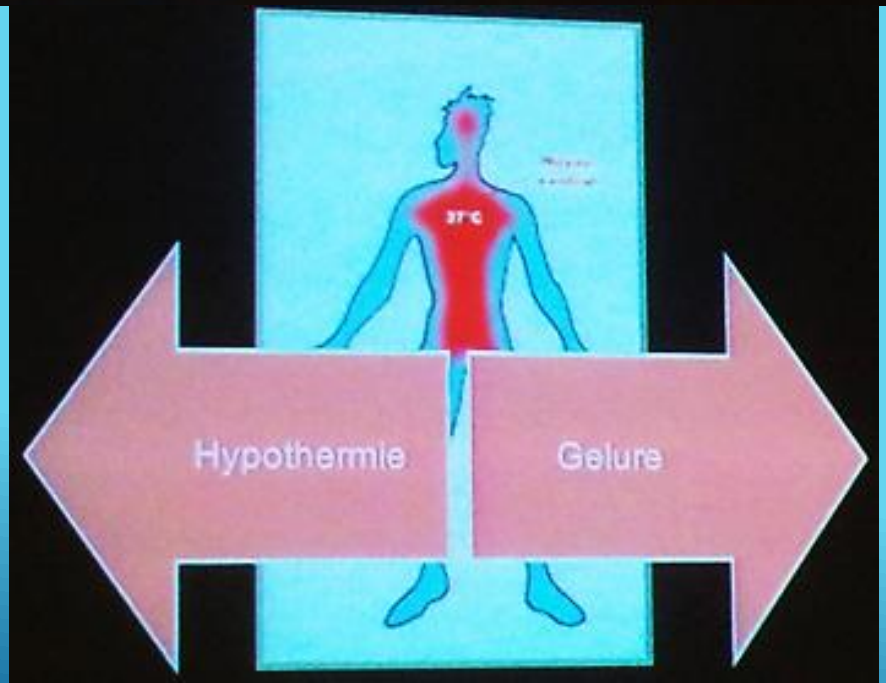
Frostbite and Hypothermia.
New Advances
Case Report

Emmanuel Cauchy
Président de l´IFREMONT
Sonia Popoff
Guy Dupperex



Key points

- Clinical aspect looks like a burn but the physiopathology and the treatment are different
- No randomized treatment validated until 2010
- The bone vitality determine the prognosis of amputation

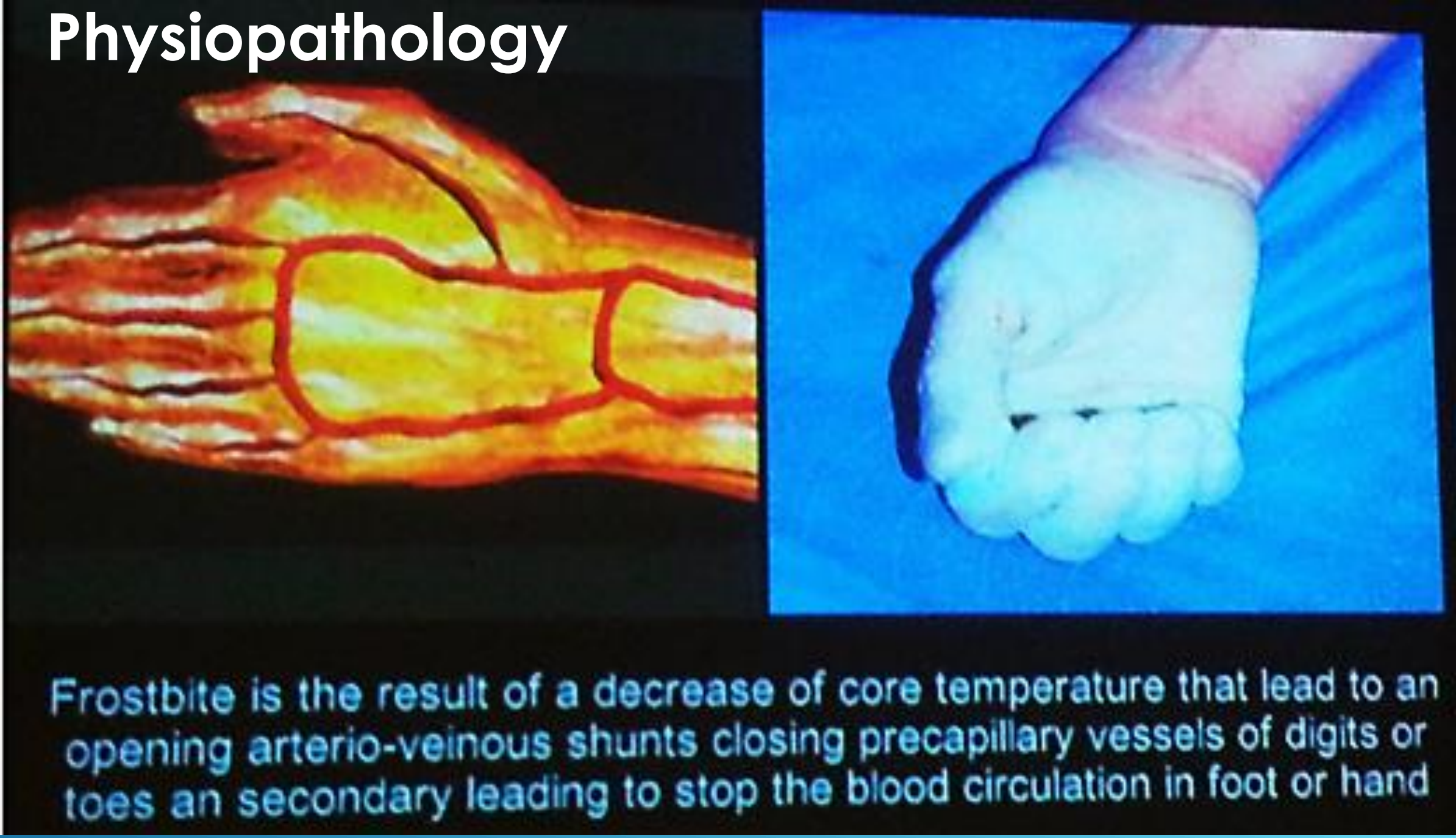


- Two kind of population
  - Sportive (mountain and polar environnement)
    - 80 cases /year
    - 20 severes (>grade 2)
  - More than 1000 cases from 30 years
- Urban population
  - Homeless
  - Psychiatric
  - Domestic

NAMME, Varese 2013

Cauchy, 2013

Physiopathology



Frostbite is the result of a decrease of core temperature that lead to an opening arterio-veinous shunts closing precapillary vessels of digits or toes an secondary leading to stop the blood circulation in foot or hand

Cauchy, 2013

ON THE FIELD

Primary phase

- Peripheral vasoconstriction
- Shunt opening
- Precapillary sphincters closing
- Cell death by mecanical agression, recristalization and dehydration

Livid aspect aspect
Rigid
Insensible
Centripetal extent

Physiopathology

DAY O

Rewarming period (1-2h)

Initial lesion

Cyanosis and grayness in color.

Hypo/anesthesia

Drop of digit tip temperature

Centripetal extent toward the base of the limb

DAY 1-2

Phase of blisters

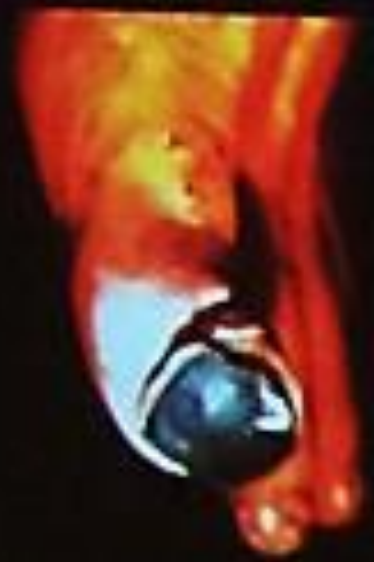
- Hematics
- Voluminous
- Compressive

Needing excision between 3 to 5 days

D 45

Tardive phase (30 to 45 days)

Progressive evolution to a
momification



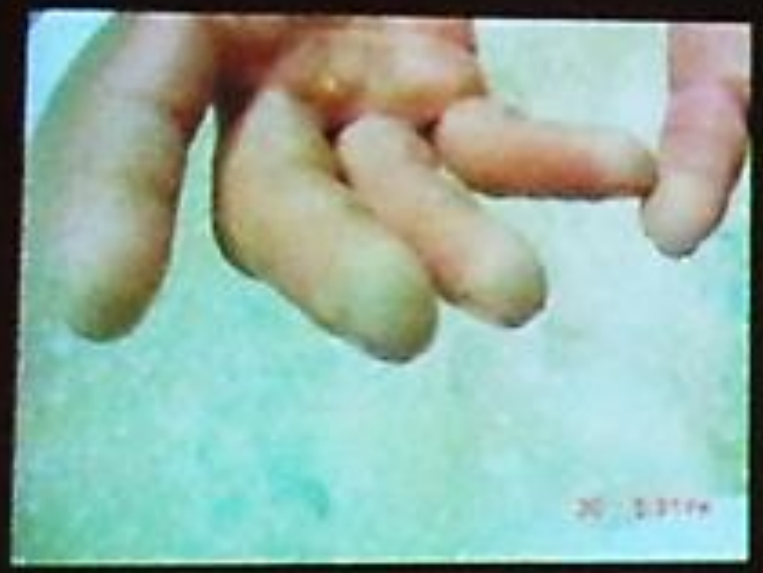
NAMME, Varese 2013

Cauchy, 2013

Therapeutic management

1. Rapid rewarming protocol »

- *Rewarming in a hot bath water at 38-40°C during 1 hour*
- Aspirin 250 mg IV bolus



Cauchy, 2013

Cauchy et al "New classification" in Wilderness Environ Med 2001 Winter; 12 (4) : 248-55.

Grade 1	Grade 2	Grade 3	Grade 4
No amputation	No amputation	30 à 80%	100%

Grade 1	Grade 2	Grade 3	Grade 4
No amputation	No amputation	40 à 80%	100%

Cauchy, 2013

- ✓ First paraclinical exam validated on a very large serie
- ✓ Non-invasive
- ✓ Pronogsis at Day 2
- ✓ Usefull in research
- ✓ Medico legal aid

Journal of Hand Surgery American (Sept 2000)

European Journal of Nuclear Medicine (Mai 2000)

Tc 99m scintigrafie

Therapeutic Approach

- **Aspirin , pentoxyfiline**
- **Alphalytic vasolilator (buflomedil), anticalcic (nifedipine)**
- **Prostacycline** , Iloprost
  - Groechenig E. Treatment of frostbite with iloprost. Lancet. 1994 Oct 22; 344(8930):1152-3.
  - Hold S. Wien Med Wochenschr. 2005
  - Cauchy E NEJM 2011
- Thrombolyse, **R-tPA**
  - Twomey JA, J Trauma. 2005 (retrospective serial)
  - Bruen Kevin J., Ballard James R., Morris Stephen E.,Cochran Amalia, Edelman Linda S., Saffle Jeffrey R. Reduction of the incidence of amputation in frostbite injury with thrombolytic therapy. Arch Surg. 2007; 142: 546-553.
  - Sheridan RL, Case records of the Massachusetts General Hospital. Case 41-2009. A 16-year-old boy with hypothermia and frostbite. N Engl J Med. 2009 Dec 31;361(27):2654-62.
- **Oxygenotherapie by hyperbaric chamber**

NAMME, Varese 2013 **Cauchy, 2013**

Cauchy, 2013

The NEW ENGLAND JOURNAL of MEDICINE

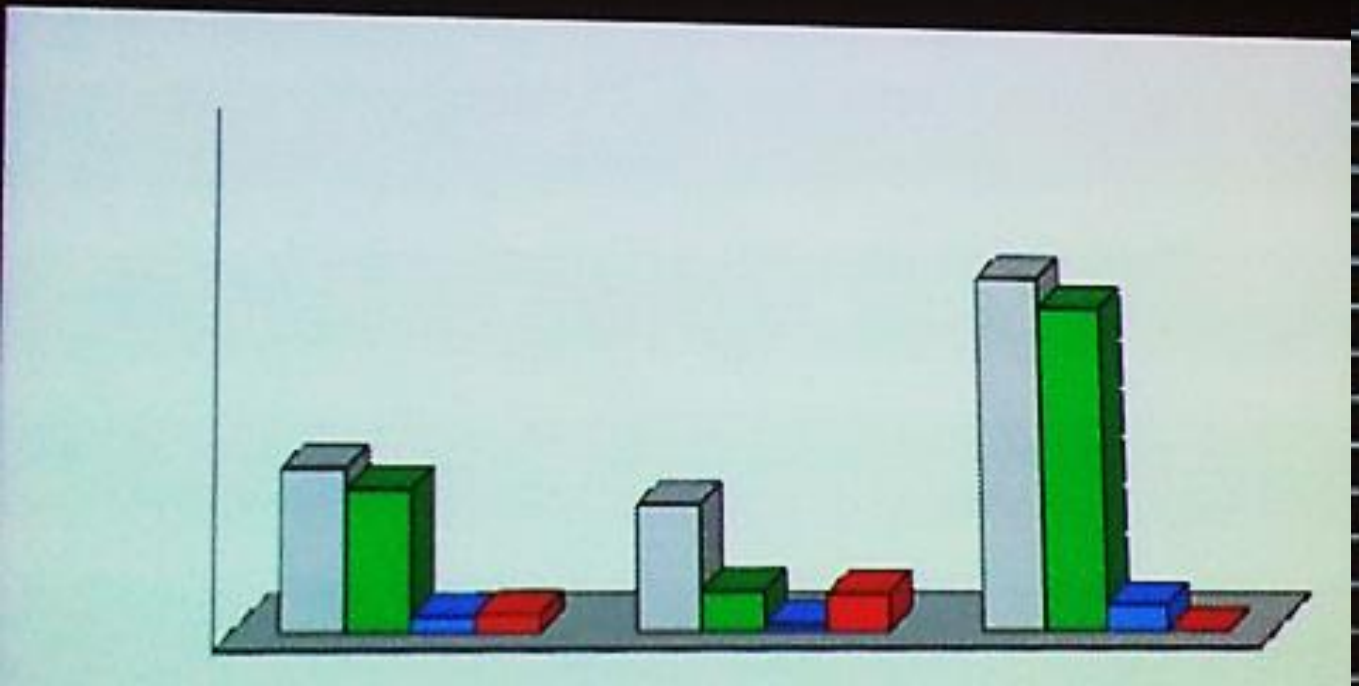
HOME | ARTICLES | ISSUES | SPECIALTIES & TOPICS | FOR AUTHORS

CORRESPONDENCE

A Controlled Trial of a Prostacyclin and rt-PA in the Treatment of Severe Frostbite

N Engl J Med 2011; 364:189-190 | January 13, 2011

Hand: % of amputation of finger according to the initial treatment (n:47)



iloprost / thrombolytic + iloprost :
% of amputation of toe according to the initial treatment

126 patients
n: 459
phalanx

Grade 3B treated by iloprost without thrombolytic
6 hours after thr rescue in Aoste hospital

After 15 days

Protocol Chammonix

Frostbites in emergency in Chamonix

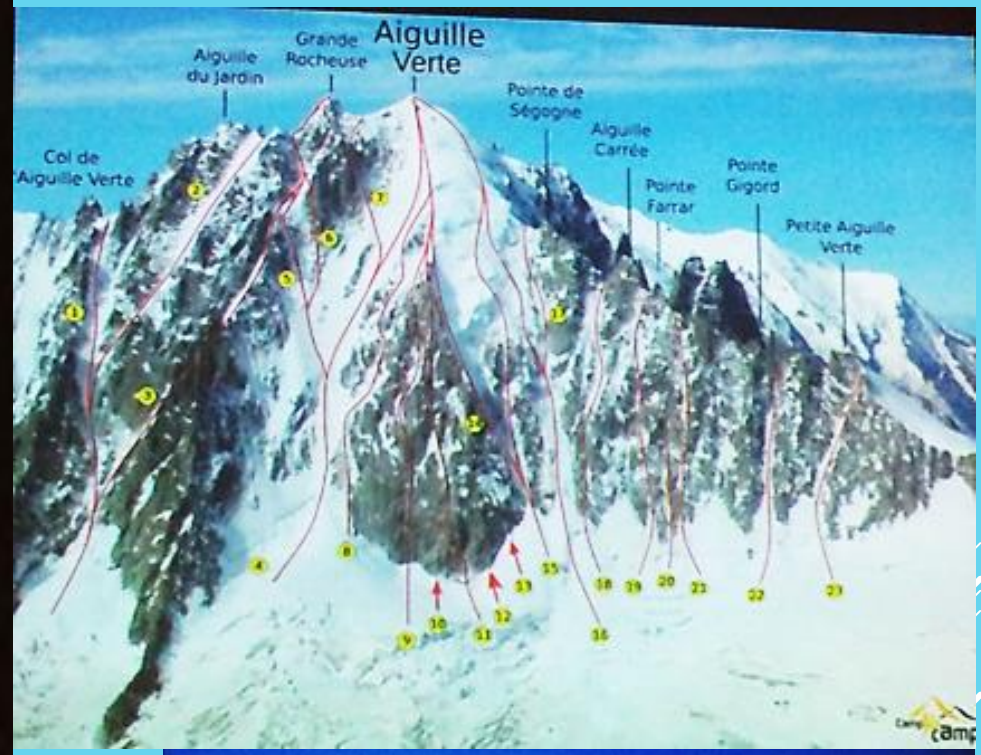
- Grade 1 et 2 : Aspirin 250 mg/j (ambulatory)
- Grade 3 : Aspirin 250 + Iloprost infusion – 8 days
- Grade 4 : Thrombolysis (?) + Iloprost PSE – 8 days

- Bone scanning à day 3 after blisters excision

- In expedition used of hypobaric chamber if staying in altitude !

Two brothers

- Misaventure of two french alpinists rescued from Aiguille verte « *Couturier corridor* »
- Bad conditions with the ice and arriving too late at the top
- Chelter in the snow at 4122 meters
- 4h00: violent north wind and decrease of core temperature - Call for rescue
- 9.30: extracted by mountain rescue



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Bruno

Bruno

Treatment

- 10h: Rapid rewarming protocol
- 24h: Hôpital Cantonal de Genève (HUG)
  - Thrombolyse Actilyse, 100 mg / 90min
  - Daily
    - Iloprost 2ng/kg/min during 5h
    - 2h d'OHB à 2,8 ATA twice a day
- Blisters excision at day 5

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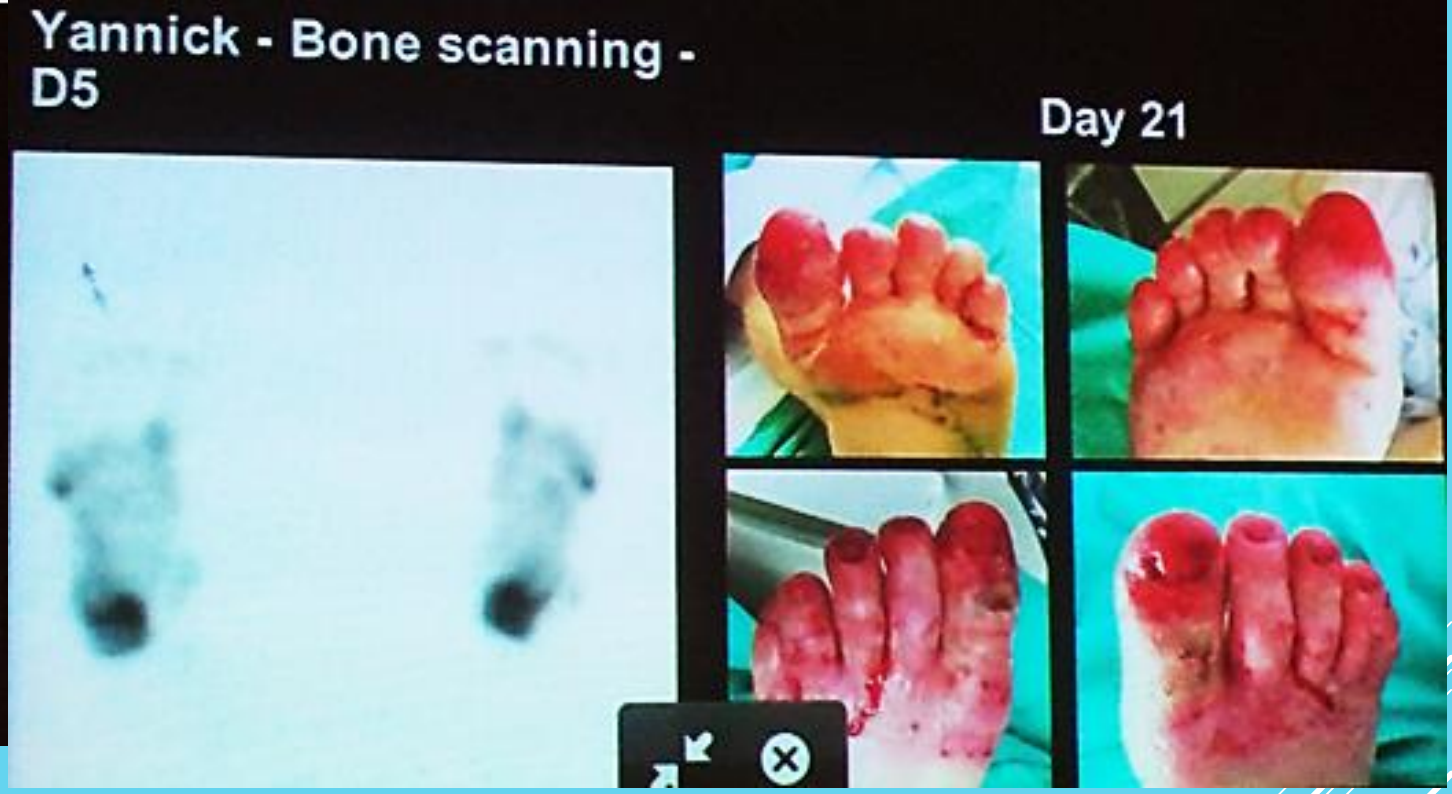
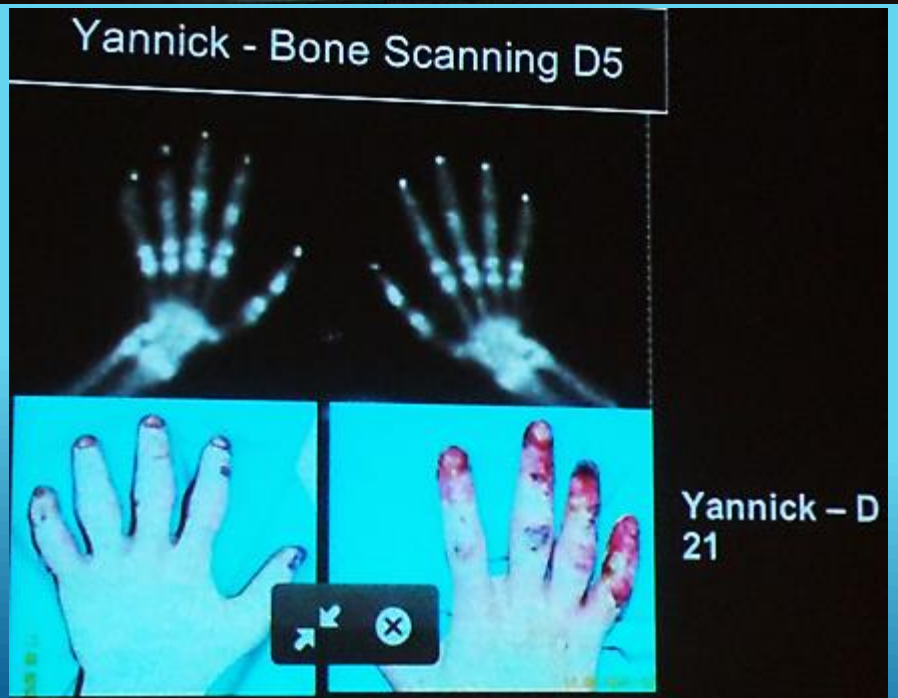

Yannick - Bone scanning -
D5
Day 21


Yannick - Bone Scanning D5
Yannick – D
21

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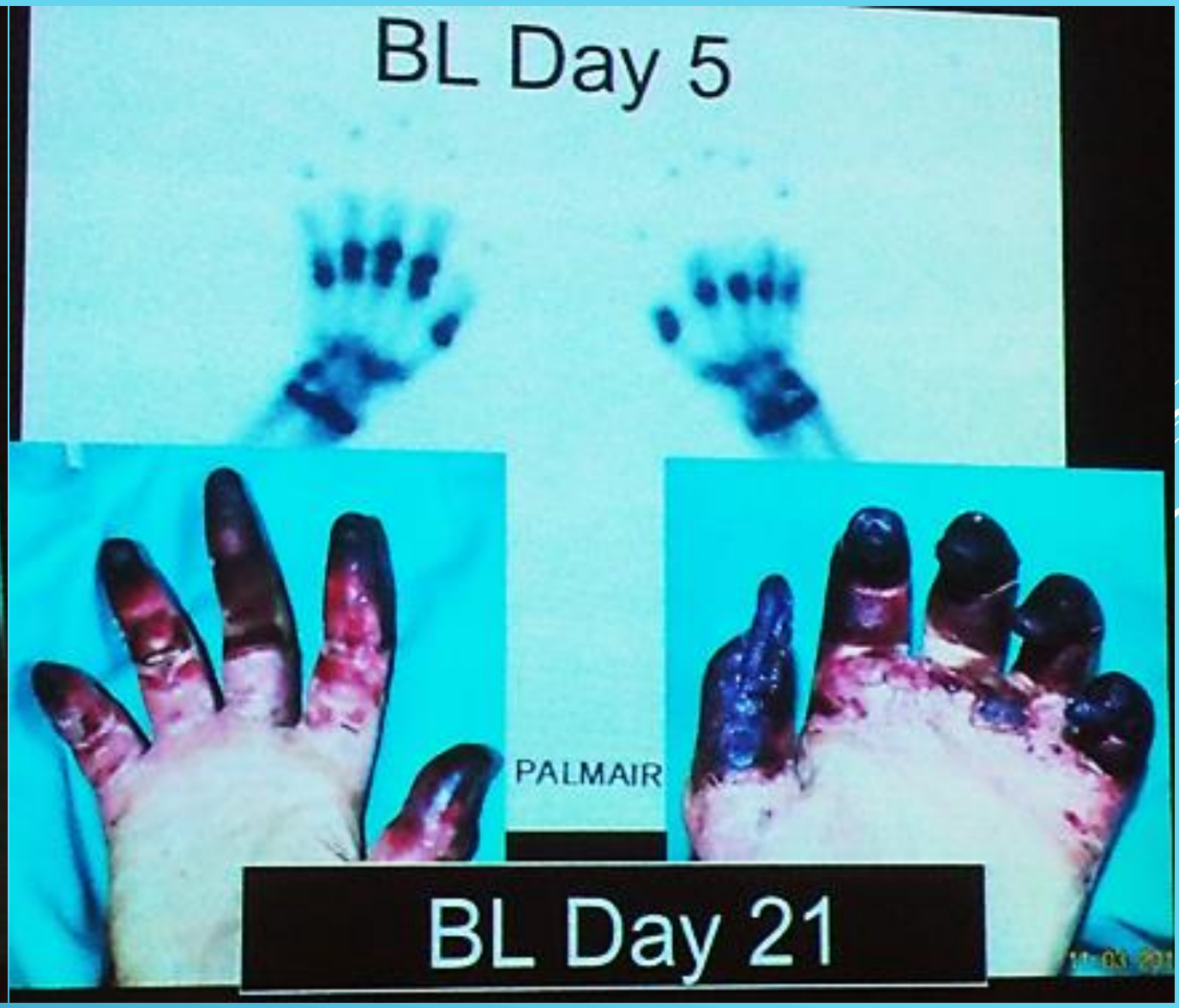

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Conclusion

- Early treatment of frostbite recommended
- The initial treatment consist to a rapid rewarming in 38°- 40°C bath with 250 mg of aspirin during 1 hour.
- The risk of amputation increase with the delay of treatment
- There are 4 grades of gravity correlated with the initial level observed just after the rapid rewarming protocol
- Le risk of amputation increase if the himalayist wait at the base camp
- The bone scanning Tc99 at day 3 is the reference to evaluate the level of amputation
- Iloprost (Ilomedine) is the first treatment validated by a randomized study.
- The thrombolysis must be considered for a grade 4 in case of early management

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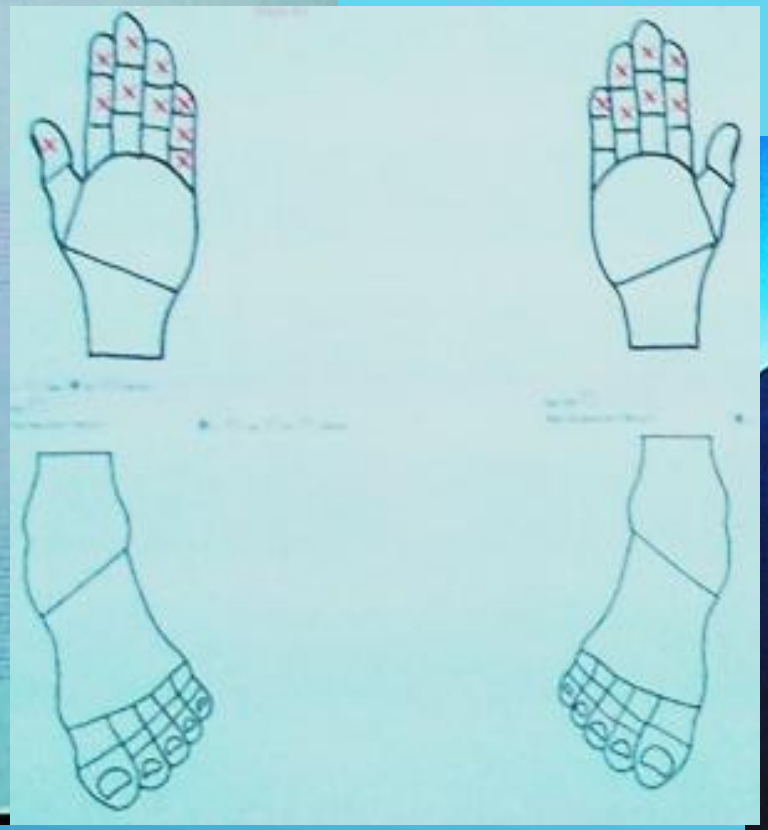
HUG
DOCUMENTATION PATIENTS
International Frostbite Registry (IFR)
Initiales
Mot de passe
Login
Hôpitaux Universitaires de Genève © 2013
Service d'Informatique Médicale



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EN MEDECINE DE MONTAGNE
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HYPOTERMIE – TRIAGE A ROZHODOVÁNÍ O TRANSPORTU V HORÁCH

Accidental Hypothermia - Out-Of-Hospital Triage and Transport Decision

Hermann Brugger MD

Institute of Mountain Emergency Medicine
EURAC Research, Bolzano

NAMME, Varese 2013

Case report

57y female hut-keeper

Partial avalanche burial

Wind speed 130km/h

Patent airway

Unconscious, spontaneous respiration at extrication

Cardiopulmonary arrest after extrication

Core temperature 27° C

Objectives

- Essential aspects of pathophysiology
- Prehospital diagnosis and management
- Algorithms 2012
- Next steps

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Case report

Out-of-hospital

2 hours terrestrial transport

Intermittent CPR, pocket mask ventilation

3 hours ambulance transport

Intubation, mechanical chest compression (Lucas2)

In-hospital

Core temperature 16.3° C, K+ 4.88mmol/L

ECMO

2 months intensive care

3 months neurological rehabilitation

Outcome

Full recovery after 10 months

Brugger, 2013

Epidemiology

- Annual US morbidity/mortality: 1560 cases, 640 deaths*
- Europe?

„Urban hypothermia affects the disadvantaged"

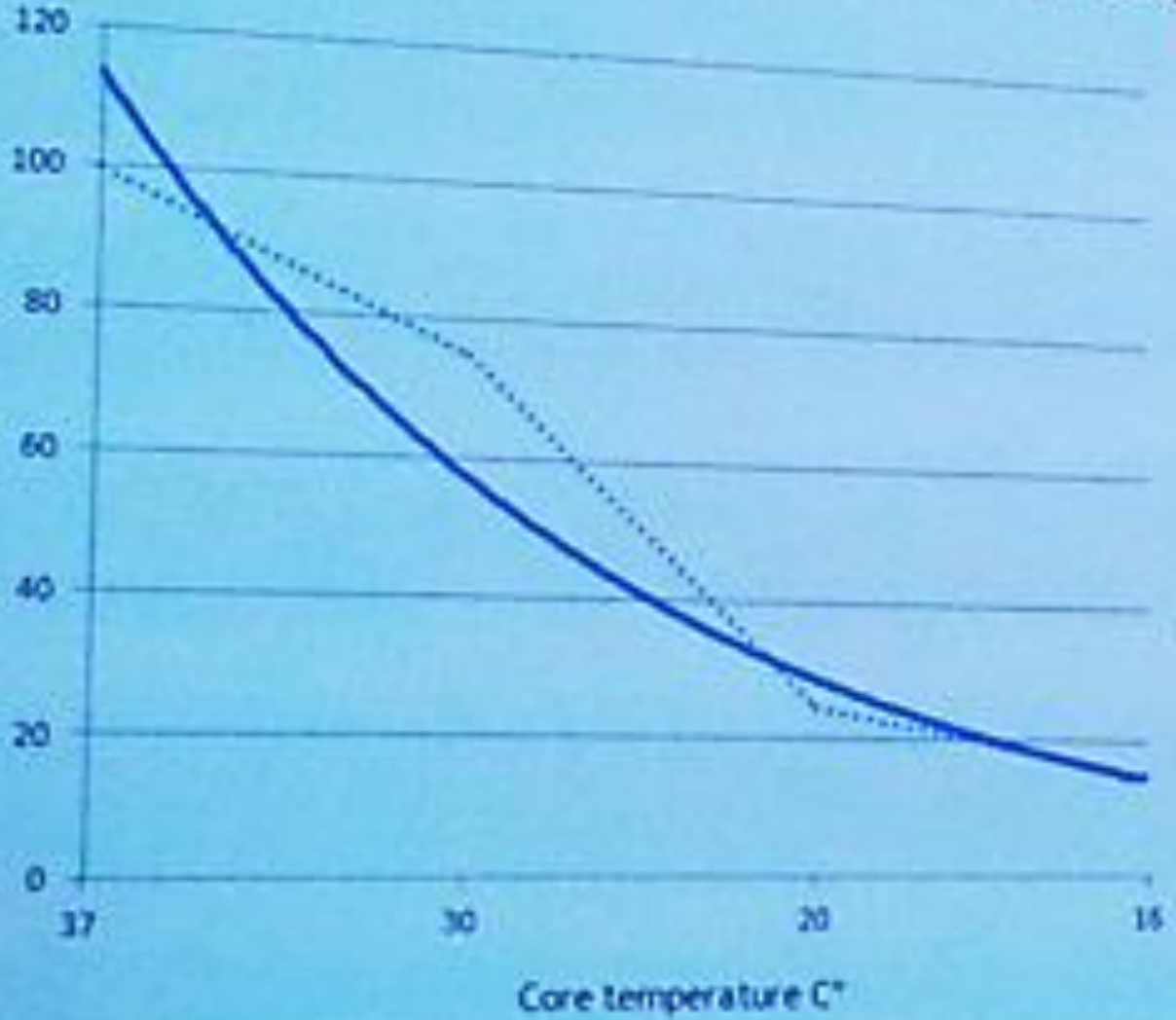
Epidemiology

- Annual US morbidity/mortality: 1560 cases, 640 deaths*
- Trauma patients (n=228): 49.6% of all, 98% of entrapped patients with CT<35°C**

„No correlation between the incidence of hypothermia and the season of year"

Brugger, 2013

Hypothermia and oxygen uptake



Oxygen uptake
-6% decrease
per ° C

..... Hypoxia uptake (%)

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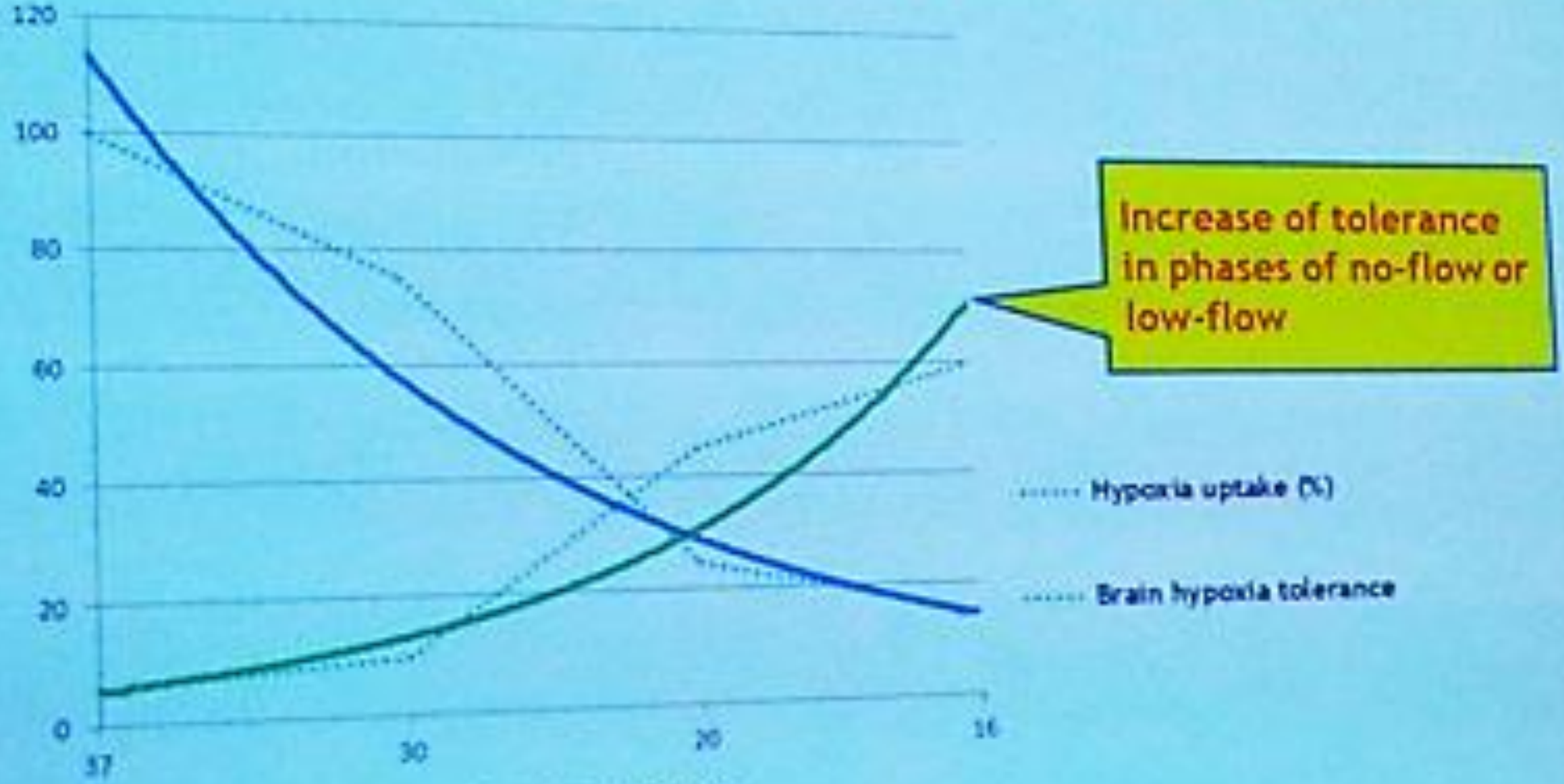
Hypothermia and hypoxia tolerance



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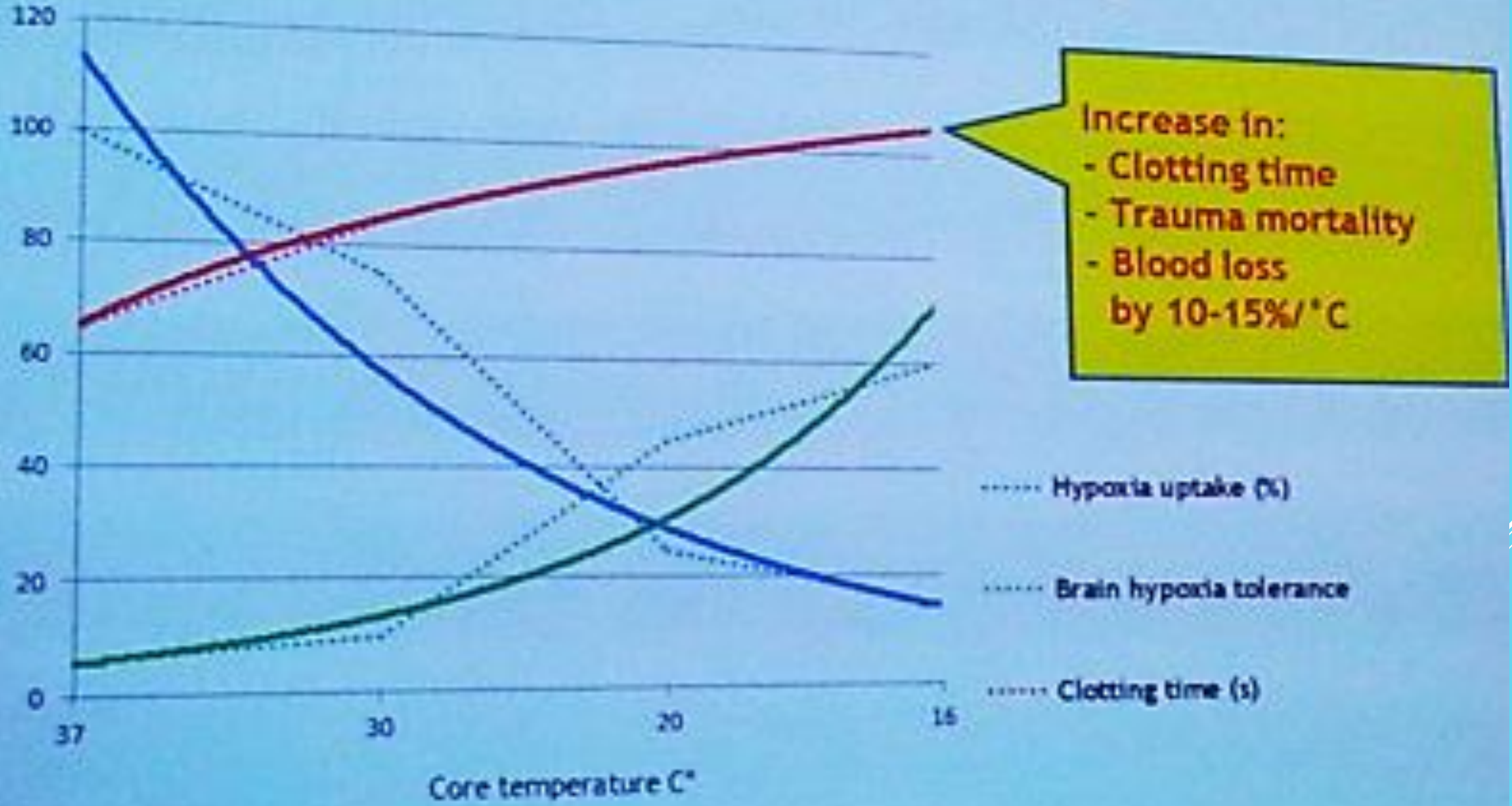
Hypothermia and clotting time



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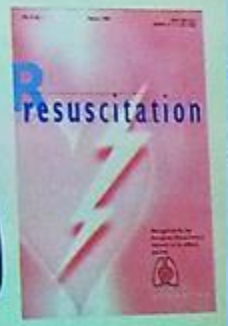
On-site staging and management

AHA & ERC
CoSTR Guidelines ILCOR 2010



On-site staging and management

The NEW ENGLAND JOURNAL of MEDICINE

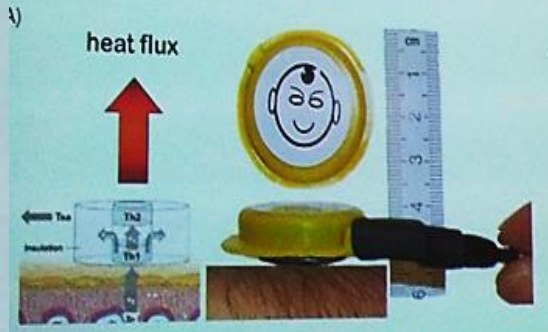
REVIEW ARTICLE

CURRENT CONCEPTS

Accidental Hypothermia

Douglas J.A. Brown, M.D., Hermann Brugger, M.D., Jeff Boyd, M.B., B.S., and Peter Paal, M.D.

On-site diagnosis



Double Sensor

On-site staging and management

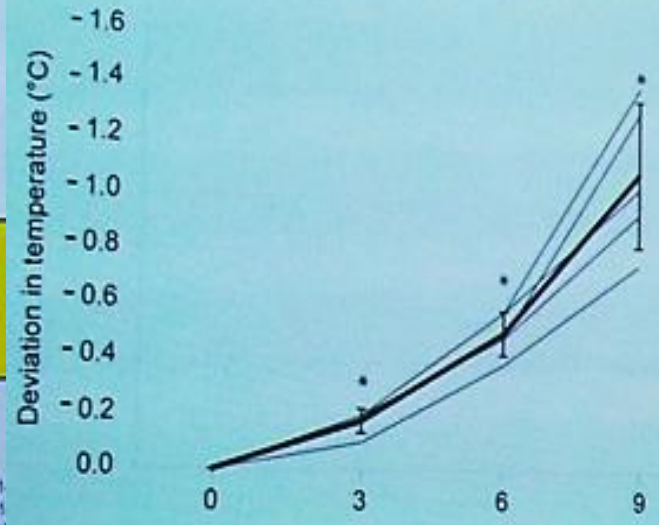
On-site diagnosis

- History and clinical signs
  - patient's trunk feels cold
- Core temperature reading
  - oesophageal (gold standard)
  - epitympanic (thermistor)

Epitympanic CT:
- Consider false low readings

Walpoth et al. J Clin Monit 1994;10:91
Brugger et al. Resuscitation 1996;31:11
Locher et al. Schweizer Med Wochenschr 1991;121:1028-
Durrer et al. Resuscitation 2001;50:243

On-site diagnosis



ge	Clinical signs	Core temperature
	Responsive, shivering	35-32°C
	Somnolent, not shivering	32-28°C
	Unresponsive	28-24°C
	No vital signs	<24°C

NAMME, Varese 2013

rugger, 2013

On-site staging and management

Stage	Clinical signs
I	Responsive, shivering
II	Somnolent, not shivering
III	Unresponsive
IV	No vital signs

35-32°C
Metabolic rate ↑
Oxygen consumption ↑
Respiratory rate ↑
Heart rate ↑
Organic brain syndrome
Risk of stumbling and falling

Stage	Clinical signs
I	Responsive, shivering
II	Somnolent, not shivering
III	
IV	

- Warm sweet drinks

Stage	Clinical signs
I	Responsive, shivering
II	Somnolent, not shivering
III	
IV	

- Warm sweet drinks
- Active movement
- Warm environment

TRANSPORT TO NEAREST HOSPITAL IF UNINJURED

Stage	Clinical signs
I	Responsive, shivering
II	Somnolent, not shivering
III	Unresponsive
IV	No vital signs

<32°C
Metabolic rate ↓
Oxygen consumption
Heart rate ↓
(50% at 28°C)
Cardiac output ↓
(45% at 25°C)
Blood pressure ↓

Stage	Clinical signs
I	Responsive, shivering
II	Somnolent, not shivering
III	Unresponsive
IV	No vital signs

<32°C

RISK OF CARDIAC INSTABILITY!
Ventricular arrhythmias
SBP <90mmHg

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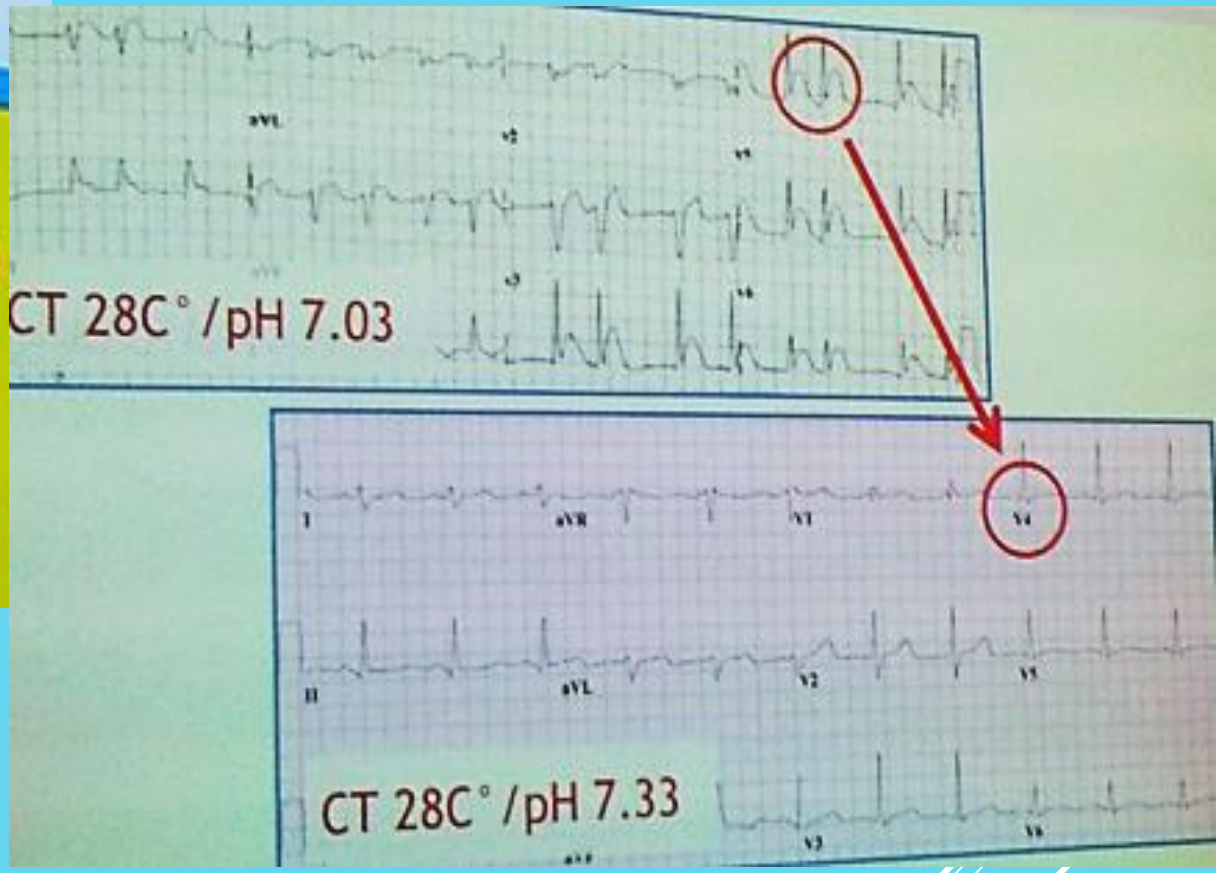

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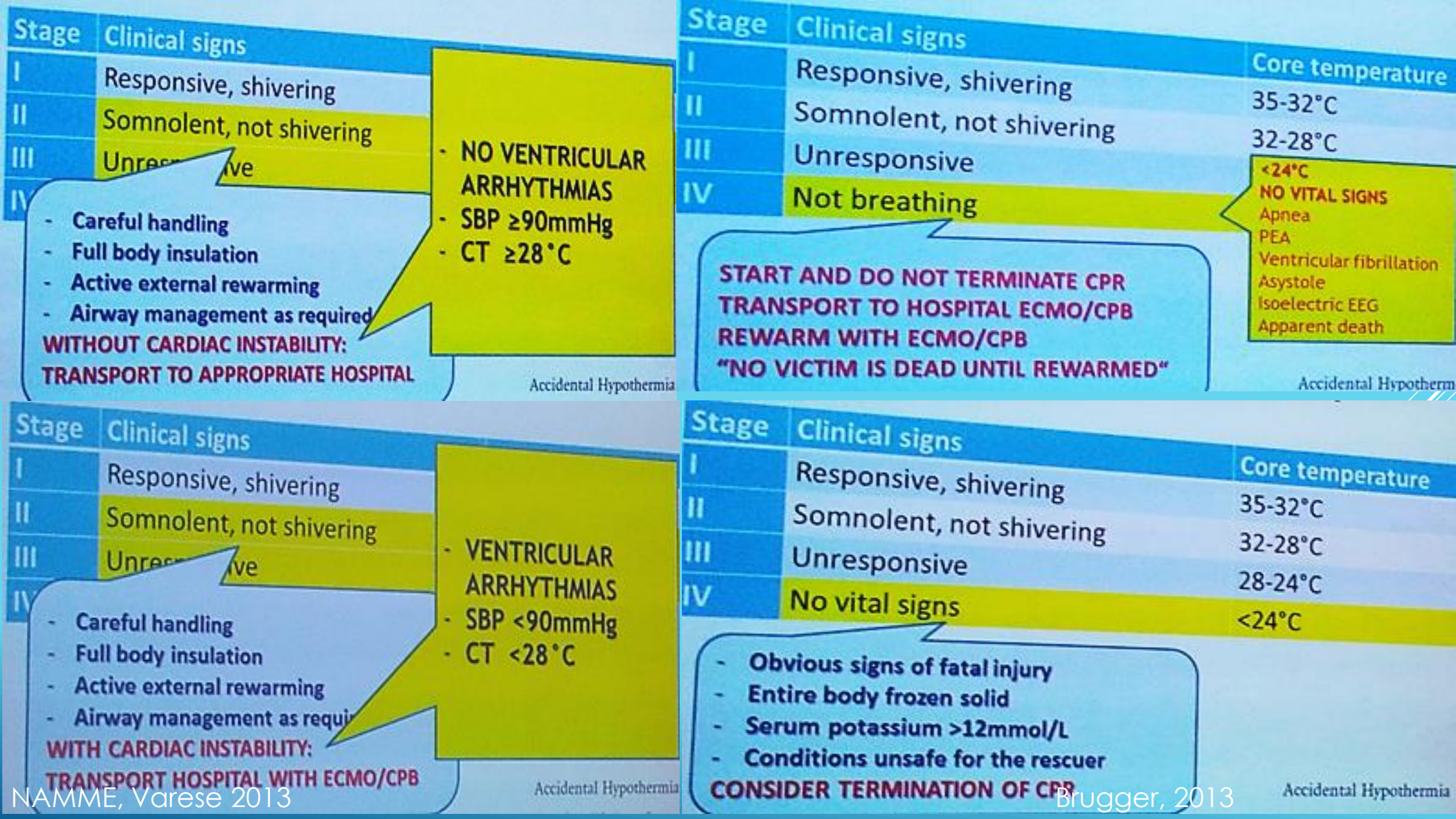

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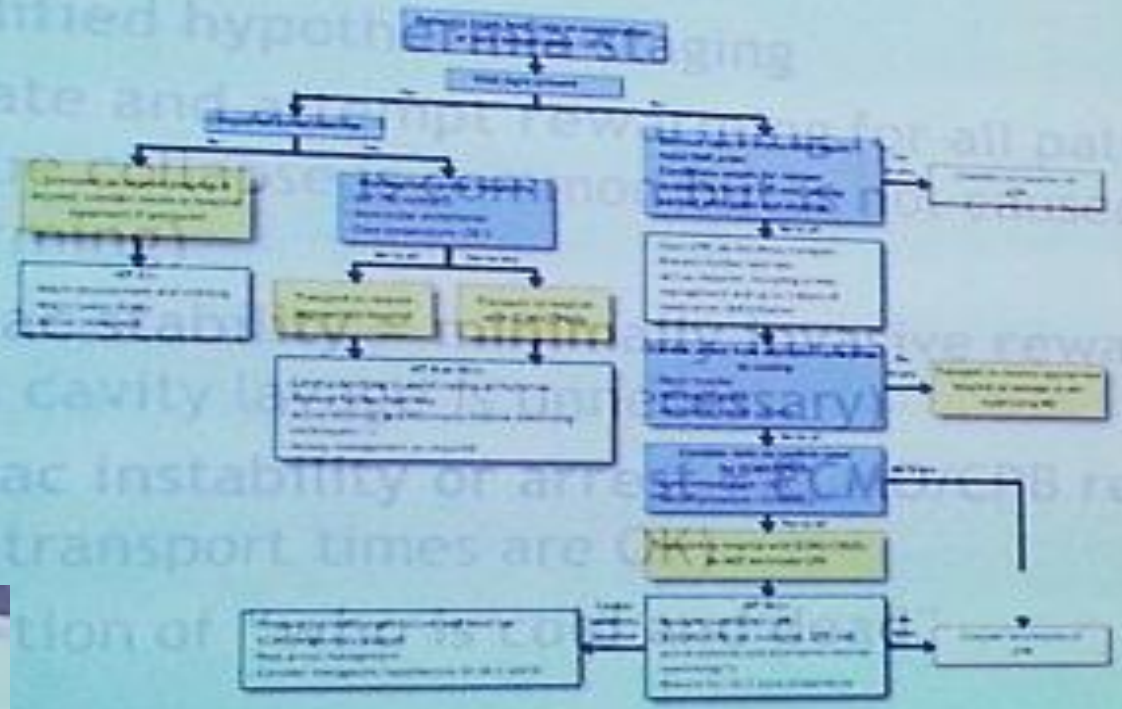
What's new?

- **Simplified hypothermia staging**
- **Insulate and attempt rewarming for all patients** (rescue collapse is common but is not caused by rewarming)
- **Cardiac stability = minimally invasive rewarming** (body cavity lavage is unnecessary)
- **Cardiac instability or arrest = ECMO/CPB rewarming** (long transport times are OK)
- Definition of "**who is cold and dead**"

On-site staging and management



Special situation

- **Hypothermia and trauma**
  - **Severe hypothermia masked by traumatic brain injury** (CT measurement)
  - **Coagulopathy undetected** by lab (samples are heated)
  - Surgical cure is compromised, **increased blood loss & mortality**

Special situations

Avalanche

- **<35min burial**: hypothermia is not the cause of cardiac arrest
- **>35min burial**: if the airway is patent, hypothermia may be the cause of cardiac arrest

Brugger, 2013

Special situations

ICAR MEDCOM Avalanche Recommendations 2012

Brugger H, Boyd J, Durrer B, Ebensechin F, Paal P, Strapazzon G, Winterberger E, Zafren K. Resuscitation, in press

Next steps

- Front line provider education & protocols
- Dispatch center education & protocols
- Hospital education & protocols

- Front line provider education & protocols
- Dispatch center education & protocols
- Hospital education & protocols

- **Hypothermia Chain of Survival**

Přežití 6 dní v trhlině

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Brugger, 2013

Conclusion

Severely hypothermic patients should be treated optimistically, if no hypoxic event precedes hypothermia and no serious underlying disease exists.

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EURAC

Bozen/Bolzano, Italy
25-31 May 2014

X World Congress on High Altitude Medicine and Physiology
Hypoxia and Cold - From Science to Treatment

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Hypoxia and Cold - From Science to Treatment

25-31 May 2014
Bozen/Bolzano,
Italy

www.ismm2014.org

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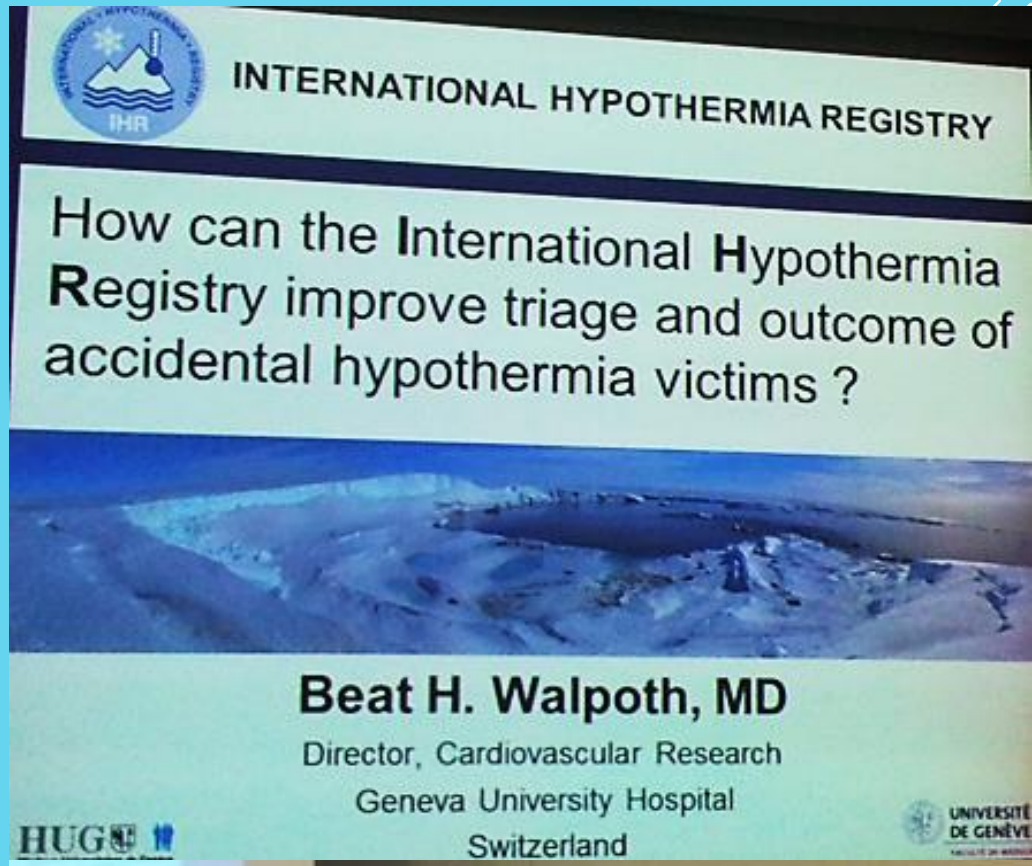
JAK MŮŽE MEZINÁRODNÍ REGISTR ZLEPŠIT TRIAGE A OSUD OBĚTÍ HYPOTERMIE

How Can the International Registry Improve Triage and Outcome of Accidental Hypothermia Victims

Beat H. Walpoth

Director, Cardiovascular Research
Geneva University Hospital, Switzerland



Why is the registry needed?

Why is the IHR needed: numbers

- USA $0.4/10^5$ hab. 2003 (Murphy T)
- The Netherlands 612 patients 1987-1990 (Bierens J)
- France $0.13/10^5$ hab. 1993 (Bouachour G)

Need for a Registry

- « Survival after accidental deep hypothermia and prolonged cardiac arrest is **rare**…however, long term survival rates without sequelae of **47%** is higher than previously reported » ***NEJM Walpoth et al 1997***
- No consensus national/international guidelines for hypothermia treatment
- Insufficient medical literature, no case reports on negative outcomes

Aim of the IHR

- Create a database on accidental hypothermia to:
  - Study pre-hospital treatments and their impact on outcome
  - Increase our knowledge on impact and complications of rewarming techniques.
  - Prevent and decrease severity of post-rewarming complications (i.e. lung and brain oedema)

Walpoth, 2013

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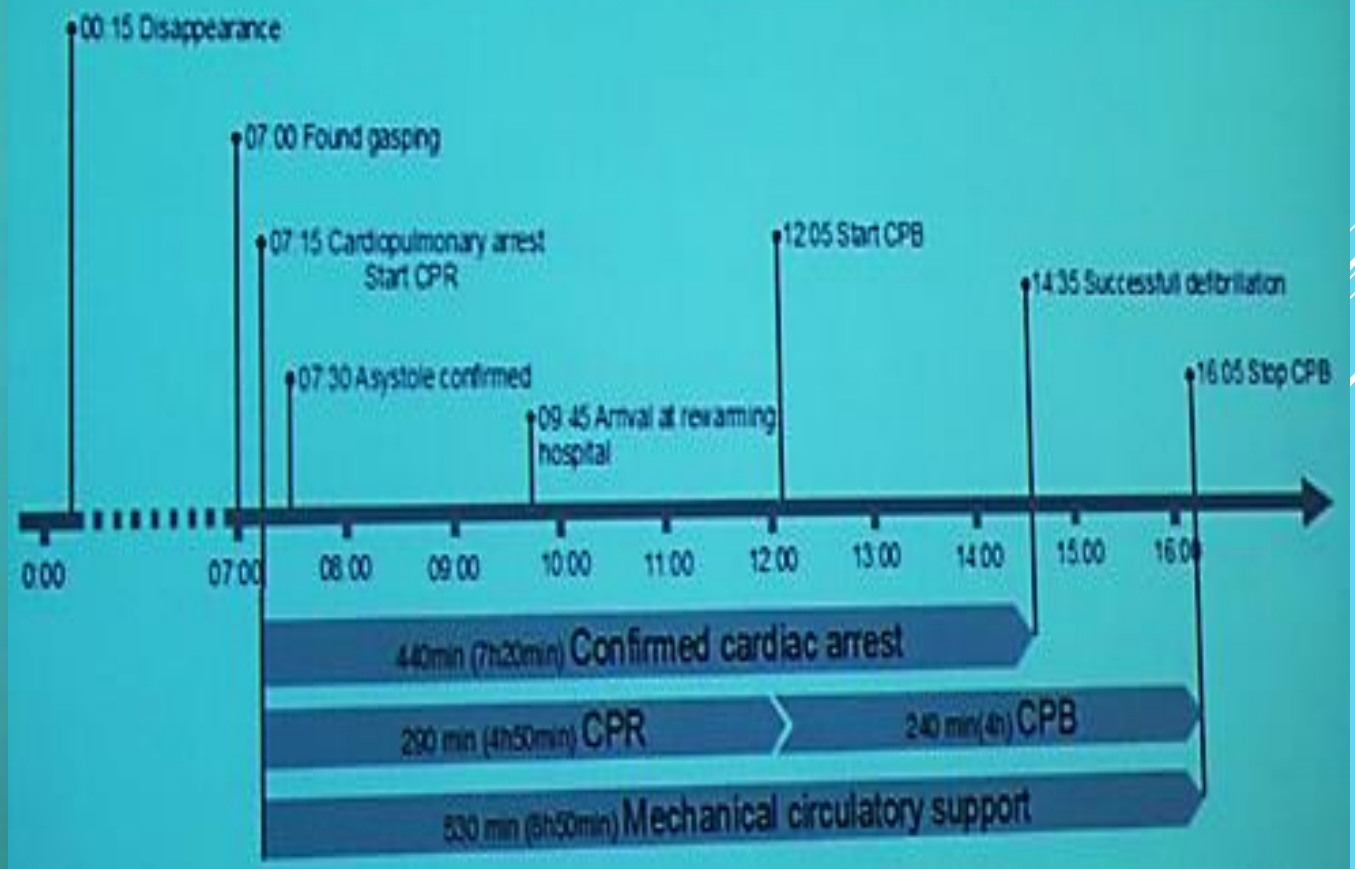
  - Increase our knowledge on impact and complications of rewarming techniques.
  - Prevent and decrease severity of post-rewarming complications (i.e. lung and brain oedema)

Why is the IHR needed: records

- 13.7° C adult — *Gilbert. 2000 Lancet*
- 15.2° C infant — *Nozaki. 1986 N Engl J Med*
- 4° C monkey — *Lewis FJ. 1957 J Appl Physiol*
- 1° C rats — *Smith AU. 1959 Ann NY Acad Sci*
- *20 min of CA at 18-20° C*
  - → *no long term cerebral sequelae .*
  - → *40 min: no apparent cerebral lesions.*

  Treasure T. 1984 Ann R Coll Surg Engl
- 8h50 cardiac arrest under circulatory support @ 21° C.
  - → No long term sequelae. *HUG patient 2008*

Sequelae-free long-term survival of a 65-year old woman after 8h50 of deep accidental hypothermic cardiac arrest



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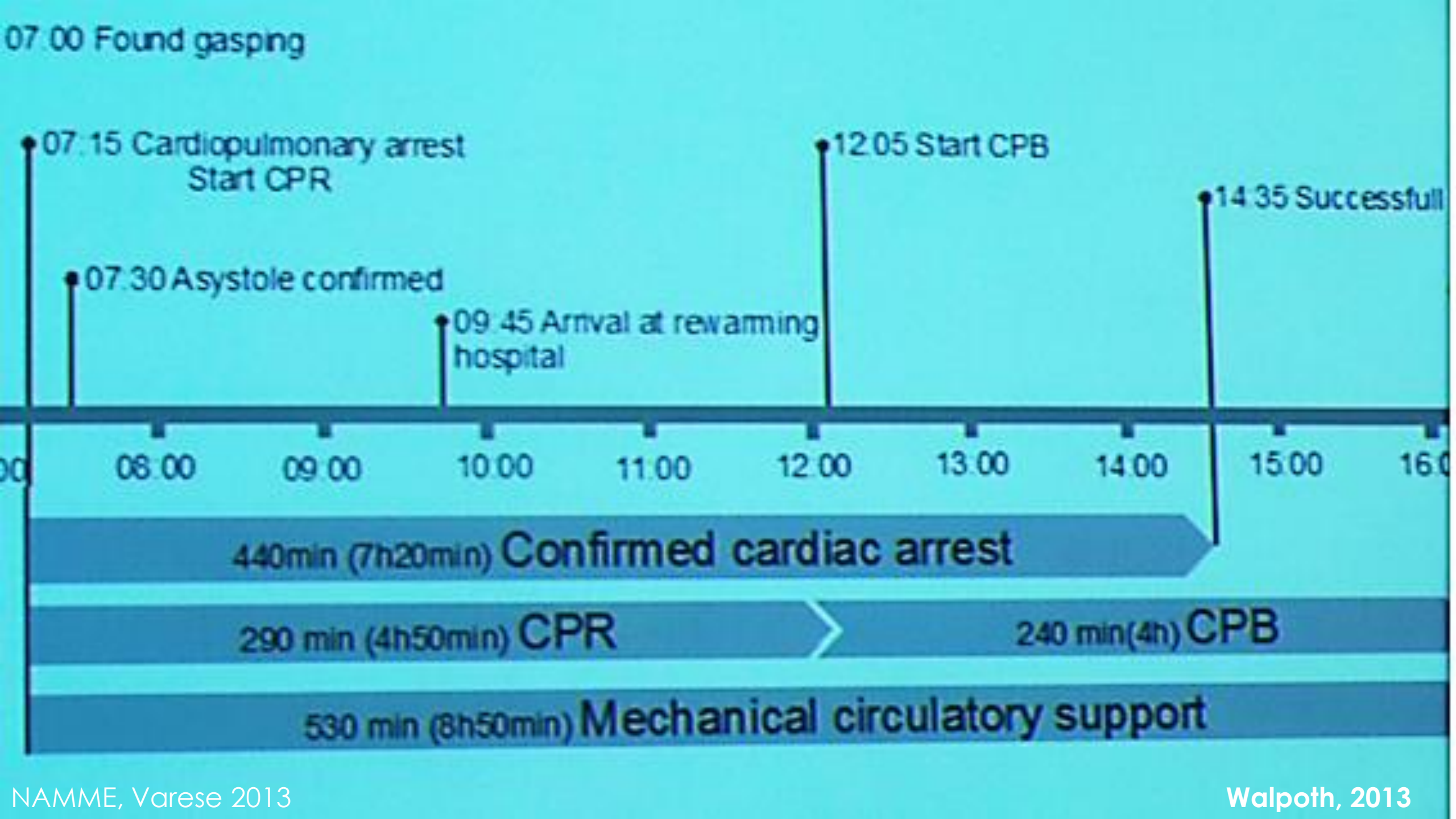
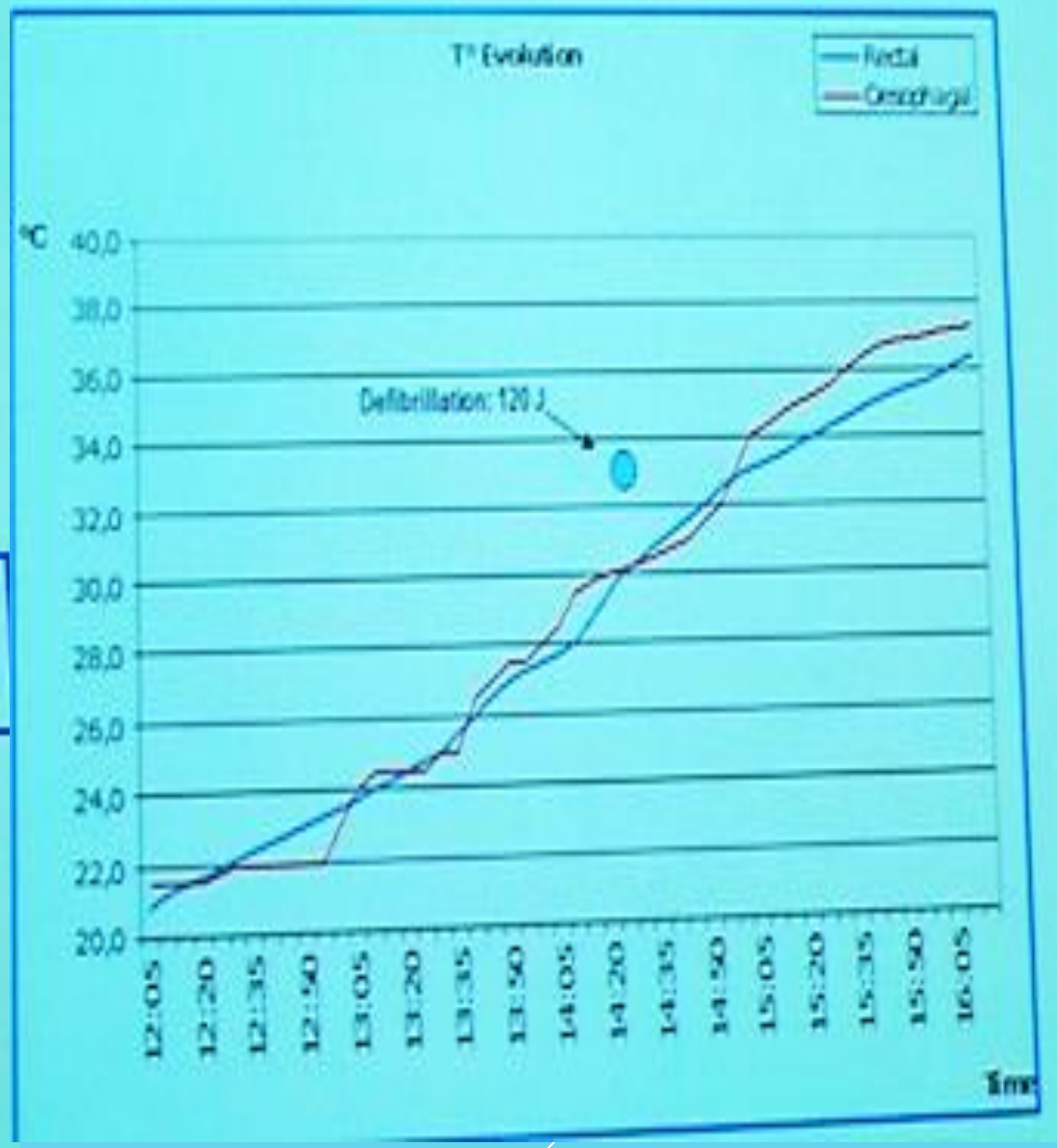


Walpoth, 2013

Hypothermia Case Report

- Rectal temperature: 21,4° C
- No asphyxia
- No associated lesions
- Asystole
- Glasgow: 3
- Blood gas values:
  - pH: 7.2
  - pCO2 3,76kPa
  - pO2: 3,24kPa
  - K+:2,6mmol/L
  - Na+ 134mmol/L
  - Glu 29mmol/L
  - Lac 8,3mmol/L
  - HCO3- 14,5mmol/L
  - BE -17.0

Decision for CPB



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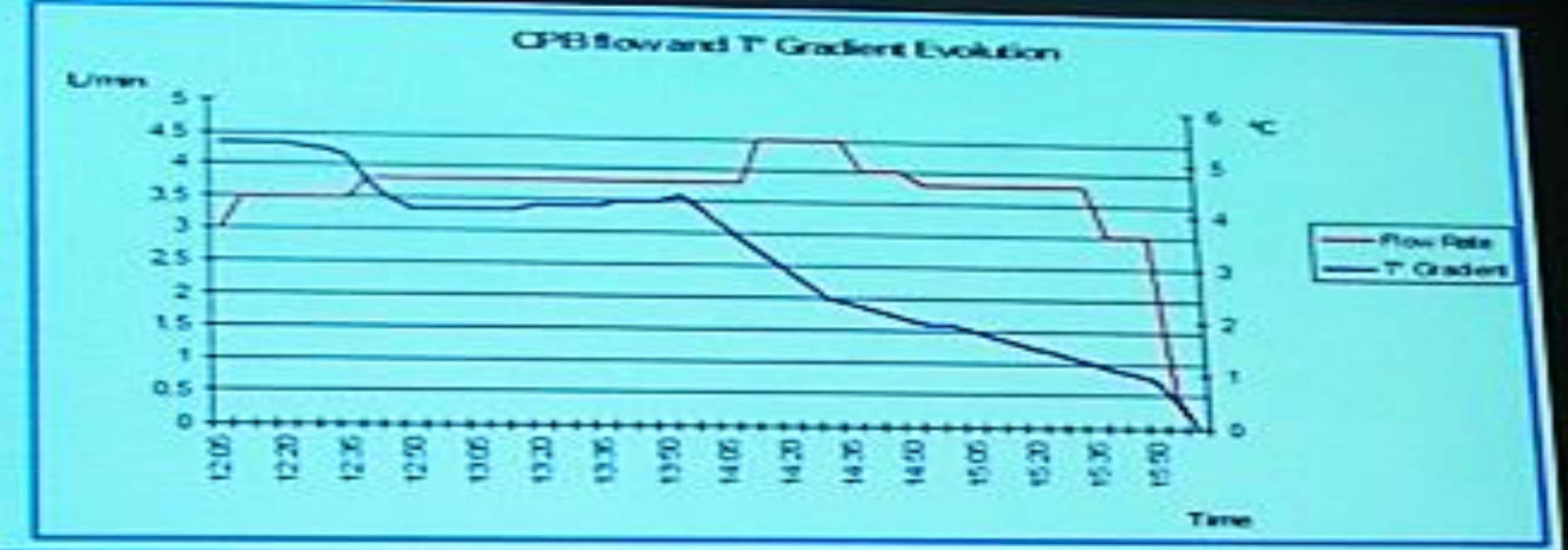

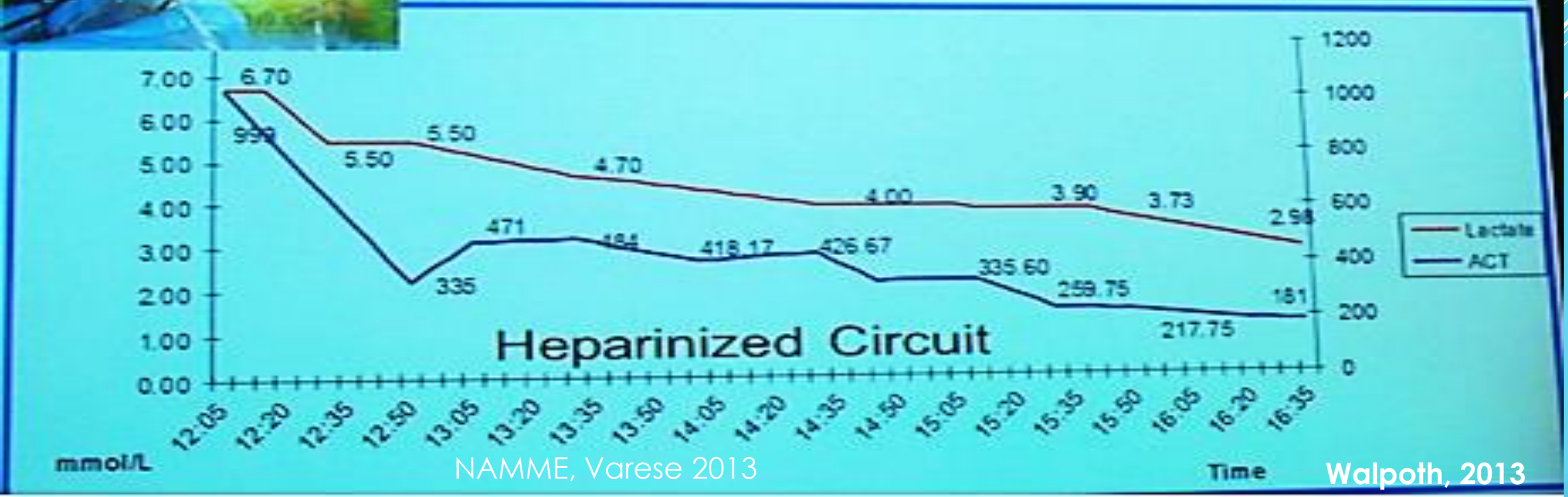

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Walpoth, 2013

Hypothermia Case Report: Hospital Course

- Recurrent pulmonary edema until day 5
- Hemodynamic instability requiring catecholamines until day 3
- Left ventricular dysfunction with 43% ejection fraction
- Neurological: retrograde amnesia, confusion, agitation

NEVE

Negative Survival Factors

- Old Patient (65 Years)
- Long CPR (4 H 50 Min)
- Long CPB (4 H) and Slow rewarming (4° C/h)
- Temperature drop during transport & isolation
- Asystole

Positive Survival Factors

- No asphyxia
- No trauma
- Homogenous T° drop and rewarming
- Tricyclic drug abuse
- Good renal function
- Heparinised circuit

Walpoth, 2013

CITED LONGEST HYPOTHERMIA TIMES WITH SURVIVAL

Longest cases - cited in NEJM : 367;20:2012

Longest reported CPR with full recovery after CPB rewarming = **190'**
(?CPR or total time) - Husby
Survival of **390'** has been documented with forced air rewarming – Lexow

Case report Tromso (International Journal Emergency Medicine 2012)
6h52' = **412'** arrest time until weaned from CPB

Locher, Schweiz Med Wiss 1991
4,75h = 4h45 = **285'** arrest until successful defibrillation (temp. 20C)

HUG Case Report
290' = 4h50 CPR before CPB + **240'** = 4h CPB **total = 8h50**

International Journal of Emergency Medicine
a SpringerOpen Journal

CASE REPORT Open Access

Hypothermic cardiac arrest far away from the center providing rewarming with extracorporeal circulation

Eckhard Mark[1], Olaf Jacobsen[2], Astrid Kjerstad[2], Torvind Naesheim[2], Rolf Busund[3], Ramez Bahar[3], Jon Kjetil Jensen[4], Per Kristian Skorpen[5] and Lars J Bjertnaes[1,2,6*]

Abstract

A 41-year-old man suffered hypothermic cardiac arrest after water immersion and was transported to our university hospital by ambulance helicopter for rewarming on cardiopulmonary bypass. He resumed spontaneous cardiac activity 6 h 52 min after cardiac arrest and recovered completely.

Why is the IHR needed: problems unsolved

- Survival predictors to be tested:
  - pH<6.5, ACT>400s: non survival — *Mair 1994 Resuscitation*
  - Vasoactive drugs: non survival — *Vassal 2001 Chest*
  - Low PaCO2 and K+: survival — *Silfvast 2003 Resuscitation*

- Drug efficiency:
  - No Adrenaline < 30° C — *AHA 1992 JAMA*
  - Positive effect of adrenaline in pigs 26.5° — *Krismer 2000 Anesth Analg*

- Multiple rewarming methods
  - 14 different Methods used on 84 patients. Amsterdam 2000 - 2008 — *Von der Ploeg. 2010 Resuscitation*

Why is the IHR needed: problems unsolved

- Rewarming rate
  - Quick: 8° C/h
  - Slow: 4° C/h
  - To Temp 34-35

Locher, Walpoth. Schweiz Med Wschr 1991

Current HUG Guidelines

- Severe post rewarming events

47% survival without sequelae

Walpoth 1997 NEJM

1) Lung oedema
2) Neuro brain oedema,focal deficits
3) Cardiac failure,hepatic failure,pancreatitis

Walpoth, 2013

INTERNATIONAL HYPOTHERMIA REGISTRY

IT by Unit of Clinical Informatics - University Hospitals of Geneva

- HOME
- DATABASE ACCESS
  - General information
  - Registered user
  - New user or new centre
- ACCESS RIGHTS
  - Definitions
  - Management
- PASSWORD
- USER'S MANUAL
- COLLABORATING CENTRES
- WORKING GROUP
- CONTACT AND HELP

Introduction to the IHR project

The International Hypothermia Registry (IHR) is the first and only world wide database on human accidental hypothermia. This internet based registry was created by the hypothermia working group with the University Hospital of Geneva, Switzerland which hosts the data on its secure server.

Transient mild hypothermia (core body temperature 35-32°C) is common and usually without consequences for the brain or other organs. However, prolonged deep accidental hypothermia due to accidents is rare, and usually fatal in more than 50% of cases. Little is known on its physiopathology, on prognostic factors for rewarming decision or ideal rewarming techniques for better survival. Furthermore, complications after successful rewarming are extremely frequent and very often severe or fatal.

The IHR's principle goal is to increase knowledge on accidental hypothermia by gathering sufficient relevant data through international networking, creating the largest data base on deep accidental hypothermia. The registry will enable comparison of treating and rewarming methods, study survival predictor factors and prevention of post rewarming complications. This will help select the most efficient ways to treat these patients and permit the establishment of evidence based diagnosis and treatment guidelines.

https://www.hypothermia-registry.org/WebObjects/Frameworks/IHRFoundation001.framework/WebServerResources/indexPROD.html

What is the IHR ?

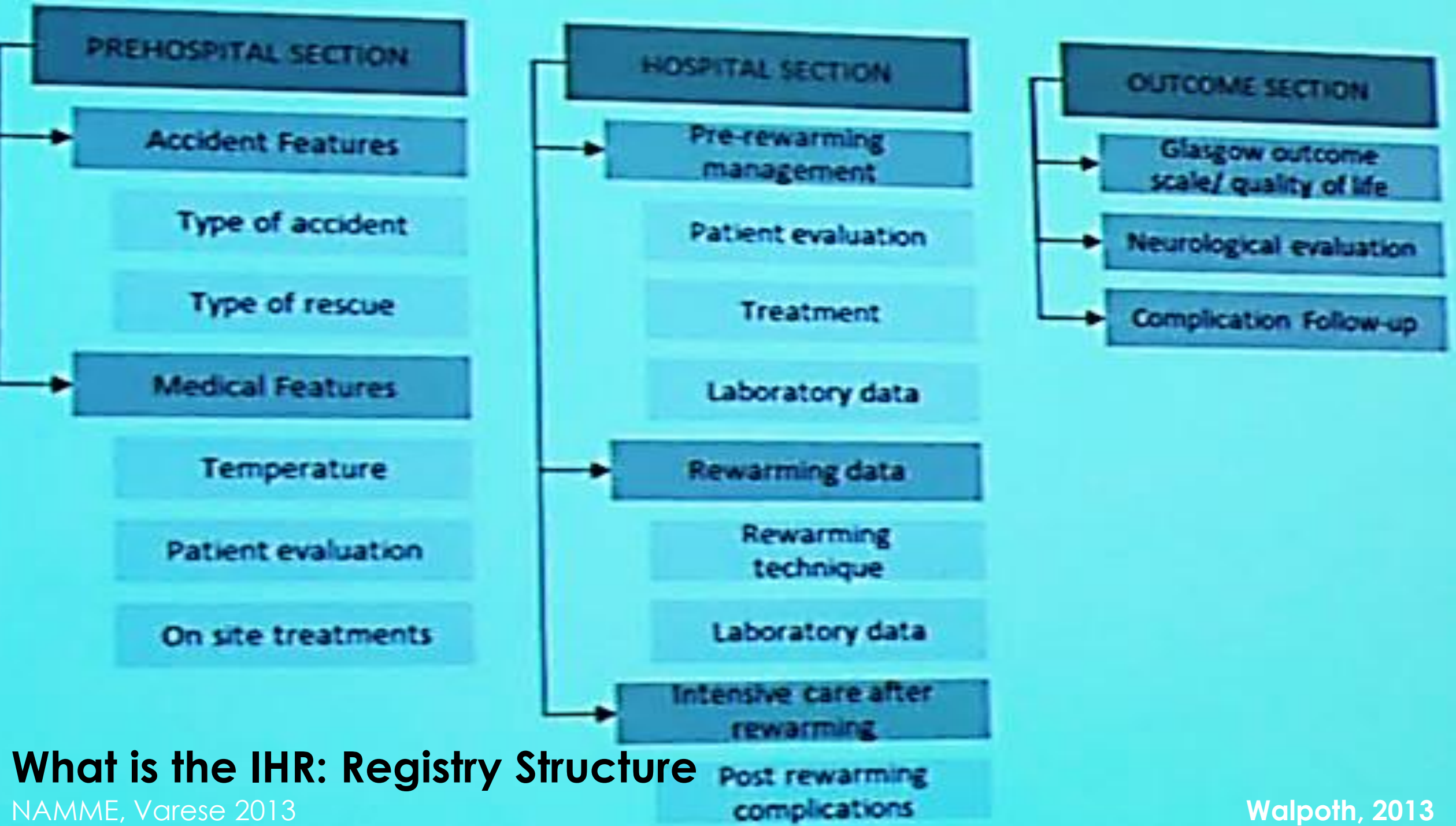
- Web based.
- Highly secured server of University Hospital of Geneva
- Patient confidentiality/data protection: anonymous data. Patient consent recommended. If impossible, local directives apply.
- Inclusion criteria: accidental hypothermia T<32° C, all origins, all outcomes.
- Retrospective cases welcome.

NAMME, Varese 2013

What is the IHR :Method

- Internet-based English survey, protected ananomous data
- Eligibility: all interested hospitals/rescue centres
- Includes:
  - victims with core body T° < 32° C, preference for T° < 28° C with cardiac arrest
  - accidental hypothermia of any origin (exposure/avalanche/immersion/suicide attempt...)
- Registry components:
  - Anonymous patient data
  - Accident data
  - Prehospital treatment
  - Hospital treatment, rewarming method, clinical and laboratory data
  - Post-rewarming complications
  - Outcome
- Data access and publication possible for your own cases
- Global data analysis by nominated international working group
- Quality control reports on a yearly basis

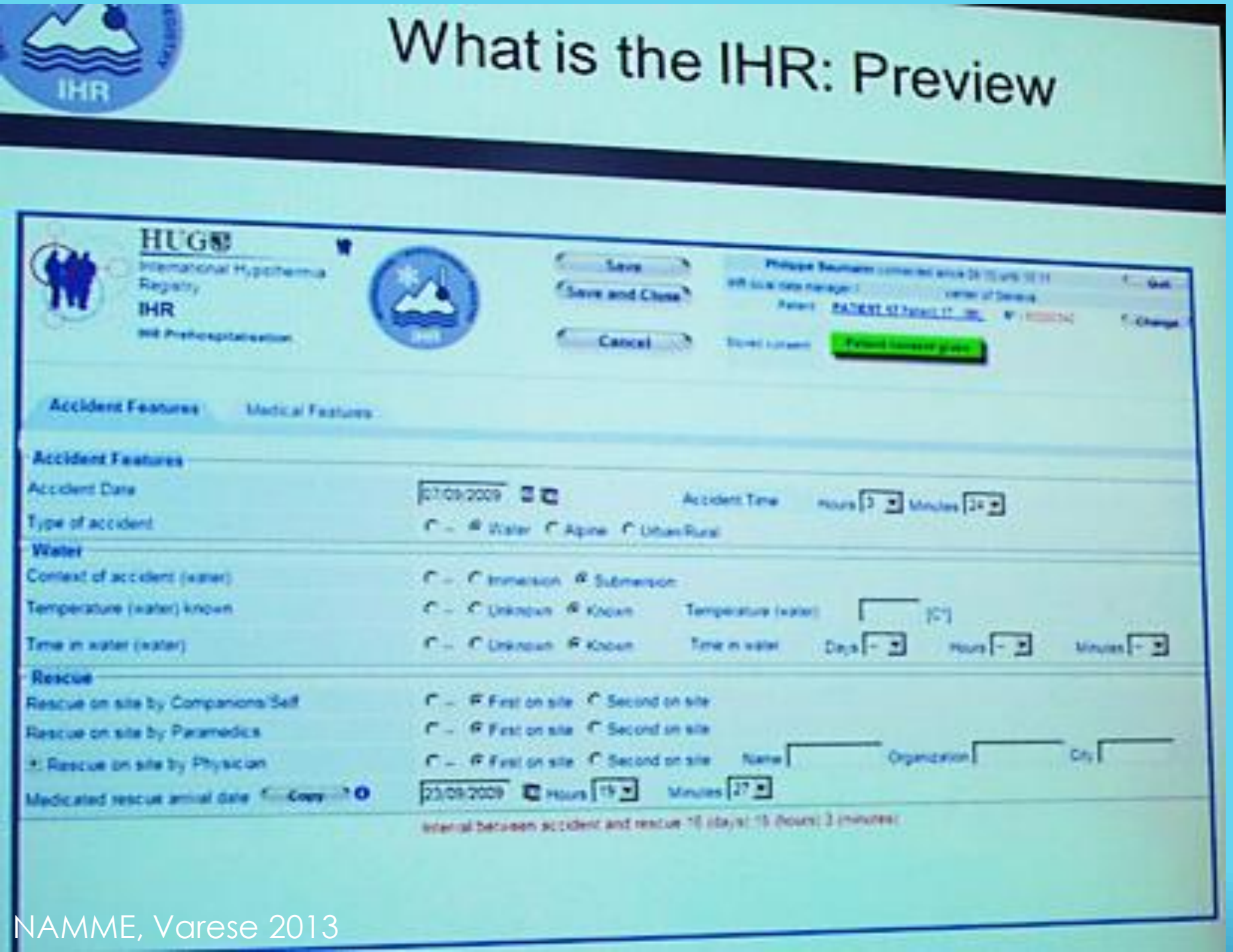
Walpoth, 2013



What is the IHR: Registry Structure

NAMME, Varese 2013

Walpoth, 2013


What is the IHR: Preview
IHR
HUG
International Hypothermia Registry
IHR
Save
Save and Close
Cancel
Accident Features
Medical Features
Accident Features
Accident Date
Accident Time
Type of accident
Water
Context of accident (water)
Temperature (water) known
Time in water (water)
Rescue
Rescue on site by Companions/Self
Rescue on site by Paramedics
Rescue on site by Physician
Medicated rescue arrival date

Viz PDF

Who is participating ?

- Europe:
  - Switzerland
  - France
  - The Netherlands
  - Italy
  - Germany
  - Austria
  - Norway
  - UK
- USA
- Japan

Over 50 Centers

- Geneva: 6 cases 2011 mean T° 28° C no CA, all survived. No disabilities. +30 retro cases
- 97-2012: 42 cases T° < 32 (2/3 alive)
- Chamonix-Sallanches: *in progress* all + 85 complete cases since 1990. Thesis work.
- Berne: min 150 cases. Student Masters work.

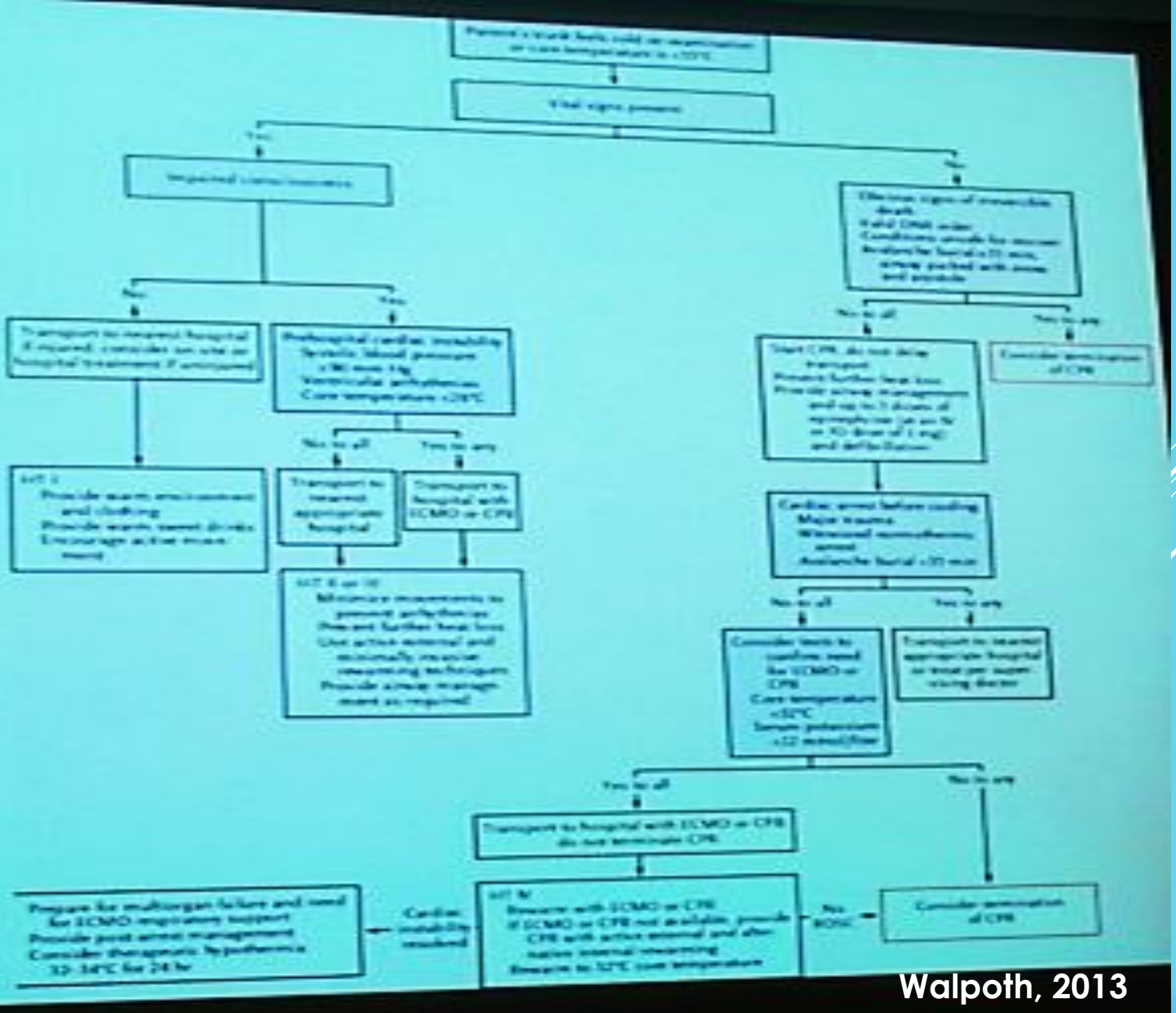
Walpoth, 2013

Expectations

- Global awareness on hypothermia
- Increases the number of successfully rewarmed hypothermia victims
- Large participation in the IHR for minimum 5-10 years
- Multicentre quality control
- Issue new guidelines and recommendations

Walpoth, 2013

D. Brown et al
N.Engl.J.Med
2012;367



NAMME, Varese 2013

Walpoth, 2013

Hypothermia - What's New?

- Simplified clinical staging
- Insulate and attempt rewarming for all patients
  (rescue collapse is common but is not caused by rewarming)
- Hypothermic cardiac arrest or instability requires ECMO/CPB (long transport times are OK)
- Cardiac stability = minimally invasive rewarming
  (body cavity lavage is unnecessary)

NAMME, Varese 2013

Who is Cold & Dead?

- Frozen solid (chest not compressible)
- *History of arrest prior to cooling*
- Major trauma and cardiac arrest
- Avalanche burial>35min, airway packed with snow
- K>12mmol L^{-1}

D. Brown 2013,
http://vimeo.com/57950513

Walpoth, 2013

Next Steps

Hypothermia Chain of Survival:

- Front line provider education & protocols
- Dispatch center education & protocols
- Hospital education & protocols

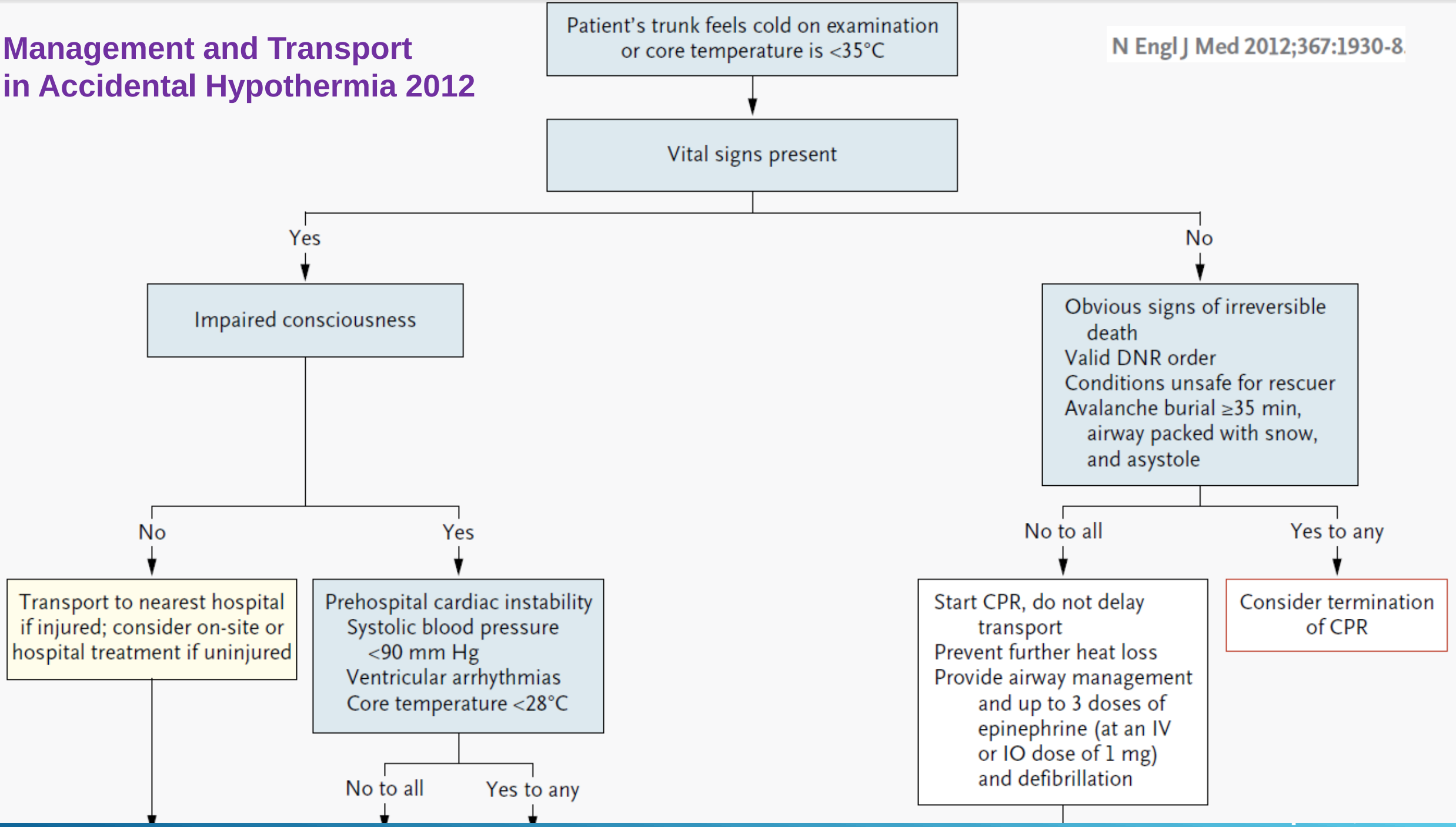
D. Brown 2013,
http://vimeo.com/57950513

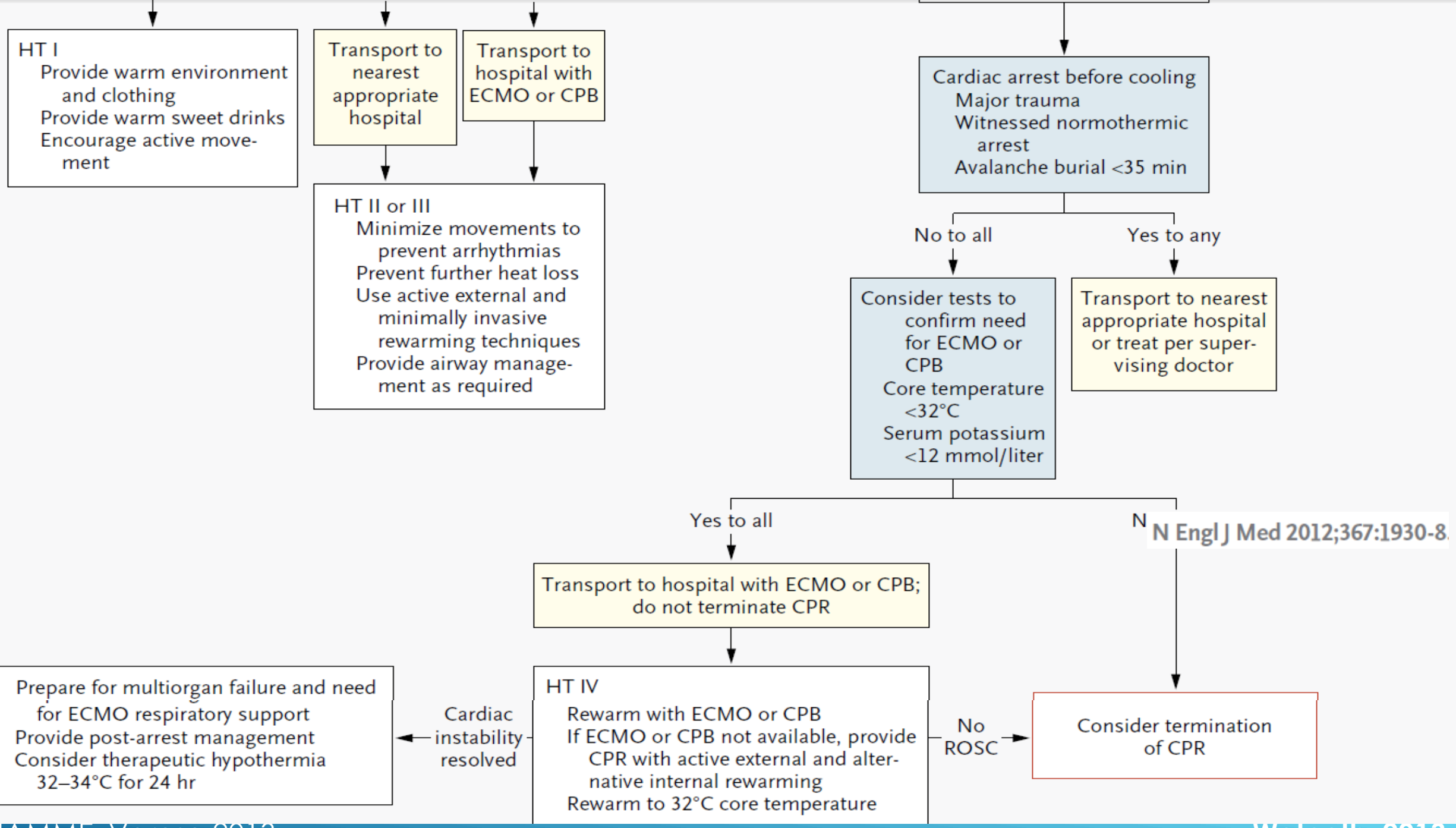
NAMME, Varese 2013

Walpoth, 2013

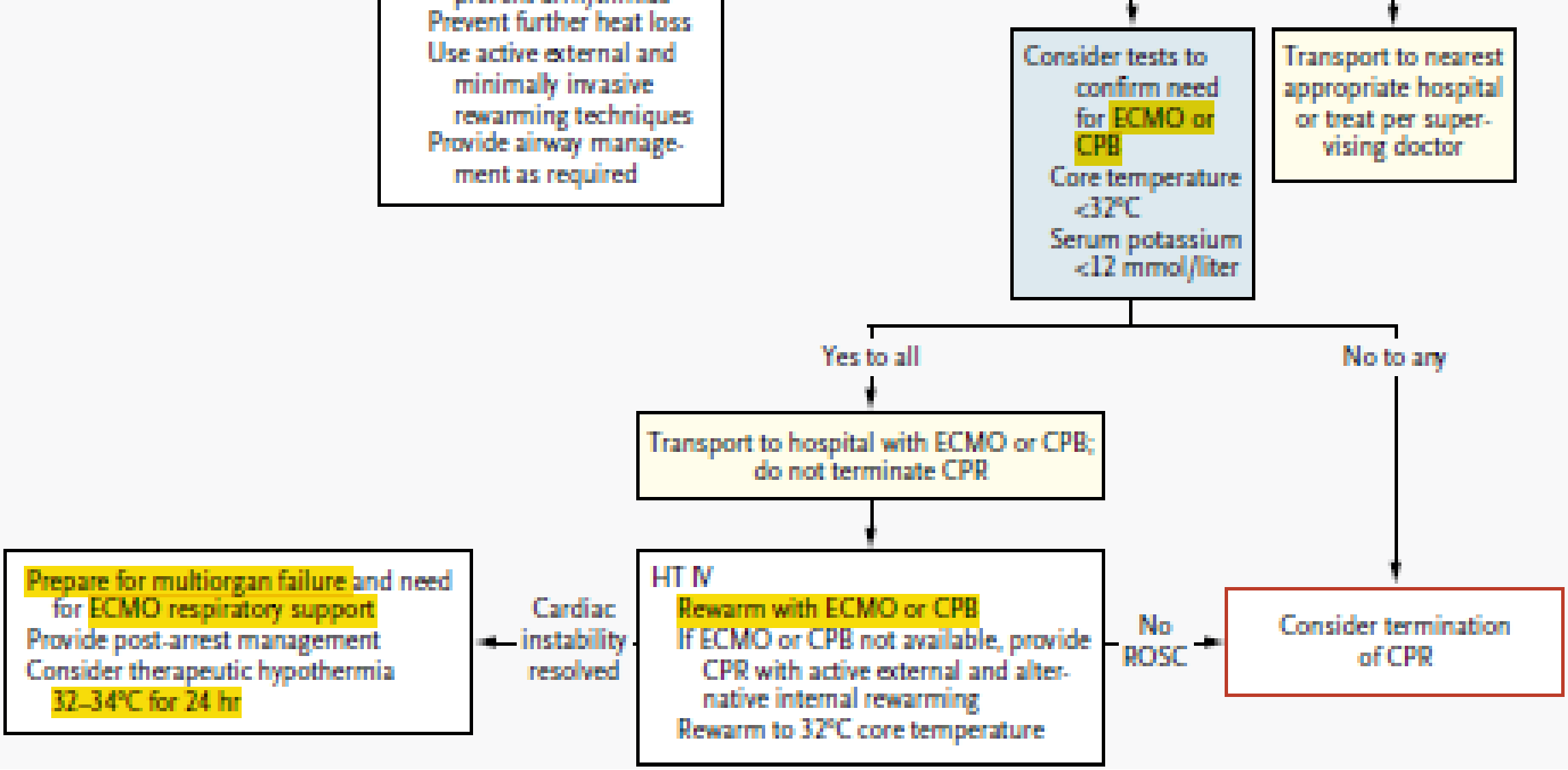
Management and Transport in Accidental Hypothermia 2012

N Engl J Med 2012;367:1930-8.





Walpoth, 2013



The New England Journal of Medicine
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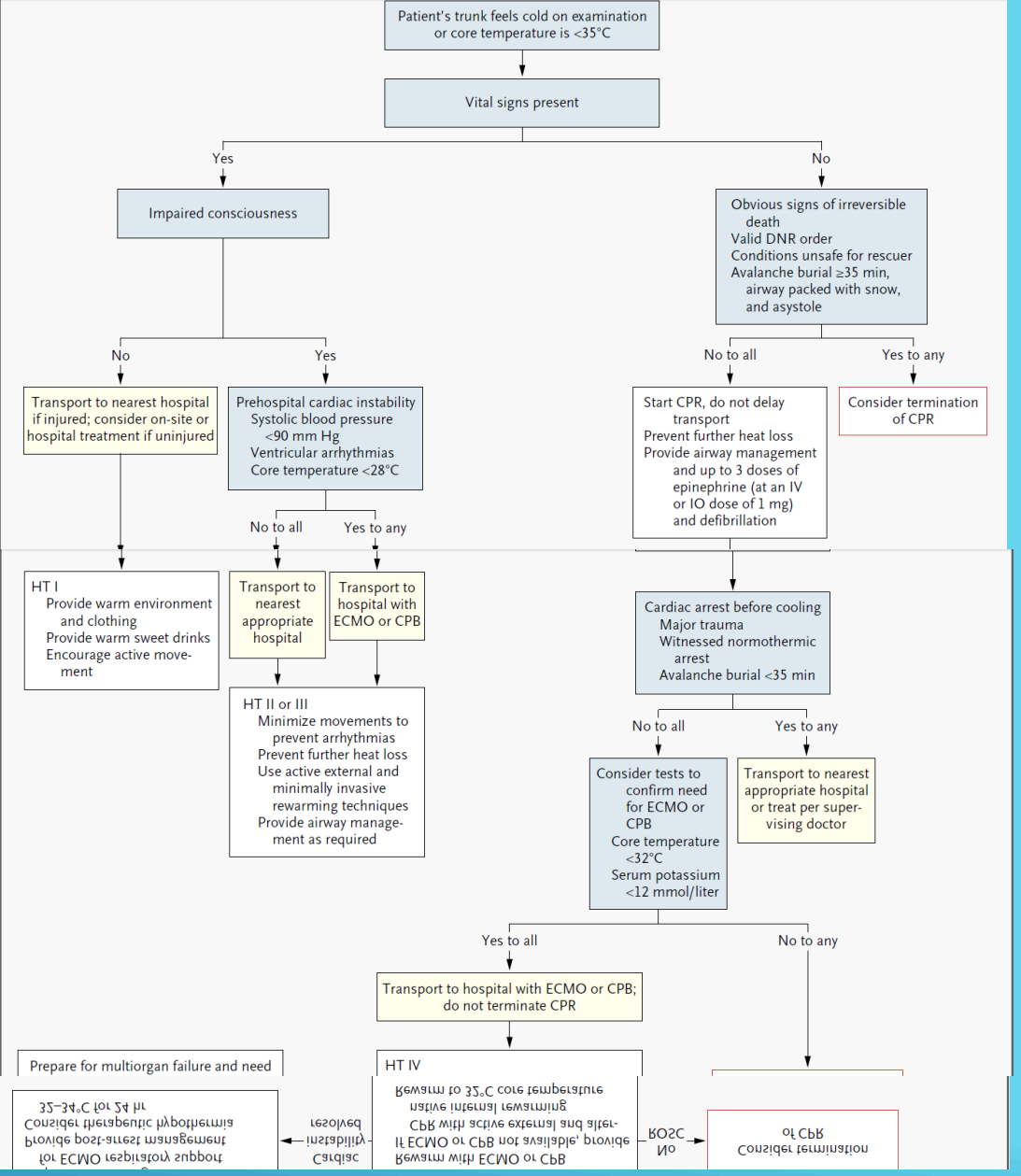


N Engl J Med 2012;367:1930-8

NAMME, Varese 2013

Walpoth, 2013

Perspectives

- 1000 cases
- Simplified Emergency/ICU rewarming with ECMO by the Cardiac Team
- Adjoining of a frostbite registry by Dr Cauchy, Chamonix

NAMME, Varese 2013

Benefits from the IHR

1. Large numbers = statistical power
2. All cases should be recorded: lessons from negative outcomes
3. Comprehensive data-base: standardized entries and no missing values
4. Follow-up of patient from accident to home : Doctors' and patients' benefit
5. Helps your research and quality control since the entered data are yours !

Walpoth, 2013

Conclusions

1. The IHR should allow the gathering of standardized large number of entries of accidental hypothermia victims

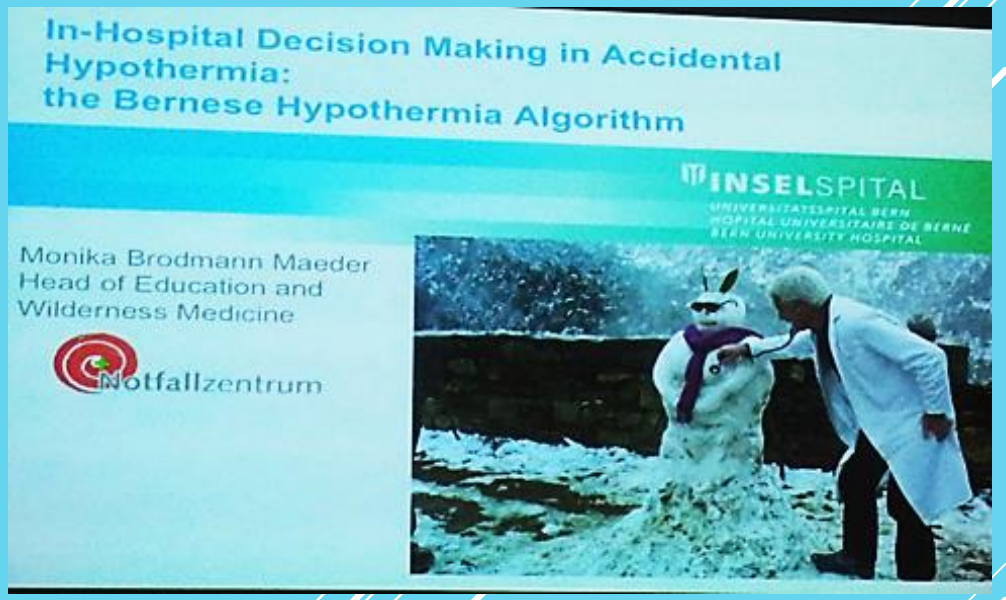
2. The data analysis by the International Hypothermia Working Group should find answers to unsolved problems and foster the recommendations of new Algorithms and Guidelines

3. Additionally, the awareness of better treatment of accidental hypothermia victims will help doctors and patients

NAMME, Varese 2013

Walpoth, 2013

PODCHLAZENÍ - ROZHODOVACÍ PROCES V NEMOCNICI - BERNSKÝ ALGORITMUS



In-Hospital Decision Making in Accidental Hypothermia: the Bernese Hypothermia Algorithm

Monika Brodmannn Maeder

Inselspital Bern
Department Emergeny Medicine
Education and Wilderness Medicine

NAMME, Varese 2013

Overview

- The setting
  - The ED of the University Hospital Bern
- The problem
  - story
- The solution
  - 2010
  - 2013
- The future
  - IHR
- Take home message

The Setting: The University Hospital Inselspital Bern

Covering big parts of the Alps:

- –Bernese Oberland
- –Valais; region of Zermatt

The Setting: The Emergency Department

- Level I trauma center
- 35'000 patients/y
- 1'000 traumas in the shock room/y
- > 1'000 heli landings/y
  - –2/3 primary interventions with direct admission from the site to the hospital

The Setting: Standards in the ER

- Primary and Secondary Survey according to ATLS® guidelines
- Radiological exams
  - –CT scan available within 5 minutes
  - –Multiple trauma protocol
- High-standing quality of cooperation between ED, anesthesia and other specialities
  - –Regular team training

The Problem: Winter 2010

- Situation in January:
  - –Very low temperatures after warm period
  - –Light snowfall
  - –First sunny day
  - –Sunday
- Avalanche
  - –Bernese Oberland
  - –1 ski tourist fully buried in an avalanche

Diemtigtal January 2010;Photo: © SLF/J. Schweizer

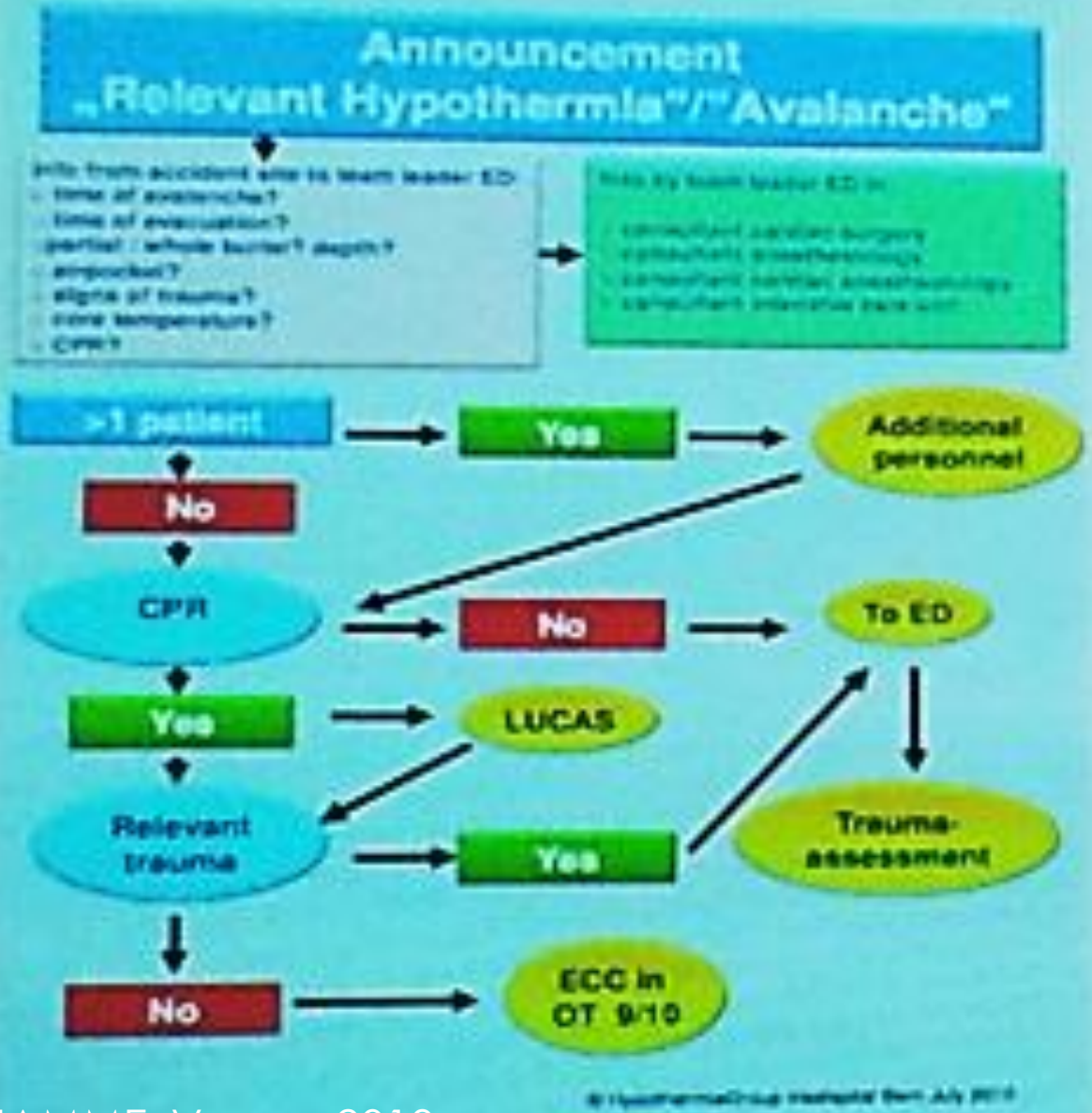
NAMME, Varese 2013

The Problem: Winter 2010

- 2nd avalanche burying the rescuers and the first victim
  - –7 people die, amongst them the emergency physician
  - –ED Bern:
    - 3 patients arrive in severe hypothermia, one of them under CPR
      - –Unclear decision making
      - –Emotions

M. Brodmann Maeder, 2013

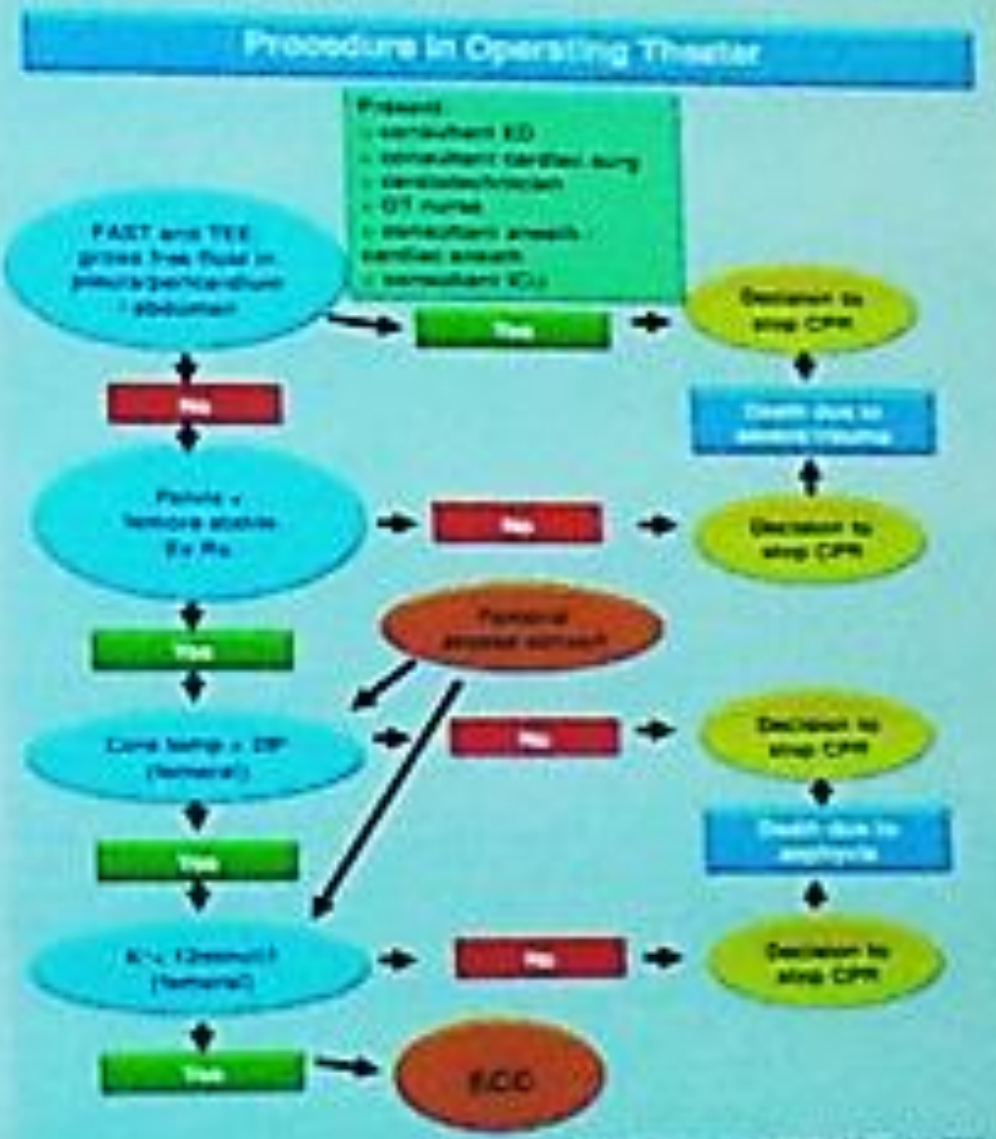
The Solution 2010: Bernese Hypothermia Algorithm



- Organisation within the hospital
  - Team from
    - ED
    - Anesthesia, especially cardiac anesthesia
    - Cardiac surgery
    - ICU
  - >1 patient ?
- Patient assessment
  - No CPR -> „normal" trauma management
  - CPR + Relevant trauma -> trauma management

The Solution 2010: Bernese Hypothermia Algorithm

- CPR + „minor“ trauma:
  - Directly go to OT
  - Prepare for active rewarming
    - Cannulation
  - Exclude death due to asphyxia
    - Core temperature > 28°C
    - Potassium > 12 mmol/l
  - Limited trauma assessment:
    - EFAST
    - Pelvic stability, Rx if unclear
    - The problem of coagulation
  - Team decision: yes we go!



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The Solution 2010: Bernese Hypothermia Algorithm

- During rewarming
  - –Control of volemia
    - Signs of hemorrhage?
      - –Hb
      - –Re-FAST
- Defibrillation when appropriate
- Weaning from ECC
- Therapeutic mild hypothermia for 12 hrs

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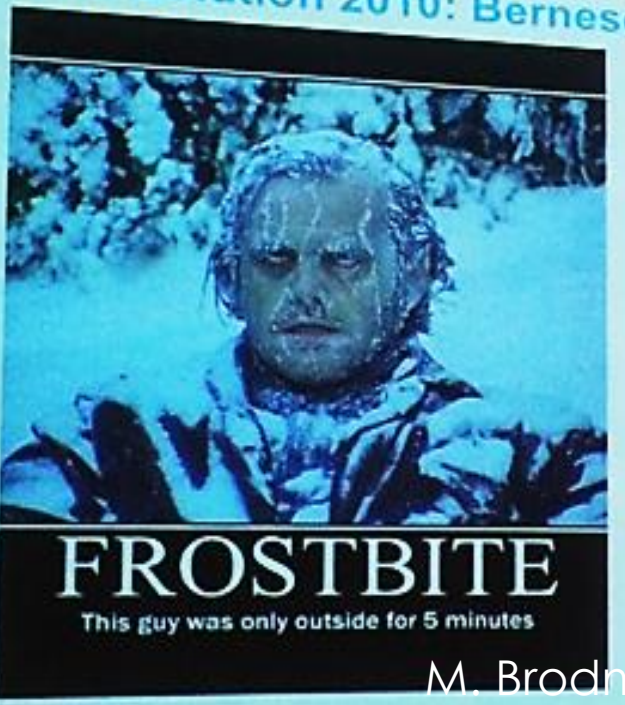
The Solution 2010: Bernese Hypothermia Algorithm



- Trauma assessment according to multiple trauma protocol
- ICU therapy
- Secondary Survey
  - –Find all injuries
  - –Find frostbite!

M. Brodmann Maeder, 2013

Injury. 2011 May;42(5):539-43. doi: 10.1016/j.injury.2010.11.037.

The Bernese Hypothermia Algorithm: a consensus paper on in-hospital decision-making and treatment of patients in hypothermic cardiac arrest at an alpine level 1 trauma centre.

Monika BM, Martin D, Balthasar E, Stefan L, Roland D, Lars E, Luca M, Markus N, Mario S, Eva RK, Heinz Z, Aristomenis EK.

University Centre for Emergency, Inselspital, Bern University Hospital, Switzerland. Monika.Brodmann@insel.ch

NEJM 2012

- Douglas Brown, Hermann Brugger, Jeff Boyd, Peter Paal
- Current Concepts; Accidental Hypothermia
- NEnglJMed2012; 367:1930-8

The Solution 2013

- New algorithm?
  - –Renewal of the interdisciplinary Accidental Hypothermia Working Group in Bern
  - –Integrate ECMO

- New algorithm:
  - –AH WG in Bern
    - Integrate ECMO
- November 27th; First Swiss Accidental Hypothermia Day
  - National guidelines for the in-hospital treatment of patients in severe accidental hypothermia

1st Swiss Accidental Hypothermia Day

- With international experts:
  - –Hermann Brugger
  - –Peter Mair
  - –Bruno Durrer

The Future: International Collaboration

Inselspital Bern / Switzerland

PLNN Hospital Lukla / Nepal

The Future: Data Collection and Recommendations

- Open questions:
  - Correct speed of active rewarming?
  - Laboratory findings other than potassium to facilitate decision-making?
    - pH?
    - Lactate?

The Future: Data Collection and Recommendations

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  - Correct speed of active rewarming?
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M. Brodmann Maeder, 2013
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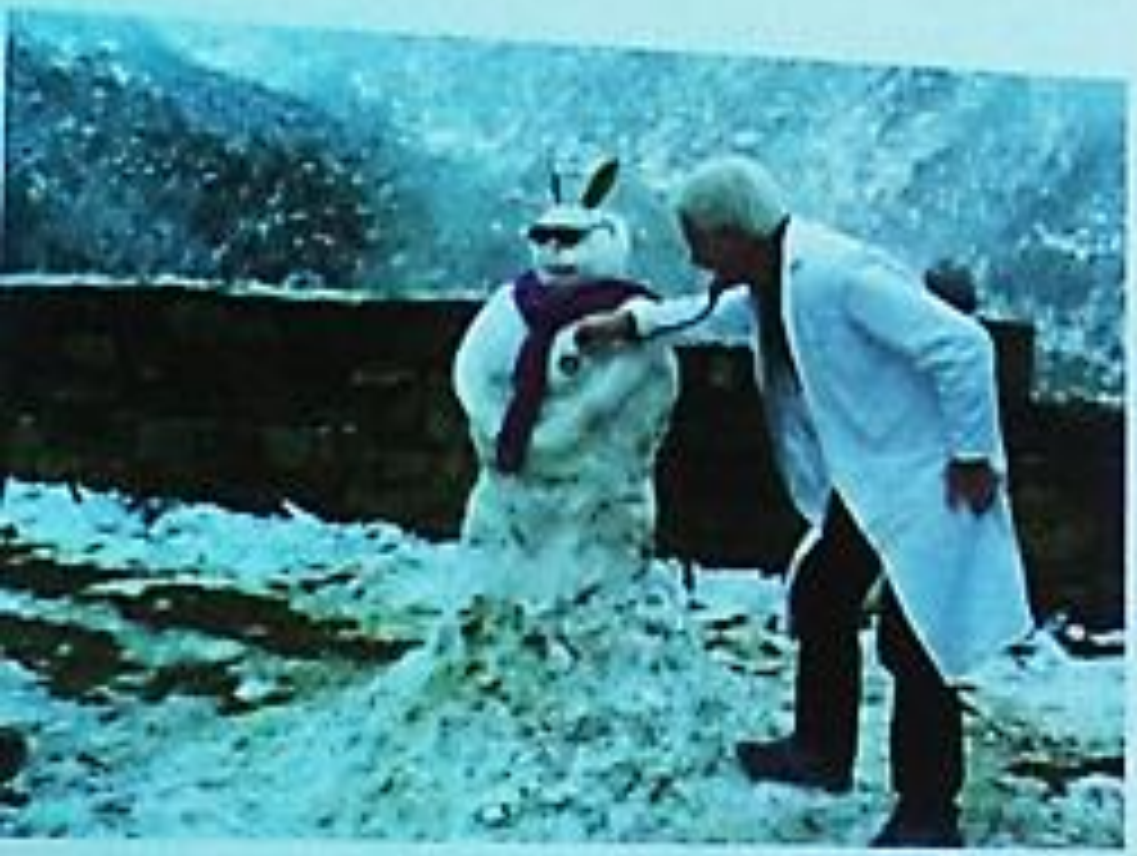
Take Home Message



- Standards for preclinical therapy well-accepted
- In-hospital decision-making tbd
  - Standard of care
  - Multidisciplinary team approach
- SOC / Algorithm:
  - Exclude asphyctic death
  - Exclude traumatic death
  - Rewarm
  - Assess injuries and frostbites
- Create a team
  - Know your setting and specialists
    - ECMO / CPB
- Implement and train

SVĚTOVÉ PERSPEKTIVY ZÁCHRANY V HORÁCH

World Perspectives in Mountain Rescue

John Ellerton

Family doctor in the Lake District
United Kingdom

NAMME, Varese 2013

Mountain Rescue – very simple concept

1. Environment = Mountain or Remote
2. Patient with an injury or illness
3. Rescue team

Mountain?

Localism

- knowledge of terrain
- local weather patterns
- hot spots for injury
- resources that can be deployed in a timely manner

Functional unit = local mountain rescue team

Mountain Rescue – organization

- Voluntary ⟷ Paid
- Terrestrial ⟷ Helicopter
- Police ⟷ Fire ⟷ Medical
- €€€€ ⟷ Resource/Political

Ellerton, 2013

More important mountain rescuers

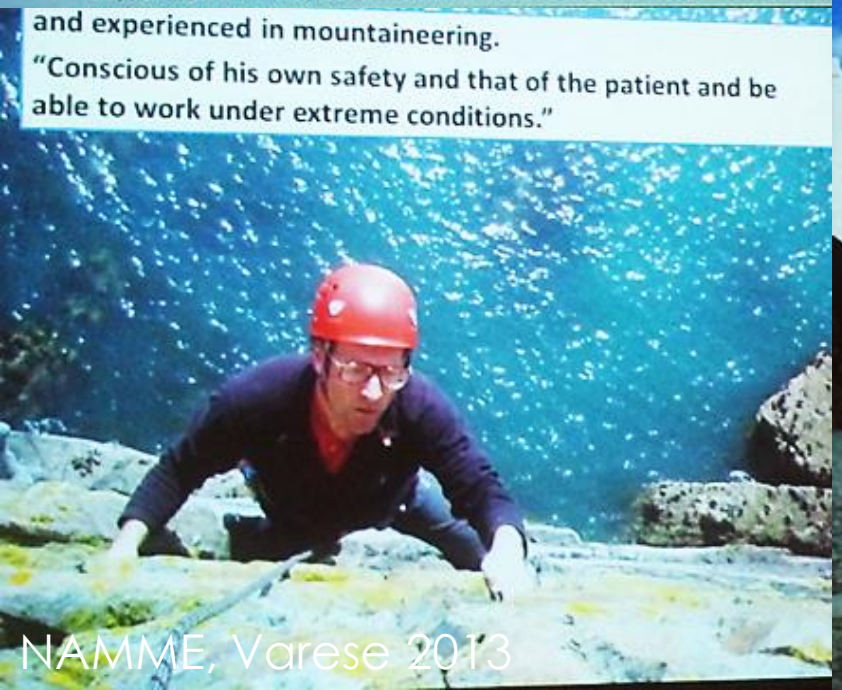
must be physically fit

- Typical load was 17% of body mass
- VO_2 max 52.6 ± 4 ml/kg/min (compared with naval firefighters (52; 26 yr old); city ambulance (37; 45 yr old)
- Heart Rate > 154 min^{-1} for 80% of ascent (6% in descent)

Physiological demands of mountain rescue work. Emerg Med J (2011)

and experienced in mountaineering.

"Conscious of his own safety and that of the patient and be able to work under extreme conditions."



Mountain Rescue Education

1. Localism and being rooted in mountaineering
2. Educational opportunities and support
3. Internal Rescue team development

More important mountain rescuers

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Mountain Rescue Education

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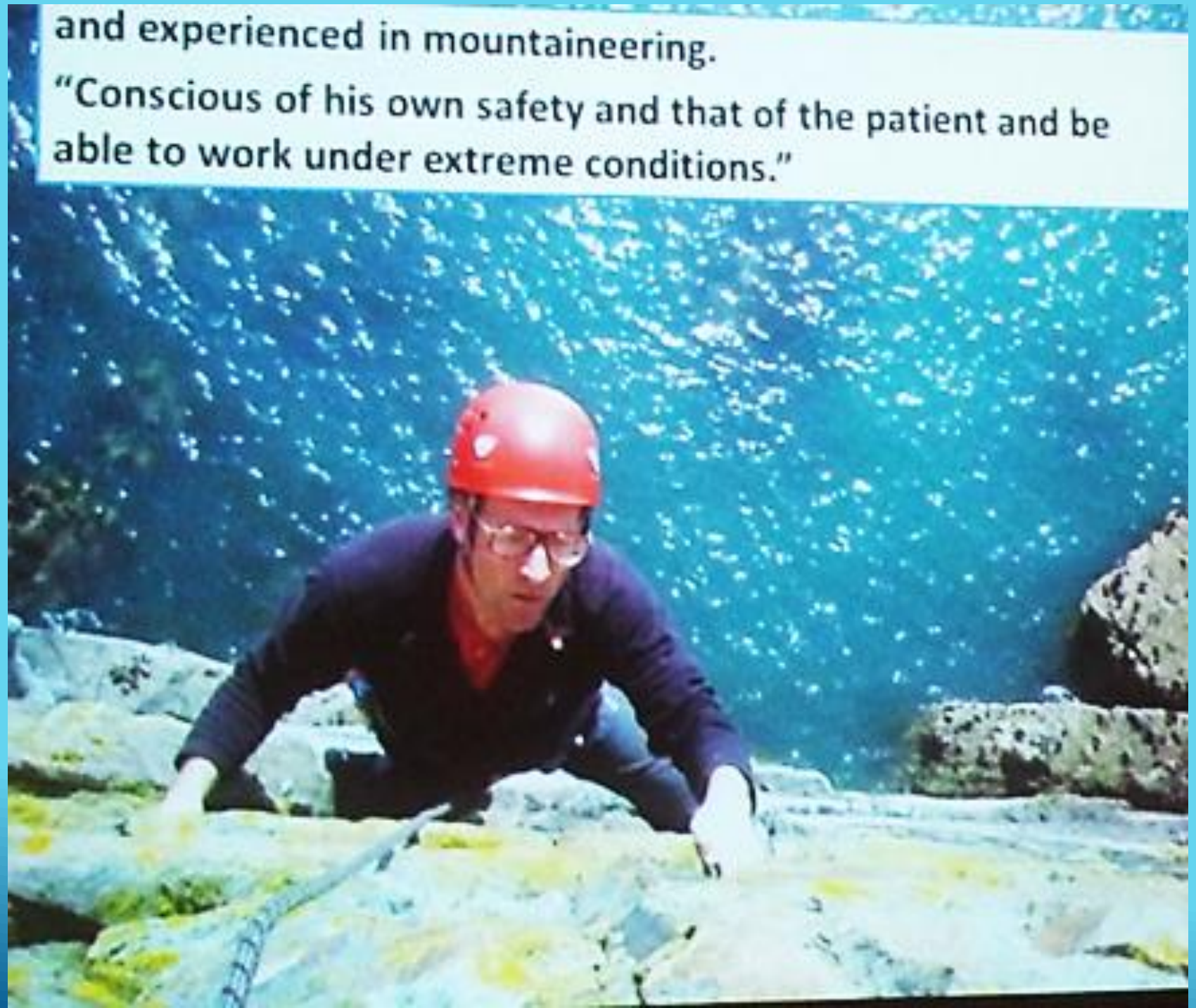


UIAA

DIPLOMA IN MOUNTAIN MEDICINE

NAMME, Varese 2013

UIAA

DIPLOMA IN MOUNTAIN MEDICINE

Ellerton, 2013

ÚRAZ HRUDNÍKU V HOROLEZECKÉ PRAXI

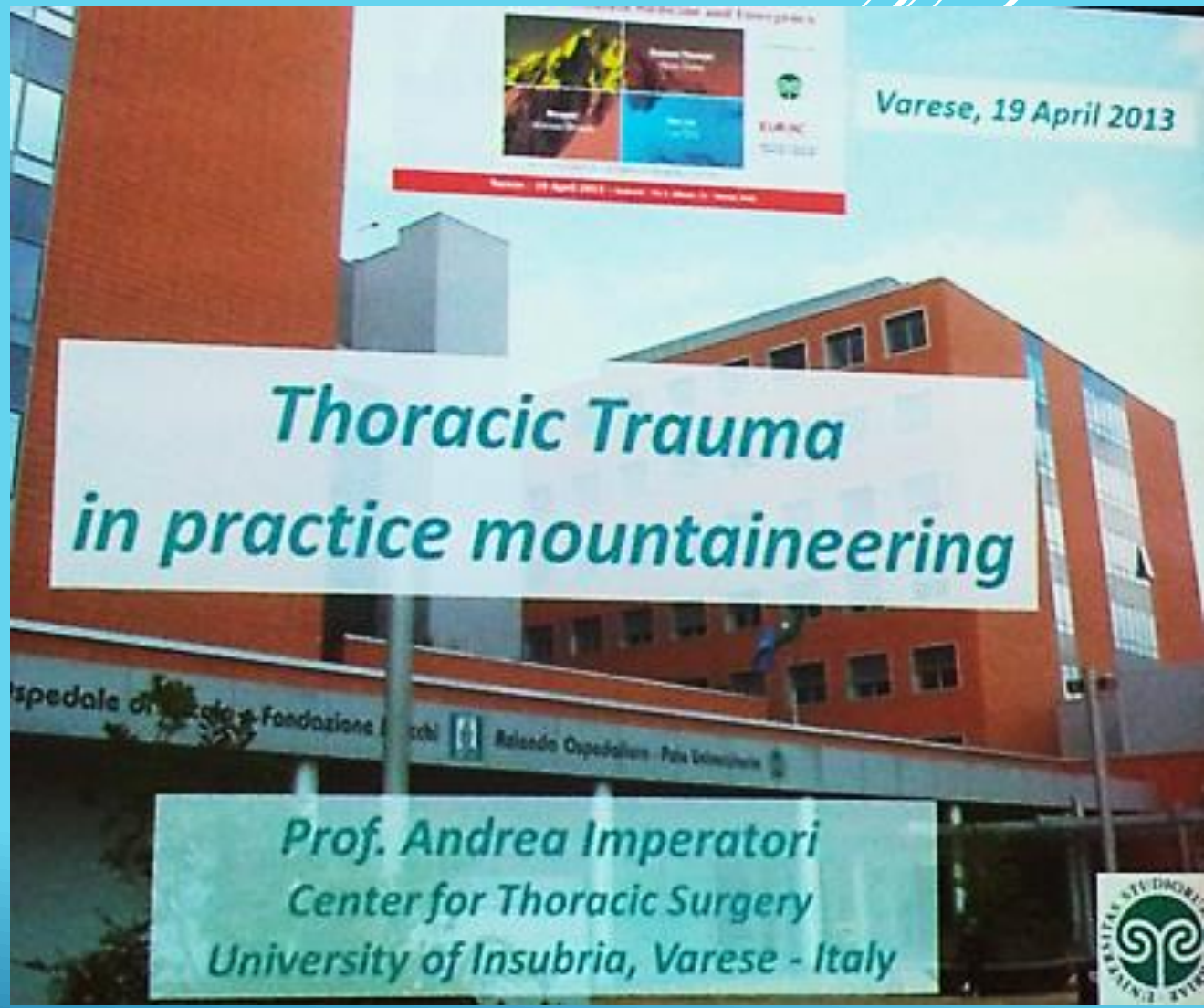
Trauma in Practice Mountaineering

Prof. Andrea Imperatori

Center for Thoracic Surgery

Universita of Insubria, Varese - Italy

NAMME, Varese 2013



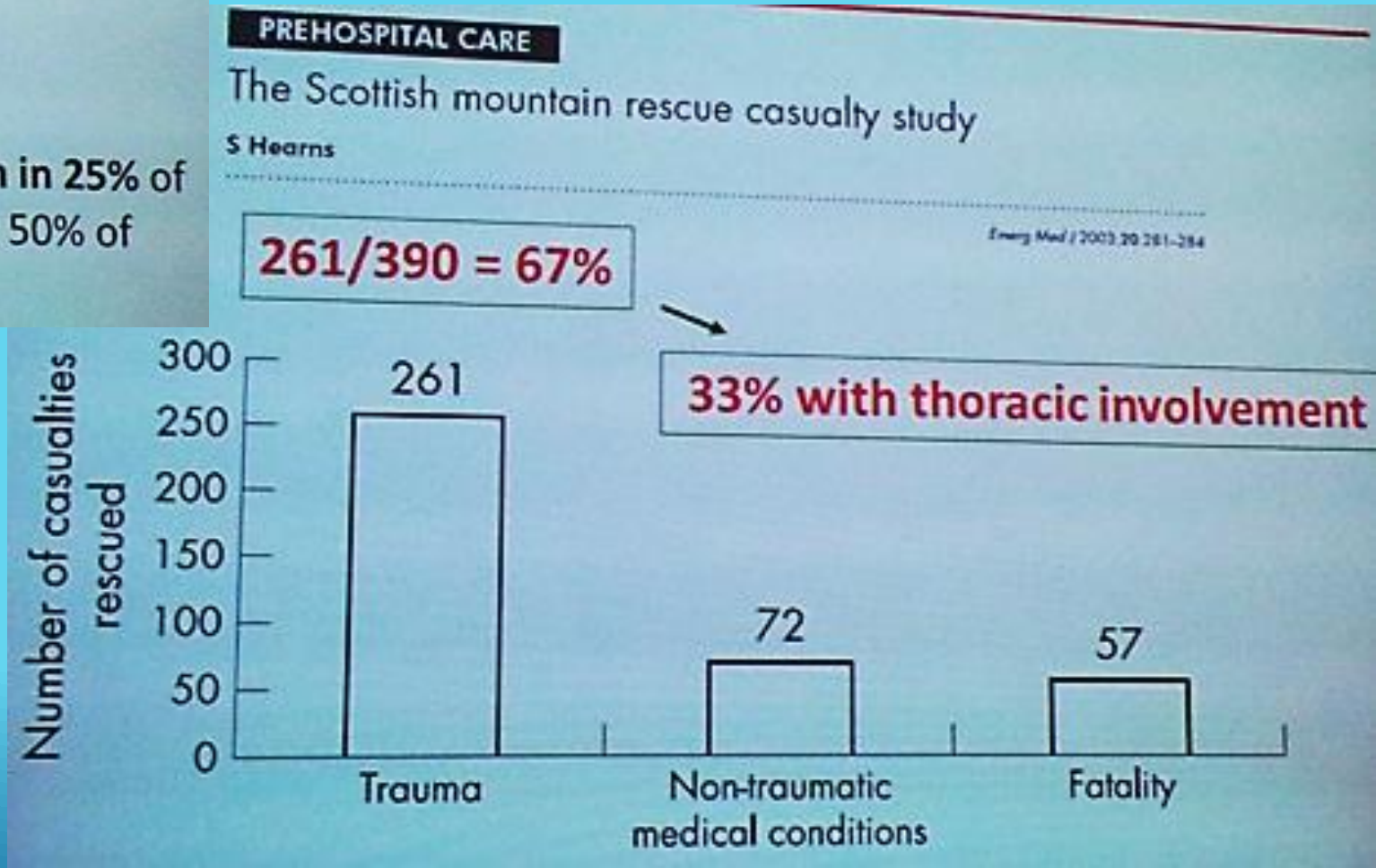
THORACIC TRAUMA EPIDEMIOLOGY

- **Trauma** is correlated with **high mortality**
- In Italy there are about **4,000 death/year** caused by trauma
- **Thoracic injury is the primary cause of death in 25%** of trauma victims and is a contributing factor in 50% of trauma-related deaths

PREHOSPITAL CARE

The Scottish mountain rescue casualty study

S Hearns



Imperatori, 2013

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PREHOSPITAL CARE

The Scottish mountain rescue casualty study

S Hearns

HIGH ALTITUDE MEDICINE & BIOLOGY
Volume 5, Number 3, 2004
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Severity and Pattern of Injury in Survivors of Alpine Fall Accidents

MATTHIAS HOHLRIEDER,[1,2] STEPHAN ESCHERTZHUBER,[1] HEINRICH SCHUBERT,[3] RICHARD ZINNECKER,[2,4] and PETER MAIR[1,2]

Thoracic trauma		
Rib fracture	17	(17.5)
Pneumothorax	10	(10.3)
Pulmonary contusion	5	(5.1)
Thoracic spine fracture	8	(8.2)

40/97 = 41%

Imperatori, 2013

NAMME, Varese 2013

Volume 11, Number 4, 2010
Mary Ann Liebert, Inc.
DOI: 10.1089/ham.2010.1027

Experience with Helicopter Rescue Missions for Crevasse Accidents

Matthias Hohlrieder,[1,2] Franz Kroesslhuber,[2] Wolfgang Voelckel,[3] Martin Lutz,[4] and Peter Mair[2,5]

TABLE 2. PATTERNS OF INJURY IN CREVASSE ACCIDENTS

Injury	*Patients (n)*	
Injuries with AIS score ≥4	18	
Thorax	9	9/18 = 50%
Extremities and/or pelvis	5	
Head	3	
Abdomen	1	
Injuries with AIS score 3	29	
Extremity fractures	11	
Lumbar or thoracic spine fracture	7	11/29 = 38%
Craniofacial fracture	7	
Rib fractures	4	

AIS, Abbreviated Injury Scale.

NAMME, Varese 2013

Imperatori, 2013

IMMEDIATE PRIORITIES

1	Airways Obstruction
2	Tension Pneumothorax
3	Open Pneumothorax
4	Flail Chest
5	Hemothorax (massive)
6	Cardiac Tamponade

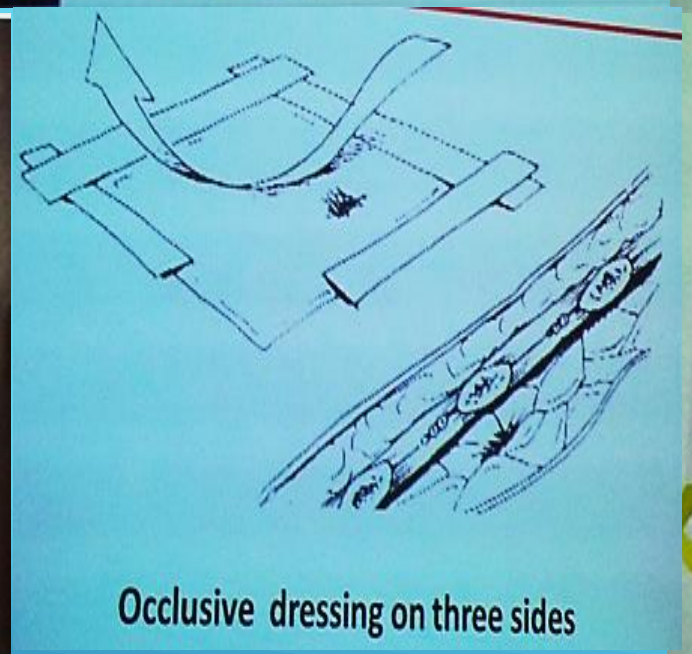
SECOND PRIORITIES

1	Pneumothorax
2	Hemothorax
3	Cardiac contusion
4	Diaphragm lesion
5	Thoracic aortic lesion
6	Tracheo-bronchial lesion
7	Esophageal lesion

TENSION PNEUMOTHORAX
(2-12% of thoracic trauma)

- Unilateral absence of breathing signs
- Contralateral deviation of the trachea
- Hypotension, tachypnea
- Jugular turgor (inconstant)
- Cyanosis (inconstant)
- Subcutaneous emphysema (inconstant)

Pleural decompression or chest drainage



Occlusive dressing on three sides

OPEN PNEUMOTHORAX
(4% open thoracic trauma)

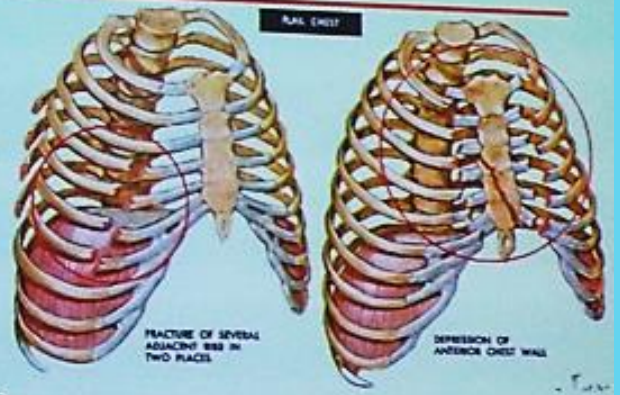
- Chest wall with open wound > 2/3 tracheal diameter
- Preferential entry of air from the parietal defect ("sucking" injury)
- Alteration of mechanical ventilatory

- Temporary closure of the defect with occlusive dressing on three sides

- Surgical closure of the defect and chest drainage

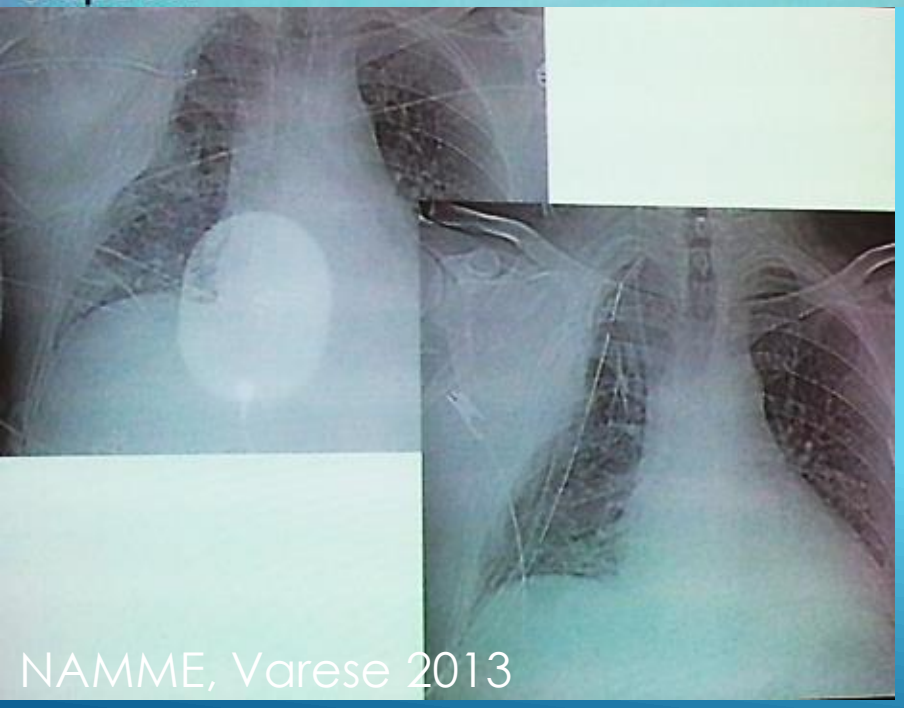
FLAIL CHEST

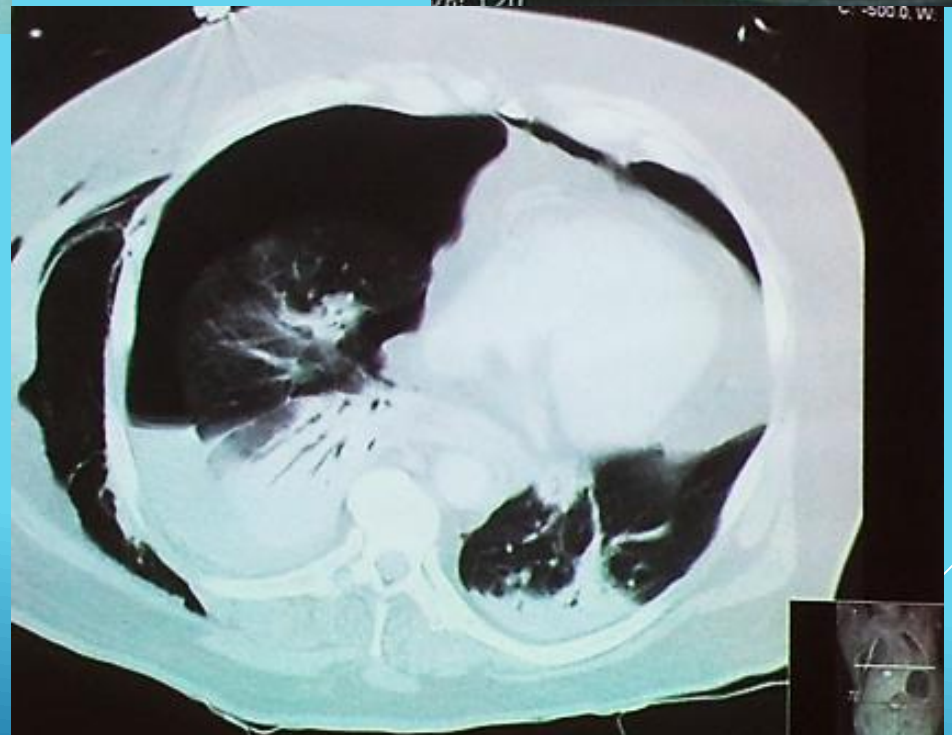
Often associated to:
- Hemothorax
- Pneumothorax
- Lung contusion



Dyspnea - Tachypnea
PAIN – Bone rattle

Modest manual compression or drape set





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Display Settings: Abstract

Send to:

J Am Coll Surg. 1998 Aug;187(2):130-8.

Operative chest wall stabilization in flail chest--outcomes of patients with or without pulmonary contusion.

Voggenreiter G, Neudeck F, Aufmkolk M, Obertacke U, Schmit-Neuerburg KP.
Department of Trauma Surgery, University Hospital Essen, Germany.

Abstract

BACKGROUND: The aim of operative chest wall stabilization in patients with flail chest and respiratory insufficiency is to reduce ventilator time and avoid ventilator associated complications. The purpose of this retrospective study was to analyze the indications and outcomes of operative chest wall stabilization in defined groups of patients sustaining flail chest with and without pulmonary contusion.

METHODS: The hospital records of 405 patients with multiple trauma (Injury Severity Score > 17) between 1988 and 1994 were reviewed. Forty-two patients sustained flail chest. Twenty of these underwent operative chest wall stabilization for the following indications: 1) flail chest with indication for thoracotomy due to intrathoracic injury (n = 6); 2) flail chest without pulmonary contusion (n = 9); 3) paradoxical movement of a chest wall segment in the weaning period from the respirator (n = 3); and 4) severe deformity of the chest wall (n = 2). For the purpose of analysis the patients were separated into groups: group 1: operative chest wall stabilization in flail chest without pulmonary contusion (n = 10); group 2: operative chest wall stabilization in flail chest with pulmonary contusion (n = 10); group 3: flail chest without pulmonary contusion and without chest wall stabilization (n = 18); group 4: flail chest with pulmonary contusion and without chest wall stabilization (n = 4). Data were coded for time of operation, duration of ventilatory support, and complications.

RESULTS: There were no significant differences in age, severity of injury, and extent of injury between groups 1, 2, and 3 ($p < 0.42$). Group 4 was excluded for statistical analysis because of the small number of patients. Patients in group 1 required a shorter ventilatory support time compared to patients in group 3 (6.5+/-7.0 versus 26.7+/-29.0 days) and group 2 ($p < 0.02$). In group 2 (ventilator time 30.8+/-33.7 days) early extubation was only possible in patients being operated on for chest wall instability during weaning from the ventilator. One patient in group 1, three patients in group 2 and five patients in group 3 developed pneumonia with further disturbance of gas exchange. All patients in group 1 survived; deaths in group 2 were attributed to massive hemorrhage in two and septic multiorgan failure in one patient. Four patients in group 3 died of head injury, one of acute respiratory distress syndrome, one of severe hemorrhage, and one of multiple organ failure.

CONCLUSIONS: In patients with flail chest and respiratory insufficiency without pulmonary contusion, operative chest wall stabilization permits early extubation. Patients with pulmonary contusion do not benefit from chest wall stabilization. Secondary operative chest wall stabilization in these patients is indicated when progressive collapse of the chest wall is evident during weaning from the ventilator.

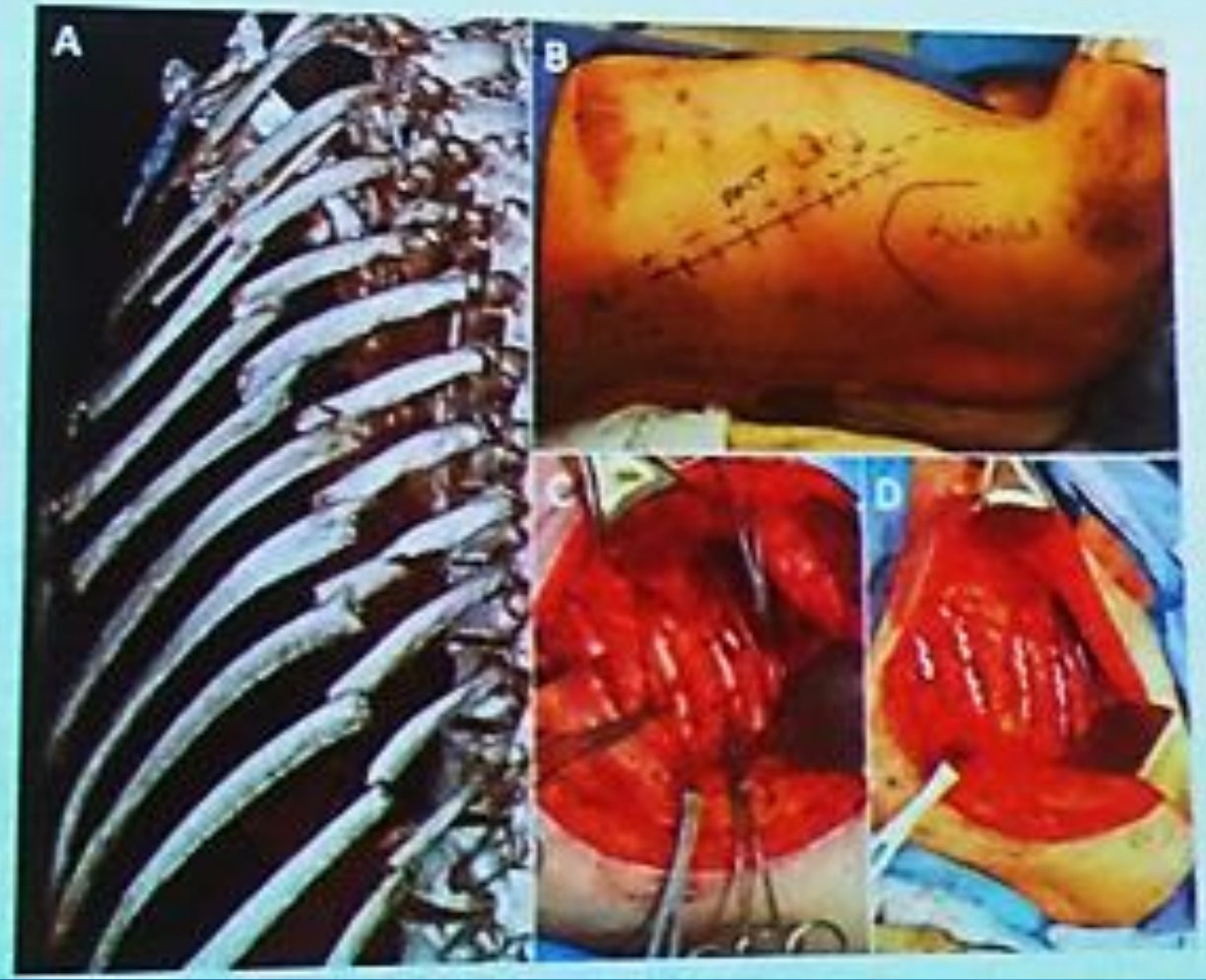
PMID: 9704507 [PubMed - indexed for MEDLINE]

Surgical stabilization of flail chest injuries with MatrixRIB implants: A prospective observational study

Michael Bottlang[a,*], William B. Long[a], Daniel Phelan[a], Drew Fielder[b], Steven M. Madey[a]

[a] Legacy Research Institute, 1225 NE 2nd Ave, Portland, OR 97232, United States
[b] 1409N. IH 35, Ste 300, Austin, TX 78701, United States

Injury. 2013 Feb;44(2):232-8.



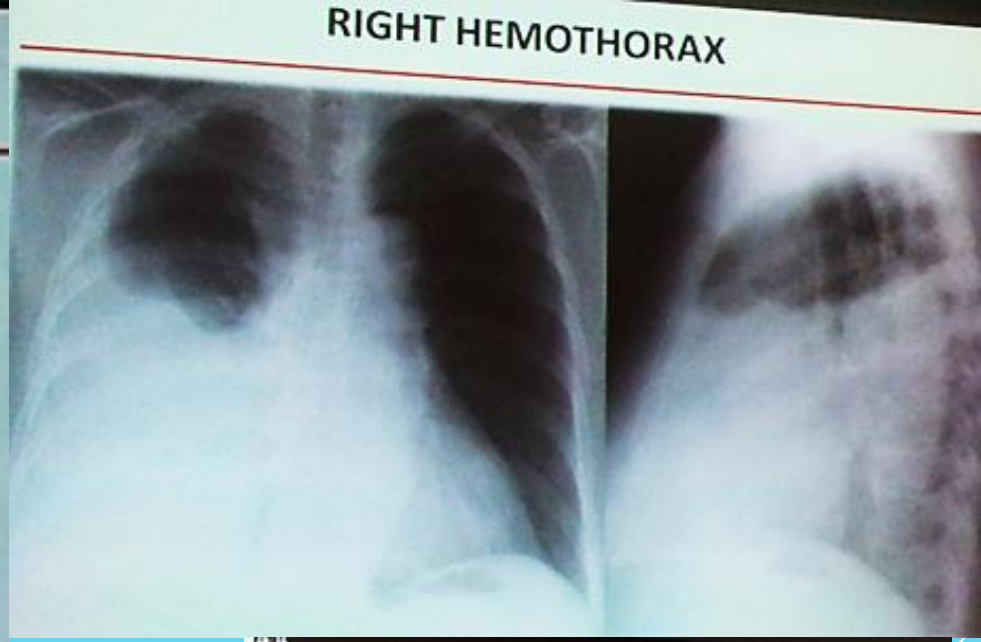
Imperatori, 2013

Reconstruction plates

HEMOTHORAX

Hemothorax is the second most common complication of chest trauma, after rib fractures

- It can be **effectively treated by** placement of a **chest tube**
- **18-30%** of patients with chest tube will develop **retained** or clotted **hemothorax**
- Nearly half of these patients will require thoracotomy for non resolving intrapleural collection



NAMME, Varese 2013

Imperatori, 2013

Hemothorax

Chest tube + i.v. fluids

> 1500 ml

> 200 ml / h during 2 – 4 h

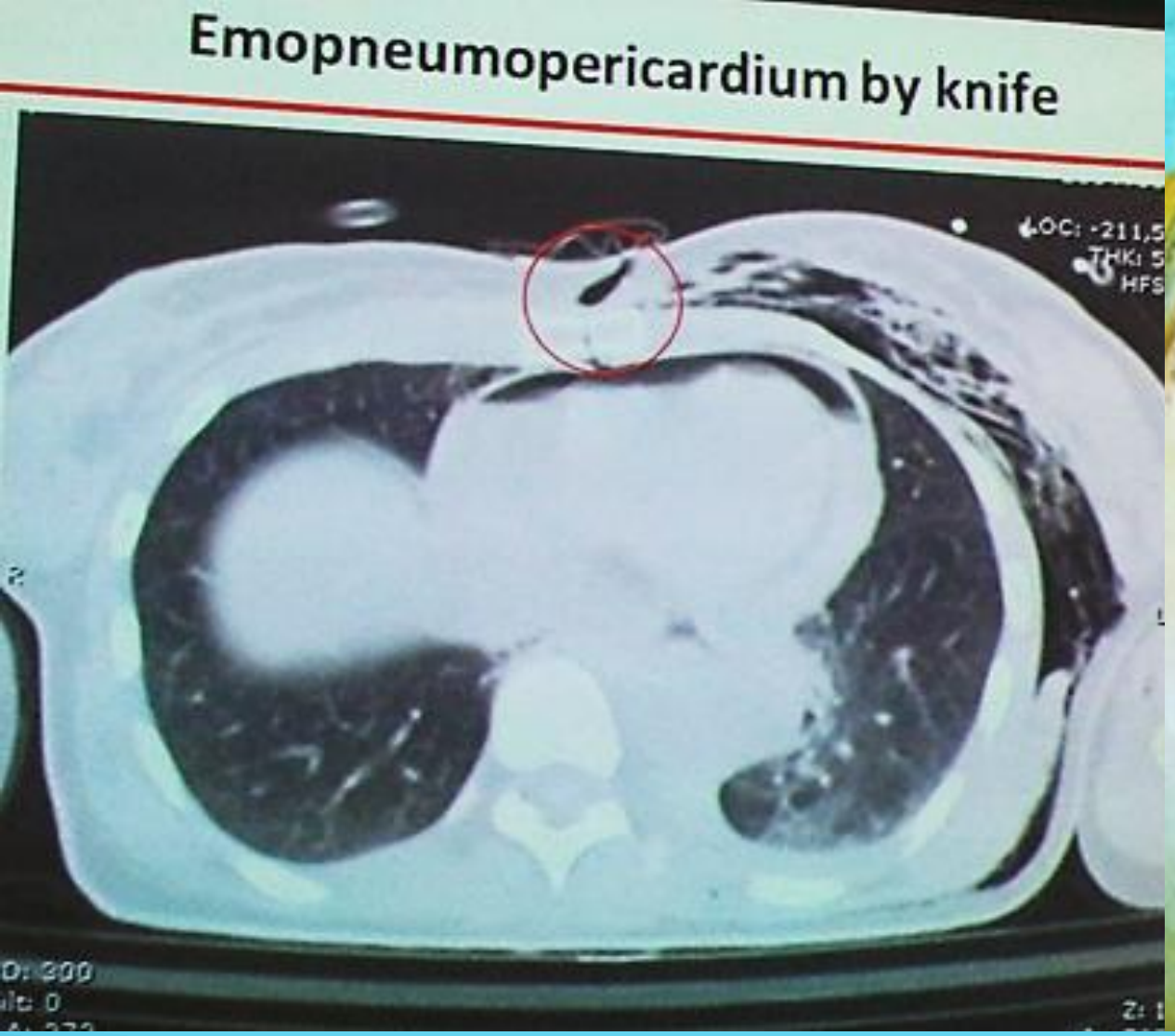
Continuous need of transfusion

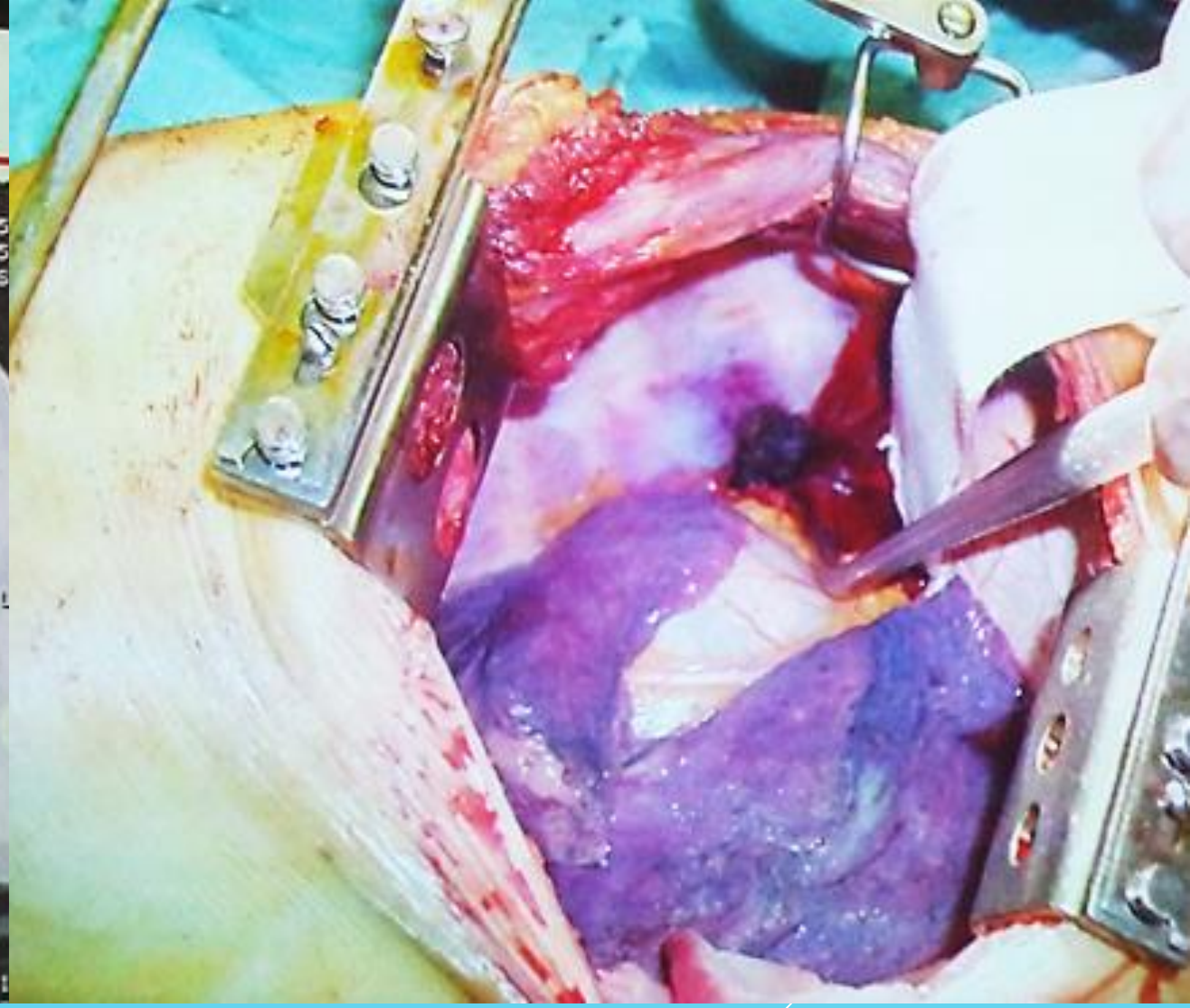
Hemodynamic instability

URGENT THORACOTOMY

ATLS, 2005 guidelines

U.S., 27 yrs; right parasternal wound associated to ipsilateral pneumo-hemothorax (2000 ml)





extracorporeal membrane oxygenation (ECMO)

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Imperatori, 2013

DIAGNOSIS OF THORACIC TRAUMA

On the field

- Call for Rescue Team - Helicopter
- Clinical evaluation
- Ultrasonography (Rescue Team)

In the Hospital:

- Chest X-ray
- Chest CT scan

TREATMENT OF THORACIC TRAUMA

- 85-90% ➡ **CONSERVATIVE**
  - Observation
  - Stabilization (central vein access)
  - Chest tube
  - Intensive Care Support
- 10-15% ➡ **SURGERY**
  - 10% in blunt thoracic trauma
  - 15-30% in penetrating thoracic trauma

ATLS, 2005 guidelines

EMERGENCY THORACOTOMY

YES

Penetrating thoracic trauma,
No pulse, persistent heart activity

Procedures

1. Intra-pericardic blood evacuation
2. Intra-thoracic massive blood loss control
3. Cardiac resuscitation
4. Descending aorta clamping

NO

Blunt thoracic trauma,
No pulse, persistent heart activity

Imperatori, 2013

MASSON
www.em-consulte.com

Article original

Les traumatisés graves en montagne : une étude observationnelle☆

Severe trauma patients in a mountain area: An observational study

C. Jacquot[a,*], F. Mongenot[a], J.-F. Payen[a], J. Brun[a], P. Albaladejo[a,b], J.-L. Bosson[b], M. Freysz[c]

avec une forte incidence de lésions médullaires. La population touchée est essentiellement masculine, entre dix et 30 ans, et les lésions les plus fréquentes sont respectivement les traumatismes crâniens, puis thoraciques. Comme pour les accidentés de la voie publique, les décès sont fréquents, précoces et causés prioritairement par les atteintes cérébrales. Il est important de développer une politique de prévention en montagne par des mesures éducatives et législatives, au même titre que la prévention routière.

Annales Françaises d'Anesthésie et de Réanimation 30 (2011) 730–733

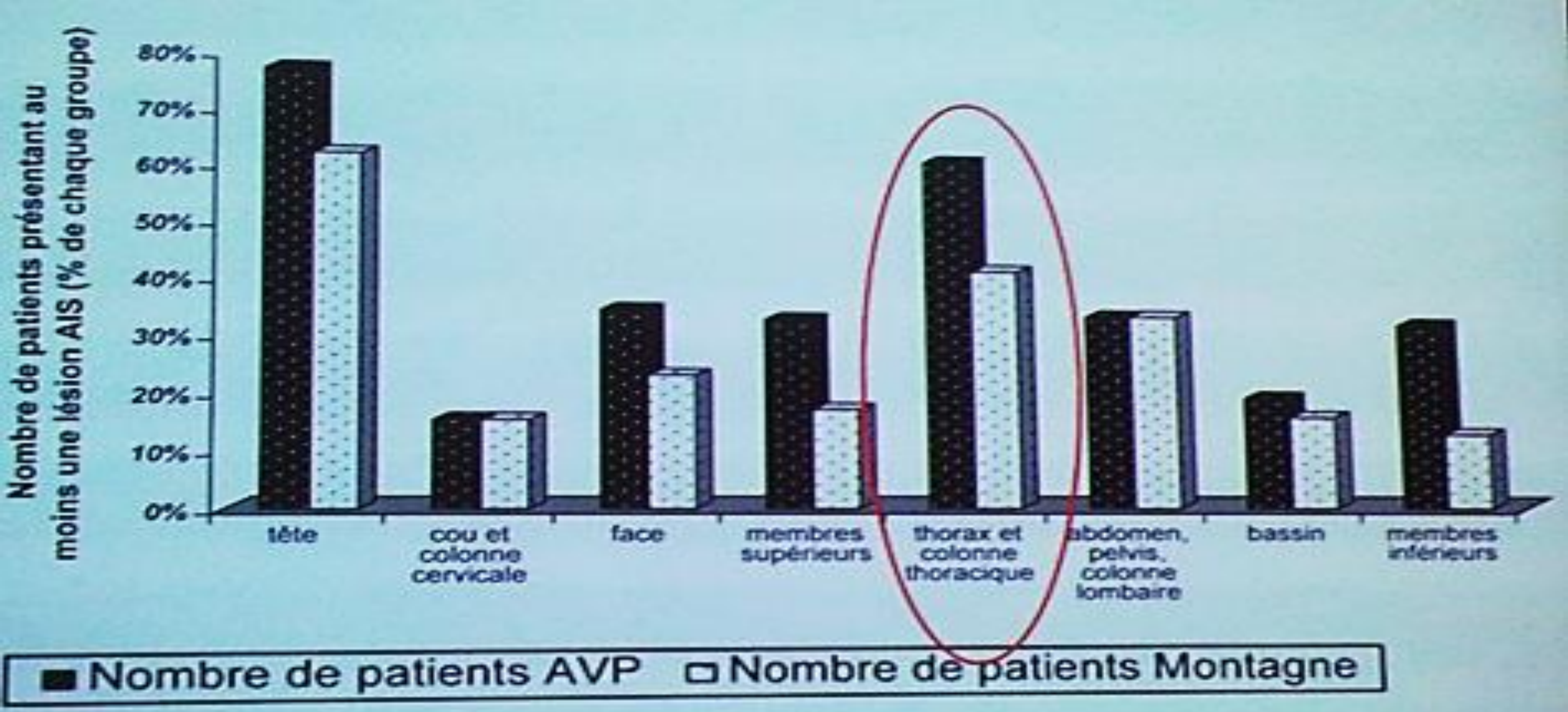

Fig. 2. Répartition des lésions AIS en fonction du groupe.

Annales Françaises d'Anesthésie et de Réanimation 30 (2011) 729–733

Imperatori, 2013

ELSEVIER MASSON

Disponible en ligne sur ScienceDirect
www.sciencedirect.com

Elsevier Masson France
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www.em-consulte.com

Article original

Les traumatisés graves en montagne : une étude observationnelle☆

Severe trauma patients in a mountain area: An observational study

C. Jacquot[a,*], F. Mongenot[a], J.-F. Payen[a], J. Brun[a], P. Albaladejo[a,b], J.-L. Bosson[b], M. Freys

Les trois premières causes de décès dans les deux groupes étaient par ordre décroissant le traumatisme crânien, le choc hémorragique, puis le traumatisme thoracique.

Results. – The study did not show higher severity or mortality rates in patients with mountain accide
In both groups, we found a peak of mortality for young adults and similar causes of death. Howe
spinal cord injuries were statistically more frequent in mountain accidents.
Conclusion. – So, it seems important to continuously warn population about dangers of this playgro

Annales Françaises d'Anesthésie et de Réanimation 30 (2011) 730–73

Resuscitation of avalanche victims: Evidence-based guidelines of the international commission for mountain emergency medicine (ICAR MEDCOM)

Brugger H et al, Resuscitation in press

"Management should include spinal precautions and other trauma care as indicated."

Education + training + multidisciplinary approach

PO STOPÁCH ZABIJÁKA – TRAUMATICKÝ PNEUMOTORAX (MINITHORAKOTOMIE)

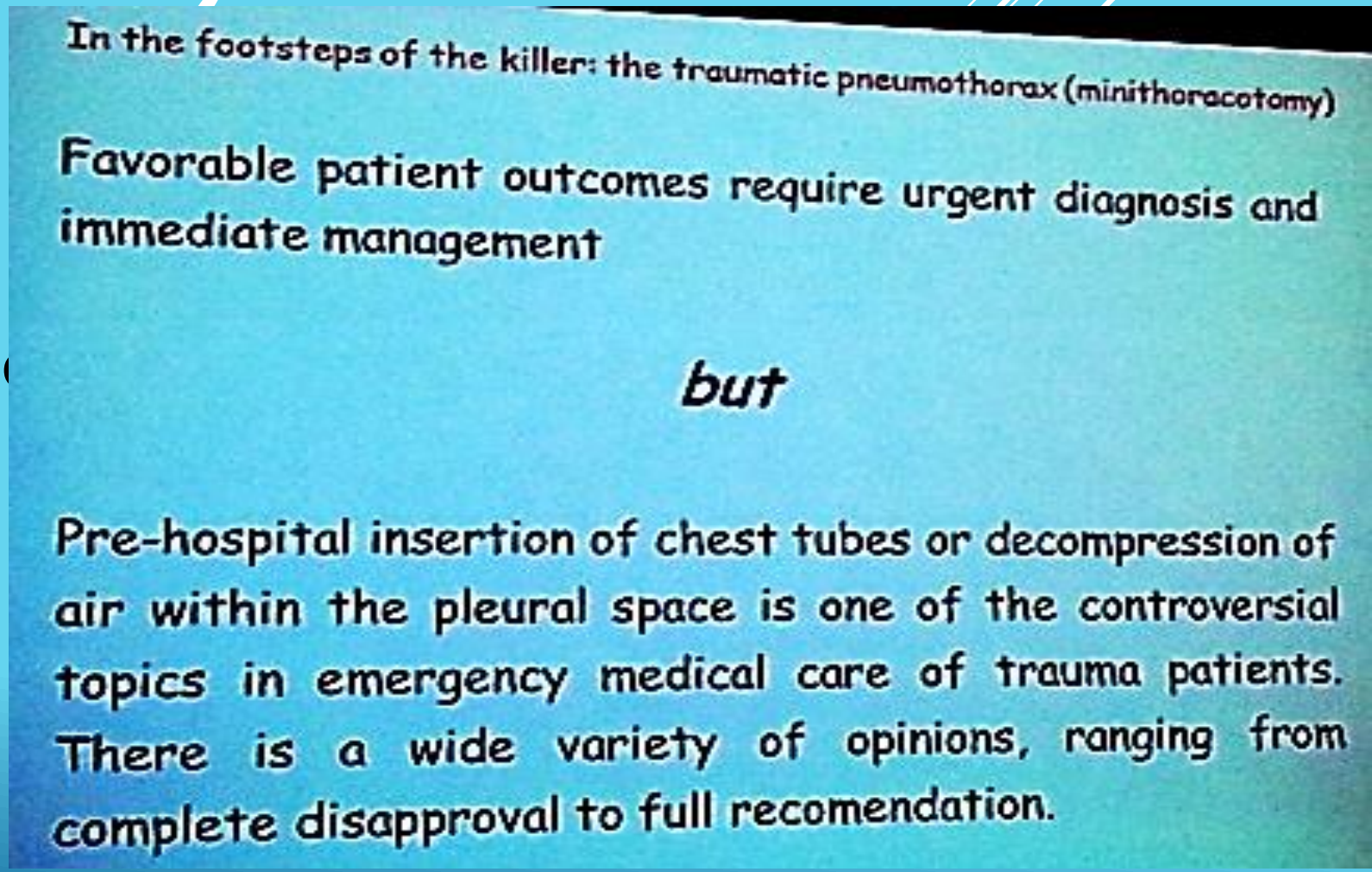
In the Footsteps of the Killer – The Traumatic Pneumothorax (Minithoracc

Adriano Rinaldi

Department of Anaesthesia and Intensive Care

Trieste

NAMME, Varese 2013



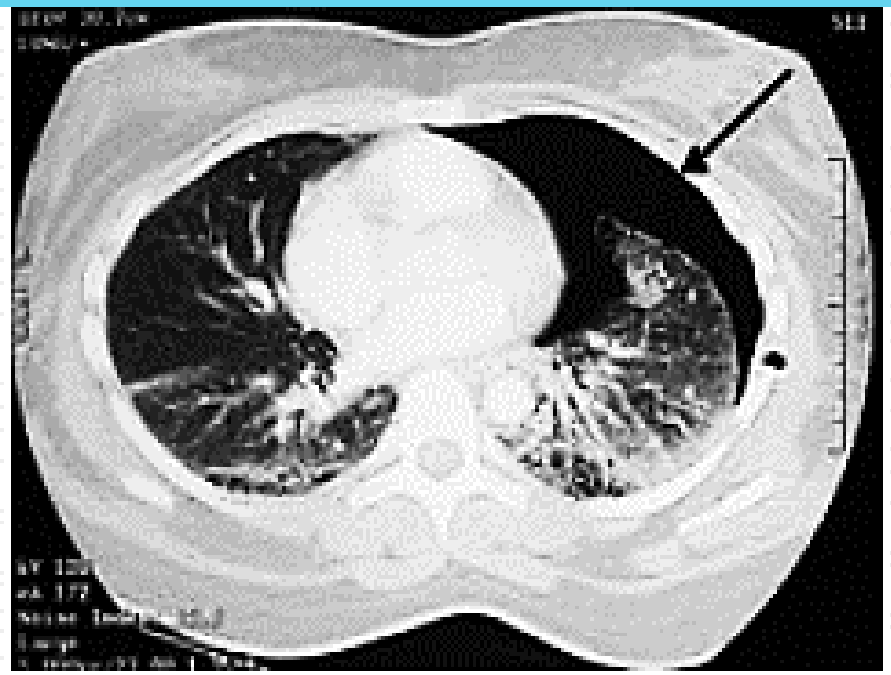
http://cs.wikipedia.org/wiki/Pneumotorax

traumatický pneumotorax

spontánní pneumotorax

ventilový pneumotorax

iatrogenní pneumotorax



CT snímek levostranného pneumotoraxu

HISTORIE

popsán r. 1803
Jean Marc Gaspard Itard
student René Laenneca,
který pořídil úplný klinický obraz roku 1819

Rentgenový snímek oboustranného pneumotoraxu. Šipky ukazují hranice kolabovaných plic.

Pietro, 80 years old

Accident dynamics: head-on car and truck collision

Primary survey:

- conscious, speaks
- thoracic trauma with impairmant of respiratory mechanics, multiple rib fractures, asymmetry on the left side
- vesicular murmur present bilaterally
- respiratory rate: N.A.D.
- pulse oximetry: 97% on O_2 100%
- blood pressure: 200/100
- heart rate: 92 bpm
- cervical neck collar, O_2 100%, 16G peripheral venous catheter, long spinal board

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... at the Emegency Room

GCS 15

SpO_2 80 % with FiO_2 100%

BP 125/70

HR 160 bpm

VM decreased in the left lung

Emergency needle decompression: negative

Chest X-ray:

Multiple-rib fractures (5th, 6th, 7th in left side), lung contusion and subcutaneous enphysema in the left side

...Pietro was intubated and taken to the CT scanner where he suffered a cardio-circulatory arrest

Rinaldi, 2013

In the pre-hospital setting, without echography and CXR, the diagnosis of tension pneumothorax relies on physical exam findings

Symptomatic pneumothorax

physical examination

ipsi-lateral diminished breath sounds, subcutaneous emphysema, localized thoracic pain, asymmetry, dyspnea, respiratory rate

Rinaldi, 2013

Progression of Pneumothorax

The progression of an initially small pneumothorax to a symptomatic or even tension pneumothorax is of same concern in the pre-hospital setting, particularly during air rescue

NAMME, Varese 2013

Incidence of tension pneumothorax

Tension pneumothorax was confirmed (hiss of air on decompression) in 5.4% of major trauma victims (64% of whom were ventilated)

Rates of undiagnosed TPT range from 1.1% to 3.8% (patients dying in ICUs)

Rinaldi, 2013

ZACHOVANÉ VĚDOMÍ

Pathophysiology of Tension Pneumothorax in awake patients

The pulmonary shunting and parenchymal collapse are the main causes of **hypoxia**

Preservation of cardiac output is through a progressive tachycardia, incomplete trasmission of positive intrapleuric pressure to the mediastinum and increasingly negative controlateral intrathoracic pressure preserving the venous return

This leads to the disease being progressive and primarily respiratory during the compensatory phase, with predominant hypoxemia

Rinaldi, 2013

Diagnosis of tension pneumothrax in awake patients

Reliable and early
- Pleuritic chest pain
- Air hunger
- Respiratory distress
- Tachypnoea
- Tachycardia
- Falling SpO_2
- Agitation

Disease lateralization - ipsilateral
- Hyper-expansion
- Hypo-mobility
- Hyper-resonance
- Decreased breath sounds
- Added sound - crackles/wheeze

Disease lateralization - contralateral
- Hyper-mobility

Pre-terminal
- Decreasing respiratory rate
- Hypotension
- Decreasing SpO_2
- Decreasing level of consciousness

Inconsistent
- Tracheal deviation
- Distended neck veins

NAMME, Varese 2013

ZACHOVANÉ VĚDOMÍ

Rinaldi, 2013

BEZVĚDOMÍ

Pathophysiology of Tension Pneumothorax in paralysed, sedated and ventilated patients

Gas was delivered under supra-physiological positive pressure. This gives a more rapid IPP rise for the increase gas flow through the pleural defect. This lead to earlier mechanical compressive effects and rapid progress to cardiorespiratory collapse.

Cardiorespiratory compensatory mechanisms are impaired and increased alveolar pressure may obstruct cardiac output and, if alveolar pressure rise above pulmonary venous/arterial pressure, cardiac output will be reduced.

The earliest sign is hypoxia (sudden fall in SpO_2) followed by hypotension.

NAMME, Varese 2013

Rinaldi, 2013

BEZVĚDOMÍ

Diagnosis of tension pneumothrax in ventilated patients

Rapid disease progression

Early reliable
- Decrease in SpO_2 - immediate
- Decrease in cardiac output
- Decrease in blood pressure
- Tachycardia

Others
- Increased ventilation pressure
- Surgical emphysema

Disease lateralisation
- ipsilateral
  - Hyper-resonance
  - Decreased breath sounds
  - Chest hyper-expansion
  - Chest hypo-mobility
  - Added sound

Inconsistent
- Cyanosis
- Distended neck veins
- Tracheal deviation

Monitor dependent
- Increasing CVP
- Increasing pulmonary arterial pressure
- ECG data
- Decreased mixed venous oxygen saturations

NAMME, Varese 2013

Rinaldi, 2013

Indications for decompression of the pleural space

There are no high quality studies available with respect to the indication for pleural space decompression in the pre-clinical environment.

All recomendations are based on case series, single cases and expert opinion

NAMME, Varese 2013

Indications for decompression of the pleural space

Pre-clinical decompression leads to an release of air in only **32-50%** of cases

and

the indication for chest tube insertion was uncertain in **9-25%** of patients, because no pneumothorax or chest injury was present

Rinaldi, 2013

Therapy

Initial goal

decompress the increased intra-pleural pressure of tension pneumothorax

Secondary aim

prevent a progression from simple to tension pneumothorax

Recomendations for immediate chest decompression in awake patients with tension pneumothorax as the suspected cause

- SpO_2 <92% on O_2
- Systolic BP <90 mmHg
- Respiratory rate <10
- Decreased level of consciousness on O_2
- Cardiac arrest

- bilateral finger or tube thoracostomy
- avoid needle thoracentesis

Rinaldi, 2013

The early treatment of pneumothorax is essential.

A delay in treatment of more than 30 minutes in patients with pneumothorax from mechanical ventilation was associated with a mortality rate of 31%. When drainage was peformed within 30 minutes the mortality rate was only 7%.

nedoporučuje

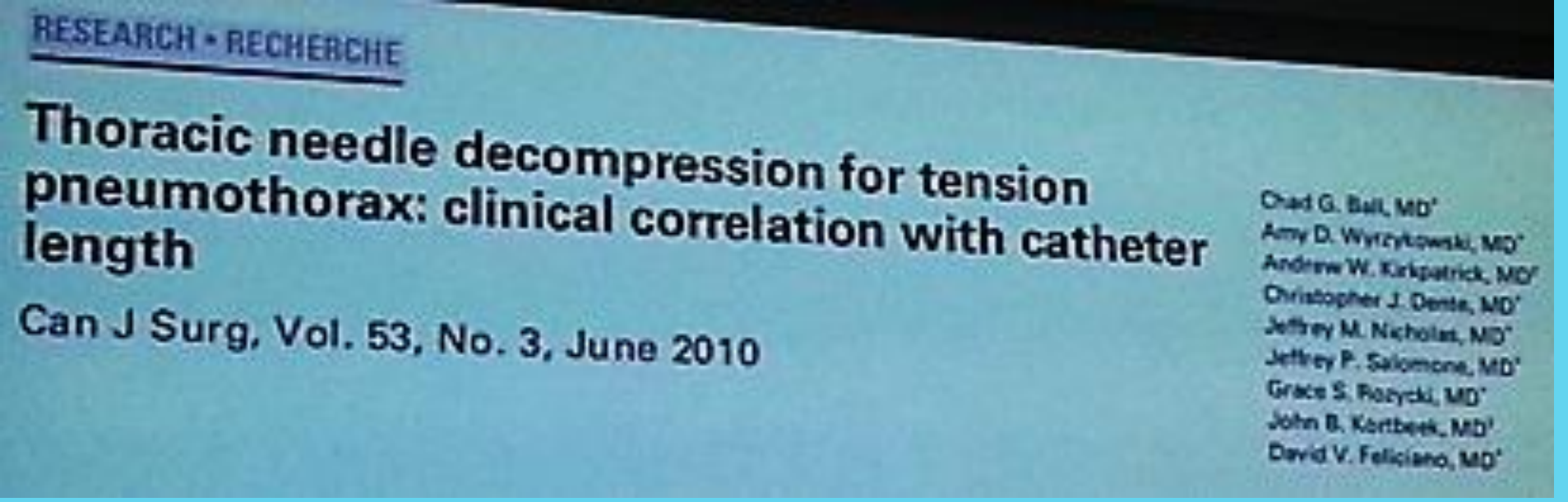
Rinaldi, 2013

NAMME, Varese 2013

Emergency needle decompression

- Once performed (i.e. air inside the chest is confirmed), tube thoracostomy is strongly recommended
- commonly used technique in pre-hospital environments
- proven as safe and effective (but great thickness might make it vain)
- there is an associated morbitity
- on-scene time shorter than tube thoracostomy
- Probably, frequently treated when actually absent

Steier et al., J Thorac Cardiovasc Surg 1974, 67:17



RESEARCH • RECHERCHE

Thoracic needle decompression for tension pneumothorax: clinical correlation with catheter length

Can J Surg, Vol. 53, No. 3, June 2010

Chad G. Ball, MD*
Amy D. Wyrzykowski, MD*
Andrew W. Kirkpatrick, MD*
Christopher J. Dente, MD*
Jeffrey M. Nicholas, MD*
Jeffrey P. Salomone, MD*
Grace S. Rozycki, MD*
John B. Kortbeek, MD†
David V. Feliciano, MD*

Tension pneumothorax decompression has a higher failure rate (65%) if associated with 3,2 cm catheters compared with 4,5 cm catheters (4%).

Rinaldi, 2013

Needle Thoracostomy in the Treatment of a Tension Pneumothorax in Trauma Patients: What Size Needle?

Imme Zengerink, MD, Peter R. Brink, MD, PhD, Kevin B. Laupland, MD, MSc, FRCPC, Earl L. Raber, MD, FRCPC, Dave Zygun, MD, MSc, FRCPC, and John B. Kortbeek, MD, FRCSC, FACS

J Trauma. 2008;64:111–114.

Mean chest wall thickness (cm) in the second intercostal space midclavicular line

	Right	Left
Female	3.84 ± 1.17	3.92 ± 1.42
Male	3.41 ± 1.04	3.37 ± 0.99
p value	<0.0001	<0.0001

CWT ≥ 4.5 cm

Percentage of men and women in each age group with CWT ≥ 4.5cm.

* 9.9% vs. 35.4% p<0.0001
**11.6%vs. 30.9% p<0.0001

19.3% vs. 28.4% p=0.08
18.5% vs. 24.1% p=0.28

NAMME, Varese 2013

Rinaldi, 2013

PAPER

ONLINE FIRST

Radiologic Evaluation of Alternative Sites for Needle Decompression of Tension Pneumothorax

Kenji Inaba, MD; Crystal Ives, BSc; Kelsey McClure, BA; Bernardino C. Branco, MD; Marc Eckstein, MD, MPH; David Shatz, MD; Matthew J. Martin, MD; Sravanthi Reddy, MD; Demetrios Demetriades, MD, PhD

Arch Surg. 2012;147(9):813-818. Published online May 21, 2012. doi:10.1001/archsurg.2012.751

42,5% of catheters would not have entered the chest in the second ICS compared with 16,7% at the fifth space.
Female patients had an even higher chance of catheter failure because of increased chest wall thickness compared with males.

NAMME, Varese 2013

Rinaldi, 2013

Tube thoracostomy

It is the definitive treatment of pneumothorax

The success rate (decompression/evacuation of air from the pleural space) of pre-hospital chest tubes ranges between 79-95%

Simple thoracostomy

Deakin CD, Davies G, Wilson A.

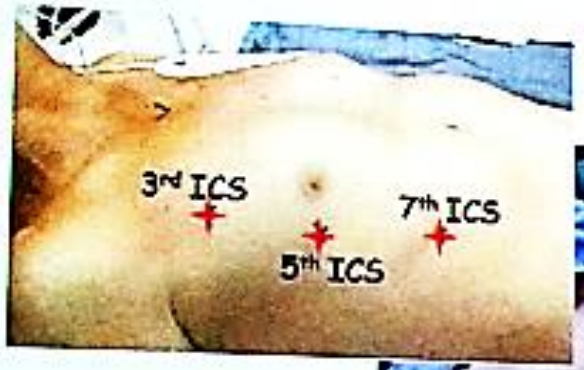
Simple thoracostomy avoids chest drain insertion in prehospital trauma.

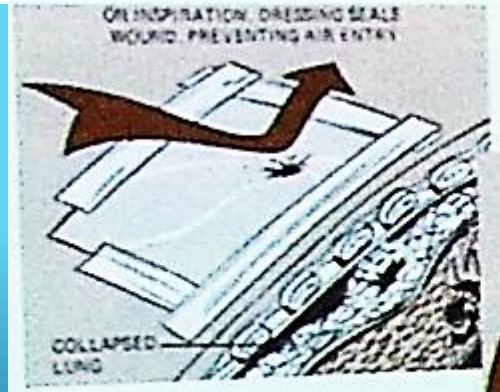
Tension pneumothorax and hemothorax are life-threatening emergencies that require immediate treatment. Fiel stabilization of trauma patients often requires rapid surgical drainage of these injuries but inevitably delays departure fo hospital. Conventional treatment involves the insertion of a chest drain but we describe a modified technique of simpl thoracostomy that is faster and simpler to perform and avoids the risks associated with insertion of the chest drain Following use of a simple thoracostomy as an alternative to chest drain insertion in 45 patients at the roadside, th technique appears to have important advantages over conventional techniques and warrants further clinical evaluation.

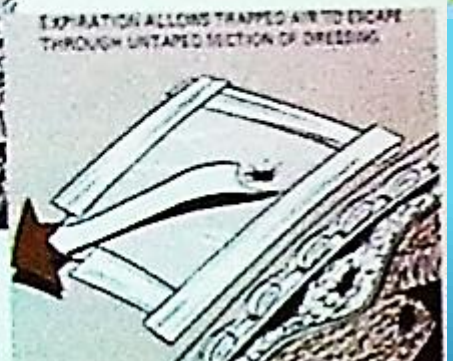
J Trauma. 1995 Aug;39(2):373-4.

Surgical incision and decompression of the pleural space without insertion of a chest tube appears to be an effective method to treat tension pneumothorax

Minithoracostomy with three-sided dressing





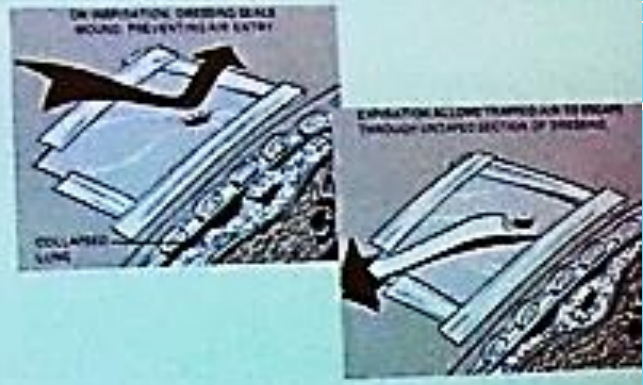


NAMME, Varese 2013

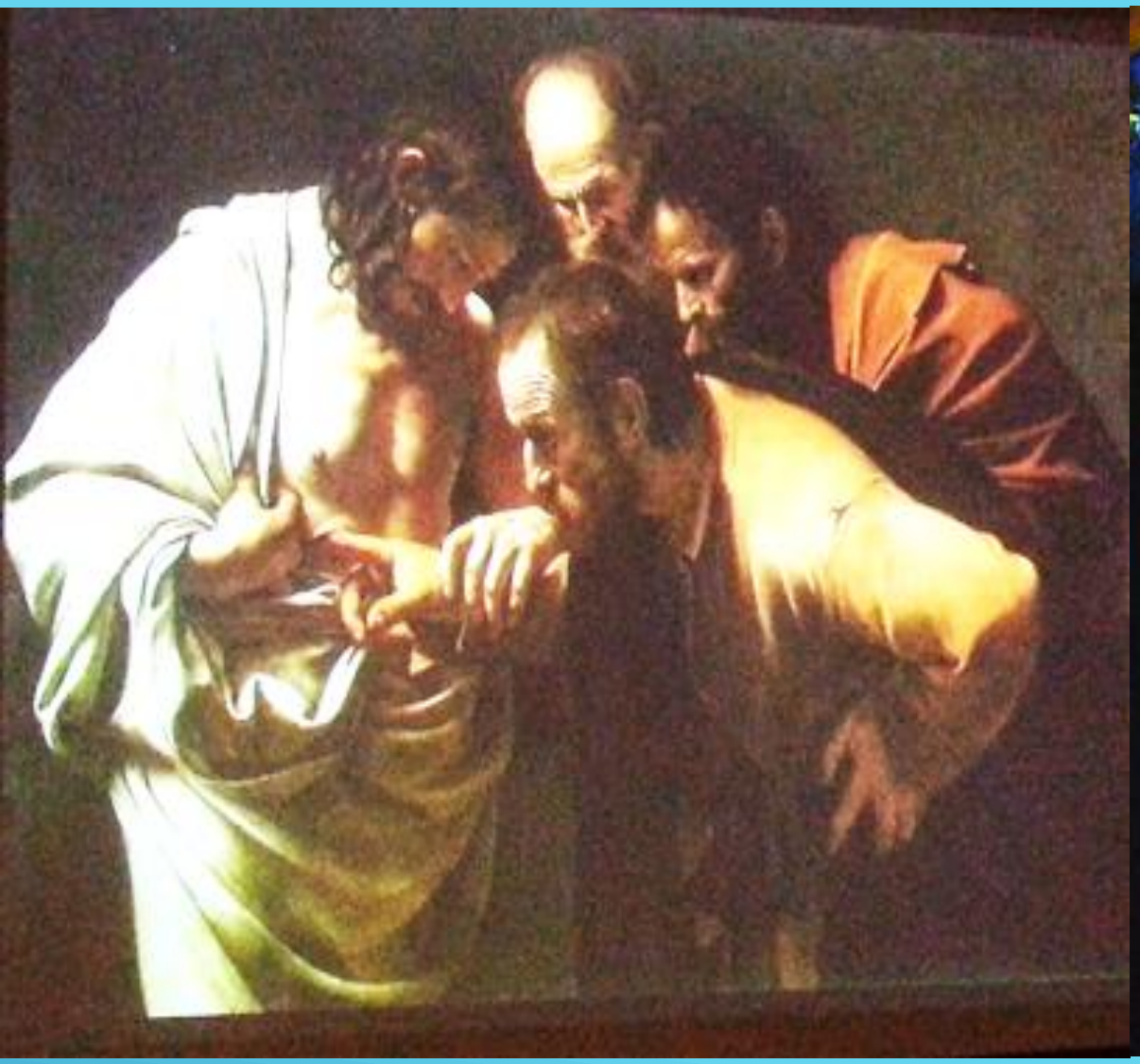
Minithoracostomy with three-sided dressing

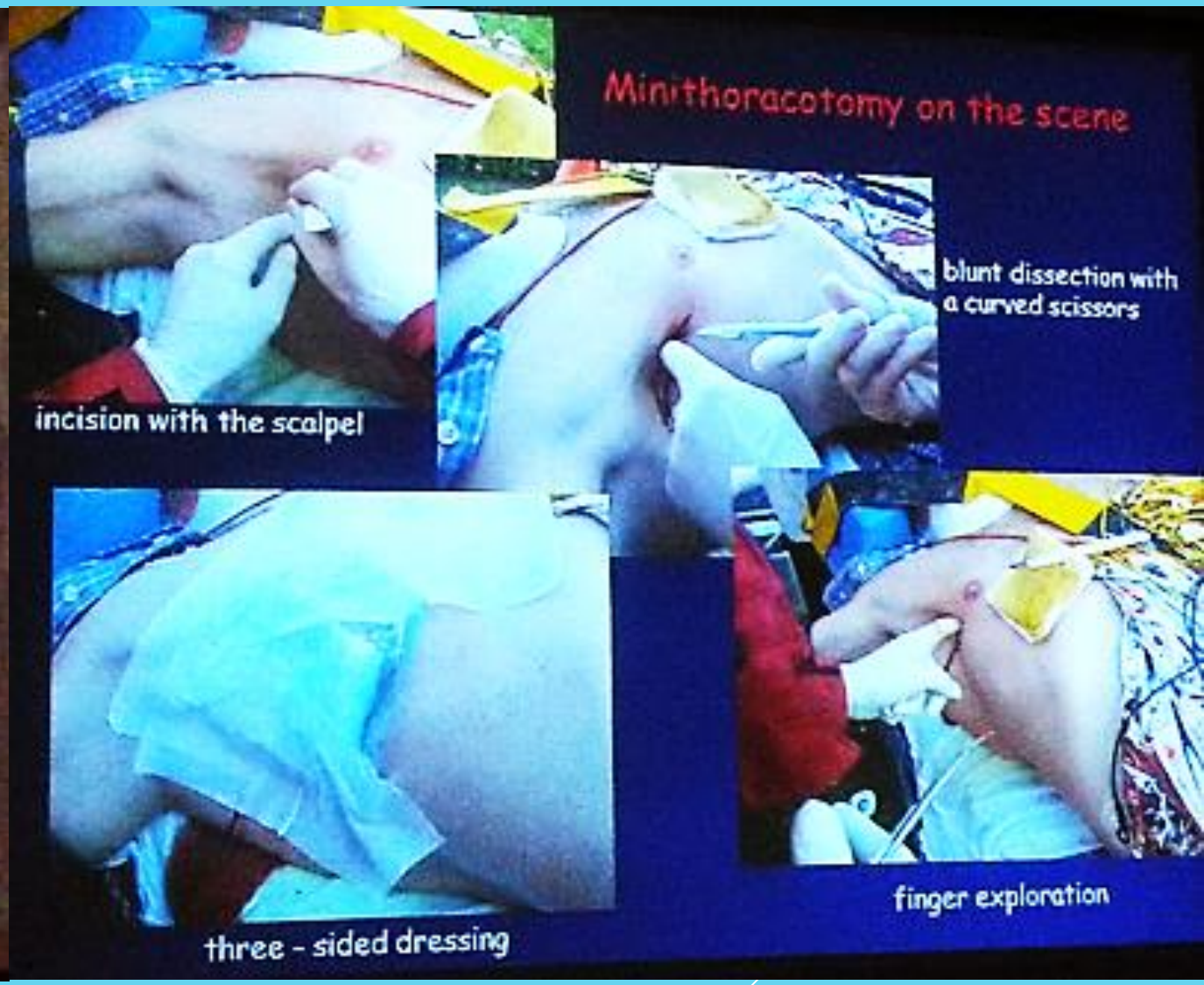
Midaxillary incision (4-5 cm) at fifth interspace

1. 4th-5th intercostal space, between mid and anterior axillary line
2. blunt dissection with curved scissors
3. open the pleura with gloved finger
4. protected with three - sided dressing



Rinaldi, 2013



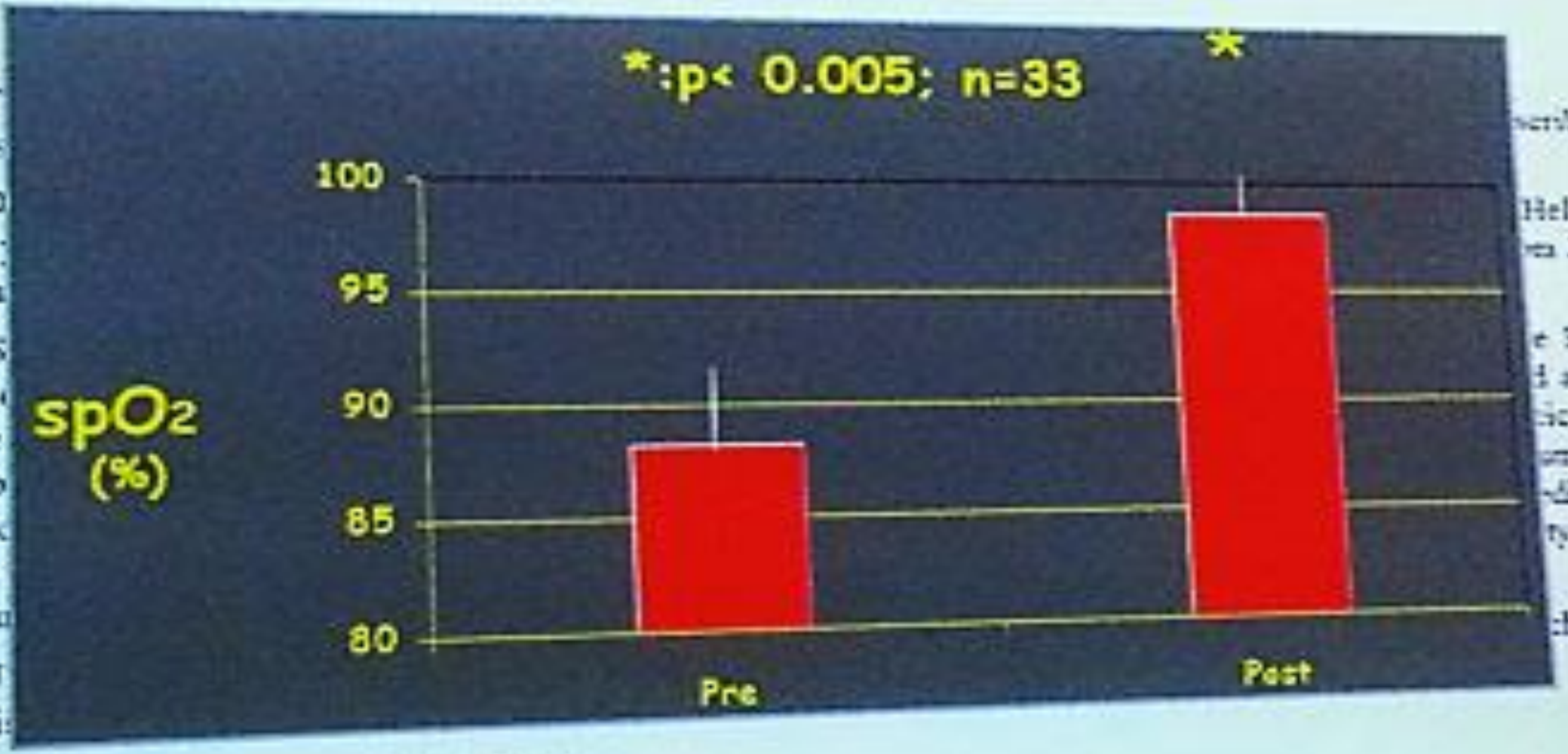


NAMME, Varese 2013

Rinaldi, 2013

Simple thoracostomy in prehospital trauma management is safe and effective: a 2-year experience by helicopter emergency medical crews.

Massarutti D, Trillò G, Berlot G, Tomasini A, Bacer B, D'Orlando L, Viviani M, Rinaldi A, Babbin A, Barato L, Carchietti E.



Eur J Emerg Med. 2006 Oct;13(5):276-80.

NAMME, Varese 2013

Rinaldi, 2013

In the footsteps of the killer: the traumatic pneumothorax (minithoracotomy)

What I have presented so far, is what I do when I'm on duty. To cut short this long story:

in *ventilated patients* if the diagnosis of TPT is suspected the decompression must be done, especially if transportation is by means of helicopter

in *awake patients* we can temporally wait before giving decompression, unless the patient is unstable and potentially in the advanced stages of tension

NAMME, Varese 2013

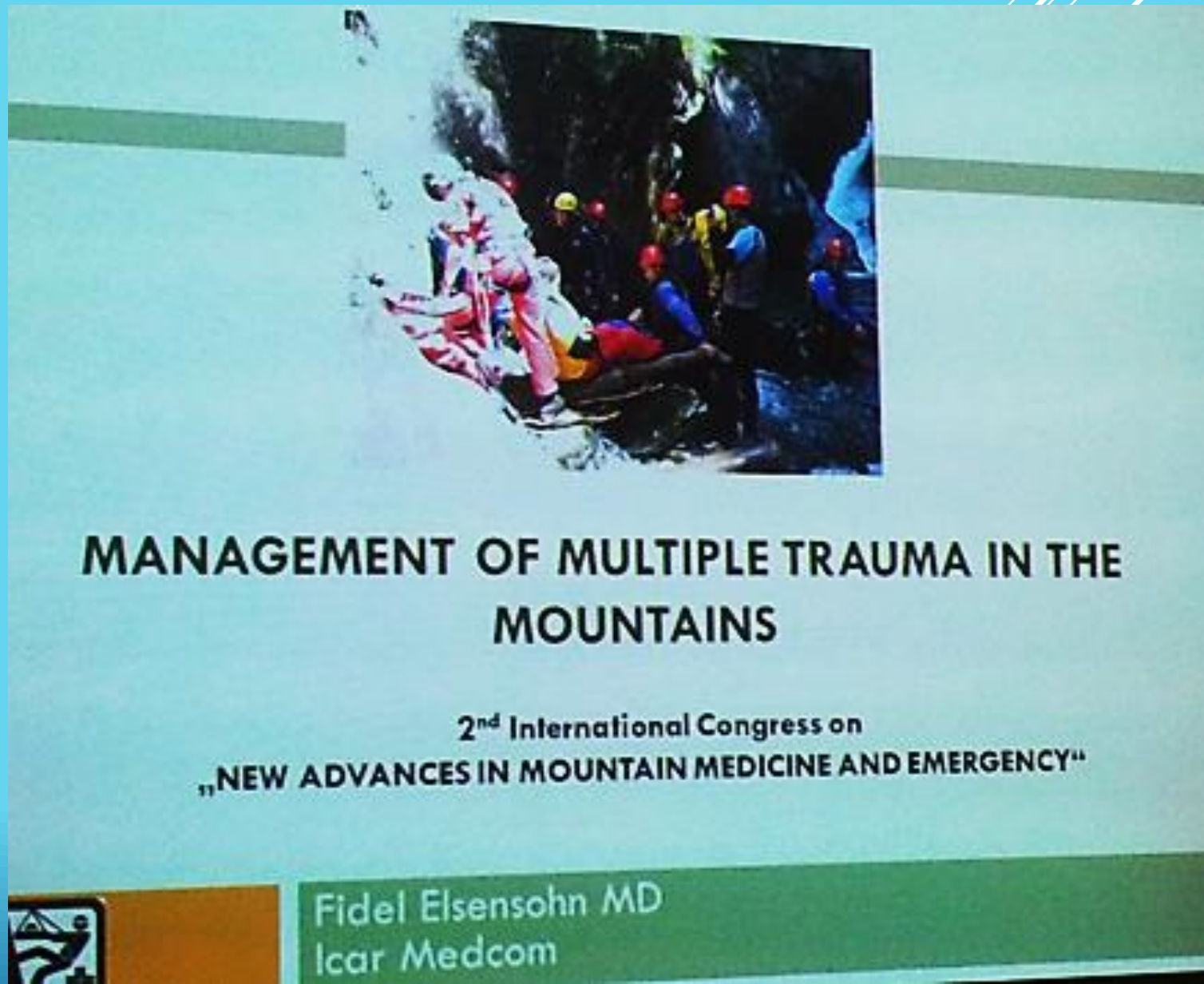
Rinaldi, 2013

LÉČENÍ MNOHOČETNÝCH ÚRAZŮ V HORÁCH

Management of Multiple Trauma in the Mountains

Fidel Elsensohn MD

ICAR MEDCOM



Co všechno je možné?

0200 pm: 45 y female
Hit by rock-fall and fall appr. 50 m over rocks (altitude 3300m)
Immidiate call through husband by cell phone
Arrival at scene 0230 (25 min flight-time
Patient located below rock face in area with large blocks

Clinical Findings:
Patient unconscious (GCS 3)
Impaired breathing, instabile thorax
Subtotal amputation of left lower leg
Suspected fracture of cervical spine
Suspected pelvic fracture, BP 90/40, O2-Sat. 80% CT 33°

NACA Score: 6

Elsensohn, 2013

Co všechno je možné?

Transport of Physician and Air Rescuer to the site of accident by long line
Belaying the patient
Initial assessment
2 large iv-lines
Neck stablisation
250 ml hyperoncotic/hyperosmotic solution
Analgosedation with Fentanyl/Dormicum
Rapid evacuation by long line and transport to level 1 trauma-center
Intubation
Thoracic drainage by thoracostomy
Sterile wounddressing and splinting
Immobilisation on vacuum matress

Outcome: complete recovery

NAMME, Varese 2013

Elsensohn, 2013

HIGH VELOCITY TRAUMA

- Falls higher than 3 m
- Faster than 30 kmph
- Unprotected body

Expect major injury
Symptoms may occur delayed

POLYTRAUMA (multipl

- Injuries of more than one compartment
- Each or combination is life threatening
- High Danger when combined with TBI or thoracical, abdominal or pelvic trauma

NAMME, Varese 2013

Elsensohn, 2013

Principles of prehospital emergency medicine

- Bring professional care to the patient as soon as possible
- Early stabilisation of vital functions
- Start pre-hospital emergency care at the site of accident
- Sufficient analgesia
- Rapid transport to ICU

METHOD: Individual therapeutic concept adapted to the clinical situation of the patient and the rescue strategy

- Mechanism of injury
- Pattern of injury
- Actual situation of circulation and tendency
- Time for medical intervention and transport
- Geographical situation, transport facilities, hospital
- Skills of emergency physician

Complete rehabilitation after severe trauma

NAMME, Varese 2013

Elsensohn, 2013

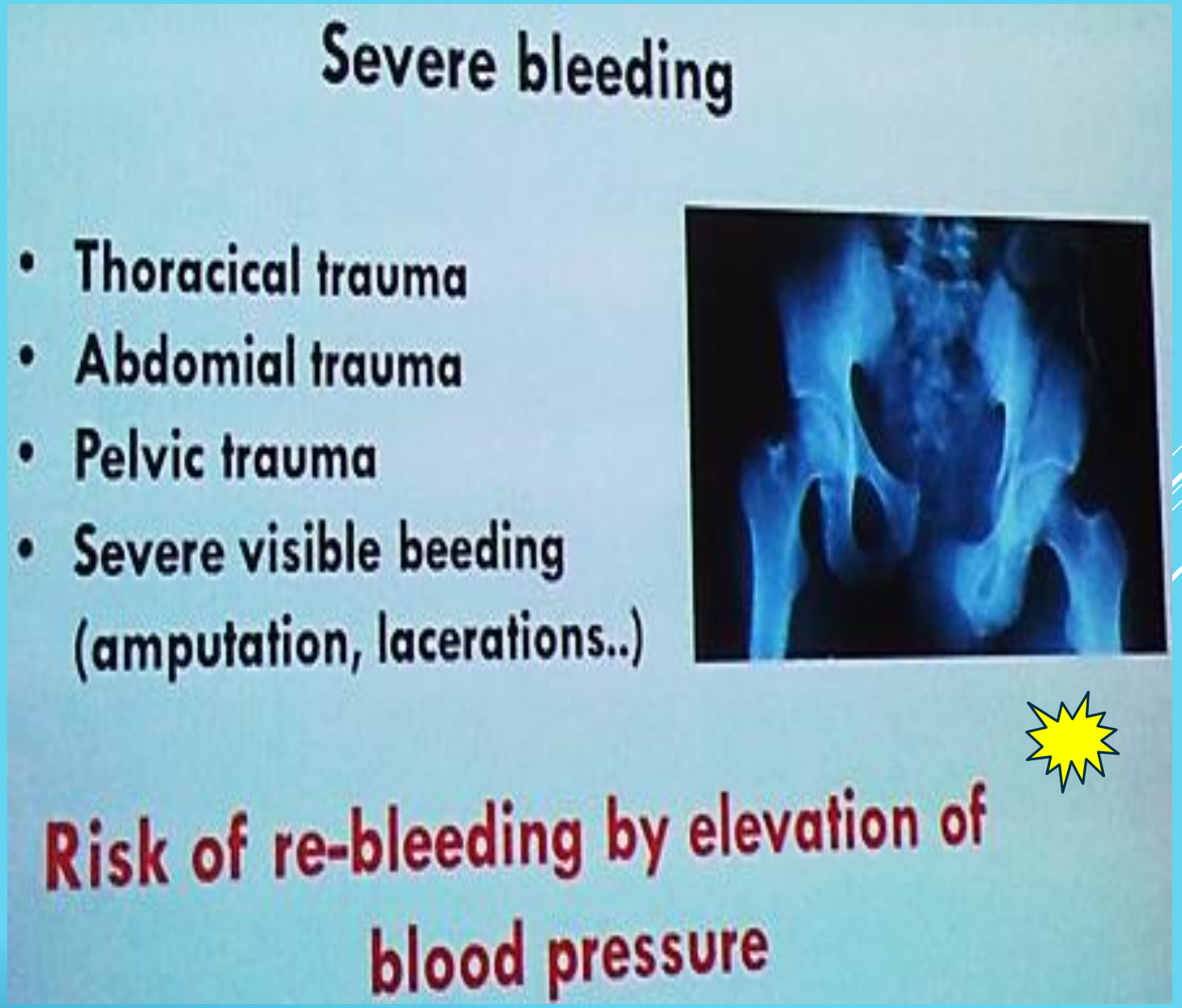
Rozhodující příznaky

? Mozkové trauma

? Aktivní krvácení

Obecná praxe u traumat

? Maximální podpora oběhu vysokými objemy tekutin?



NAMME, Varese 2013

Elsensohn, 2013

Suspected severe hemorrhage:

2 Options:

No prehospital volume resuscitation?

„Delayed resuscitation"

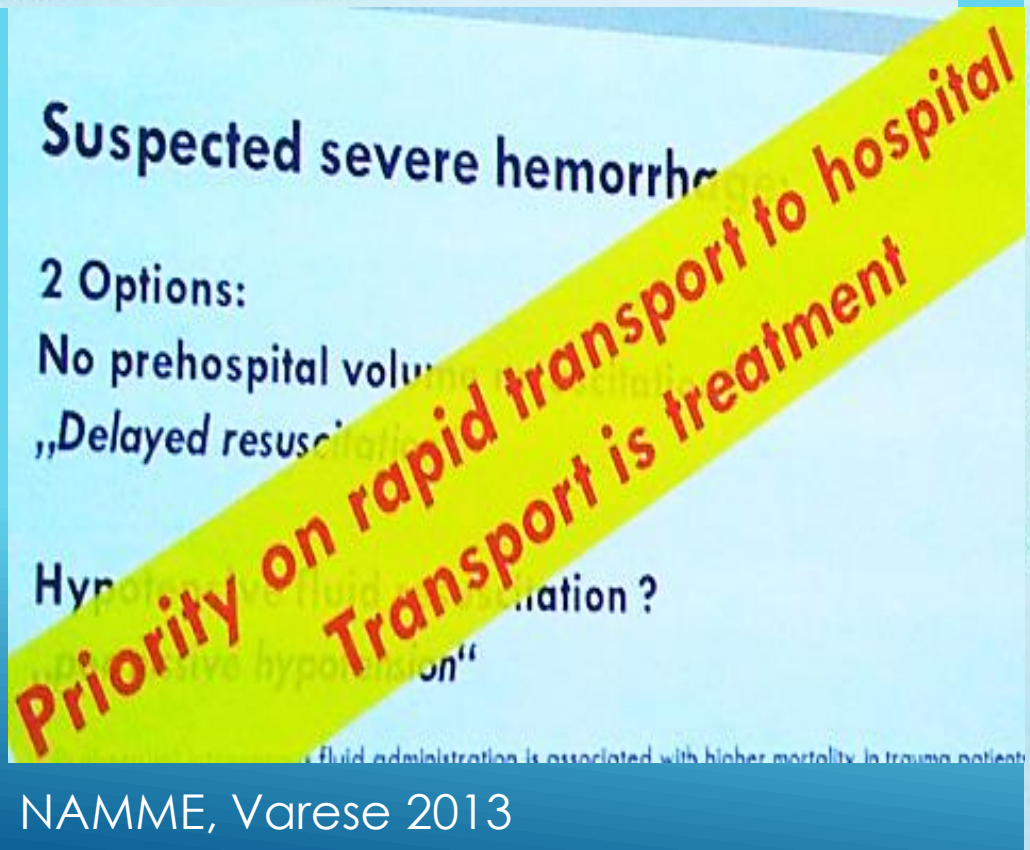
Hypotensive fluid resuscitation ?

„permissive hypotension"

Prehospital Intravenous Fluid Administration is Associated With Higher Mortality in Trauma Patients: A National Trauma Data Bank Analysis

Annals of Surgery 2011

Elliott R. Haut, MD, Brian T. Kalish, BA*, Bryan A. Cotton, MD, MPH†, David T. Efron, MD*, Adil H. Haider, MD, MPH*‡, Kent A. Stevens, MD, MPH*‡, Alicia N. Kieninger, MD§, Edward E. Cornwell, III, MD¶, and David C. Chang, MBA, MPH, PhD‖*



NAMME, Varese 2013

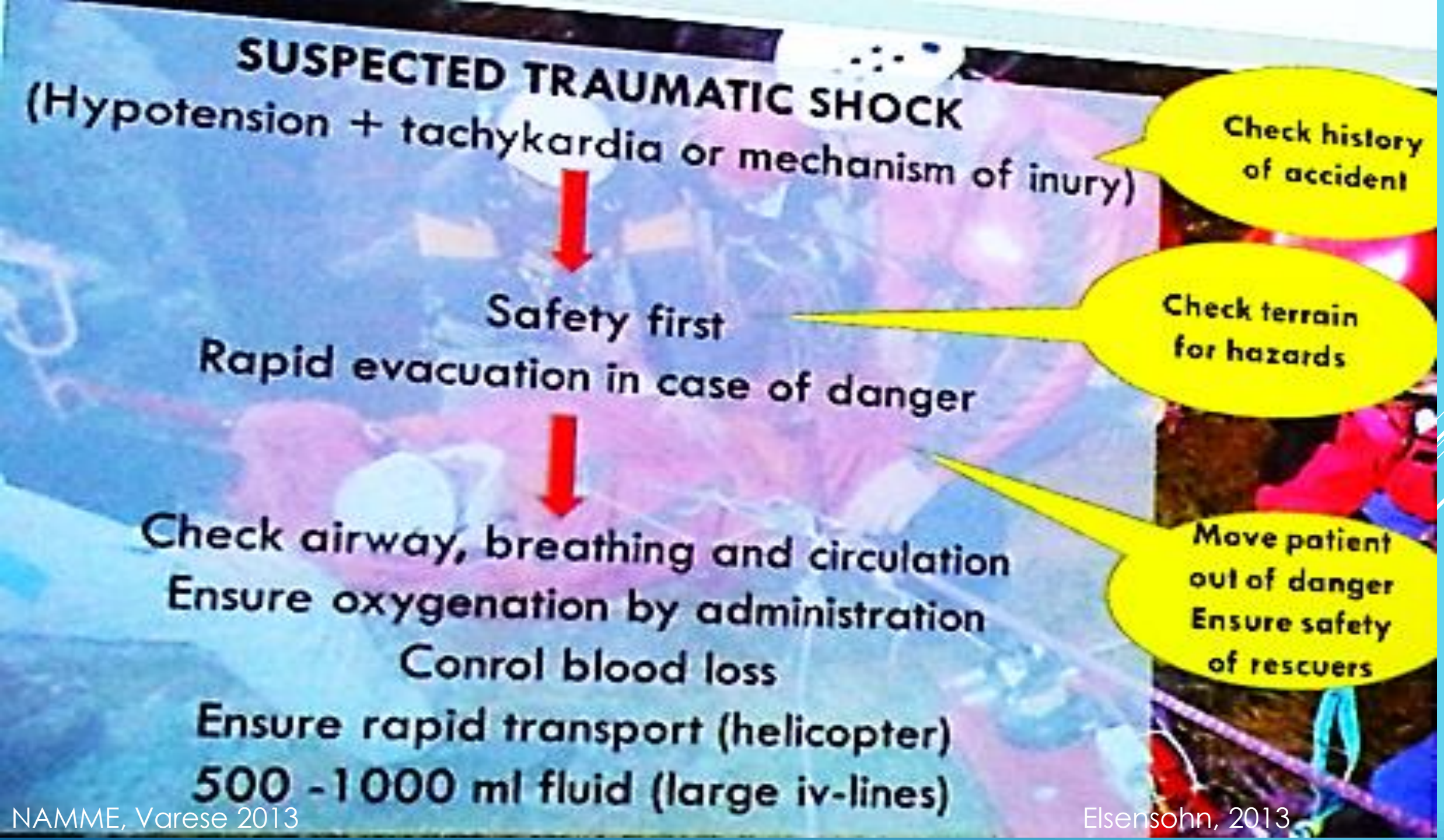
ON SCENE: environment, exposure, entrapment, extrication, evacuation,
INJURY AND TREATMENT: Ongoing bleeding and shock; anaesthesia/sedation, fluids
TRANSPORT: environment, anaesthesia/sedation, fluids

PREVALENCE: - 30% (CT < 35°C)

PROGNOSTIC IMPLICATION OF HYPOTHERMIA IN TRAUMA:
Higher mortality in severy trauma with TBI
Hypothermia as independant factor? (may be generated by severe injury and hemorrhage

DETECTION AND PREVENTION OF HYOTHERMIA IN MULTIPLE TRAUMA IN THE MOUNTAINS IS ESSENTIAL

Elsensohn, 2013



NAMME, Varese 2013

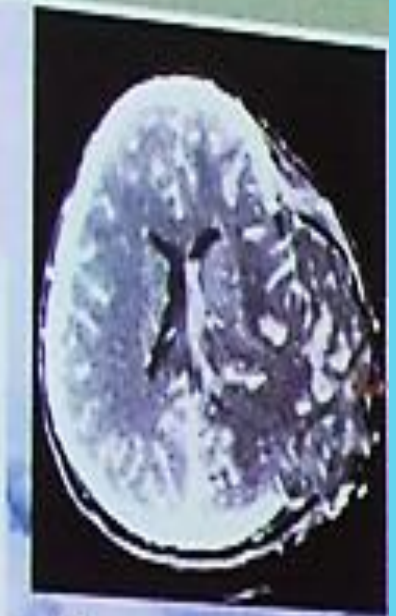
Elsensohn, 2013

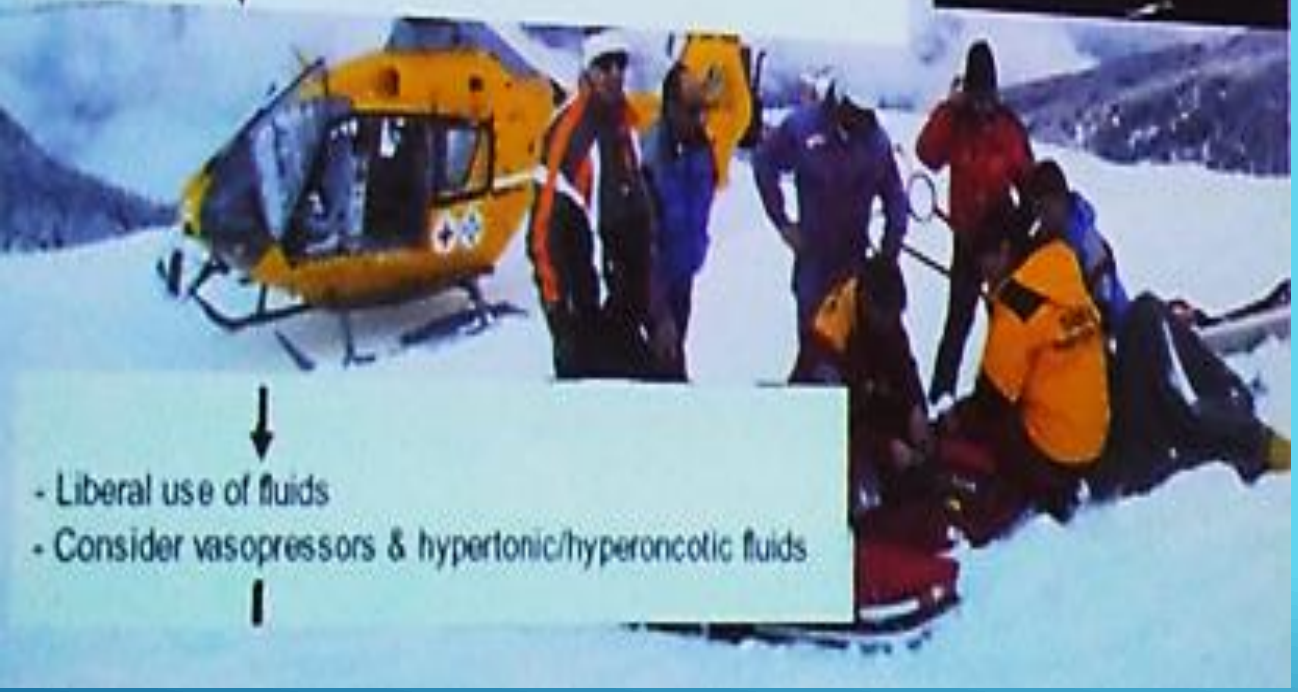
SEVERE TRAUMATIC BRAIN INJURY (TBI)

Severe Traumatic Brain or Spinal Injury (GCS < 9)*

Yes

Forced Fluid Resuscitation
Target SABP ≥ 110 mmHg





- Liberal use of fluids
- Consider vasopressors & hypertonic/hyperoncotic fluids

NAMME, Varese 2013

Main goal: stabilisation of vital funktions

- Avoid hypoxia
  (SpO2< 90 or. PaO2< 60 mmHg, hypoxia increases mortalitiy from 14% to < 50%)
- Avoid hypotension
  keep blodd pressure > 90 mm/Hg
- Protect the airway, ev. intubation and ventilation
- Stabilize circulation
- Immobilize cervical spine
- Transport the patient to trauma center

Elsensohn, 2013

NAMME, Varese 2013

Only small volumes of fluids

Keep blood pressure ≤ 50 – 60 mm/Hg

if necessary: hyperosmotic/hyperoncotic solutions

Sufficient analgesia

Protect the airway

Prevent hypothermia

„permissive hypotension“

Elsensohn, 2013

IS THE CONCEPT OF MAXIMAL PREHOSPITAL THERAPY ALWAYS FEASABLE IN THE MOUNTAINS

WHAT IS THE OPTIMUM?

NAMME, Varese 2013

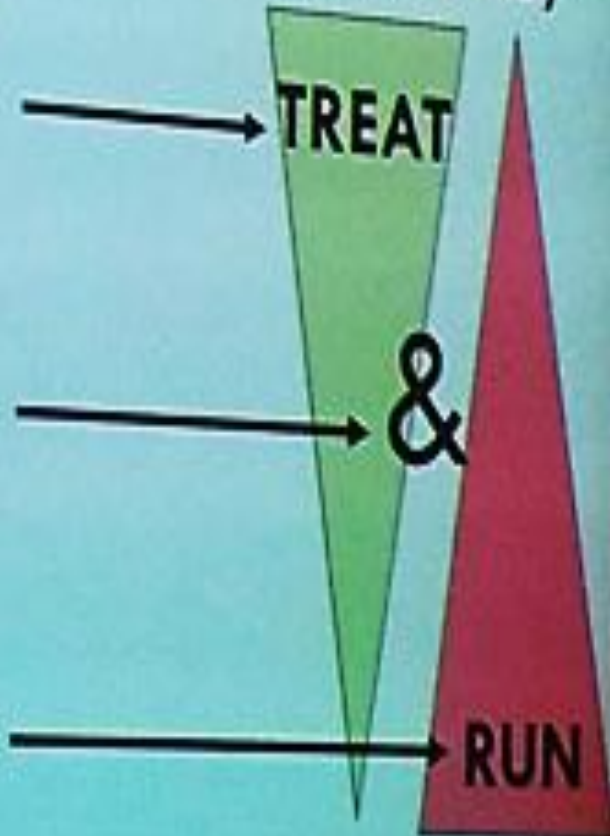
Fluid Management in Traumatic Shock – A Practical Approach for Mountain Rescue

„Stay and Play"

„Immidiate volume resuscitation"
TBI , mult. trauma with TBI, fractures

„permissive hypotension"
mult. trauma without TBI, major bleeding

„delayed resuscitation"
isolated liver or spleen rupture
severe therapy-resistant bleeding



„Load and Go"

Elsensohn, 2013

Rovnováha mezi rizikem a prospěchem podávání tekutin

Krvácení

Chlad

Terén

Vzdálenost od nemocnice

Stav oběhu

Těžké mozkové trauma

NAMME, Varese 2013

Meze pozemní záchrany v horách

? Dostupnost léků, kyslíku, tekutin (hmotnost, objem)

? Trvání záchranné akce

? Manipulace během transportu

? Teplota

? Teplota infúze

? Indikace pro objemovou resuscitaci v horolezeckém prostředí během záchranné akce

Elsensohn, 2013

ZÁVĚR

- Špatné výsledky u polytraumat v horách
- Šok je u polytraumat pravidlem
- Různé léčebné přístupy
- „Méně může být více“
- Vliv prostředí může omezit léčebné možnosti
- Rychlý transport je velmi důležitý
- Pokud je to možné, transport vrtulníkem
- Léčení je nutné přizpůsobit situaci
- Léčení nesmí zdržovat transport
- Vhodná cílová nemocnice (level 1 trauma centre)
- Trauma registry

Elsensohn, 2013

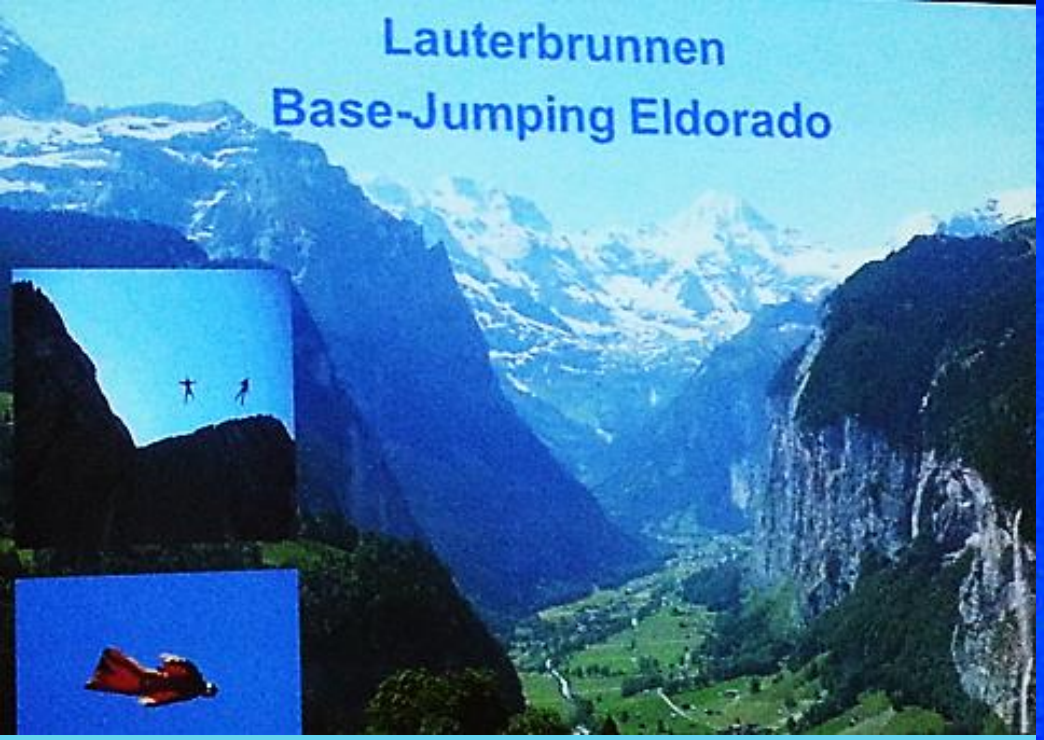
ZÁCHRANA V PODVĚSU NA VELMI DLOUHÉM LANĚ - LÉKAŘSKÁ POMOC NA MÍSTĚ NEHODY

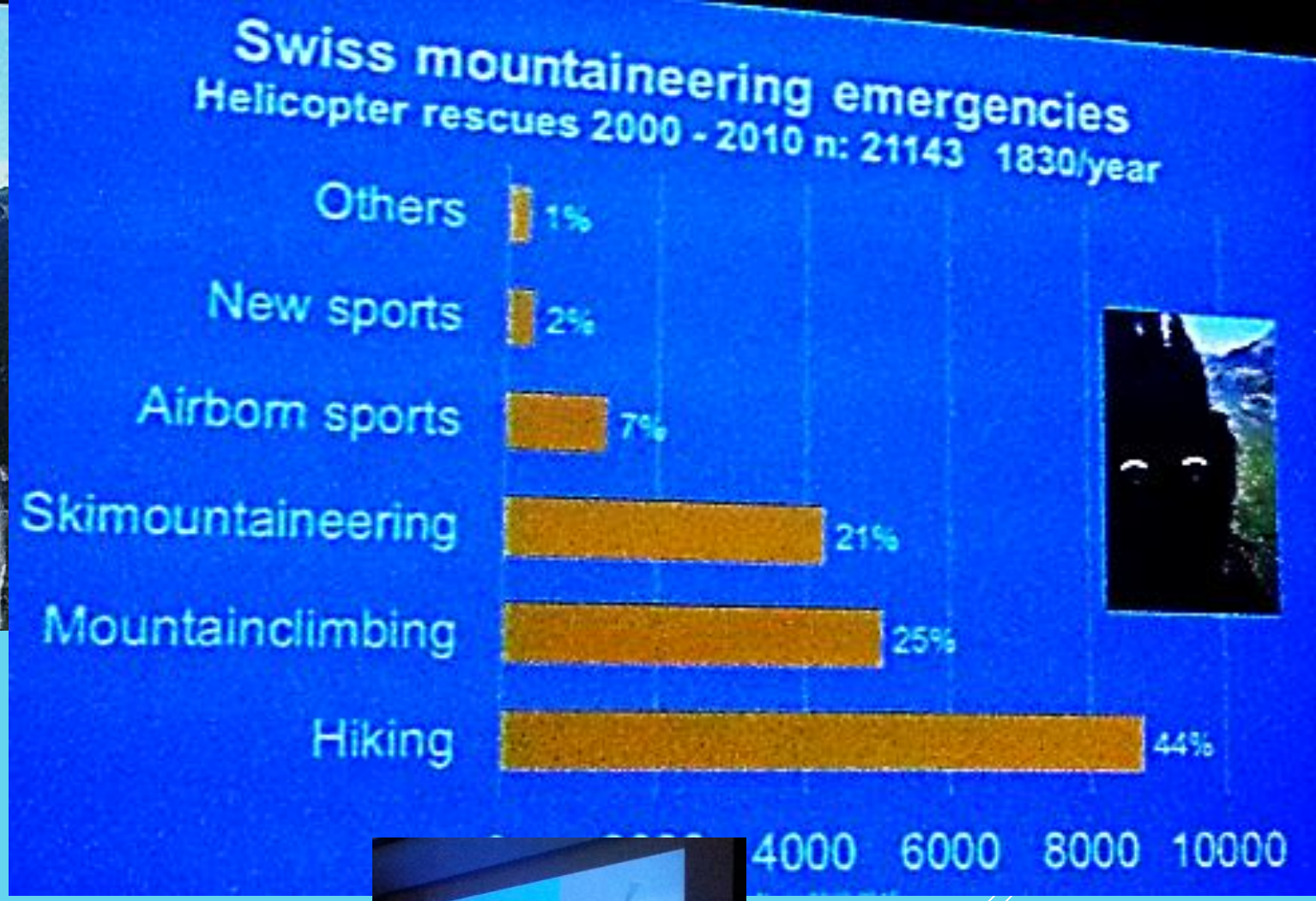
Longline Rescue
On-Site Medical Treatment

Bruno Durrer MD

General Internal Medicine FMH
Emergency Medicine SGNOR
Sports Medicine SGSM
Lauterbrunnen

NAMME, Varese 2013





Definice „Line – Longline

- **Line (LL) ocelové lano < 50 m**
- **Longline (LL) ocelové lano 50-270 (?) m**

Durrer, 2013

NAMME, Varese 2013

L- and LL - missions

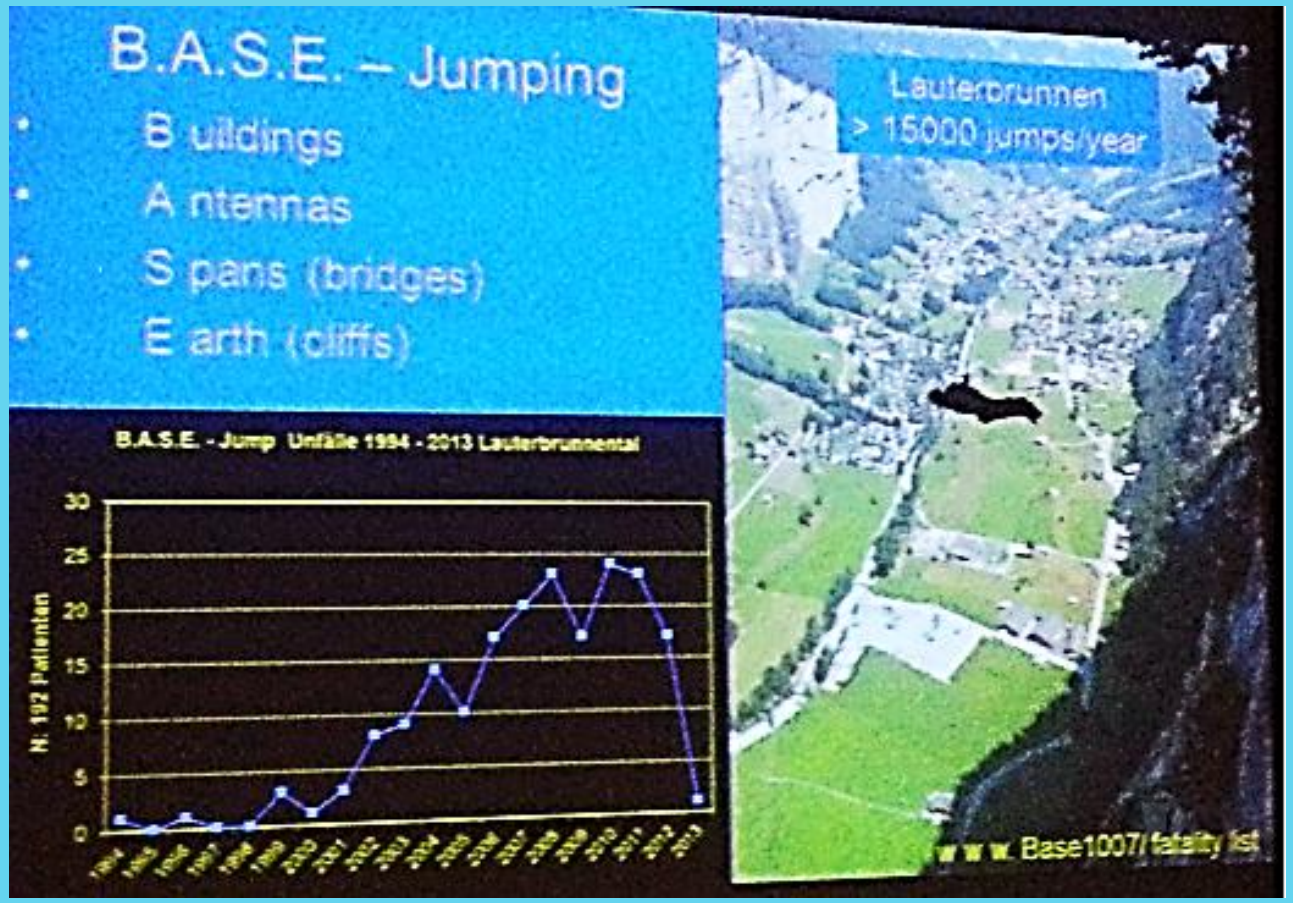
- Danger of downwash !:
  Falling rocks, falling ice
  Basejumper, Delta-, Paraglider
- Vertical cliffs, overhangs
- Canyons, steep forests
- Pulk-Evacuation (4-5Px)
- Patient in bag +doc +guide
- Evacuation of blocked cablecars
- High winds, altitude

NAMME, Varese 2013

Longline: on-line-technic

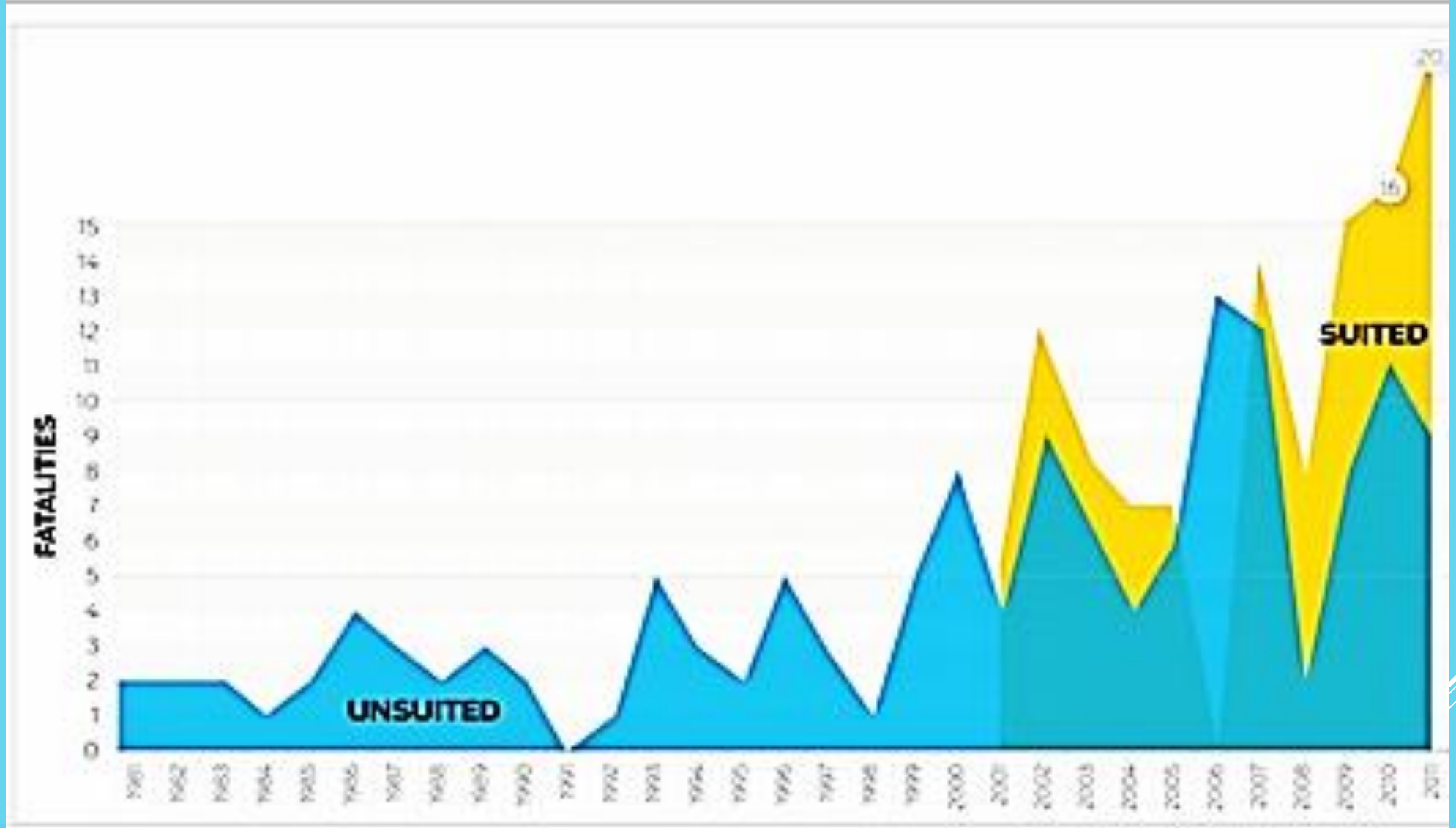
Two rescuers attached via flexible Grillon to the longline of the helicopter during the capturing of the patient.
Minimizing risks of rock-icefall / 2nd avalanche

Durrer, 2013


B.A.S.E. – Jumping
B uildings
A ntennas
S pans (bridges)
E arth (cliffs)
B.A.S.E. - Jump Unfälle 1994 - 2013 Lauterbrunnental
N. 192 Patienten
0
5
10
15
20
25
30
Lauterbrunnen
> 15000 jumps/year
www.Base1007/fatality list

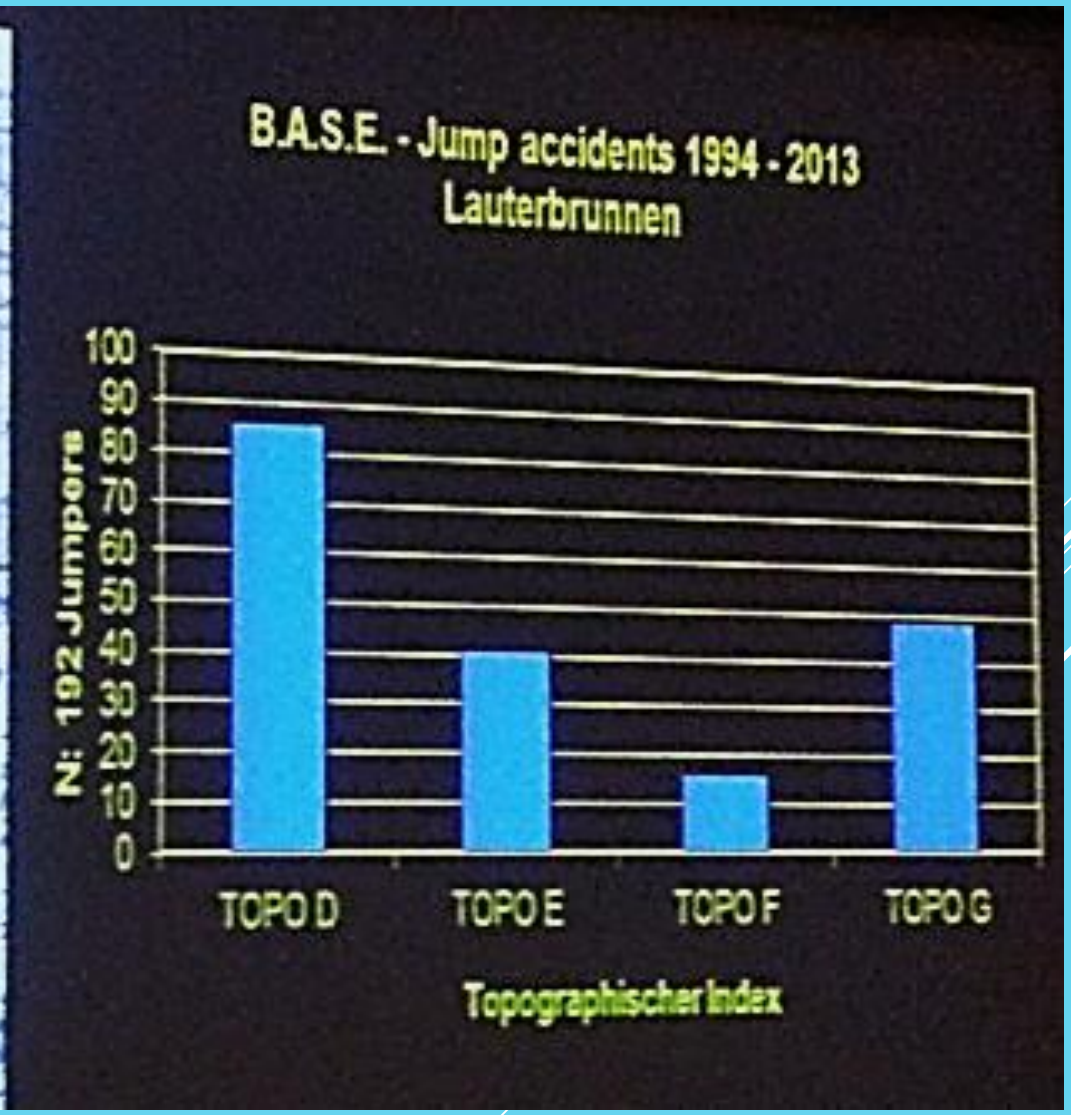
Eiger Champignon
~ 20 Exit points

Durrer, 2013



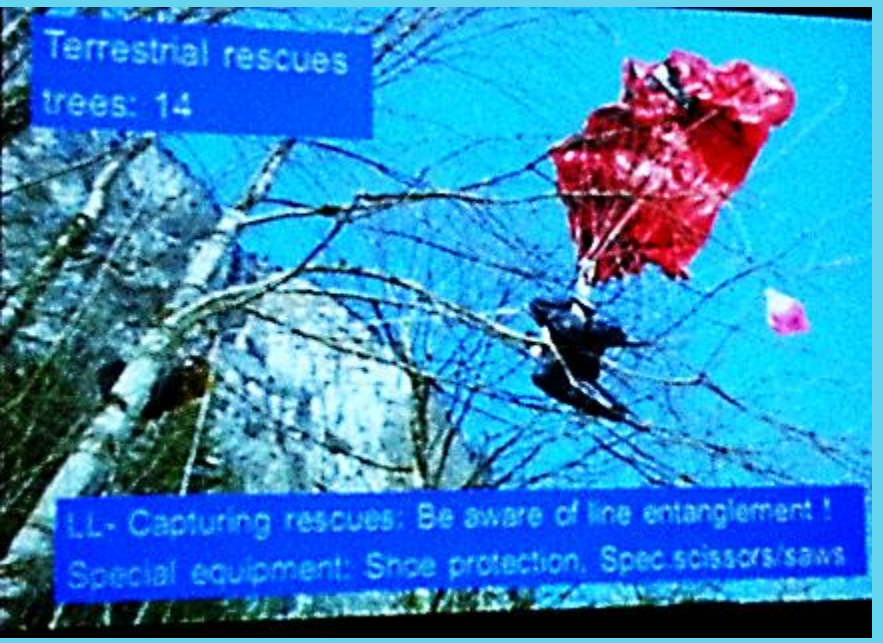
The rise of wingsuits and fatalities in BASE jumping *Photo:* Outside Magazine

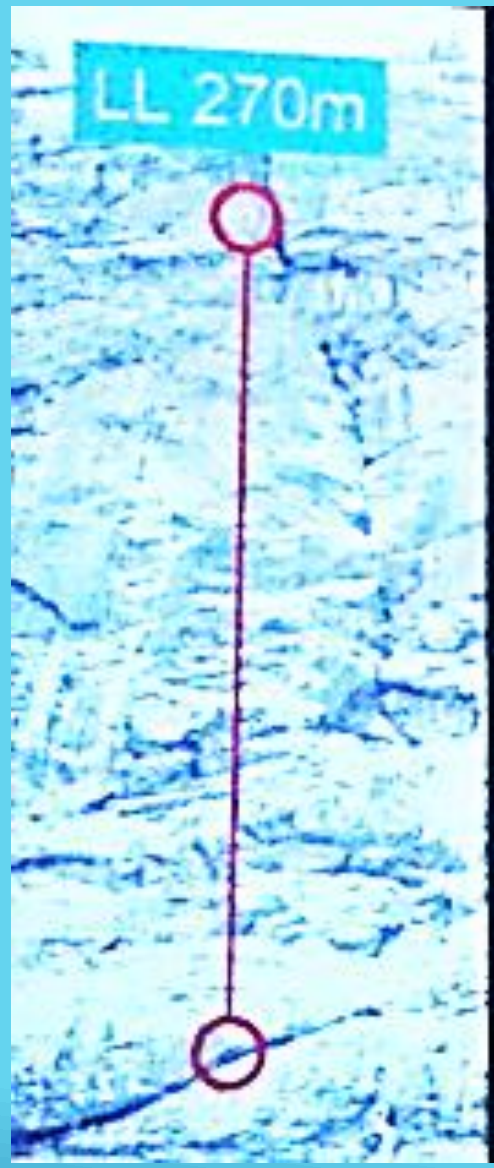
In the early oughts, wingsuits (a.k.a. flying-squirrel suits) and tracking suits (baggy pants and jackets that catch more air) became popular with jumpers who wanted extra glide, both to clear obstacles and to extend free fall.

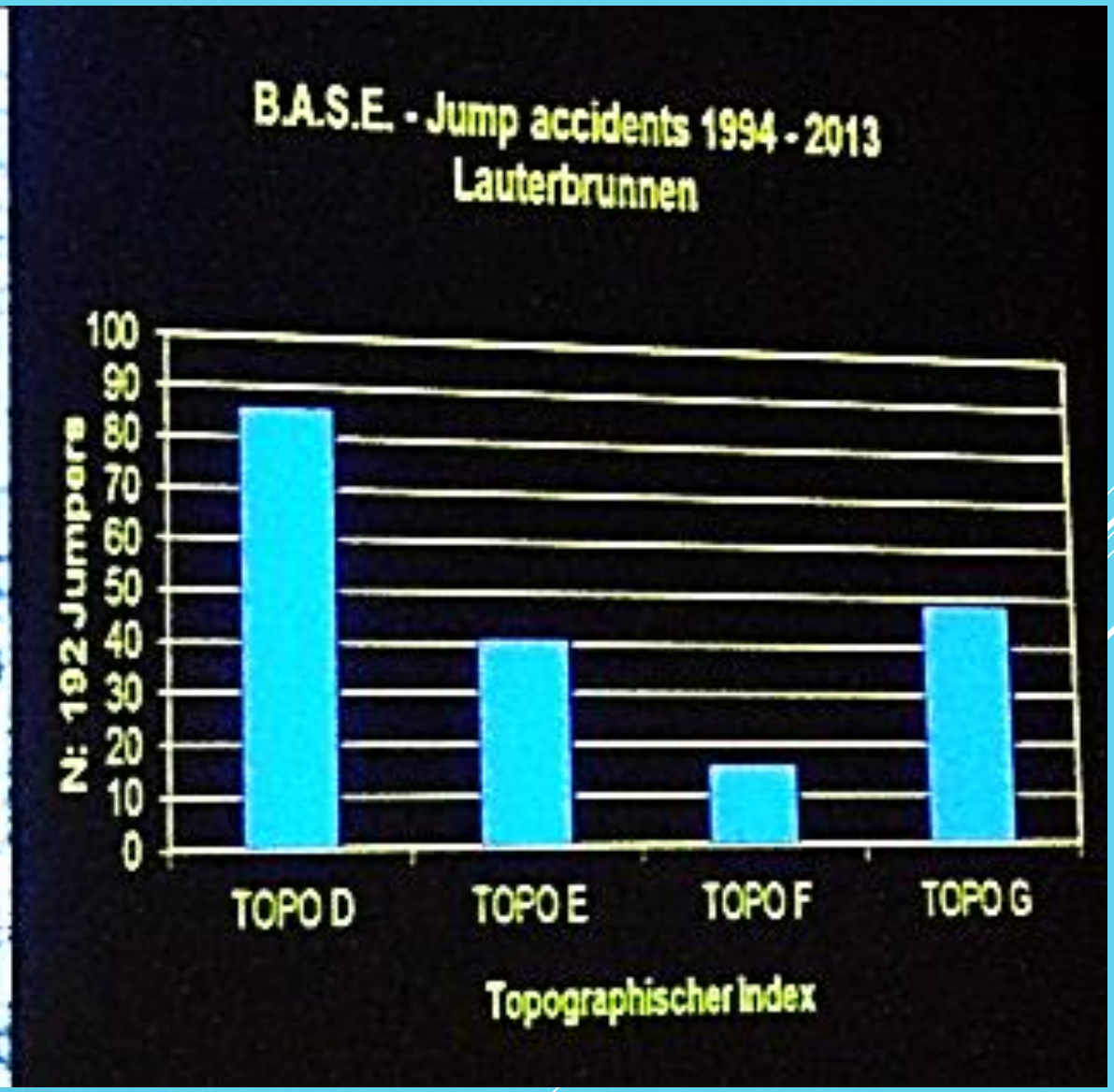


NAMME, Varese 2013

Durrer, 2013

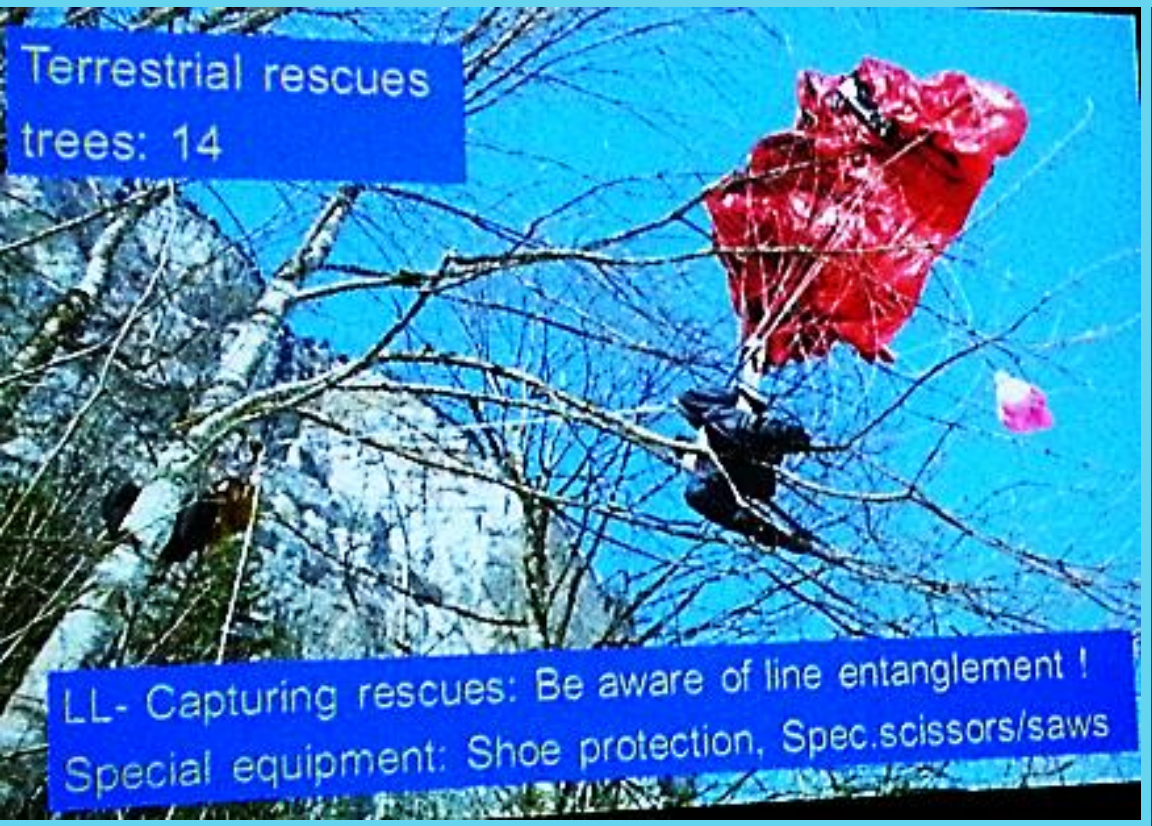


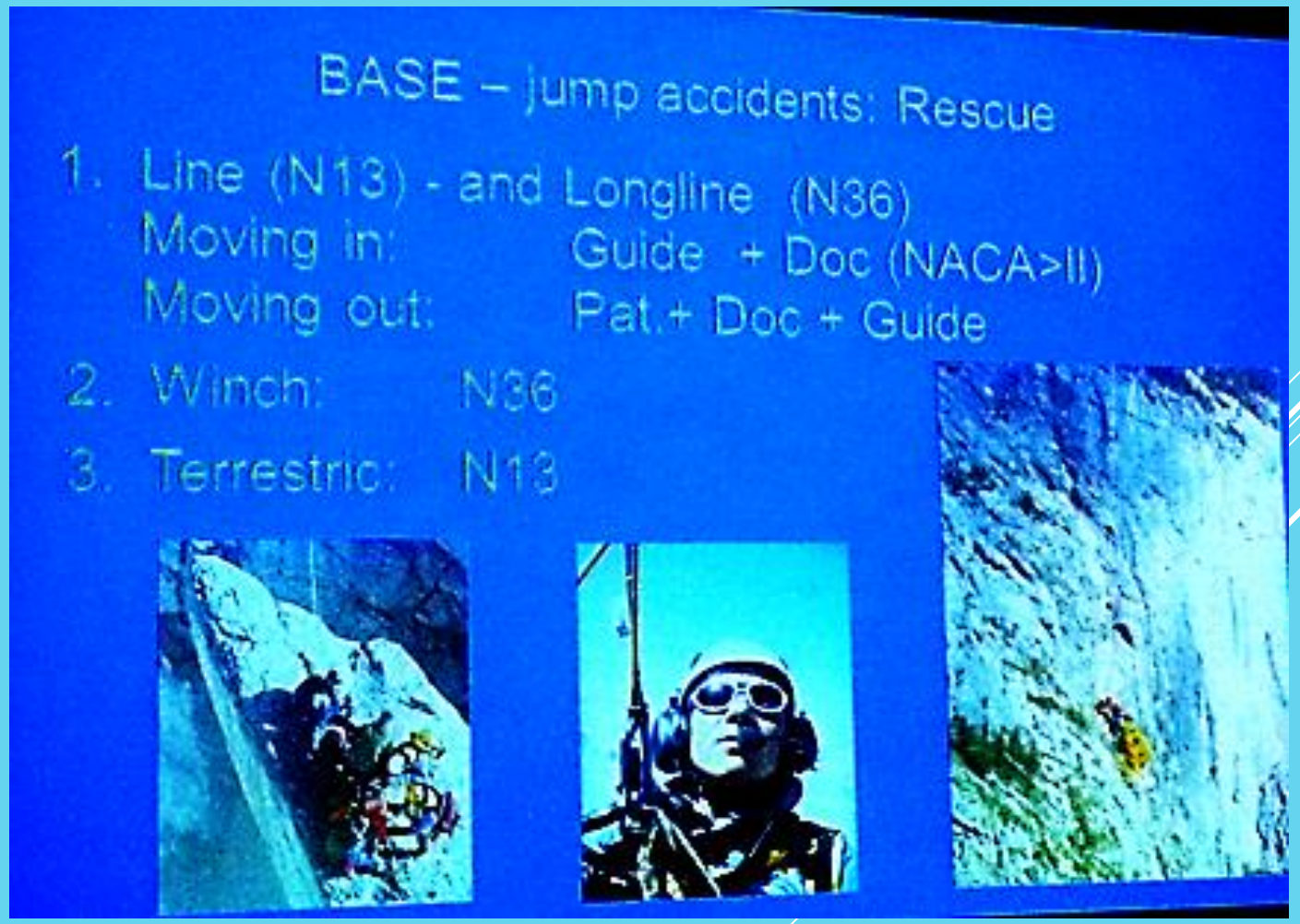




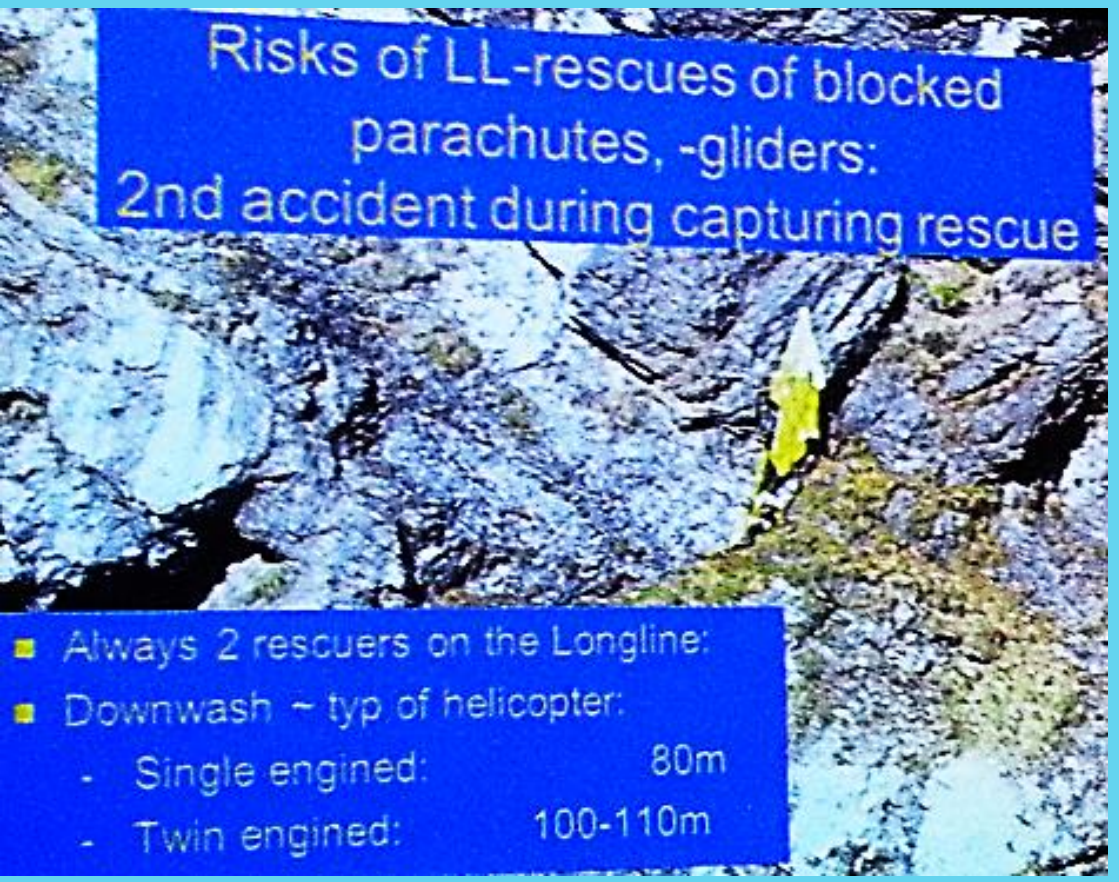
NAMME, Varese 2013

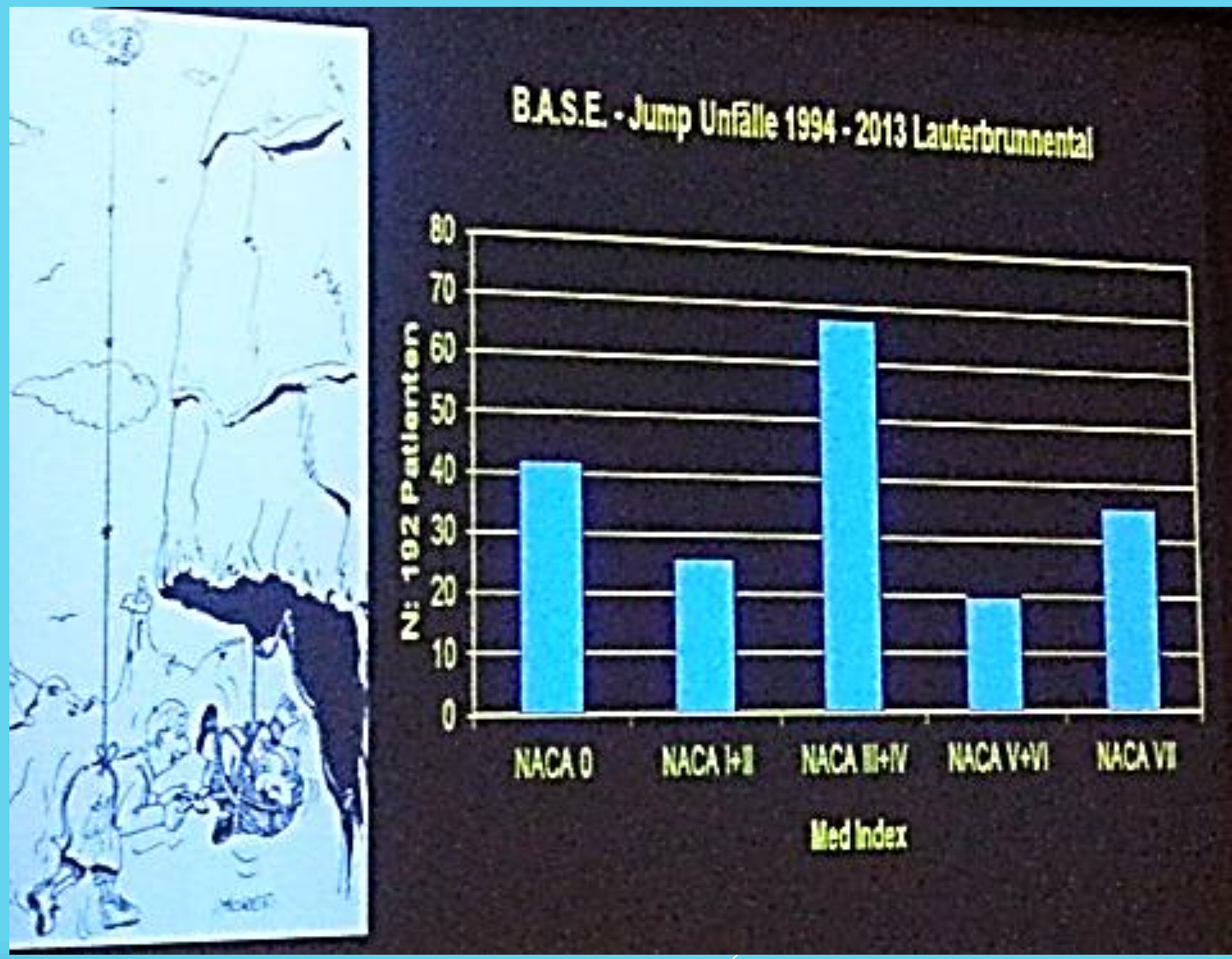
Durrer, 2013


Terrestrial rescues
trees: 14
LL- Capturing rescues: Be aware of line entanglement !
Special equipment: Shoe protection, Spec.scissors/saws


BASE – jump accidents: Rescue
1. Line (N13) - and Longline (N36)
Moving in: Guide + Doc (NACA>II)
Moving out: Pat.+ Doc + Guide
2. Winch: N36
3. Terrestric: N13

Durrer, 2013





Durrer, 2013

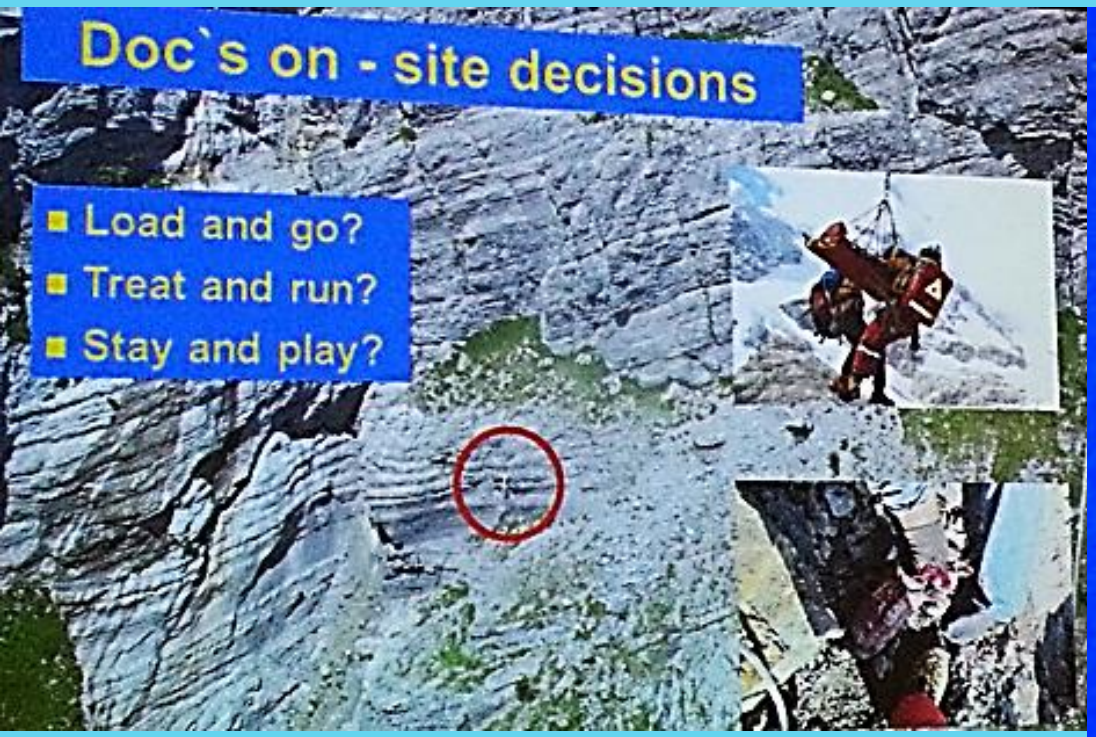
NAMME, Varese 2013

2008 there were about 10'000 jumps in the valley, 23 ending in an accident, 3 of those fatal. "the sport became safer", says bruno durrer, who works as a paramedic for air glacier, and has rescued already lots of BASE jumpers. his team developed a special technique to rescue people from mountainsides, if they entangled with their parachutes

http://www.base-jump.com/index.php?topic=3091.0;wap2

Als Arzt verfügt Bruno Durrer über das kompletteste Statistikmaterial. Und dieses besagt das Gleiche: Die Zahl der nicht tödlichen Unfälle ist weit grösser, als man annehmen könnte. Von den bis gestern im Lauterbrunnental erfassten knapp 200 Basejumping-Unfällen verliefen 35 tödlich, während über 160 Springer überlebten. Mehr als 40 von ihnen überstanden die Zwischenfälle unverletzt. Gut 25 trugen leichte Verletzungen davon wie Verstauchungen. Rund 70 erlitten Brüche, also mittelschwere Verletzungen. Und schliesslich waren es um die 20, die schwer verletzt wurden und zum Teil direkt ins Inselspital geflogen werden mussten.

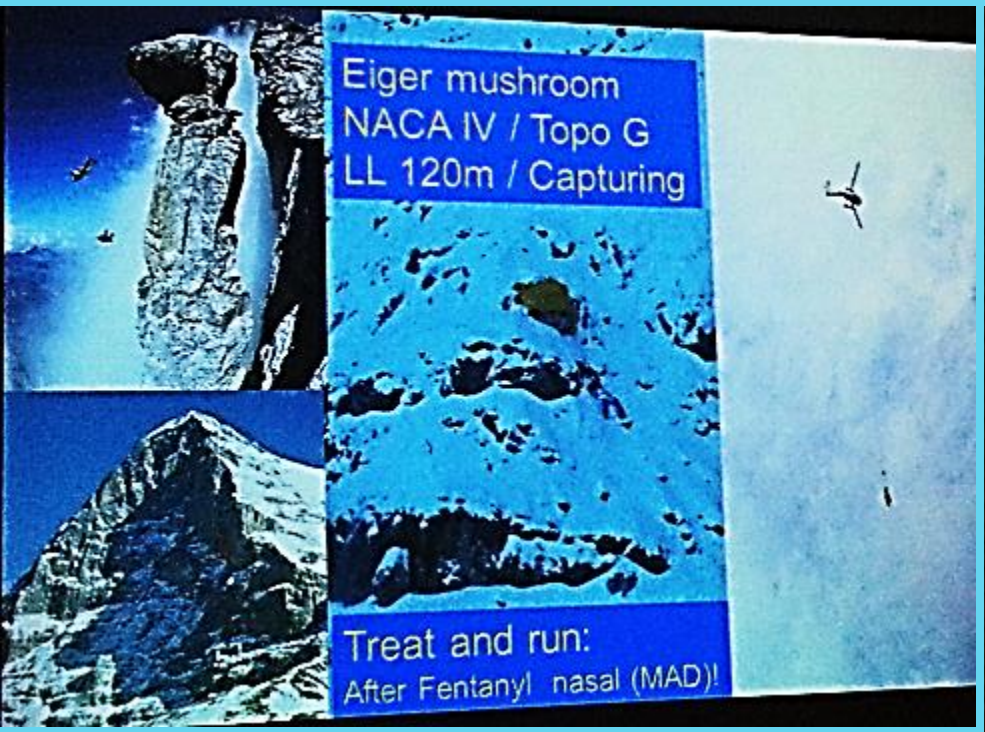
http://www.derbund.ch/bern/region/Im-freien-Fall-das-Bein-gebrochen/story/17600463?track 4. 8.2013

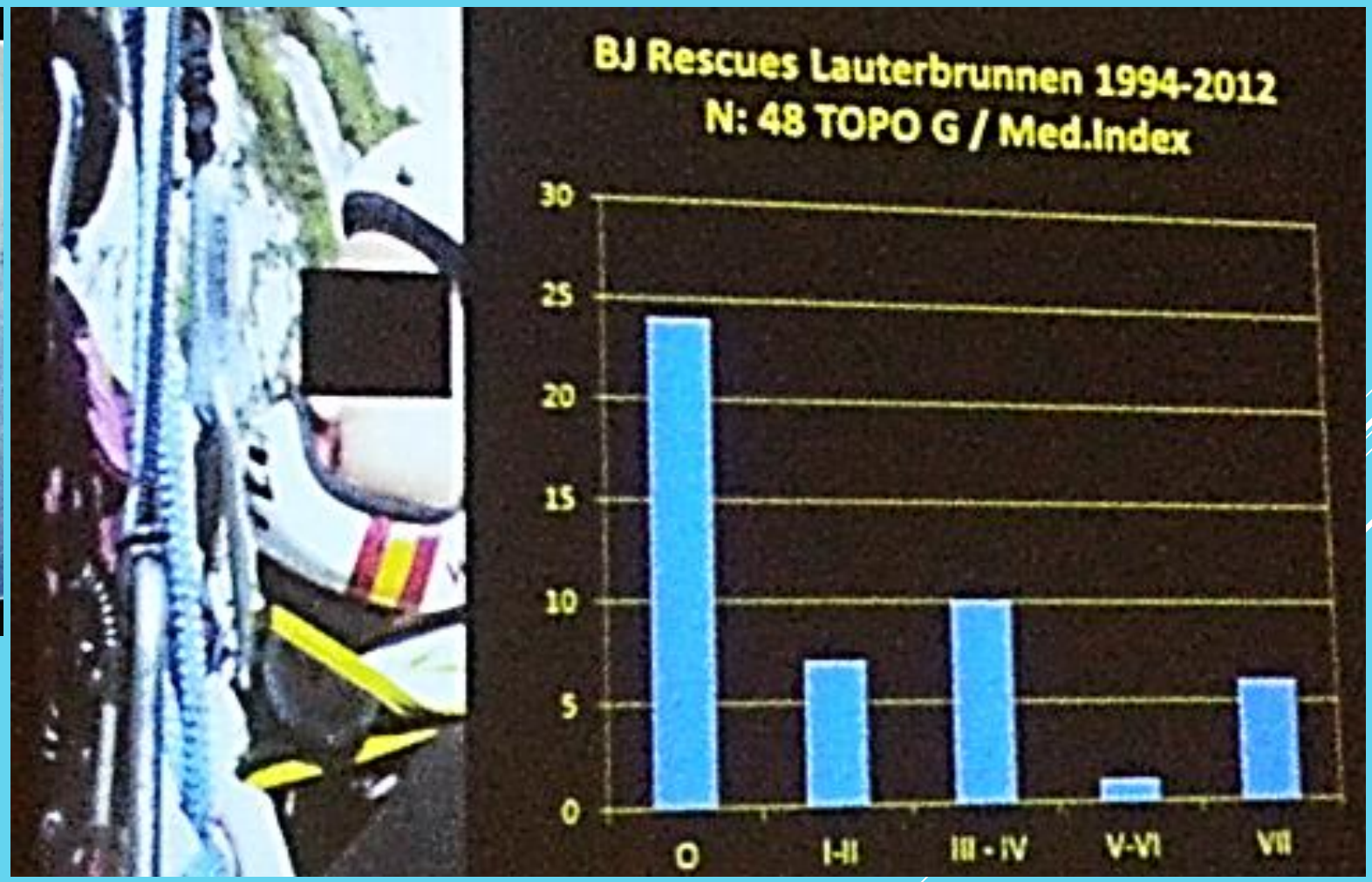


Topo > D: On-site ATLS ? ABCDE ?

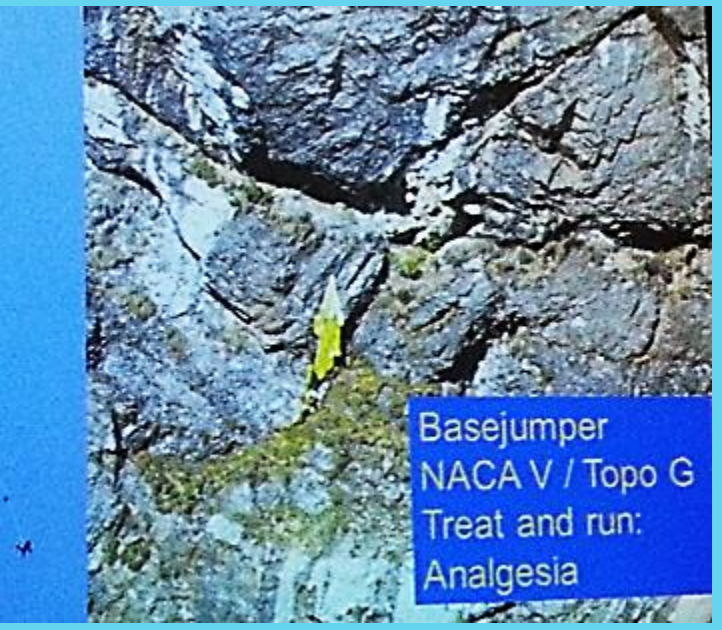
A!	Analgesia: i.v. / nasal
A	Intubation, Laryngealtube
B	Ventilation / Oxygen
B	Punction: tension- pneumothorax
C	Hemostasis/Volume/TPOD
	CPR (exceptionally!)
D	Drugs / Defibrillation?
E	Fixation, Reposition
	Cold prevention

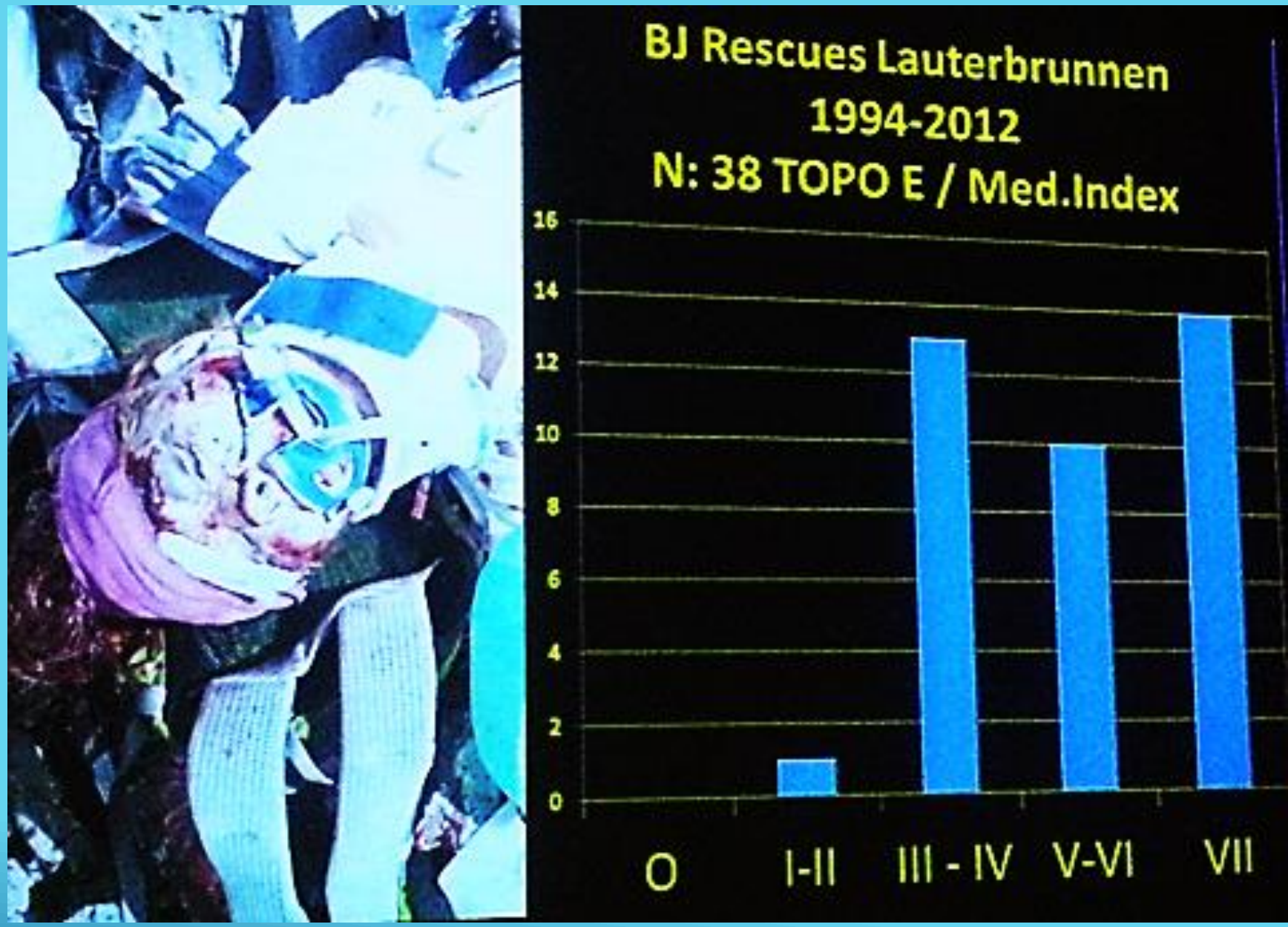
Durrer, 2013


Eiger mushroom
NACA IV / Topo G
LL 120m / Capturing
Treat and run:
After Fentanyl nasal (MAD)!


BJ Rescues Lauterbrunnen 1994-2012
N: 48 TOPO G / Med.Index
30
25
20
15
10
5
0
0
I-II
III - IV
V-VI
VII

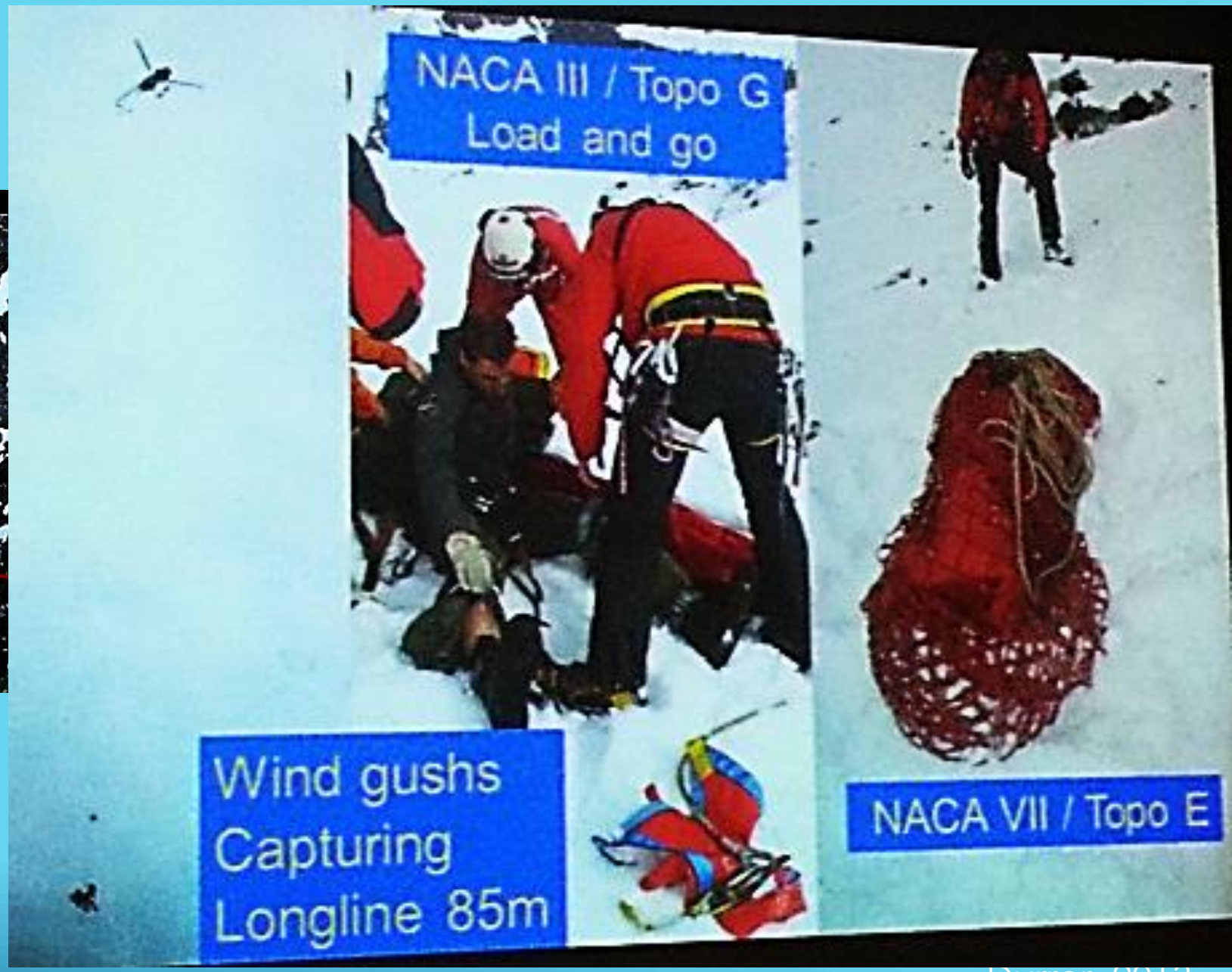
Durrer, 2013


Basejumper
NACA V / Topo G
Treat and run:
Analgesia

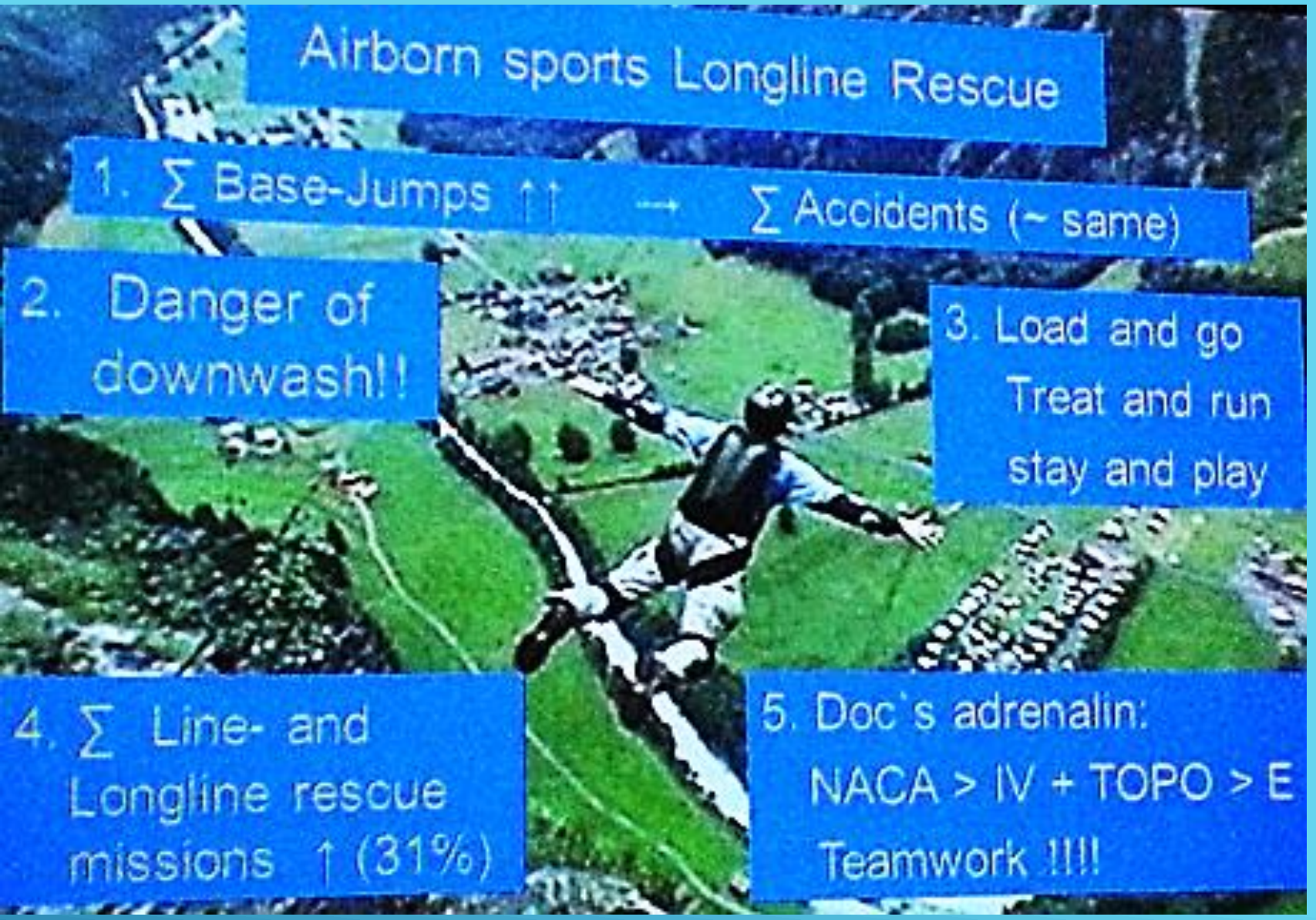

BJ Rescues Lauterbrunnen
1994-2012
N: 38 TOPO E / Med.Index
16
14
12
10
8
6
4
2
0
O
I-II
III - IV
V-VI
VII

Durrer, 2013

Tornado jet crash
Ejection seat


NACA III / Topo G
Load and go
Wind gushs
Capturing
Longline 85m
NACA VII / Topo E

Durrer, 2013


Airborn sports Longline Rescue
1. ∑ Base-Jumps ↑↑ → ∑ Accidents (~ same)
2. Danger of downwash!!
3. Load and go
Treat and run
stay and play
4. ∑ Line- and Longline rescue missions ↑ (31%)
5. Doc's adrenalin:
NACA > IV + TOPO > E
Teamwork !!!!

Thanks for your kind attention !
bd@ caremed.ch
www.mountainrescue.ch
Albert Bierstadt, the valley of Lauterbrunnen, 1857, Salander-O Reilly Galleries,NY

Durrer, 2013

ZKUŠENOSTI S AKLIMATIZACÍ U REKREAČNÍCH NÁVŠTĚVNÍKŮ VELKÝCH VÝŠEK

Acclimatization Practices of High-Altitude Recreationalists

Leslie H. Rozier
Family Nurse Practitioner
Pinedale, Wyoming, USA

NAMME Varese 2013

Research Question

Why are people who ascend to high altitude noncompliant with evidence-based acclimatization recommendations?

Objectives

1) To survey high-altitude recreationalists regarding their decision to defer or comply with current acclimatization recommendations prior to their ascent to altitude, and

2) To incorporate the findings from the pilot survey in a separate field study of rapid ascent South Pole bound scientists and support staff at a later date.

Background:

Only 40% of South Pole scientists and support staff took acclimatization medication prior to their rapid deployment to altitude placing them at risk for developing hypobaric hypoxia and the subsequent cascade of symptoms known as acute mountain sickness (AMS). (Anderson, et al. 2011)

- 3 hour flight
- Physiologic altitude varies between 10,827' and 13,123
- Physical altitude is 9,300'

Methodology

Study Design: Cross-Sectional, Descriptive Study

Convenience Sample: High-Altitude Recreationalist Volunteers

Location: Elkhart Trailhead (9,300 ft) Bridger-Teton National Forest, Wy

Survey Tool: Three page questionnaire regarding:

- Acclimatization practices of recreationalists arriving at high altitude including rationale of choice to acclimatize (or not)
- Demographics of the recreationalists including (risk factors): vital sign pulse oximetry, height & weight, BMI, and
- Completion of the Lake Louis Symptoms Score Questionnaire that evaluates the presence and severity of AMS

Rozier, 2013

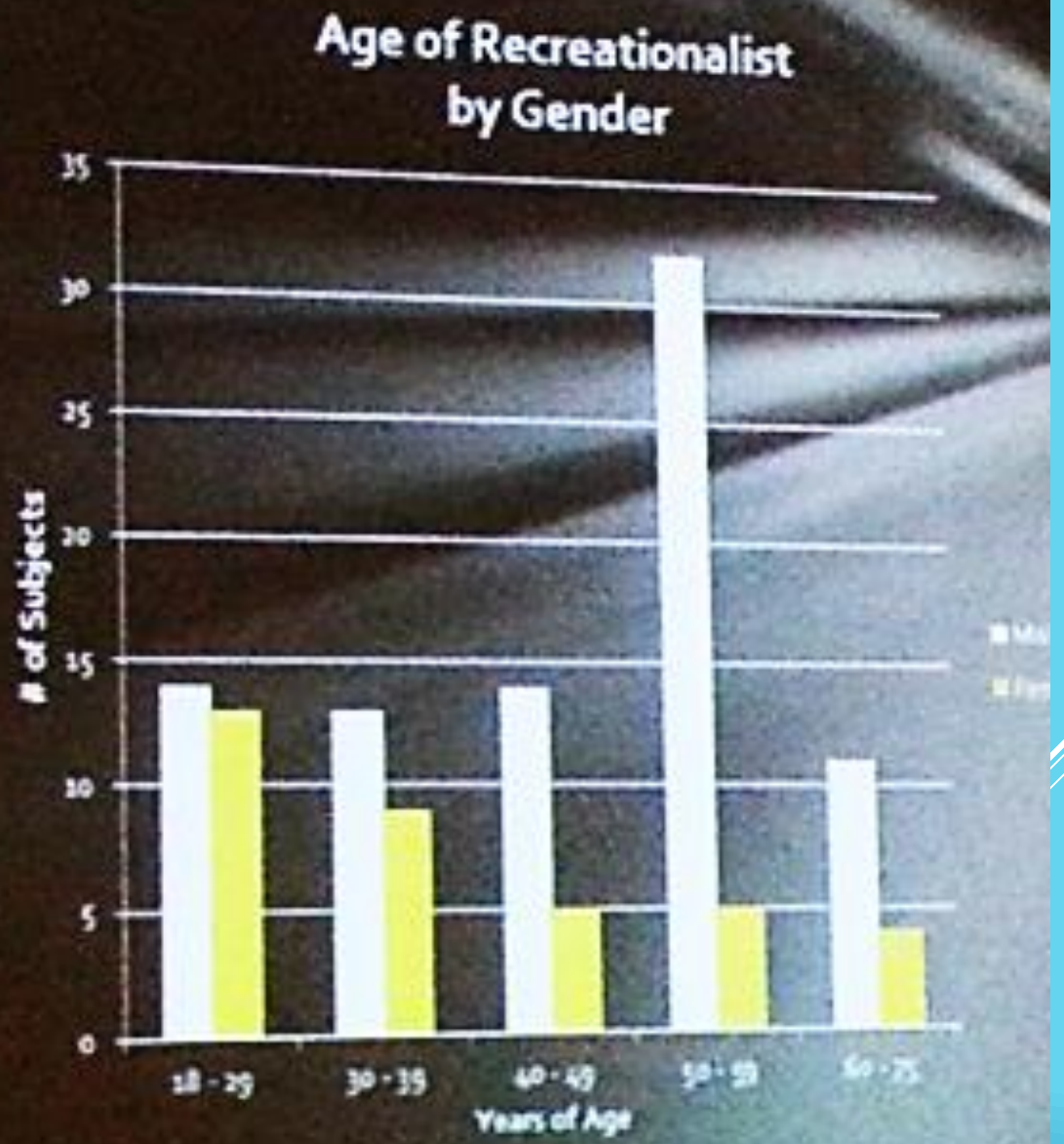
Results

Sex (N=120)

Males	84	70 %
Females	36	30 %

Age (n=120)

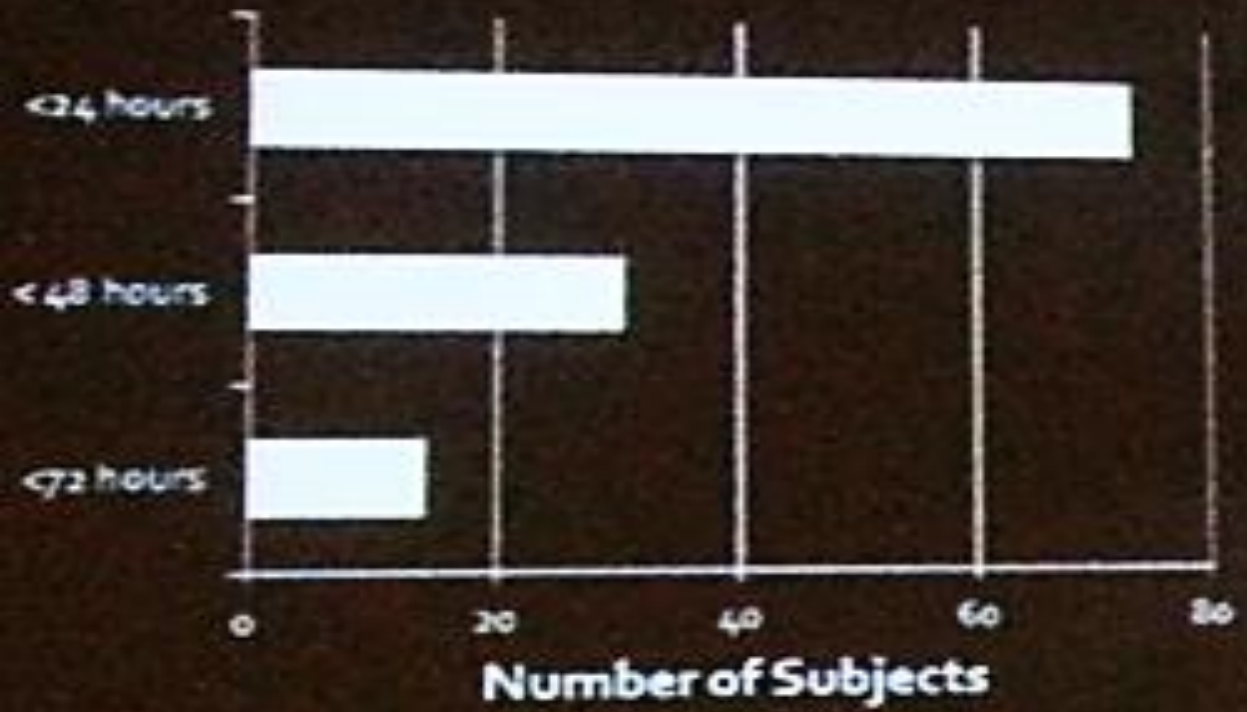
18 - 29	27	23 %
30 - 39	22	18 %
40 - 49	19	16 %
50 - 59	37	31 %
60 – 75	15	13 %



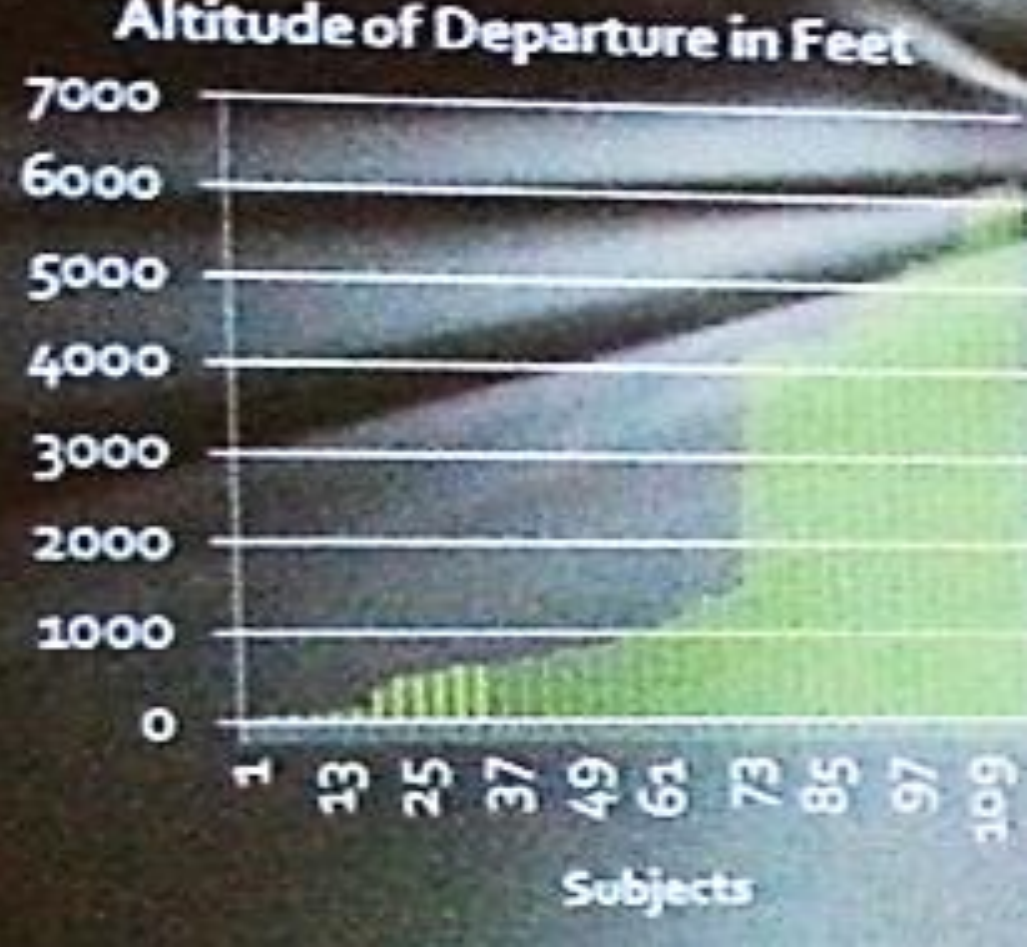
NAMME, Varese 2013

Rozier, 2013

61% of the subjects took less than 24 hours to ascend to 9,300 feet to begin their journey



50% of the subjects came from below 1,000 feet with the majority below 5,000 feet



Results

- Three subjects (2.5%) were taking acetazolamide and
- Five subjects (4%) consulted a health professional prior to their high-altitude sojourn.

Forty percent (40%) of the respondents camped at the trailhead or above 6,800 feet the night before their departure and seven individuals (6%) took hikes to enhance acclimatization the day before their departure.

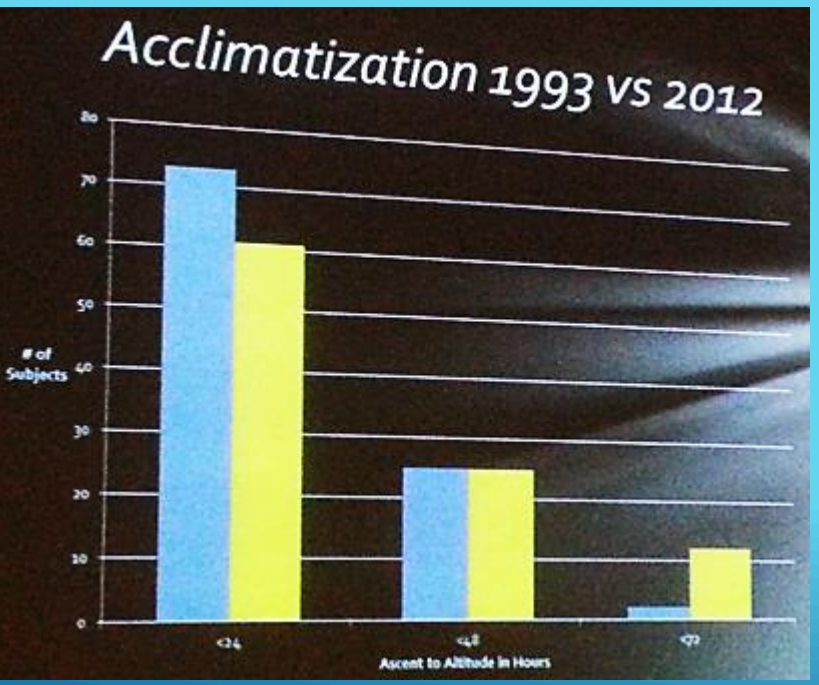
Many subjects were veteran backpackers and reported their acclimatization symptoms could be controlled with hydration (12%), adequate rest and anti-inflammatories (40%) to control headaches, joint pain and AMS symptoms.

- The general consensus was to "suffer through" any symptoms.

- Twelve subjects (10%) were unaware that acclimatization was a recommendation for ascent to altitude.

Conclusions

Despite the current Wilderness Medical Society guidelines for acclimatization to altitude, the majority of high-altitude volunteers in this study reported following few acclimatization practices.



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Rozier, 2013

Honor Society of Nursing, Sigma Theta Tau Internation
24th International Nursing Research Congre
Prague, Czech Republic • 22-26 July 2013

Despite recent Wilderness Medical Society (WMS) recommendations (Luks et al., 2010) stressing gradual ascent and medication prophylaxis for the prevention of AMS, 61% of the subjects took less than 24 hours to ascend to 9,300 feet to begin their journey. The majority (55%) of subjects (n=66) did not perceive the need for medications. Only three subjects (2.5%) were taking acetazolamide and just 4% had consulted a health professional prior to their high altitude sojourn. The general consensus was to "suffer through" any symptoms. Twelve subjects (10%) were unaware that acclimatization was a recommendation for ascent to altitude.

VRTULNÍKY PRO ZÁCHRANU VE VELKÝCH VÝŠKÁCH

High Altitude Rescue Helicopters

Augusta Westland

NAMME
Varese
2013

... IS OUR BUSINESS
AW169
AW169 Versatility no limits

Grand new
AgustaWestland
A Finmeccanica Company

Emergency Medical Services
AW139