



Mountain Medicine in Pills

- Lorenza Pratali MD PhD

IR0000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System
(D.D. n. 130/2022 - CUP B53C22002150006) Funded by EU - Next Generation EU PNRR-
Mission 4 “Education and Research” - Component 2: “From research to business” - Investment
3.1: “Fund for the realisation of an integrated system of research and innovation infrastructures”



Mountain Medicine in pills

 Index

 Introduction










 Physiological responses to altitude

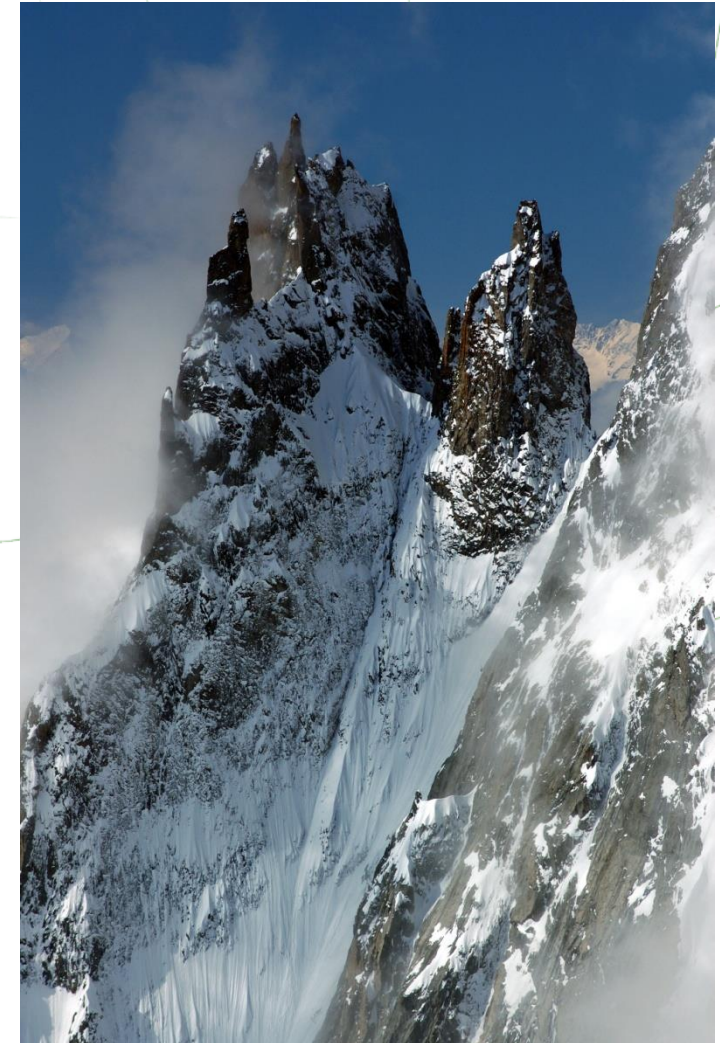
 Acute high altitude illnesses:

- Acute high altitude illness
- High altitude cerebral edema
- High altitude pulmonary edema
- Hypertensive response at altitude



Physical characteristics of the mountain environment

-  Reduced partial pressure of oxygen in atmospheric air
-  Reduced barometric pressure
-  Reduced temperature
-  Increased solar radiation
-  Lower air density
-  Lower air humidity
-  Reduced quantity of allergens
-  Reduced pollution
-  Increased wind



Physical characteristics of the mountain environment

🌐 Oxygen



🌐 Temperature



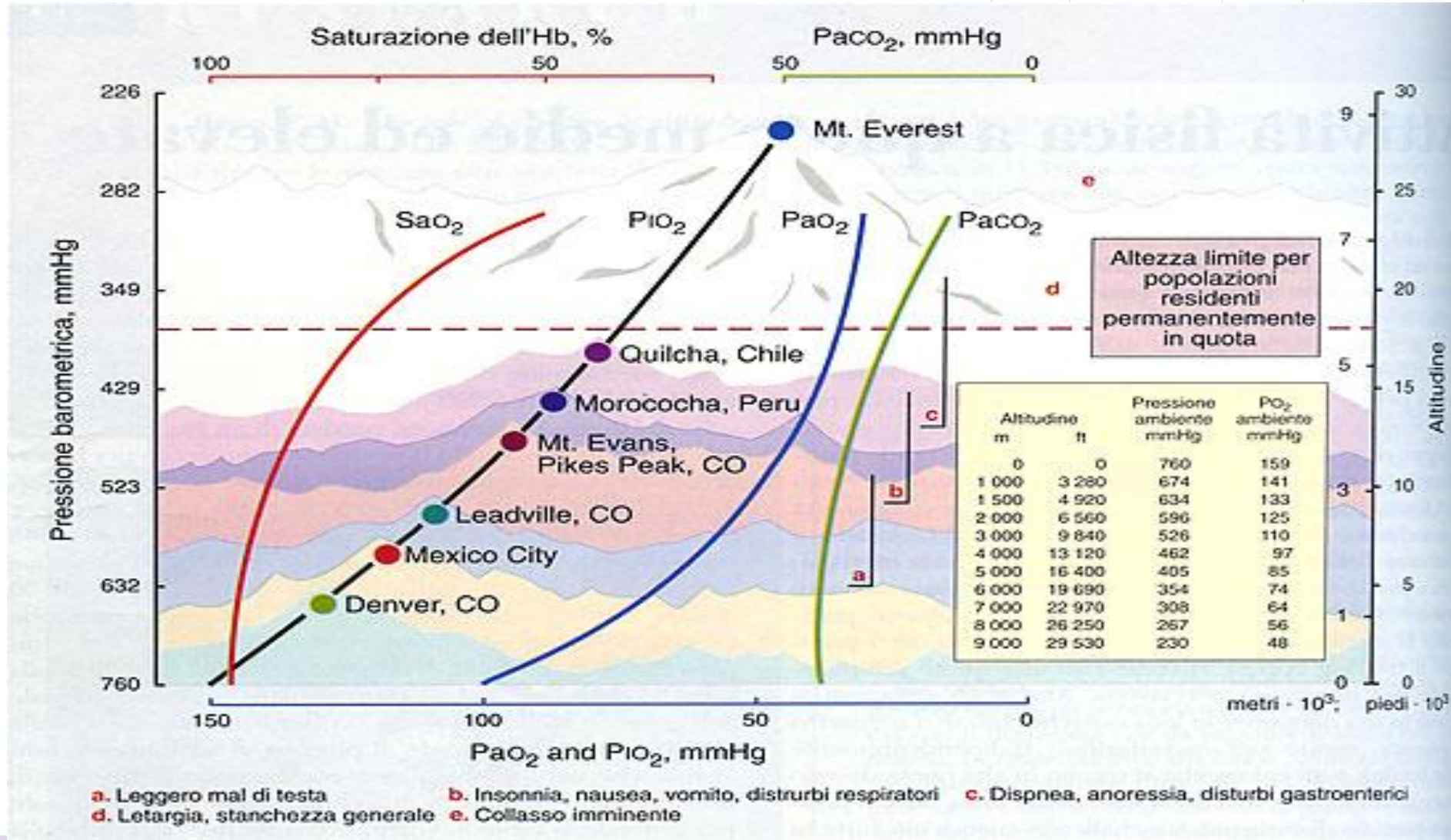
🌐 Humidity



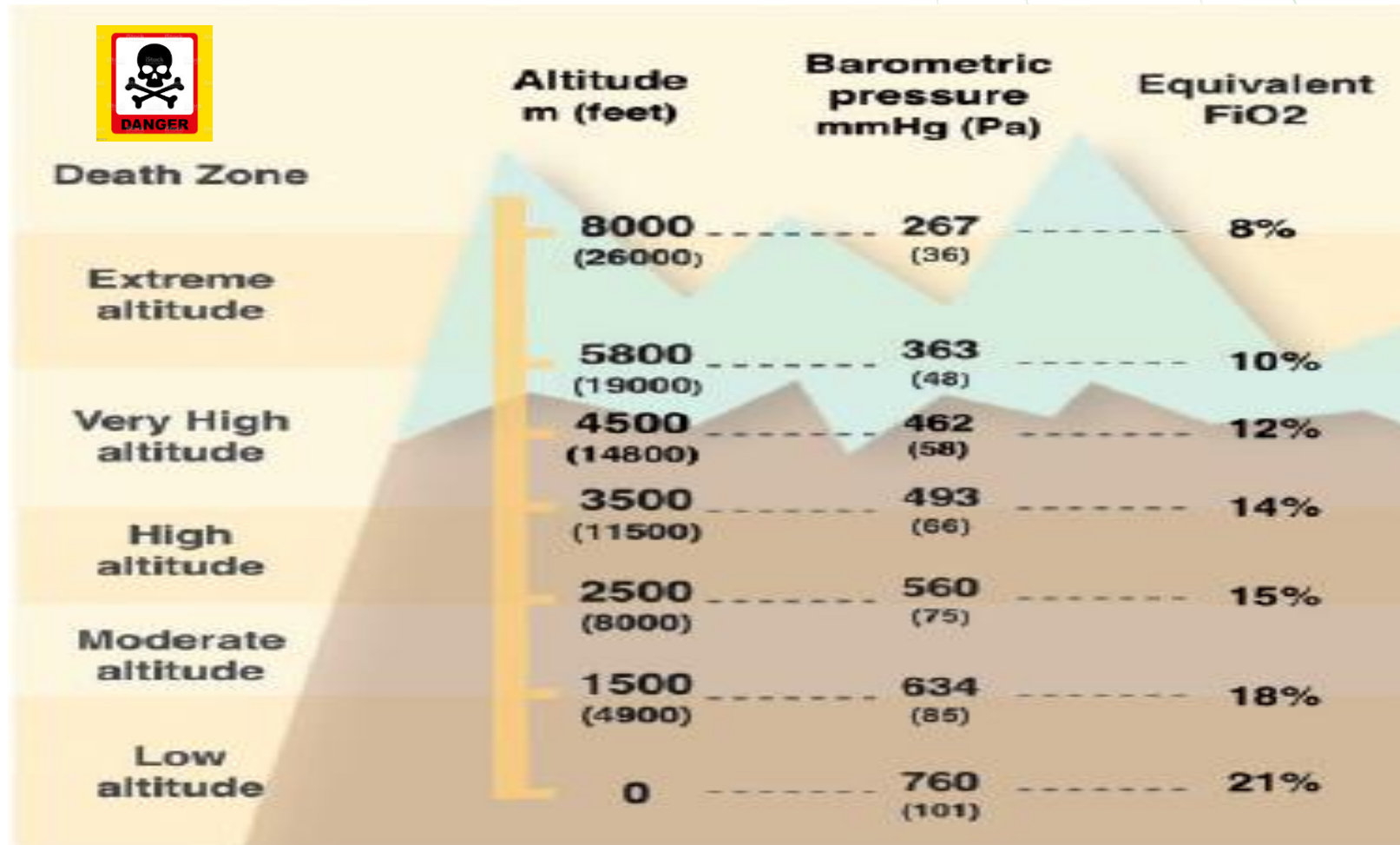
🌐 UV radiation



Barometric Pressure and Inspiratory Oxygen Pressure

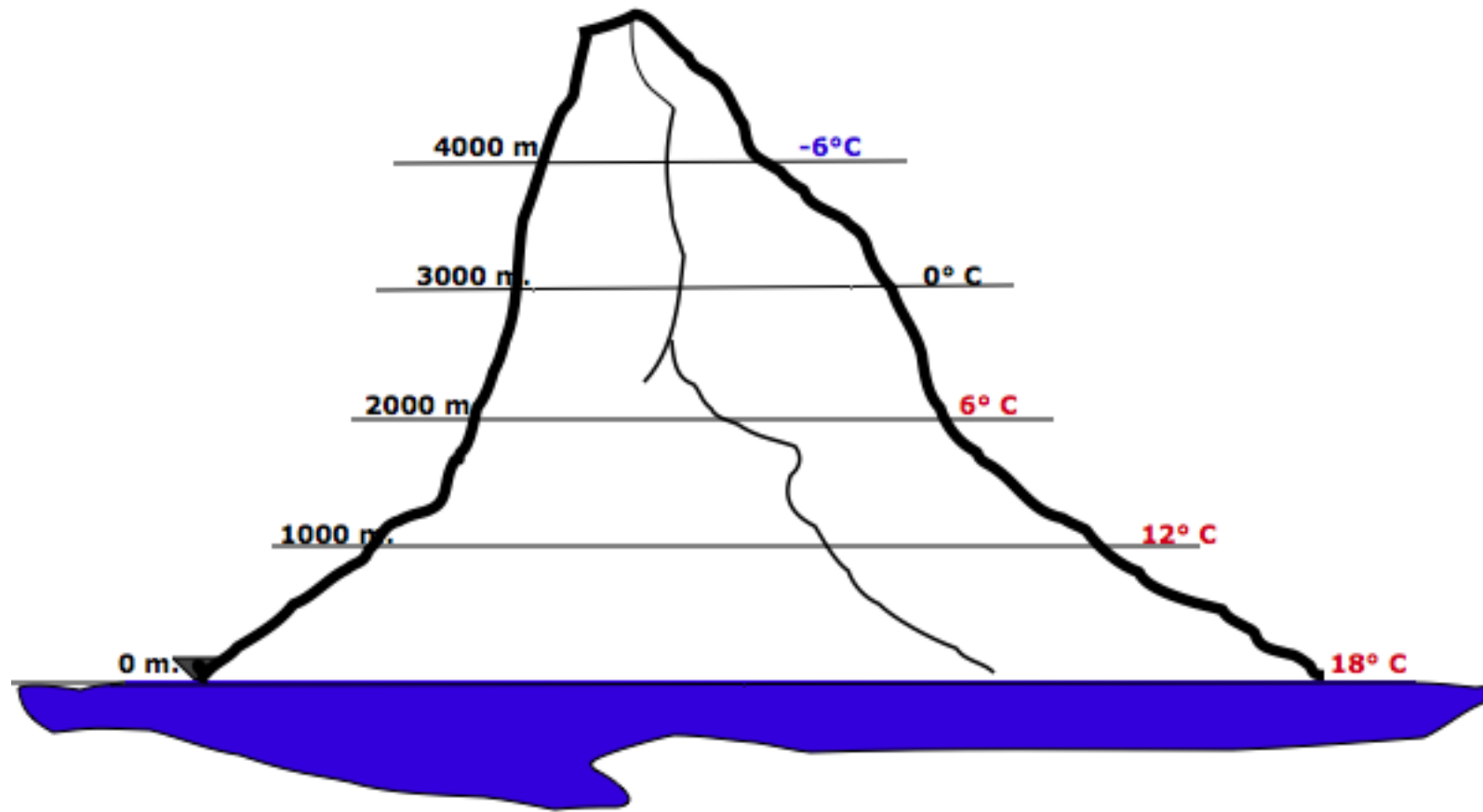


Level of Altitude



Parati G Eur Heart J 2017

Vertical Thermal Gradient



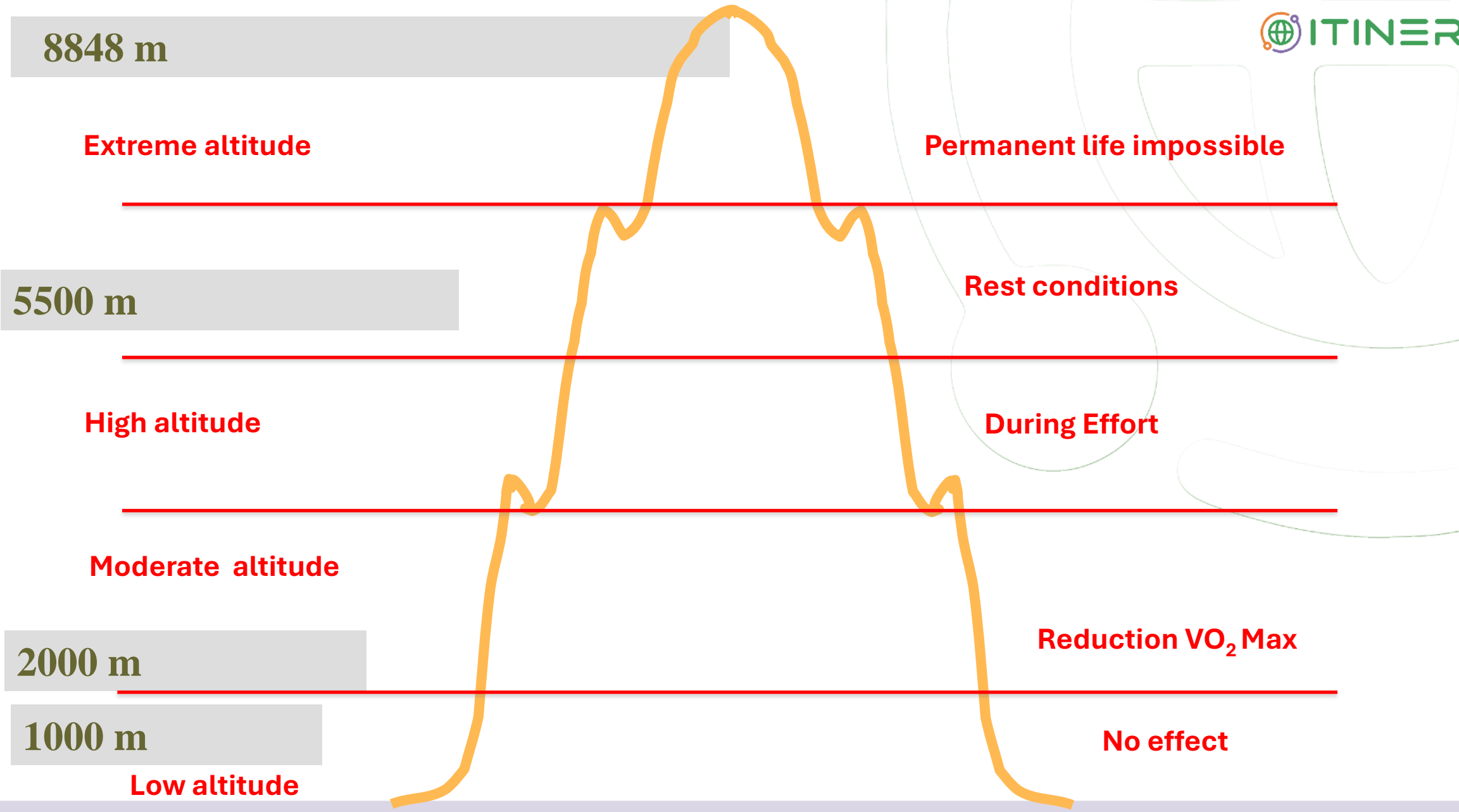
Wind chill chart (Celsius)

Wind speed (km/hr)	Temperature (°C)									
	6	0	-5	-10	-15	-20	-25	-30	-35	-40
calm	6	0	-5	-10	-15	-20	-25	-30	-35	-40
10	3	-3	-9	-15	-21	-27	-33	-39	-45	-51
20	1	-5	-12	-18	-24	-31	-37	-43	-49	-56
30	0	-7	-13	-20	-26	-33	-39	-46	-52	-59
40	-1	-7	-14	-21	-27	-34	-41	-48	-54	-61
50	-2	-8	-15	-22	-29	-36	-42	-49	-56	-63
60	-2	-9	-16	-23	-30	-37	-43	-50	-57	-64
70	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65
80	-3	-10	-17	-24	-31	-38	-45	-52	-59	-66
90	-3	-10	-17	-25	-32	-39	-46	-53	-60	-67
100	-3	-11	-18	-25	-32	-40	-47	-54	-61	-68

$$\text{wind chill (}^\circ\text{C)} = 13.12 + 0.6215T - 11.37(V^{0.16}) + 0.39857(V^{0.16})^2$$
 where T = air temperature (°C) and V = wind speed (km/h)

Frostbite times: ■ 30 minutes ■ 10 minutes ■ 5 minutes

Sources: U.S. National Weather Service and Meteorological Services of Canada



Himalaya Plateaus (3.500 - 5.500 m. sl)



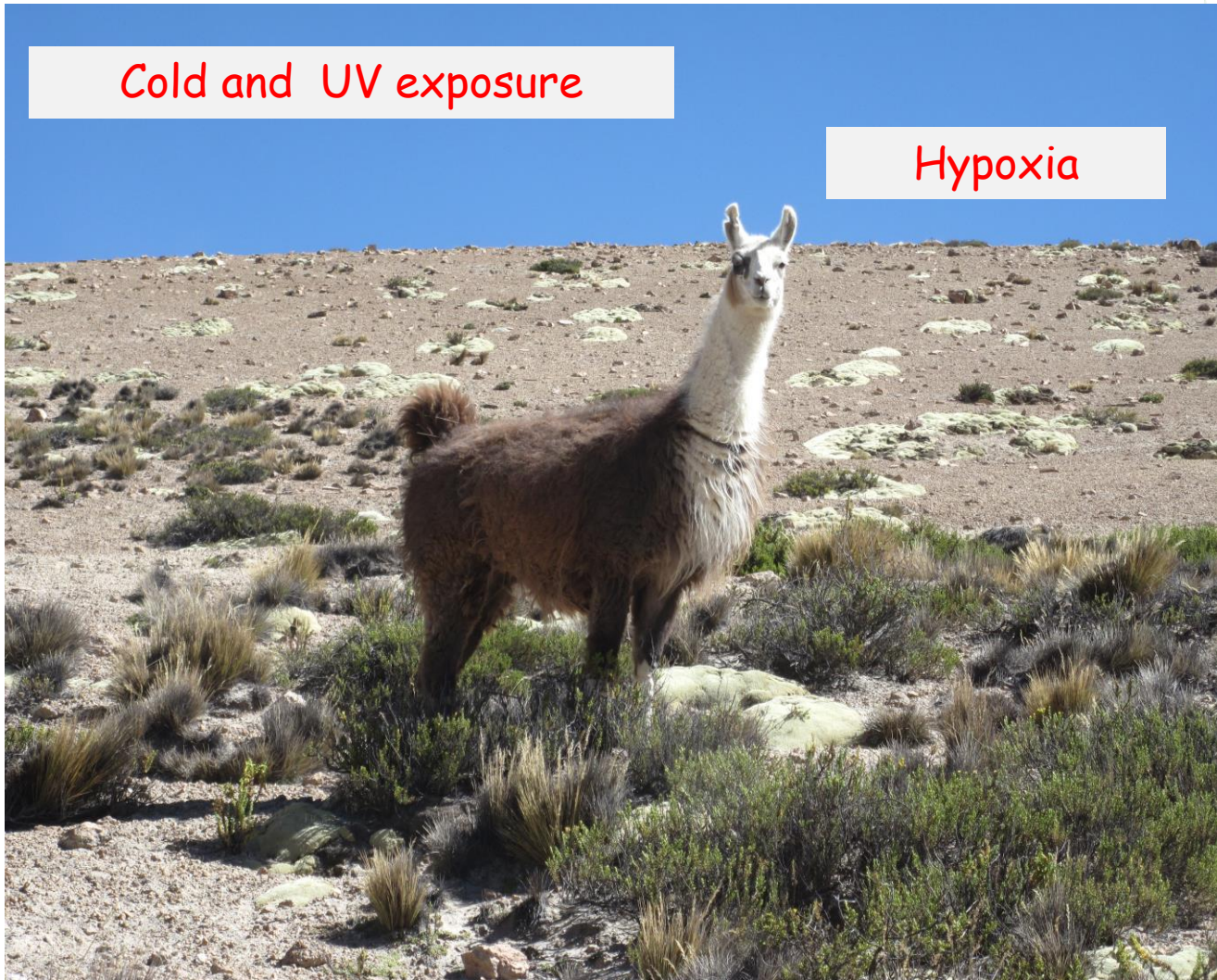
..... Andes (3.500 - 4.500 m. sl).....



Ethiopian Plateaus (3.500 - 4.000 m. sl)



How to deal with hostilities at high altitude



Technological adaptation

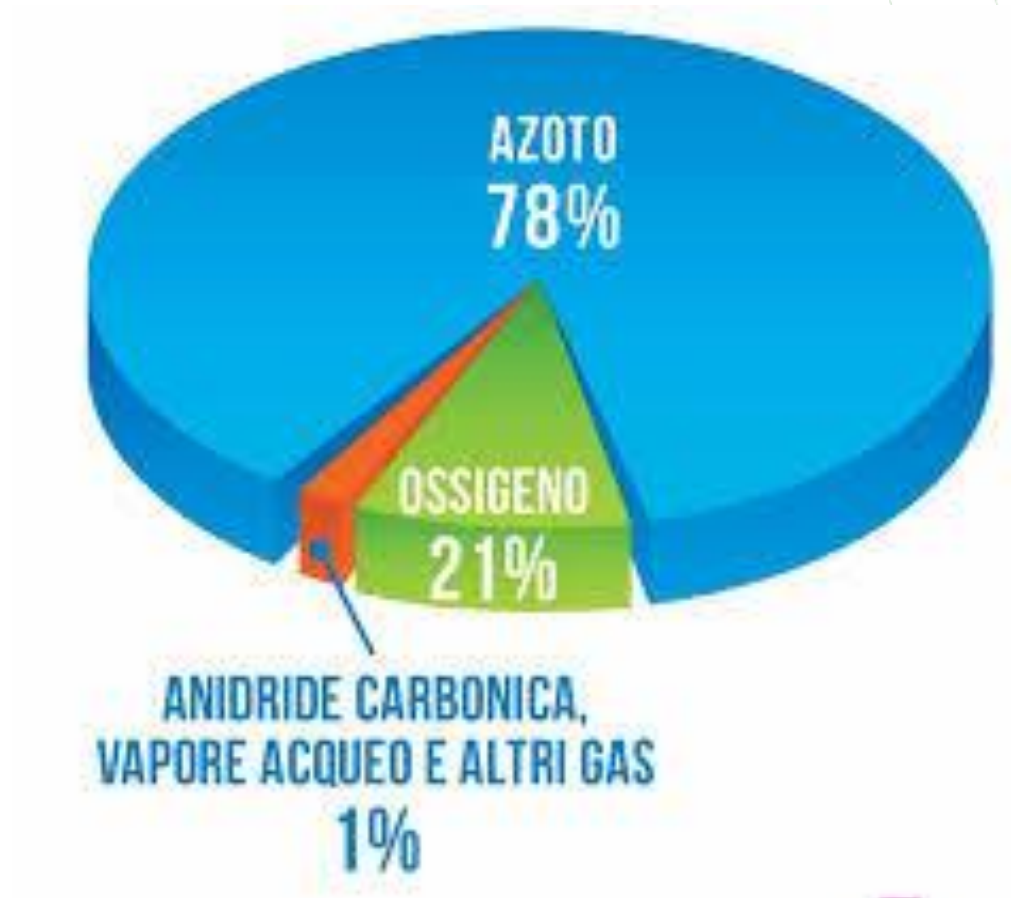
Genetical adaptation

Genetical Adaptation: how and where





Ambient air



What is the % oxygen in the air a 8000 m

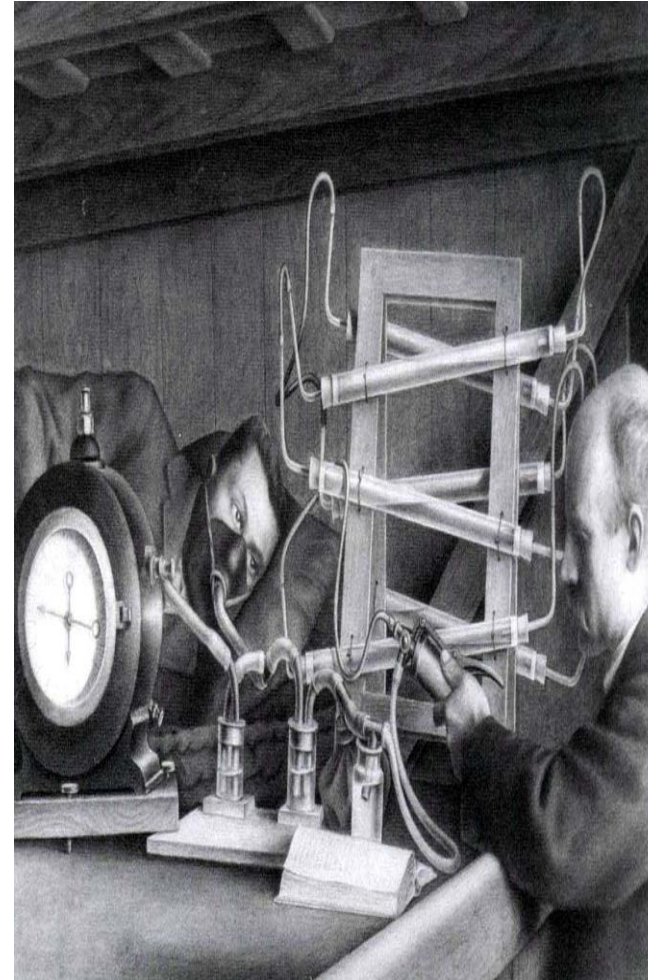
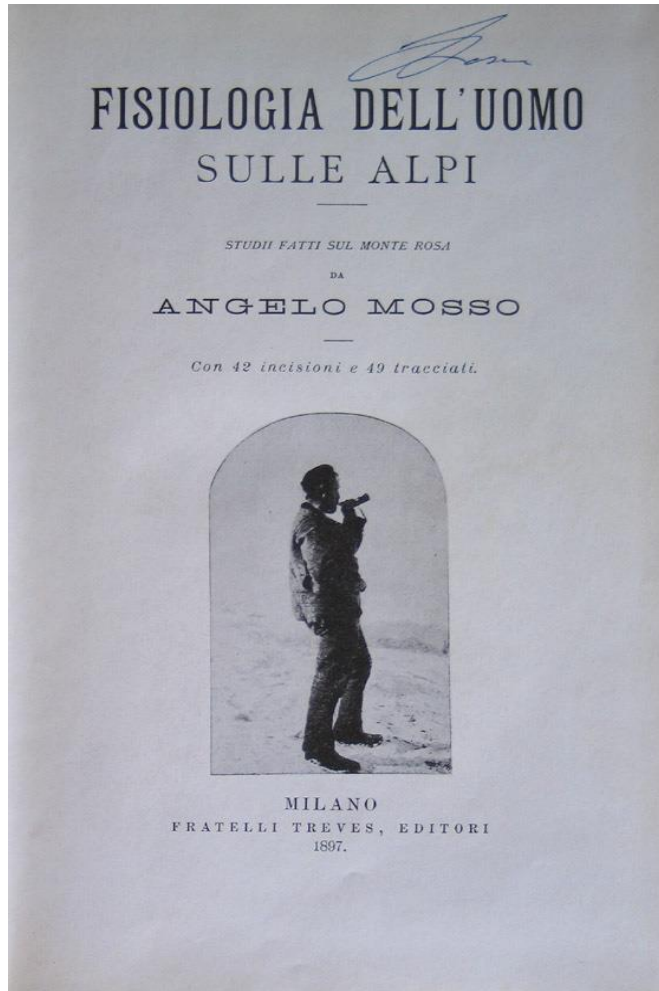
< sea level



= sea level



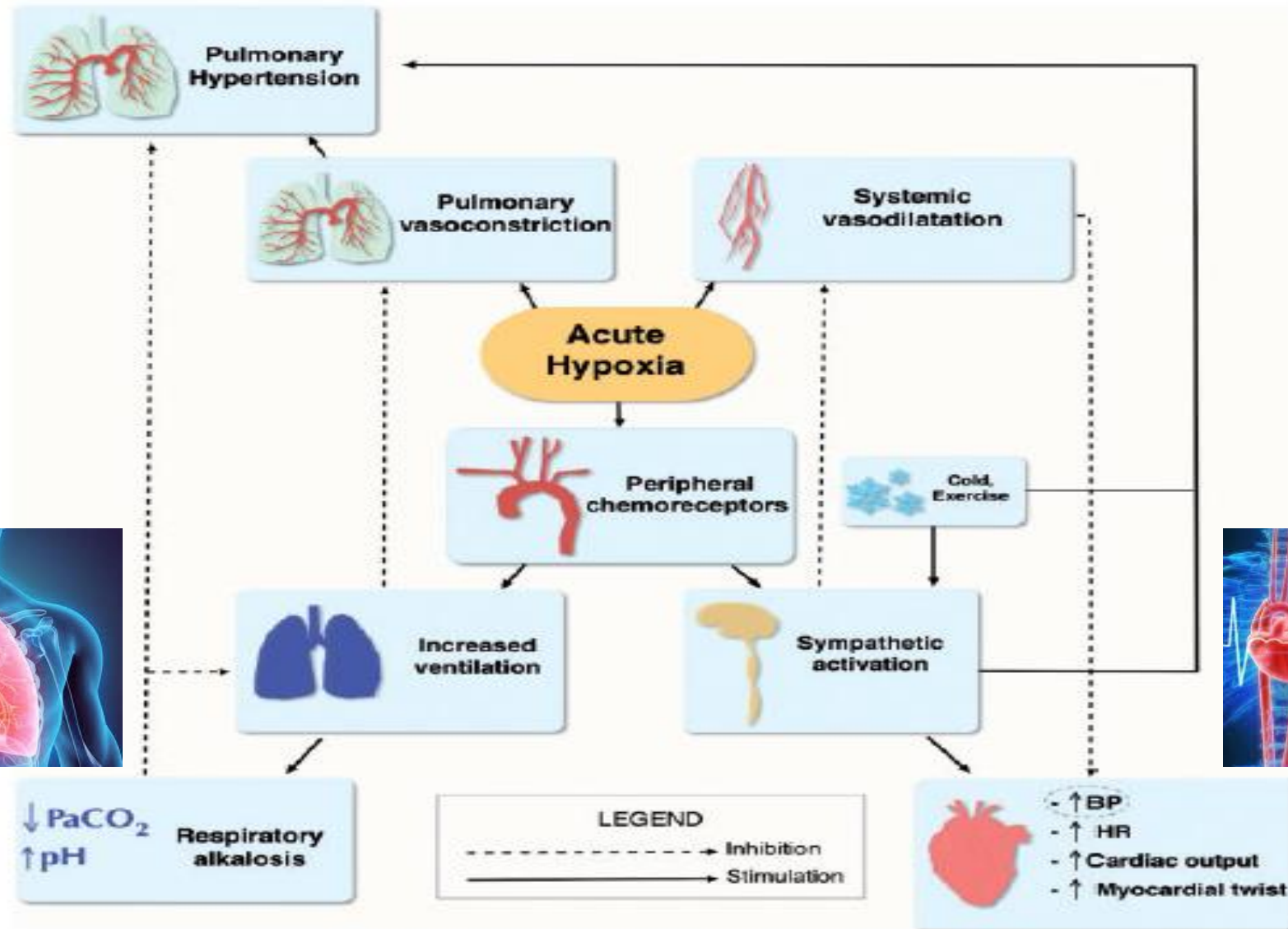
High Altitude Physiology



Inaguration Margherita Hut



Physiological responses to hypoxia

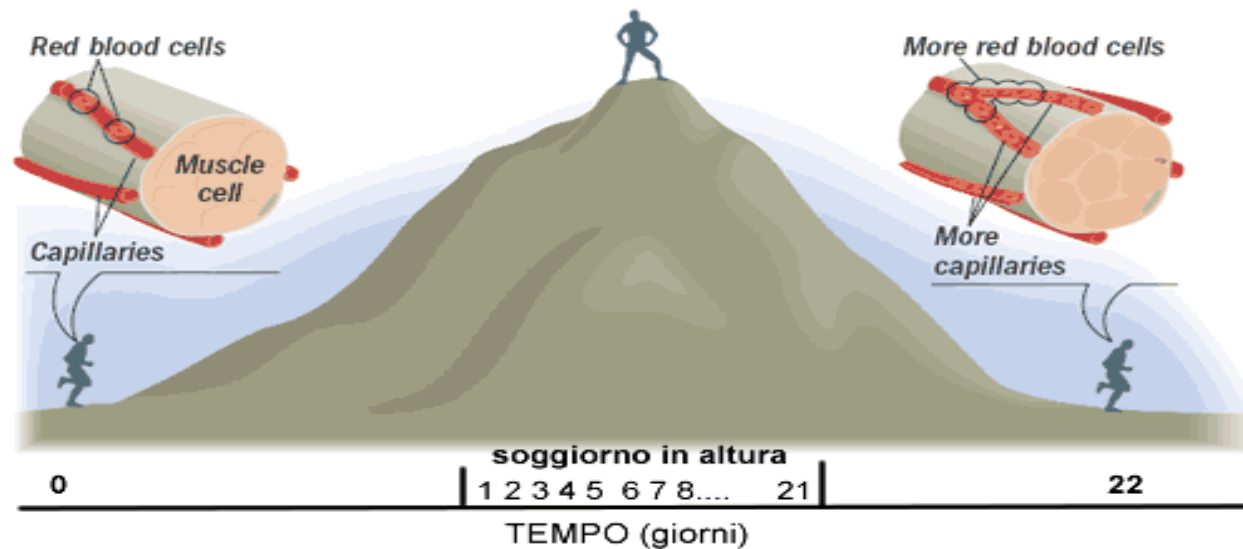


Acute and chronic physiological responses to hypoxia

Physiological Balance

Acute exposure: Ventilation
 Heart rate

Chronic Exposure: Hemoglobin
 Heart rate



Which physiological parameter increases first when you go up to altitude?

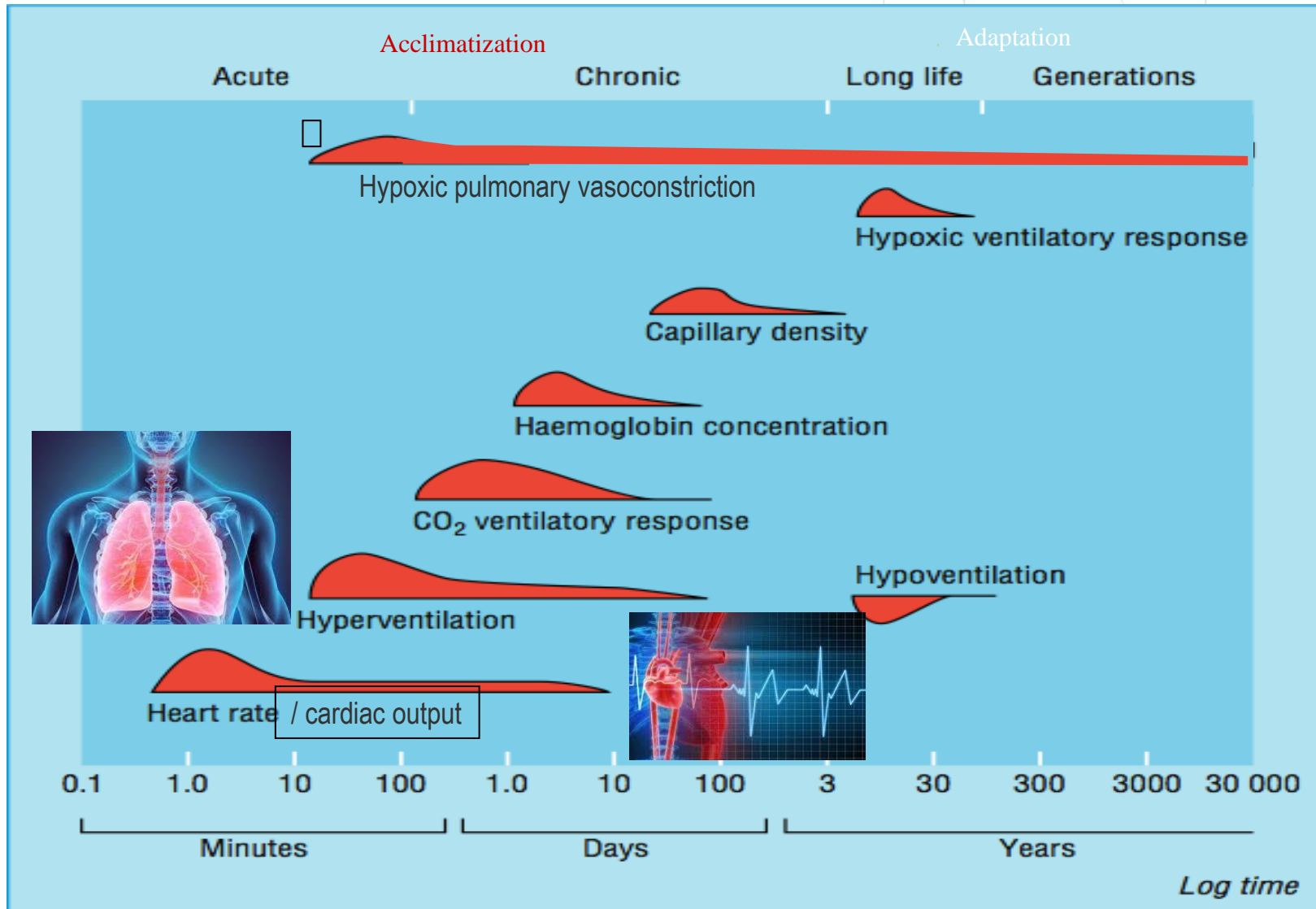
Heart rate



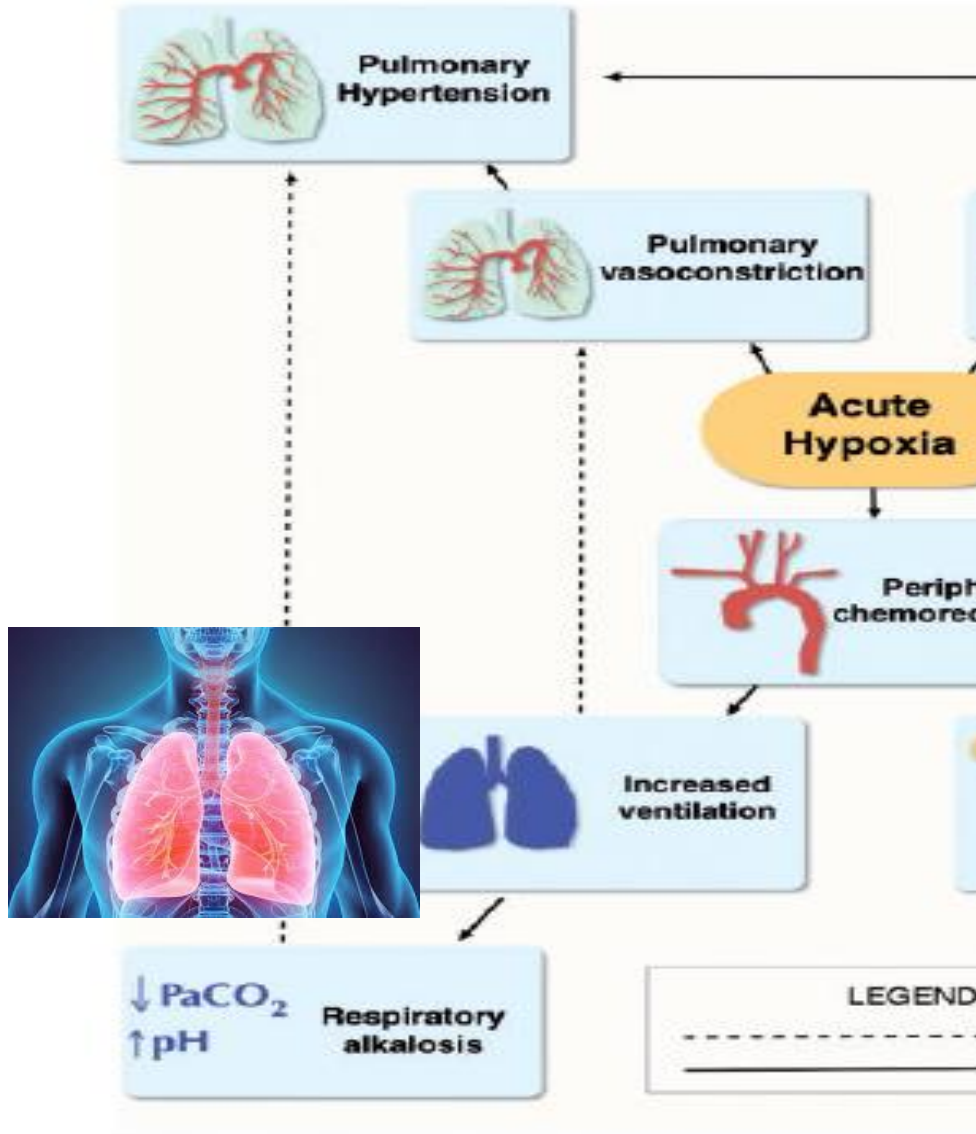
Breath Frequency



Timing in the physiological responses



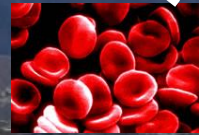
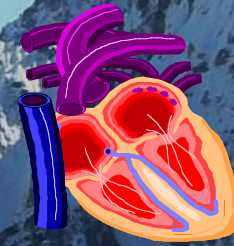
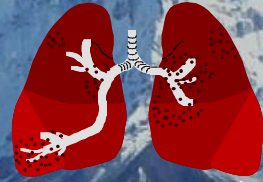
Respiratory System



Respiratory System

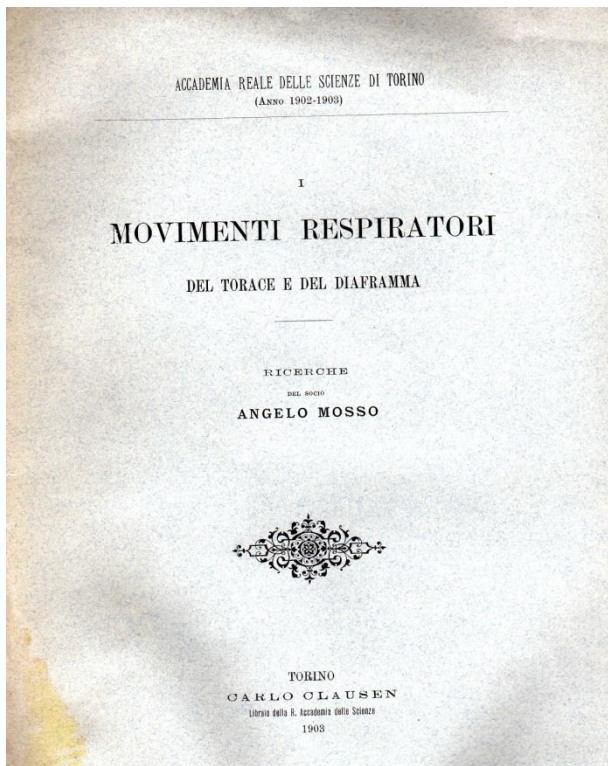
Oxygen Transport

Air



"I am nothing more than a single, narrow, gasping lung, floating over the mists and summits"

(R. Messner)



Il tracciato 33 rappresenta una esperienza fatta sopra Giorgio Mondo, mentre sta in posizione di 45° ed ha il pneumografo doppio intorno al torace ed un altro intorno

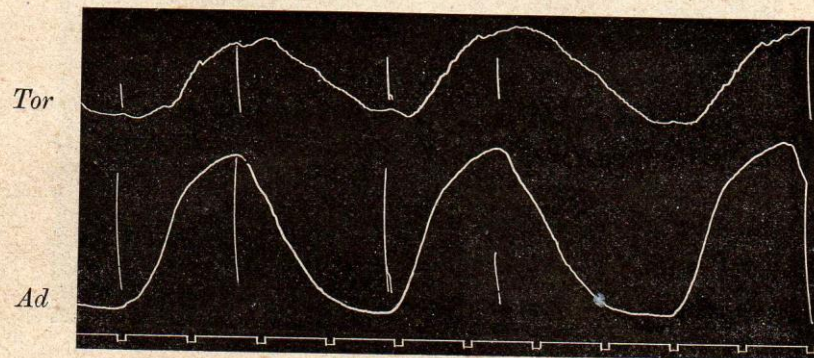


Fig. 33.

all'addome. Gli avevo messo sulla faccia la maschera di ...

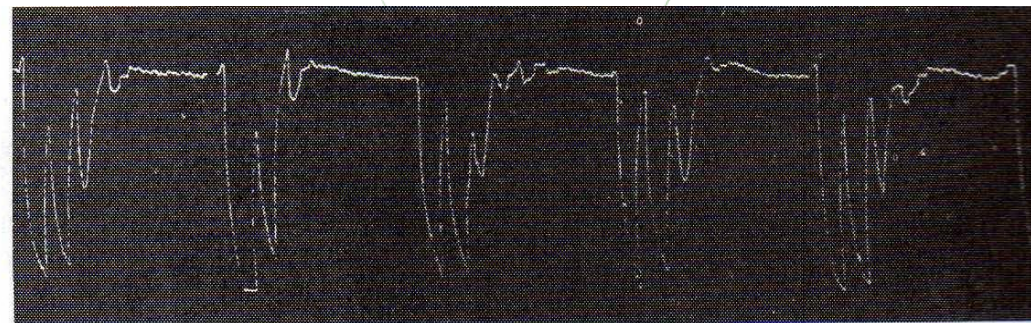
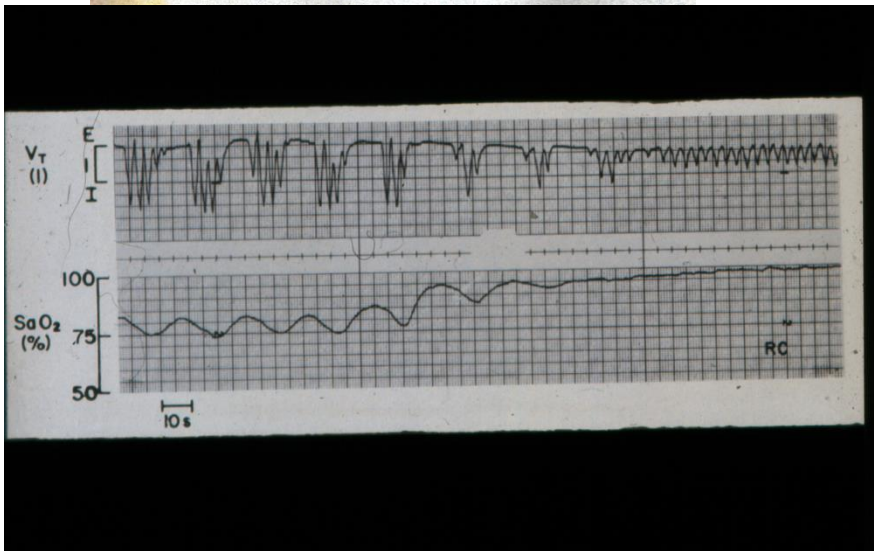
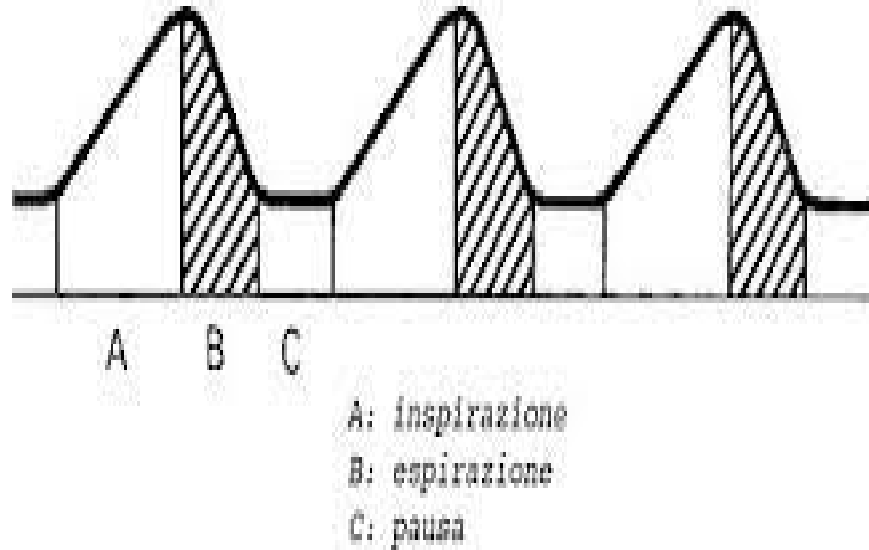


Figure 3.10. Example of periodic breathing recorded on Angelo Ugolino at the Capanna Margherita. The apneic periods lasted ... Mosso also recorded periodic breathing on his dog, Nerino. [From ...]

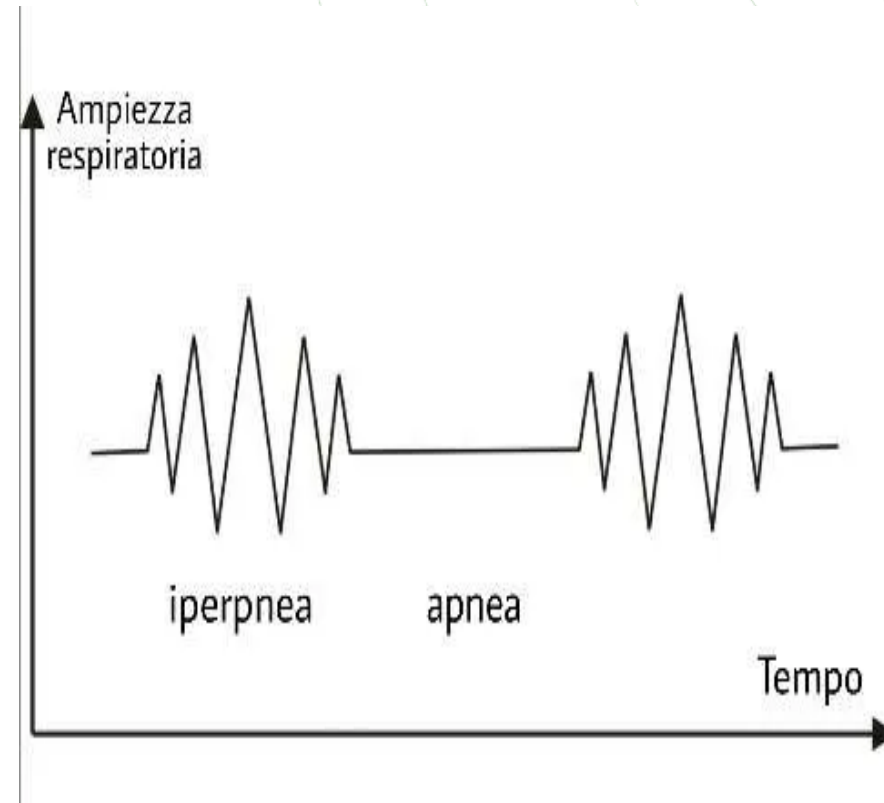
Respiratory pattern

Normal

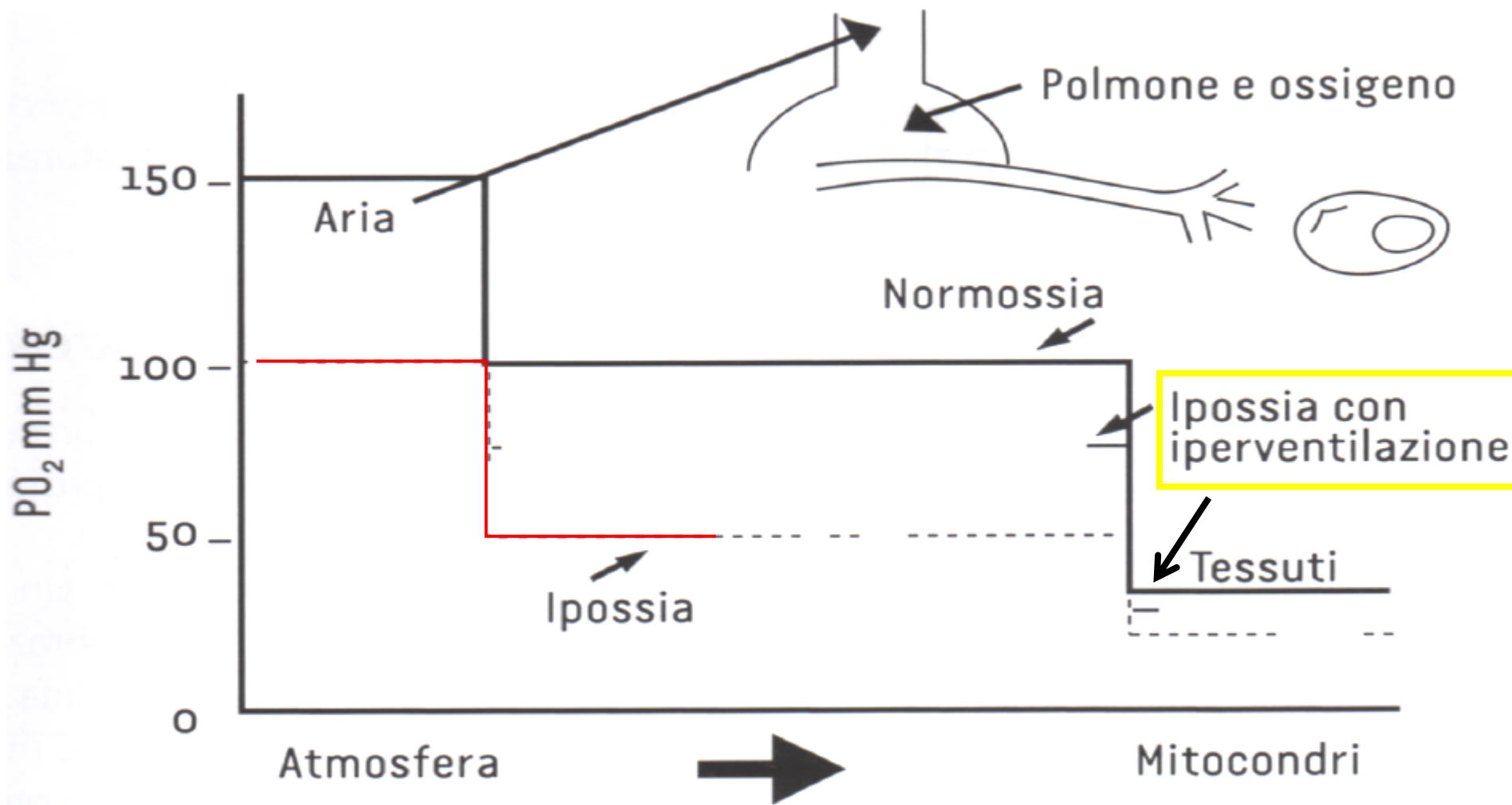
Dinamica respiratoria normale



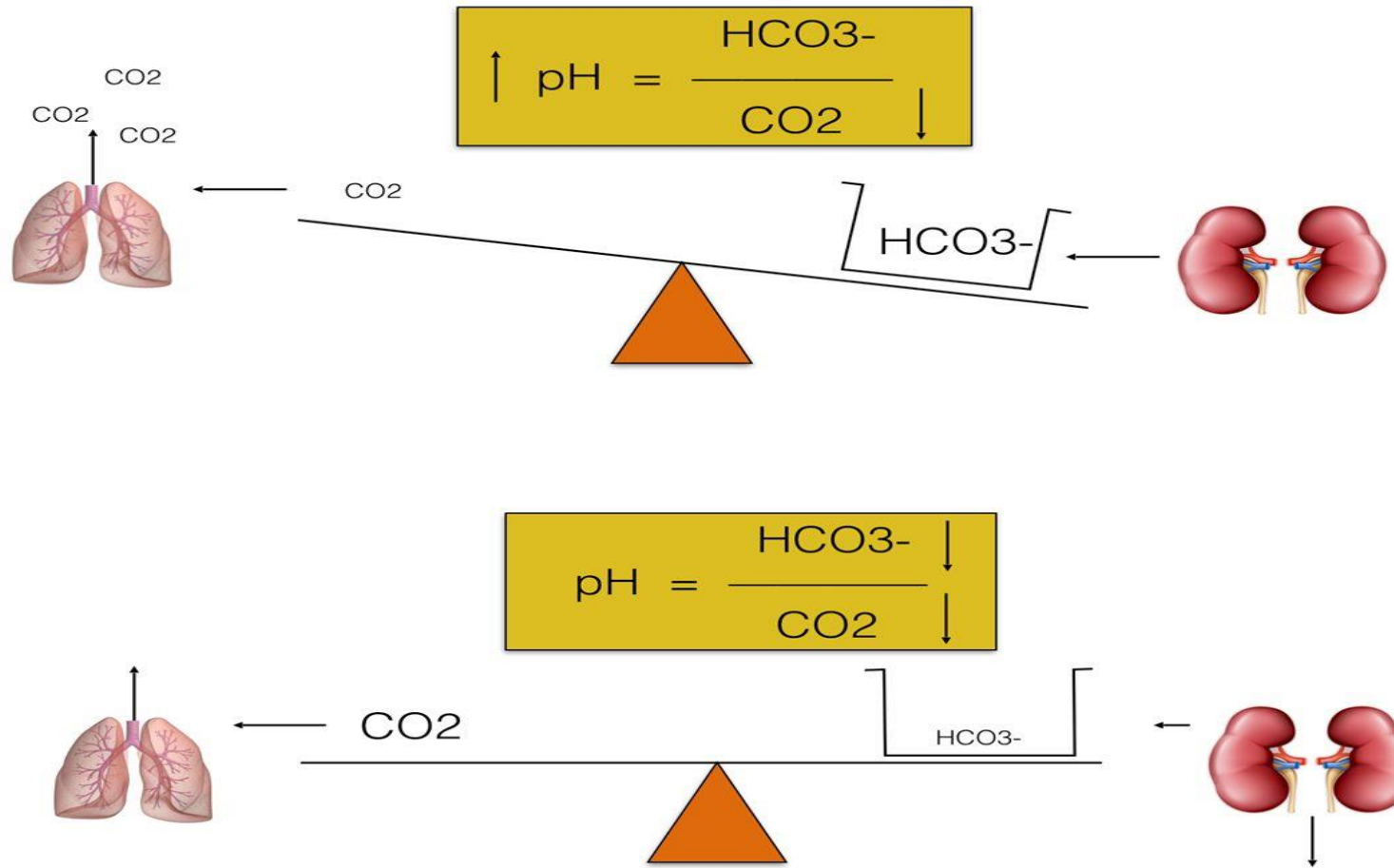
Normal in high altitude environment

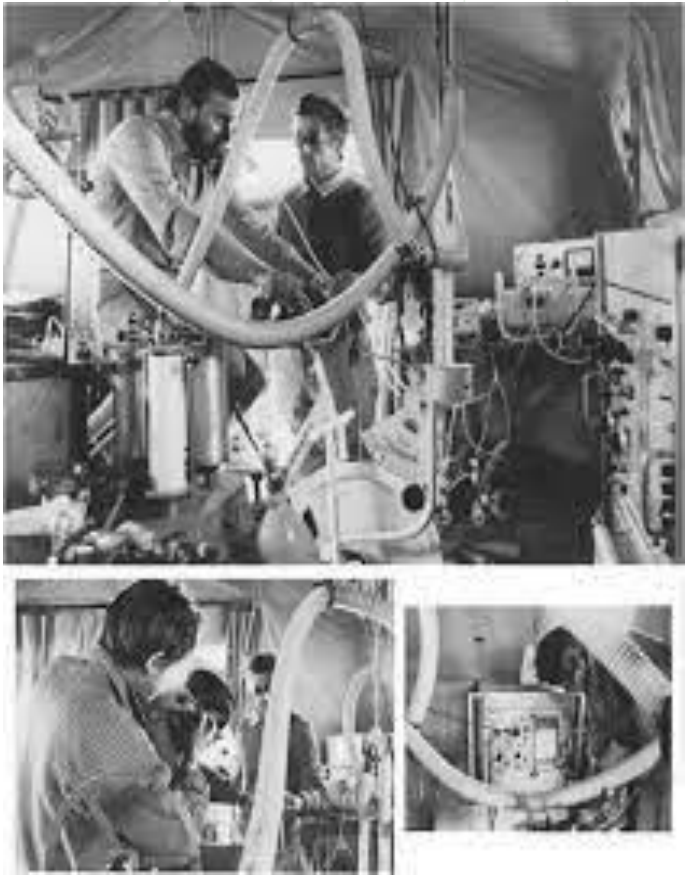


Increased ventilation



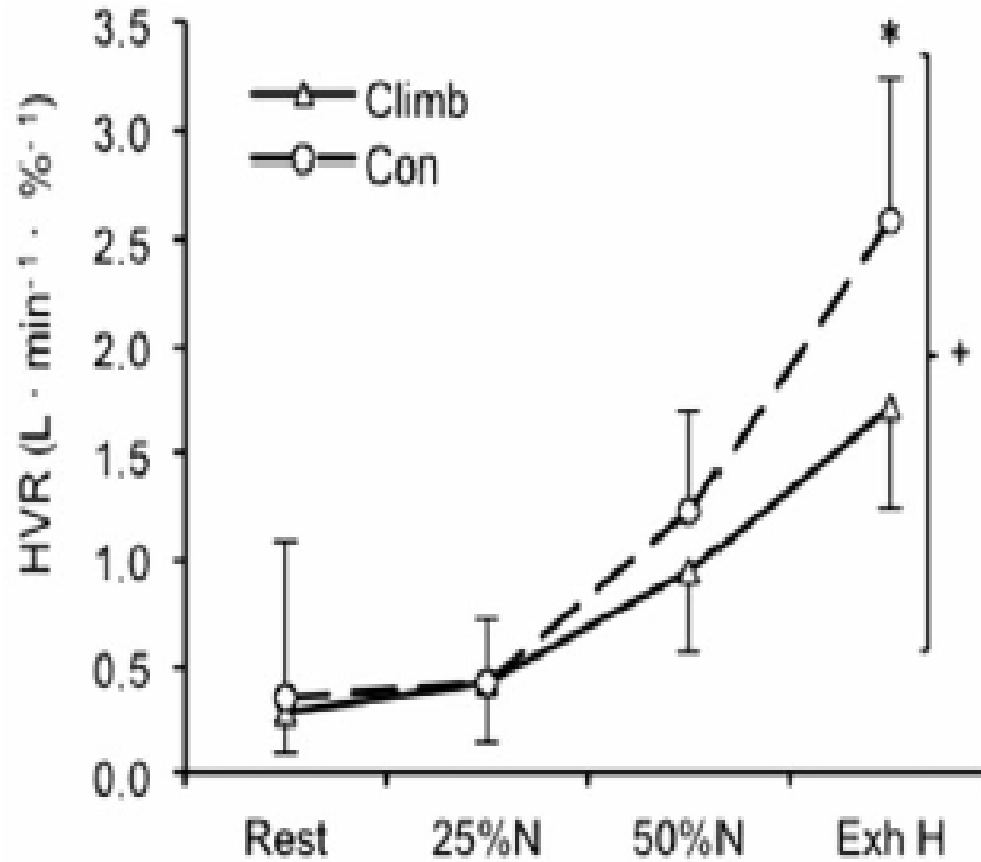
Increased ventilation and Alkalosis





Physiological characteristics of elite high-altitude climbers

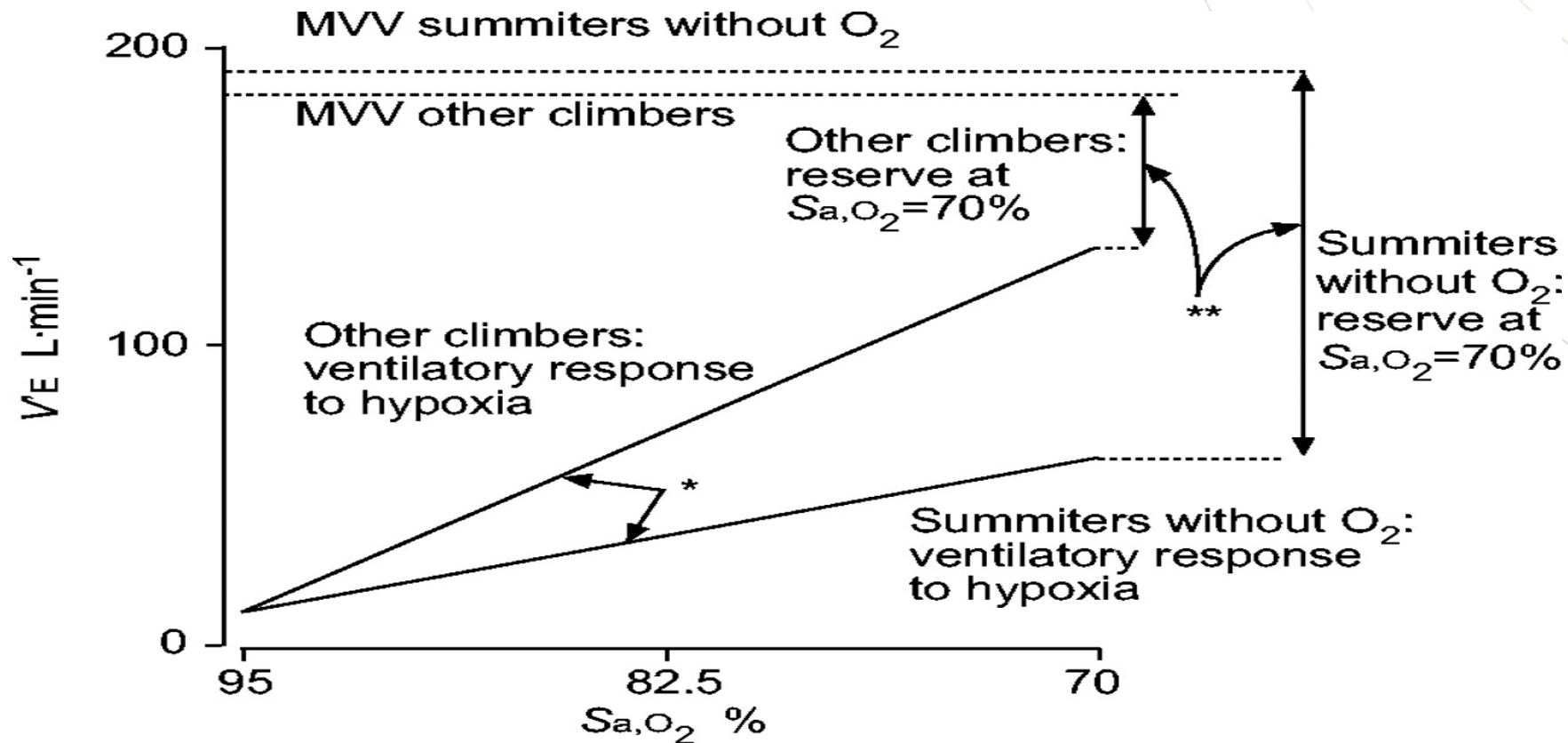
L. Puthon^{1,2,3}, P. Bouzat^{3,4}, T. Rupp⁵, P. Robach^{1,2,6}, A. Favre-Juvin^{1,2}, S. Verges^{1,2}





Hypoxic ventilatory response in successful extreme altitude climbers

L. Bernardi*, A. Schneider#, L. Pomidori[†], E. Paolucci[†] and A. Cogo[†]

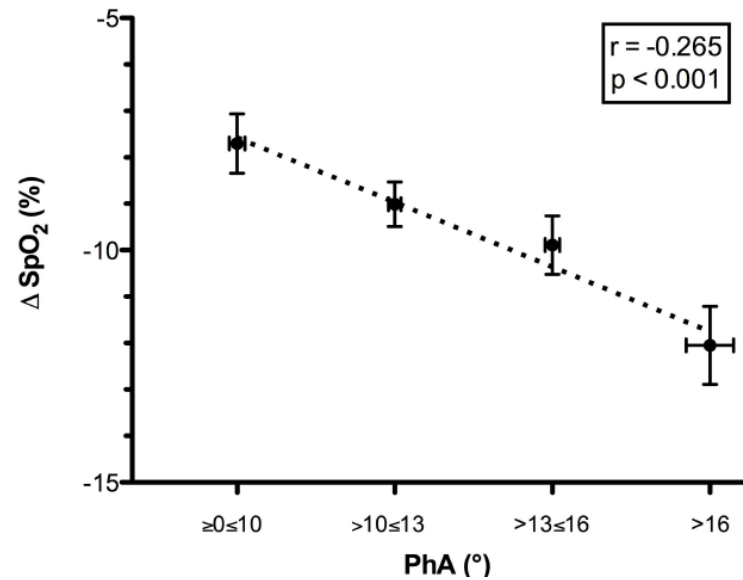
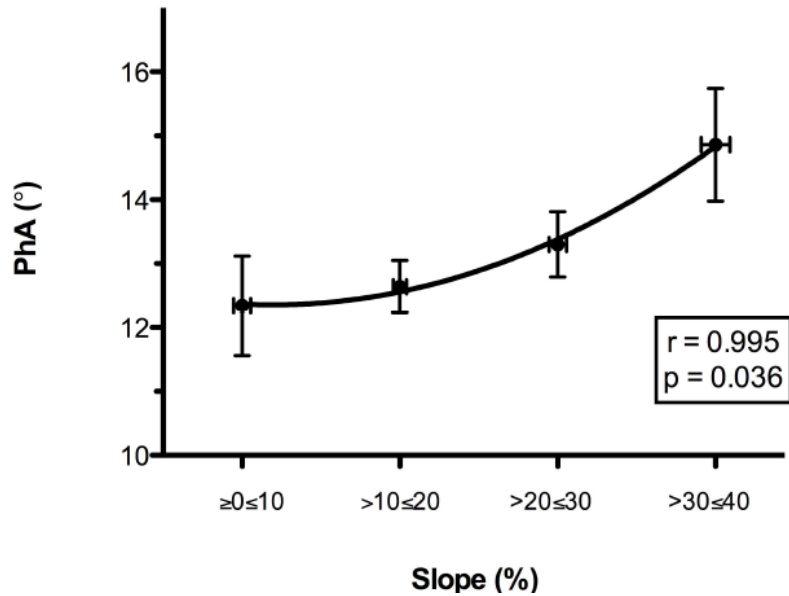




RESEARCH ARTICLE

Thoraco-abdominal coordination and performance during uphill running at altitude

Eva Bernardi^{1*}, Lorenza Pratali², Gaia Mandolesi¹, Maria Spiridonova¹, Giulio Sergio Roi³, Annalisa Cogo¹





The hypoxic hyperventilation response is fundamental for adaptation to hypoxia

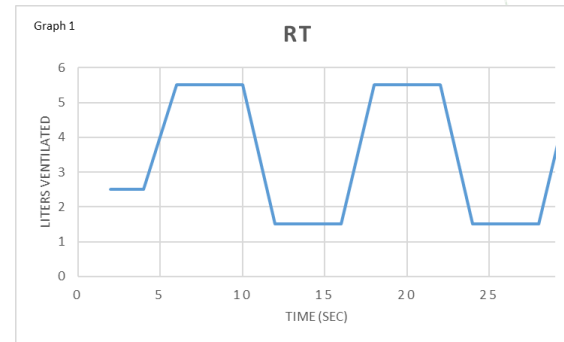
BUT

For efficient ventilation the following are important:
The Ventilatory pattern, Thoracic abdominal coordination

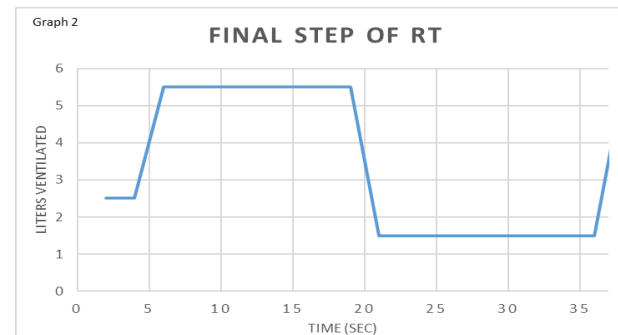
Can be trained ?

Can be trained?

Ascent to Capanna Margherita (4560 m) without acclimatization 18 subjects



- 8 weeks of respiratory training
- 30' min per day
- 7 days a week



Can be trained?

Ascent to Capanna Margherita (4560 m) without acclimatization 18 subjects



- Oxygen Saturation
- Acute Mountain sickness symptoms
- Interstitial pulmonary edema
- Breathing pattern



Acclimatization «Zone»



legge penale antidoping 376/2000

CICLISMO

La tenda ipobarica che dà gli effetti dell'epo. «Così dormo a 4.700 metri». Ma per l'Italia è vietata: è doping

Il belga Campenaerts detentore del record dell'ora rivela di dormire «a 4.700 metri» per ricaricare i globuli rossi: «Come prendere l'Epo». La sua squadra allenata da Riis, Nibali penalizzato

di MARCO BONARRIGO

di Marco Bonarrigo



Notizie

27 novembre 2023

DOPING - REVISIONE LISTA SOSTANZE E PRATICHE MEDICHE

In G.U. n. 277 del 27 novembre 2023, S.O. n. 38, è pubblicato il [Decreto 3 ottobre 2023](#) del Ministero della salute: Revisione della lista dei farmaci, delle sostanze biologicamente e farmacologicamente attive e delle pratiche mediche, il cui impiego è considerato doping.



RICERCHE

Tenda ipobarica come allenamento in altura? Non proprio. Ecco perché

Gazzetta
ACTIVE

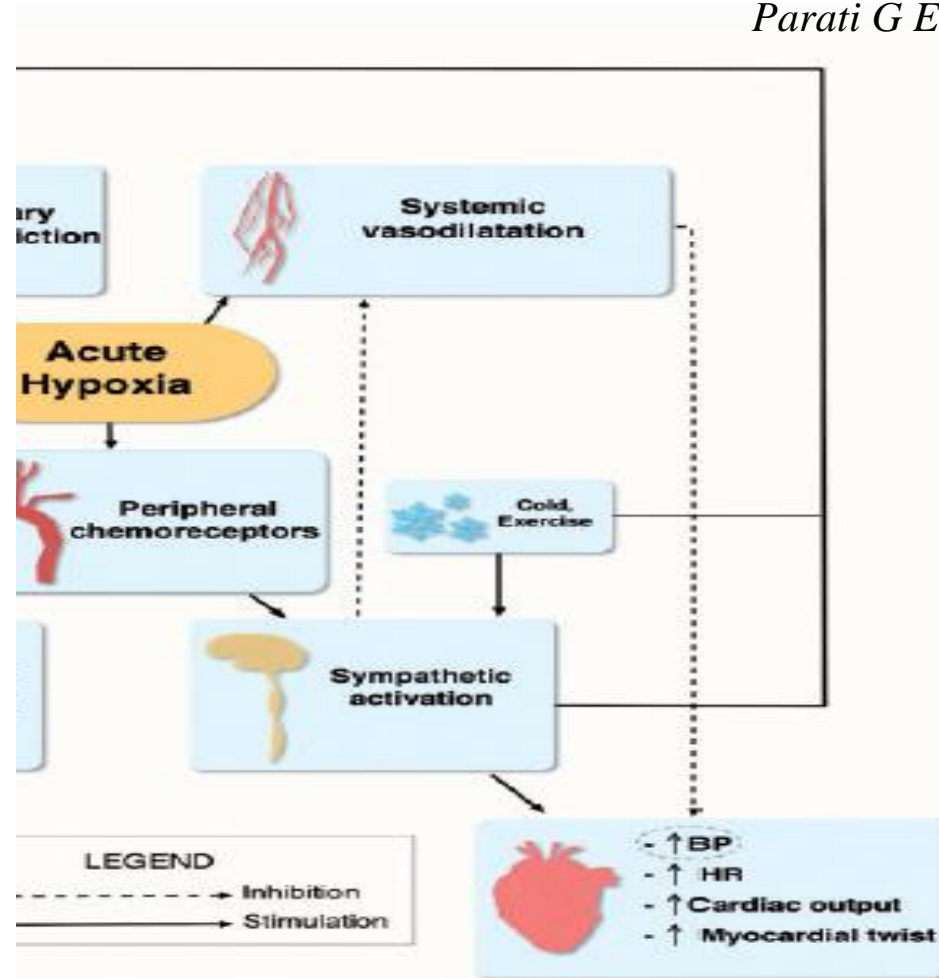
Gazzetta
Active:

Dall'anno scorso anche gli atleti italiani possono usare le tende ipossiche o ipobariche, 8no alla stagione 2023 ritenute al pari di una pratica dopante

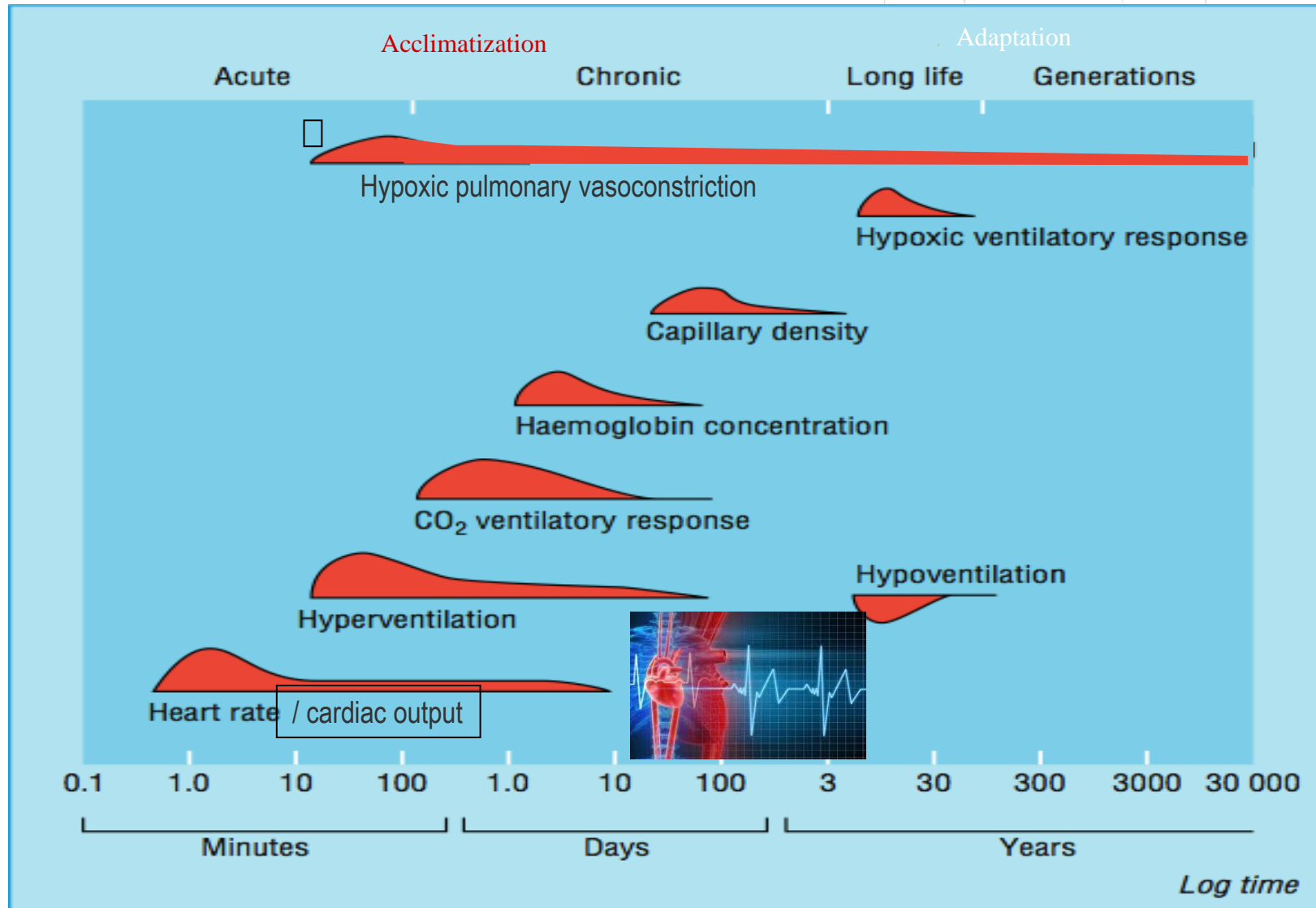
Cardiovascular System

Parati G Eur Heart J 2018

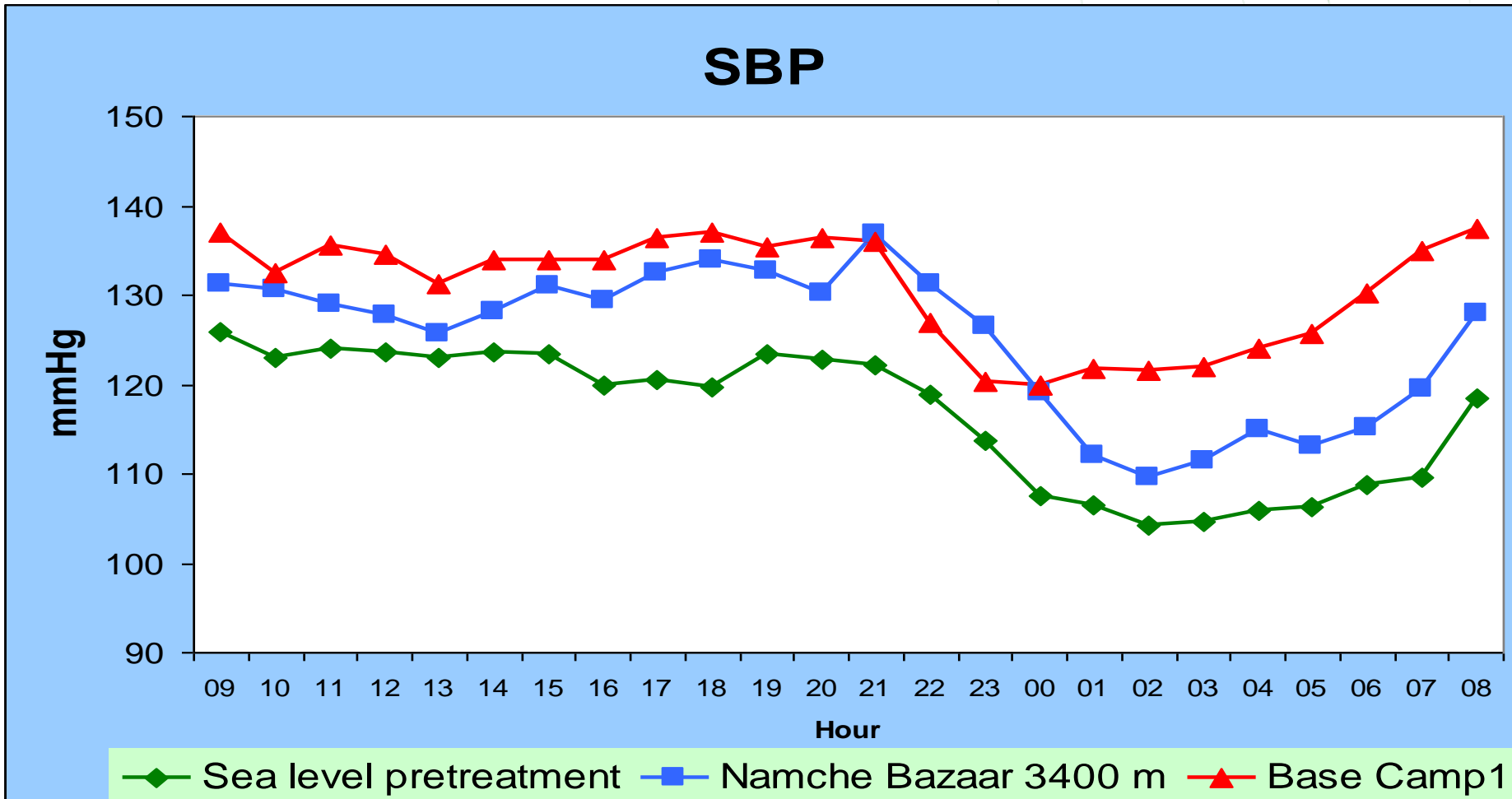
Cardiovascular System



Timing in the physiological responses

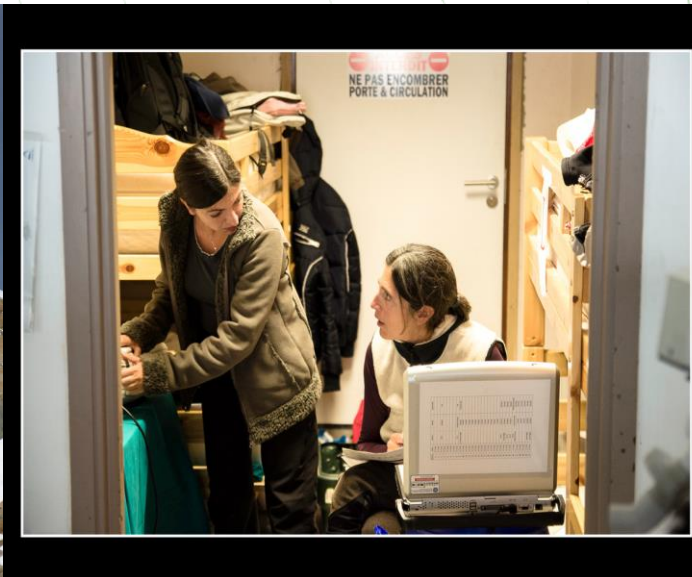


Circadian trend of blood pressure at altitude



Parati et al EHI 2014

RÉSA MONT 2



Day 1: Aosta (583 m)

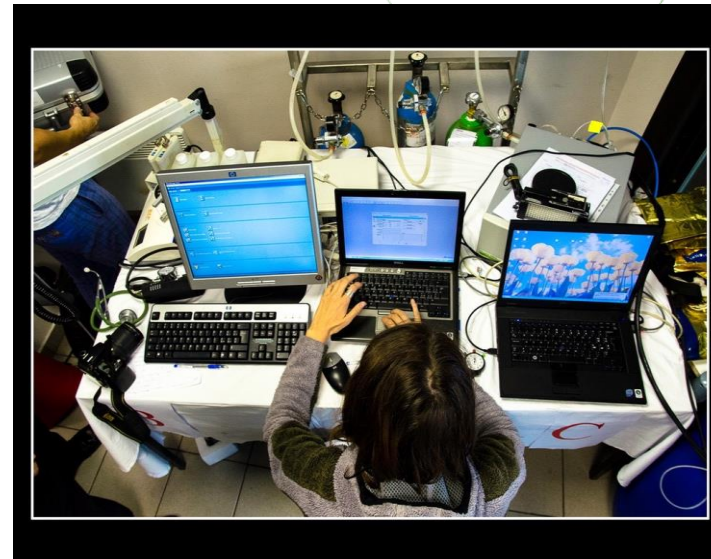
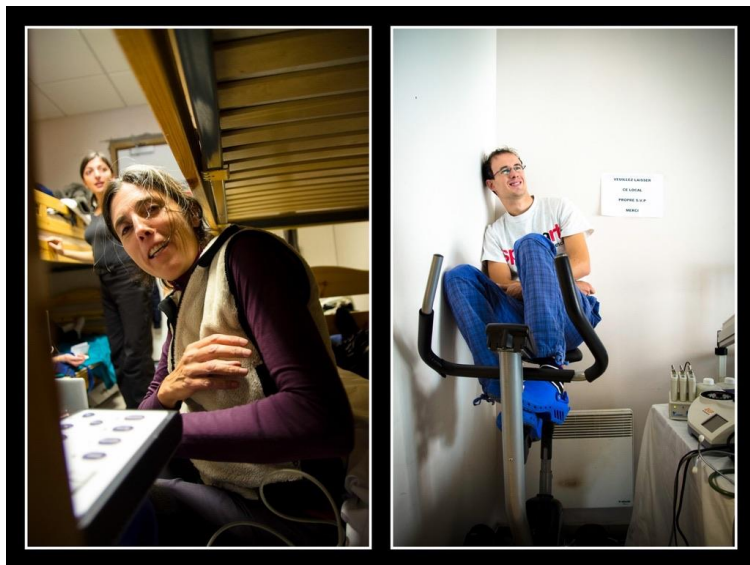
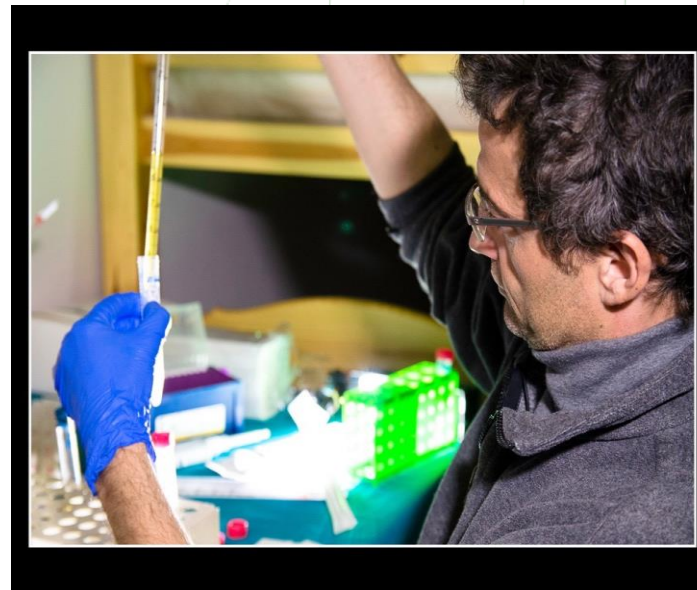
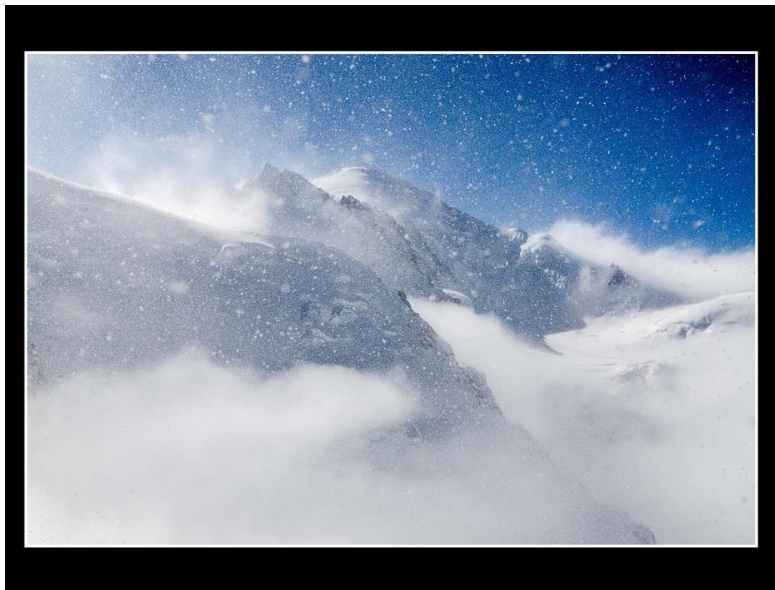
- Basal study
- Study with simulated hypoxia

Giorno 2: Aiguille du Midi (3842 m)

- Study of hypobaric hypoxia after 4 hours

Giorno 3: Aiguille du Midi (3842 m)

- Hypobaric hypoxia study after one day and one night at altitude



WORLD
HYPERTENSION
DAY

23
LUGLIO



Società Italiana dell'Ipertensione Arteriosa
Lega Italiana contro l'Ipertensione Arteriosa



FONDAZIONE
SIIA
per la ricerca sull'Ipertensione Arteriosa,
le patologie correlate e la
prevenzione cardiovascolare



SOCIETÀ ITALIANA
MEDICINA DI MONTAGNA

XIII Giornata Mondiale contro l'Ipertensione

23 Luglio 2017

Campagna Mondiale di Sensibilizzazione
per la Lotta all'Ipertensione Arteriosa

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DELLA PRESSIONE
IN ALTA QUOTA

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Con il contributo incondizionato di



WHL • NEWSLETTER

News from the World Hypertension League (WHL)
In Official Relations with the International Society of Hypertension and the
World Health Organization

No. 181, September 2023

ITALY

Extension of 2023 World Hypertension Day Activities to Blood Pressure Measurement at High Altitude Campaign

Submitted by Gianfranco Parati MD, FESC
President Elect, WHL

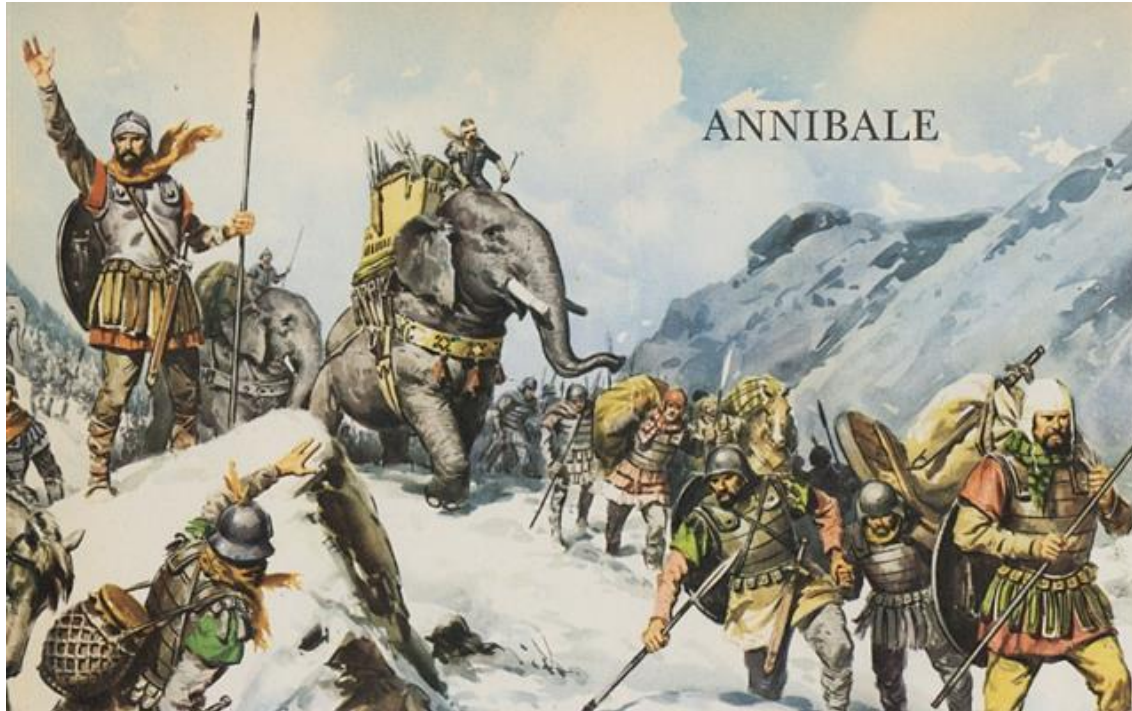
On 8 and 9 July 2023, as done in the last 7 years, in 50 shelters located on the Italian Mountains (either on the Alps and on the Apennine chain of mountains all across Italy), an awareness-raising campaign on arterial hypertension and on the blood pressure and cardiovascular effects of hiking or climbing at moderate to high altitudes was organised. This initiative is promoted yearly in association with World Hypertension Day activities and organized by WHL Volunteers from the Italian Society of Hypertension, the Italian Alpine Club, the Italian Society of Mountain Medicine, the Istituto Auxologico Italiano of Milan and the University of Milan-Bicocca, who offered educational information on cardiovascular risk associated with blood pressure together with blood pressure, heart rate and pulse oximetry measurements to all individuals reaching mountain shelters located at altitudes of 2,000 metres or higher. This was done in July rather than on May 17 because it is in summer that most people hike or climb in mountain regions.





Coffee Break

Hannibal crosses the Alps



218 a.c.



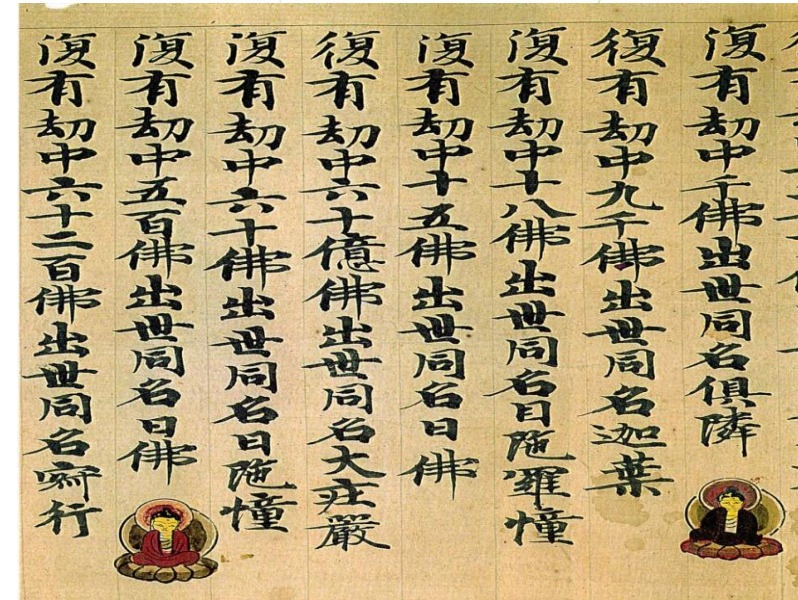


“...passing the Great Headache Mountain, the Little Headache Mountain, the Red Earth and the Fever Slope, men's bodies become feverish, they lose color and are afflicted with headaches and vomiting...”

Too-Kin (37-32 a. C.)



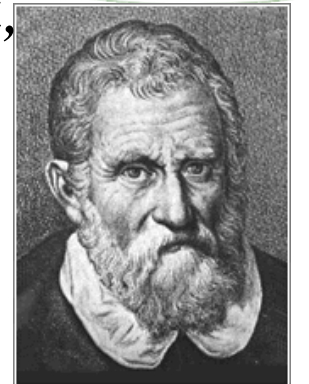
“...foamed at the mouth and died in the ascent of that Pass...”
Fa Hsien (403 d. C.)





*“... L’aere è così puro in quelle
sommità e l’abitarvi così sano che
gli uomini che stanno nella città e
nel piano e valli, come si sentono
assaltar dalla febbre di cadauna
sorte o d’altra infirmità
accidentale, immediate ascendono
il monte e stanvi duoi o tre giorni,
e si ritrovano sani per causa
dell’eccellenza dell’aere”*

Marco Polo: Il Milione 1298



Acute Mountain Sickness

Ravenhill 1913

Puna of normal type

Puna of nervous type

Puna of cardiac type

Oct. 15, 1913.] THE JOURNAL OF TROPICAL MEDICINE AND HYGIENE.

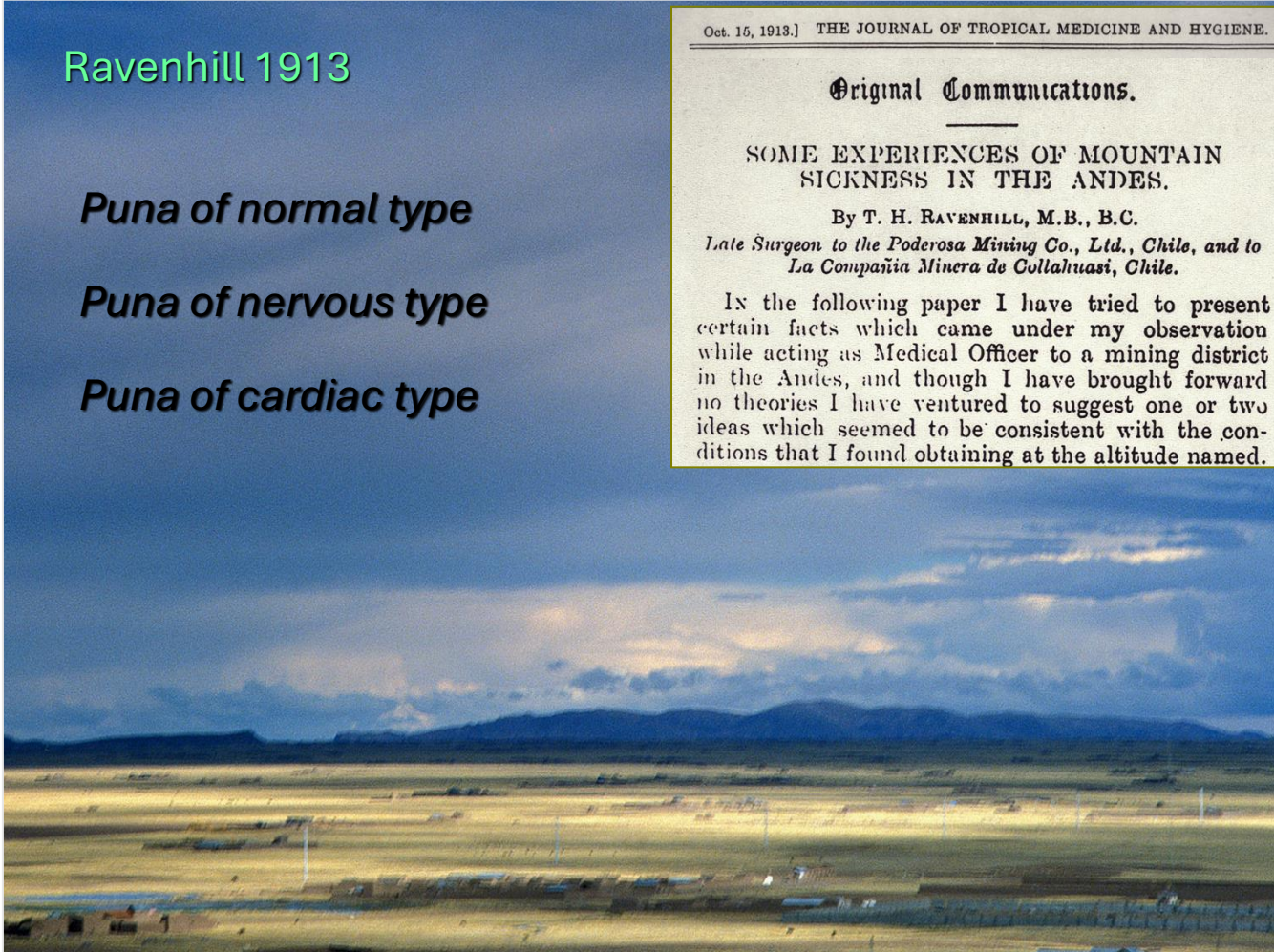
Original Communications.

SOME EXPERIENCES OF MOUNTAIN SICKNESS IN THE ANDES.

By T. H. RAVENHILL, M.B., B.C.

Late Surgeon to the Poderosa Mining Co., Ltd., Chile, and to La Compañía Minera de Collahuasi, Chile.

In the following paper I have tried to present certain facts which came under my observation while acting as Medical Officer to a mining district in the Andes, and though I have brought forward no theories I have ventured to suggest one or two ideas which seemed to be consistent with the conditions that I found obtaining at the altitude named.



Acute Mountain Illness



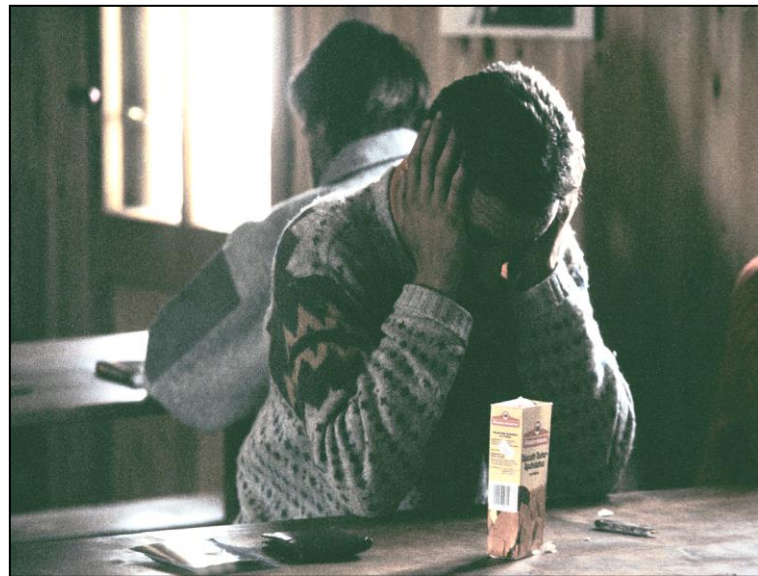
Acute Mountain Sickness (AMS)
Headache
+
Anorexia
Nausea
Lassitude
Dizziness
Fatigue
Lightheaded

High Altitude Cerebral Edema (HACE)
Headache
Vomiting
Disorientation
Loss of coordination
Memory Loss
Psychotic behaviour
Coma

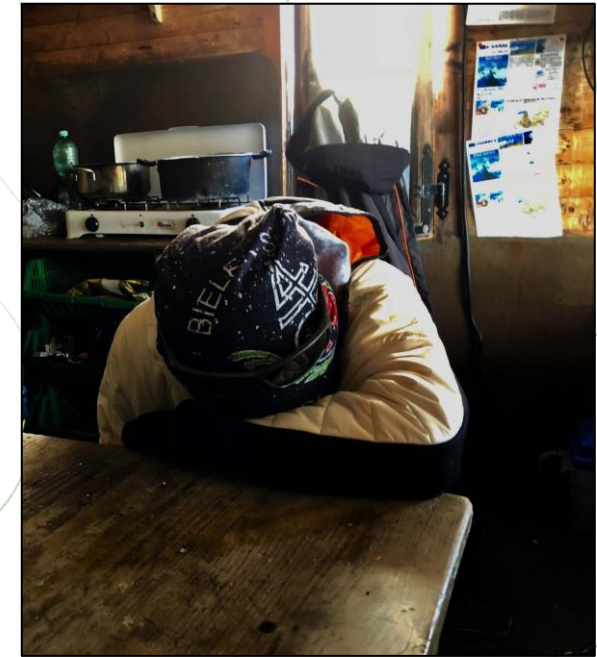
High Altitude Pulmonary Edema (HAPE)
Chest tightness
Severe breathlessness during exercise
Breathlessness at rest
Persistent cough
Frothy sputum

Acute Mountain Sickness Symptoms

Headache +



Weakness



Tiredness

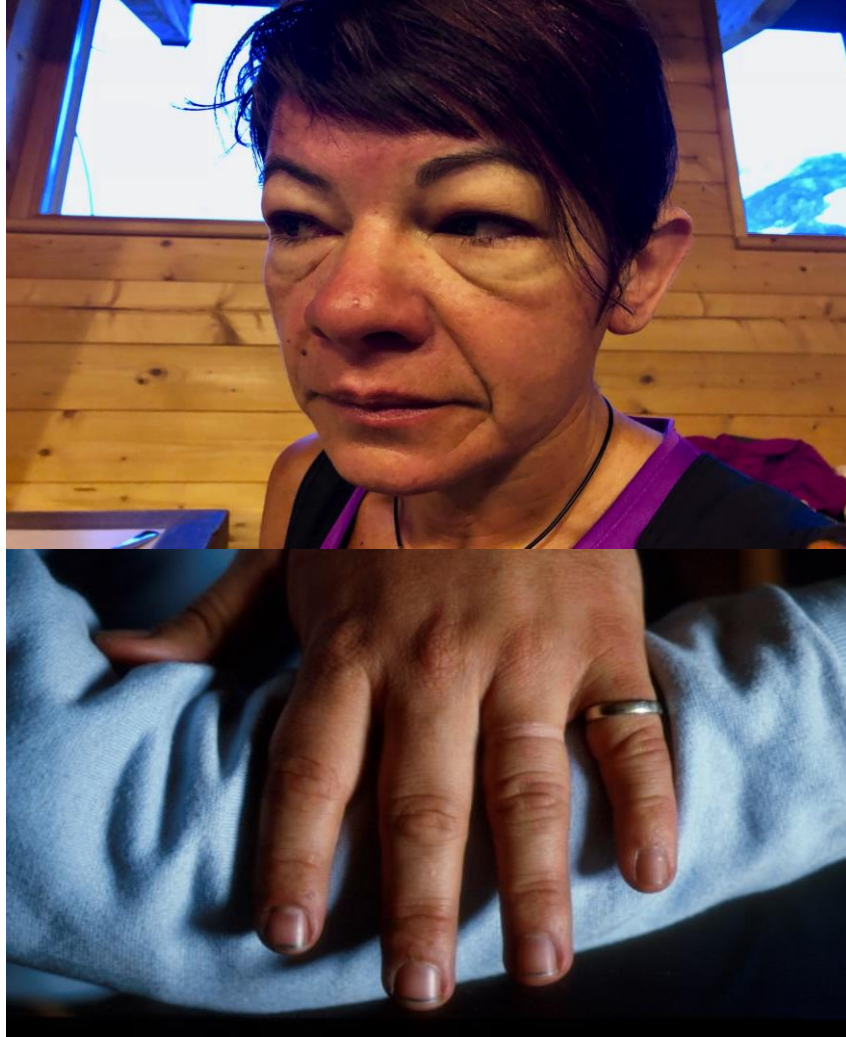


Dizziness



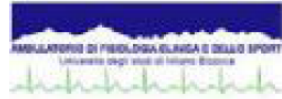
Nausea, Vomiting, Diarrhea

Acute Mountain Sickness Signs



- Peripheral edema (eye sockets, hands, feet)
- Cyanosis of the lips
- Altered mental state
- Inability to walk in a straight line (ataxia)





In collaborazione con:



C.A.I. – Club Alpino Italiano

S.I.M.E.M. – Società Italiana Medicina di Montagna

Questionario sui problemi di salute connessi ad attività in alta quota

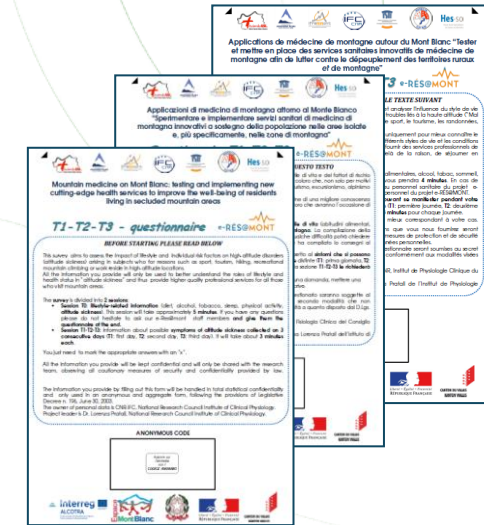
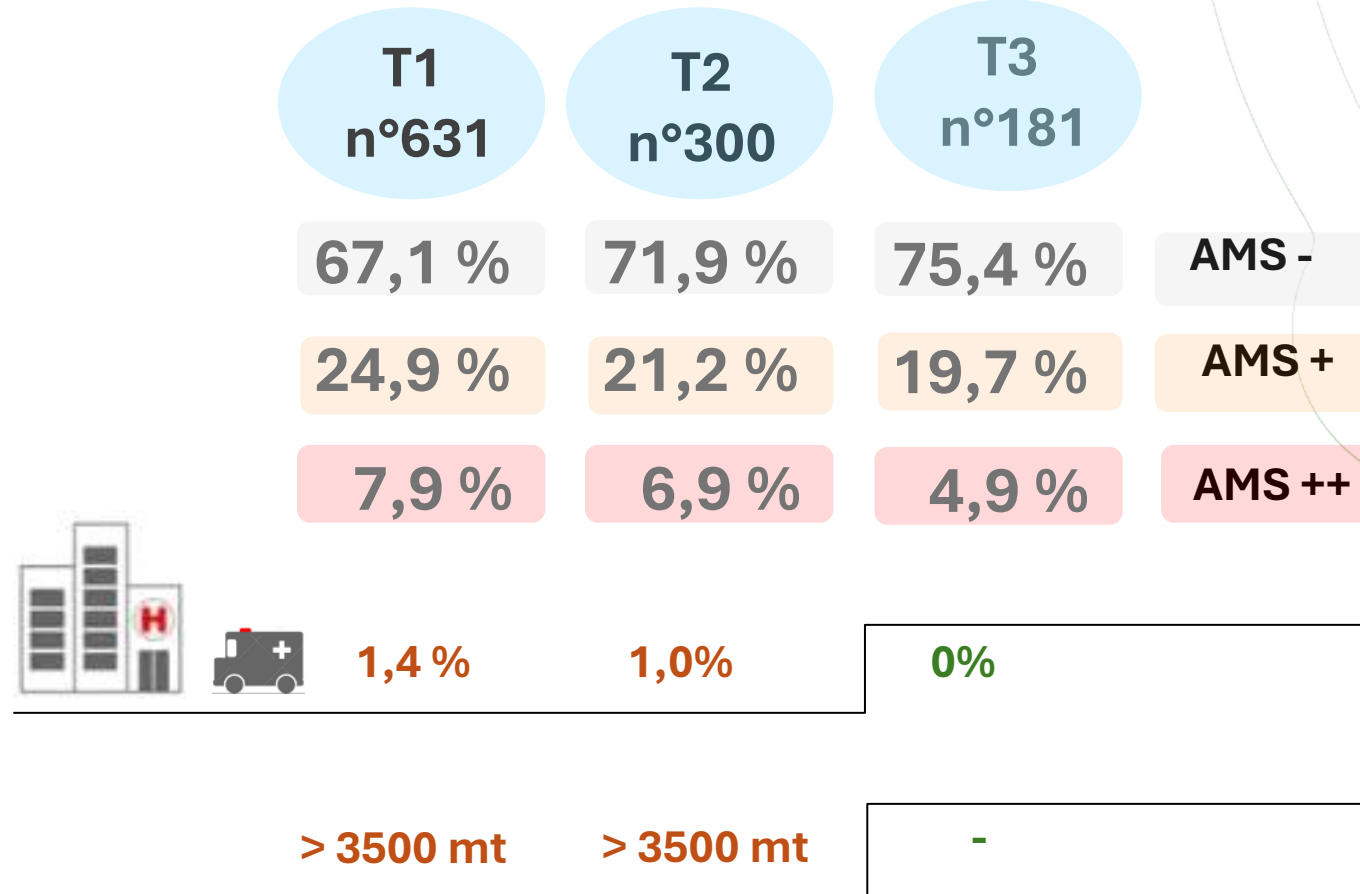
AL.P.I.

ALtitudine & Patologia in Italia

Italian ALtitude Pathology survey

Lake Louise Score: diagnosis

T1-T2-T3-Questionnaire



ALTITUDE SICKNESS

T0-Questionnaire

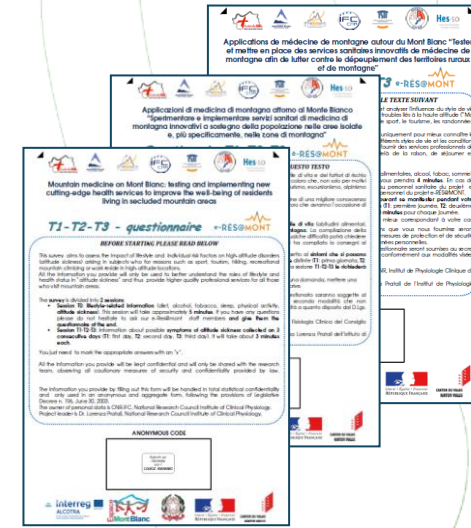


Have you ever suffered from altitude sickness?

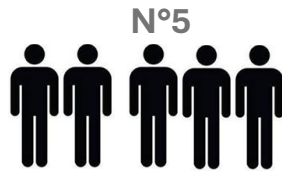
N 79,3 %

Y 20,7 %

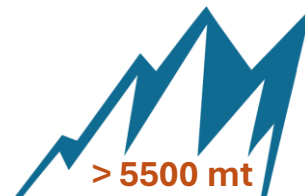
52,9 %	22,4 %	AMS -
36,1 %	35,1 %	AMS +
11,0 %	42,5 %	AMS ++



High Altitude Pulmonary edema



High altitude cerebral edema



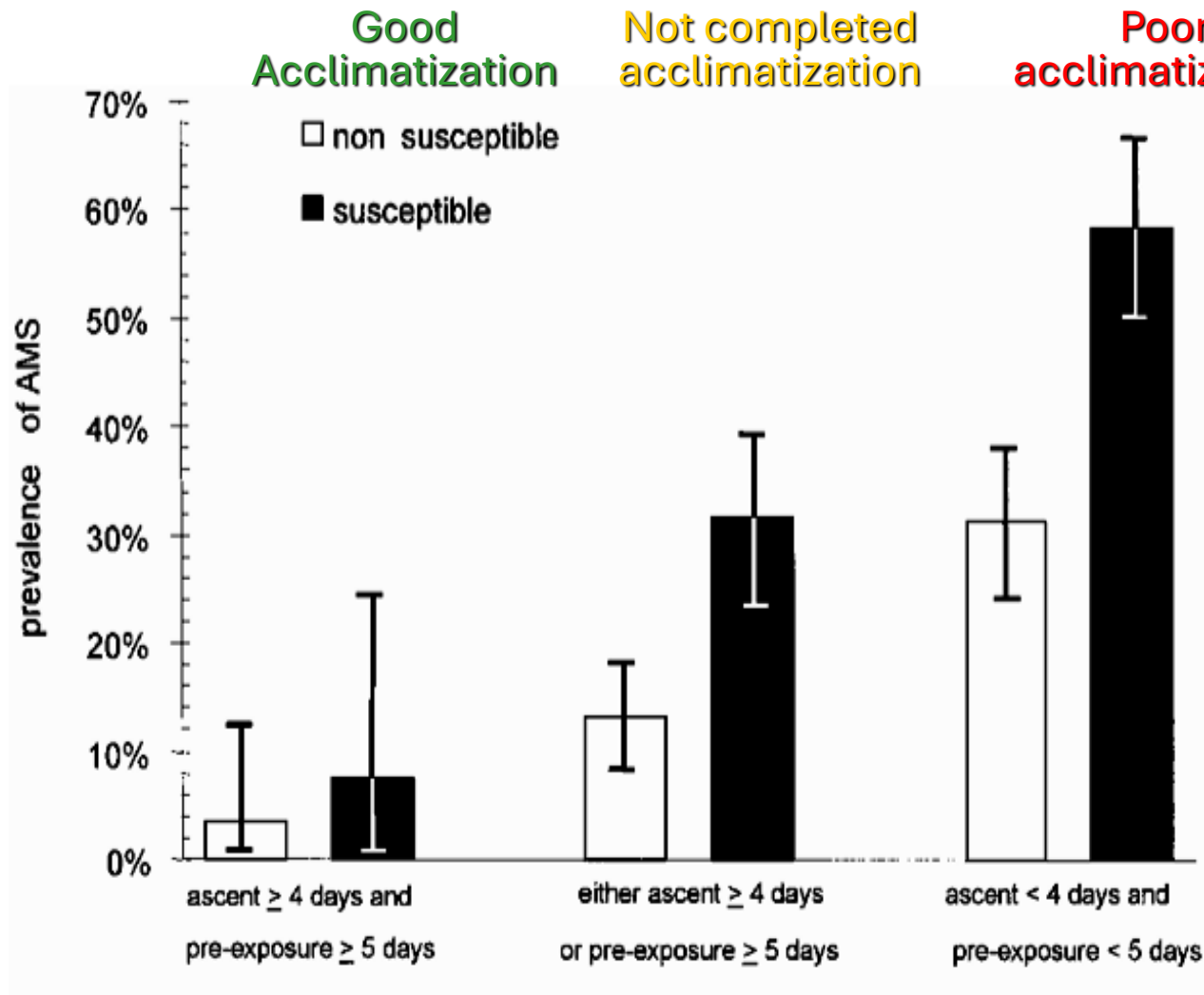
▷ 70 %
▷ 80 %

AMS: Predisposing factors

- Low altitude residence (non-acclimatization)
- Individual susceptibility
- Previous episodes of AMS
- Age
- Excellent physical condition
- Reduced ventilatory response to hypoxia
- Obesity
- Snorers
- Migraine
- Operations on the neck



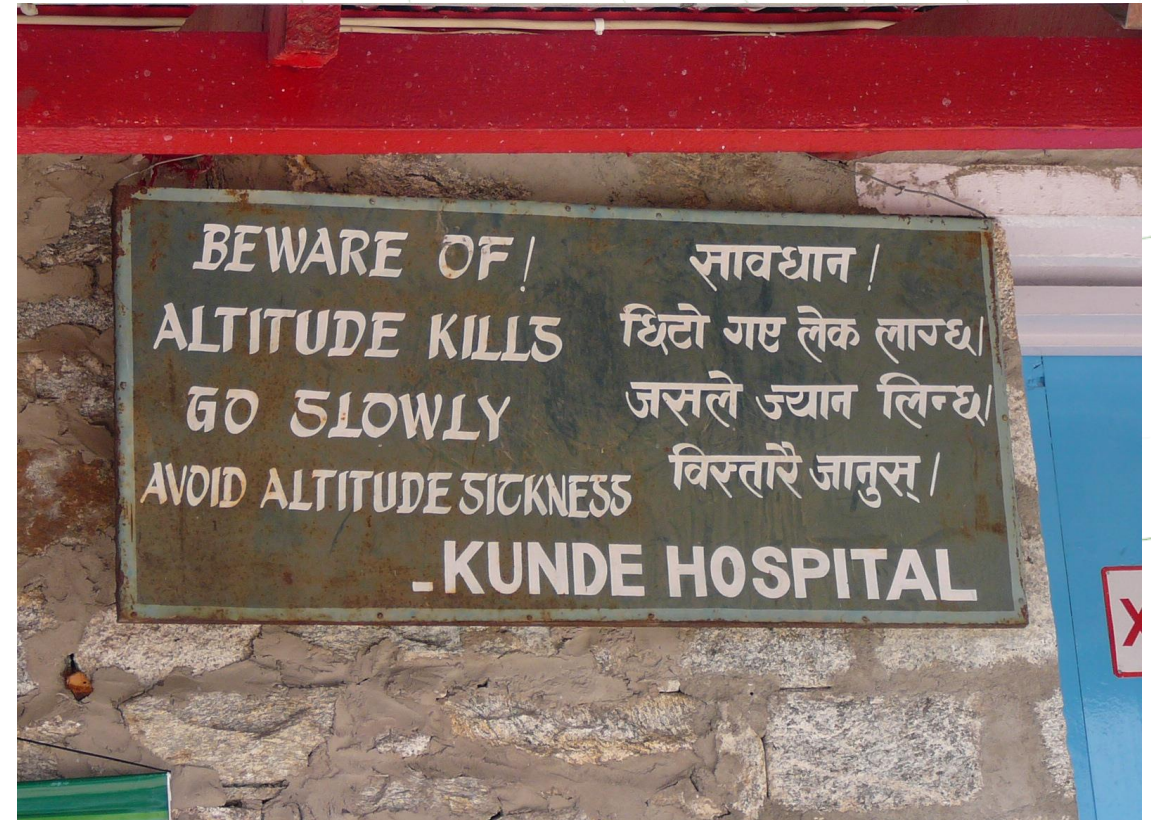
Individual susceptibility at 4559 m



Schneider et al Med Sci Sports Exerc
2002,; 34:1886

AMS: Triggering factors

- Ascent speed
- Cold
- Intense exercise
- Infections



2018 Lake Louise Acute Mountain Sickness

Headache

- 0—None at all
- 1—A mild headache
- 2—Moderate headache
- 3—Severe headache, incapacitating

Evaluation after at least 6
hours

AMS => 3

AMS Clinical Functional Score

Overall, if you had AMS symptoms, how did they affect your activities?

- 0—Not at all
- 1—Symptoms present, but did not force any change in activity or itinerary
- 2—My symptoms forced me to stop the ascent or to go down on my own power
- 3—Had to be evacuated to a lower altitude

Gastrointestinal symptoms

- 0—Good appetite
- 1—Poor appetite or nausea
- 2—Moderate nausea or vomiting or diarrhea
- 3—Severe nausea and vomiting, or diarrhea
incapacitating

Fatigue and/or weakness

- 0—Not tired or weak
- 1—Mild fatigue/weakness
- 2—Moderate fatigue/weakness
- 3—Severe fatigue/weakness, incapacitating

Dizziness/Ligh-Headedness

- 0—No dizziness/light-headedness
- 1—Mild dizziness/light-headedness
- 2—Moderate dizziness/light-headedness
- 3—Severe dizziness/light-headedness, incapacitating

App for Lake Louise score



The screenshot displays the 'Lake Louise Quiz' interface. At the top, a blue header bar contains the text 'e-Resamont' and a menu icon. Below this, a yellow line graph is visible. The main content area shows the quiz title 'Cefalea, mal di testa' and the result 'Score: 8'. A large red overlay box contains the following text in white: 'Score 8', 'AMS grave', 'Si consiglia', 'Supplementazione di ossigeno disponibile', and 'Scendere di almeno 500 m senza fare fatica'. At the bottom, there is a blue bar with the text 'IL PROGETTO E-RÉS@MONT' and a section titled 'Affaticamento e/o sensazione di debolezza' with three radio button options: 'No (0)', 'Leggero affaticamento, debolezza lieve (1)', and 'Affaticamento o debolezza moderata (2)'. The background of the app shows a stylized mountain range.

AMS staging

Mild AMS: a little discomfort, does not limit activity, good response to symptoms

Moderate AMS: fairly annoying, limits daily activities, responds to medications, but then returns

Severe AMS: prevents activities, poor response to drugs

AMS treatment

MILD

- Do not climb any further
- Rest
- Maintain good hydration (>3 liters per day)
- Avoid strain
- Avoid cold
- Sleep with your trunk slightly raised

Paracetamol 1000 mg , Ibuprofen 600 mg
and/or Anti-nausea-vomiting

If after 6-12 hours it does not improve, **Acetazolamide 250 mg x2** can be taken

AMS treatment

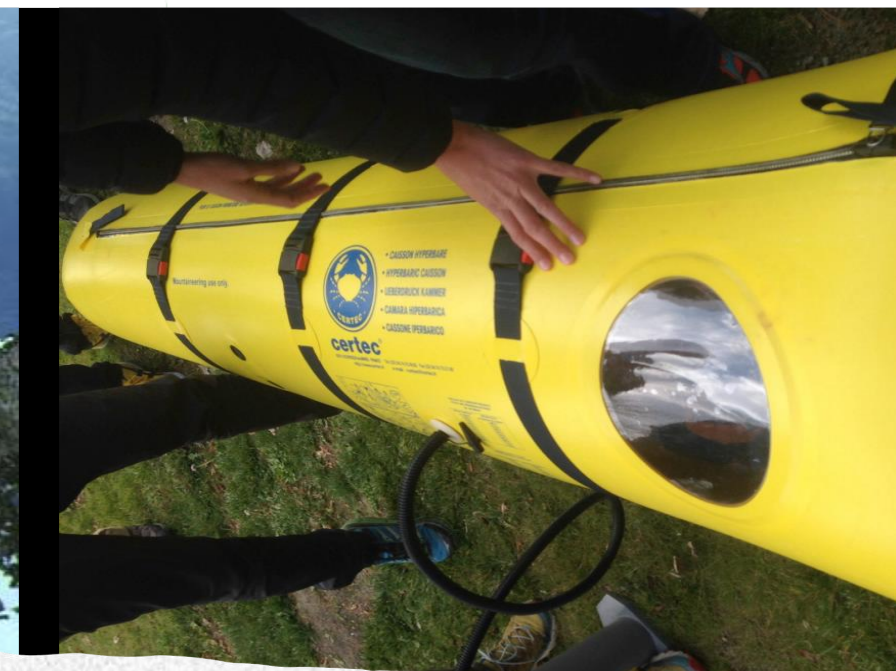
Moderate-Severe

- Do not climb further, rest and avoid cold
- Use oxygen if available
- Treat with Paracetamol or Ibuprofen and Anti-nausea/vomiting + Acetazolamide 250 mg 1 tablet every 12 hours and/or Desametasone up to 4 mg every 6 hours
- Evaluate the administration of oxygen and use of the hyperbaric bag
- Descend > 500 meters or in any case to the last altitude where the subject was asymptomatic.

The descent must take place as soon as possible taking into account the technical difficulties and the possible presence of ascents which could worsen the clinical picture.

The subject must not carry weights





Hyperbaric Chamber

The devices must be inflated or pressurized by hand or foot pumps.

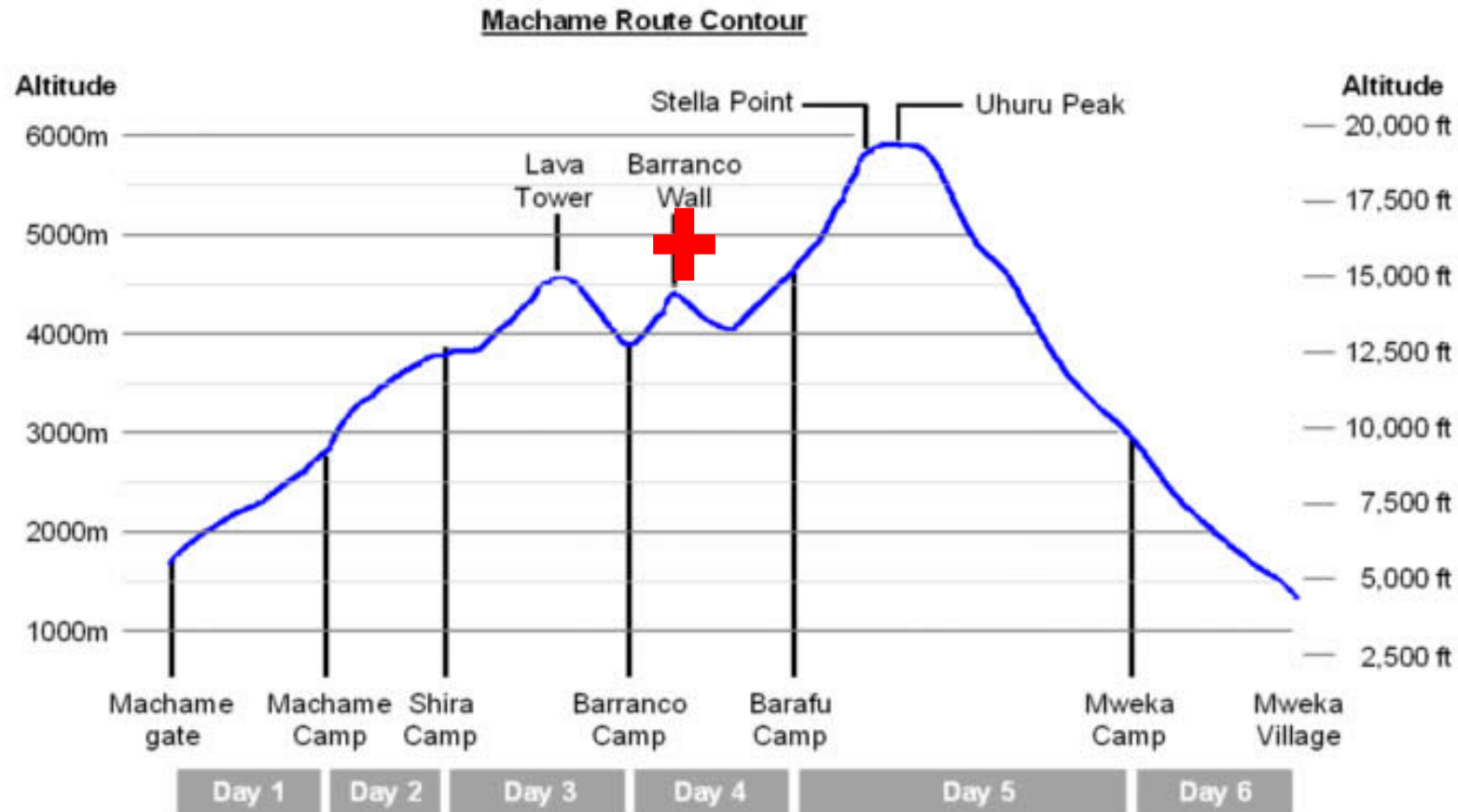
The mechanism of action is a rapid pressurization of the patient (increase of oxygen pressure) which simulates a descent of about 1500 to 2500m.

Mind the descend...

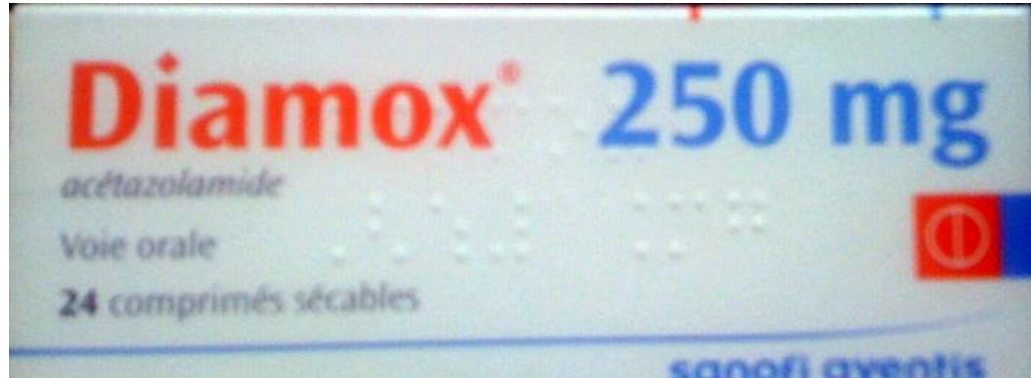
Descend > 500 meters

or

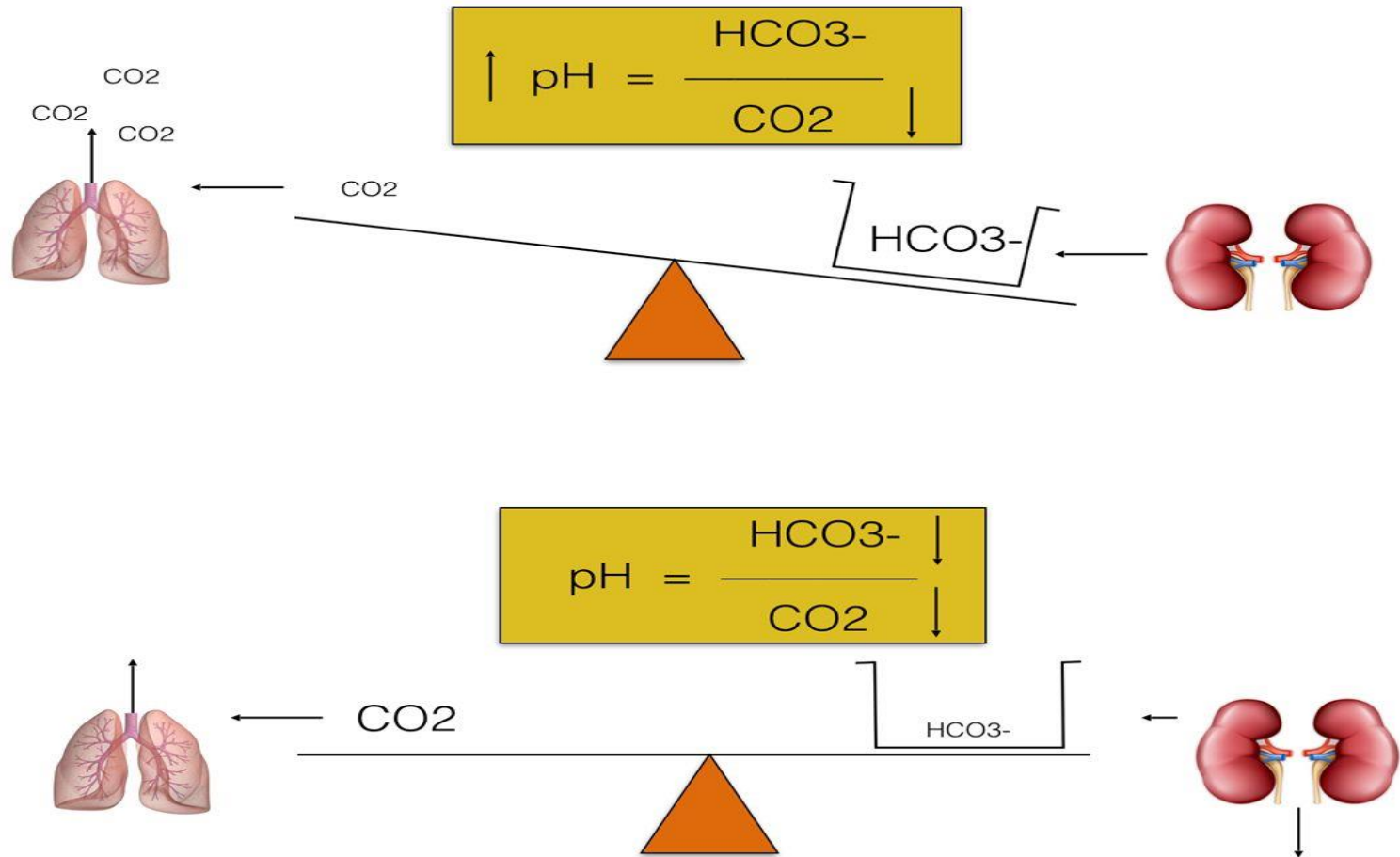
in any case to the last altitude where the subject was asymptomatic



Acetazolamide: carbonic anhydrase inhibitor



Increased ventilation and Alkalosis

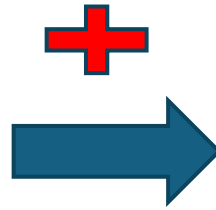


Acetazolamide: carbonic anhydrase inhibitor

Facilitates the excretion of bicarbonates
Reduces respiratory alkalosis
Increases breathing rate

- ⬆️ Breathing rate
- ⬆️ ⬇️ Periodic Breathing
- ⬆️ ⇒ ⬆️ PaO₂

Diuretic and hypotensive effect
Allergy to Sulphonamides
Negative effects



Reduces the AMS' incidence
Improves sleep
Limits subcutaneous edema



Hypotension and malaise
Risk of renal colic
Acclimatization delay
Metallic taste of carbonated drinks
Tingling in the limbs and peribuccal
at low temperatures
Ethical question!

A few days before journey, it is advisable to test the individual reaction with a single intake

Trekking Manaslu

Woman 50 yrs, expert in mountain activity in Italy, but not acclimatised to high altitudes.

No previous experience at high altitude

The expedition decides to acclimatise on site

Arriving at 3800 m she had:

- 1) Headache moderate
- 2) Labored breathing
- 3) Disappetence
- 4) Sleepless nights due to the feeling of not breathing as soon as you fall asleep
- 5) Severe excessive fatigue when walking
- 6) Moderate light-headedness

LLS?

LLS 2018 during Manaslu trekking

3800 m

	No	Mild	Moderate	Severe
Headache	0	1	X2	3
Gastrointestinal symptoms	0	1	X2	3
Fatigue and/or weakness	0	1	2	X 3
Dizziness/Ligh-Headedness	0	1	X2	3

Trekking Manaslu

At **4200 m** same symptoms

And the night they left to ascent to a pass at **5200 m**

At **4900 m**

hallucinations (black shape with a match inside)

She reached that altitude dragged by the Sherpas

They decide to put her in a tent: shaking chills, delirium and hallucinations, difficult breathing, unable to drink or eat, severe pain in the groin

AMS Clinical Functional Score

Overall, if you had AMS symptoms, how did they affect your activities?

0—Not at all

1—Symptoms present, but did not force any change in activity or itinerary

2—My symptoms forced me to stop the ascent or to go down on my own power

3—Had to be evacuated to a lower altitude

Trekking Manaslu

The expedition Sherpa decided to let her get to the pass and then descend as quickly as possible for 1500 m where they arrive at a lodge.

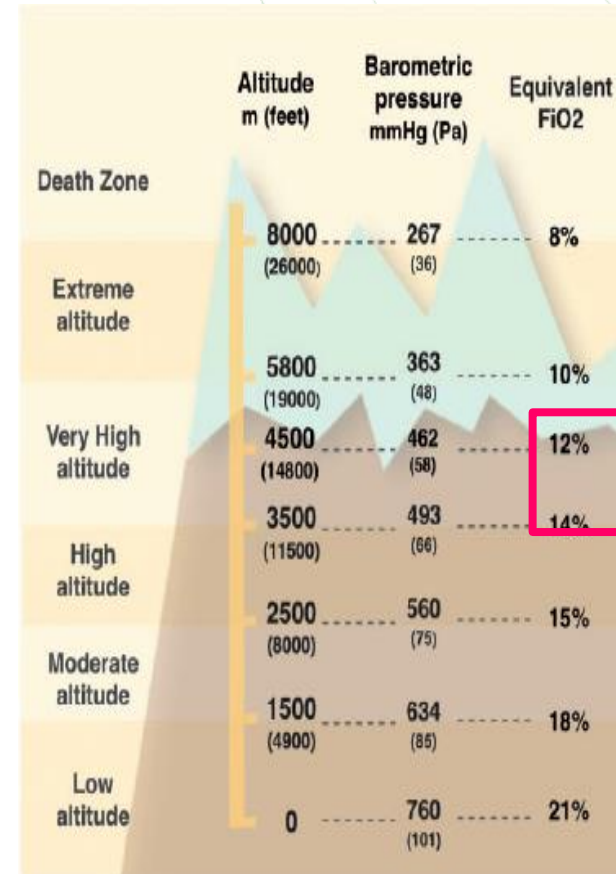
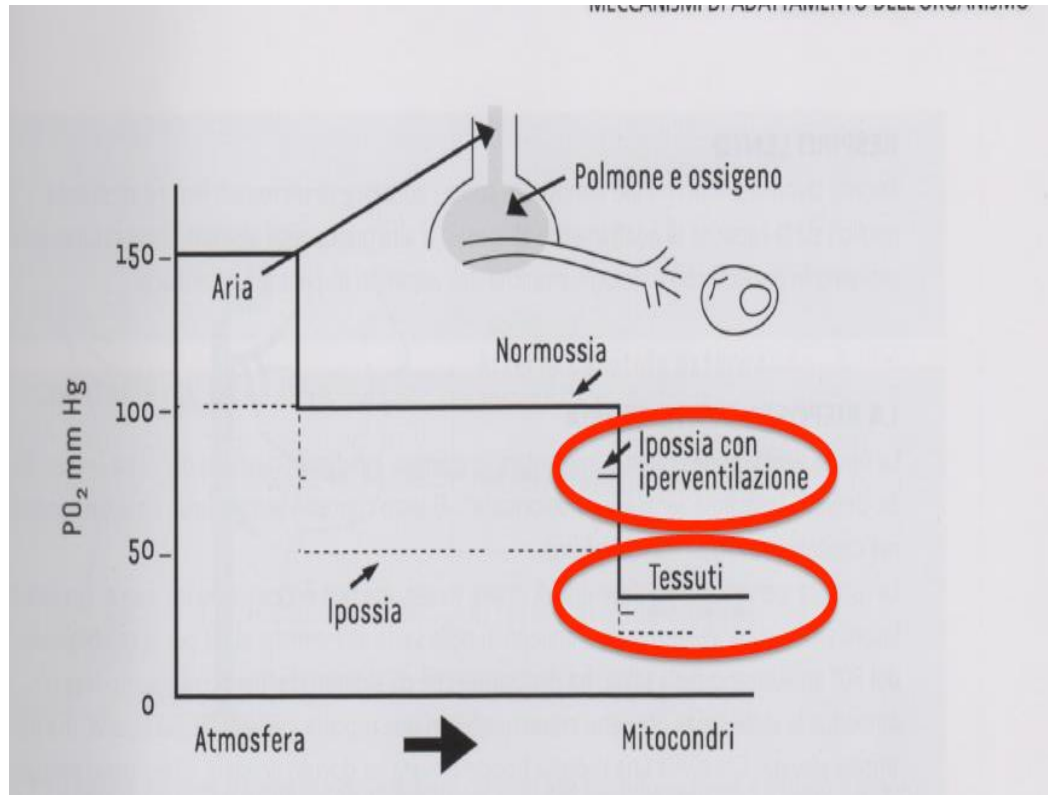
The next morning she has widespread edema (face, hands and feet) and Diamox is administered 250 mg x 2

In the following days, despite descending in altitude, she continued to have difficulty with minimal efforts.

This feeling remained upon arrival in Italy.

Post -Trekking Manaslu

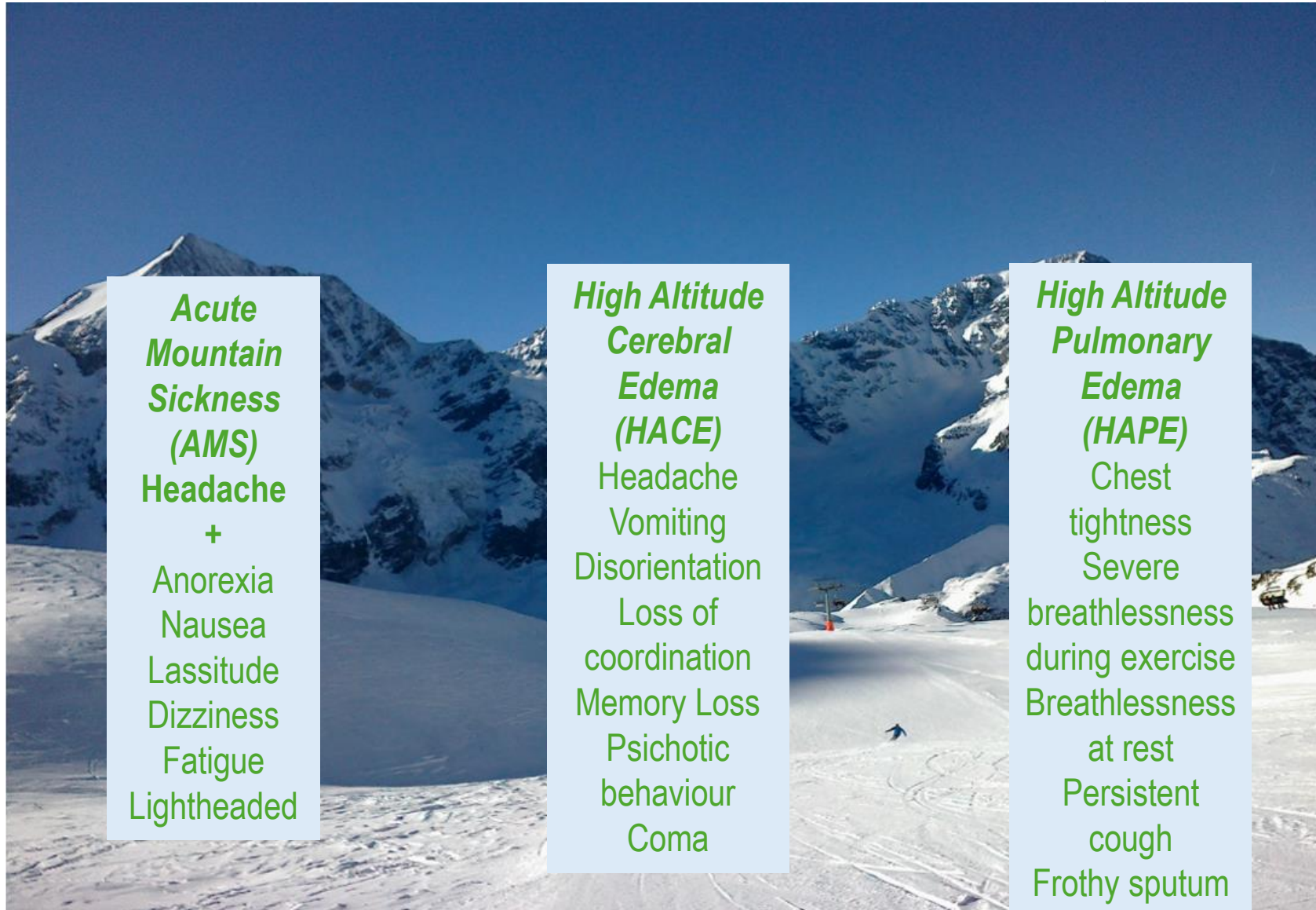
What did she really have?



Post -Trekking Manaslu

ESAME EMOCROMOCITOMETRICO			
Metodo: Conteggio con analizzatore automatico			
Globuli bianchi (WBC)	5,96	x10 ³ /μl	4,00 - 10,80
Globuli rossi (RBC)	3,84	x10 ⁶ /μl	4,00 - 5,20
Emoglobina (Hgb)	8,20	g/dl	12,00 - 16,00
Ematocrito (Hct)	28,50	%	37,00 - 47,00
Volume globulare medio (MCV)	74,30	fl	82,00 - 99,00
Contenuto medio di Hgb (MCH)	21,40	pg	27,00 - 36,00
Concentrazione media di Hgb (MCHC)	28,80	g/dl	32,00 - 37,00
Distribuzione Vol. Eritrocitario (RDW)	17	%	12 - 17
Piastrine	382	x10 ³ /μl	130 - 400
FORMULA LEUCOCITARIA			
Granulociti Neutrofili	56,40	%	40,00 - 74,00
Linfociti	23,90	%	20,00 - 45,00
Monociti	10,60	%	3,40 - 11,00
Granulociti Eosinofili	8,50	%	0,00 - 8,00
Granulociti Basofili	0,60	%	0,00 - 1,50
Valori Assoluti			
Granulociti Neutrofili	3,36	x10 ³ /μl	1,50 - 8,00
Linfociti	1,42	x10 ³ /μl	0,90 - 4,00
Monociti	0,63	x10 ³ /μl	0,20 - 1,00
Granulociti Eosinofili	0,51	x10 ³ /μl	0,00 - 0,80
Granulociti Basofili	0,04	x10 ³ /μl	0,00 - 0,20

Acute Mountain Illness



Acute Mountain Sickness (AMS)
Headache
+
Anorexia
Nausea
Lassitude
Dizziness
Fatigue
Lightheaded

High Altitude Cerebral Edema (HACE)
Headache
Vomiting
Disorientation
Loss of coordination
Memory Loss
Psychotic behaviour
Coma

High Altitude Pulmonary Edema (HAPE)
Chest tightness
Severe breathlessness during exercise
Breathlessness at rest
Persistent cough
Frothy sputum

High altitude cerebral edema

Conditions of onset:

During the acclimatization period: from 3500 to 5000 m
or

At a very high altitude around 7000 m

Prevalence: 0.5-1% between 4200-5500

Favoring factors:

- lack of acclimatization
- state of acute mountain sickness

High altitude cerebral edema

Intracranial hypertension




- 🌐 Headache resistant to analgesic treatment
- 🌐 Sudden vomiting
- 🌐 Gait ataxia
- 🌐 Change of mood
- 🌐 Diplopia
- 🌐 Delirium and/or Hallucinations

Evolution

- Quick recovery at lower altitude < 1000 m down
- Loss of consciousness followed by death (in 60% of cases)

High altitude cerebral edema

Reoxygenation:

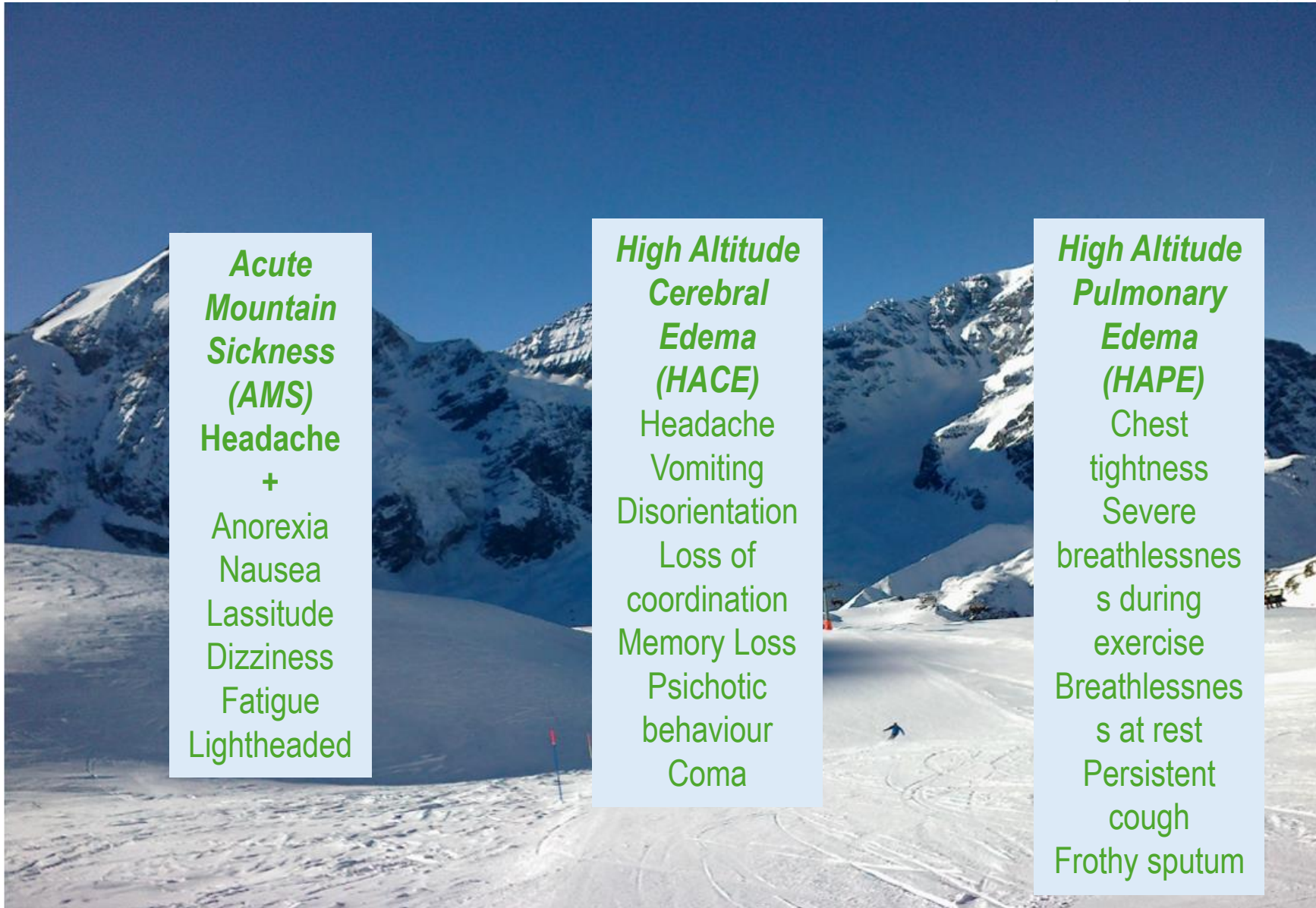
-  Descent of 500-1000 m
-  Portable hyperbaric caisson
-  Oxygen



Drugs:

Dexamethasone 8 mg followed by 4 mg every 6 hours

Acute Mountain Illness

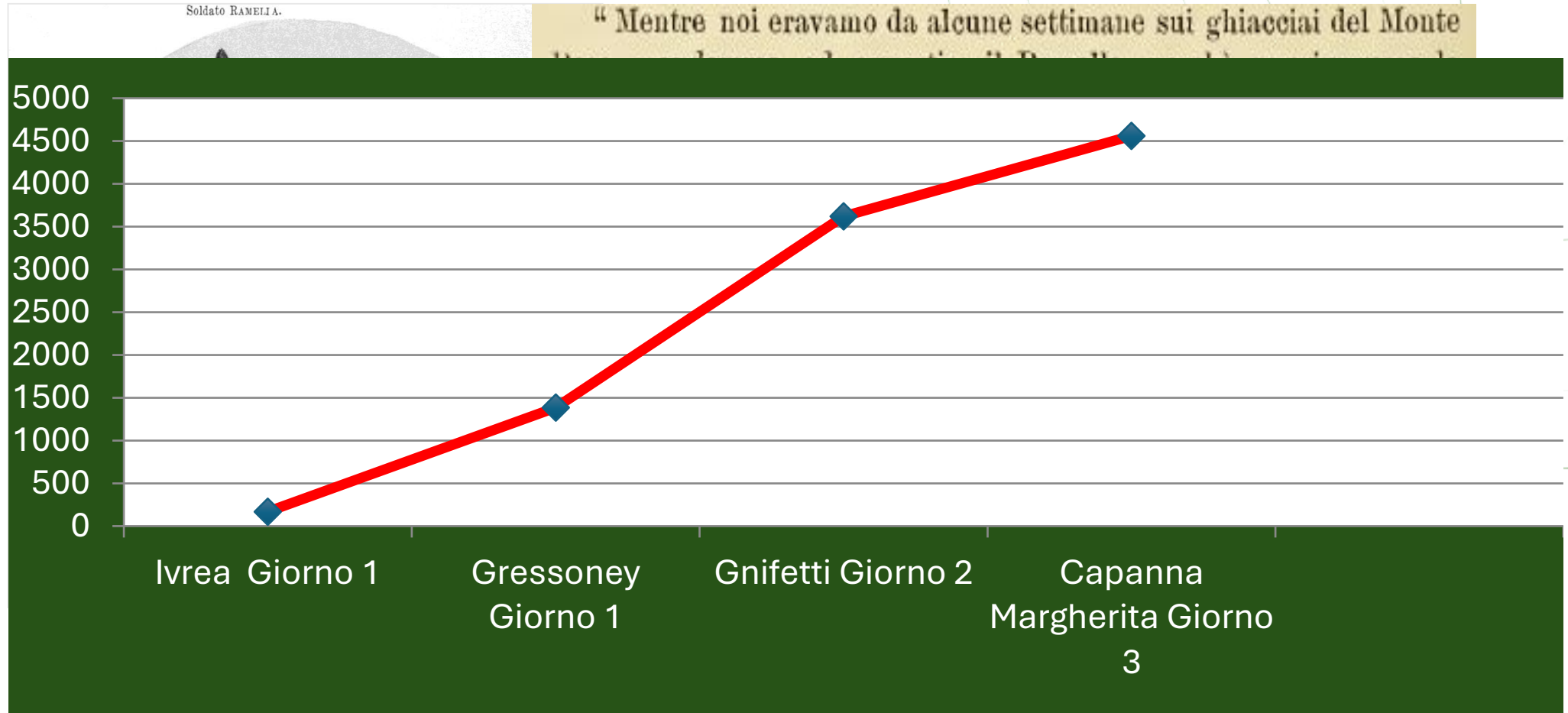


Acute Mountain Sickness (AMS)
Headache
+
Anorexia
Nausea
Lassitude
Dizziness
Fatigue
Lightheaded

High Altitude Cerebral Edema (HACE)
Headache
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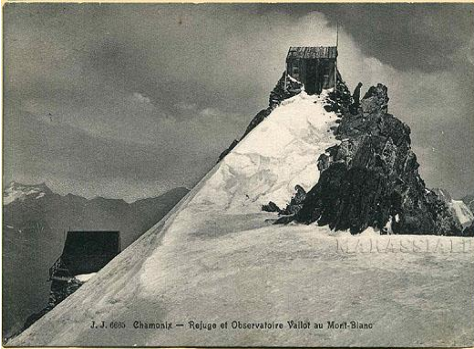
Soldato Ramella 1894



Mosso A. *Fisiologia dell'uomo sulle alpi*. Vol. 1889. Milano: Fratelli Treves, Editori, 1889

Dr Jacottet († 1892)

Osservatorio Vallot (4520 m)



“ Vigoureuse constitution, nombreuses lividités, cyanose marquée des lèvres, du visage, des extrémités, cerveau très-bien constitué. Meninges notamment congestionnées. Pas d'adhésions. Vaisseaux de la pie mère augmentés de volume et gorgés de sang. État piqueté de la substance grise, et blanche. Rien de particulier dans les centres, si ce n'est toujours l'état congestif secondaire à un état asphyxique.

“ *Thorax*. Pas d'adhérences, pas d'épanchement.

“ *Cœur* normal, valvules suffisantes. Les cavités pleines de caillots.

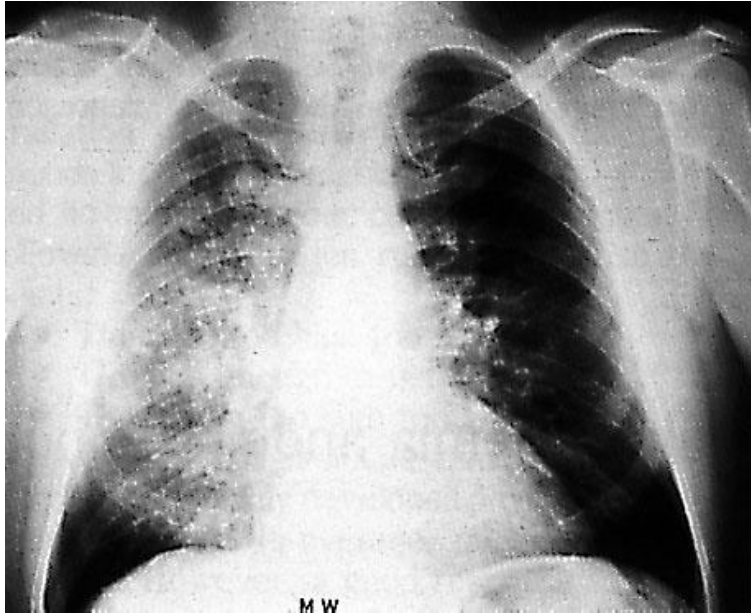
“ *Poumon* couleur violet, gonflé, foncé, congestion bilatérale, œdème considérable, muqueuse bronchique injectée fortement. Le liquide de la coupe est écumeux. Congestion égale partout. Foie, rate, reins normaux. Pas d'œdème des jambes.”

Mosso, *Fisiologia dell'uomo sulle Alpi*.

27

cottet è morto di bronchite capillare e di polmonite lobulare. La causa più immediata della morte sarebbe dunque stato un catarro soffocante accompagnato da edema acuto del polmone.

High altitude pulmonary edema



- Occurs > 2500 m within 1-5 days of arrival
- Main cause of death at high altitude
- Mortality: 44% if no action is taken to descend from altitude or without treatment
- Effective prevention
- Effective medical treatment

High altitude pulmonary edema

Conditions of onset:

- from 2000 m to 7000 m, very frequent above 5000 m
- It occurs in the first 3 days
- More frequent in young subjects

Favoring factors:

- lack of acclimatization
- intense exercise
- acute lung infections
- personal predisposition

Prevalence

Mountaineers at the Margherita hut (4559m)

- Ascension in 2-4 days 4%
- Ascension in 24 hours
 - Controls 6%
 - History of HAPE 60-70%

High altitude pulmonary edema

Profilaxys

Nifedipina 30 mg ogni 12 ore

Therapy:

Descent of 500-1000 m

Oxygen

Portable hyperbaric caisson

Positive pressure ventilation (PEP)

Nifedipine 30 mg every 12 ore



High altitude pulmonary edema

Profilaxys

Nifedipina 30 mg ogni 12 ore

Therapy:

Descent of 500-1000 m

Oxygen

Portable hyperbaric caisson

Positive pressure ventilation (PEP)

Nifedipine 30 mg every 12 ore



Prophylaxis of Acute Mountain Diseases

GENERAL RULE: Ascend slowly, avoiding strenuous exertion, maintain good hydration.

>**3000m** plan overnight stays within 600m of elevation gain (400-600m). If not possible, stay overnight for two nights at the same altitude.

If you plan to spend the night >**3000m** avoid the use of mechanical lifts as much as possible.

Do not drink alcohol and do not take sleeping pills, especially benzodiazepines.

If you absolutely must reach an altitude >**3000m** by plane/helicopter or mechanical means, take acetazolamide 125-250mg every 12 hours starting the evening before departure and/or dexamethasone 2-4mg orally every 6 hours.

If you plan to spend the night >**3000m** in the presence of a positive history for high-altitude pulmonary edema, take nifedipine.

NONPHARMACOLOGIC MEASURES FOR ALTITUDE SICKNESS PREVENTION

Pre-exposure:

A high-elevation exposure (> 9,000 ft [\approx 2,750 m]) for \geq 2 nights, within 30 days before the trekking/expedition helps in preventing AMS.

Also spending 6 to 7 d at moderate altitude (\sim 2200 to 3000 m) before proceeding to higher altitude decreases the risk of AMS, improves ventilation and oxygenation.

Hypoxic Tent

Before leaving

- Find out the problems present in the location.
- Access to health facilities or possibility of telemedicine
- No connectivity
- Variability of atmospheric situations



Before leaving

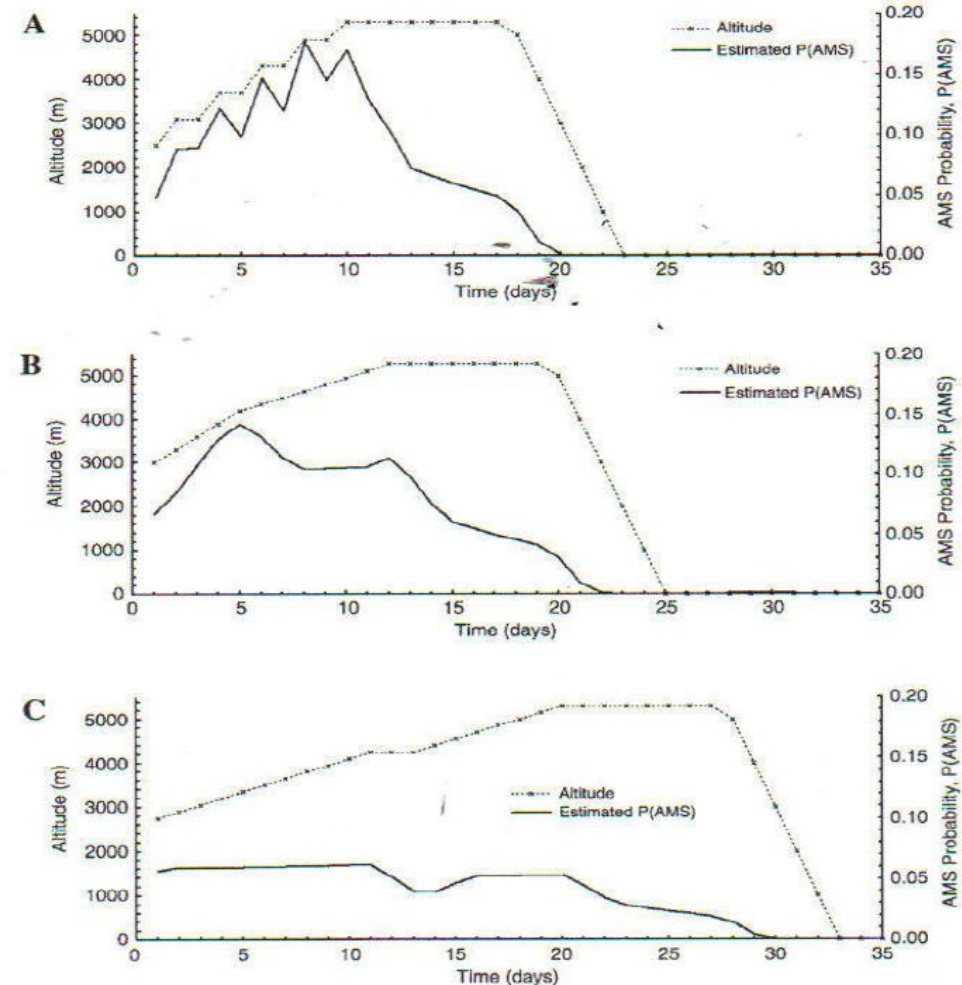
- Have a doctor-patient meeting (1 month before departure)
- Discuss the itinerary and necessary materials
- Help to collect a detailed medical history: present chronic pathologies, previous pathologies
- Check previous and necessary vaccinations
- Show the planned extreme activities (e.g. climbing, diving, surfing)
- Follow specific training or acclimatization if traveling at altitude
- Health insurance coverage in the chosen country
- drugs or devices to take with you on the trip and, if necessary, in the case of drugs to be used prophylactically, advise them to try them before departure
- Recommend an App that can also be used offline to evaluate the symptoms caused by the extreme environment

Plan a safe climb to high altitude

600m/day > 2500m + 1 day rest
for increments >600<1200m
(Hackett-Roach 2001)

300m/day >3000m 300m/2day
>4200m
(Houston-Dickinson 1975)

>2750m 150m/day break for a
few days at 4250m 150m/day



Plan a safe climb to high altitude

For the prevention of high-altitude illness, the best strategy is a gradual ascent to promote acclimatization. The suggested guidelines are that once above an altitude of 2500 m, the altitude at which one sleeps should not be increased by more than 600 m in 24 hours and that an extra day should be added for acclimatization for every increase of 600 to 1200 m in this altitude. For example, as compared with ascent to an altitude of 3500 m in a one-hour period, a gradual ascent over a period of four days reduced the incidence and severity of acute mountain sickness by 41 percent.

Hackett and Roach NEJM 2001, 345:107

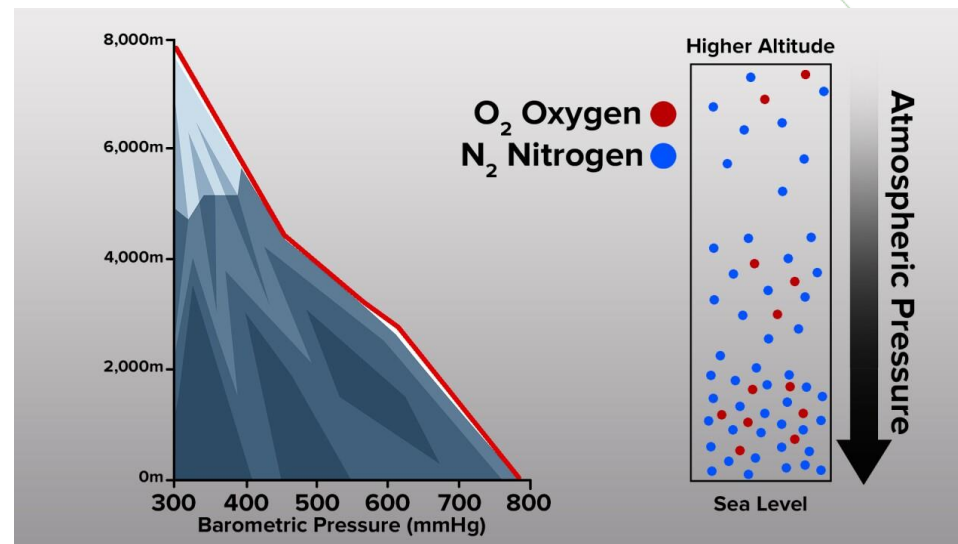
Oxygen Saturation = SpO2

The blood oxygen level (blood oxygen saturation) is the amount of oxygen you have circulating in your blood.

Oxygen is essential to life, and our bodies need a certain amount of oxygen to function properly.

Oxygen enters your body through your nose or mouth when you breathe (inhale) and passes through your lungs into your bloodstream.

Once in your bloodstream, the oxygen then goes to cells all over your body.



Things That Affect Pulse Oximeter Readings:

- Having cold hands
- Moving while taking your reading
- Wearing nail polish (especially black, blue, or green)
- Having artificial nails
- Experiencing an extremely low oxygen saturation (below 80%)
- Having thicker-than-normal skin



• Pulse Oximeter is a non-invasive and painless technique for determining the oxygen saturation level or the amount of oxygen in the blood.

It can detect even small variations in the efficiency with which oxygen is transported to the extremities furthest from the heart, such as the legs and arms.

• A pulse Oximeters is a little clip-like device worn on the toes or earlobe. It's normally worn on one's finger..

TIPS TO MEASURE OXYGEN SATURATION (SPO2)



During measurement, keep the measuring position steady and avoid too much trembling.

An imperfectly fitting of the sensor should be avoided, and the sensor should always be used in the appropriate position.

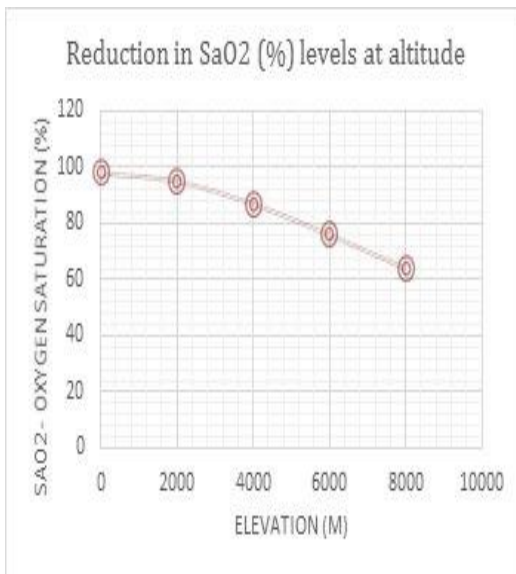
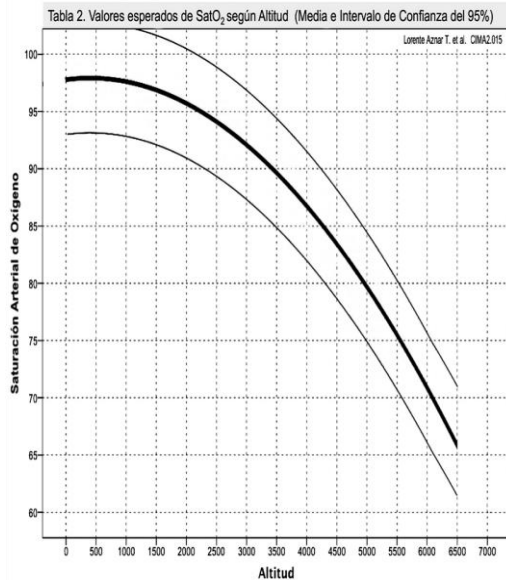
Measurements should be conducted at rest after the person keeps silent and gentle breathing for several minutes.

The measurement duration should be extended over a few minutes and the most frequent occurring value should be used

Protect the sensor from sunlight

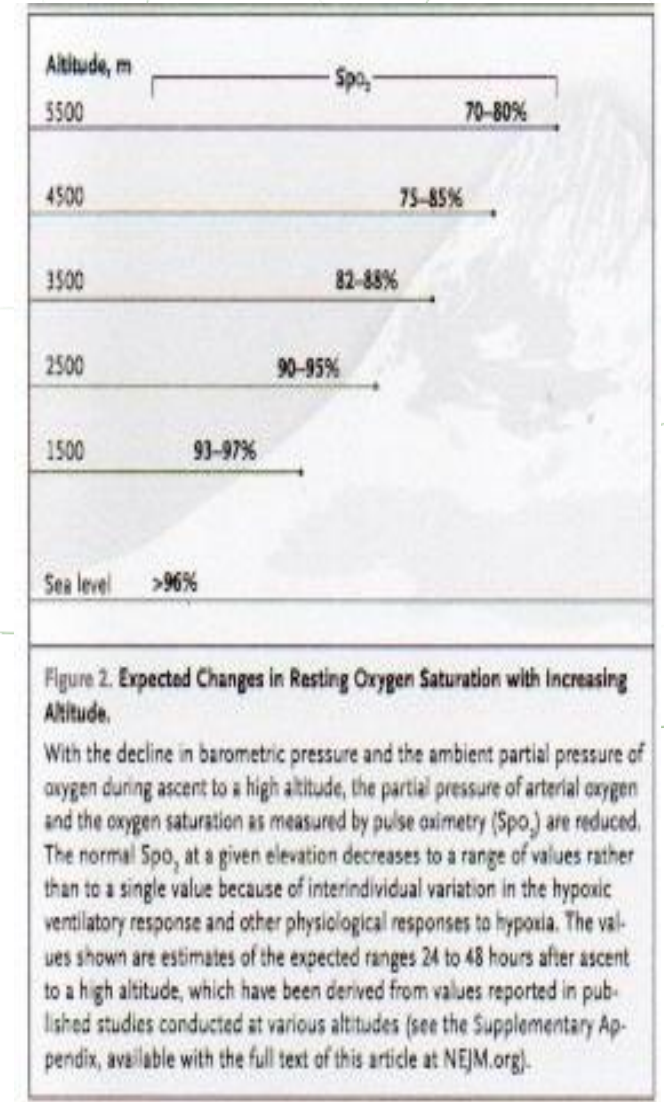
Warming the measuring site before and preferably during the measurement (e.g., using heating pads)

SpO2



There is no single normal value of oxygen saturation for healthy individuals at any altitude.

There is a range of values, as the response to hypoxia is different from individual to individual





BENVENUTI NEL SITO DELLA SOCIETÀ ITALIANA MEDICINA DI MONTAGNA

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Società Italiana di Medicina di Montagna

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Rispondi più velocemente per attivare il badge

Piace a 868 persone · « questa settimana Pierluigi Giardin e altri 111 amici

Copertura dei post questa settimana: 453

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Vedi post di altre Pagine

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Promuovi Pagina

INFORMAZIONI

Pagina Ufficiale della Società Italiana di Medicina di Montagna

Società Italiana di Medicina di Montagna

Publicato da Francesco Marchionni (19 · 10 marzo alle ore 20:08 · @)

Cari Amici,

vi segnaliamo questo corso organizzato dall'Università di Pavia che si terrà in più date tra il 21 marzo ed il 21 aprile 2016. Gli argomenti sono davvero stimolanti.

Sul nostro sito troverete il PDF del programma completo. Diffondete la voce!... Altro...

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Pagine Ufficiale della Società Italiana di Medicina di Montagna

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Recenti

2015

2014

Visualizza la tua interazione...

Visualizza la tua interazione...

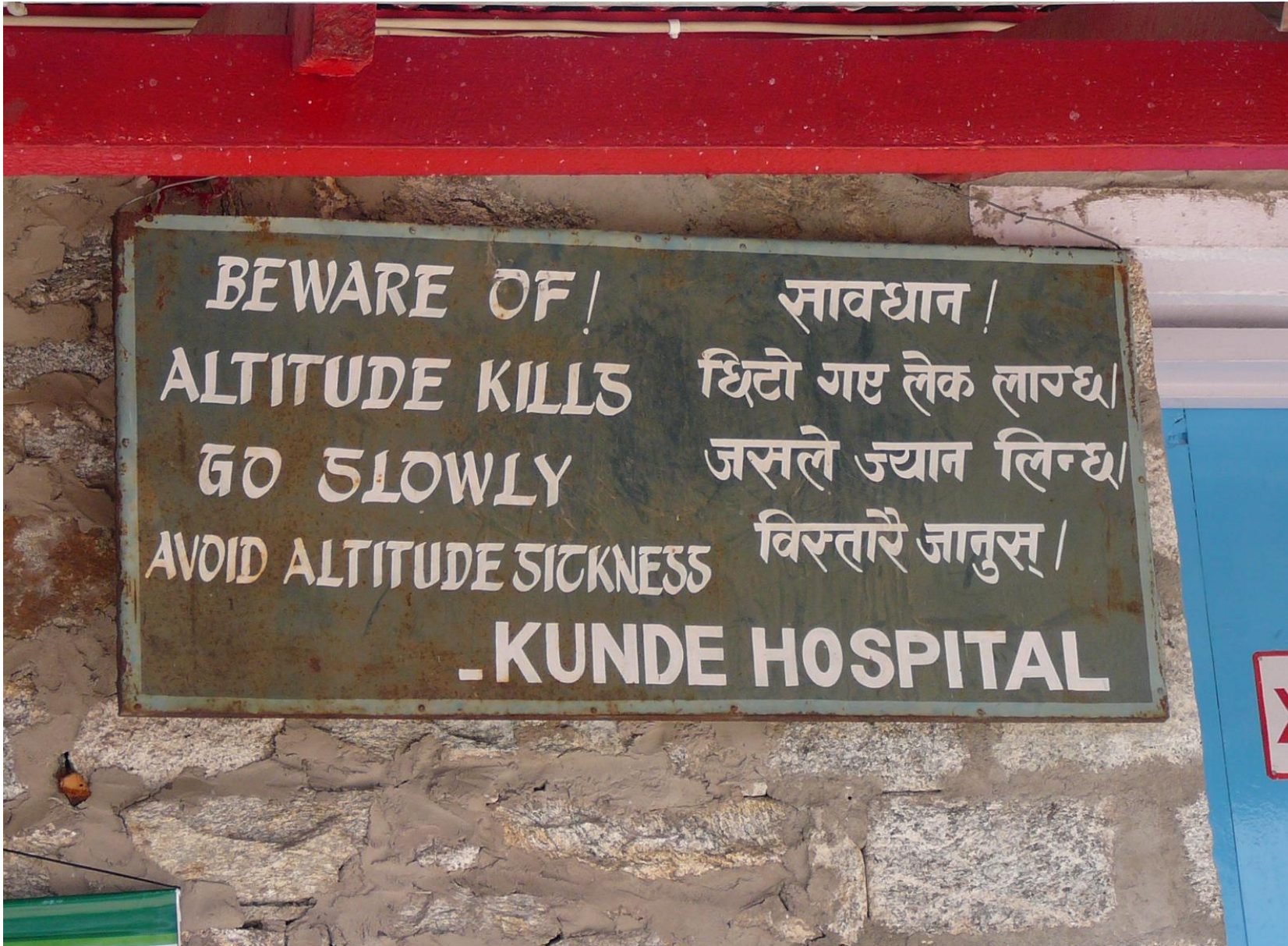
Società Italiana di Medicina di Montagna

Pagina Ufficiale della Società Italiana di Medicina di Montagna

Mi piace questa Pagina · A 868 persone piace questa Pagina

Promuovi Pagina

Cerca



Grazie per l'ascolto
lorenza.pratali@cnr.it



THANKS!

IR0000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System
(D.D. n. 130/2022 - CUP B53C22002150006) Funded by EU - Next Generation EU PNRR-
Mission 4 "Education and Research" - Component 2: "From research to business" - Investment
3.1: "Fund for the realisation of an integrated system of research and innovation infrastructures"

