High-Altitude Medicine
Current trends and prevention

FMF - 2014
Eric Mercier, MD, MSc
jeudi 27 novembre 14
Objectives
CIWEC clinic
Nepal
Plan

Acclimatization process
Altitude-related diseases
Prevention | Treatment
Plan

Acclimatization process
Altitude-related diseases
Prevention | Treatment

No conflicts of interest
Acclimatization
Series of **integrated adaptations** that take place at high altitude, which **tend** to restore the **oxygene pressure** toward normal sea levels despite the lowered PO2

**Acclimatization**
<table>
<thead>
<tr>
<th>Barometric pressure</th>
<th>FiO2</th>
<th>Inspired oxygen pressure (PiO2)</th>
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Sea level:

\[
760 \text{ mmHg} \times 0.21 =
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Sea level:

$$760 \text{ mmHg} \times 0.21 = 160 \text{ mmHg}$$
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<td>760 mmHg x 0.21</td>
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# of Oxygen in air at sea level

# of Oxygen in air at altitude

WMS, 2011
Arterial Blood Gases and Oxygen Content in Climbers on Mount Everest

Michael P.W. Grocott, M.B., B.S., Daniel S. Martin, M.B., Ch.B.,
Denny Z.H. Levett, B.M., B.Ch., Roger Mc Morrow, M.B., B.Ch.,
Jeremy Windsor, M.B., Ch.B., and Hugh E. Montgomery, M.B., B.S., M.D.,
for the Caudwell Xtreme Everest Research Group*
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Camp 4
Pb, 292 mm Hg
PiO₂, 51.3 mm Hg

Camp 3
Pb, 317 mm Hg
PiO₂, 56.5 mm Hg

Camp 2
Pb, 350 mm Hg
PiO₂, 63.4 mm Hg

Base Camp
Pb, 403.5 mm Hg
PiO₂, 74.7 mm Hg

Kathmandu
Pb, 650 mm Hg
PiO₂, 126.2 mm Hg

The Balcony
Pb, 272 mm Hg
PiO₂, 47.1 mm Hg

Summit
Pb, 253 mm Hg
PiO₂, 43.1 mm Hg

London
Pb, 754 mm Hg
PiO₂, 148.0 mm Hg

Altitude (m)

Days

jeudi 27 novembre 14
Original Article

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jeudi 27 novembre 14
Table 2. Arterial Blood Gas Measurements and Calculated Values for Pulmonary Gas Exchange from Four Subjects at an Altitude of 8400 m, during Descent from the Summit of Mount Everest.*

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*Presented are mean values ± SEM.
†Values are presented as partial pressure of oxygen or carbon dioxide.
‡Values are presented as concentration or percentage.
§Values are presented as concentration or volume.
¶Values are presented as ratio or exchange.
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Hypoxic ventilatory response
Altitude-related diseases
jeudi 27 novembre 14
Acute mountain sickness (AMS)

Table 2: Lake Louise Consensus Definition For The Diagnosis Of AMS

- An individual is at or above 2500 m above sea level and
- A headache is present and
- An individual has any one of the following:
  - GI Symptoms (nausea, vomiting, anorexia)
  - Sleep symptoms (insomnia, difficulty sleeping)
  - Fatigue/weakness
  - Dizziness/lightheadedness
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High-altitude cerebral edema (HACE)

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<th>Table 7: The Lake Louise Consensus Criteria For HACE</th>
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<td>The presence of a change in mental status or ataxia in a person with AMS</td>
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<tr>
<td>OR</td>
</tr>
<tr>
<td>The presence of both a change in mental status and ataxia in a person without AMS</td>
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### Table 4: The Lake Louise Consensus

**Definition Of HAPE Includes**

- At least two of the following symptoms:
  - Dyspnea at rest
  - Cough
  - Weakness or decreased exercise performance
  - Chest tightness or congestion

- And two of the following signs:
  - Crackles or wheezing in at least one lung field
  - Central cyanosis
  - Tachypnea
  - Tachycardia
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High-altitude pulmonary edema (HAPE)
Most of the deaths are caused by a trauma.
Planification
Planification

Single MOST important factor
Before

The time allowed to complete your trip MUST be longer than the expected one.

It is IMPOSSIBLE to save a significant amount of money without compromising your safety.
Case report
Day 1 (3440 m) : Did not feel good
Case report

Day 1 (3440 m) : Did not feel good

Day 2 (3860 m) : Continued to climb, was feeling worst
Day 1 (3440 m) : Did not feel good
Day 2 (3860 m) : Continued to climb, was feeling worst
Day 3 (4410 m) : Used a horse to continue her ascension
Case report

Day 1 (3440 m) : Did not feel good

Day 2 (3860 m) : Continued to climb, was feeling worst

Day 3 (4410 m) : Used a horse to continue her ascension

Day 4 : Was not able to walk
   Fell off the horse
   Broke her wrist
   Rescuers were called
Planification

During

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Respect your body and pay close attention to your symptoms.
Planification

During

Respect your body and pay close attention to your symptoms

Your position within the group should be the same during the whole trip
Planification

During

Climb high, sleep low

Respect your body and pay close attention to your symptoms

Your position within the group should be the same during the whole trip
I. Sleep the first night ≤ 2750 meters

2. Climb a maximum of 500 meters per day

3. Sleep an extra night at the same altitude every 1000 meters
AMS → stay

HACE → go down

HAPE → go down*

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Medication
Medication

- Acetazolamide
- NSAID
- Dexamethasone
- Nifedipine
- 5-phosphodiesterase inhibitors
- Azithromycin

AMS/HACE

HAPE
Acetazolamide

Respiratory stimulant

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Acetazolamide

Prophylaxis: 125 mg PO BID  NNT = 8
Treatment: 500 mg PO BID
Altitude Sickness in Climbers and Efficacy of NSAIDs Trial (ASCENT): Randomized, Controlled Trial of Ibuprofen Versus Placebo for Prevention of Altitude Illness

Original Research

Ibuprofen most studied

AMS/HACE

Ibuprofenen most studied

Efficacy?

Prevention - Maybe

Treatment - Yes

NSAID
Only a few studies

Dexamethasone
Only a few studies

Efficacy proven for prevention and treatment of AMS

Standard of care for HACE

Dexamethasone
Only a few studies

Efficacy proven for prevention and treatment of AMS

Standard of care for HACE

Prevention of HAPE

Dexamethasone
Nifedipine for the Treatment of High Altitude Pulmonary Edema

Rajesh Deshwal, MD, FHM; Mohd Iqbal, MD; Sidhant Basnet, MBBS

From the Department of Medicine, Military Hospital, Gangtok, Sikkim, India (Drs Deshwal, Iqbal, and Basnet).
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WILDERNESS & ENVIRONMENTAL MEDICINE, 23, 7–10 (2012)

HAPE

Nifedipine

Controversial

No role in prevention
Maybe for treatment
5-phosphodiesterase inhibitors
Only one small RCT

5-phosphodiesterase inhibitors
Only one small RCT

Maybe for prevention
Maybe for treatment

5-phosphodiesterase inhibitors
Azithromycin

Absolutely no studies but...
Azithromycin

Absolutely no studies but...

many clinicians think it works
Other medications

- Furosemide
- Prednisone
- Salbutamol
- Magnesium
- Ginko bilboa
Avoid all substances that may interfere with the hypoxic ventilatory response
Technologies
Hypobaric chamber
Hypobaric chamber

**NO** scientific evidence Dangerous !
Pulse oximetry

Pulse Oximetry at High Altitude

Andrew M. Luks and Erik R. Swenson
Pulse oximetry

No scientific evidence

Inaccurate
No correlation SpO2 - HAPE
REVIEW ARTICLE

Using Ultrasound Lung Comets in the Diagnosis of High Altitude Pulmonary Edema: Fact or Fiction?

Yashvi Wimalasena, BM, FCEM, DiMM; Jeremy Windsor, MBChB, DCH, FCARCS; Mark Edsell, MBChB, FRCA, FFICM

From the Emergency Department, University Hospitals Coventry and Warwickshire (Dr Wimalasena) and the Birmingham Medical Research Expeditionary Society (Drs Wimalasena and Edsell), Birmingham; and University College London (Dr Windsor) and St George’s Hospital London (Dr Edsell), UK.
Ultrasound

Maybe

Sensitive for HAPE
Specific?
Eric-based medicine
Eric-based medicine

Planification is the key
Eric-based medicine

Planification is the key

Respect the ascension rate
Eric-based medicine

Planification is the key

Respect the ascension rate

Avoid sedatives
What to bring with you
What to bring with you

Acetazolamide
Dexamethasone
Nifedipine
Cipro/azithro
Immobilisation kit
Questions ?

Thank you