

High Altitude Medicine

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About me

- Studied at the Medical Faculty, University in Prague
- Clinical practice for 17 years as an internist – nephrologist, head of dialysis unit in Prague
- Participated in a number of expeditions to peaks higher than 6 000 m (including one 8 000 m peak) as an expedition doctor
- Currently in a global medical role at GlaxoSmithKline (Pharmaceutical company)





Medical advice



Recommendations

Before departure for a trek or an expedition:

- routine medical check up (blood pressure, ECG, basic biochemistry - namely blood glucose, cholesterol, blood count);
- dentist check up;
- gynaecology check up for women.

Basic vaccination

- hepatitis A
- hepatitis B
- tetanus
- typhoid
- rabies
- cholera

Other vaccination

- Requirement depends on the approach route to the final trekking or climbing destination (rain forest, rural area etc.).
- Consult a vaccination center for an advice what other vaccination is mandatory and/or recommended for the specific destination.
- Vaccination for the prevention of yellow fever, meningococcal diseases, japanese encephalitis as well as prevention against malaria may be considered.



Take care

- Radial keratotomy (myopia correction) can lead to refractive changes at altitude from minor discomfort to severe disability.
- There is an increased risk of thrombotic events at high altitude.
 - Oral contraceptives make this risk even higher.
 - Tight fitting socks (elastic bands) reduce blood circulation and can also lead to thrombophlebitis.

Normal physiology

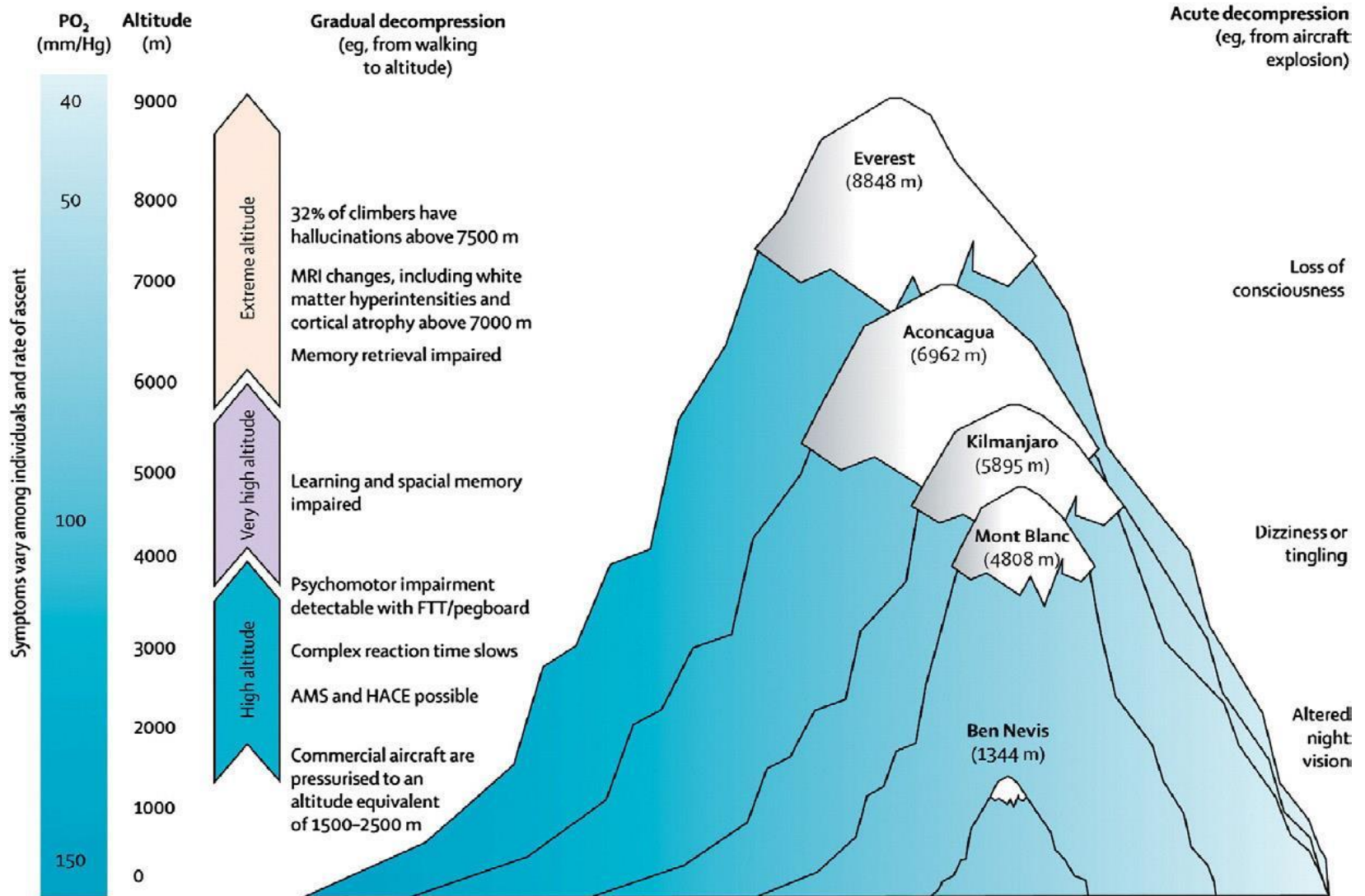


Definitions

- High altitude 1 500 – 3 500 m
- Very high altitude 3 500 – 5 500 m
- Extreme altitude above 5 500 m

- Zone of tolerance – individual, changes with acclimatisation.
- When above 3000 m, it is recommended to ascend 300 to 500 m per day and have a rest day for acclimatisation every gained 1000 m (or every 3 days).

High altitude



Normal reaction to altitude

- hyperventilation during exertion
- shortness of breath during exertion, resolving rapidly at rest
- changed breathing pattern at night (Cheyne-Stokes)
- increased urine output
- awakening at night
- weird dreams

Altitude and atmospheric pressure

- The amount of oxygen (O_2) in the air at the altitude of 5 500 m is 50 % of that at sea level. At the altitude of 8848 m (Mt Everest) it is only 30 %.
- The atmospheric pressure at a given sea level is higher around the equator and is higher in the summer than in the winter.

Pulse & PaO₂

- Partial pressure of arterial oxygen
at 4 200 m: 80 – 86 % normal acclimatized,
 50 – 60 % with HAPE.
When giving O₂ saturate the arterial blood to 99 – 100 %.
- Pulse oxymeter – simple, light and easy device for monitoring individual acclimatisation.
Pulse at altitude increases by 20 beats per min at awakening without acclimatization, returns to normal when acclimatized.
Appropriate O₂ saturation at the cost of extremely increased pulse rate is a sign of insufficient acclimatisation.
Very low O₂ saturation and an extremely increased pulse rate is a sign of high altitude disease.

Pulse oxymeter



Altitude

- Human habitation ends at the altitude of 5 400 m.
- It is possible to stay at altitude over 6 000 m for weeks or months, but organism starts to deteriorate.
- Aim to acclimatize up to 6 500 m. Above that, it is just tolerance, no further acclimatization is possible.
- At high altitude there is an increased risk of bacterial, not viral infection.
 - Active immunity and B cell function is normal.
 - T cell function is impaired.

Nutrition & hydration

- It is essential to keep good hydration at altitude.
 - Air at high altitude is dry, the fluid intake must be increased compared to low altitude.
 - If no unusual fluid loss - intake should be at least 3 litres / 24 hrs up to 6 000 m.
 - Above 6 000 m - fluid intake over 3 litres / 24 hrs.
 - Simple test – pale yellow urine colour.
- Diet should have > 70 % of energy from carbohydrates (pasta, rice, potatoes...).



High altitude medical disorders & diseases

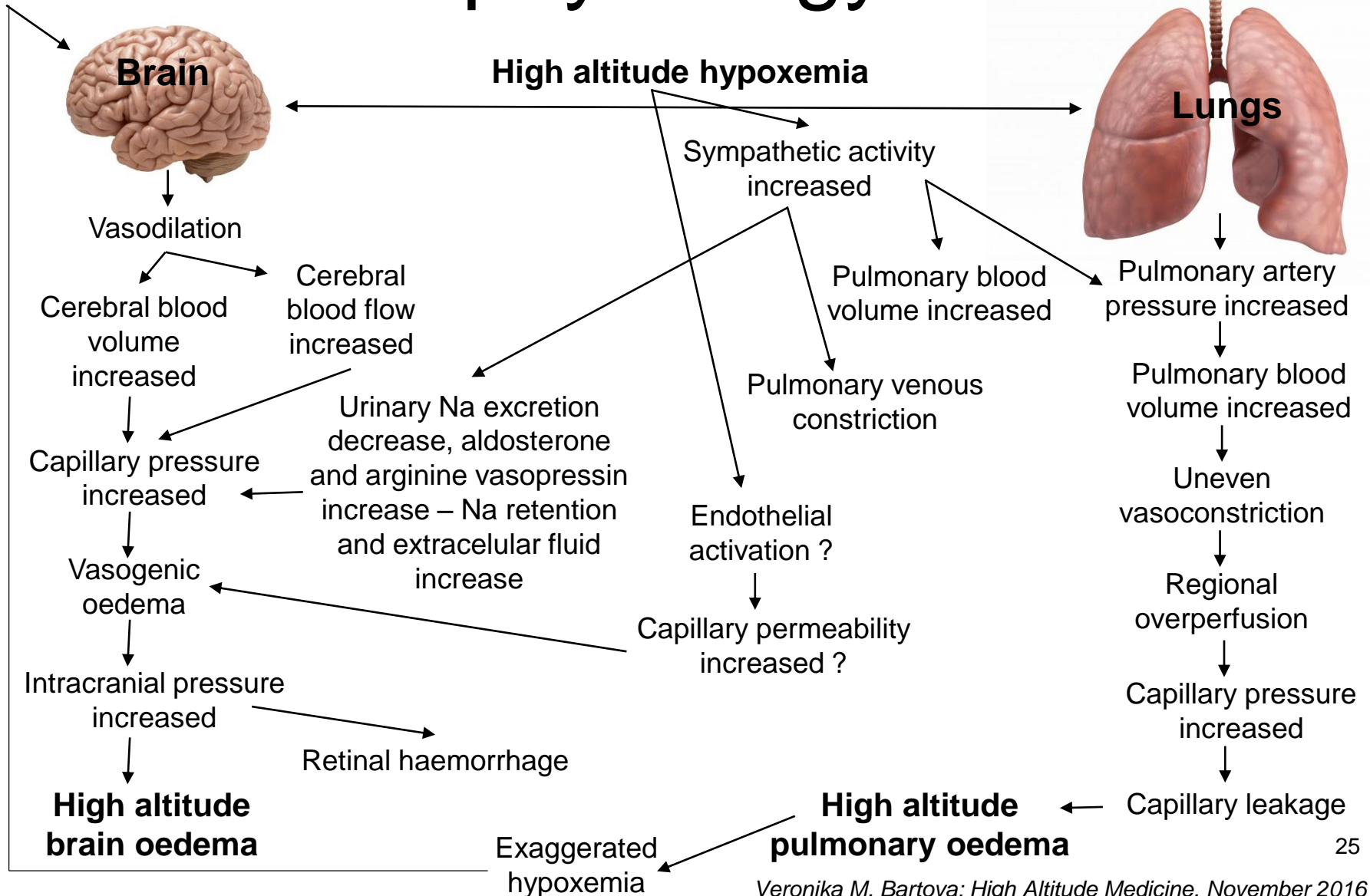


Acute mountain sickness (AMS)

- Pathophysiology is not fully understood.
- Symptoms from brain swelling due to hypoxic stress.
- AMS = headache + 1 of the following symptoms:
 - loss of appetite, nausea, vomiting;
 - fatigue and/or weakness;
 - dizziness and/or lightheadedness;
 - difficulty sleeping;
 - staggering gait (unable to walk in straight line but normal finger to nose test);
 - Confusion.

(Spontaneously resolving headache after sufficient fluid intake is not AMS.)

Pathophysiology of AMS



Altitude disorders & diseases

- dehydration & oedema
- diarrhoea
- cough; CO poisoning
- snow blindness
- frostbite
- hypothermia
- high altitude pulmonary edema (HAPE)
- high altitude cerebral edema (HACE)

Dehydration & oedema

- Dehydration increases the risk of headache & thrombotic complications.
- There is an extreme loss of fluid during physical activity at high altitude (especially in sunny weather).
- Peripheral oedema (face – puffy eyes, swollen feet) in absence of other symptoms of AMS can be treated with acetazolamide (Diamox) or other mild diuretic.



Diarrhoea

- Diarrhoea is not always of infectious aetiology – do not treat with ATB before trying other means (ATB can make it worse by killing the normal intestinal bacteria).
- Possible causes: dietary, stress, allergy, medication).
- Sufficient fluid and mineral intake – use electrolyte supplements (mineral drinks).



TOILET
शौचालय

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शौचालय

Cough; CO poisoning

- Dry air leads to dry irritative cough (so-called Khumbu cough). Note – do not overlook beginning HAPE.
- Carefull when cooking inside tents at high altitude – let sufficient fresh air in to avoid CO poisoning.
- When cooking inside tent, move all inflamable materials far from gas stove.



Snow blindness

- UV keratitis – damage caused by the strong ultraviolet light to the eye cornea with reactive conjunctival inflammation.
- It is very painful and causes temporary blindness.
- Usually resolves in 2 to 5 days; if serious, can leave permanent damage.
- Prevention – sunglasses with category 4 filter.



Frostbite

- Local damage caused by low temperature
- Enhanced by dehydration
- Prevention:
 - dry clothes & boots.
 - Never ignore numbness (it may happen to be the last sensation you've ever felt).
 - Use thin gloves for cooking, photography...
- Never rub frostbitten area directly, defrost only when further treatment is possible.



Hypothermia

- Overall damage caused by low temperature
 - Normal body temperature is 37 °C.
 - Decrease of body temperature below 37 °C leads to shivering.
 - With further decrease below 36,5 to 35 °C shivering stops, feeling of dizziness and disorientation appears, pulse is weak and slow, illusion of warmth follows, then the heart stops.
- Risk increases in strong wind, with hunger, dehydration, exhaustion.



Fatigue

- Increases the risk of possible
 - complications (frostbite, dehydration, hypothermia);
 - mistakes (falling into crevasses, stepping into the void);
 - bad judgement (distance & time estimation).
- Fatigue cannot be always avoided, but should always be remembered as a risk factor and precautions taken.



High Altitude Pulmonary Edema (HAPE)

- HAPE is caused by fluid retention in the lung interstitial tissue, progresses into fluid in the lung alveoli.
 - Signs & symptoms: fatigue, breathlessness at rest, cough, pink sputum, fast and shallow breathing, blue lips and fingertips, gurgling sounds when breathing.
- Never take HAPE for pneumonia, never treat with ATB at high altitude, always descend, then treat if needed.
- May culminate the 1st or 2nd night after ascent! In case of any signs descend as fast & as low as possible (500 to 1 000 m lower).
- HAPE leads to extremely low PaO₂, may be equal to rapid ascent & lead to progressive HACE.



High Altitude Cerebral Edema (HACE)

- Brain swelling due to hypoxia, alteration of all brain functions.
 - Signs & symptoms: change of mentation & ability to think, agitation or lethargy, loss of coordination, ataxia (walking straight line is altered, touching the nose tip with closed eyes is not).
- Immediately descend as fast and as low as possible (at least 500 – 1 000 m), never wait till the morning at the same altitude – it may be too late in the morning!
- Treatment will help the sick person survive, but cannot match the positive effect of descent. Symptoms usually recede spontaneously at lower altitude.



Rescue

- Do not underestimate the risks even when you go “just” trekking.
- Always have an option to call help (satellite phone, walkie-talkie).
- Be sure to have correct rescue phone numbers.
- Do not hesitate to call for help – better rather early than too late.
- Have basic treatment ready before help arrives (oxygen, medication, Gamow bag).



Symptoms and long term effects of high altitude exposure

- Transient disorders of motoric and sensory functions have been described at high altitude including transient cognitive disorders and impaired memory.
- Neither long-term brain impairment nor disorder of normal intellectual functions following uneventful (even repeated) ascents to very high and extreme altitude have been confirmed.
- In case of HACE (brain oedema) microhaemorrhage has been identified by magnetic resonance imaging. The lesions may persist up to several years.

Golden rules

- It is OK to get high altitude sickness. It is not OK to die from it.
- Acetazolamide (Diamox) is not recommended as a routine drug before any ascent!!!
- Any illness at altitude is altitude sickness unless proven otherwise after descent.
- Never ascend with symptoms of AMS.
- If AMS is getting worse, descend at once. Do not wait till the morning.
- Never leave someone with AMS alone.



Case studies

HACE – Biafo

Female 39 years, headache from the altitude of 3 000 m, improving at rest, slow ascent up to 4 150 m, where she loses coordination, feels extremely weak. Rescue helicopter called at noon.

Treatment with Diamox & Hydrocortison started in camp at 4 pm. On treatment overnight, helicopter cannot fly due to bad weather in Skardu. From morning unconscious, i.v. infusion, bradycardia treated by noradrenalin.

Helicopter arrived at 2 pm, she left with the last available infusion. She received O₂ on the way, was dismissed from hospital after 24 hrs without complications.

Case studies

HACE – Spantik

Female 42 years, descending from C2 to C1 accompanied by another climber. Unable to continue due to „fatigue“ decided to stay between camps.

Her partner left her alone and descended to C1 to bring help, which he had called by walkie-talkie. Two climbers returned to the place where she stayed three hours later and found her lying between 2 crevasses.

She was lying on the snow unconscious, no contact was possible. Then her heart stopped. Not even CPR brought her back to life.

Her body was buried in a crevasse at 5 431 m.

Medical kit



Personal medical kit

- Usual medication taken for any disorder, antihistamines, aspirin, band aid, elastic bandage, pain killers, paracetamol, water purifying tbl.
- Multivitamin and mineral tablets and/or drinks are recommended.

Expedition medical kit

- **Tablets:** antipyretics, analgetics, diarrhoea treatment, treatment for HAPE & HACE
- **Antiinfectives:** ATB, antivirotics, antiprotozoal (amoeba)
- **Injections & infusions:** corticosteroids, antithrombotics, analgetics, fluid replacement, treatment for HAPE & HACE
- **Eye drops & ointments:** antiinfectives, corticosteroids, analgetics
- **Ointments & powder:** antiinfectives, antimycotics, analgetics, antithrombotics, antiflogistics
- **Varia:** corticosteroid inhaler, antiemetics, disinfection
- **Instruments, sutures, dressings:** small surgical kit, syringes, needles, splints, infusion sets
- **Oxygen as rescue treatment; Gamow bag**



Literature

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