

## Introduction

With time, humans can acclimatise to increasing altitude (up to about 18000 ft or 5490 m) by:

- ↑Ventilation (via carotid body hypoxic ventilatory response)
- ↑RBC production (via erythropoietin)
- ↑Vascularity of lungs and tissues
- Suppression of ADH and aldosterone, and ↑tissue mitochondria

High altitude illness commonly occurs when ascending to more than 2500 m (8000 ft).

- *Acute mountain sickness (AMS)*: milder and more common form; self-limiting and consists of a number of non-specific symptoms including headache, loss of appetite, and nausea.
- *High-altitude cerebral oedema (HACE) & high-altitude pulmonary oedema (HAPE)*: More severe forms which may lead to coma and death if left untreated.

Note:

- AMS and HACE are a continuum from hypoxia-induced changes in blood-brain barrier.
- In HAPE, exaggerated pulmonary hypertension leads to increased vascular permeability.

## Risk factors

- Rapid ascent
- Physical exertion at high altitudes, including climbing
- Continued ascent with AMS is a RF for HACE
- Individual susceptibility
- History of high-altitude sickness
- Permanent residence at low altitudes (below 900m)
- High altitude dwellers returning from a brief period at low altitude
- Age less than 50 years
- Neck irradiation or surgery
- URTI or bronchitis, cardiac or lung disease
- Exertion, low T and cardiopulmonary circulation abnormalities predispose to HAPE

## Acute mountain sickness (AMS)

- Typically occurs at altitudes greater than 2,500m (8,202ft).
- ↑Incidence with: height, rate of ascent & sleeping altitude. Unrelated to fitness, gender.
- Symptoms may take hrs to days to develop, depending on rate of ascent and altitude:
  - Loss of appetite, N or V, headache, fatigue, irritability, insomnia, dizziness.
  - Visual disturbances may be experienced at higher altitudes.
  - Peripheral oedema, pulmonary crepitations & retinal haemorrhages may occur.
- Usually self-limiting but may → peripheral oedema, retinal haemorrhages, dyspnoea at rest, altered consciousness and ataxia, cerebral and pulmonary oedema.

## High altitude cerebral oedema (HACE)

- Incidence <1%.
- Usually occurs 1-3 days after ascent.
- Presents with features of AMS but also:
  - Truncal ataxia, hallucinations, disorientation, confusion, drowsiness, ↓LOC.
  - Seizures, blurred speech and double vision are less common.
  - Focal and non-focal signs of ↑ICP (severe headache, papilloedema, vomiting, IIIIn or VIIn palsies); retinal haemorrhages & other focal neurological deficits.
- May progress rapidly to coma and death if untreated.

## High altitude pulmonary oedema (HAPE)

- Incidence: 0.01-15% (slightly greater in males and individuals under 20 years).
- Usually occurs 2-4 days after ascent:
  - Typical APO, incl dyspnoea at rest, cough (initially dry and then frothy sputum ± blood stained), chest tightness, poor exercise tolerance and eventually cyanosis.
  - Pulmonary creps, central cyanosis, tachycardia, tachypnoea
  - Other signs include mild fever, orthopnoea.
- Increases the risk and severity of AMS/HACE and can lead to death.

## Investigations

- Pulse oximetry helpful in HAPE, but doesn't correlate well with severity of AMS/HACE.
- ABG and CXR (uni- or bilateral fluffy infiltrates) in HAPE.
- CT/MRI scan in HACE to rule out CVA/TIA.

## Management

### Symptom control

- Analgesics and anti-emetics
- Ibuprofen is more effective than aspirin for relieving high-altitude headache

### Mild AMS

- Rest and avoiding further ascent until symptoms improve

### Moderate-to-severe cases of AMS:

- Gradual descent with supplementary oxygen therapy
- **Dexamethasone** 8mg stat then 4mg qid &/or **acetazolamide** 125-250mg bd

### HACE:

- Immediate descent with supplementary oxygen.
- **Dexamethasone** to relieve symptoms and aid descent
- Hyperbaric therapy (e.g. Gamow Bag) to aid descent or when descent is not possible.

### HAPE:

- Rest, warm, avoid exertion.
- Descent with supplementary oxygen if available.
- Hyperbaric oxygen or CPAP
- **Nifedipine** 10mg stat or 20-30mg SR bd/tds esp if descent is not possible.
- Consider **salbutamol or salmeterol, frusemide, morphine**

## Prevention

- Gradual ascent allowing time for acclimatisation. Modest exercise on acclimatising days.
- Low sleeping altitude. Avoid sleeping tablets.
- Keep warm, well hydrated, high carbohydrate diet & avoid alcohol.
- AMS prophylaxis: **acetazolamide** (125-250mg bd) or **dexamethasone** (4mg qid.) 1d before/after ascent, if hx altitude sickness, or where rapid ascent is unavoidable.
- **Ginkgo biloba extract** may be prophylactic for AMS but the evidence is less strong.
- **Nifedipine** can be used prophylactically for individuals with a history of HAPE.

## Other high altitude conditions

- Peripheral oedema
- High altitude retinopathy
- High altitude pharyngitis and bronchitis
- Chronic mountain polycythaemia (CMP)
- Ultraviolet keratitis (snow blindness); FB sensation, irritation/pain, photophobia, tearing, blepharospasm, ↓acuity 6-12hrs post-exposure; good prognosis, full recovery <24-72hrs.