



# Altitude Illness

(A Quick  
Summary)

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<i>Altitude</i>	<i>Meters</i>	<i>Feet</i>
<i>High</i>	<i>1,500 - 3,500</i>	<i>5000 - 11,5000</i>
<i>Very High</i>	<i>3,500 - 5,500</i>	<i>11,5000 - 18,000</i>
<i>Extreme</i>	<i>above 5,500</i>	<i>above 18,000</i>

# definitions

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- Altitude Illness is a consequence of **hypobaric hypoxia**
- physiologically different than run-of-the-mill hypoxia
- Partial Pressure vs Concentration

## **hypobaric hypoxia**

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- Most of the above responses involve the early, short-term acclimatization (hours)
- Longer-term changes (days to weeks):
  - Hb and hematocrit increased concentration
  - RBC mass increases
  - capillary density increases
  - skeletal muscle mitochondrial density decreases

## **acclimatization**

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# summary of physio responses to altitude

## CEREBRAL

- ↑ Cerebral blood flow

## RESPIRATORY

- Hypoxic ventilatory response
- ↑Alveolar  $O_2$ , hypocapnia
- ↑ $O_2$  delivery
- ↑Pulmonary Vasoconstriction
- Alkalosis

## KIDNEYS

- ↑Diuresis
- ↑Epo secretion
- ↑Bicarbonate excretion
- Compensation for respiratory alkalosis

## PERIPHERAL CHEMORECEPTION (Carotid body)

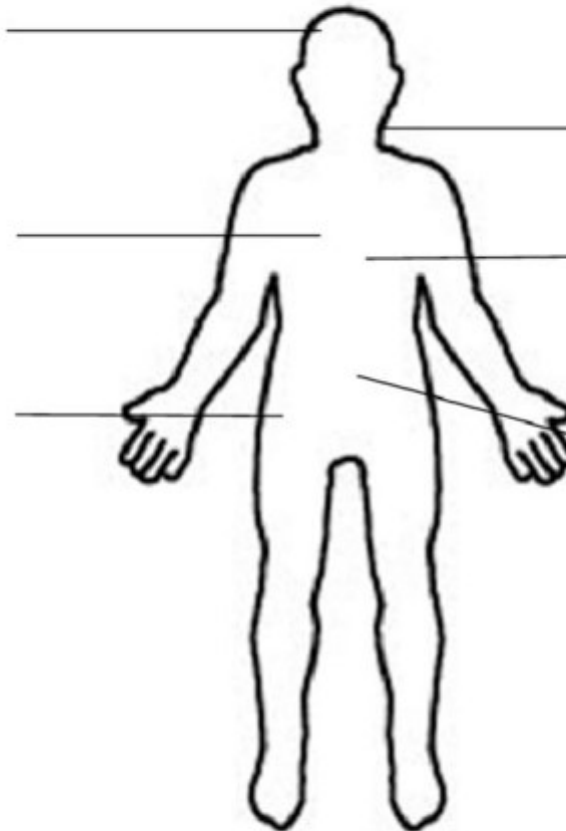
- Senses low arterial  $pO_2$  and raised  $pCO_2$

## HEART

- ↑Cardiac output, PAP
- ↑Pulse rate, velocity of blood flow
- ↓ $O_2$  demand

## BLOOD

- ↑Haematocrit, RBC number, Hb
- ↑2,3-DPG in RBC
- ↓Plasma volume



- vascular permeability coupled with increased vascular hydrostatic forces



**pathophysiology**

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- Hands, Feet, Face
- Not dangerous or contraindicative to ascent
- It is a nice window to what may be going on inside

## **edema at altitude**

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**edema at altitude**

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- >6,500 ft with a recent history of ascent
- Headache +
  - GI symptoms
  - Fatigue/weakness
  - Dizziness
  - Sleeping difficulties?

## **acute mountain sickness**

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# acute mountain sickness

## Scoring System

### Headache

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

### Gastrointestinal symptoms

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

### Fatigue and/or weakness

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

### Dizziness/light-headedness

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

### 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



- Descent

**AMS treatment**

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- Ataxia (significant problems with coordination of movements)
- Altered mental status
  - confusion, speech problems, hallucinations
- Almost certainly a progression of acute mountain sickness

## **high altitude cerebral edema (HACE)**

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- Same prevention strategies as for AMS
- Immediate evacuation/descent
  - assisted descent, may require short-roping the person
- dexamethasone **8** mg once, then **4** mg q6
- O2 if available

## **treatment of HACE**

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- Profound exertional fatigue
- Disproportionate dyspnea at rest, low SaO<sub>2</sub>, cough, tachycardia
  - initially hard to distinguish from usual difficulties of high altitude
  - hard to distinguish from other medical conditions
- Not part of the AMS → HACE spectrum

## **high altitude pulmonary edema (HAPE)**

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- Same prevention strategies as for AMS
- Immediate evacuation/descent
  - assisted descent
- Supplemental oxygen if available – realistically, 1-2 lpm
  - Sit upright – improve oxygenation
- Keep warm – minimize increased PA bloodflow caused by peripheral vasoconstriction
- Minimize exertion – let others carry their pack
  - Nifedipine SR 30 mg po BID; may consider albuterol
  - No established role for diuretics or acetazolamide

## **treatment of HAPE**

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- *acetazolamide*: carbonic anhydrase inhibitor
- initiates renal bicarb excretion, inducing a metabolic acidosis
- lowers CSF bicarb—>stimulation of respiration
- *dexamethasone*: glucocorticoid
- mechanism not agreed upon; anti-inflammatory
- alleviates the symptoms of the disease, without addressing the underlying pathophysiology
- *ibuprofen*: NSAID
- anti-inflammatory & alleviates some symptoms

## **meds for altitude illness**

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**artificial descent**

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- Illness at altitude is a “High Altitude Illness” until proven otherwise (but remember other conditions exist too)
- **Gradual ascent** is primary prevention of HAI
- **Descent** is best treatment of HAI, but not always necessary
- **Never ascend with ongoing symptoms:**

*“Continued ascent while symptoms are present or worsening is totally inappropriate, and is the main cause of death and evacuations.”*

*– AMGA Guidelines*

**pearls**

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# **Real Incidents from LBTO, ML, KP**

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At about 18:30 on 11 April while showing 6 contractors from Atlantic Pacific Services (subcontracted by Trane Industries for chiller work) their bedrooms at LBT, one of the contractors lost consciousness for about 10 seconds resulting in a fall to the carpeted floor. He quickly regained consciousness and said he started to feel "like he was an a dream" just before he lost consciousness. He appeared to have landed on his back and may have hit his head but denied any injury or pain and wanted to sit up. I asked him to do so slowly and if he felt any pain or discomfort to stop. We went to the kitchen and used a pulse oximeter which showed his SpO2 level 90 and pulse 100. He was offered oxygen which raised his SpO2 to 99 and lowered his pulse to 80. His blood pressure was about 126/76. I placed him in contact with our medical on call assistance at UA Banner. The recommendation was he go down by either ambulance or be driven by others to get checked out at a hospital for the loss of consciousness and any indication of a concussion. Two of his coworkers volunteered to drive him to base cam where he would meet his supervisor to take him to the hospital and then home. The emergency protocol along with the Banner on call guidance where very helpful in quickly determining the correct actions for what appeared to be elevation sickness. Coworkers reported the next day he would be staying home.

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**IMMEDIATE CORRECTIVE ACTION:**

Checked out contractor physically, checked pulse-ox, offered oxygen, called Banner on-call physician line, drove person down mountain and advised they get checked out. They were driven to Tucson by their company lead and checked out later at Banner Medical Center, and released with no injury.

**LONG TERM CORRECTIVE ACTIONS:**

1. Although altitude health, prevention, and emergency response is covered in the site orientation training, consider an altitude acknowledgment of risk document that each worker also signs and/or copy gets attached to all contracts via business office (TBD) for high altitude sites.
2. Revise MGIO Emergency Response Contingency Plan emergency response algorithms with current Banner on-call physician line phone numbers (note: numbers are on emergency contact cards at the telephones, but should be added to next revision to the plan which is pending).
3. Continue to pursue/consider altitude health pre-screening (this is not easy to implement).
4. Create altitude health notice and send to observatory. Convert to potty poster and site entry posting.

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**BRIEF DESCRIPTION/DETAILS  
OF ADVISORY:**

A UA/FM Fire vendor partner arrived on site at Kitt Peak and upon exiting their vehicle had a panic attack caused by a fear of heights. UA/FM Fire Call # UAFS2204180007, UA Risk Management Incident # INC22-000003003.

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**IMMEDIATE CORRECTIVE  
ACTION:**

Our staff stabilized the person and then escorted them off the mountain. The person was fine once off the mountain. Worked with the vendor to coordinate follow up support.

**LONG TERM CORRECTIVE  
ACTIONS:**

We will not have this person return to the site or any of the mountain sites.

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At around 15:00 on April 26, 2022, after working successfully all day on the chiller, a contractor at the LBTO from Budzar reported that they were not feeling well and exhibited altitude sickness symptoms. Their pulse oximeter was checked and varied between 82 and 92. It was generally 89. Blood pressure, pulse we're fine. He was pale. He had slow/slurred speech. We called the MGIO Banner on-call physician line, and they recommended he go back down the mountain; otherwise, could be a pulmonary edema risk. Chris and I escorted the Budzar tech to base camp. We measured his O2 at base camp and it was restored to 97. His color was back and speaking normally.

From talking with the contractor, we attributed his temporary sickness due to travelling, eagerness to be productive, failure to hydrate, failure to eat and physical labor. He is a relatively young guy and appears to be in good health and good physical condition. His job requires travel. He admitted he should have hydrated more.

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**IMMEDIATE CORRECTIVE ACTION:**

1. Called Banner, driven down mountain, reviewed altitude health information w/ contractor.
2. FA jump bag in wrong cabinet; returned to proper cabinet (which is labeled). Informed desk staff.
3. Chris Williams (Banner Medical Director) reminded his on-call dispatch of MGIO/Mt. Graham location (it took a minute for dispatch to find where to direct the call, despite the instructions being posted at dispatch desk).

**LONG TERM CORRECTIVE ACTIONS:**

1. Revise MGIO ERCP altitude sickness algorithm to include check pulse ox and provide optional O2 even for mild cases (currently only instructed for serious cases). There is no harm in offering oxygen, which is a standard practice, but should be captured better in the algorithm.
2. Move altitude sickness algorithm to front of MGIO ERCP situational guide, as it has been most common situation.
3. For other sites without O2, pulse oximeters, on-call physician line, or training on the topic, consider these additions for altitude health awareness/response.
4. Create altitude health notice and send to observatory. Convert to potty poster and site entry posting.


**BRIEF DESCRIPTION /  
DETAILS OF ADVISORY:**

On the morning of the second day of a multi-day program at the MLSC, a student became light-headed and fainted in the lower dorms. They were immediately attended to by school's chaperons. The student's parents were called and they collected the student about one hour later. The student was not injured.

IMMEDIATE CORRECTIVE  
ACTION:

LONG TERM CORRECTIVE  
ACTIONS:





On the evening of July 5th, Brian Waggoner (LBTO staff) walked into the LBTO kitchen around 12:30 AM and a visitor mildly struggling with oxygen saturation, low 80,s to mid 90,s. The team lead was with the visitor monitoring them. Brian refreshed the visitor and the team lead on oxygen tank usage should the need arise. Visitor was only experiencing problems when lying flat on his back, so the visitor and the team lead were resting in the recliners in the lounge area. Team lead said that he would monitor the situation and wake management if the situation worsened. Team lead relayed the following morning morning that the visitor slept all night and is feeling outstanding this morning. Staff checked in with the team members the following days to ensure they were doing well.

On July 7th, a follow up discussion occurred between Kelly Baker, Emergency Response Coordinator for MGIO, and the visitor team lead and visitor that was previously having low oxygen and shortness of breath. The visitor reported they attributed the illness to altitude and jet lag. They were feeling much better after 3 days at altitude, attributing the recovery to acclimation. Kelly confirmed they did not utilize the oxygen, nor did they report to the on-duty manager or telescope operator, who was not available at the time because the telescope was closed for weather. She reminded them if they have any other similar events to report them to a mountain staff member so they could assist in monitoring them.



<b>IMMEDIATE CORRECTIVE ACTION:</b>	<ol style="list-style-type: none"><li>1. Offered oxygen to and monitored the patient (time of incident).</li><li>2. Reminded visitors to immediately inform observatory staff of health and safety issues (7/7).</li><li>3. Reminded staff in 7/7 mountain staff meeting to always err on side of caution for any similar incident by calling Banner physician line to get their medical direction.</li></ol>
<b>LONG TERM CORRECTIVE ACTIONS:</b>	<p>Install altitude health poster and cards at entry point of buildings. Send out reminder email to all staff on altitude health.</p>



- No reliable clinical or historical tool to predict susceptibility to altitude
- some data supports measuring HRV, PF

## **Risk Assessment**

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- Any preexisting medical state that diminishes respiratory rate, lung function, oxygenation, heart rate, blood pressure will:
  - make altitude illness more likely
  - be exacerbated by altitude

## **Risk Assessment**

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**Thank you**