

# You Take My Breath Away - Losing Consciousness at 12,600 feet

## A Case Study and Review of Updates from the WMS

Sterling Adams D.O. PGY1; Robert Petro D.O. PGY3; Kathryn Vidlock M.D. CAQ-PCSM. May 2020.



### Case Report

Imagine running in a 100 mile high altitude race in the Rocky Mountains. At mile 45 you suddenly see a fellow runner unconscious at 12,600 feet. Do you stop to help him, or continue to race against the clock for the race which you've spent years training. Medical personnel were required to race up the mountain on foot to evacuate the patient who was found going in and out of consciousness. He had coarse crackles noted on lung bases bilaterally, tachypnea/dyspnea (spO2 ranging in the 70's), tachycardia and cough. Patient was safely transported off the mountain, with acute supportive treatment in the field. He was then transported by helicopter to a large metropolitan hospital in a nearby city. Patient was from New York City. He had arrived to Colorado the day before the race.

You quickly list off a few possible differential diagnoses:

1. Acute Mountain Sickness with Pulmonary Edema
2. High Altitude Cerebral Edema
3. Exercised Associated Hyponatremia
4. Hypoglycemia
5. Acute Bronchospasm
6. Pneumothorax

### Final Diagnosis

High Altitude Pulmonary Edema (HAPE).

### Objectives

1. Identify risk factors and the signs/symptoms of HAPE
2. Implement preventative strategies for HAPE
3. Execute treatments based on updated guidelines from the Wilderness Medical Society of 2019

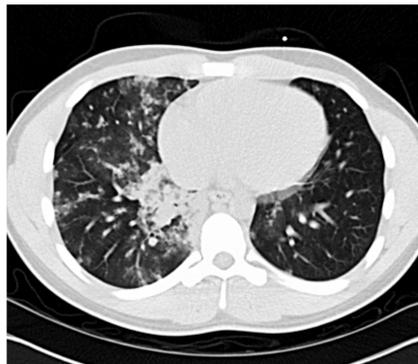
### Pathophysiology

- A. HAPE is the abnormal accumulation of plasma and RBCs in the lung (alveolar spaces) secondary to breakdown of the blood/gas barrier from hypobaric hypoxia.
- B. Risk factors for HAPE include male gender, cold climate, alcohol, high carbohydrate diet, vigorous exertion, pre-existing cardio-pulmonary disorder(s) (ie. COPD/asthma, pulmonary HTN, cardiac ASD/VSD/PFO) and faster rate of ascents (especially > 500m (1,600ft) per day (1,3).

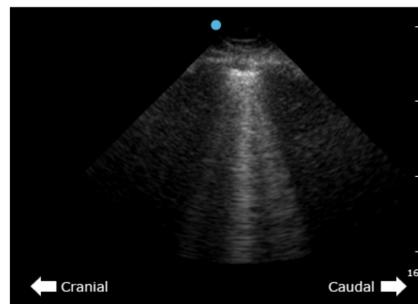
### Imaging



Plain chest radiography is useful in HAPE and reveals characteristic patchy alveolar infiltrates, predominantly in the right central hemithorax, which become more confluent and bilateral as the illness progresses. In a few cases, HAPE may not take this classic radiographic appearance.



With HAPE, chest CT often reveals patchy alveolar infiltrates, predominantly in the right central hemithorax, which become more confluent and bilateral as the illness progresses.



Pleural ultrasound image depicting B lines ("comet tail artifact"), which are seen in acute pulmonary edema and acute respiratory distress syndrome. The presence of B lines would provide an alternate explanation for increased density seen on the chest radiograph, other than pleural fluid.

### Clinical Signs and Symptoms

- A. Symptoms: Fatigue, fevers/chills, racing heart, dry to productive cough, SOB, DOE (especially walking uphill), dizziness/lightheaded, nausea and weakness (1,2).
- B. Signs: Low grade fever, tachycardia, tachypnea, inspiratory crackles, low SpO2 (at least 10 points lower than expected for the altitude, could be as low as 40-50%, but the patient often looks better than vitals/exam/imaging suggest) (1,2,3).
- C. Labs: Leukocytosis, elevated BNP and troponin (from dilated ventricles and right heart strain, respectively) and respiratory alkalosis on ABG.
- D. Imaging: POCUS (Point of Care US) - "Ultrasound Lung Comets" (ULCs), aka "B-lines" or "comet tails" showing abnormal pulmonary fluid levels. CXR reveals patchy alveolar infiltrates (predominately in right central lobe initially and then bilaterally). CT chest shows patchy lobular ground-glass opacities/consolidations.

### Prevention

- A. Gradual Ascent (defined as a slow increase in sleeping elevation, ie. 500m or 1600ft per day) Grade: 1B recommendation.
- B. Staged Ascent/Pre-acclimatization- staying at moderate altitude (2200m or 7200 ft) for 7 days before climbing. Grade 1C.
- C. Nifedipine (DHP-CCB; relaxes smooth muscle, promotes vasodilation) 30 mg ER po BID started 1 day before ascent and continued for 4-7 days once at highest altitude, Grade 1B.
- D. Acetazolamide (Carbonic Anhydrase inhibitor; hastens acclimatization) for RE-entry HAPE only; 125-250 mg po BID started 1 day before ascent and continued for 2-3 days after reach highest altitude. Grade 1C.
- E. Tadalafil (Phosphodiesterase inhibitor, increases cGMP and thus Nitric Oxide to promote pulmonary vasodilation) 10 mg po BID, started on day of ascent, continued for 3-5 days at max altitude. Grade 1C.
- F. Dexamethasone (anti-inflammatory and immunosuppressant; alleviates vasogenic cerebral edema and improves endothelial integrity) 8 g po BID day of ascent, continued 2-3 days at max altitude (if not candidates for Nifedipine or Tadalafil). Grade 1C.

### Treatment

- A. Descend to lower altitude! Grade 1A.
- B. Continuous Supplemental Oxygen via nasal cannula to keep SpO2 > 90% (suitable alternative to descent). Grade 1A.
- C. CPAP if not responding to supplemental O2. Grade 2C.
- D. Portable Hyperbaric Oxygen Chamber (if descending or supplemental O2 not available). Grade 1C.
- E. Nifedipine ER 30 mg po BID until descent completed, normal SpO2 and asymptomatic. Grade 1C.
- F. Tadalafil 10 mg po BID until descent completed, normal SpO2 and asymptomatic. Grade 2C.
- G. Do NOT use: Acetazolamide (Grade 1C; not enough studies, can cause hypotension), beta agonists (albuterol, salmeterol; lack of data), diuretics (ie. Lasix; hypotension, Grade 1C), Dexamethasone (insufficient evidence).

### References

1. "High Altitude Pulmonary Edema." Gallagher, Scott A. MD; Hackett, Peter MD. UptoDate. August 28, 2018. Literature review current through Feb 2020.
2. "High Altitude Pulmonary Edema." Goyal, Rohit MD; Mosenifar, Zab MD, FACP, FCCP. Medscape. September 28, 2016
3. "Wilderness Medicine Society Clinical Practice Guidelines for the Prevention and Treatment of Acute Altitude Illness: 2019 Update." Luks, Andrew M. MD, et al. Wilderness Medical Society Clinical Practice Guidelines. Wilderness and Environmental Medicine April, 2019; 30(4S): S3-S18