CLINICAL VIGNETTE

High Altitude Pulmonary Edema

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Case

An 87-year-old male with well-controlled type 2 diabetes mellitus and myelodysplastic syndrome presented for evaluation of hypoxia at altitude. He lives in Los Angeles, but visited family in Aspen, Colorado. He traveled via direct flight from Los Angeles to Aspen, 2438 meters above sea level and did not experience any respiratory issues on the flight. Approximately 2 days after his arrival in Aspen, he began to feel exhausted, weak, with shortness of breath both at rest and with exertion. On home pulse oximeter he reported oxygen level of 62% on room air. His daughter acquired an oxygen tank for him, and he used it at home with improvement of his oxygen saturations to 90%. When he removed the oxygen to ambulate, his saturation dropped to 50%. They did not recall the rate of supplemental oxygen he was using. He was assessed by a naturopath, who provided a vitamin infusion, which the patient did not feel improved his symptoms. On day 6 of his stay in Aspen, his symptoms spontaneously improved. He was scheduled to fly home that day, and his daughter rented a portable oxygen tank, however, his oxygen saturations remained in the 90's on room air. He denied any headache, confusion, nausea, leg swelling, or fever while in Aspen. He had taken plane flights to other locations in the past without incident, but does not recall traveling to any other locations at high altitude. Since his return to Los Angeles, his oxygen saturations have remained 98-99% on room air. He exercises regularly and denies any dyspnea with exertion. He had plans to return to Aspen again and wanted to schedule a telemedicine evaluation to prevent a recurrence of shortness of breath and hypoxia.

Limited physical exam via telemedicine was significant for oxygen saturation of 98% on room air and normal respiratory effort. Recent vitals obtained one week prior were normal.

Four months after he returned from Aspen, he had a mechanical fall with a left femur fracture. He underwent open reduction and internal fixation of the left intertrochanteric fracture the following day and a routine pre-operative chest x-ray immediately prior to surgery demonstrated prominence of the pulmonary vasculature. A follow up chest x-ray the day after surgery was normal. A transthoracic echocardiogram (TTE) done a year prior to his trip demonstrated normal ejection fraction, severe left atrial enlargement, thickened mitral valve leaflets with mild to moderate regurgitation, mild tricuspid regurgitation, tricuspid regurgitant jet velocity (TRV) of 3.4 m/s, and normal right ventricular size and function.

A clinical diagnosis of high altitude pulmonary edema (HAPE) was made based on the onset of symptoms 2 days after arrival, profound hypoxia, TTE suggestive of possible pulmonary hypertension, rapid improvement with supplemental oxygen, lack of neurologic symptoms, and spontaneous resolution of hypoxia 3 days after onset. Given the high recurrence rate of HAPE, he was given nifedipine to start taking 24 hours prior to departure for Aspen and to continue taking it for 5 days after arrival. He returned to Aspen on this regimen and did not have recurrence of dyspnea or hypoxia.

Discussion

With travel to high altitude destinations defined as higher than 2000m above sea level, there is risk of developing High Altitude Illness, which encompasses Acute Mountain Sickness (AMS), High Altitude Cerebral Edema (HACE) and High Altitude Pulmonary Edema (HAPE). Although rare, occurring in 0.1-4% of travelers, HAPE can cause profound hypoxia and is the leading cause of death from high altitude illness.[1] Untreated, it can lead to death in up to 50% of cases.[2]

In HAPE, an overactive sympathetic response to hypoxia and defective nitric oxide synthesis contribute to excessive hypoxic pulmonary vasoconstriction and pulmonary hypertension with increased capillary pressure and extravasation of fluid into the interstitial and alveolar spaces.[3] Risk factors for HAPE include rapid ascent, male gender, sleep medication use, excessive salt ingestion, ambient cold temperature, and strenuous physical exertion.[1,2] Pre-existing conditions that increase risk include pulmonary hypertension and patent foramen ovale.[2] The rate of recurrence for mountaineers with a prior incidence of HAPE is >60%.[4] There may also be a genetic component of HAPE, as it has been observed in multiple family members across three generations in one family.[4]

Symptoms occur 2-4 days after ascent. Dyspnea with exertion, fatigue, and a dry cough are common and can progress to dyspnea at rest and a productive cough with blood-tinged sputum.[5] The patient will appear disproportionately well compared to their SpO2 which is typically between 40-70%.[2] If symptoms begin after 4 days at altitude, other causes of dyspnea should be considered.[6]

Physical exam in HAPE patients may demonstrate tachycardia, tachypnea, a prominent P2 on cardiac auscultation, right ventri-

cular heave, and rales, initially in the right mid-lung field, but can be diffuse as pulmonary edema worsens. In some patients, rales can be precipitated after brief exertion.[7] Chest radiography demonstrates patchy infiltrates without cardiomegaly. Right heart strain can be seen on electrocardiogram. Arterial blood gas demonstrates severe respiratory alkalosis with severe hypoxemia.[7]

Supplemental oxygen is a mainstay of treatment and should be supplied with the goal of keeping oxygen saturation >90%.[6,8] The definitive treatment for HAPE is descent of at least 1000 feet, though further descent may be required to alleviate symptoms. Exertion should also be avoided, as it can worsen HAPE.[8] In a wilderness setting, in addition to supplemental oxygen, nifedipine and a portable positive airway pressure device can be used as temporizing measures, but should not be used in the place of descent if descent is possible.[6,8] In locations with medical facilities, inpatient stay of 2-3 days or outpatient oxygen therapy without descent is sometimes employed if the patient chooses to remain at altitude.[6] Hyperbaric oxygen may be effective, but data is limited and it is more costly and less convenient than supplemental oxygen.[6]

Due to the high likelihood of recurrence, prophylactic measures should be taken for patients with a history of HAPE who intend to travel to high-altitude destinations. HAPE prevention measures include gradual ascent of no more than 500m per day with a rest day every 3-4 days.[3] Due to scheduled commitments, our patient was not amenable to gradual ascent. Nifedipine reduces HAPE incidence promoting pulmonary vasodilation, reducing pulmonary arterial pressure, inhibiting inflammation and blood vessel leakage, and increasing endothelial function.[3] In one study of subjects with prior episodes of HAPE, nifedipine prevented HAPE recurrence with only 1 out of 10 individuals developing HAPE compared to placebo, where 7 out of 11 individuals developed HAPE.[9] Phosphodiesterase inhibitors may be used to decrease pulmonary artery and capillary pressures if nifedipine is not available.[2]

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