High-Altitude Pulmonary Edema Among Visitors to Summit County, Colorado

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Twenty-nine cases of high-altitude pulmonary edema (HAPE) affecting visitors to Summit County, Colorado, were analyzed. The mean age of the group was 37.8 years, and all the patients were male. These results differ from previous studies and suggest that there are two varieties of HAPE. The first type (type 1, or nonresident-ascent HAPE) affects visitors to altitudes above 8,000 ft (2,439 m). At altitudes up to 11,000 ft (3,354 m), it is a disease that affects primarily adult men. The second variety (type 2, or resident-reascent HAPE) affects residents of high altitudes when they descend to an elevation below 8,000 ft (2,430 m) and then return to high altitude. This type of HAPE affects male and female residents almost equally and is a disease of childhood and adolescence.

High-altitude pulmonary edema (HAPE) is a noncardiogenic form of pulmonary edema that affects patients at elevations greater than 8,000 ft (2,439 m). The problem occurs among people who live at lower elevations when they ascend to high altitudes for periods of two to three days or longer. It also affects people who live at elevations above 8,000 ft, descend to lower altitudes for as short a time as 24 hours, and then reascend to high altitudes.

Most studies of HAPE have focused on soldiers or mountain climbers at altitudes above 15,000 ft (4,573 m) and on residents of mountain communities between 10,000 and 12,500 ft (3,049 and 3,811 m). To date, no attempt has been made to compare residents of and visitors to high altitudes who develop the disease. It seems to be generally assumed that residents and nonresidents of high altitudes are similarly affected by HAPE.

This paper presents an analysis of 29 patients who resided below 3,000 ft (915 m) and developed HAPE after ascending to Summit County, Colorado, base elevation 9,000 to 11,000 ft (2,743 to 3,354 m). The data challenge the assumption that HAPE affects all individuals equally regardless of the elevation at which they reside and suggest that there is more than one variety of the disease.

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Methods

HAPE Patients

The records of all patients with HAPE who presented to the Breckenridge Medical Center (18 cases) between December 1, 1981, and April 16, 1982, and all of those who presented to the Summit Medical Center Emergency Room (11 cases) between March 7, 1981, and April 4, 1982, were collected. They were analyzed with respect to age, sex, and altitude of residence.

In all cases the diagnosis was assumed from a history describing arrival at high altitude within 72 hours of examination, the description of a cough that developed after arrival and worsened over time, and the finding of rales and cough with deep inspiration on physical examination. In all cases the diagnosis was confirmed radiologically upon finding the characteristic fluffy, usually asymmetrical infiltrate with a normal cardiac silhouette on posterior-anterior and lateral chest films.

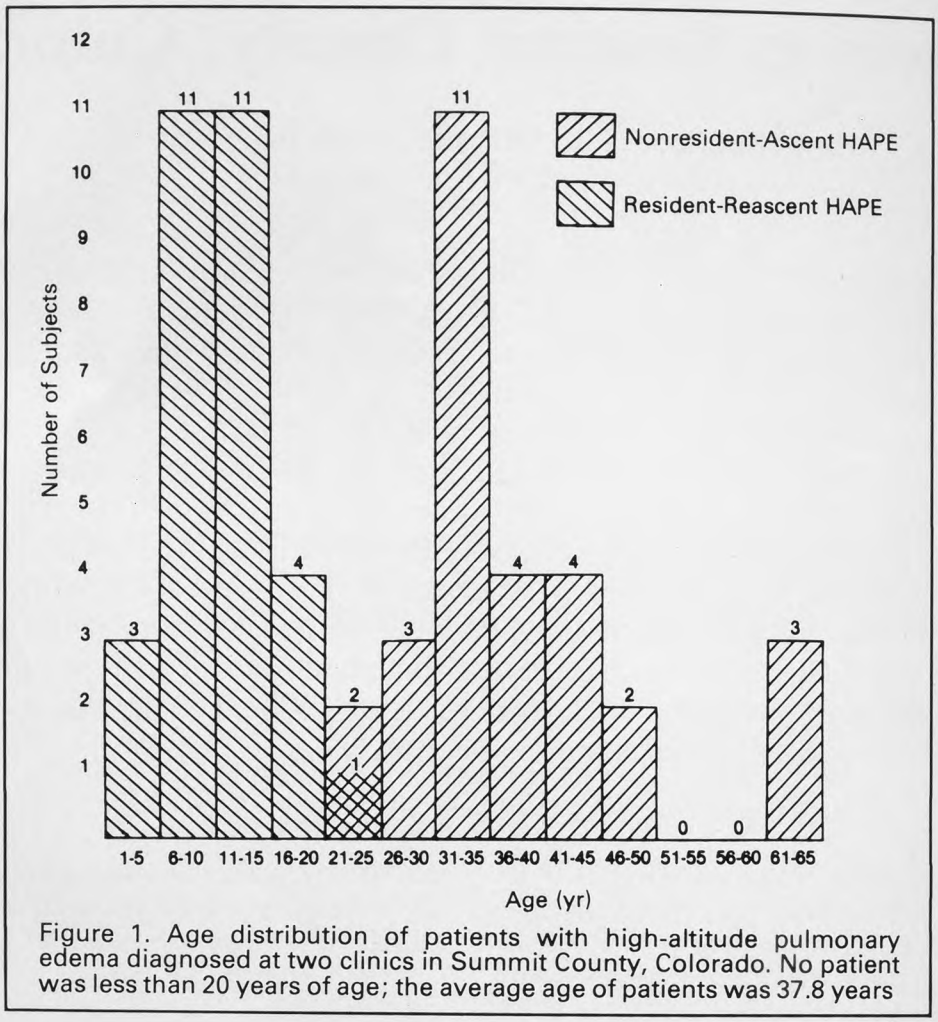

Figure 1. Age distribution of patients with high-altitude pulmonary edema diagnosed at two clinics in Summit County, Colorado. No patient was less than 20 years of age; the average age of patients was 37.8 years

The County and the Clinics

Summit County, Colorado, is a mountain resort area that ranges in altitude from 9,000 to 14,000 ft (2,743 to 4,268 m). Most visitors come to ski and spend the majority of their time between 9,000 and 11,000 ft (2,743 and 3,354 m). The Summit Medical Center serves most of the visitors to the north part of the county, and the Breckenridge Medical Center serves most who visit the south end of the county. Both medical centers are primary care clinics with emergency facilities. Children and adults are treated at each. There are no pediatric clinics in the county.

Results

Twenty-nine patients were diagnosed as having HAPE by the criteria described above. The mean age of this group was 37.8 years with a standard deviation of 10.8 years. The range of ages was 22 to 63 years. All patients were male, and all lived at elevations below 3,000 ft (915 m). All 29 patients were sent to an elevation below 8,000 ft to recover. Most went to Denver, Colorado (5,000 ft, 1,524 m), and were lost to follow-up. Figure 1 illustrates the age distribution of this group.

Discussion

As noted earlier, previous studies of HAPE did not segregate patients according to their altitudes of residence. All of the patients in the present study were visitors who resided below 3,000 ft (915 m). Their mean age of 37.8 years and the absence of female patients suggest that HAPE among visitors to high altitudes is primarily an adult disease that affects only men. These findings are consistent with those of Hultgren et al,[1] who

previously reported 13 cases of HAPE in mountain climbers at 10,000 to 17,000 ft (3,049 to 5,183 m), all of whom were male with a mean age of 28.6 years. The 9.2-year difference in mean ages raises the possibility that the age distribution shifts downward at altitudes higher than the base elevations of Summit County. The study results are also consistent with those of Hultgren,[2] who reported 33 cases of HAPE in climbers that developed between 8,600 and 24,000 ft (2,622 and 7,317 m). The mean age of this group was 30 years with a range of 20 to 43 years.

Hackett et al[3] have reported the development of HAPE in a 56-year-old female resident of a low altitude who visited a 9,000-ft (2,750 m) elevation. She was found to have a congenital atresia of her right pulmonary artery, suggesting that this pulmonary dysfunction and possibly others might render female visitors to higher elevations susceptible to HAPE. Furthermore, Steele,[4] Foster,[5] Pines,[6] and Hackett et al[7] have reported female mountain climbers developing HAPE at altitudes ranging from 15,000 to 19,000 ft (4,500 to 5,800 m). These cases suggest that at higher altitudes female visitors lose the protection they have between 8,000 and 11,000 ft (2,439 and 3,354 m).

Previous studies of HAPE among residents of high altitudes unfortunately have not excluded patients who were visiting from lower elevations. A clear trend, however, emerges from these reports. Scoggin et al[8] studied 32 cases of HAPE that presented to the Leadville, Colo, hospital, elevation 10,171 ft (3,100 m). Of these, 30 were residents of Leadville and two were visitors. The mean age was 11.9 years with a range of 3 to 41 years. Eighteen (56 percent) of the patients were male and 14 (44 percent) were female.

Marticorena and Hultgren[9] studied the therapeutic effect of bedrest on 36 patients with HAPE at 12,300 feet (3,750 m) in Peru, "most" of whom were residents. The mean age was 9.8 years, the age range 3 to 19 years, and the male-female sex ratio was 21 (58 percent) male patients to 15 (42 percent) female patients. Hultgren et al[1] also reported 15 patients with HAPE at 12,225 ft (3,737 m) in Peru. Fourteen of these were residents whose mean age was 15.5 years.

In conclusion, it appears that HAPE affects two groups with quite different epidemiologic characteristics. The first group consists of residents of lower altitudes who develop HAPE when they ascend to elevations above 8,000 ft (2,439 m). Those at risk are men with a mean age of 37.8 years and an age range of 22 to 63 years. For heuristic purposes it might be helpful to refer to this group's HAPE as type 1, or "nonresident-ascent," HAPE. It is possible that the mean age for type 1 decreases and that women become more susceptible at very high altitudes.

The second group (type 2, or "resident-reascent" HAPE) consists of residents of elevations above 8,000 feet (2,439 m) who develop HAPE after returning to high altitude following a visit to lower elevations. The mean age of this group is 9.8 to 15.5 years, and boys and girls are affected almost equally. Type 2 has not been reported at altitudes lower than 8,600 feet (2,640 m).

These observations and the suggested classification of HAPE raise some intriguing questions. First, are women and children who live at low altitudes resistant to HAPE when they visit elevations up to 15,000 ft (4,373 m)? If so, is the reason hormonal or behavioral? Conversely, why do women apparently lose their protection if they ascend higher than 15,000 ft (4,373 m) or are lacking one pulmonary artery? Second, are adults of both sexes who reside at high altitudes protected from type 2 HAPE? If so, why, and why are children not protected? Is there an elevation above which this protection is lost?

It is hoped that attention to differences between these two groups of HAPE patients will shed some light on the pathophysiology of this fascinating disease.

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