Meeting Our Enemies in the Mountains

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When we deploy into the mountains, we encounter our first two basic enemies — altitude and cold. Depending on their severity, these alone can wear us down and perhaps kill us. From the beginning, we must be aware of the burdens they place on our bodies so that we can adapt, habituate, and continue with our mission. With gaining altitude the oxygen pressure diminishes, stealing our physical energy. With cold, the heat energy and moisture we need to live are constantly being sucked from our bodies.

We should remember that Hannibal lost 50 percent of his soldiers and fighting elephants to cold and altitude as he crossed the Alps to attack the Roman forces.

Altitude as the Enemy

High-altitude illness, which usually occurs at altitudes above 1,500 meters (4,921 feet), is caused primarily by hypoxia (low oxygen) but is compounded by cold and exposure. It presents as one of three forms: acute mountain sickness (AMS), high-altitude pulmonary edema (HAPE), and high-altitude cerebral edema (HACE).

Acute Mountain Sickness

AMS is the most frequent type of altitude sickness encountered. Symptoms often manifest themselves six to 10 hours after reaching altitude and generally subside in one to two days, but they occasionally develop into the more serious conditions.

The occurrence of AMS depends primarily on the rate of ascent, the altitude attained, and the individual person's susceptibility. In the civilian environment, AMS affects 15-30 percent of Colorado resort skiers, 50 percent of climbers on Mount McKinley, 70 percent of climbers on Mount Rainier, and 25-50 percent of climbers who trek to the base of Mount Everest.

Our maximal oxygen uptake begins to decrease significantly above an altitude of 1,600 meters (5,249 feet). The altitude limitations in total body oxygen transport begin to appear above

Students cross-country ski during the bivouac portion of the Cold Weather Leaders Course 9-14 February 2017. The course is taught at the Northern Warfare Training Center in Black Rapids, AK.

Photo by David Vergun

2,000 meters (6,562 feet). For every 1,000 meters (3,281 feet) above that, the maximum oxygen consumable by our body drops by approximately 8-11 percent.

AMS is characterized by a spectrum of symptoms. Headache is the main symptom. Nausea, vomiting, dyspnea (shortness of breath), and insomnia are common symptoms. The warfighter at altitude can also experience impaired cognition and balance. The onset of symptoms typically occurs within hours to three days after arrival at altitude. These symptoms tend to resolve after several days but can persist for up to two weeks. They also can be the harbinger of the fatal conditions: HACE and HAPE.

At intermediate altitudes, 1,500-3,000 meters (4,921-9,843 feet), up to 25 percent of unacclimatized warfighters may experience AMS. The treatment of AMS consists of stopping the ascent and allowing acclimatization at the same altitude.

HAPE

Up to 15 percent of warfighters in altitudes over 2,500 meters (8,202 feet) will develop HAPE, depending on the warfighter's age, sex, and rate of ascent. HAPE is a form of noncardiogenic pulmonary edema and is associated with marked pulmonary hypertension. It is more common in persons under 20 years of age.

HAPE usually occurs at night one to three days after an ascent is begun. It is a medical emergency and is the most common cause of death from high altitude.

At an elevation of 3,900 meters (12,796 feet), the unacclimatized warfighter consumes more oxygen with the increased work of breathing than is gained by that additional ventilation.

There is no definitive treatment for HAPE other than descent. If HAPE is diagnosed early and treated appropriately, patients usually recover completely. The death rate for untreated patients can be as high as 44 percent. In one study, 66 percent of HAPE patients had a recurrence of HAPE on subsequent returns to altitude.

Altitude Effects

Altitude	Approximate Elevation	Effects of Acute Altitude Exposure
Low	Sea level — 1,200 meters (4,000 feet)	None
Moderate	1,200-2,400 meters (4,000-7,870 feet)	Mild altitude illness and decreased performance may occur
High	2,400-4000 meters (7,870-13,125 feet)	Altitude illness and performance decrements are more common and greater
Very High	4,000-5,500 meters (13,125-18,000 feet)	Altitude illness and decreased performance is the rule
Extreme	5,500 meters (18,000 feet) and higher	With acclimatization, humans can function for short periods of time

Acute Mountain Sickness (AMS)

- AMS is caused by ascending too rapidly to high altitude. Symptoms may include headache, nausea, vomiting, fatigue, irritability, insomnia, or dizziness.
- Symptoms generally appear four to 24 hours after ascent to high altitude, reaches peak severity in 24 to 48 hours, and subsides over three to seven days at the same altitude.
- To treat AMS, stop further ascent and descend. Continuing an ascent puts individuals at risk for more severe high-altitude illnesses.
- Once symptoms have gone away, troops can resume gradual ascent. Those who continue to show signs of AMS must be observed for development of high-altitude pulmonary edema or high-altitude cerebral edema, both of which could be fatal.
- All troops are susceptible to high-altitude illness. A staged or graded ascent that allows time for Soldiers to acclimate to altitude can help prevent AMS.

High-Altitude Pulmonary Edema (HAPE)

- HAPE occurs when individuals ascend too rapidly to high altitude or ascent too rapidly from a high to a higher altitude.
- HAPE normally begins within 24-72 hours after rapid ascent to 2,438 meters (8,000 feet) or more. Symptoms include coughing, noisy breathing, wheezing, gurgling in the airway, difficulty breathing when at rest, and deteriorated behavioral status (such as confusion or vivid hallucinations).
- Troops experiencing AMS who are not treated and continue to ascend to higher altitudes are at significant risk for HAPE. If untreated, HAPE can be fatal within six to 12 hours.
- Preventive measures include to drink plenty of water, eat regular meals high in carbohydrates, staged and graded ascent, proper acclimatization, sleeping at the lowest altitude possible, avoiding cold exposure, and avoiding strenuous exertion until acclimated.
- Immediate descent in the best treatment for HAPE.

High-Altitude Cerebral Edema (HACE)

- HACE is the most severe illness associated with high altitudes.
- In general, HACE occurs later than AMS or HAPE. If untreated, HACE can progress to coma in 12 hours and death within 24 hours. In some instances, death has occurred in less than 12 hours. The average onset time of symptoms following ascent is five days with a range of one to 13 days.
- Symptoms of HACE often resemble AMS (severe headache, nausea, vomiting, and extreme lethargy). However, a more visible indicator of the onset of HACE is a swaying upper body, especially when walking. Early behavioral deterioration may include confusion, disorientation, and inability to speak coherently.
- Preventive measures for HACE are the same as for AMS and HAPE. Troops with symptoms of HACE should be evacuated immediately.

ATP 3-90.97, *Mountain Warfare and Cold Weather Operations*

HACE

HACE constitutes the progression of severe AMS or HAPE to then include involvement of the brain, causing encephalopathy. While mild AMS may progress to HACE with unconsciousness within 12 hours, HACE usually requires one to three days to develop. The symptoms of HACE, like HAPE, are worse at night.

Sequelae from HACE can last weeks, but eventually patients usually recover completely. The overall death rate in untreated patients is 13 percent, but it rises to 60 percent if coma occurs.

Ascending slowly is the best way to avoid altitude sickness. Avoiding strenuous activity in the first 24 hours at high altitude reduces the symptoms of AMS. As alcohol tends to cause dehydration, which exacerbates AMS, avoiding alcohol consumption in the first 24 hours at a higher altitude is optimal.

Photo by SPC Gage Hull

A Soldier assigned to 10th Special Forces Group (Airborne) rappels while conducting mountain warfare training near Corvara, Italy, on 17 September 2018.

Sleep

In addition to the effects of fatigue, warfighters going to altitude often have unrestful sleep because of diminished stage-3/4 and rapid eye-movement sleep. In addition to a diminished quality of sleep, many individuals exhibit periodic breathing at intermediate altitudes, and all do at altitudes over 6,300 meters. Periodic breathing, the waxing and waning respirations with periods of apnea, interferes with the already suboptimal arterial oxygenation in the high-altitude environment to produce cycles of even more profound arterial oxygen deficiency. Periodic breathing occurs during 24 percent of all sleep at 2,440 meters (8,006 feet). Lastly, sleep at altitude is characterized by frequent wakening. All of these produce an unsatisfying sleep and contribute to daytime fatigue.

As with the other symptoms of AMS at intermediate altitudes, sleep can be expected to return to normal with acclimatization. Sleep at very high altitudes will remain persistently disturbed. After the initial 24 hours, dehydration and sleep disturbances will become more prominent.

Although full acclimatization to altitude takes four to six weeks, many of the physiological adaptations occur in the first two weeks and the more severe disturbances should have settled.

Up to 1,500 meters (4,921 feet), altitude has little effect on the body. Above this level, studies on men show the cardiovascular, respiratory, and metabolic systems are affected.

It takes approximately two weeks to adapt to the changes associated with the low pressure conditions at 2,268 meters (7,500 feet). Every 610-meter (2,000-feet) increase requires an additional week of acclimatization to altitude. But no matter how long an individual lives at altitude, they never fully compensate for the lack of oxygen and never regain the level of aerobic power or endurance performance they had at sea level.

The treatment of AMS consists of stopping the ascent and allowing acclimatization at the same altitude. The only reliable treatment and in many cases the only option available is to descend. Attempts to treat or stabilize the patient at altitude are dangerous unless highly controlled and with good medical facilities.

Prevention

Being physically fit does not affect the incidence of AMS, but physical fitness does improve exercise tolerance. It also may help to prevent HACE and HAPE by improving the blood's response to exercise. Warfighters going to a high altitude should keep well hydrated by forcing fluids and avoiding alcohol and drugs.

Altitude acclimatization is necessary for warfighters who move rapidly from lower altitudes to intermediate altitudes. Stopping at an intermediate altitude overnight can reduce or eliminate the occurrence of AMS.

Another option is the staged ascent. This involves traveling to an intermediate altitude and camping for several nights before continuing the ascent to the target altitude. For example, if a warfighter has an objective at 3,000-4,300 meters (10,000 -14,000 feet), they should acclimatize at 1,800-2,500 meters (6,000-8,000 feet) two to four days beforehand.

With as few as 12-16 days of acclimatization, submaximal exercise endurance increases 40-60 percent compared with exercise endurance on arrival at altitude. Be sure to enforce the drinking of enough fluids, avoidance of alcohol, and eating regularly. The foods should be relatively high in carbohydrates.

The physiological stress from hypoxia, cold, wind, and dehydration increases with altitude, and our physiological performance will always drop. The rate of ascent, altitude attained, amount of physical activity at high altitude, as well as individual susceptibility, are contributing factors to the onset and severity of high-altitude illness.

The wary use of acclimatization can be a key to victory in the mountains. In October 1962, the Chinese invaded India to seize strategic mountain territory. They utilized 80,000 troops they had prepositioned for up to one year in Nepal and their portion of the Himalayas. The Indians responded vigorously with 10,000-20,000 troops to protect their territory, but many of their troops were unacclimatized, moving slowly and hampered by altitude sickness. The war played out in the harsh terrain of the Karakoram Mountains, some 4,270 meters (14,000 feet) above sea level. Many of the casualties were caused by the harsh conditions found at that altitude rather than by enemy fire. Hundreds of the injured on both sides died of exposure before their comrades could get medical attention for them. The Chinese were able to hold the strategic territory they desired and then called for a cease fire which India accepted.

Cold as the Enemy

The thing to understand is that environmental cold can reach levels that our bodies cannot by itself adapt to — that is to stand on its own and survive. What we do is habituate, selecting behaviors that support and sustain our body's temperature and other needs so that life continues and we can succeed in our tasks. To do this we need food and water, shelter, clean dry clothes, adequate rest, and we need to understand how to act in the environment to safely sustain ourselves.

The challenge in the cold is to understand and reduce or prevent the body's loss of moisture and heat to the environment. Cold air is dry air which dehydrates the body. The steaming breath we see is the visible evidence of the water and warmth leaving our bodies. The cold environment is constantly leaching the energy and moisture from our bodies that we need to live.

The caloric requirements of warfighters are 25-50 percent higher during cold-weather operations than in warm or hot weather. Warfighters expend more energy during cold weather due to wearing heavy cold-weather gear and the increased effort required for working or walking in snow or mud or for preparing positions in frozen ground. The body uses more calories keeping itself warm when the weather is cold, and this also contributes to the increased energy requirement to accomplish our work.

Observations reveal that warfighters reduce their fluid intake during all field operations but especially during cold weather. Because field rations contain less water than garrison food, warfighters take in less water with the food they eat. Usually only half to two-thirds of the water used by the body is replaced by drinking between meals. Most people do not feel thirsty until they are already significantly dehydrated, and thirst is less noticeable in cold than in hot weather. When weather is particularly cold and/or rainy, many warfighters purposely allow themselves to become dehydrated to avoid having to leave comfortable shelter to urinate outdoors.

Stressful cold environments can require many and continuous adjustments in planning and operating. The demands for water, food, shelter, and warmth to sustain the warfighter's body are ongoing, changeable, and cannot be denied. Although lessons learned are invaluable guidance and orientation, no cookie-cutter approach in planning by itself will guarantee success over time. As human beings warfighters are adaptable, strong, and can absorb a lot of punishment, but as the environmental stress continues week after week after week all weaknesses are revealed and paid for. No fixed man-made schedule can simply be imposed on operations in a severe environment without involving potentially lethal cost. Victory always requires payment. It is up to us to be aware of the risks and costs and hopefully find the ways to pay the minimum.

Summary

Whenever we move over the general range of 4,900 feet in altitude, we must always consider that the environment is always reducing air pressure and diminishing our energy supply as we climb. As the temperature drops below 40 degrees Fahrenheit, the cold begins to suck the energy out of our bodies and take with it the moisture we need to stay alive. These two separate forces begin to undermine our physical abilities to function and survive no matter how fit we may be to begin with.

Under these conditions, our bodies then become yet just another piece of equipment that we constantly have to monitor so that we can depend on it being capable of what we need it to do when we need it.

With awareness of how our bodies respond to the environment and what they need along with proper planning and execution, we can move on to our objectives and take control, rather than staggering on to the objective and then collapsing into an exhausted, vulnerable state.

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