

# Environment medicine

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# 高山症

- 高山地區空氣稀薄、氣壓低、溫差大、風大、乾燥、輻射強。
- 每上升1000公尺，大氣壓力下降10%，溫度下降6.5度C，空氣膨脹10%。
- 玉山頂4000公尺，大氣壓力下降40%，溫度下降26度，空氣膨脹40%。
- 玉山頂, the atmosphere  $O_2$  with 60 mmHg, and  $PaO_2$  with 50 mmHg,  $O_2$  saturation with 60-70%, temperature in  $-10^{\circ}C$ - $10^{\circ}C$ .
- When over 2483 meters, the  $PaO_2$  may decrease to some degree of hypoxia enough to stimulate the chemo-receptors of carotid artery to increase ventilation and sympathetic tone for compensation of hypoxia.
- And it is the point of height which will start to induce acute altitude sickness.

# 高山症(altitude illness)症狀

- 急性高山症(acute mountain sickness)：頭痛、頭暈、煩躁不安，失眠多夢、胸悶心慌、全身無力、噁心、嘔吐、口乾、心跳加快等。大多發生於進入高原後數小時內。
- 肺水腫(high altitude pulmonary edema) HAPE：嚴重呼吸困難，持續性咳嗽，喀粉紅色泡沫痰沫，面色蒼白或灰土色，皮膚濕冷，心跳加快。大多發生於進入高原後1-3天。
- 腦水腫(high altitude cerebral edema) HACE：進行性劇烈頭痛，嘔吐頻繁，表情淡漠，反應遲頓，視力障礙，嗜睡以致昏迷，大小便失禁，大多發生於進入高原後1-3天內。

# High altitude illness

- "High-altitude illness" is used to describe the cerebral and pulmonary syndromes that can develop in unacclimatized persons shortly after ascent to high altitude.
- Acute mountain sickness and high-altitude cerebral edema refer to the cerebral abnormalities, and high-altitude pulmonary edema to the pulmonary abnormalities .
- Whether high-altitude illness occurs is determined by the rate of ascent, the altitude reached, the altitude at which an affected person sleeps, and individual physiology (genetic).
- In 1991 in Summit County, Colorado, the incidence of acute mountain sickness was 22 percent at altitudes of 1850 to 2750 m and 42 percent at altitudes of 3000 m.

# High altitude illness

- Risk factors include a history of high-altitude illness, residence at an altitude below 900 m, exertion, and certain preexisting cardiopulmonary conditions.
- Physical fitness is not protective against high-altitude illness.
- Common conditions such as age, hypertension, coronary artery disease, mild chronic obstructive pulmonary disease, diabetes, and pregnancy do not appear to affect the susceptibility to high-altitude illness.
- Diverse interactions between genetic factors and the environment most likely explain individual susceptibility or relative resistance to these hypoxia-induced illnesses.

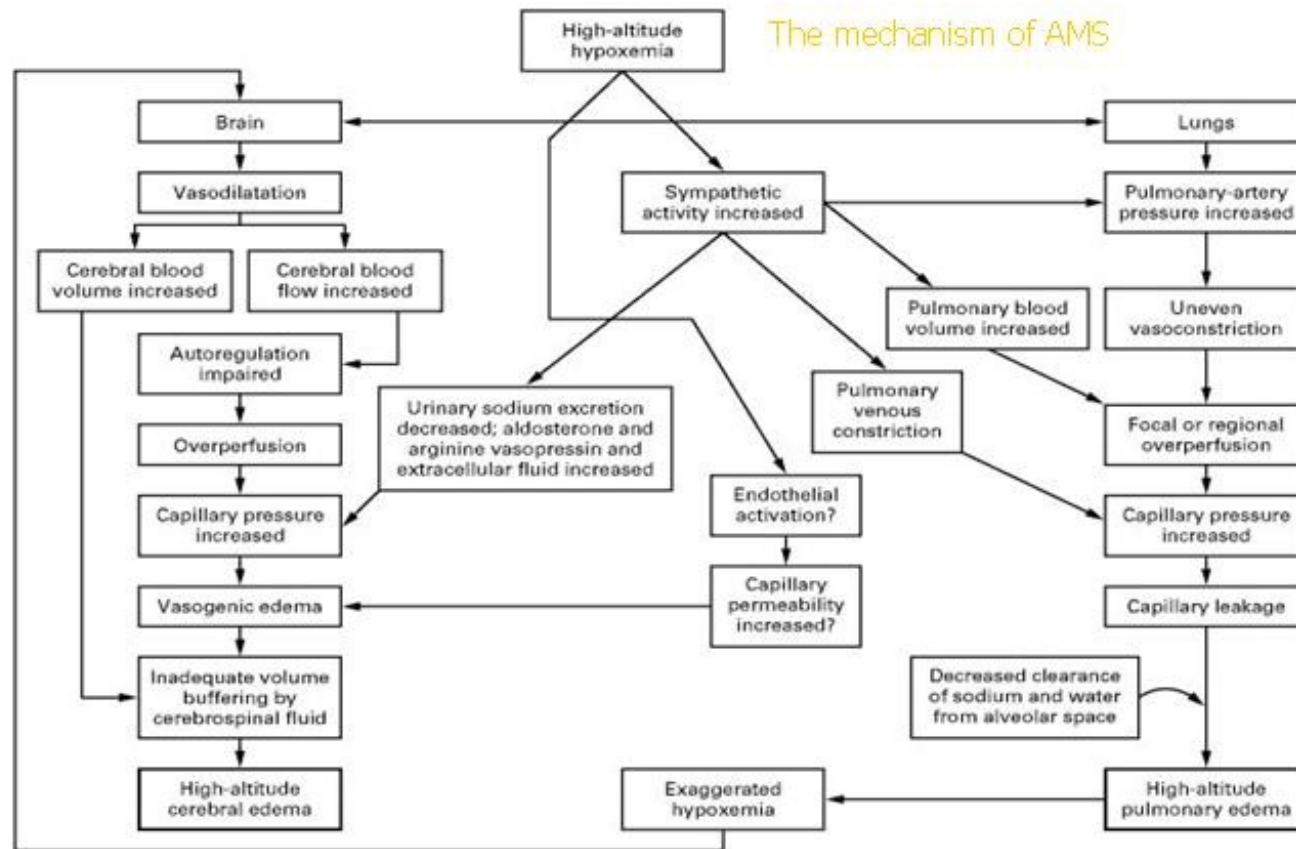
**Acute mountain sickness and high-altitude cerebral edema**

Acute psychosis  
Arteriovenous malformation  
Brain tumor  
Carbon monoxide poisoning  
Central nervous system infection  
Dehydration  
Diabetic ketoacidosis  
Exhaustion  
Hangover  
Hypoglycemia  
Hyponatremia  
Hypothermia  
Ingestion of toxins, drugs, or alcohol  
Migraine  
Seizures  
Stroke  
Transient ischemic attack  
Viral or bacterial infection

**High-altitude pulmonary edema**

Asthma  
Bronchitis  
Heart failure  
Hyperventilation syndrome  
Mucus plugging  
Myocardial infarction  
Pneumonia  
Pulmonary embolus

## The mechanism of AMS



**TABLE 2. OPTIONS FOR THE MANAGEMENT AND PREVENTION OF HIGH-ALTITUDE ILLNESS.**

CLINICAL PRESENTATION	MANAGEMENT	PREVENTION
<p><b>Mild acute mountain sickness</b> Headache with nausea, dizziness, and fatigue during first 12 hr after rapid ascent to high altitude (&gt;2500 m)</p>	<p>Descend 500 m or more; or stop, rest, and acclimatize; or speed acclimatization with acetazolamide (125 to 250 mg twice daily); or treat symptoms with analgesics and antiemetics; or use a combination of these approaches.</p>	<p>Ascend at a slow rate; spend a night at an intermediate altitude; avoid overexertion; avoid direct transport to an altitude of more than 2750 m; consider taking acetazolamide (125 to 250 mg twice daily) beginning 1 day before ascent and continuing for 2 days at high altitude.</p>
<p><b>Moderate acute mountain sickness</b> Moderate-to-severe headache with marked nausea, dizziness, lassitude, insomnia, fluid retention at high altitude for 12 hr or more</p>	<p>Descend 500 m or more; if descent is not possible, use a portable hyperbaric chamber or administer low-flow oxygen (1 to 2 liters/min); if descent is not possible and oxygen is not available, administer acetazolamide (250 mg twice daily), dexamethasone (4 mg orally or intramuscularly every 6 hr), or both until symptoms resolve; treat symptoms; or use a combination of these approaches.</p>	<p>Ascend at a slow rate; spend a night at an intermediate altitude; avoid overexertion; avoid direct transport to an altitude of more than 2750 m; consider taking acetazolamide (125 to 250 mg twice daily) beginning 1 day before ascent and continuing for 2 days at high altitude; treat acute mountain sickness early.</p>
<p><b>High-altitude cerebral edema</b> Acute mountain sickness for 24 hr or more, severe lassitude, mental confusion, ataxia</p>	<p>Initiate immediate descent or evacuation; if descent is not possible, use a portable hyperbaric chamber; administer oxygen (2 to 4 liters/min); administer dexamethasone (8 mg orally, intramuscularly, or intravenously initially, and then 4 mg every 6 hr); administer acetazolamide if descent is delayed.</p>	<p>Avoid direct transport to an altitude of more than 2750 m; ascend at a slow rate; avoid overexertion; consider taking acetazolamide (125 to 250 mg twice daily) beginning 1 day before ascent and continuing for 2 days at high altitude; treat acute mountain sickness early.</p>
<p><b>High-altitude pulmonary edema</b> Dyspnea at rest, moist cough, severe weakness, drowsiness, cyanosis, tachycardia, tachypnea, rales</p>	<p>Administer oxygen (4 to 6 liters/min until condition improves, and then 2 to 4 liters/min to conserve supplies); descend as soon as possible, with minimal exertion, or use a portable hyperbaric chamber; if descent is not possible or oxygen is not available, administer nifedipine (10 mg orally initially and then 30 mg of extended-release formulation orally every 12 to 24 hr); add dexamethasone if neurologic deterioration occurs.</p>	<p>Ascend at a slow, graded rate; avoid overexertion; consider taking nifedipine (20 to 30 mg of extended-release formulation every 12 hr) in persons with repeated episodes.</p>



**TABLE 3. MEDICAL THERAPY FOR HIGH-ALTITUDE ILLNESS.\***

AGENT	INDICATION	DOSE	MECHANISM OF ACTION	ADVERSE EFFECTS	COMMENTS †
Oxygen	All high-altitude illnesses	2–4 liters/min by cannula or mask initially, then 1–2 liters/min or titrate dose until SaO <sub>2</sub> >90%	Increases PaO <sub>2</sub> ; reduces cerebral blood flow, cerebral blood volume, and pulmonary-artery pressure	None	Lifesaving for HAPE; improves headache within minutes in AMS
Portable hyperbaric chamber	All high-altitude illnesses	Depends on model; 2–4 psi for a minimum of 2 hr; continued as long as necessary	Stimulates descent; increases PaO <sub>2</sub>	Potential rebound effect after removal of patient from chamber; limits access to airways	Effects equivalent to the administration of low-flow oxygen; can be lifesaving; does not require oxygen; can add supplemental oxygen by cannula or mask if necessary
Acetazolamide <sup>5,20,21</sup>	Prevention of AMS	125–250 mg orally twice a day 24 hr before ascent and first 2 days at high altitude	Carbonic anhydrase inhibitor; causes bicarbonate diuresis and respiratory stimulation; increases PaO <sub>2</sub> ; promotes formation of CSF; promotes ion transport across blood–brain barrier	Parosmias; alters taste of carbonated beverages; polyuria	Sulfonamide reactions possible; should be avoided by breast-feeding women; can be taken episodically for symptoms; no rebound effect; pregnancy category C
	Treatment of AMS	250 mg twice a day orally until symptoms resolve			
	Pediatric AMS	5 mg/kg of body weight/day, given orally in divided doses every 8–12 hr			
Dexamethasone <sup>20,21</sup>	Prevention of AMS	2 mg every 6 hr or 4 mg every 12 hr orally	Unknown; may reduce brain–blood volume; may prevent blood–brain barrier leak (blocks VEGF, inducible nitric oxide, lipid peroxidation)	Mood changes; hyperglycemia; dyspepsia; rebound effect on withdrawal	Can be lifesaving for AMS or HACE; effects evident in 2–8 hr; no effect on acclimatization; no value in HAPE; preferably avoided by women who are pregnant or breast-feeding
	Treatment of AMS	4 mg every 6 hr orally, IM, or IV			
	HACE	8 mg initially, then 4 mg every 6 hr orally, IM, or IV			
	Pediatric AMS or HACE	0.15 mg/kg every 6 hr orally, IM, or IV			
Furosemide <sup>22</sup>	AMS or HACE	80 mg orally every 12 hr for a total of 2 doses‡	Diuresis; decreases extracellular fluid; causes venodilation	Hypovolemia; hypotension; hypokalemia	Currently out of favor; not recommended for prevention; not established for use in HAPE
Nifedipine <sup>23,24</sup>	Prevention of HAPE	20–30 mg of extended-release formulation orally every 12 hr	Calcium-channel blocker; reduces pulmonary-artery pressure	Reflex tachycardia; hypotension (uncommon)	No value in AMS or HACE; pregnancy category C; not necessary if supplemental oxygen available
	Treatment of HAPE	10 mg orally initially, then 20–30 mg of extended-release formulation orally every 12 hr			
Nonsteroidal anti-inflammatory drugs			Inhibit prostaglandins	Dyspepsia; gastrointestinal bleeding	No clinical trials of aspirin for treatment or of ibuprofen for prevention; naproxen ineffective
Aspirin <sup>25</sup>	Prevention of headache	325 mg orally every 4 hr for a total of 3 doses			
Ibuprofen <sup>26</sup>	Treatment of headache	400 or 600 mg orally once; may be repeated			
<i>Ginkgo biloba</i> <sup>27,28</sup>	Prevention of AMS	80–120 mg orally twice daily	Unknown; may block inducible nitric oxide; an antioxidant oxygen radical scavenger; may block platelet-activating factor	Occasional headache; rare episodes of bleeding	Requires further study; preparations vary; should not be used with antithrombotic agents; may be used by women who are pregnant or breast-feeding
Antiemetics	Nausea; vomiting		Phenothiazine; centrally acting	Extrapyramidal reactions; cause sedation	Pregnancy category C; use diphenhydramine intramuscularly for extrapyramidal reactions
Prochlorperazine		10 mg orally or IM every 6–8 hr			
Promethazine		25–50 mg orally, IM, or rectally every 6 hr			
Zolpidem <sup>9</sup>	Insomnia	10 mg orally	Nonbenzodiazepine modulator of $\gamma$ -aminobutyric acid receptors	Rare, short-acting	Does not depress ventilation at high altitude; pregnancy category B

# Normal acclimatization in high altitude

- A process for facing hypoxia, usually takes place over 3-5 days with below transient s/s.
- Hyperventilation with respiratory alkalosis.
- Shortness of breath during exercise.
- Increased urination with hemoconcentration.
- Changed breathing pattern at night with periodic breath.
- Awakening with dream frequently at night.

## Golden rules for altitude sickness

- It is OK to get altitude illness.
- It is not OK to die from it.
- Any illness at altitude is altitude illness until proven otherwise.
- Never ascent with symptoms of acute mountain sickness.
- If you are getting worse, go down at once.
- Never leave someone with acute mountain sickness

# 高山症

## Acute mountain sickness

- 登高大於2483 meters。
- 一般說來，活動的海拔愈高、爬升的速度愈快、活動量愈大、高度適應做得愈少、過去愈常發生高山症的人，愈容易出現「高山症」的症狀。
- 出現高山症與否反倒與身體強不強壯無關。
- 病患有登高，且高山病指數—露易絲急性高山病指數(Lake Louise AMS Score, LLAMSS)大於三分，即可診斷為急性高山病。

# 預防高山症之道

- 1. 做高度適應：
  - 高度超過3000公尺以上之高山，最好以每天300公尺的高度上升較適當。
- 2. 適時補充水份：
  - 在登山過程中活動量大且呼吸快，水份流失增加，加上在高海拔「口渴感」會變得比較遲鈍，所以主動補充水份很重要。
- 3. 藥物的預防及治療：

# Diamox

- 一種很弱的利尿劑，也用來治療癲癇和青光眼，被廣泛用在急性高山症和高海拔肺水腫。
- 可以在一天之內透過造成「高氧性代謝酸血反應」來刺激呼吸達成高地適應。
- 在一般的高地適應中，「高氧性代謝酸血反應」要五天的時間才能達成高地適應。
- 預防劑量從爬升前二天開始，每12小時口服125-250mg，共服用五天。
- 這個藥物的結構和磺胺藥很類似，對磺胺藥過敏或有腎臟疾患的人，絕對不可以使用。

# 高山症症狀出現時 (I)

- 最有效而且保險的方法是下降(Descend)。
- 登山界流傳一句很有意思的話-對付高山症的三大策略是3D，即『Descend，Descend，and Descend』(下降，下降，再下降)。
- 一旦下降幾乎所有人的所有症狀都會馬上緩解。