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Short Communication

Anesthesia in high altitude: A clinical communication

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Abstract

High altitude refers to regions located above the elevations of 1,500 meters comparing sea level, where decreased atmospheric pressure results in hypobaric hypoxia. This environmental condition causes a range of physiological adaptations and can trigger altitude-related illnesses in unacclimatized individuals. Key syndromes include Acute Mountain Sickness (AMS), High-Altitude Pulmonary Edema (HAPE), High-Altitude Cerebral Edema (HACE), and Chronic Mountain Sickness (CMS). Understanding the classification of high-altitude regions, physiological changes, and illness mechanisms is crucial for prevention and management. This article outlines these components and provides guidance on the prevention and treatment strategies essential for maintaining health at high altitudes.

Keywords: High-Altitude Pulmonary Edema (HAPE), High-Altitude Cerebral Edema (HACE, Acute mountain sickness (AMS)

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1. Introduction

High-altitude environments pose a unique physiological challenge due to the reduced availability of oxygen in the atmosphere, a condition known as hypobaric hypoxia. As elevation increases, barometric pressure and partial pressure of oxygen (PaO2) decrease, impairing oxygen delivery to tissues. While humans can acclimatize to moderate altitudes, sudden or prolonged exposure to high altitudes may lead to acute or chronic altitude illnesses. Understanding the underlying physiological responses and recognizing the clinical presentations of high-altitude illness are vital for effective prevention and management, especially in mountaineers, travelers, military personnel, and residents of highland regions.

1.1. Physiological changes at high altitude

Hypoxia stimulates hyperventilation causing respiratory alkalosis, partially compensated by renal bicarbonate excretion. Decreased PaO2 and SaO2. Increased heart rate and cardiac output seen. Pulmonary vasoconstriction may lead to elevated pulmonary artery pressure.[1] Increased erythropoietin production causes polycythemia. Enhances oxygen-carrying capacity but increases blood viscosity. Reduced cerebral oxygenation may cause headache, dizziness, and confusion. Risk of cerebral edema in severe cases. Initial respiratory alkalosis with partial renal compensation over days.

2. High Altitude Illnesses

Acute Mountain Sickness (AMS) starts within 6–24 hours of ascent. Symptoms include headache, nausea, vomiting, fatigue, dizziness, insomnia. Diagnosis is mainly clinical with Lake Louise Score >3 with headache. High-Altitude Pulmonary Edema (HAPE) is a non-cardiogenic pulmonary edema due to increased pulmonary arterial pressure. Symptoms include dyspnea at rest, cough with frothy sputum, cyanosis, crackles on auscultation. Starts in 2–5 days after rapid ascent. High-Altitude Cerebral Edema (HACE) is a severe form of AMS, potentially life-threatening.[2] Symptoms are ataxia, altered mental status, coma. Chronic Mountain Sickness (CMS) also known as Monge’s disease occurs in long-term residents of high altitude. Features include

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excessive polycythemia, hypoxemia, pulmonary hypertension and right heart failure.

3. Prevention of High Altitude Illness

Gradual Ascent, avoid rapid ascent. Ascend no more than 300–500 meters per day above 2,500 m. Include rest days during ascent. Acclimatization is important so stay at intermediate altitudes before going higher. "Climb high, sleep low" principle. Hydration and Nutrition taken care by avoiding dehydration and alcohol.[3] Medications commonly used are acetazolamide for AMS prevention. Dexamethasone for AMS and HACE prevention. Nifedipine and sildenafil for HAPE prophylaxis in susceptible individuals.

4. Anaesthesia Considerations at High Altitude

High-altitude environments pose unique challenges to anesthetic management due to the effects of hypobaric hypoxia on human physiology, equipment performance, and pharmacodynamics. An understanding of these changes is essential for safe anesthetic care in high-altitude settings. Preoperative Considerations include acclimatization Status: Assess for signs of acute mountain sickness (AMS), high-altitude pulmonary edema (HAPE), or high-altitude cerebral edema (HACE). Comorbid Conditions: Respiratory and cardiovascular diseases may be exacerbated at altitude. Hydration and Nutrition: Dehydration is common at altitude; ensure fluid balance. Polycythemia: May lead to hyper viscosity and thrombotic risk so check hematocrit. Hypobaric Hypoxia: Reduced PaO2 may impair oxygenation under anesthesia. Hyperventilation: Alters acid-base status (respiratory alkalosis). Postoperative Hypoventilation Risk: Increased due to blunted hypoxic drive with sedatives or opioids. Increased Sympathetic Tone: Elevated heart rate and cardiac output. Pulmonary Hypertension: Chronic exposure can lead to right heart strain or failure.[4] Monitoring: Continuous ECG and pulse oximetry are mandatory; invasive monitoring may be indicated in high-risk patients. Volatile Anesthetics: MAC is reduced at high altitude (lower PaO2 affects CNS sensitivity). Vaporizers calibrated at sea level may deliver inconsistent doses. Use of desflurane (with electronically controlled vaporizers) or total intravenous anesthesia (TIVA) may be safer. Intravenous Agents: Propofol, opioids, and muscle relaxants generally retain efficacy but require titration due to altered kinetics and respiratory effects.

Intraoperative and Postoperative Care: Supplemental Oxygen: Essential intra- and postoperatively. Post-op Monitoring: Risk of delayed emergence and respiratory depression. Avoid Nitrous Oxide: Due to risk of expansion in closed air spaces at lower pressures. Equipment Considerations include Vaporizers: Conventional vaporizers may under-deliver at low barometric pressures. Ventilators: Must be pressure-compensated or volume-controlled. Pulse Oximeters: May give falsely high SpO2 readings due to poor perfusion or cold extremities.[5-6] Regional Anesthesia: Preferred in many cases to avoid respiratory depression and minimize systemic effects. Altered CSF dynamics and drug distribution may affect block height and duration.

5. Treatment of High Altitude Illness

Table 1: Treatment options for high altitude illness

Condition	First-line Treatment	Adjuncts
AMS	Descent, O2, Acetazolamide	Analgesics, hydration
HAPE	Immediate descent, O2, Nifedipine	Portable hyperbaric bag
HACE	Descent, O2, Dexamethasone	Hyperbaric therapy, supportive care
CMS	Descent (if possible), phlebotomy, Acetazolamide	Supplemental O2, monitor for heart failure

6. Conclusion

High-altitude exposure presents complex challenges due to hypobaric hypoxia and its systemic effects. Understanding the classification, physiological responses, and potential altitude-related illnesses is essential for individuals venturing into or residing at high altitudes. Prevention strategies such as gradual ascent and pharmacological prophylaxis are critical. Prompt recognition and treatment of conditions like AMS, HAPE, and HACE can be life-saving. With proper education, acclimatization, and preparedness, the risks associated with high-altitude exposure can be significantly reduced.

7. Source of Funding

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8. Conflict of Interest

None.

References

1. Hackett PH, Roach RC. High-altitude illness. *N Engl J Med*. 2001;345(2):107-14.
2. West JB. High-altitude medicine. *Am J Respir Crit Care Med*. 2012;186(12):1229-37.
3. Basnyat B, Murdoch DR. High-altitude illness. *Lancet*. 2003;361(9373):1967–74.
4. Luks AM, Swenson ER, Bärtsch P. Acute high-altitude sickness. *Eur Respir Rev*. 2017;26(143):160096.
5. Wu TY, Ding SQ, Liu JL, Jia JH, Chai ZC, Dai RC. Who should not go high: chronic disease and work at altitude during construction of the Qinghai–Tibet railroad. *High Alt Med Biol*. 2007;8(2):88–107.
6. Imray C, Wright A, Subudhi A, Roach R. Acute mountain sickness: pathophysiology, prevention, and treatment. *Prog Cardiovasc Dis*. 2010;52(6):467–84.

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