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Acute mountain sickness: pathophysiology and prevention

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Abstract

This review discusses the epidemiology, pathophysiology, prevention and treatment of acute mountain sickness (AMS). Key mechanisms including changes in blood-brain barrier permeability, activation of the renin-angiotensin-aldosterone system and the role of diuresis in the development of AMS are analysed. The effectiveness of various preventive strategies, such as acclimatisation and pharmacotherapy (acetazolamide, dexamethasone, ibuprofen), as well as alternative approaches, including the use of natural remedies such as Rhodiola roses, coca leaves and Ginkgo biloba, are discussed. The paper emphasises the importance of correct diagnosis and prompt action in the treatment of AMS, which is crucial in preventing complications.

Material and methods

Data bases such as Pubmed and GoogleScholar were used for research with the key words: acute mountain illness (AMS), acetazolamid, dexametazone, altitude, prevention, acclimatisation.

Conclusions

Acute altitude sickness is a challenge in terms of understanding pathophyslogy and effective treatment methods. The primary methods of preventing AMS are properly managed acclimatisation and the use of acetazolamide. Other pharmacological and natural measures require further research.

Keywords: acute mountain illness (AMS), altitude, prevention, acclimatisation.

Introduction

Mountain environments have always posed challenges to human survival and adaptation. Conditions at high altitudes differ significantly from those prevailing in the lowland regions of the Earth. The most significant factor that the human body has to contend with is the decrease in the partial pressure of oxygen in the atmosphere. This phenomenon leads to a number of physiological challenges that people at altitude have to face. An exceptionally vulnerable group are those who suddenly and without prior acclimatisation find themselves at high altitudes. A drop in the partial pressure of oxygen can lead to a number of undesirable symptoms, which are collectively referred to as altitude sickness. With the increasing popularity of trekking. mountaineering and high altitude expeditions, the number of cases of altitude sickness is increasing significantly.

Depending on the symptoms, altitude sickness covers a spectrum of syndromes divided into:

- acute mountain sickness (AMS)
- high altitude pulmonary edema (HAPE)
- high altitude cerebral edema (HACE)

1. Epidemiology

Acute mountain sickness is the most common form of altitude sickness. The possibility of onset of symptoms may take place above 2500 m, although predisposed individuals may complain of experiencing mild symptoms from as low as 2000m [1].

AMS is the mildest form of altitude sickness. The possibility of onset of symptoms can take place above 2500 m although predisposed individuals may complain of mild symptoms from as low as 2000 m. A mild form of AMS occurring in 10-25% of people at altitudes above 2500

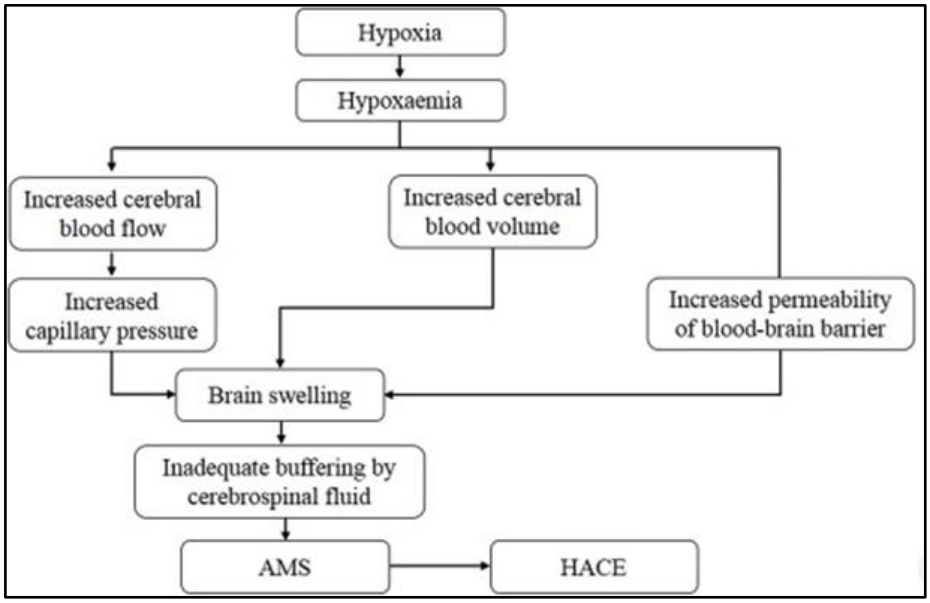
m, and at altitudes above 4500m the incidence increases to 50-85%, above 7000m almost everyone will develop symptoms of AMS, especially when gaining altitude quickly. Symptoms appear 6-12h after ascending to altitude and may worsen with remaining at altitude [2][3].

2. Pathophysiology

Although the oxygen content of the atmosphere is constant at around 21%, the partial pressure of oxygen decreases non-linearly with altitude. At the altitude of Mount Everest (8849 m), the partial pressure of oxygen is only 1/3 of that found at sea level. This causes a decrease in the diffusion of respiratory gases and results in tissue hypoxia [4].

Despite many years of research into the aetiology of AMS, the causes of its occurrence have not been directly identified. Many researchers are trying to describe the pathomechanism of this phenomenon. Trying to understand what mechanisms lead to the occurrence in AMS is crucial to better understand what this disease is and, consequently, to be able to better manage its prevention and treatment.

One hypothesis for the occurrence of AMS and HACE is progressive cerebral oedema due to an increase in cerebral blood flow and pressure and an increase in blood-brain barrier permeability [5]. Although the pathophysiology of AMS and HACE are similar, they are not the same disease entities differing only in the presence of increased symptoms in HACE.



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As altitude increases, hypoxia can cause an increase in cerebral flow, while hypocapnia causes a decrease in cerebral flow; the balance of these two interactions is crucial to overall cerebral flow. When the balance of the two processes is impaired, a significant increase in blood pressure and increased cerebral flow can cause impairment of the blood-brain barrier, potentially leading to vasogenic oedema and the onset of AMS.

In his study, Peter Hacker found that reduced diuresis and intraluminal fluid retention play a key role in the mechanism of oedema due to AMS, as well as in HAPE and HACE [6]. He noted the existence of a correlation between mountain sickness symptoms and urine excretion. The lower the urine excretion, the more severe the symptoms were. This was directly related to the body weight of the study participants. Increased body weight, translated into retention of body fluids and increased symptoms of altitude sickness. Other researchers came to similar conclusions, indicating that participants in the experiment who developed AMS within 12 hours showed a positive water balance due to low fluid loss. Consequently, they hypothesised that pharmacological measures to avoid excessive fluid retention are likely to reduce AMS symptoms [7].

The cause of fluid retention in the body was addressed by the Jack A. Loepky team. The experiment studied two groups of people at the same altitude - with and without AMS symptoms.

He concluded that vasopressin levels decreased for patients without AMS, increasing for patients with AMS within 90 minutes of exposure and continued to increase for patients with AMS, which was closely related to symptom severity and fluid retention [8].

The cause of the increase in oedema was studied by Hackett and Roch [9]. They found that an increase in capillary permeability and an increase in sympathetic nervous system activity were responsible for the appearance of oedema. Hypoxaemia associated with elevation causes an increase in blood flow in the vascular bed with an increase in capillary pressure resulting in fluid permeation. The increase in sympathetic nervous system activation, in turn, causes renal arteriolar contraction, activating the renin-angiotensin-aldosterone system (RAAS). Activation of the RAAS system in turn translates into a decrease in glomerular filtration rate, a decrease in body diuresis resulting in fluid retention in the body.

Although there is a strong correlation between reduced diuresis and the severity of AMS symptoms, the researchers demonstrated that higher fluid intake resulted in higher diuresis but did not prevent AMS. This indicates that urine output is a secondary cause to physiological phenomena in the human body at high altitude, and not a direct cause of AMS onset [10].

In contrast, other studies have challenged the hypothesis that the onset of symptoms is based on subsequent cerebral oedema caused by a decrease in oxygen partial pressure with altitude. The researchers believe that there is no conclusive evidence that intracranial pressure increases in humans in AMS and that swelling of astrocytes is not sufficient to cause brain swelling resulting in AMS.

This study showed that mild cerebral oedema due to vasogenic oedema occurs in response to hypoxia, but is not correlated with AMS symptoms. The adaptive response of the brain to hypoxia involves a small breach of the blood-brain barrier that cannot be detected by standard molecular methods[11]. An alternative hypothesis focusing on redox activation of the trigeminovascular system has been proposed.

An increase in endothelial permeability also plays an important role in AMS symptoms. The researchers demonstrated that leukotriene E4 levels increase soon after exposure to high altitude, even after a four-day stay in these conditions. Although the results do not support a clear link between leukotriene E4 levels and AMS symptoms, they support the hypothesis that leukotrienes may play a role in the pathophysiology of this condition [12].

3. Symptoms

AMS is a spectrum of clinical symptoms. Here is a list of the most common symptoms [13]:
Headache: 70-80%
Fatigue/weakness: 40-60%
Dizziness/slight dizziness: 50-60%
Nausea and/or vomiting: 30-50%
Loss of appetite: 20-40%
Insomnia: 30-50%

Depending on the research group and the methods of the experiment carried out, the data on symptom prevalence may vary slightly, but headache is by far the most common symptom of AMS reaching up to 96 % of AMS sufferers.
In addition to the most common symptoms listed above, the following may also occur: increased thirst, flatulence, respiratory distress, chest pain, constipation, increased heart rate, hysterical reactions, speech disorders, increased blood pressure, peripheral oedema, haemoptysis, visual disturbances, excessive sleepiness, coma.
The multitude of symptoms of AMS, is associated with diagnostic difficulties. Despite many years of research, there is no simple diagnostic criterion for the disease. Although symptoms may not initially be severe, they can increase with altitude. Exacerbated symptoms, as well as often poor medical care in high altitude areas, can result in many adverse complications and even death of the patient. It is therefore crucial that suddenly appearing symptoms in a patient above 2500 m are first considered as symptoms of potential AMS, rather than looking for explanations in other complaints such as infection, food poisoning, tension headache, etc.
To facilitate diagnosis, as well as to have a standardised tool for diagnosing AMS for research purposes, the Lake Louise scale was developed.
The system was first presented at the International Hypoxia Symposium in 1991, and since then, despite minor adjustments in scale, it has continued to be regarded as an essential diagnostic tool and a reference point in ongoing research worldwide [14].

LAKE LOUISE SYMPTOM SCORE (LLSS)

Symptoms	Severity	Points
Headache	No headache	0
	Mild headache	1
	Moderate headache	2
	Severe headache Incapacitating	3
Gastrointestinal symptoms	No gastrointestinal symptoms	0
	Poor appetite or nausea	1
	Moderate nausea or vomiting	2
	Severe nausea or vomiting, incapacitating	3
Fatigue and / or weakness	Not tired or weak	0
	Mild fatigue/weakness	1
	Moderate fatigue/weakness	2
	Severe fatigue/weakness, incapacitating	3
Dizziness / lightheadedness	Not dizzy	0
	Mild dizziness	1
	Moderate dizziness	2
	Severe dizziness, incapacitating	3

https://medycyna-gorska.pl/en/scute-mountain-sickness-symptoms-prevention-and-practical-insights-for-mountain-trekkers/

A diagnosis of AMS can be made when the score on the Lake Louise scale reaches at least3 points from the four symptom groups, including at least 1 point for headache. In addition to this, the patient under examination must be at least 6 hours post altitude.
Depending on the severity of symptoms, we can divide AMS into: mild 3-5 points, 3-5 points, moderate-6-9 points, severe-10-12 points.

4. AMS prevention

Prevention of AMS primarily involves correct acclimatisation and pharmacological methods that play a supporting role. Acclimatisation is a key element of prevention, as it reduces the risk of AMS and also protects against more serious forms of altitude sickness, such as pulmonary oedema (HAPE) or cerebral oedema (HACE). Pharmacotherapy, while not a substitute for the body's adaptation to high altitude conditions, can support this process, especially in those at higher risk of developing symptoms.

Acclimatisation

Acclimatisation is the body's adaptation to altitude. Individuals climbing to altitude over relatively short period of time must apply the appropriate rules for maximum daily ascent to a given altitude, as well as the time spent at altitude. There are several strategies for adapting to high altitude:
1) gradual acclimatisation - maximum daily recommended ascent: after reaching 2500 m, do not increase the altitude of the overnight stay by more than 300-500 metres per day. Every 3-4 days (or after an increase in altitude of 1000 m), a full day should be spent recuperating, without gaining altitude to allow the body to adapt to the altitude [15]. The described strategy will work especially well during long expeditions and high altitude training. The most important thing is to walk slowly during this option and not to make a very intensive effort. Each successive night will be at a higher and higher altitude, so by doing too much intense exercise, the oxygen deficit may result in poorer recovery and accumulation of oxygen debt. Avoid “breathlessness” and march steadily. This strategy is the safest and significantly reduces the occurrence of mountain sickness.

2) An acclimatisation strategy based on the principle “climb high, sleep low” is commonly used in mountaineering. It involves gaining a given altitude during the day and then descending for the night to the lower parts of the mountains, where the body can recover better thanks to the higher partial pressure of oxygen. This method involves intense physical exertion and adaptation to lower oxygen availability during the day, leading to a significant oxygen deficit. At night, on the other hand, at lower altitude, the body has a chance to effectively saturate with oxygen. This strategy is particularly effective in mountains up to 5,500 m above sea level, especially for shorter, intensive expeditions where the goal is to climb one or two peaks. Because of the longer distances to be covered, the described strategy is recommended for people with very high physical capacity [16].

3) The acclimatisation strategy known as 'yo-yo' is used by climbers at altitudes above 5500 m. It involves alternating between ascending to higher altitudes and returning to the main base camp to recover. Scientific research confirms its effectiveness, especially in climbing very high

peaks such as Mount Everest. The acclimatisation process begins at base camp, usually located at an altitude of 4000-5500 m. From there, climbers set off towards intermediate camps higher up, spending a day or several days there to adapt, before returning to base camp to rest. As the body does not regenerate efficiently at altitudes above 5500 m, prolonged exposure to such conditions weakens performance. Over the course of an expedition of several weeks, a mountaineer may make 2-3 such exits and returns.

Acetazolamide

In addition to long-term acclimatisation, the human body's adaptation to altitude can be assisted pharmacologically. No medication can fully replace properly planned and carried out acclimatisation, but it can reduce the duration and severity of AMS symptoms. The best-studied drug with proven activity as prevention and treatment of AMS is acetazolamide [17][18].

Acetazolamide is a drug that inhibits the activity of carbonic anhydrase and has a diuretic effect Carbonic anhydrase catalyses the reaction that produces carbonic acid. As a result of inhibition of this reaction, there is an increased excretion of bicarbonate ions (HCO_3^-) in the urine, which reduces their concentration in the blood and leads to metabolic acidosis. This results in carbonic acid deficiency, which reduces the availability of H+ ions. Sodium reabsorption in the renal tubules is coupled to H ion exchange (e.g. at the sodium-hydrogen pump). Decreased H ion secretion impairs this process, leading to increased sodium excretion and thus a decrease in renal osmotic water reabsorption, which leads to increased diuresis. After about 3 days of acetazolamide use, its diuretic effect disappears. A short break in treatment allows the carbonic anhydrase activity to recover and the diuretic effect to resume.

As altitude increases and the oxygen partial pressure decreases, the human body increases respiratory rate, resulting in hypocapnia, which leads to metabolic alkalosis. The effect of acetazolamide was initially thought to be effective on AMS, as the drug induces metabolic acidosis which compensates for the altitude-induced metabolic alkalosis. This directly translates into allowing chemoreceptors to respond more fully to hypoxic stimuli [19]. This results in better oxygenation of the blood of individuals at high altitude [20]. Nevertheless, this does not seem to be the only mechanism that leads to the efficacy of acetazolamide in AMS. Other studies show that the reason for the increase in blood oxygenation is due to an increase in tidal volume rather than respiratory rate alone [21].

In addition to the effect resulting in increased blood oxygenation, the diuresis effect of acetazolamide is also important. The cause is not clear, but there is a strong correlation between AMS symptoms and diuresis. The more severe the symptoms a person presents, urination decreases. According to Currie [22], the action of diuretics is to counteract the increased secretion of aldosterone that occurs at high altitudes as an adaptive response to reduced plasma volume and water loss caused by prolonged hyperventilation. Aldosterone, by causing antidiuresis, can disrupt homeostasis, especially when the pulmonary and cerebral circulation is overloaded. In such conditions, diuretics may prove therapeutically beneficial. An additional benefit of diuresis is an increase in haematocrit and improved oxygen transport capacity due to a reduction in extracellular fluid volume.

Dosage

There has been a scientific debate for years about the effective dose of prophylactic use of acetazolamide. The effects of different doses of the drug have been studied: 62.5 mg, 125 mg 250 mg, 375 mg, 500 mg, 750 mg [23]. It was once thought that 750mg was the lowest effective dose [24]. However, further experiments indicated that a dose of 500 mg or even 250 mg could be effective.

Domont and colleagues, in a large meta-analysis on a group of 1512 participants, analysed scientific studies to determine the minimum effective dose of acetazolamide. The criteria were age over 16 years and entry at least 3000. Any studies on groups of people who permanently reside in high mountain areas were excluded [25]. As a result of the analysis, it was shown that the minimum effective dose for the prophylaxis of AMS is 250 mg of acetazolamide per day. administered in two doses of 125 mg. Furthermore, this dose of the drug resulted in the statistically lowest risk of side effects such as paresthesias and reduced the risk of severe headaches Although the UIAA guidelines, as well as the current scientific consensus, considers the 250 mg dose to be the least effective dose, there are studies that challenge this claim. Researchers tested a dose of 62.5 mg on a small group of several dozen subjects. It was shown that even such a low dose of acetazolamide was comparable to a dose of 125 mg taken twice daily [26] [27].

Dexamethasone

Dexamethasone is an effective agent in the prevention and treatment of severe AMS and high altitude cerebral oedema (HACE). It acts by reducing vascular permeability, inhibiting inflammatory processes, improving oxidative balance, and promoting blood oxygenation without increasing ventilation. The drug increases the respiratory response, improves saturation and reduces pulmonary hypertension, promoting acclimatisation at high altitude [28]. Studies support the efficacy of doses of 8 mg daily in reducing AMS and pulmonary oedema (HAPE). A meta-analysis conducted in 2013, considering eight different scientific studies, proved that the use of dexamethasone 8/12/16 mg may be useful in the prevention of AMS. Moreover, the data show that the effectiveness of the drug depends on the dose and the amount [29]. Some studies indicate that dexamethasone may even be a more effective drug than acetazolamide in the prevention of AMS. Researchers on a group of 47 climbers, in a randomised, double-blind trial, compared acetazolamide at a dose of 250 mg with dexamethasone at a dose of 4 mg. Although both drugs proved to be equally effective, dexamethasone had fewer of the side effects of headache, tiredness, dizziness, nausea, clumsiness, and a greater sense of feeling refreshed [30].

Although some studies support the efficacy of taking dexamethasone for AMS prophylaxis, the official 2024 Wilderness Medical Society guidelines indicate that the drug can only be used in extremely high-risk situations, such as air transport of military or rescue personnel at altitudes above 3500 m followed immediately by high-intensity physical exertion. If dexamethasone is used for more than 5-7 days, the dose should be gradually reduced over one week rather than abruptly discontinued. It is not recommended as a means of preventing AMS in children. The drug should be started the day before climbing, but is also effective if started on the day of climbing [31].

Ibuprofen

Ibuprofen is a non-steroidal anti-inflammatory drug (NSAID) used to relieve pain, fever and inflammation. It works by inhibiting the enzyme cyclooxygenase (COX), which is responsible for the production of prostaglandins - compounds that cause pain, swelling and fever in response to injury or infection. By blocking COX, ibuprofen reduces the intensity of these processes in the body [32].

In 2012, a randomised trial was conducted in which participants were given either ibuprofen or placebo during ascent to altitude, where the risk of AMS was significant. It found that ibuprofen,

given at a dose of 600 mg three times a day, significantly reduced the risk of AMS compared to placebo. The study included healthy adults who had no previous symptoms of altitude sickness and who were not using other medications such as acetazolamide or glucocorticosteroids. The results suggest that ibuprofen may be an effective prophylactic option to improve tolerance to high altitude [33]. Similar conclusions were reached by researchers on a group of 443 people who compared the efficacy of ibuprofen against acetazolamide. Both drugs were shown to be similarly effective against the prevention of AMS and both groups differed significantly from placebo in terms of the number of AMS occurrences [34].

Other studies were also conducted to compare acetazolamide and ibuprofen in the prevention of AMS. The results showed that ibuprofen had slightly lower efficacy in the prevention of AMS and therefore was not recommended instead of acetazolamide [35]. On the other hand, researchers in 2020 conducted a meta-analysis concluding that, based on existing research papers, the superiority of acetazolamide over ibuprofen could not be established due to insufficient scientific evidence [36].

Iron

Iron may play an important role in the prevention of AMS through its function in oxygen metabolism: it is part of haemoglobin which is essential as an oxygen carrier to the tissues. At altitude, the body tries to increase its oxygen transport capacity by producing more red blood cells. Iron is essential for this process. Iron deficiency can limit the body's ability to adapt to hypoxia. Iron deficiency anemia reduces the body's oxygen capacity, which can exacerbate AMS symptoms.

Despite the potential beneficial properties of iron in the prevention of AMS, there is very scanty evidence of its efficacy. One study of 24 subjects, randomised to placebo, suggests the efficacy of intravenous iron (III) hydroxide with sucrose (200 mg) in the prevention of AMS [37]. Another study of 41 volunteers, on the other hand, showed no efficacy of administered iron [38]

Other natural measures

Despite the proven efficacy of several drugs for the prevention ofAMS, researchers have been working hard for years to discover new potential pharmacological agents as well as those of natural origin that can reduce the incidence of AMS at altitude.

Traditional Chinese, Indian and Tibetan medicine, as well as practices originating from the Andes, have for centuries used a variety of plants with properties to support the body in high mountain conditions. Despite a rich medicinal tradition, most of these plants have not yet been subjected to detailed scientific research, limiting the possibility of fully understanding their mechanisms of action and potential therapeutic applications [39].

Rhodiola rosea

Rhodiola roses, known as mountain rhodiola, is a plant used to improve the body's performance under stress, including hypoxia. Extracts from this plant contain active substances such as rosavins and salidroside, which support the functioning of mitochondria, which are key to energy production. Rhodiola also improves the body's ability to cope with hypoxia by reducing oxidative stress and increasing the activity of antioxidant enzymes [40]. Studies have shown that this plant can alleviate symptoms of fatigue and improve endurance, making it an ideal support for altitude sickness. Furthermore, there are scientific reports of beneficial effects of Rhodiola roses taken together with acetazolamide [41].

Coca leaves

Coca, a member of the Erythroxylaceae family, is traditionally used in South America to relieve digestive problems, depression, sore throat and AMS symptoms. The plant has been cultivated for more than 4,000 years. Once reserved for the Inca high realm, it is now used as a popular stimulant in South America [42]. In its natural form, coca leaves do not cause toxicity or addiction, and an infusion of coca leaves is considered an effective remedy for nausea, dizziness and headaches associated with AMS in Andean regions [43].

The main alkaloid present in coca leaves, cocaine, accounts for about 0.5 percent of the leaf weight. The mechanism of action of coca in alleviating AMS may involve breaking the vicious circle between the gastrointestinal and central nervous systems by acting through stimulation of the hypothalamic-pituitary-adrenal axis, activating the sympathetic nervous system [44]. Studies indicate that coca leaves inhibit the glycolytic pathway of glucose oxidation, resulting in the accumulation of glucose and pyruvate. The energy required for physical activity is then mainly obtained from beta-oxidation of fatty acids. In addition, the released glycerol also accumulates, as its oxidation process is blocked. These observations suggest that chewing coca

leaves may support the body during physical exertion, especially with prolonged, continuous activity. The biochemical changes in the body, described above, suggest that coca leaves have a positive effect on physical performance at altitude [45].

Fuchs suggested that the alkaloids contained in whole coca leaves may pharmacologically reduce excessive red blood cell production caused by hypoxia. By reducing hyper-haemorrhagic stress, symptoms of altitude sickness are alleviated, modifying the body's adaptation mechanisms to high altitude conditions [46].

However, despite the centuries-old tradition of coca leaf consumption by South American populations and studies that indicate its beneficial effects on the human body while at altitude, more thorough research and standardisation of dosage are needed to ensure its safe and effective use.

Ginkgo biloba

Ginkgo biloba has been valued for centuries in Chinese medicine for its properties to improve blood circulation, particularly in the brain. Its extracts contain flavonoids and terpenoids, which act as powerful antioxidants that protect cells from oxidative stress damage. Ginkgo biloba also increases the elasticity of blood vessels, which improves oxygen delivery to tissues in low oxygen conditions. Research suggests that it may be effective in relieving symptoms associated with altitude sickness, such as dizziness and fatigue. Despite the long tradition of the use of ginkgo biloba in mountain medicine, scientific studies give conflicting results on the effects of its use. Some of them prove similar efficacy to acetazolamide [47]. Others, on the other hand, refute this thesis, concluding that there is no significant difference between the use of ginkgo biloba and placebo, such as a study conducted on several hundred volunteers 2004 [48]. Also, a study conducted a year later at an altitude of 3800 m did not confirm its efficacy [49].

Although there is conflicting evidence of the efficacy of ginkgo biloba as a prophylactic for AMS, there is ongoing scientific research on the subject. This seems to be influenced by the lack of standardisation of the ginkgo biloba product, and the variability in the concentrations of active substances in the products ultimately used. The future may lie in conducting further research into the individual active substances contained in ginkgo biloba [50].

5. Treatment of AMS

The most important thing is to make a good diagnosis. AMS is a clinical diagnosis, based on the medical history taken with the patient. Symptoms on physical examination will most often be absent. The use of the Lake Louise Acute Mountain Sickness Score can help with this. When AMS is suspected, it is most important to rule out HACE, as failure to recognise and treat HACE can lead to the death of the patient

Once a diagnosis of AMS has been made, the patient should not continue to participate in climbing. You should remain at altitude until symptoms resolve. If symptoms persist, or if symptoms worsen, a descent to a lower altitude should be considered. Pharmacological treatment (especially if symptoms persist for 6-12h) should include acetazolamide. In addition, symptomatic treatment (paracetamol, ibuprofen, dimenhydrinate) should be used. If severe AMS symptoms are present, proceed as with a diagnosis of HAPE. Prompts evacuation of the patient to a lower altitude of at least 500-1000 m, oxygen supplementation and dexamethasone administration are essential [51].

Conclusions

AMS results from complex physiological processes such as cerebral oedema, water-electrolyte imbalance and activation of the sympathetic nervous system, highlighting the need for further research into these mechanisms to better understand the disease and develop effective treatments. Acclimatisation remains the most effective method of AMS prevention, and the 'climb high, sleep low' strategies and the 'yo-yo' method are particularly useful during expeditions to extreme altitudes. Acetazolamide and dexamethasone are effective drugs for the prevention and treatment of AM. Natural remedies such as Rhodiola Rosea and coca leaves show promise in alleviating AMS symptoms, although they require further clinical trials to fully determine their efficacy and safety. The Lake Louise scale is an effective diagnostic tool for AMS, and rapid intervention, including descent to a lower altitude and the use of pharmacotherapy, is crucial in cases of severe symptoms. Further research is needed to investigate the pathophysiological mechanisms of AMS and to evaluate the efficacy of different therapeutic strategies, including new pharmacological and natural agents. A holistic approach including acclimatisation, pharmacotherapy and preventive measures can significantly reduce the risk of AMS and improve the safety and comfort of people at high altitude.

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