Following our **tips to get a good acclimatization**, we take a deeper look at the different, scientific, technical and practical, aspects to keep in mind when we talking about altitude acclimatization.

I.- What it's normal acclimatization from a medical point of view

Acclimatization is the process of the body adjusting to the decreased availability of oxygen at high altitudes. It is a slow process, taking place over a period of days to weeks, depending on your own physiology and circumstances.

High altitude is defined as:

- High Altitude: 1500 - 3500m (5000 - 11500ft)
- Very High Altitude: 3500 - 5500m (11500 - 18000ft)
- Extreme Altitude: above 5500m (over 18000ft)

Practically speaking, however, we generally don't worry much about elevations below about 2500m (8000ft) since altitude illness rarely occurs lower than this.

Certain **normal** physiologic changes occur in every person who goes to altitude:

- Hyperventilation (breathing faster, deeper, or both)
- Shortness of breath during exertion
- Changed breathing pattern at night
- Awakening frequently at night
- Increased urination

I.a.- How works

As one ascends through the atmosphere, barometric pressure decreases (though the air still contains 21% oxygen) and thus every breath contains fewer and fewer molecules of oxygen. One must work harder to obtain oxygen, by breathing faster and deeper. This is particularly noticeable with exertion, such as walking uphill. Being out of breath with exertion is normal, as long as the sensation of shortness of breath resolves rapidly with rest. The increase in breathing is critical. It is therefore important to avoid anything that will decrease breathing, e.g. alcohol and certain drugs. Despite the increased breathing, attaining normal blood levels of oxygen is not possible at high altitude.

Persistent increased breathing results in reduction of carbon dioxide in the blood, a metabolic waste product that is removed by the lungs. The build-up of carbon dioxide in the blood is the key signal to the brain that it is time to breathe, so if it is low, the drive to breathe is blunted (the lack of oxygen is a much weaker signal, and acts as an ultimate safety valve). As long as you are awake it isn't much trouble to consciously breathe, but at night an odd breathing pattern develops due to a back-and-forth balancing act between these two respiratory triggers.

I.b.- Other outcomes

Periodic breathing consists of cycles of normal breathing which gradually slows, breath-holding, and a brief recovery period of accelerated breathing. The breath-holding may last up to 10-15 seconds. **This is not altitude** sickness.

Solution: *It may improve slightly with acclimatization, but does not usually resolve until descent.*

Periodic breathing can cause a lot of anxiety:

- In the person who wakes up during the breath-holding phase and knows he has stopped breathing.
- In the person who wakes up in the post-breath-holding hyperventilation (recovery) phase and thinks he's short of breath and has High Altitude Pulmonary Edema (HAPE).
- In the person who wakes up and realizes his neighbour has stopped breathing.

In the first two cases waiting a few moments will establish a normal breathing pattern. In the final case, the sleeping neighbour will eventually take a breath, though periodic breathing cycles will likely continue until he or she is awake.

Optional solution: *If periodic breathing symptoms are troublesome, a medication called acetazolamide* may be helpful. (*please see note on medication on III.c)*

Dramatic changes take place in the body's chemistry and fluid balance during acclimatization. The osmotic center, which detects the "concentration" of the blood, gets reset so that the blood is more concentrated. This results in an **altitude diuresis** as the kidneys excrete more fluid. The reason for this reset is not understood, though it has the effect of increasing the haematocrit (concentration of red blood cells) and perhaps improving the blood's oxygen-carrying ability somewhat; it also counteracts the tendency for edema formation. It is normal at altitude to be urinating more than usual. If you are not, you may be dehydrated, or you may not be acclimatizing well.

Solution: *Keep yourself hydrate at all time.*

II.- Altitude Sickness

Also known as acute mountain sickness (AMS), is a pathological effect of high altitude on humans, caused by acute exposure to low partial pressure of oxygen at high altitude.

It presents as a collection of nonspecific symptoms, acquired at high altitude or in low air pressure, resembling a case of "flu, carbon monoxide poisoning, or a hangover". It is hard to determine who will be affected by altitude sickness, as there are no specific factors that correlate with a susceptibility to altitude sickness.

AMS can progress to high altitude pulmonary edema (HAPE) or high altitude cerebral edema (HACE), which are potentially fatal.

II.a.- Altitude Sickness Prevention

First always follow the acclimatization Rules of Thumbs

1. **Climb High – Sleep Low**
   Always follow a saw strategy going up during the day, but coming lower to sleep
2. **Hydrated, Hydrated, Hydrated**
   Keep drinking. You lose lot of humidity just by breathing the mountain's dry air
3. **Be honest with yourself**
   If you not feeling well, rest, go down, try later.
4. **Keep an eye on yourself**
   Don't dismiss those new symptoms as something you should not pay attention. Talk to your guide.

II.b.- Lake Louise Score for the diagnosis of Acute Mountain Sickness (AMS)

A diagnosis of AMS is based on:

1. A rise in altitude within the last 4 days
2. Presence of a headache

PLUS

3. Presence of at least one other symptom
4. A total score of 3 or more from the questions below

SELF-REPORT QUESTIONNAIRE

Add together the individual scores for each symptom to get the total score.

Symptom	Severity	Score	Your Points
Headache	No headache	0	
	Mild headache	1	
	Moderate headache	2	
	Severe headache	3	
Gut (gastrointestinal) symptoms	None	0	
	Poor appetite or nausea	1	
	Moderate nausea and/or vomiting	2	
	Severe nausea and/or vomiting	3	
Fatigue and/or weakness	Not tired or weak	0	
	Mild fatigue/weakness	1	
	Moderate fatigue/weakness	2	
	Severe fatigue/weakness	3	
Dizziness/light-headedness	Not dizzy	0	
	Mild dizziness	1	
	Moderate dizziness	2	
	Severe dizziness	3	
Difficulty sleeping	Slept as well as usual	0	
	Did not sleep as well as usual	1	
	Woke many times, poor sleep	2	
	Could not sleep at all	3	
	Total of your score		

Total score of:

3 to 5 = **mild AMS**
6 or more = **severe AMS**

Note:

Do not ascend with symptoms of AMS
Descend if symptoms are not improving or getting worse
Descend if symptoms of HACE or HAPE develop

II.c.- The Lake Louise Consensus on the Definition of Altitude Illness

AMS: In the setting of a recent gain in altitude, the presence of headache and at least one of the following symptoms:

- gastrointestinal (anorexia, nausea or vomiting)
- fatigue or weakness
- dizziness or lightheadedness
- difficulty sleeping

HACE: Can be considered "end stage" or severe AMS. In the setting of a recent gain in altitude, either:

- the presence of a change in mental status and/or ataxia in a person with AMS
- or, the presence of both mental status changes and ataxia in a person without AMS

HAPE: In the setting of a recent gain in altitude, the presence of the following:

Symptoms: at least two of:

- dyspnea at rest
- cough
- weakness or decreased exercise performance
- chest tightness or congestion

Signs: at least two of:

- crackles or wheezing in at least one lung field
- central cyanosis
- tachypnea
- tachycardia

II.d.- Things to Avoid

Respiratory depression (the slowing down of breathing) can be caused by various medications, and may be a problem at altitude. The following medications can do this, and should never be used by someone who has symptoms of altitude illness (these may be safe in persons who are not ill , although this remains controversial):

- Alcohol *and caffeine as they also tend to cause dehydration and exacerbates AMS.*
- Sleeping pills (acetazolamide is the sleeping tablet of choice at altitude)
- Narcotic pain medications in more than modest doses

III.- What it's normal, good acclimatization from a practical point of view. A guide's perspective.

Remember this it's not about your physical shape, it's about physiology, but a good fitness *helps as a good use of your daily energy level according to age and conditions are critical.*

It's about how your body adapts not only to altitude but as well to a set of different conditions such as: dry mountain air, daily outdoor exercise routine, variable temperature regime, windy conditions, sleeping conditions and so on.

The physiology of how human do adapt to altitude is quite known but the reasons why similar people do react so differently or the same person react not always the same at different times, places, circumstances is still cause of debate and uncertainty. Till now the only accepted "good" strategy to get a good acclimatization are resumed on the ***Rules of Thumbs (II.a)*** mentioned before.

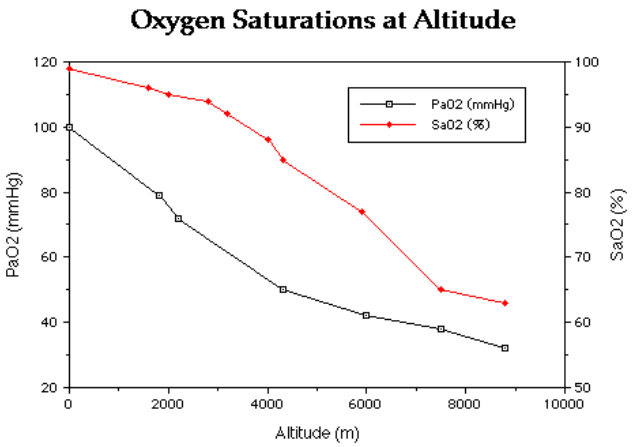
III.b.- So, how you do it? How do you find out if you could do it or not?

The only reasonable, sound answer its begin in lower mountains / shorter expeditions, as a process to know yourself not just how your body is reacting to altitude, some people need a couple of days to arrive to 6000m some, like myself I need a week, but if I do it right I could keep going forever… but also if do you liked it or not.

So if you do a lower peak, shorter adventure and you feel OK, you may continue with bigger objectives, if you don't, well you go do something else.

III.c.- Prevention tools

So beside the above mentioned Lake Louise score the only other practical tools, a guide have to his/her disposition is to maintain, based on his/her own experience, a continuous quality assessment of everybody acclimatization process, including the regular measure of your SaO2 levels, heart rate and recovery, rest abilities.



SaO2 varies over a range in normal individuals at a given altitude. It is usually lower on first arrival at a given altitude, and rises somewhat with acclimatization. Once above about 6500 m, SaO2 flattens out at about 60-65%, and then drops very little because of the large increase in ventilation and the subsequent respiratory alkalosis (which shifts the oxyhemoglobin dissociation curve to the left).

It's always useful to know what are your own "normal" heart rates at just after wake up, during extraneous exercise and meanwhile doing normal day activities.

III.d.- AMS Treatment and Medication

The mainstay of treatment of AMS is rest, fluids, and mild analgesics: acetaminophen (paracetamol), aspirin, or ibuprofen. These medications will not cover up worsening symptoms. The natural progression for AMS is to get better, and often simply resting at the altitude at which you became ill is adequate treatment. Improvement usually occurs in one or two days, but may take as long as three or four days. Descent is also an option, and recovery will be quite rapid.

A frequent question is how to tell if a headache is due to altitude. Altitude headaches are usually nasty, persistent, and frequently there are other symptoms of AMS; they tend to be frontal (but may be anywhere), and may worsen with bending over. However, there are other causes of headaches, and you can try a simple diagnostic/therapeutic test. Dehydration is a common cause of headache at altitude. Drink one liter of fluid, and take some acetaminophen or one of the other analgesics listed above. If the headache resolves quickly and ***totally*** (and you have no other symptoms of AMS) it is very unlikely to have been due to AMS.

Preventing Severe AMS

This simply cannot be emphasized too much. **If you have symptoms of AMS, do not ascend any higher**. Violating this simple rule has resulted in many tragic deaths.
If you ascend with AMS you will get worse, and you might die. This is extremely important - even a day hike to a higher elevation is a great risk. In many cases of High Altitude Cerebral Edema, this rule was violated. Stay at the same altitude (or descend) until your symptoms completely go away. Once your symptoms are completely gone, you have acclimatized and ***then*** it is OK to continue ascending. It is always OK to descend; you will get better faster.

Acetazolamide (Diamox®)

We do not recommend acetazolamide as a prophylactic medication. Most people who have a reasonable ascent schedule will not need it. Since acetazolamide works by forcing a bicarbonate diuresis, you will urinate more on this medication and in addition to you may experience some common minor but unpleasant side effects include numbness, tingling, or vibrating sensations in hands, feet, and lips. Also, taste alterations, and ringing in the ears. These go away when the medicine is stopped. Most important its carries the risk of any of the severe side effects that may occur with sulfonamides, such as nausea and headache. A few trekkers have had extreme visual blurring after taking only one or two doses of acetazolamide; fortunately, they recovered their normal vision in several days once the medicine was discontinued.
Acetazolamide is a sulfonamide medication, and persons allergic to sulfa medicines should not take it.

Also acetazolamide will NOT prevent AMS from worsening during ascent, acetazolamide just accelerated the normal process of the body adjusting to the decreased availability of oxygen but if your body is not reacting then it's nothing Acetazolamide could do about it

So, if for whatever the reason you hit a wall due to the lack of O2, the only proved good strategy is go down and sometimes you need that little extra that a dose of acetazolamide gives you, to be able to walk down those 100-200m that will do all the difference.

AMS Prophylaxis: *125-250 mg (depending on body weight; persons over 100 kg (220 lbs) should take the higher dose) twice a day starting 24 hours before ascent, and discontinuing after the second or third night at the maximum altitude (or with descent if that occurs earlier). Children may take 2.5 mg/kg of body weight twice a day.*

Dexamethasone (Decadron®)

A potent steroid used to treat brain edema. Whereas acetazolamide treats the ***problem*** (by accelerating acclimatization), dexamethasone treats the ***symptoms*** (the distress caused by hypoxia). Dexamethasone can completely remove the symptoms of AMS in a few hours, but it does not help you acclimatize. If you use dexamethasone to treat AMS you should not go higher until the next day, to be sure the medication has worn off and is not hiding a lack of acclimatization.
Side effects include euphoria in some people, trouble sleeping, and an increased blood sugar level in diabetics.

For treatment of AMS: *Two doses of 4 mg, 6 hours apart. This can be given orally, or by an injection if the patient is vomiting. Children may be given 1 mg/kg of body weight, up to 4 mg maximum; a second dose is given in 6 hours. Do not ascend until at least 12 hours after the last dose, and then only if there are no symptoms of AMS.*

Oxygen

AMS symptoms resolve very rapidly (minutes) on moderate-flow oxygen (2-4 litters per minute, by nasal cannula). There may be rebound symptoms if the duration of therapy is inadequate - several hours of treatment may be needed. In most high altitude environments, oxygen is a precious commodity, and as such is usually reserved for more serious cases of HACE and HAPE.

Hyperbaric Therapy

Treatment in a portable hyperbaric bag is essentially equivalent to descent or treatment with oxygen; the person is inside a pressurized bag breathing an atmosphere equivalent to a much lower altitude. AMS symptoms rapidly resolve (minutes), but may recur if treatment is too short - at least two hours are needed. Dexamethasone works as well, though not quite as fast, is much cheaper, and far less labour-intensive than hyperbaric therapy. Hyperbaric treatment is usually reserved for more serious cases such as HACE and HAPE.

O2 Data Control Chart