

High Altitude Awareness

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Welcome to the on-line Altitude in Antarctica course. This course is designed to help you gain awareness regarding our body's reactions and adaptations to high altitude. Our first concern at RPSC and in Field Science Support is for the safety of each individual in your group. While altitude is often not recognized as a medical threat, our experience in the deep field has taught us that high altitude combined with the harsh Antarctic environment can create life-threatening situations. All of us react differently to altitude and it is important for everyone working "up high" to recognize altitude effects on themselves and their team members.

This on-line module is designed to streamline your field safety training while in McMurdo. We hope this presentation will increase your awareness of altitude complications long before you deploy to the ice. By reading this presentation and taking the quiz you will receive the material that was traditionally offered in the altitude class. Upon your arrival at McMurdo if you have read the material and taken the quiz, our field safety training instructors will offer a short practical class where you can ask additional questions and most importantly operate a Gamow bag which you will have in your field equipment.

Thank you for taking time from your busy schedule to prepare for your Antarctic field season. We appreciate any comments that you may have on this information, and other ideas to electronically present more field safety training material.

Best Regards,

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Introduction

Congratulations. You have the opportunity to work in one of the most extreme environments on earth. If you are viewing this presentation, you will also be working at high altitudes. By addressing altitude issues before deployment, you will be better prepared mentally and physically. This also gives you the opportunity to research and look beyond the information presented.

Altitude Scale

- **High:** 8,000 to 12,000 feet.
- **Very high:** 12,000 to 18,000 feet.
- **Extreme:** over 18,000 feet.
- Most high altitude camps are at an altitude of 8,000 to 12,000 feet.
- You will be arriving from sea level.
- However uncommon, altitude illness signs and symptoms can be seen at elevations as low as 7,000 feet.

Basic Physiology of Altitude (Or What's Going On Up There?)

- Oxygen remains at about 21% as altitude increases.
- Barometric pressure decreases as the altitude increases.
- With the decrease of barometric pressure, partial pressure of oxygen decreases.
- Due to the reduced partial pressure of oxygen at altitude, the body has to work harder to push oxygen from the lungs into the bloodstream.
- Oxygen loses its "pushing power" to diffuse from the air sacs to the bloodstream.
- The result is less oxygen available to the body (hypoxia).

Altitude and Polar Regions

- Barometric pressure is affected by its distance from the equator.
- In polar regions, hypoxia (inadequate oxygen in the lungs and blood) develops at lower altitudes.
- A low-pressure weather system can further reduce barometric pressure.
- Extreme cold provokes altitude related problems.

How does this relate to you?

- It means that your body has to function with less oxygen.
- Your body needs the same amount of oxygen at altitude as it does at sea level.
- Your body has to adjust or acclimatize to the altitude.
- Acclimatization is the process by which your body adjusts and adapts to the decrease in oxygen available to the tissues.

How the body acclimatizes

- **Ventilation:** The depth and rate of breathing increases to provide more oxygen to the lungs to be absorbed into the blood.
- **Cardiac output:** Heart rate increases in order to allow the heart to pump more blood (more O₂) to the body.

- **Pulmonary artery pressure:** Pressure elevates to help “push” oxygen from the air sacs into the blood stream.
- **Red cell production:** The increased concentration of RBCs allows the blood to carry more oxygen to the body.
- **Diuresis:** Urinary output increases to rid the body of bicarbonate.
- **Enzyme and tissue changes:** Allows efficient oxygen transport and use of oxygen by the body.

The acclimatization process is different for everyone

- Time varies for the different processes just discussed.
- Each individual varies widely in the ability to acclimatize, both in degree and time.
- The average time for acclimatization is three to five days.
- Prior experience at altitude does not exclude you from altitude related illnesses.
- Some individuals are unable to acclimatize at all!

Normal Body Responses To Altitude

- Hyperventilation.
- Shortness of breath on exertion.
- Increased urination.
- Periodic breathing during sleep.
- Sleep disturbances.
- **Remember these are normal responses. It is your body’s way of adapting to altitude!**

How To Achieve Acclimatization

- Graded ascent unfortunately we do not have this opportunity. We are normally flown from sea level directly to altitude.
- Climb high – sleep low.
- Stay properly hydrated.
- Do not over-exert.
- Avoid alcohol, tobacco, depressant drugs (like sleeping pills, narcotics).
- High carbohydrate diet.
- There are several ways we can prepare for altitude, both prior to departure and once we arrive. We will get to them later first altitude illness

Common Altitude Illnesses

- Acute Mountain Sickness (AMS).
- High Altitude Cerebral Edema (HACE).
- High Altitude Pulmonary Edema (HAPE).
- Several medical problems can occur when ascending to high altitude. The problems can range from uncomfortable symptoms to life threatening conditions. The occurrence of these problems varies with the rate of ascent, elevation gained and individual susceptibility to high altitude.

Acute Mountain Sickness

- Possibly due to hypoxia (lack of oxygen).

- Symptoms occur 12-24 hrs after ascent.
- Symptoms decrease around the third day.
- Symptoms range from mild to severe.

Mild Symptoms

- Feels like a “hangover”.
- Headache.
- Fatigue.
- Shortness of breath.
- Nausea.
- Lack of appetite.
- Lightheadedness/dizziness.

Moderate / Severe Symptoms

- Headache not relieved by analgesics.
- Loss of muscular coordination (cannot walk a straight line).
- Decrease in mental status.
- Symptoms do not subside or worsen.

Treatment (Mild)

- Stop ascent(if possible).
- Rest.
- Analgesics for headache.
- Medications for nausea.
- Hydration & nutrition.
- Low flow oxygen.
- Diamox.
- Do not ascend until symptoms go away!

Treatment (Moderate / Severe)

- Descend! Descend! (if possible).
- Gamow Bag.
- Treat as above.
- Dexamethasone.

High Altitude Cerebral Edema

- Results from swelling of the brain due to fluid leakage.
- Generally occurs after 5 to 7 days at high altitude.
- Serious illness that could lead to death if unrecognized and untreated.

Symptoms

- Severe headache.
- Loss of coordination.
- Decreased mental status (lethargy, confusion).
- Weakness.
- Vomiting.

- Coma.

The Diagnosis of Severe AMS vs. HACE Is Difficult. Always Assume the Worst.

Treatment

- Immediate descent (if possible).
- Oxygen.
- Gamow bag.
- Dexamethasone.

High Altitude Pulmonary Edema

- Results from fluid leakage into the lungs.
- Oxygen transfer from the lungs to the blood is impaired.
- Not caused by heart failure or pneumonia.
- Severe illness that could lead to death if unrecognized and untreated.

Symptoms

- Shortness of breath at rest.
- Bluish color to the skin.
- Productive cough with frothy pink tinged fluid.
- “Tight chest”.
- Fatigue/weakness.
- Gurgling/crackling noise heard in the chest during breathing (often called “Rales”).
- Increased heart/respiratory rate.
- Mental changes (confusion).
- Dry persistent cough.

Treatment

- Descend (if possible).
- Oxygen.
- Prop up patient.
- Gamow bag.
- Nifedipine.

High Altitude Medications and Treatment

- The medications listed in the following pages are used for the prevention and/or treatment of high altitude illnesses.
- These medications as well as a Gamow bag are provided by the medical facilities in Antarctica and are carried by your camp medical provider.
- If you have any concerns or questions, you should discuss all of these medications with your medical provider before you deploy.

Diamox (acetazolamide)

- Used for prevention and treatment.
- Diamox is the drug of choice for prevention of AMS. It speeds acclimatization and may help to avoid the development of illness if given early. It is a carbonic anhydrase (CA)

inhibitor, slowing the hydration of carbon dioxide. By inhibiting renal carbonic anhydrase Diamox reduces the reabsorption of bicarbonate and sodium, causing bicarbonate diuresis and metabolic acidosis within hours of ingestion. This does a few things: Rapidly enhances ventilatory acclimatization and maintains oxygenation during sleep. It prevents periods of extreme hypoxia. Because of its diuretic action it also counteracts the fluid retention of AMS.

- Dose: 125-250 mg the night before ascent, followed by 125-250 mg twice a day during ascent and for 3-4 days after reaching altitude.

Diamox Side Effects

- *Numbness/tingling of fingertips and around mouth.
- *Increased urination.
- *Less Commonly nausea, drowsiness, impotence, myopia.

- Diamox allows you to taste carbon dioxide, ruining the flavor of carbonated beverages.

Diamox contraindications

- *Allergy to sulfa drugs.
- Consult with your medical provider about possible interactions with any medications you take on a regular basis.

Dexamethasone (Decadron)

- Used for treatment.
- Dexamethasone is indicated for the treatment of HACE. It is a steroid that is effective in reducing edema in the brain. It should be used in conjunction with descent or use of gamow bag.
- Dose: 4 mg (tablet or injection) every 6 hours until evacuated to a safe elevation.

Nifedipine (procardia,adalat)

- Used for treatment.
- Nifedipine is a calcium channel blocker that aids in the treatment of HAPE. It is effective in reducing pulmonary vascular resistance and pulmonary artery pressure. It should be used in conjunction with oxygen and descent.
- DOSE: 10 mg every 4 hours, titrate to response or,
- 10 mg once, then 30 mg sustained release tablet every 12 to 24 hours

The Gamow bag

- The Gamow bag is a portable hyperbaric chamber.
- It is used when the patient is unable to descend or is awaiting transport to a lower altitude.
- It simulates descent to lower altitudes.
- By increasing pressure inside the bag, oxygen regains its “pushing power” allowing oxygen to be pushed into the bloodstream.

Preparing For Altitude

Preparing before deployment

- Talk to your medical provider! Let them know you will be working at altitude. Discuss any concerns you have or anything you do not understand about working at altitude.
- Inform your medical provider if you have ever experienced altitude illness in the past.
- It is especially important to talk to your medical provider if you take ANY medications on a regular basis. Also, you may be taking Diamox so make sure there are no adverse interactions of Diamox with your medications. You should also discuss any pre-existing medical conditions that could be affected by going to altitude.
- As already mentioned, you need to bring your own supply of your regular medications. The medical facilities on the ice do not have a large enough inventory to supply you for a whole season.
- Use the references at the end of this presentation to research more info about altitude.

Preparing for Departure to Your Field Camp

- Begin to hydrate NOW. Start to increase your water intake to at least 4 to 5 quarts a day. Sip a quart an hour. Trying to drink a lot at one time does not work. Drink slowly and space it out over time.
- Try to rest and get some good quality sleep while here in the “thick” air. This can be difficult to do while preparing for a big project, but try to relax at the end of the day.
- Even harder to do, decrease caffeine and avoid alcohol 2 days prior to departure.
- The night before departure begin to take Diamox (acetazolamide). The dose is 125 to 250 mg. Take one tablet the night before departure and continue to take 1 tablet twice a day for 4 days. This will begin the acclimatization process before you depart. The medical department will dispense Diamox to you. No appointment is necessary, just walk in during clinic hours.
- Mentally prepare yourself. Understand that the first two days after arrival at camp you will be relaxing! No work is to be done. This will give your body a chance to acclimatize to the altitude.

Arrival At Altitude

- BREATHE! Even though this will occur naturally, you need to remember to breathe. There is less available oxygen at altitude so you need to take advantage of every breath you take.
- REST. You need to let the altitude get used to you! Read a good book, play cards. Think about what you need to do after the first few days, but NO heavy exertion!
- LIGHT EXERCISE. It is better to get up every once in a while and move around rather than just lay in bed. Stretch and do light exercises. Shoveling snow is NOT light exercise!
- Continue to take Diamox twice a day for the first few days. The medical provider at your camp will evaluate your progress adapting to altitude after that time period.
- Again, DECREASE CAFFEINE AND AVOID ALCOHOL during the acclimatization period. Alcohol impedes ventilatory acclimatization.
- You may have a medical care provider at your camp who is trained in altitude illness. If you have any questions or concerns please talk to them.
- If you have any worsening of symptoms or increasing headache, see the medical provider ASAP! The more quickly you are assessed and treated, the less likely you will develop HAPE or HACE.

- It is also very important to talk to the medical provider before taking ANY medication. In particular, narcotics and sleep medications should NOT be taken while acclimatizing as they are respiratory depressants and may kick you into AMS.

A reminder of normal things that happen at altitude.

- Hyperventilation and shortness of breath.
- Increased urination.
- Waking up many times during the night (mainly to pee!).
- Periodic breathing at night while you sleep.
- All of these things are the body's way of adapting to the high altitude and they are all normal! Again, if any of these symptoms are increasing or you have a headache that is increasing in severity, see the medical provider right away, even in the middle of the night!

No Worries!!

The occurrence of altitude related illnesses are LOW in Antarctica. Most participants in the USAP have no problem acclimatizing to altitude and do fine. Following the recommendations offered in this presentation will greatly increase your chances of avoiding an altitude related illness and will help your body adjust to the high altitude environment.

Enjoy and be safe up there!

Pre-Deployment Check List

- Inform your medical provider you will be working at high altitude.
- Discuss concerns regarding any pre-existing medical illnesses and how they may be affected by altitude.
- Inform your medical provider if you have experienced any altitude related problems in the past.
- Inform your provider about the option of taking Diamox to acclimatize to altitude.
- Contact your Science PI or your RPSC manager with any concerns about your assignment regarding altitude.
- Feel free to do further research about high altitude environments and physiology with the references provided.

Where to find more information about altitude and altitude related issues:

- Wilderness Medicine by Paul Auerbach, M.D.
- Going Higher: Oxygen, Man, and Mountains by Charles Houston
- Medicine for Mountaineering by James Wilkerson, M.D.
- Altitude Illness: Prevention & Treatment by Stephen Bezruchka, M.D.
- Many web sites exist with generous amounts of altitude related issues: use a "search" for "altitude" to browse the many topics available.

References

- Auerbach, Paul S. Wilderness Medicine. St. Louis: Mosby, 2001
- Houston, Charles. Going Higher: Oxygen, Man, and Mountains. Seattle: Mountaineers, 1998.

- Wilkerson, James A, ed. Medicine for Mountaineering. 3rd ed. Seattle: Mountaineers, 1985.

ALTITUDE QUIZ

1. What elevation is considered "high" altitude?
 - a) Sea level
 - b) Sea level to 4,000 feet
 - c) 8,000 feet and above
2. In Polar regions, inadequate oxygen in the bloodstream occurs at lower elevations.
 - a) True
 - b) False
3. The Process by which your body adjusts and adapts to the decrease in oxygen available to the tissues is called:
 - a) Attitude adjustment
 - b) Adjustment zone
 - c) Acclimatization
4. The body acclimatizes to altitude by altering which processes?
 - a) Increased Ventilation
 - b) Increased Cardiac output
 - c) Increased RBC production
 - d) Increased Pulmonary artery pressure
 - e) all of the above
5. Everyone acclimatizes at the same rate.
 - a) True
 - b) False
6. Normal body responses to altitude include all of the following except:
 - a) Hyperventilation
 - b) Vomiting
 - c) Shortness of breath with exertion
 - e) Sleep disturbances
7. Mild symptoms of AMS include a headache with which of the following:
 - a) Fatigue
 - b) Shortness of breath
 - c) Nausea
 - c) Lack of appetite
 - d) any or all of the above
8. High Altitude Cerebral Edema is a serious illness that must be treated immediately.
 - a) True
 - b) False
9. Signs/Symptoms of High Altitude Pulmonary Edema include:
 - a) Shortness of breath at rest
 - b) Productive cough with signs of fluid in lungs
 - c) Increase heart rate and respiratory rate

d) all of the above

10. Initial treatment for all altitude illnesses include:

- a) Report to medical leader
- b) Oxygen
- c) Rest
- d) Descent
- e) all of the above

11. Prior to departing for altitude you should:

- a) Stay up all night so you can sleep enroute
- b) Rest, Hydrate and avoid alcohol, tobacco and depressant medications
- c) Sleep on oxygen the night before departure

12. The altitude medication Diamox is available at McMurdo Medical clinic:

- a) True
- b) False

13. After arriving at altitude you should:

- a) Work as hard as you can to get settled in
- b) Do rigorous exercise to get used to the altitude
- c) Rest, Hydrate, light exercise and avoid tobacco, alcohol and depressant medications
- d) Sleep for 2 days straight

QUIZ ANSWER KEY

1. C

2. A

3. C

4. E

5. B

6. B

7. D

8. A

9. D

10. E

11. B

12. A

13. C