

ALTITUDE IN ANTARCTICA



A photograph of a penguin standing on a vast, snow-covered mountain range. The penguin is positioned in the center of the frame, facing left. The background consists of rugged, snow-capped peaks under a clear blue sky. The overall scene conveys a sense of a harsh, high-altitude environment.

**CONGRATULATIONS!
YOU HAVE THE OPPORTUNITY TO WORK IN ONE OF THE MOST
EXTREME ENVIRONMENTS ON EARTH.....**



**....AND 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.**

INFORMATION CONTENT

- **BASIC PHYSIOLOGY OF ALTITUDE**
- **HOW AND WHY ALTITUDE AFFECTS THE BODY**
- **ALTITUDE ILLNESS AND RECOGNITION OF EFFECTS OF POLAR REGIONS ON ALTITUDE**
- **SYMPTOMS OF ALTITUDE ILLNESSES**
- **HOW TO PREPARE FOR WORK AT ALTITUDE**
- **MEDICAL ISSUES OF WORKING AT ALTITUDE**
- **CHECK SHEET FOR PREPARING FOR DEPLOYMENT TO ALTITUDE CAMPS**
- **ADDITIONAL RESOURCES ON ALTITUDE RELATED ISSUES**

ALTITUDE SCALE

- **HIGH: 8,000 TO 12,000 FEET**
- **VERY HIGH: 12,000 TO 18,000 FEET**
- **EXTREME: 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 & 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 & 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 ascents...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.....**

ALTITUDE ILLNESSES



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

MOD/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 (MOD/SEV)

- 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**

TREATMENT

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

**THE DIAGNOSIS OF SEVERE
AMS VS. HACE IS
DIFFICULT. ALWAYS
ASSUME THE WORST.**

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 slides 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 AND CONTRAINDICATIONS

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

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

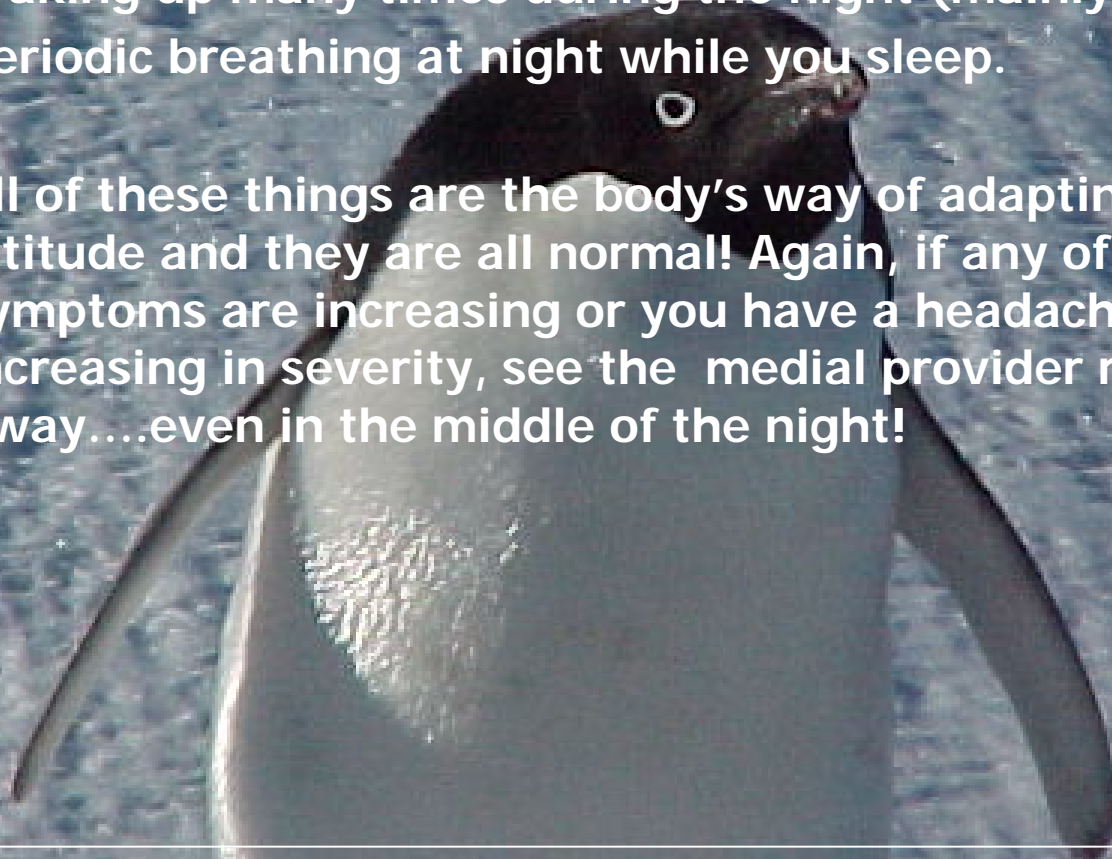
- **BREATHE!** Even though this will occur naturally, you need to remember to breathe. There is less available oxygen at altitude so you need to take advantage of every breath you take.
- **REST.** You need to let the altitude get used to you! Read a good book, play cards. Think about what you need to 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.
- More on the next slide...

MORE THINGS TO DO ON ARRIVAL.....

- **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.

RESOURCES

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