Advances in High Altitude Illnesses

Judith R. Klein, MD, FACEP
Assistant Clinical Professor
UCSF-SFGH Emergency Medicine

A bit too high

- 24 year old on trek to Everest Base Camp
- Headache, vomiting, severe fatigue
- Arrives at clinic: 14K feet
- PE: 170/100, P 110, O_2 78%, RR 18
- Tired, oriented, clear lungs, steady gait

Differential diagnosis

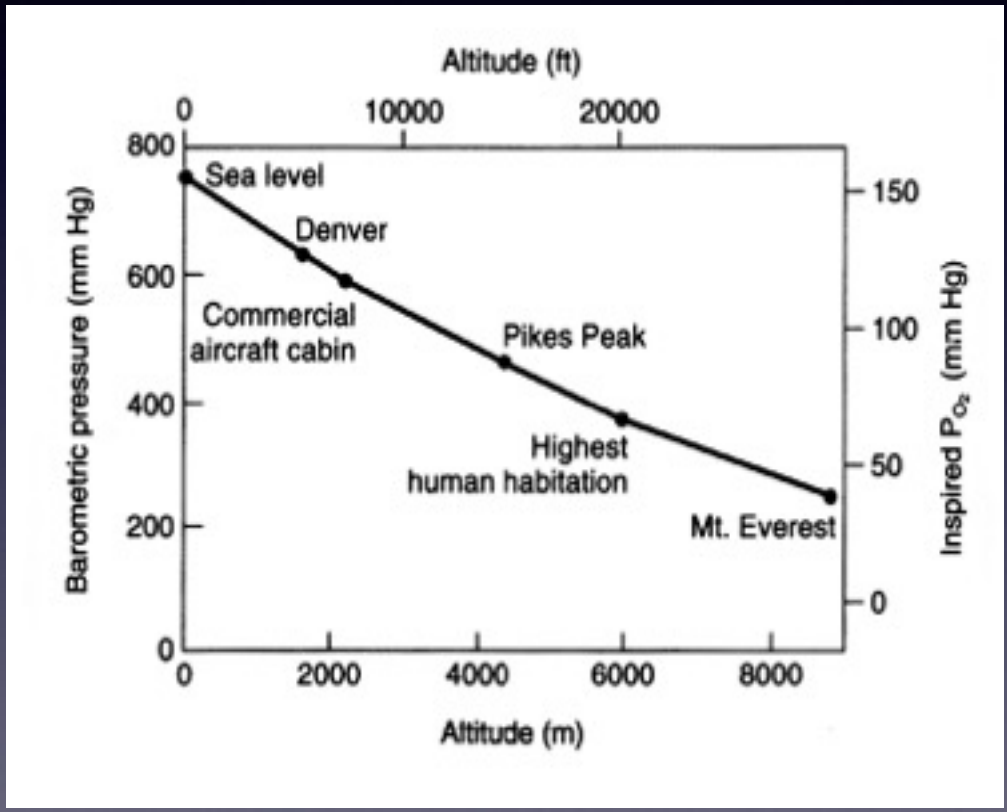
- Viral syndrome
- Meningitis
- Subarachnoid hemorrhage
- Carbon monoxide poisoning (floor heaters)
- Migraine/tension headache
- **Acute mountain sickness (AMS)**

Objectives

- AMS: physiology, prevention and treatment
- HACE: how do you distinguish it from AMS and how do you treat it
- HAPE: the fascinating physiology and how do you approach prevention and treatment

Acute mountain sickness (AMS)

- Increase altitude→ decrease inspired O_2
- Sea level: 100%
- 3000m: 68%
- 4500m: 57%
- 6000m: 47%
- 8848m (Mt Everest): **33%!!**

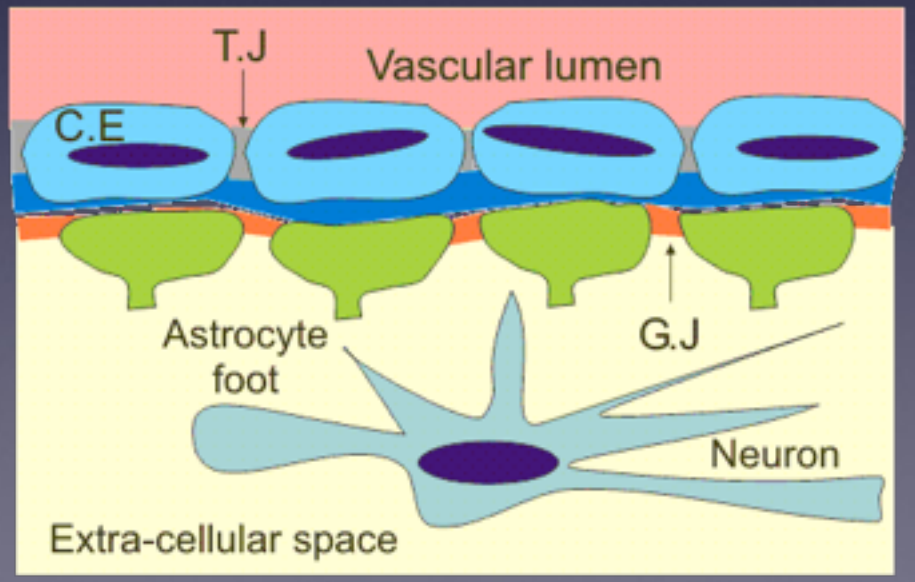


Acclimatization to altitude

- ***Minutes:***
  - ↑ RR (resp alkalosis)
  - ↑ HR
- ***Days:***
  - Alkaline diuresis
- ***Weeks to months:***
  - ↑RBC Production
  - More efficient O_2 use
  - ↑ Muscle vascularity

AMS: What's happening in the brain?

- Hypobaric hypoxia-->↑cerebral blood flow--> ↑hydrostatic pressure in brain-->edema
- Inflammatory mediators compromise BBB and neuronal cell integrity



Normal symptoms at altitude

- Exertional fatigue
- Increased urination
- Nocturnal awakening/ periodic breathing
- Odd dreams
- Dependent edema (particularly women)
- HAFE

are less vulnerable. Unfortunately, one problem we face is the patient's notion that doctors are omniscient and omnipotent, a harmfully erroneous attitude. As one lawyer remarked, "Patients think of doctors as junior gods, but since people don't understand God, they don't understand doctors either." Let us help our patient-employers understand us better. To do this we must descend from the pedestal they have placed us on. We must let them know our humanity, our shared concerns, what we can and cannot do.

We can also publicize the virtues of our profession. Medicine is both *logical* and *moral*. Unlike the legal profession, which is logical and amoral (legalizing tobacco) and the clerical profession, which is moral but illogical (opposing all abortion, all euthanasia), the medical profession stands as a corrective, judicious balance between law's critical, analytical left-hemisphere mode and religion's emotional, intuitive right-hemisphere mode. Whereas both left-mode and right-mode strive for *perfection* (the enemy of good), the balanced mid-mode, by adhering to a standard and allocating functions to whichever hemisphere does it best, strives toward *good*. (Interestingly, the judiciary, the clergy and the villainous Darth Vader wear black; the medical profession, the nursing profession and the heroic Luke Skywalker wear white.) Medicine's role, then, is to care for the real physical and psychological needs of mankind. We are neither paid to marshal arguments for legislation in this life or prepare souls for the next. We are simply concerned with what is knowably true and good. I suggest that we need to communicate this more clearly.

REFERENCES

1. Edwards B: Drawing on the Right Side of the Brain. Los Angeles, JP Tarcher Inc, 26-40, 1979
2. Major RH: A History of Medicine. Springfield, IL, Charles C Thomas, 207-478, 1954
3. Carnegie D: The Quick and Easy Way to Effective Speaking. Garden City, Dale Carnegie & Associates, Inc, 1962
4. Carnegie D: How to Win Friends and Influence People. New York, Simon and Schuster, 1964

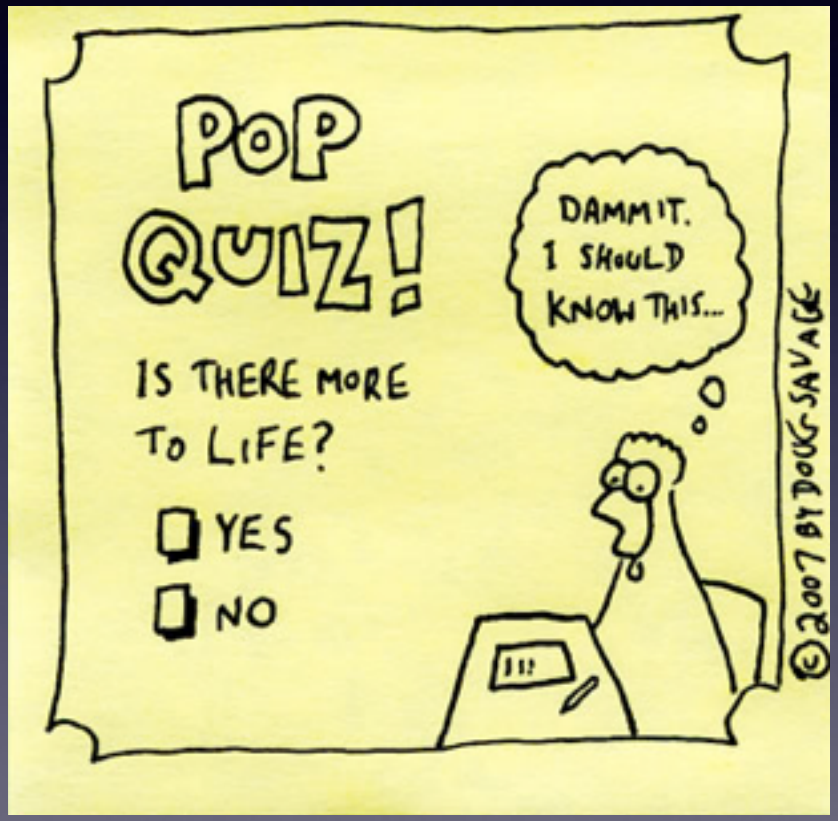
High Altitude Flatus Expulsion (HAFE)

TO THE EDITOR: We would like to report our observations upon a new gastrointestinal syndrome, which we shall refer to by the acronym HAFE (high altitude flatus expulsion). This phenomenon was most recently witnessed by us during an expedition in the San Juan Mountains of southwestern Colorado, with similar experiences during excursions past. The syndrome is strictly associated with ascent, and is characterized by an increase in both the volume and the frequency of the passage of flatus, which spontaneously occurs while climbing to altitudes of 11,000 feet or greater. The eructations (known to veteran back-packers as "Rocky Mountain barking spiders") do not appear to vary with exercise, but may well be closely linked to diet.[1] The fact that the syndrome invariably abated on descent leads us to postulate a mechanism whereby the victim is afflicted by the expansion of colonic gas at the decreased atmospheric pressure of high altitude. This is somewhat analogous to the rapid intravascular expansion of nitrogen which afflicts deep-sea divers and triggers decompression illness.

While not as catastrophic as barotrauma nor as debilitating as HAPE (high altitude pulmonary edema), HAFE nonetheless represents a significant

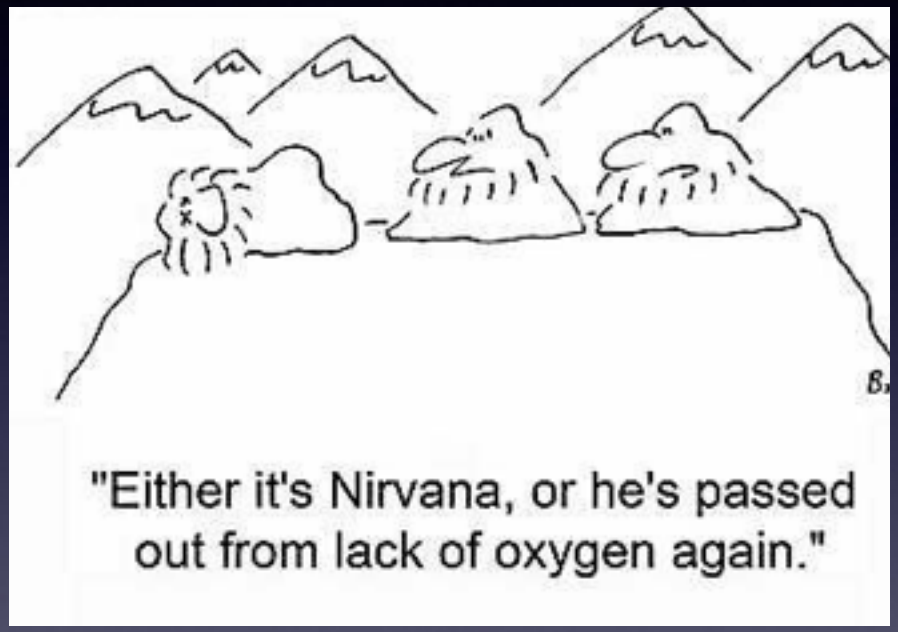
Quiz: AMS risk factors?

- A. Age
- B. Dehydration
- C. Rate of ascent
- D. Fatigue/exertion
- E. Alcohol use
- F. Prior altitude illness
- G. Physical fitness



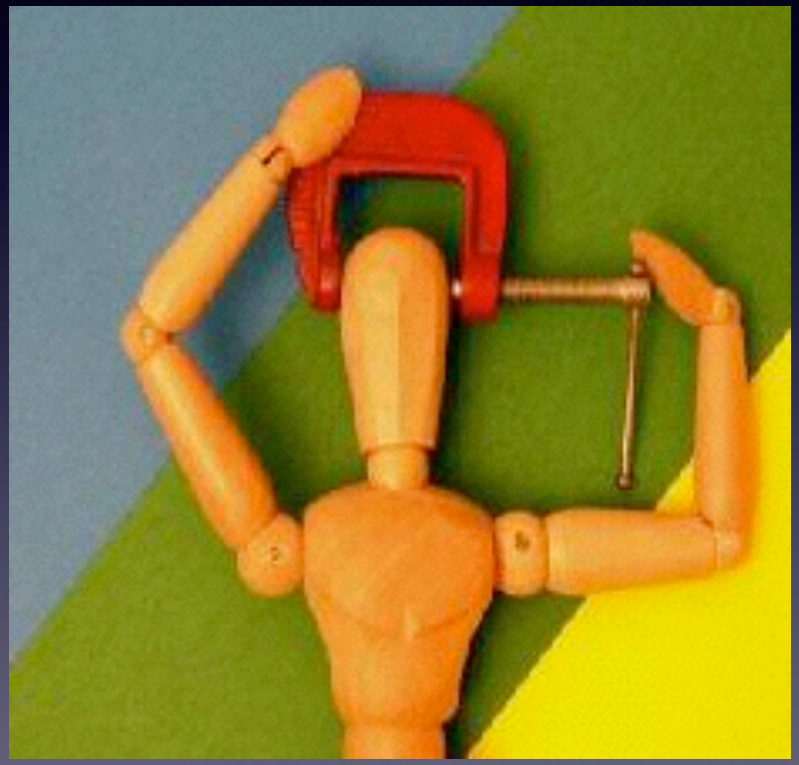
AMS risk factors

- B. Dehydration
- C. **Rate of ascent**
- D. Fatigue/exertion
- E. Alcohol use
- F. Prior altitude illness (particularly HAPE)



AMS symptoms

- Headache
- Fatigue
- Nausea/vomiting
- Dizziness
- Poor sleep



AMS treatment:

- **Descent**
- Rest if mild symptoms
- Oxygen
- Fluids

AMS treatment: acetazolamide

- Mechanism:
  -alkaline diuresis
  -central resp stimulant
  -reduces BBB leakage
  -anti-inflammatory?
- Efficacy: better for prophylaxis
- Dosing: 250mg BID
- Side effects

AMS treatment: dexamethasone

- Mechanism:
  -enhances BBB integrity
  -anti inflammatory
- Efficacy: lots of evidence
- Dosing: 8mg load then 4mg q6h
- DOES NOT FACILITATE ACCLIMATIZATION: do not ascend further on dex

AMS prevention

- Ascend <1500 feet/day over 8000 feet
- Rest day every 3-4 days
- Climb high; sleep low
- Fluids/ carb rich foods
- **Avoid**: alcohol, sleeping pills

AMS prevention

- Diamox*:
  -125mg bid start 1 day prior
- Ibuprofen*:
  -86pt RCT vs placebo: NNT4
  -600mg tid same day
- Dexamethasone:
  -4mg q12; NNT 2-3
  -if unable to take diamox or NSAID
- Gingko? Coca? Sumatriptan? Gabapentin?

I think she's hit the bottle..

- 32 yo female trekking in Annapurna, Nepal
- HA, vomiting at 15 K feet
- Ascends 17K pass
- Stumbling, unstable gait, agitated, resisting assistance

Differential diagnosis

- Stroke
- Drug/alcohol intoxication
- Subarachnoid hemorrhage
- Meningitis
- **High Altitude Cerebral Edema (HACE)**

HACE: diagnosis

- **Signs: Confusion and ataxia**
- Time from onset-->death in as little as 6 hours
- **Treatment:**
  -DESCENT
  -Dexamethasone and oxygen to temporize
  -Gamow bag

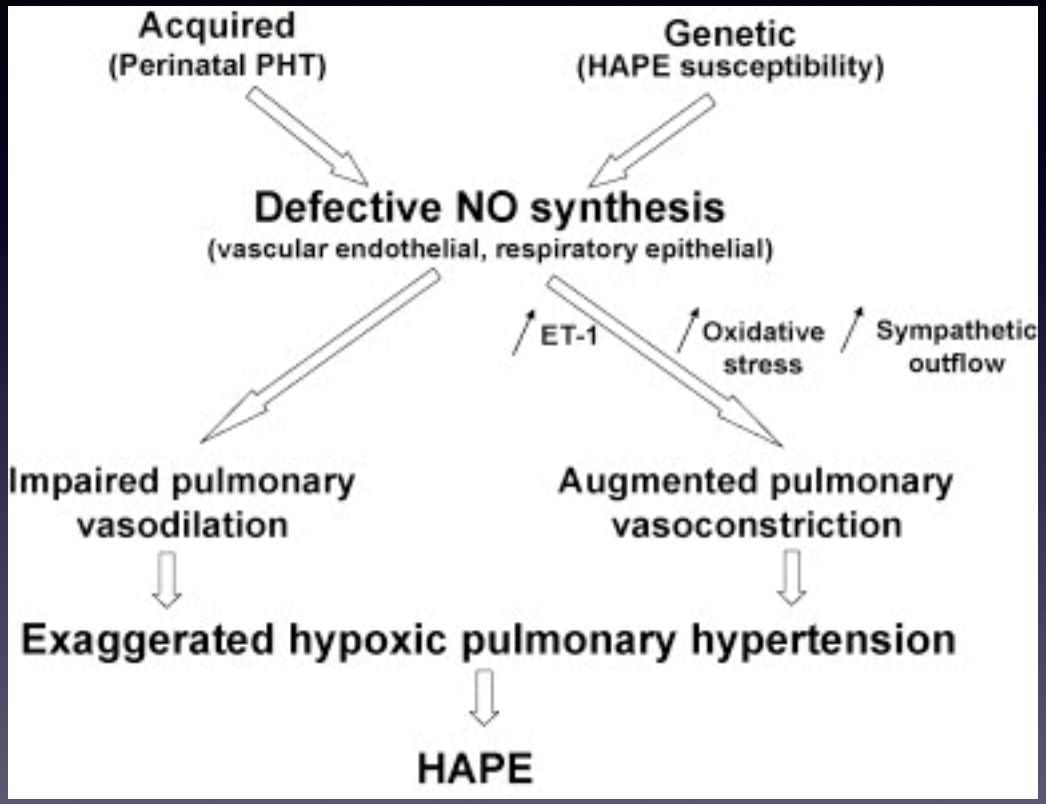
He's gotta stop smoking..

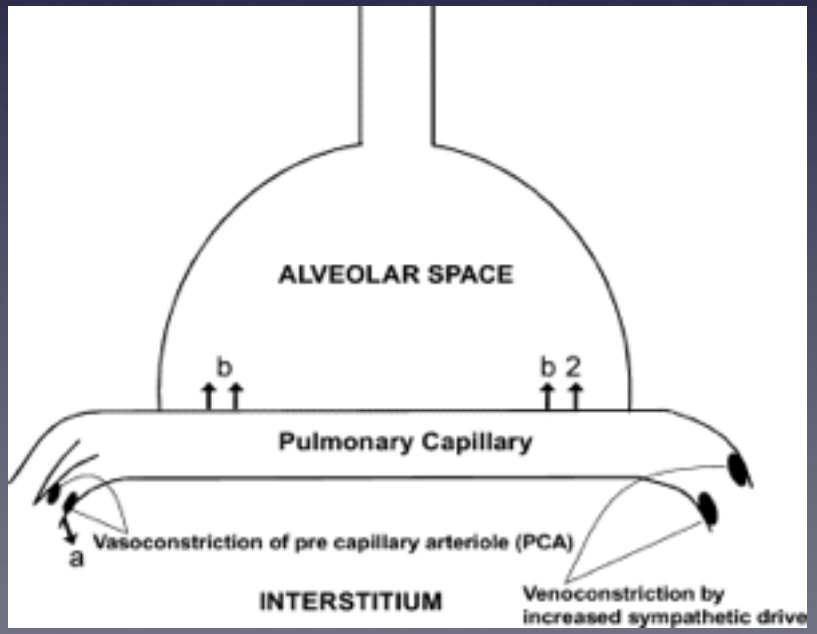
- 42 year old Italian mountaineer at 14K feet c/o SOB at rest, cough
- Similar episode in Alps
- RR 28, O_2 70%, T nl
- PE: scattered crackles

Differential diagnosis

- Pneumonia
- Pulmonary embolus
- Pneumothorax
- Congestive heart failure (CHF)
- **High Altitude Pulmonary Edema (HAPE)**

What causes HAPE?





*Sartori, Resp Physiol Neurobiol 2007

Diagnosis of HAPE

- Early:
  -cough
  -reduced exercise performance/DOE
- Later:
  -**shortness of breath at rest** (hallmark)
  -orthopnea
  -frothy sputum
- Can present without AMS

Management of HAPE

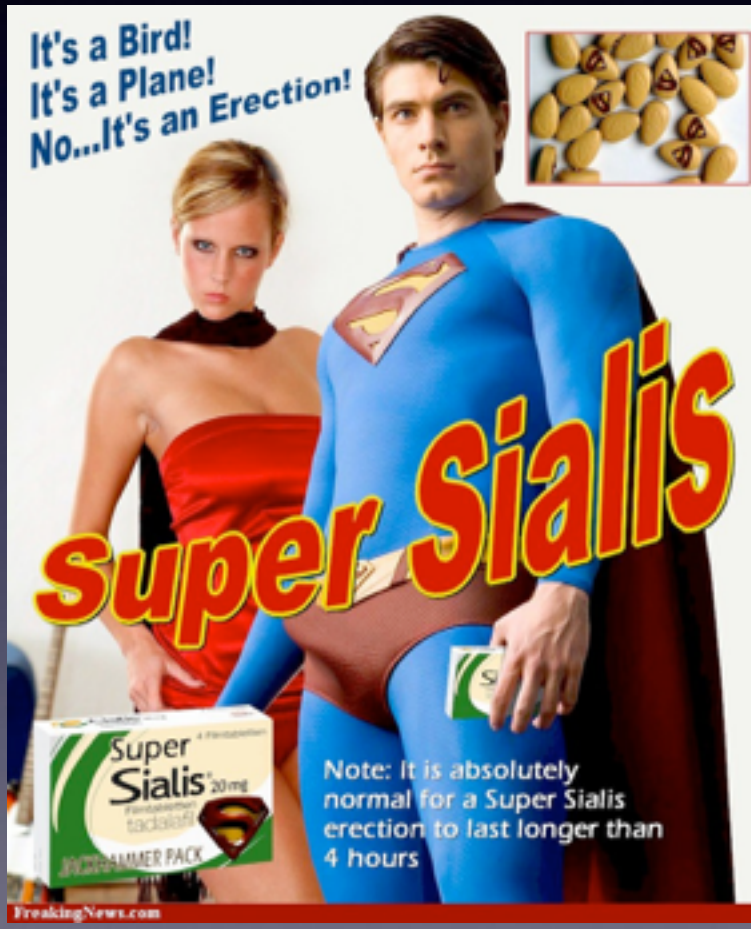
- **DESCENT** (minimal exertion)-sx still last days
- If delay:
  - Oxygen/Gamow bag
  - Nifedipine 20mg q6hr **OR**
  - Phosphodiesterase inhibitors (e.g. Sildenafil 25-50 mg q8)
  - **NO** diuretics

Prevention of HAPE

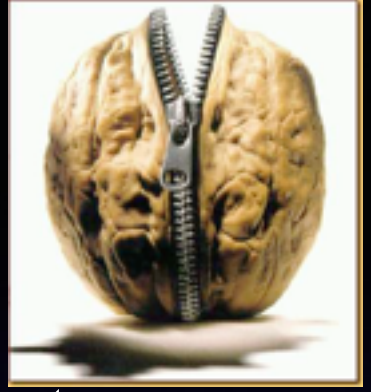
- Gradual ascent
- If prior history of HAPE:
  - Nifedipine: SR 60mg div BID
    1 day prior
    *First line: 64% →10% HAPE
  - Salmeterol: 125 ug BID
    *tighten endothelial jxn and decrease PA pressure
    *74→33% reduction in HAPE

Prevention of HAPE

- If prior history of HAPE:
  - Tadalafil: 10mg BID 1day prior
    *single small study: 74→10%
    *can increase AMS risk
  - Dexamethasone: 8mg bid
    *small study
    *reduced AMS risk



In a nutshell



- **AMS**
  - Ascend slowly, take diamox or ibuprofen to prevent
  - Go down, take diamox/dex if you have it
- **HACE**
  - Confused and ataxic—>DESCEND plus dex
- **HAPE**
  - Nifedipine or salmeterol if you've *had* it
  - DESCEND, nifedipine or viagra if you *have* it

www.himalayanrescue.org