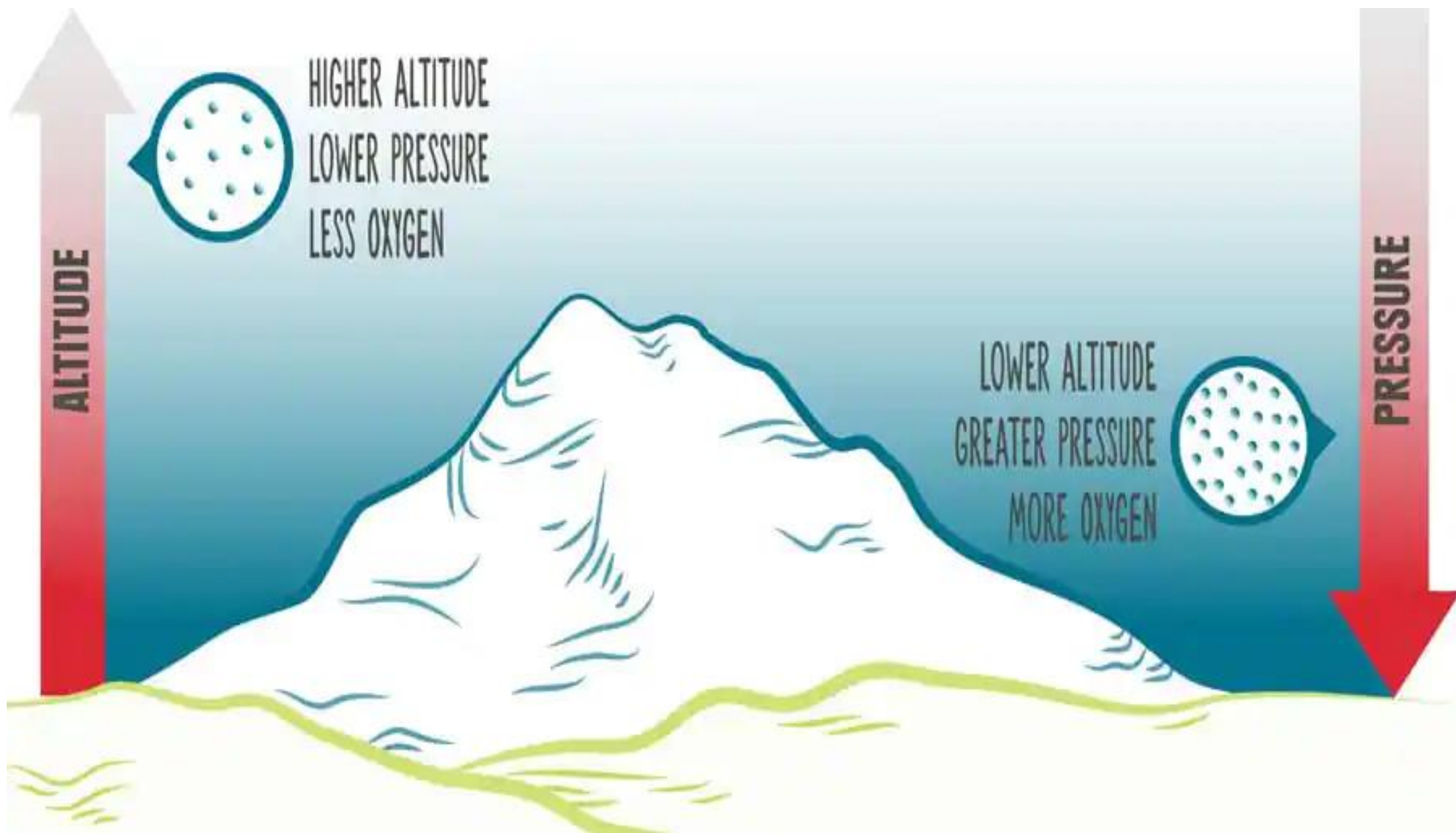
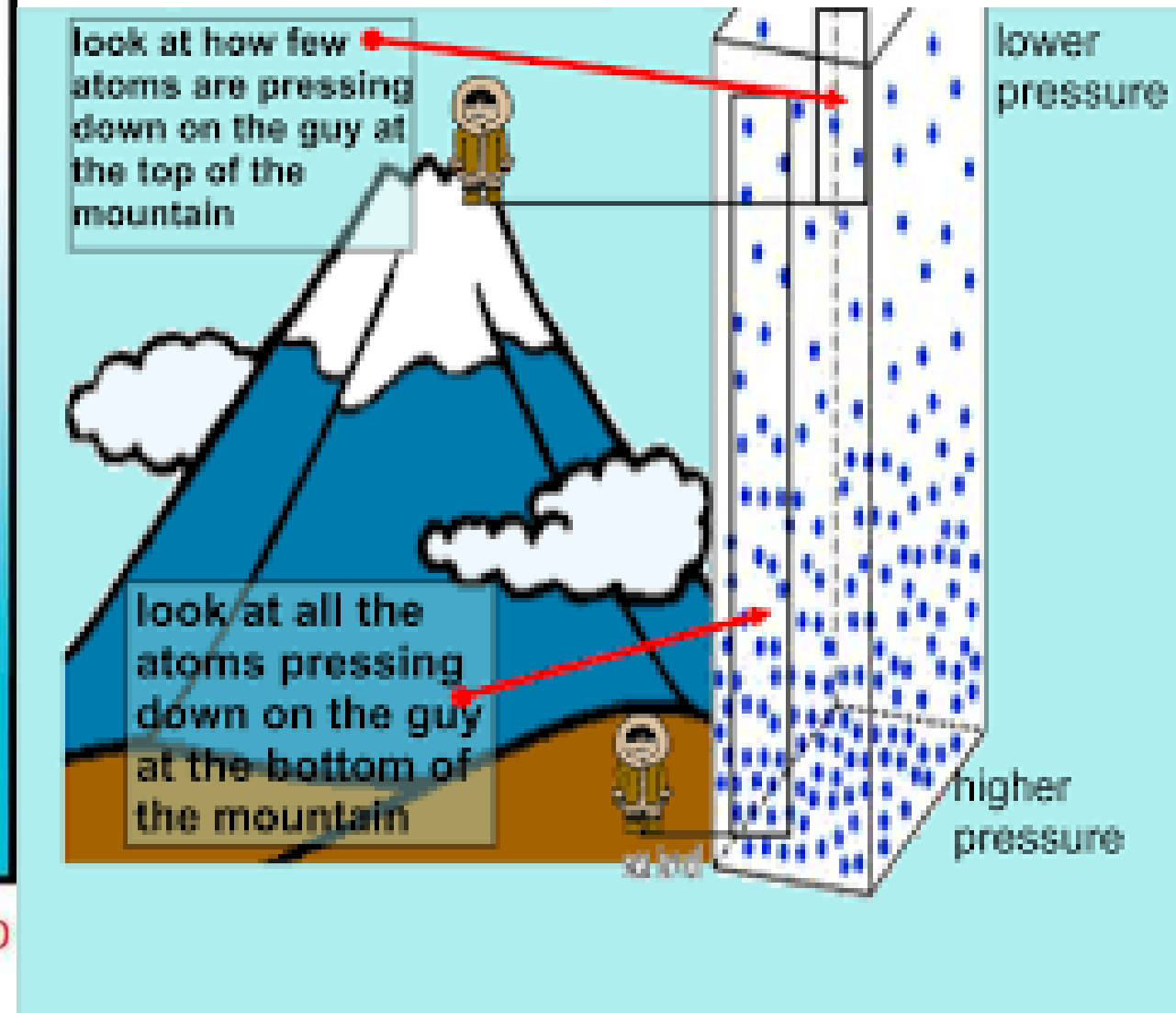
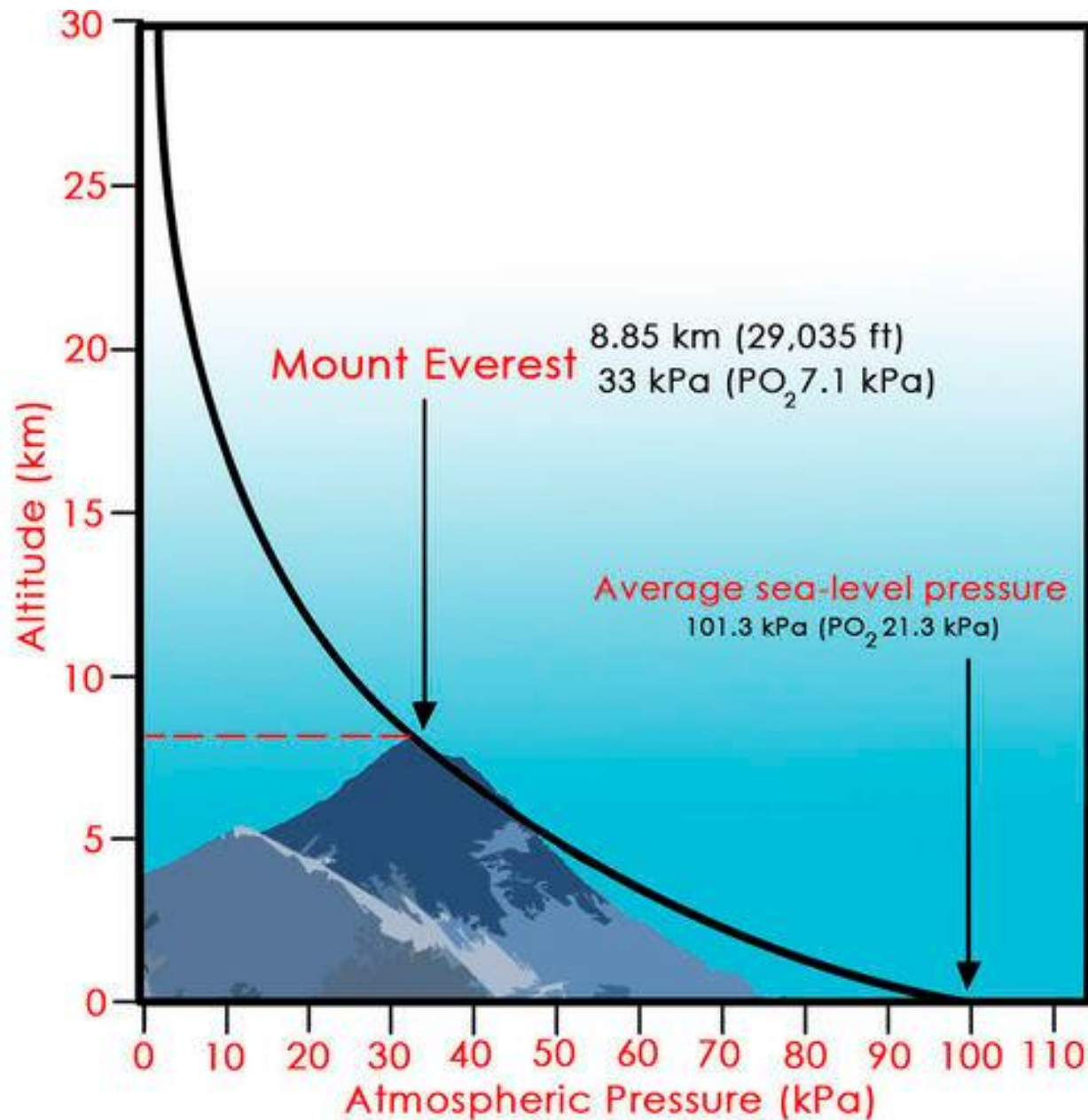


# Dr Ali Ashraf Intensivist

*High altitude sickness*  
*Hypo and hyperthermia*

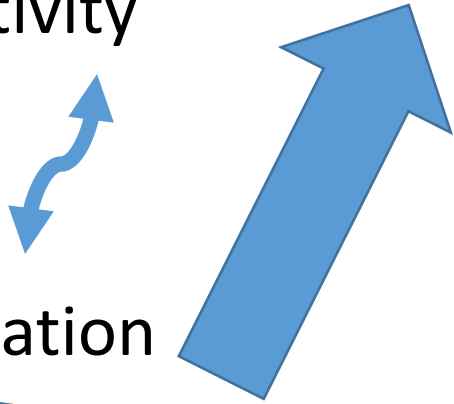






# Hypoxia/Acclimatization physiologic responses

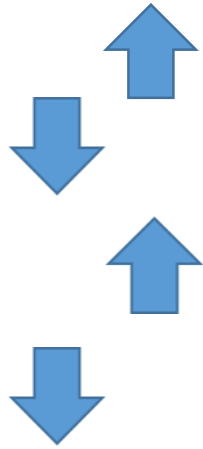
- Sympathetic activity
- Heart rate
- Cardiac output
- Systemic vasodilation
- Blood pressure





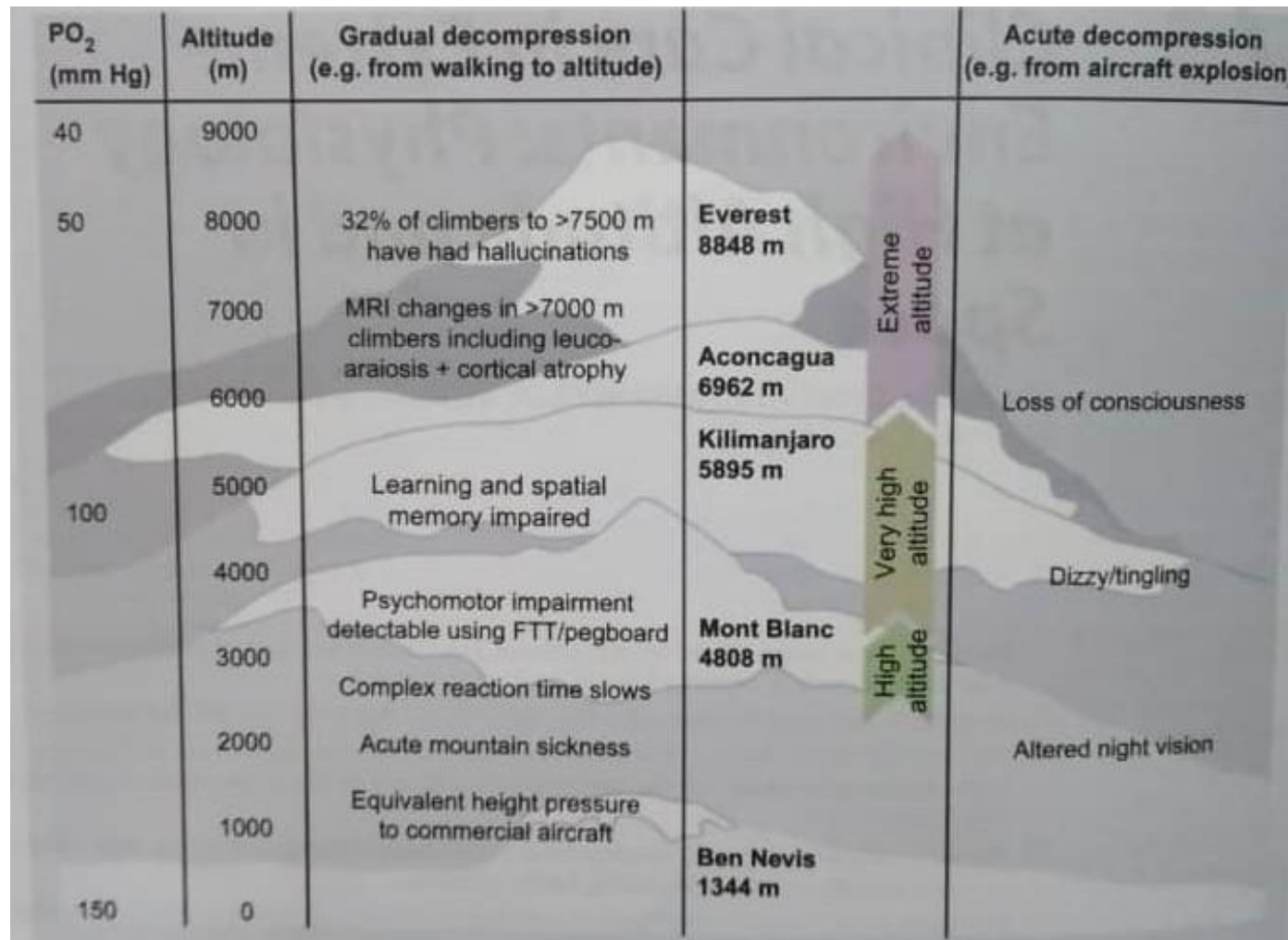
# Hypoxia/Acclimatization hematologic responses

- Hb concentration
- Plasma volume
- Erythropoietin
- Microcirculation



# Hypoxia/Acclimatization

## Respiratory responses



Extreme Altitude

30,000 ft (32% O<sub>2</sub>\*)

Very High Altitude

18,000 ft (52% O<sub>2</sub>\*)

11,500 ft (66% O<sub>2</sub>\*)

High Altitude

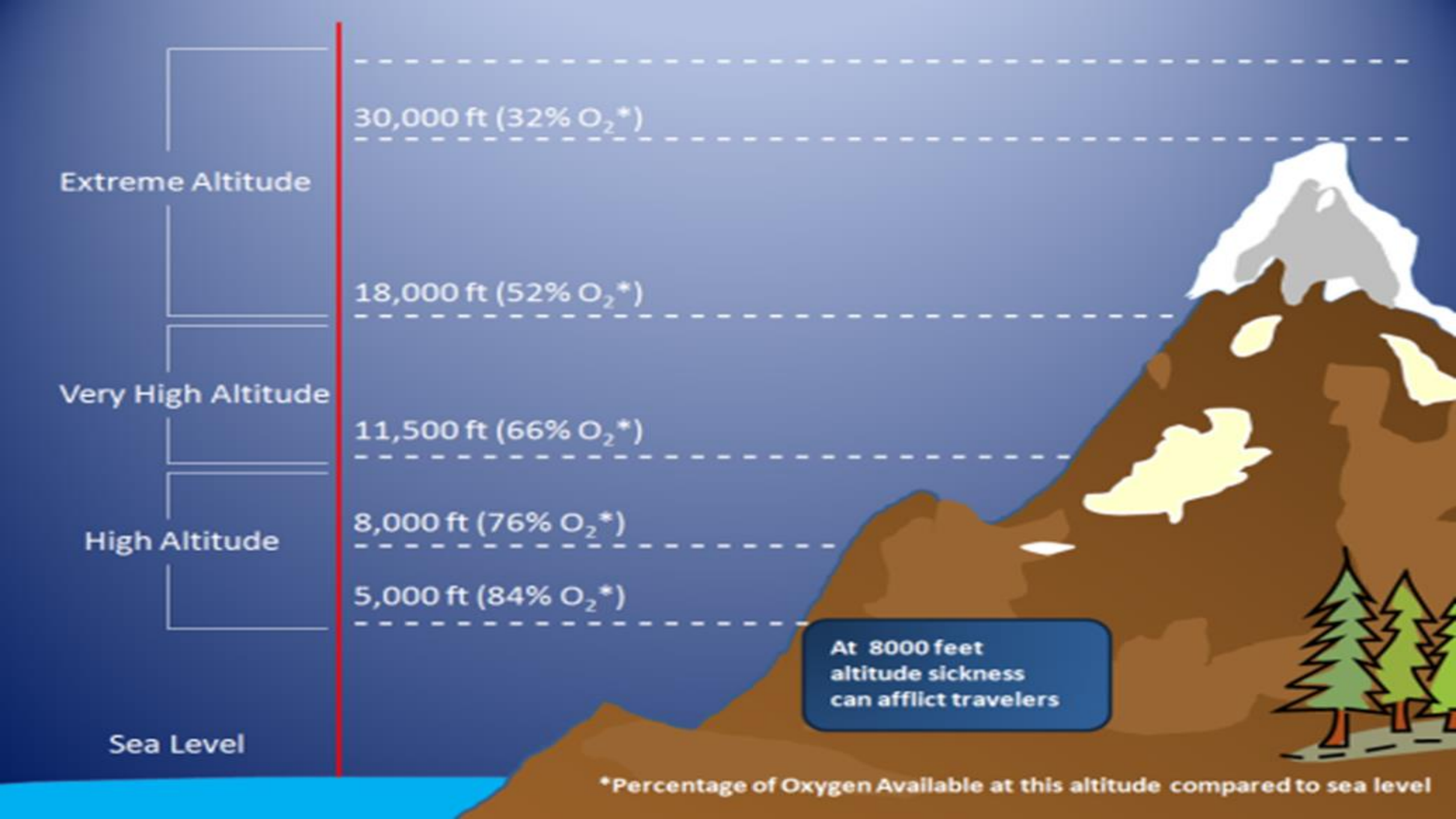
8,000 ft (76% O<sub>2</sub>\*)

5,000 ft (84% O<sub>2</sub>\*)

Sea Level

At 8000 feet  
altitude sickness  
can afflict travelers

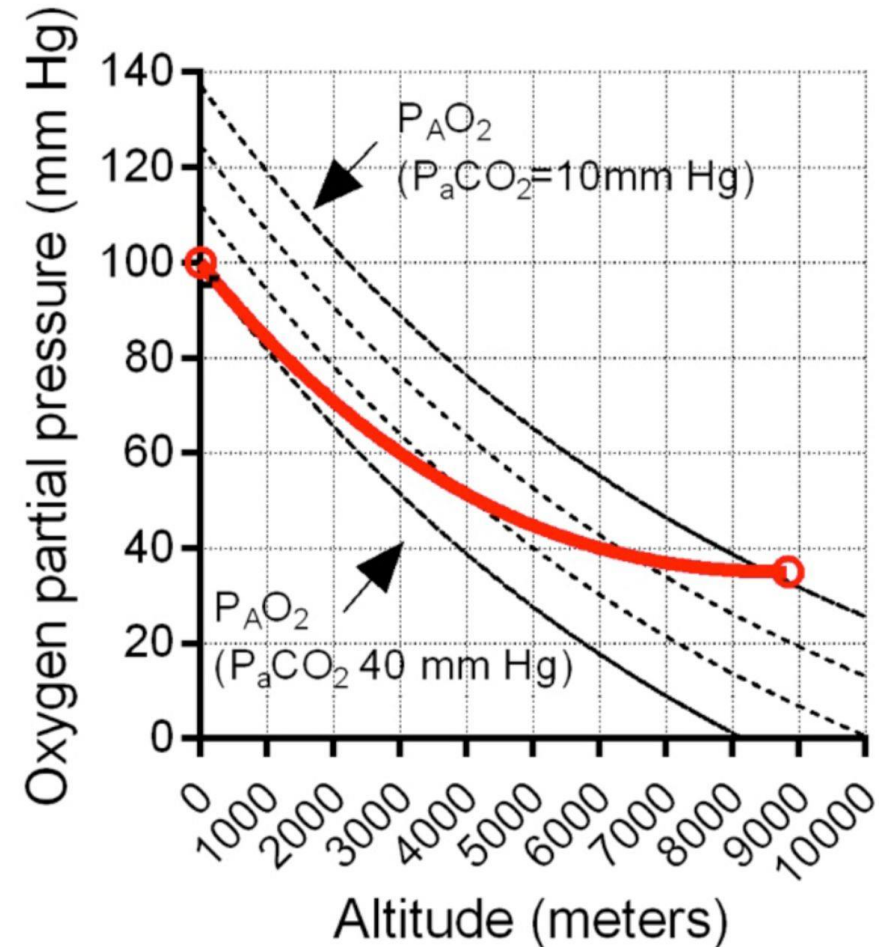
\*Percentage of Oxygen Available at this altitude compared to sea level



# Hypoxia/Acclimatization

## Respiratory responses and HVR

- $P_{AO_2}$  ↓
- $P_{aO_2}$  ↓
- $P_{aCO_2}$  ↓
- $P_{AO_2}$  ↑
- Oxygen dissociation curve ←
- 2,3-DPG ↑
- Oxygen dissociation curve →

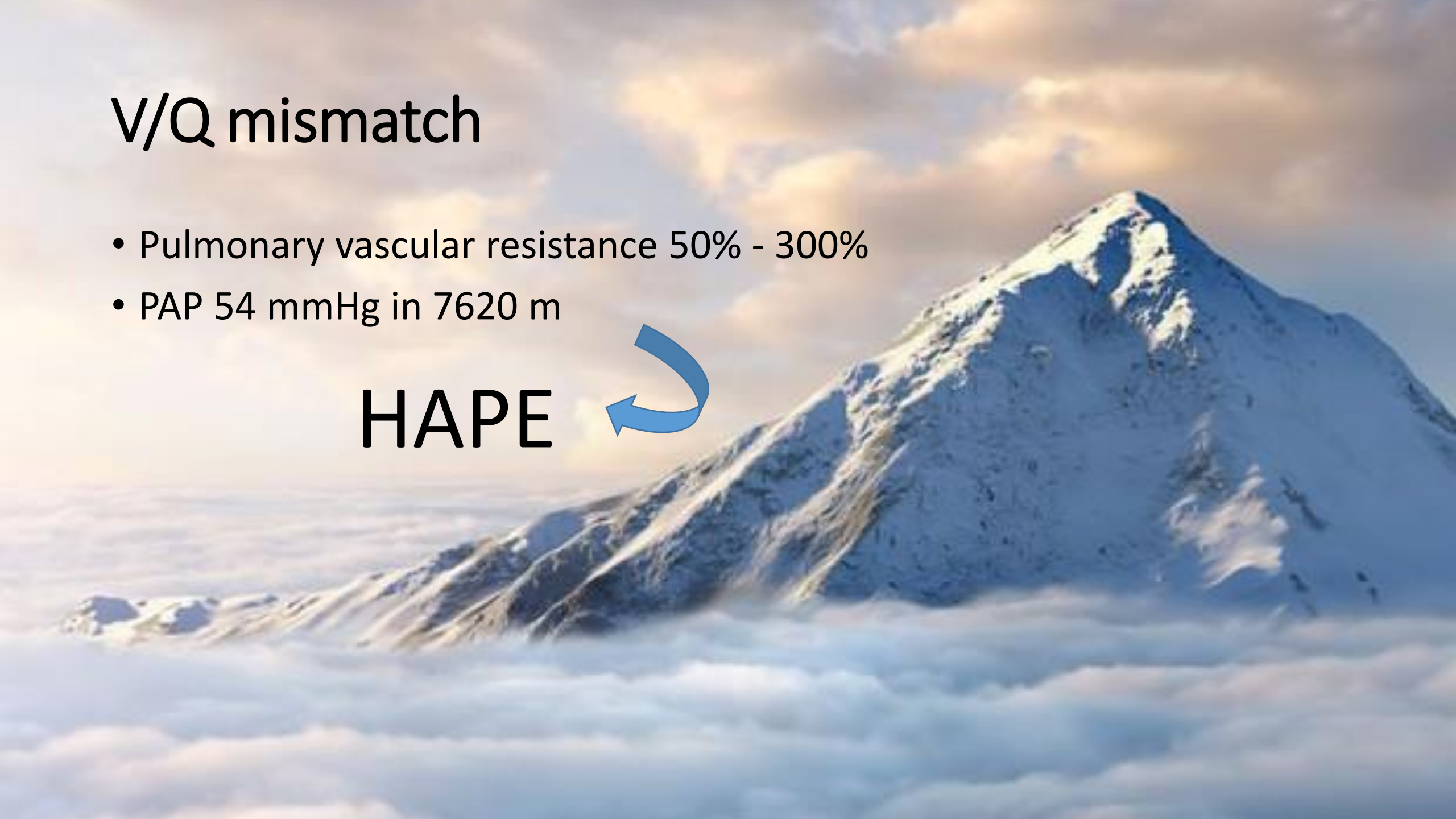


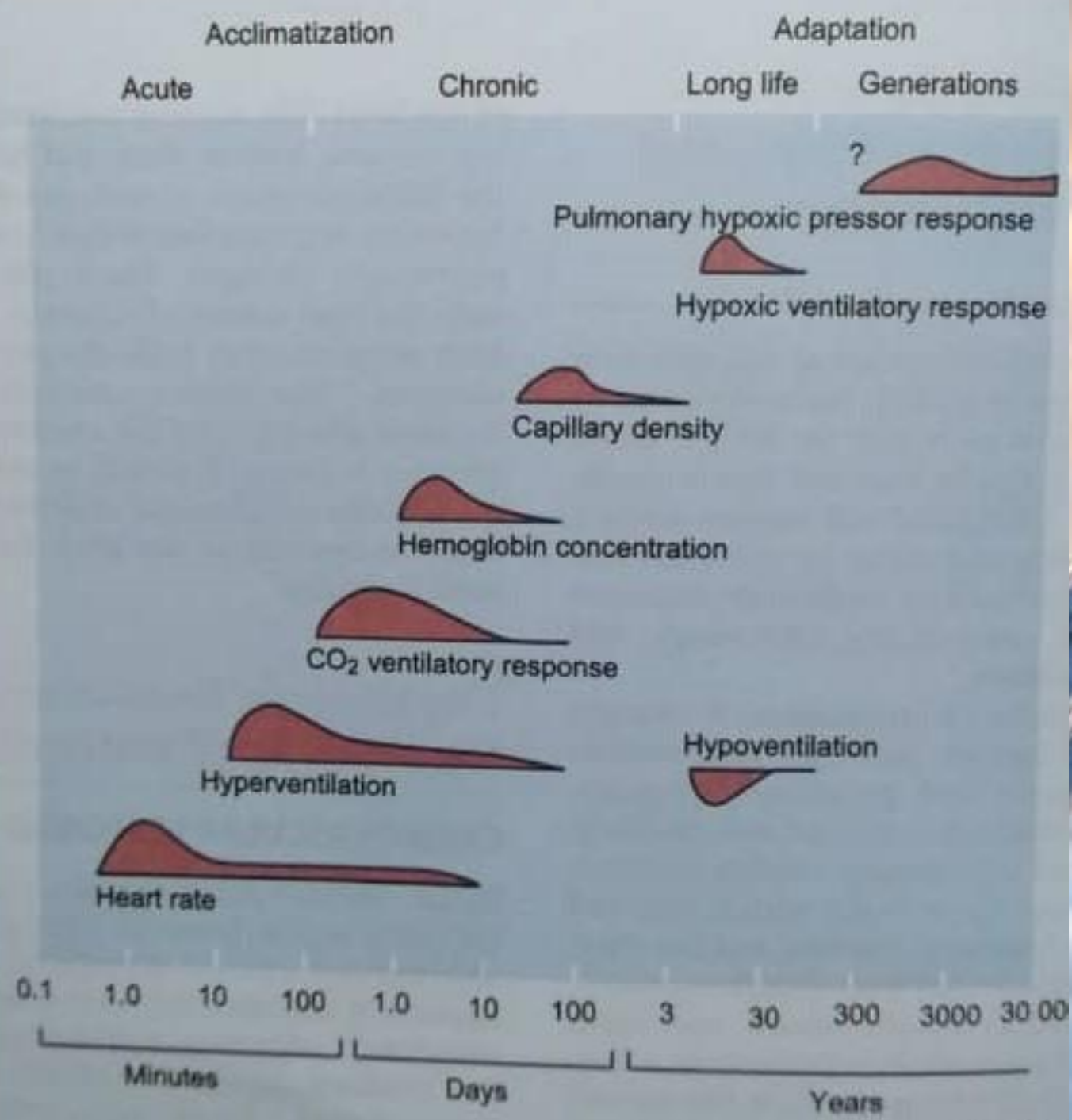


# V/Q mismatch

- Pulmonary vascular resistance 50% - 300%
- PAP 54 mmHg in 7620 m

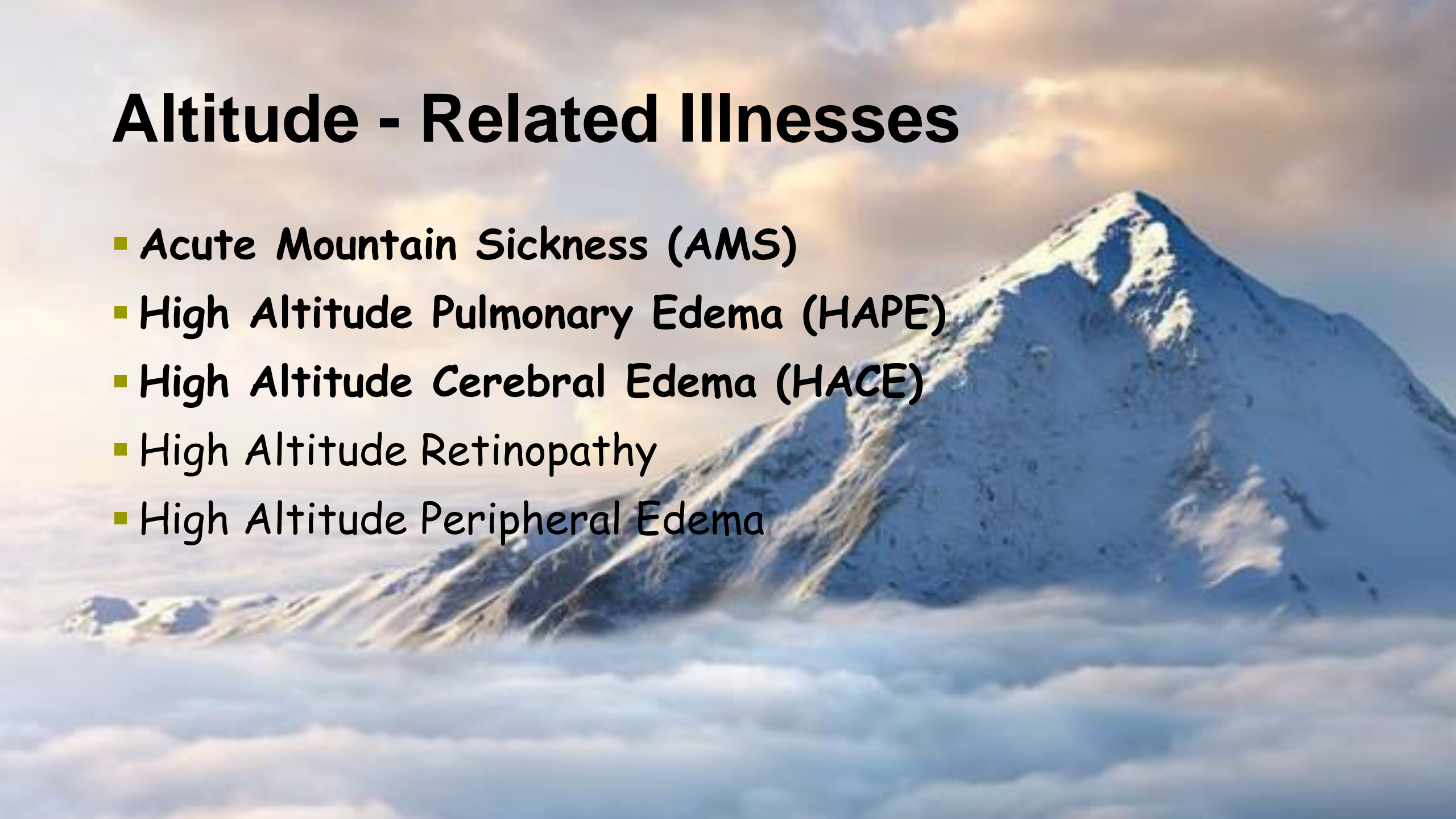
HAPE





# Altitude - Related Illnesses

- Acute Mountain Sickness (AMS)
- High Altitude Pulmonary Edema (HAPE)
- High Altitude Cerebral Edema (HACE)
- High Altitude Retinopathy
- High Altitude Peripheral Edema





# Acute Mountain Sickness :

## Incidence

- Typically occurs at altitude  $> 8000$  feet
- Rarely occurs at altitude 6000 to 8000 feet
- No predeliction based on gender
- More likely if :
  - Rapid ascent
  - Lack of acclimatization





# Acute Mountain Sickness : Exacerbating Factors

- Sudden ascent
- Exertion soon after arrival
- Alcohol intake
- Sedatives (sleeping pills)
- Narcotics



# Acute Mountain Sickness :

## Symptoms

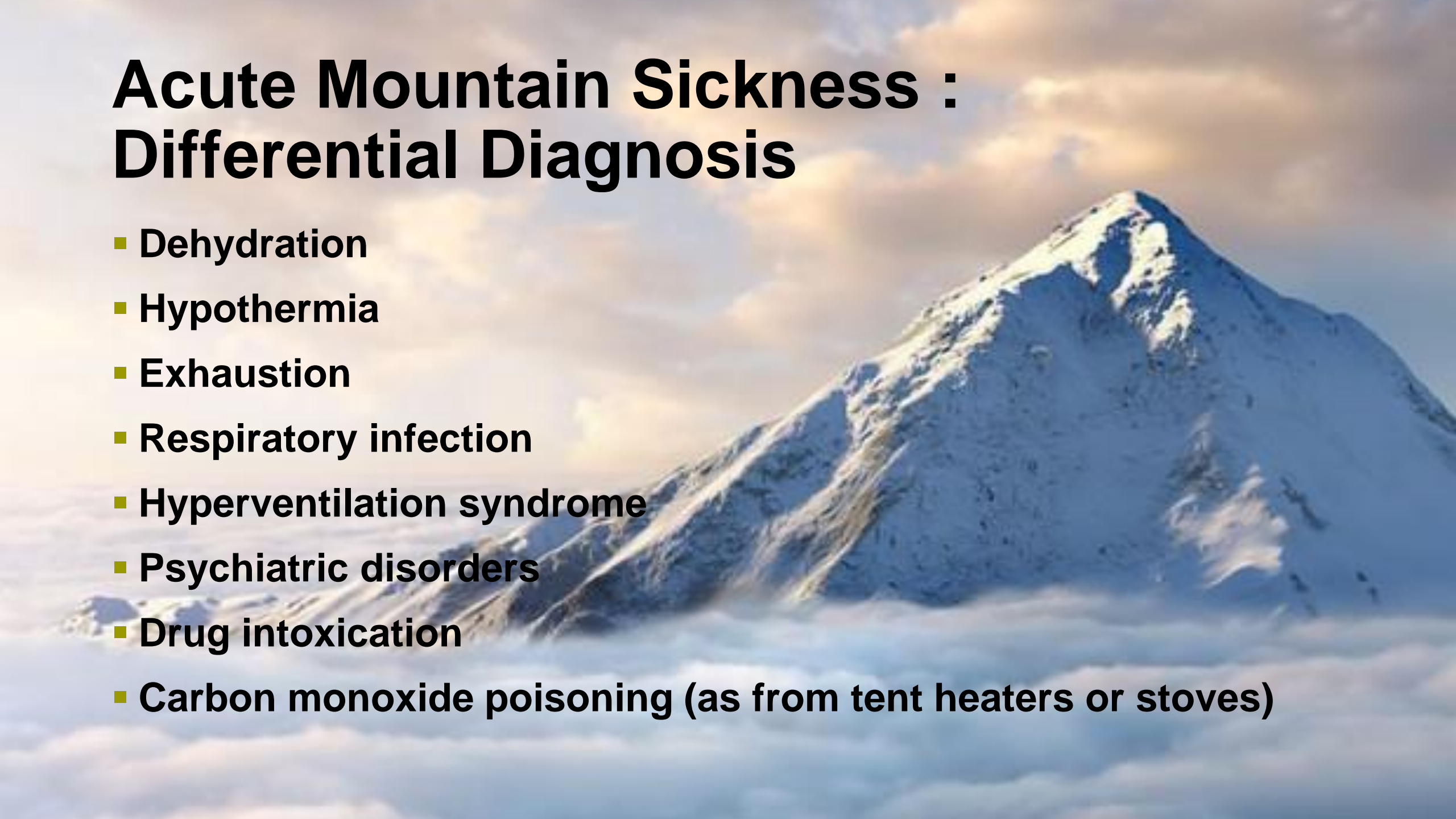
- Headache
- Nausea
- Anorexia
- Lassitude
- "Like a hangover"
- Insomnia
- Decreased urination
- Onset typically 8 to 24 hours after ascent





# Acute Mountain Sickness : Differential Diagnosis

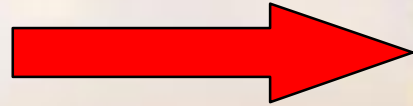
- Dehydration
- Hypothermia
- Exhaustion
- Respiratory infection
- Hyperventilation syndrome
- Psychiatric disorders
- Drug intoxication
- Carbon monoxide poisoning (as from tent heaters or stoves)



# Relationships of the Different Forms of Altitude Illness

Altitude illness may be an interrelated spectrum :

AMS



HAPE



HACE





- **Acclimatization**
  - Staging of ascent
  - Delaying exertion
- **Medication choices :**
  - Acetazolamide (Diamox) 250 mg PO bid or tid
  - Dexamethasone (Decadron) 4 mg PO tid or qid
  - Should start either med 24 hours prior to ascent

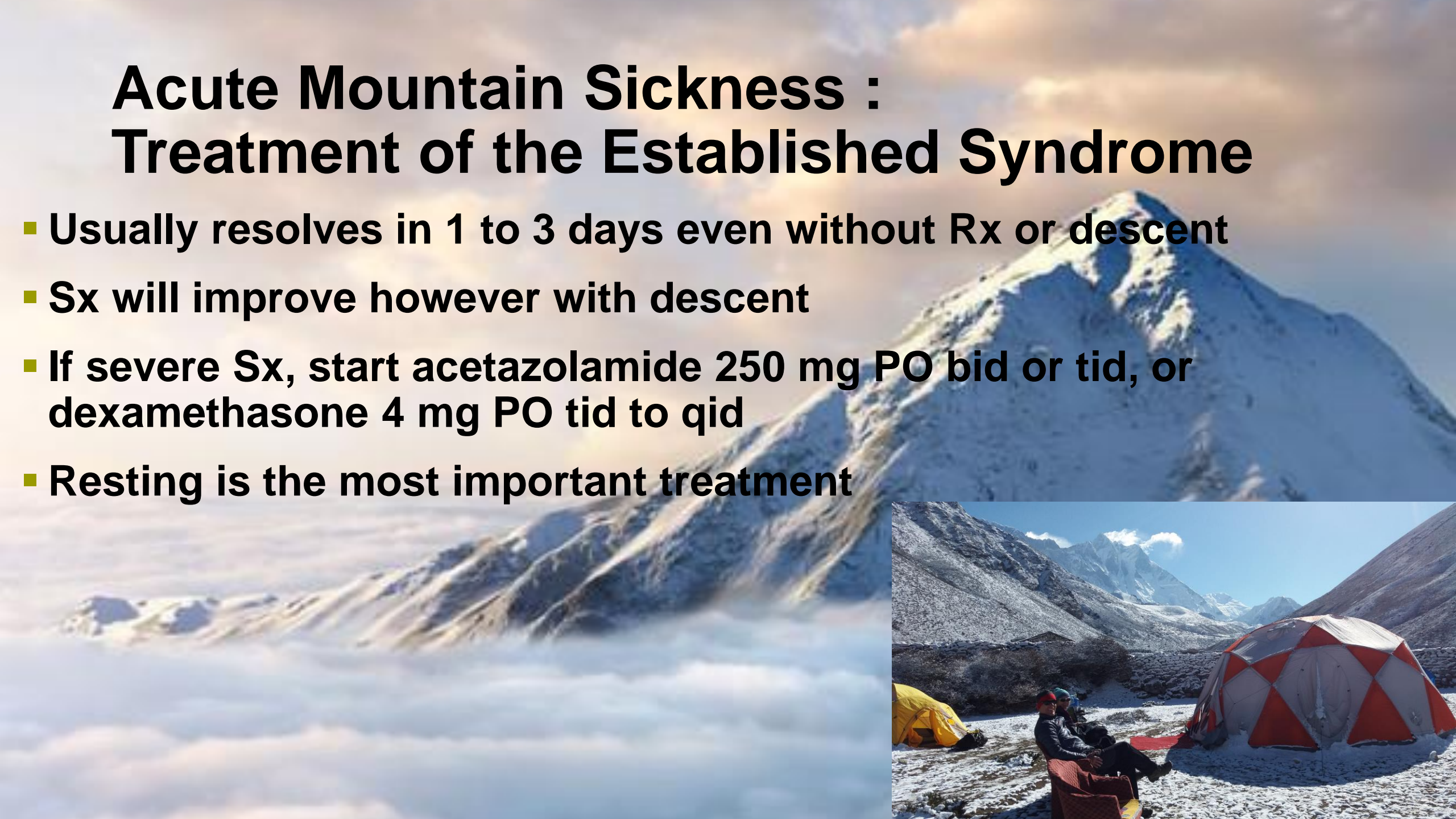


Wall mounted oxygen in hotel in Lhasa, Tibet (altitude 13,000 feet)



# Acute Mountain Sickness : Treatment of the Established Syndrome

- Usually resolves in 1 to 3 days even without Rx or descent
- Sx will improve however with descent
- If severe Sx, start acetazolamide 250 mg PO bid or tid, or dexamethasone 4 mg PO tid to qid
- Resting is the most important treatment



# Progression of Acute Mountain Sickness

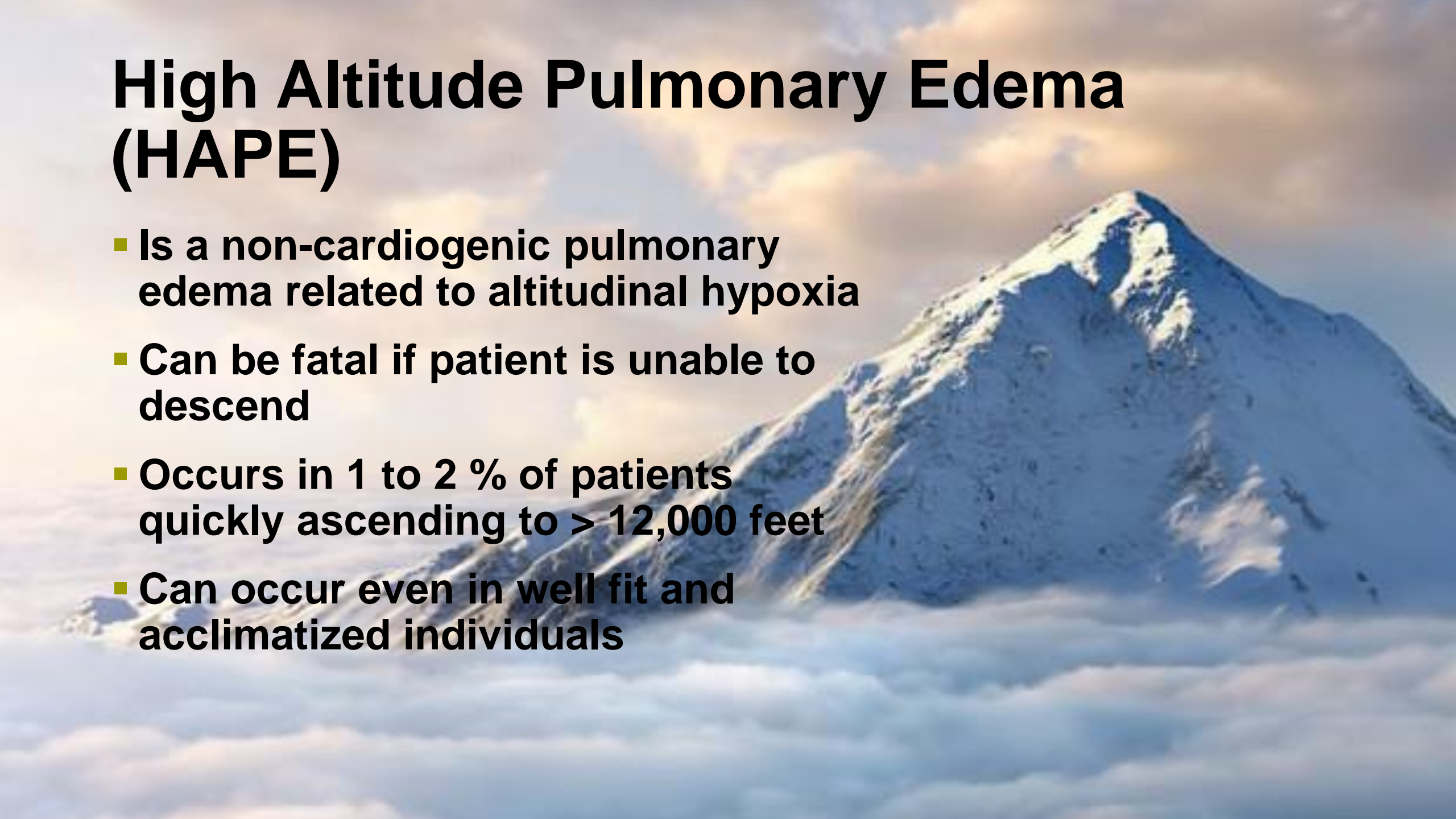
- If ascent is continued or accelerated by a patient with untreated AMS,
- HAPE or HACE may occur and
- death may result





# High Altitude Pulmonary Edema (HAPE)

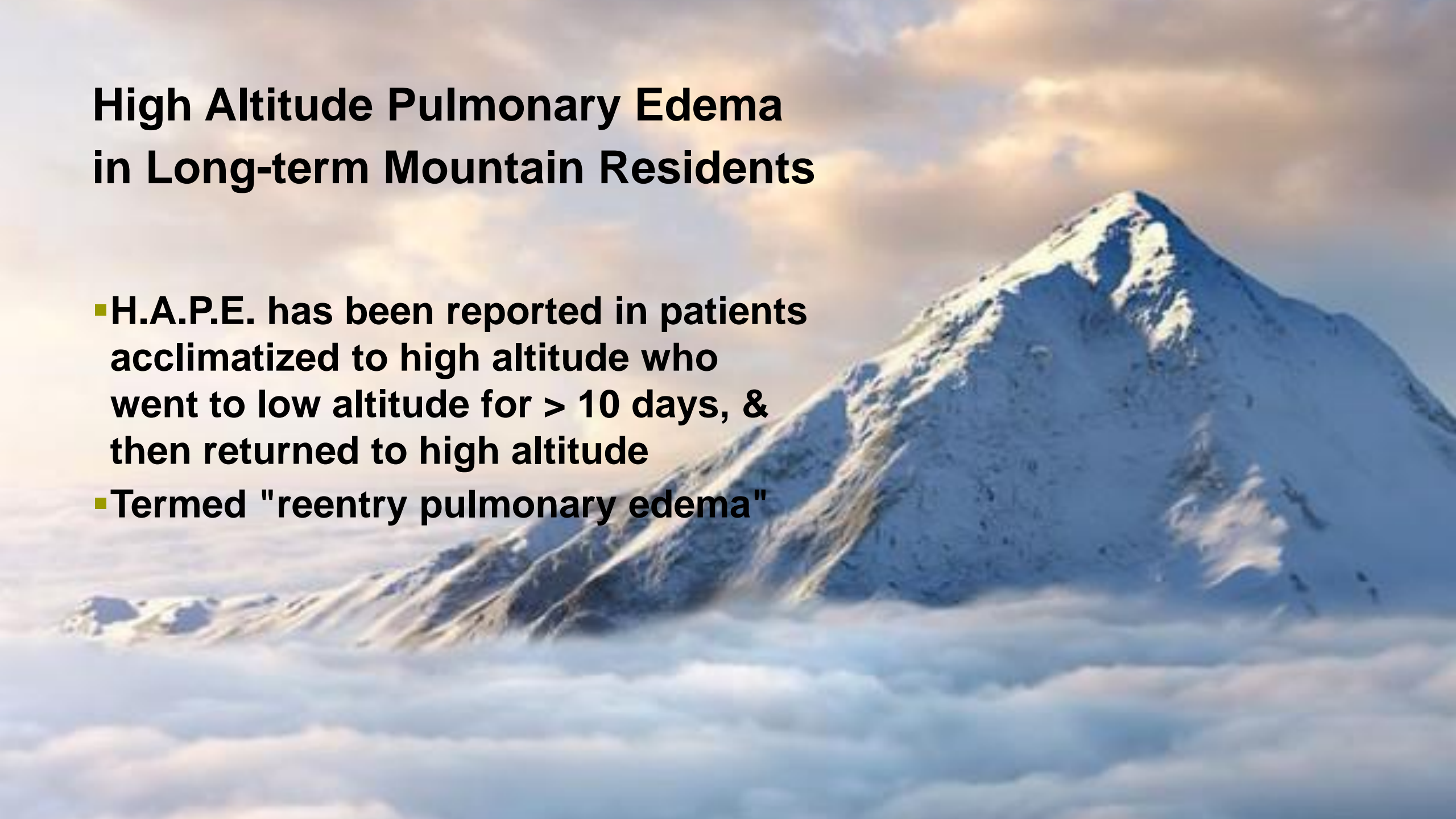
- Is a non-cardiogenic pulmonary edema related to altitudinal hypoxia
- Can be fatal if patient is unable to descend
- Occurs in 1 to 2 % of patients quickly ascending to > 12,000 feet
- Can occur even in well fit and acclimatized individuals





# High Altitude Pulmonary Edema in Long-term Mountain Residents

- H.A.P.E. has been reported in patients acclimatized to high altitude who went to low altitude for  $> 10$  days, & then returned to high altitude
- Termed "reentry pulmonary edema"



# High Altitude Pulmonary Edema :

## Symptoms

- **Usual sequence :**

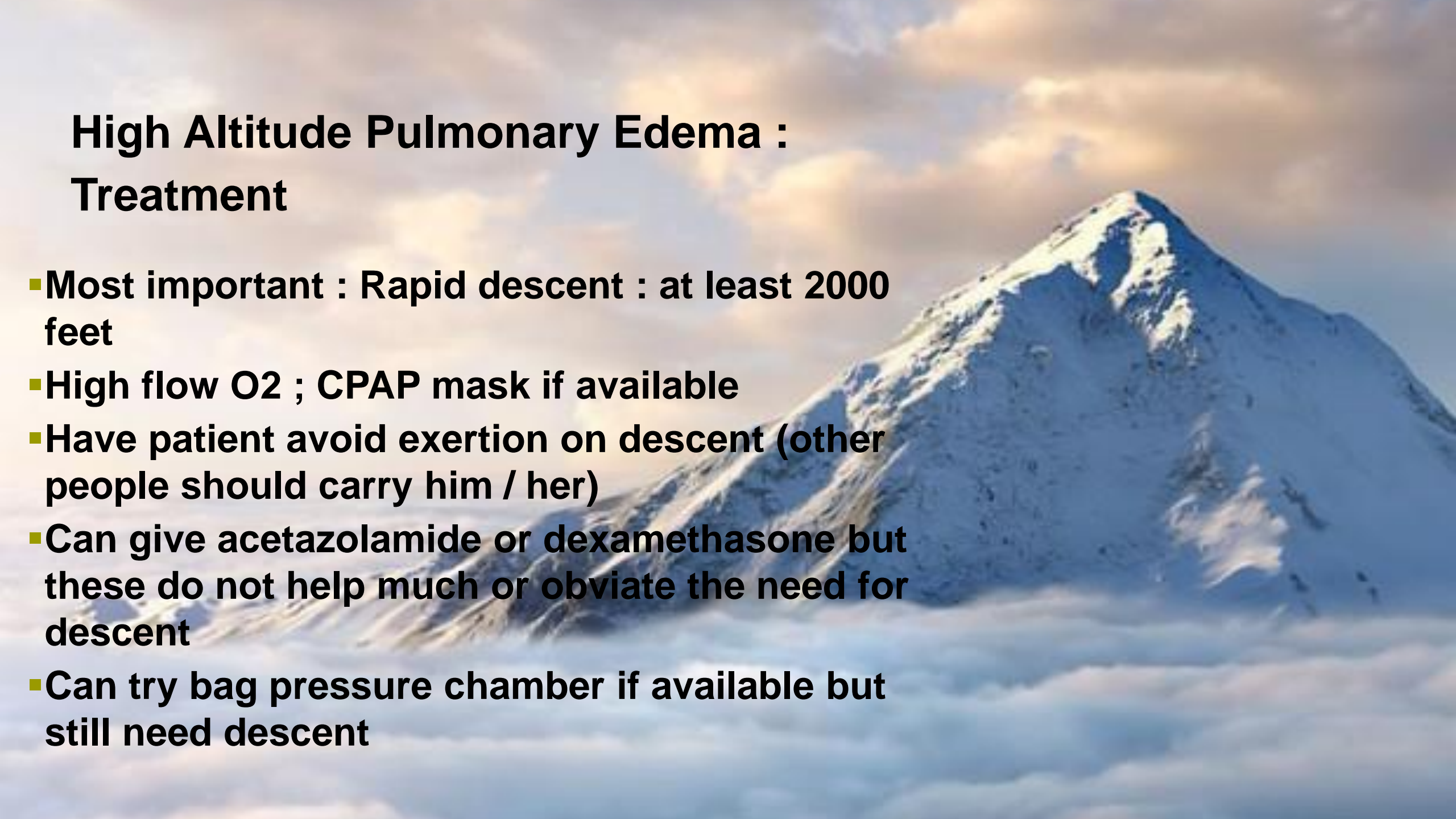
- Cough → dyspnea at rest → achy chest pain → progressive cough → progressive rales → frothy sputum → hemoptysis → frank respiratory failure

- **Chest X-ray appearance is variable :**

- Patchy infiltrates (often right > left)
  - If severe, may be bilateral "whiteout"

# High Altitude Pulmonary Edema : Treatment

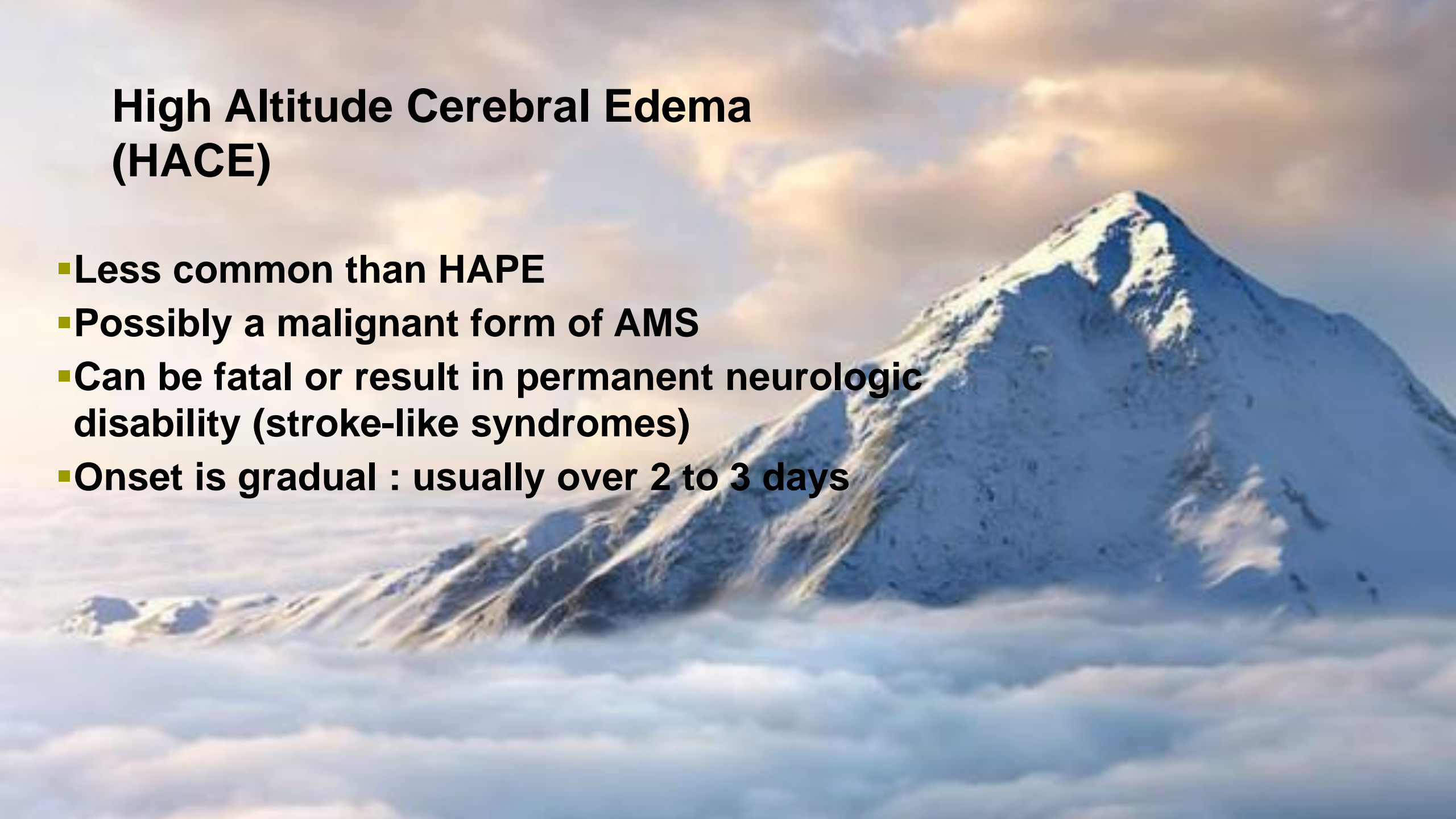
- **Most important : Rapid descent : at least 2000 feet**
- **High flow O<sub>2</sub> ; CPAP mask if available**
- **Have patient avoid exertion on descent (other people should carry him / her)**
- **Can give acetazolamide or dexamethasone but these do not help much or obviate the need for descent**
- **Can try bag pressure chamber if available but still need descent**





# High Altitude Cerebral Edema (HACE)

- Less common than HAPE
- Possibly a malignant form of AMS
- Can be fatal or result in permanent neurologic disability (stroke-like syndromes)
- Onset is gradual : usually over 2 to 3 days

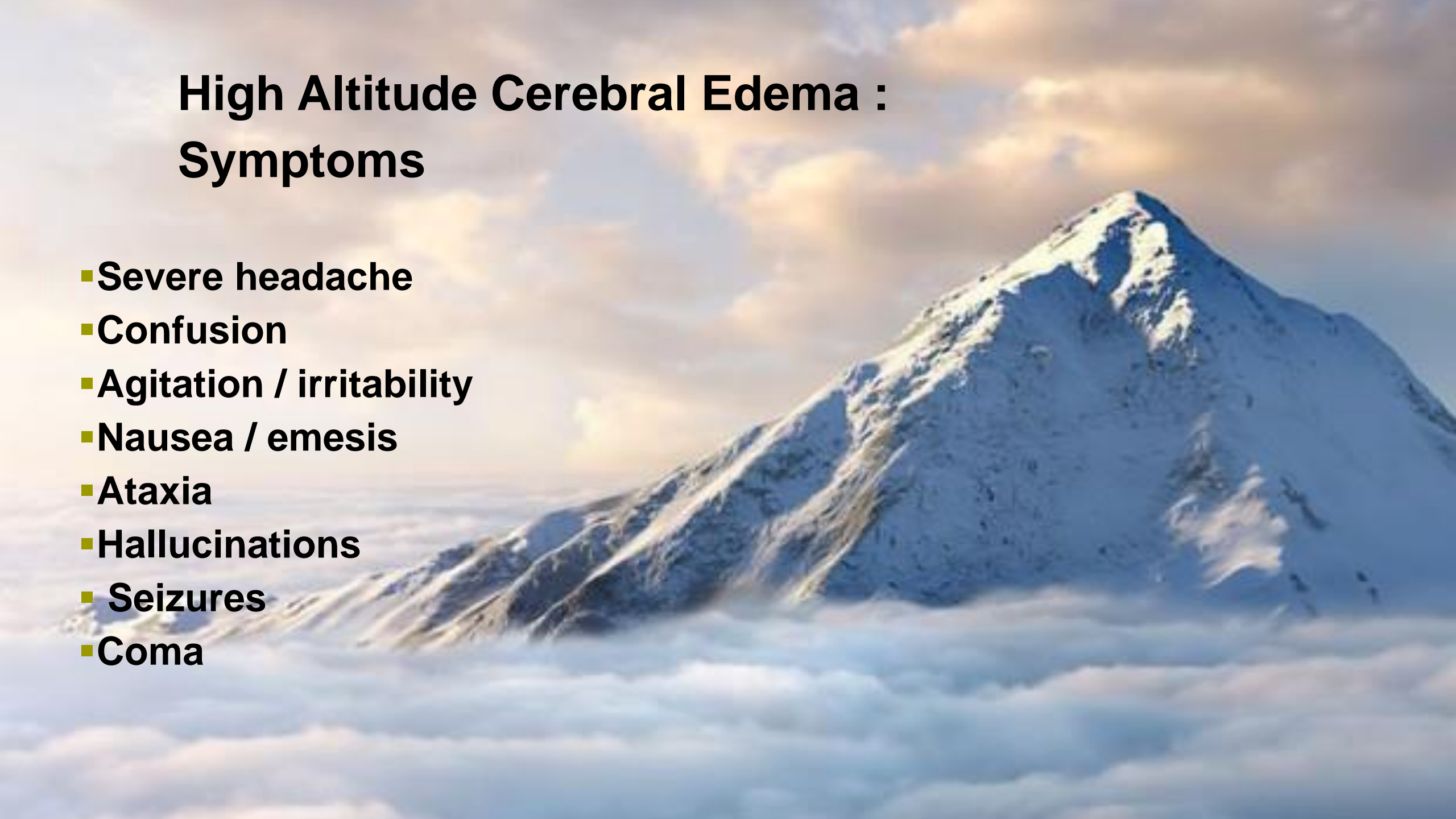




# High Altitude Cerebral Edema :

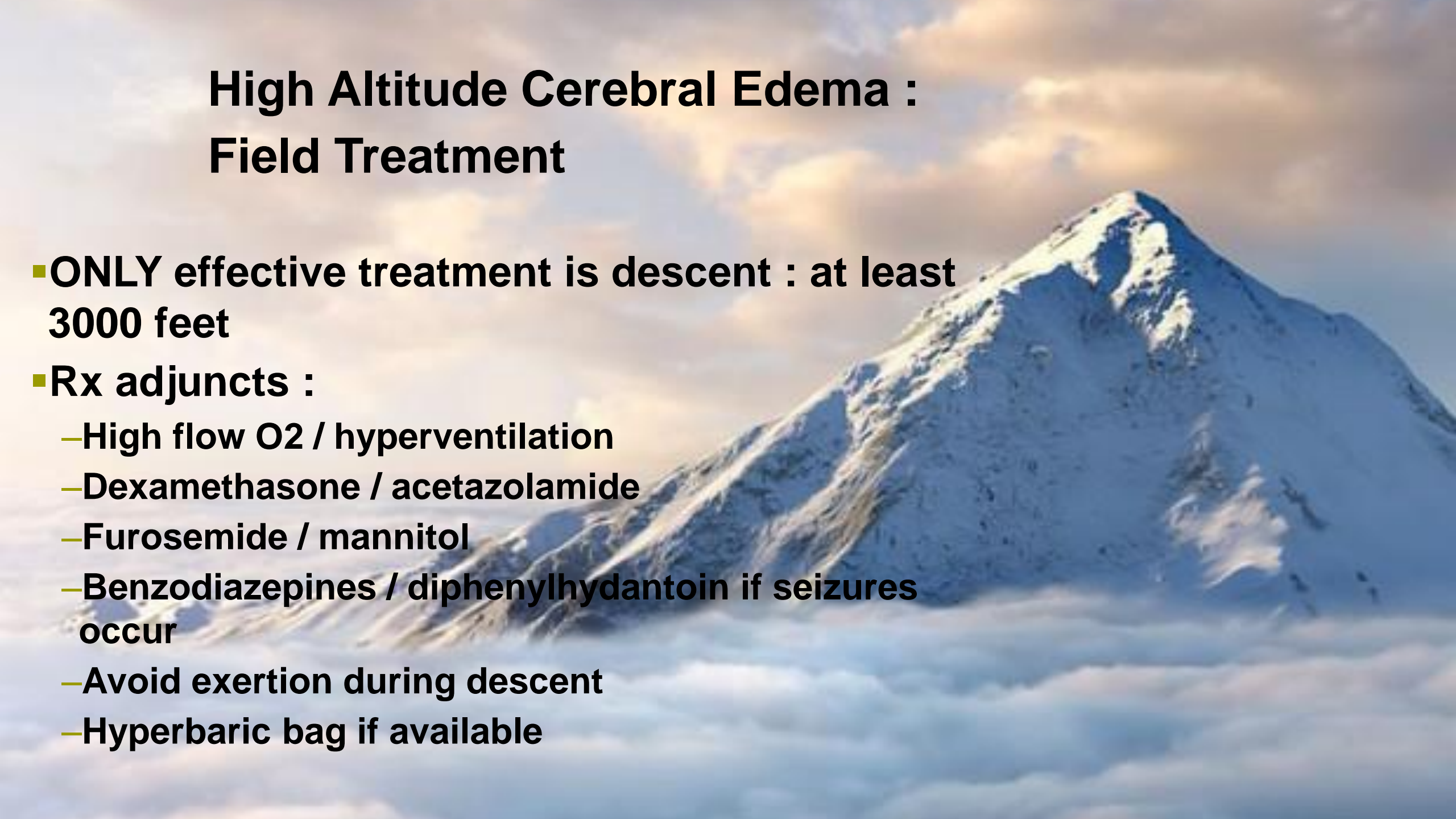
## Symptoms

- Severe headache
- Confusion
- Agitation / irritability
- Nausea / emesis
- Ataxia
- Hallucinations
- Seizures
- Coma



# High Altitude Cerebral Edema : Field Treatment

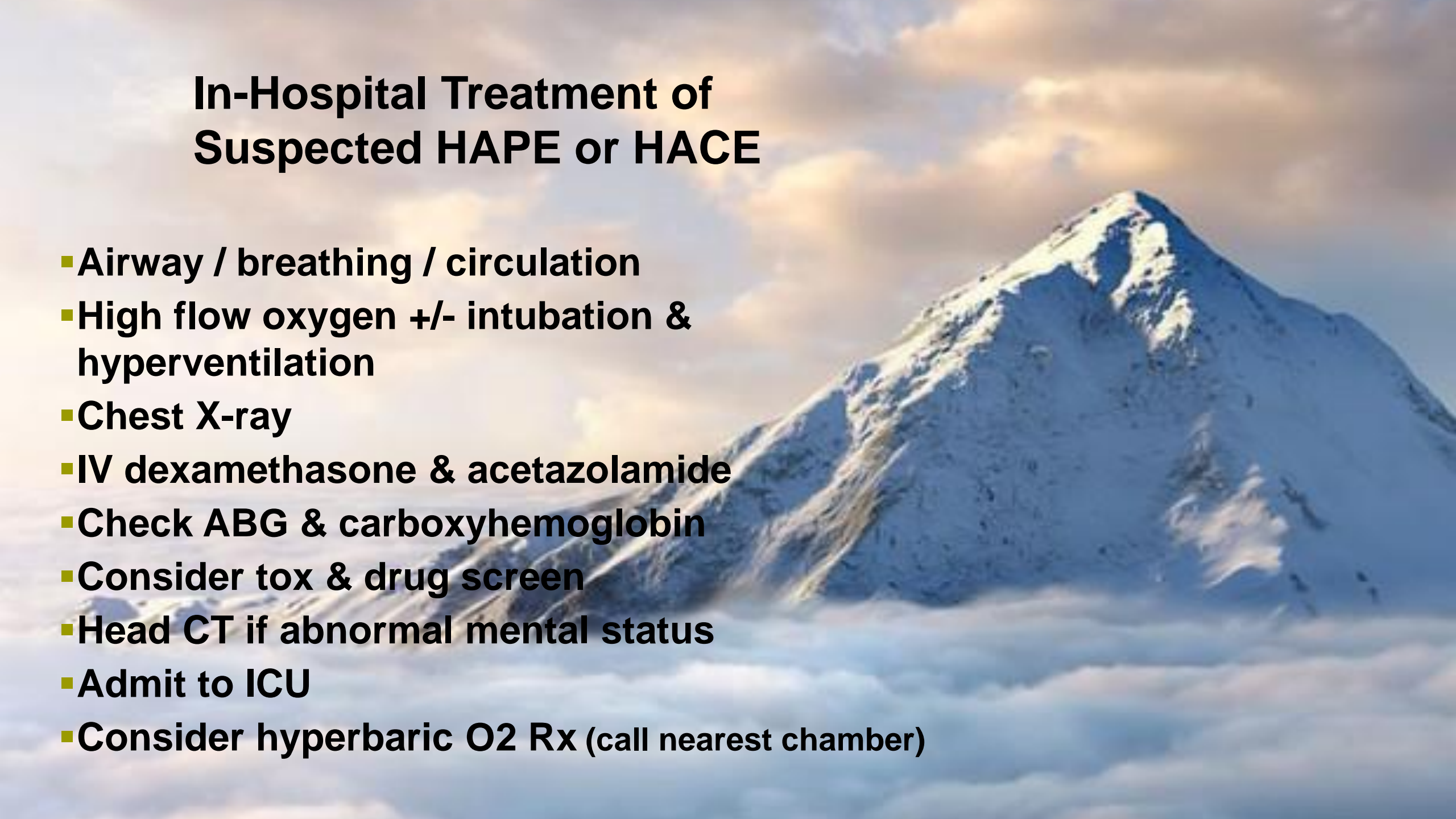
- **ONLY effective treatment is descent : at least 3000 feet**
- **Rx adjuncts :**
  - High flow O<sub>2</sub> / hyperventilation
  - Dexamethasone / acetazolamide
  - Furosemide / mannitol
  - Benzodiazepines / diphenylhydantoin if seizures occur
  - Avoid exertion during descent
  - Hyperbaric bag if available





# In-Hospital Treatment of Suspected HAPE or HACE

- Airway / breathing / circulation
- High flow oxygen +/- intubation & hyperventilation
- Chest X-ray
- IV dexamethasone & acetazolamide
- Check ABG & carboxyhemoglobin
- Consider tox & drug screen
- Head CT if abnormal mental status
- Admit to ICU
- Consider hyperbaric O2 Rx (call nearest chamber)







# HYPOTHERMIA

- HYPOTHERMIA
- ‘Hypo’ = Below / under      ‘Thermia’= heat
  - Condition in which a person’s body temperature is sufficiently below normal to cause distress and disorder of normal bodily functions.
    - Mental deterioration
    - Loss of coordination
    - Unconsciousness
    - Failure of breathing and circulation
    - Death

# What is Hypothermia?

- Lowering of core body temperature.
  - Normal temperature 37.5°C
  - Lowering of core body temperature to below 35°C (95°F)
- Mild Hypothermia 35°C – 34°C
- Moderate hypothermia 30°C – 33.9°C
- Severe Hypothermia below 30°C



# What is Hypothermia

- Body losses heat
- Radiation can occur when ambient temperature is below 98.6°F
- Conduction water conducts heat away 25 times faster than air
- Convection ie wind chill, swimming.
- Evaporation ie sweating

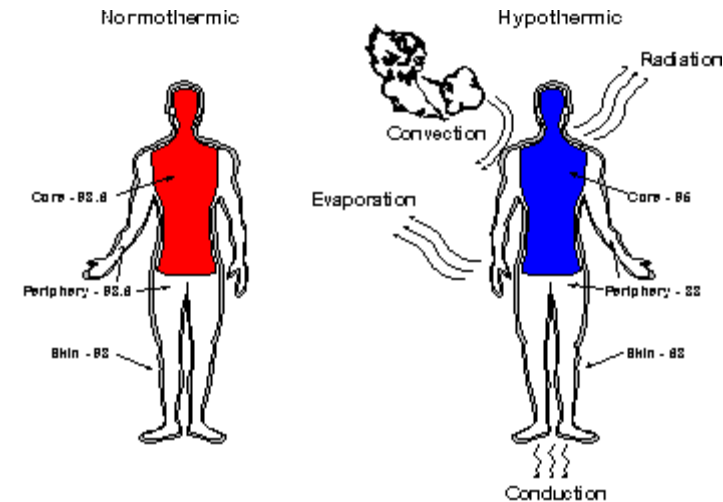


Diagram from Princeton University

- **Causes:**

- Cold
- Wind
- Wet clothing
- Perspiration
- Water immersion

- **Stages:**

Peripheral (core 37-36)

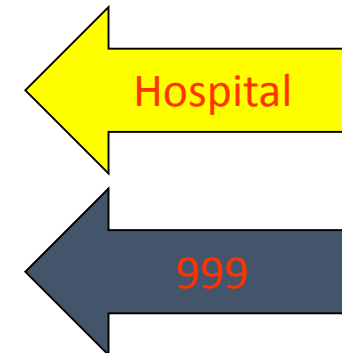
Moderate (core 34)

Severe (core 32 or lower)



# Symptoms

temp °C	Body Symptoms
37.5	Normal
36	Feel Cold
35	Shivering
34	Clumsy, Irrational, Confused
33	Muscle Stiffness
32	Shivering stops, Collapse
31	Semi Conscious
30	Unconscious
29	Slow pulse and Breathing
28	Cardiac Arrest





# Regulating Core temperature

- What your body does
  - Hot
    - Sweat – cools by evaporation
    - Vasodilation – blood vessel open on surface
    - Take layers off
  - Cold
    - Shiver – muscle activity
    - Vasoconstriction – reduce blood flow to surface
    - Put layers on

# Prevention

## Wear the correct clothing

- Take layers off or put layers on
- Stay Dry
- Prevent Windchill
- Provide Energy
- Don't get dehydrated
- Avoid alcohol

# Wetsuits and Drysuits

- Wetsuits work by trapping a layer of water near the skin thereby (when immersed)
  - Reducing conduction by insulation
  - Reducing convection
- Drysuits work by keeping occupant dry
  - Prevent convection
  - Require additional insulation to prevent conduction



# Other Clothing

- Thermals under drysuit
- Man-made materials next to skin reduce moisture
- Hat – 30% heat loss through head
- Personal bouyancy – don't need to work to stay afloat (reduces convection)

# Prevention - if you fall in!

- Get out of the water if possible
  - Climb onto upturned boat
- Minimise movement
  - BA/ LJ helps you stay afloat without swimming
  - Help position
  - Stay with boat
- Share warmth

# Hypothermia

- Treatment:
- Removal from cold, wet, windy conditions (shelter)
- Insulation to prevent further heat loss
- Passive or active re-warming
- Gentle and minimal handling
- Provision of nutritional and fluid support
- Transport to medical facility



# Hypothermia



Gloucester  
30<sup>th</sup> Oct 2000  
New Zealand Vs  
Lebanon  
Rugby League  
Group2



**H.E.L.P.**

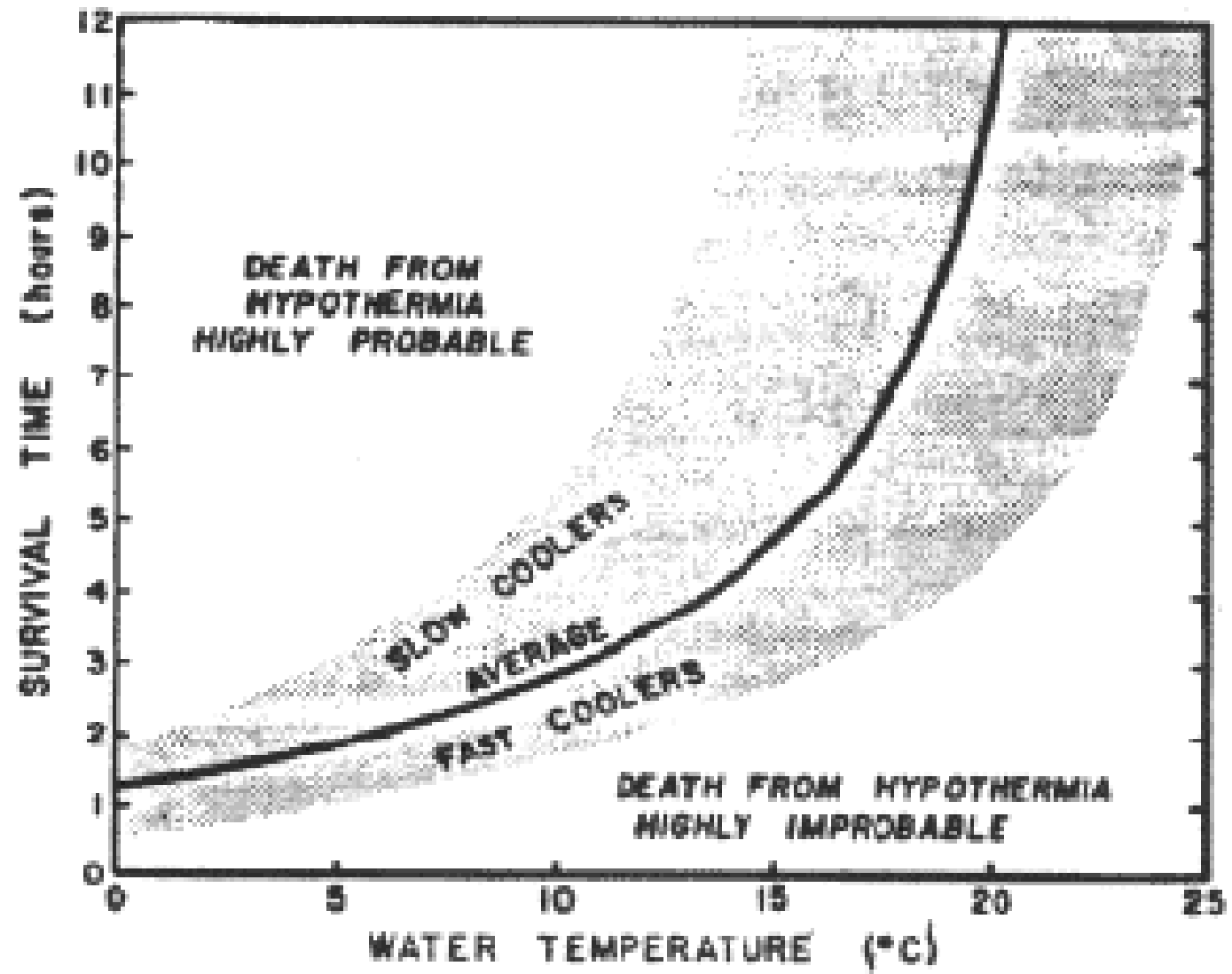


**HUDDLE**



Picture from [www.hypothermia.org](http://www.hypothermia.org)





Survival time in water

# Treatment

- Mild Hypothermia
  - Reduce heat loss
    - Additional clothing
    - Dry clothing
    - Shelter
  - Add Fuels and Fluids
    - Carbohydrates – warm liquids better than solids
    - Avoid Alcohol, Caffeine and Nicotine
  - Slowly Warm Core
  - Consider Professional Assistance

# Moderate or Severe Hypothermia

- Check ABC
- Shelter, Insulate – keep horizontal if possible
- Get assistance – 999
- Patient should be kept horizontal, insulated and breathing/signs of life monitored until ambulance crew arrive. Minimise any movement.
- Treat the patient for ABC and shock only ON NO ACCOUNT IS EXTERNAL HEAT TO BE APPLIED IF THE PATIENT IS INCOHERENT OR UNCONCIOUS.



# Moderate or Severe Hypothermia

- Rescue
  - Keep patient horizontal
  - Minimal physical activity
- Examine
  - ABC (airway, breathing, circulation)
  - Respiration and pulse may be very slow
  - Check for other injuries
  - Mental status (ability to think and walk)

# Moderate or Severe Hypothermia

- Stabilise
  - CPR
  - Control bleeding
  - Deal with shock
  - Nil by mouth

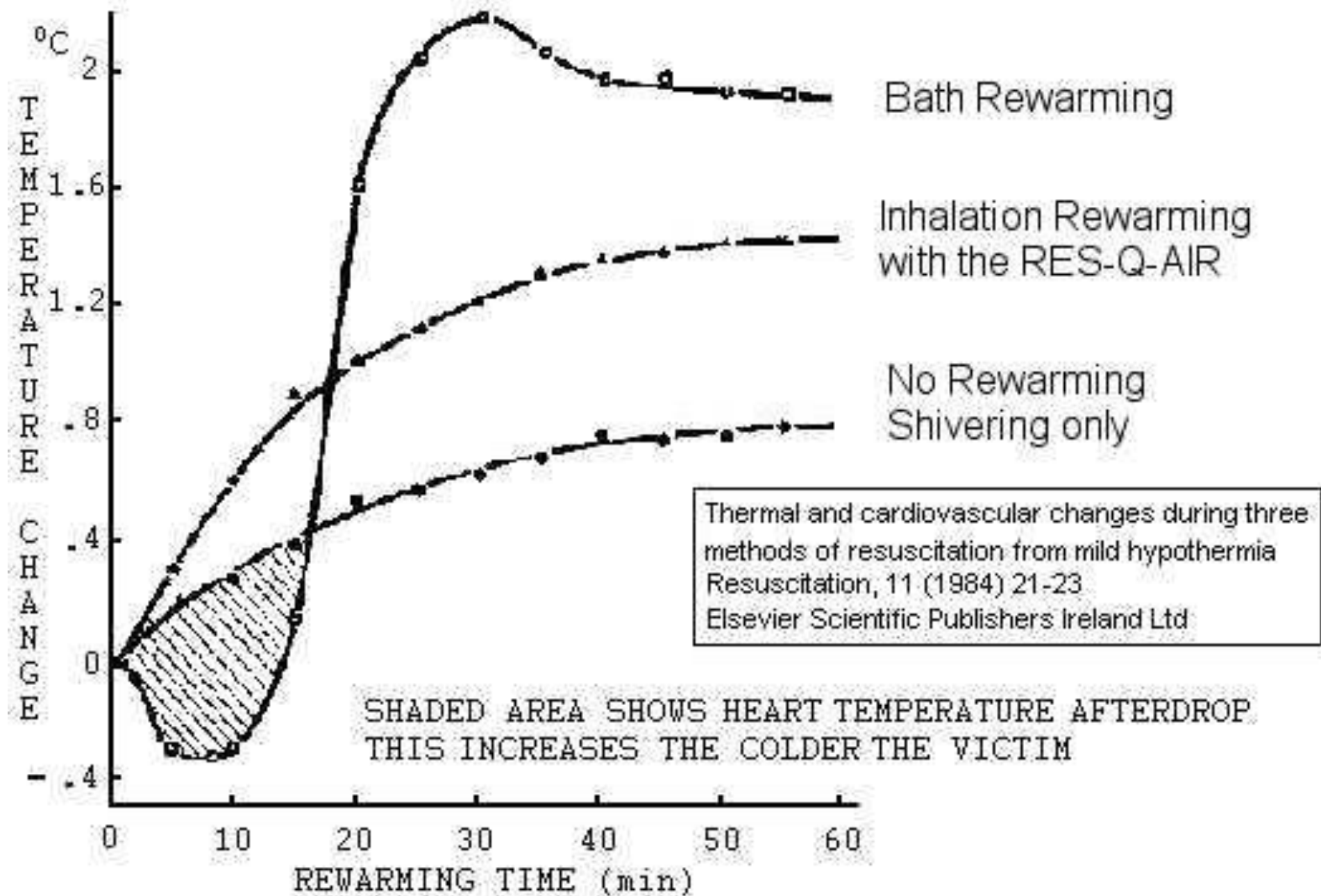
# Moderate or Severe Hypothermia

- Insulate
  - Prevent further heat loss
  - Provide humidified, heated air via mask if available (this is carried by SAR teams in Canada)
  - Gentle heat to neck, armpits and groin?
  - External heat from rescuer?
- Transport
  - Get patient to hospital ASAP



# Dangers of Rewarming

- Blood chemistry at extremities changes and may cause cardiac failure (VF) if it returns to the heart.
- Cold blood at extremities may cause VF if it returns to the heart.
- Chart shows effect of rewarming.
- Body capable of rewarming itself at 2°C per hour.



Rewarming Mild hypothermic Victim

# Regulating Core temperature

- What your body does
  - Hot
    - Sweat – cools by evaporation
    - Vasodilation – blood vessel open on surface
    - Take layers off
  - Cold
    - Shiver – muscle activity
    - Vasoconstriction – reduce blood flow to surface
    - Put layers on

- **Signs / Symptoms:**

- Tiredness / exhaustion
- Shivering
- White / purplish appearance  
(bluish tinge to lips / fingers)
- Clumsiness / falling/ tumbling
- Weak grip and slowness in muscle contraction
- Cold rigid arms and legs
- Poor concentration, loss of interest, lethargy
- Slurred speech



# Hyperthermia

- Hyperthermia = overheating of body
- Hyper = 'high', therma = 'heat'
- Body can not effectively regulate excess heat / elevated temperatures
- Temperature > 37.5–39.9 °C
- Causes:
  - Exposure to excessive heat
  - Exposure to high humidity
  - High physical exertion
  - Dehydration

- **Signs and Symptoms**

- Hot, dry skin
- Dizziness / Fainting
- Nausea / Vomiting
- Headaches
- Gastrointestinal problems e.g. Diarrhoea
- Multi-organ dysfunction

**Treatment:**

- Cool / tepid water immersion
- Rehydration
- Sponging head, neck, trunk with cold water
- Sit in shade



# Dehydration

- Fluid Loss exceeds Fluid Intake
- Causes:
  - Excessive Sweating
  - insufficient fluid intake
  - Hot & humid conditions
  - High intensity exercise



- **Consequences:**

- Increase in perceived effort
- Reduced performance
- Impaired reaction times, judgement, concentration and decision-making

- **Electrolyte Drinks**

- Sodium (speeds fluid absorption)
- Carbohydrate (provides fuel)
- Small amounts frequently (500-800ml/Hr)



**Questions:**

