RESUSCITATION IN MODERATE ALTITUDE SETTINGS

07.11.2013

MUCAHIT EMET, ASSOC PROF DR

LOW PRESSURE WEATHER ILLNESSES

- AMS
- HAPE
- HACE
- HARS: high-altitude

Current guidelines for resuscitation lack specific recommendations regarding treatment of cardiac arrest after ascent to moderate/high altitude or in aircraft

What is moderate altitude?

- 950 – 2,240 m ✳ Eur Respir J 2006; 27: 594–599

- 2000 – 3000 m ✳ Int Heart J 2010; 51: 170-175


Statistics

Statistics

- More than 140 million people worldwide live at an altitude of greater than 2500 m above sea level in 1998
- Of these, 80 million live in Asia, and 35 million live in the Andes
- Of those in the Andes, the major population density is found above 3500 m

Circulation. 2007;115(9):1132-1146


Karadeniz
(Schwarzes Meer)
Akdeniz
(Mittelmeer)
BULGARIEN
GRIECHENLAND
RUSSLAND
GEORGIEN
ARMENIEN
IRAN
IRAK
SYRIEN
LIBANON
TÜRKISCHE REP. NORDZYPERN
REP. ZYPERN
GB
KÜRE DAĞLARI
KÖROĞLU DAĞLARI
ILGAZ DAĞLARI
CANIK DAĞLARI
DOĞU KARADENIZ DAĞLARI
(OSTPONTISCHES GEBIRGE)
DOĞU TOROSLAR
(TAURUSGEBIRGE)
GÜNEY (SÜDOST)
TAHTALI DAĞLARI
BOZ DAĞLARI
BATI TOROSLAR
ORTA TOROSLAR
AMANOS DAĞLARI
ARAS DAĞLARI
KARASU
MERCAN DAĞLARI
TECER DAĞLARI
BOZOK PLATOSU
KIRŞEHIR PLATOSU
MARDIN PLATOSU
Kızılırmak
Yeşilırmak
Sakarya Nehri
Gökırmak
Filyos Çayı
Devrez Çayı
Delice Çayı
Kelkit Çayı
Aras Nehri
Kura Nehri
Murat Nehri
Peri Çayı
Karasu Çayı
Gediz Nehri
Büyük Menderes Nehri
Dicle Nehri
(Tigris)
Fırat Nehri
(Euphrat)
Seyhan Nehri
Ceyhan Nehri
Botan Çayı
Meriç Nehri
Simav Çayı
Porsuk Çayı
Manyas
Kuşgölü
İznik Gölü
Altınkaya Barajı
Hirfanlı Barajı
Tuz Gölü
Eber Gölü
Akşehir Gölü
Eğirdir Gölü
Beyşehir Gölü
Burdur Gölü
Keban Barajı
Karakaya Barajı
Atatürk Barajı
Van Gölü
Çıldır Gölü
Auswahl der Berge der Türkei (in Meter)
Meerestiefen (in Meter)
0
-500
-1.500
-2.500
-3.500
-4.500
Landhöhen (in Meter)
5.000
4.000
3.000
2.000
1.000
0
0
100
200 km
Lambert'sche Schnittkegelprojektion
(Schnittparallele 37° und 40° Nord)
28°
32°
36°
40°
44°


2290 m
39.8590/41.2553
Erzurum Türkiye
runtastic


wowTURKEY.com


3138 m
39.8324/41.3009
runtastic

ERZURUM 2011
winter universiade

- The commonest way of exposure to high altitude is traveling by airplane

- Every year more than 600 million passengers are exposed to a cabin pressure equivalent of that of 8000 ft (2438 m)

AIRCRAFTS

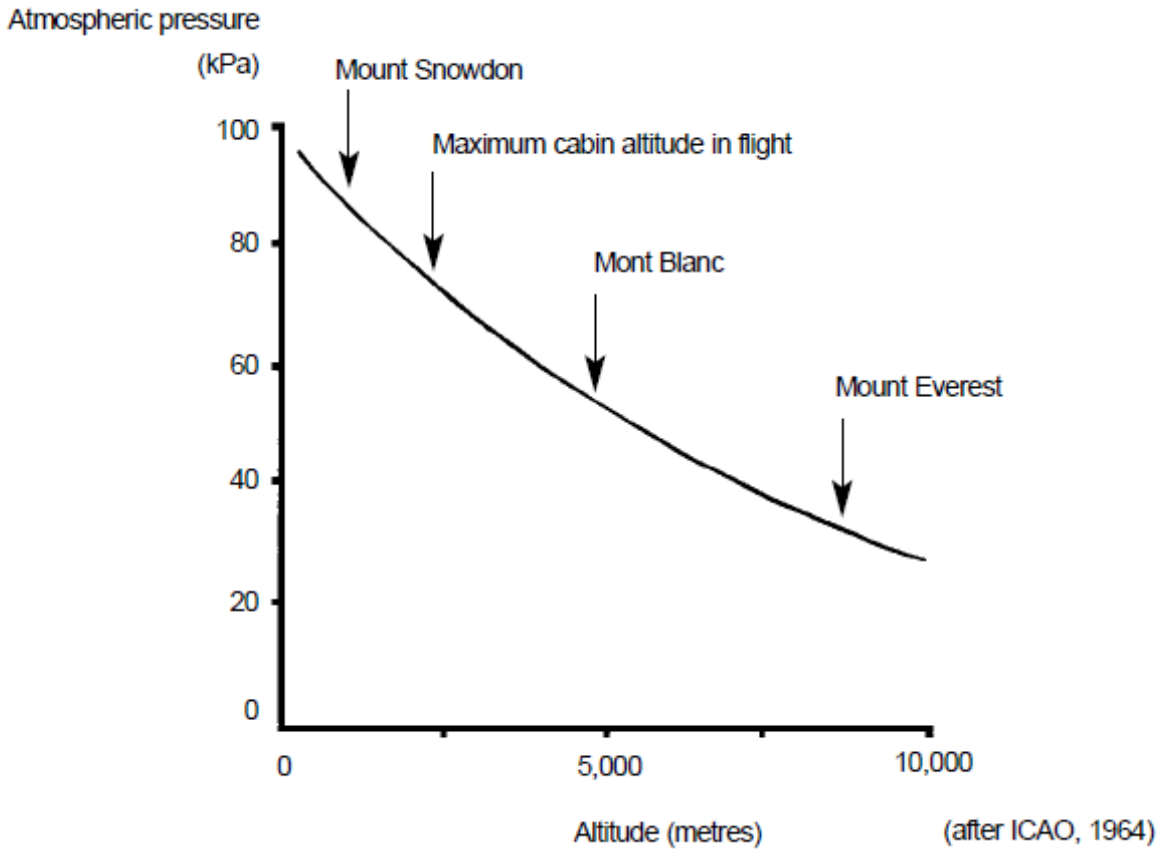
- **The physiologically preferred cabin altitude 1,520-2,130 m (5,000-7,000 ft)**

- **Aircraft regulatory bodies (such as the Federal Aviation**

The Journal of The Royal Society for the Promotion of Health; March 2002, 122 (1), pp. 14-20

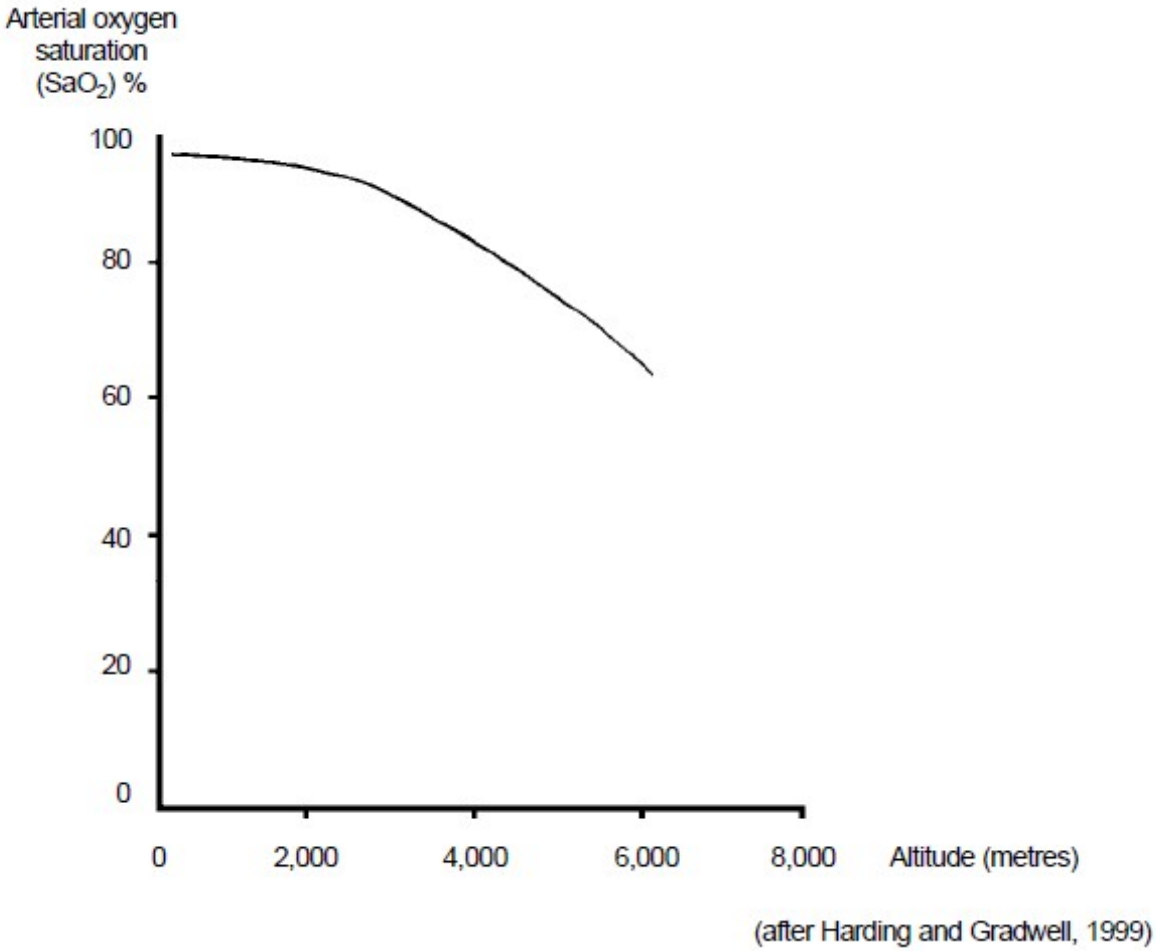

Physiological changes at high altitude

The atmospheric pressure is lower at higher altitudes



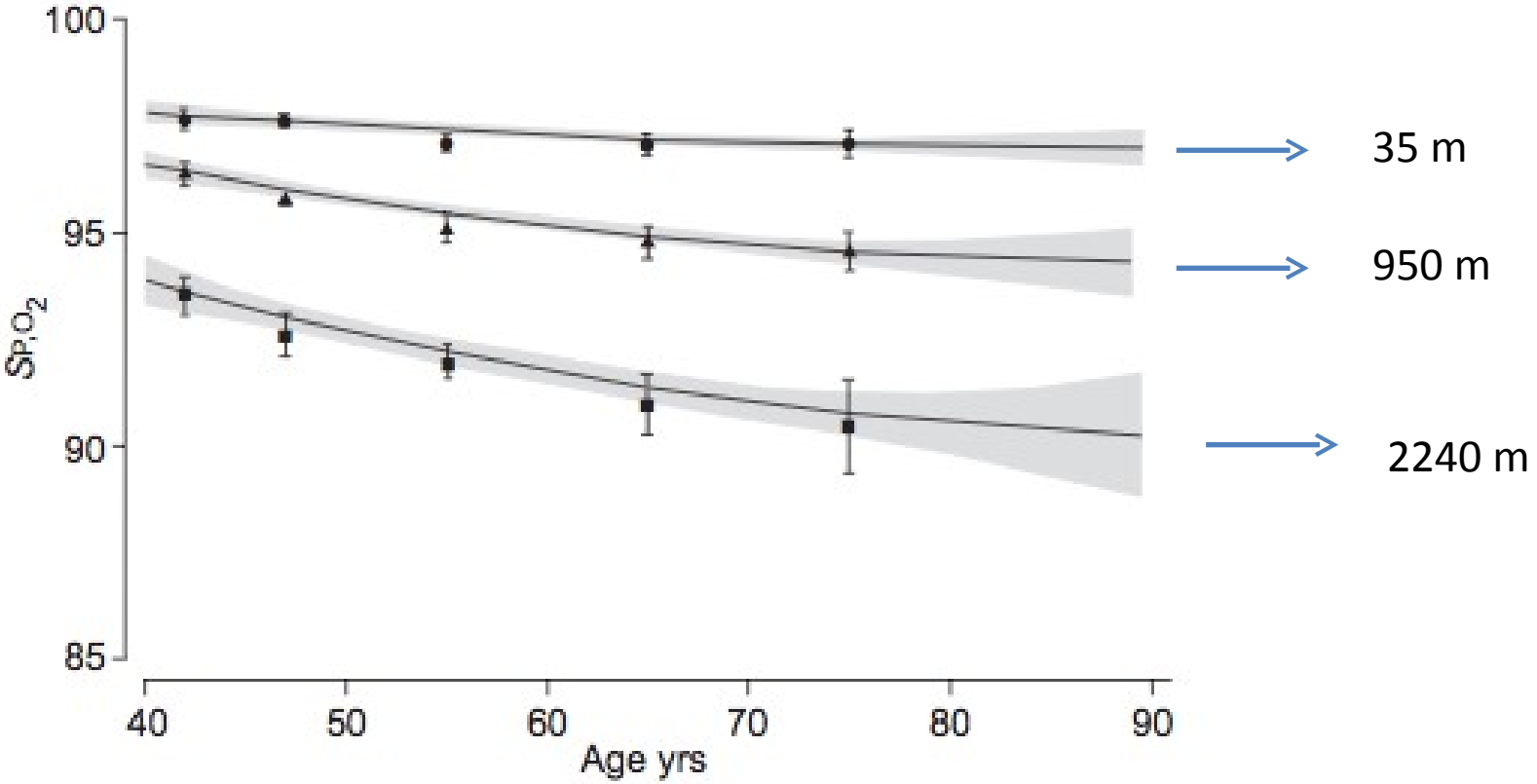
The Journal of The Royal Society for the Promotion of Health; March 2002; 122 (1), pp. 14-20

Oxygenation saturation decreases with altitude



The Journal of The Royal Society for the Promotion of Health; March 2002 122 (1), pp. 14-20

Above 3000 m, the resting O2 saturation is less than 90%



Eur Respir J 2006; 27: 594–599

Modification

- Altitude is the most important determinant of low oxygen saturation (Eur Respir J 2006; 27: 594–599)

1) Give supplemental O2 at high altitude as soon as possible

Respiratory system

- Hypoxia
- RR ↑ (hyperventilation)
- Respiratory alkalosis

Lungs

- The pulmonary vasculature constricts in response to hypoxia

- Pulmonary vascular resistance ↑ (in 5 min)

Sympathetic hyperactivity

- Sympathetic nervous system is activated
- Release of epinephrine
- Noradrenaline decreases

CVS

- Short-term stay (1 w) at moderate altitude is associated with
  - blood pressure ↑,
  - heart rate ↑ and
  - cardiac output ↑ likely due to augmented sympathetic activity

CVS

- A significant reduction of the systolic blood pressure after 1 week at moderate altitude remaining reduced until return

The 24-h ambulatory BP and holter ECG

Austrian Moderate Altitude Study 2000 (AMAS 2000). The effects of moderate altitude (1,700 m) on cardiovascular and metabolic variables in patients with metabolic syndrome. Eur J Appl Physiol 2003; 88: 506–514.

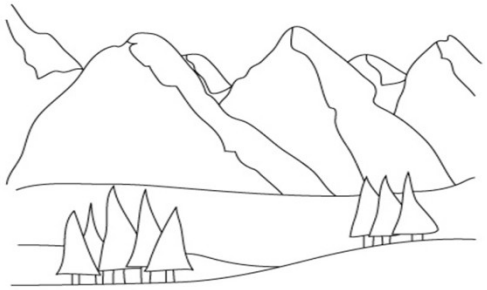
CVS

- Coronary spasm
- Ischemia
- Arrhythmias

SNS ↑+˚C ↓ + Hypervent +PAP↑

Coronary Heart Disease (CHD)

- Hypobaric hypoxia at high altitude may induce myocardial ischemia (Hutchison SJ, Litch JA. Acute myocardial infarction at high altitude. JAMA. 1997;278(20):1661-1662.)
- Altitude-induced depressions of ST-segments and decreased thresholds for ischemia in patients with underlying CHD have been demonstrated (Levine BD, Zuckerman JH, deFilippi CR. Effect of high-altitude exposure in the elderly: the Tenth Mountain Division study. Circulation. 1997;96(4):1224-1232.)



- Sudden cardiac death (SCD) is the most common etiology of nontraumatic death at altitude

Decreased plasma volume

12% over the first 24 hours

- Due to, fluid shift from the intravascular space,
- suppression of aldosterone,
- changes in thirst regulation,
- decreased water intake, and

International Journal of Cardiology 167 (2013) 1703–1711
PlosOne 2013; 8 (8); e70081

The Brain at Altitude

- Cerebral artery dilatation
- Cerebral blood flow increases
- Cerebrospinal fluid decreases
- Elevation of intracranial pressure
- Edema formation

Coagulation

- D-Dimer increases significantly as altitude increases
- Prothrombin time increases
- Activated plasma thromboplastin time
- Von Willebrand factor activity decreases

Pichler Hefti J, Risch L, Hefti U, et al. Changes of coagulation parameters during high altitude expedition. Swiss Med Wkly. 2010;140(7-8):111-117.

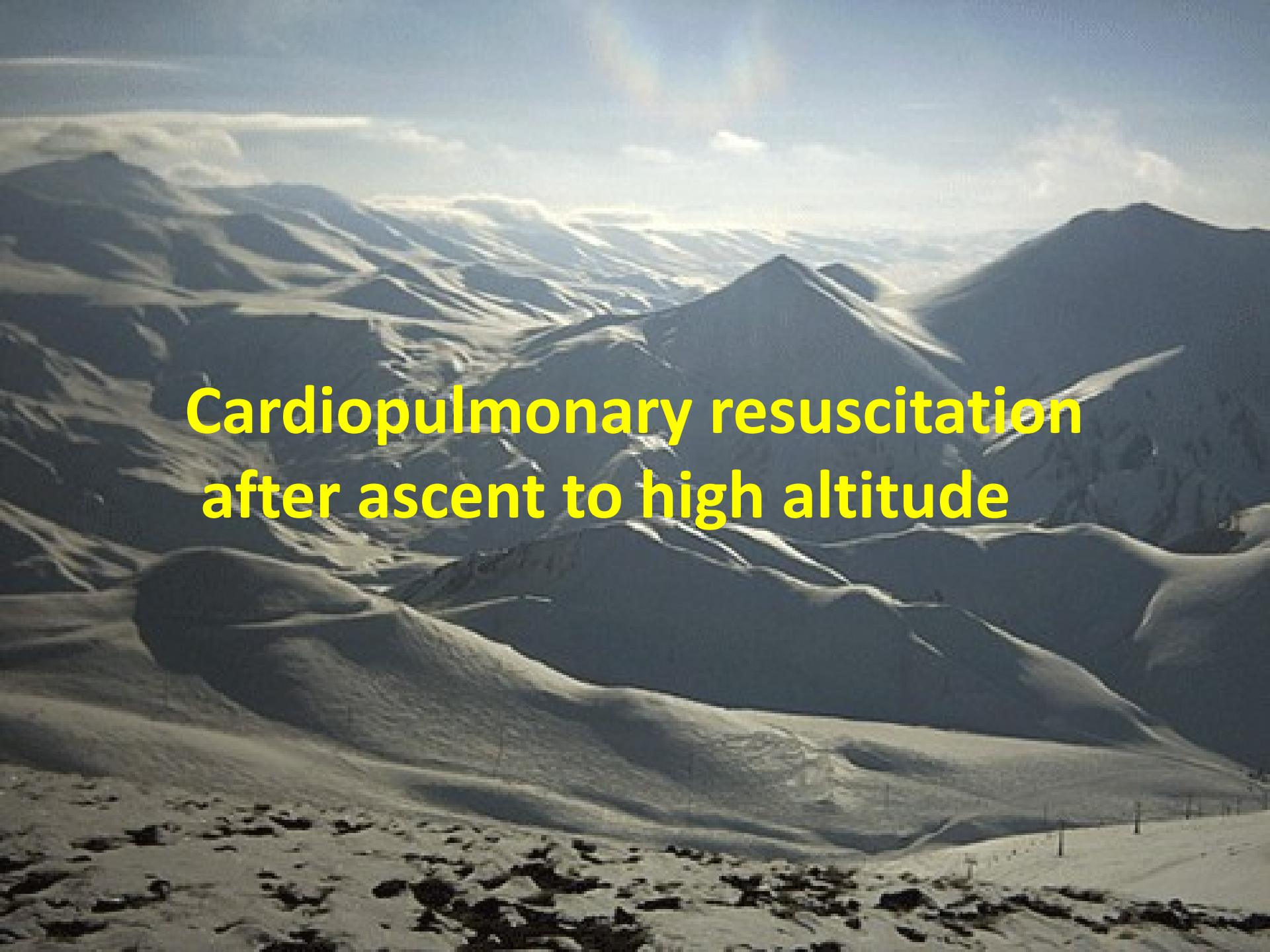
Hb

- In the first few days at altitude, [Hb] is increased due to plasma volume contraction

- Within a few hours, hypoxemia stimulates increased production of erythropoietin ✳ RBCs over 10 to 14 days

WHAT DOES ALTITUDE DO TO A PERSON?

- depends upon the individual,
- the individual's degree of fitness and health,
- obesity,
- the speed of ascent,
- Altitude reached and


Cardiopulmonary resuscitation
after ascent to high altitude

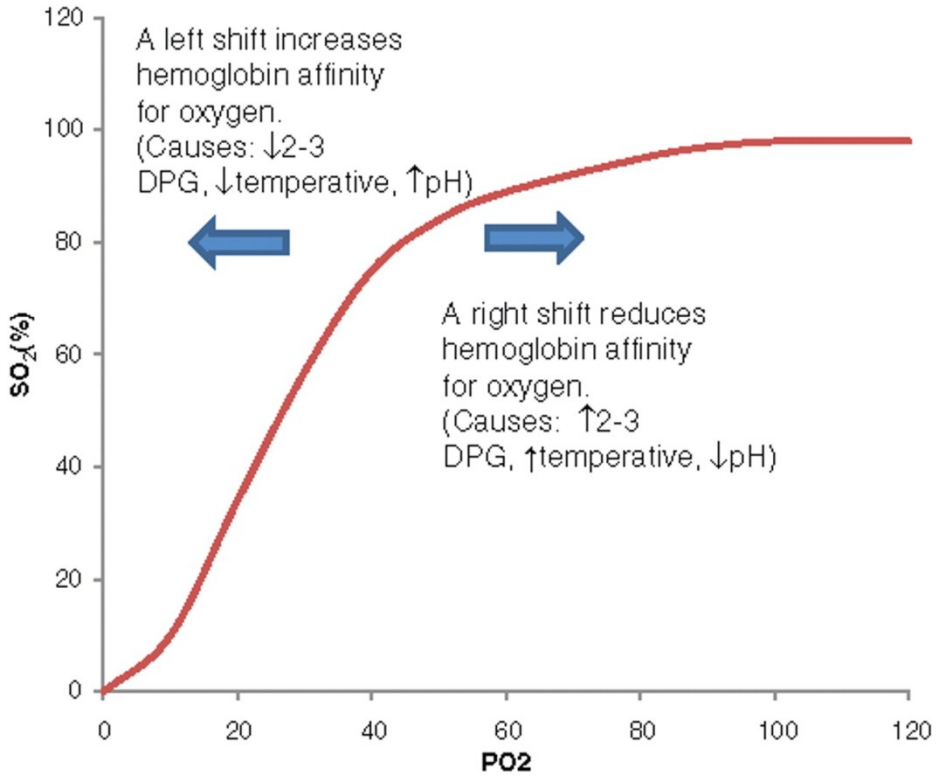
Airway management

2) All patients are at risk for aspiration because gastric emptying is significantly delayed at high altitude

3) Use water to fill the tracheal tube or supraglottic airway device cuff

Leissner KB, Mahmood FU. Physiology and pathophysiology at high altitude: considerations for the anesthesiologist. J Anesth 2009;23:543-53

Hyperventilation causes a respiratory alkalosis, increasing the oxygen affinity of hemoglobin



4) It is reasonable to hyperventilate the arrest patient

Ventilation

5) Automatic ventilators should be used as soon as possible because they are associated with lower peak airway pressures than manual ventilation, which reduces intrathoracic pressure and facilitates improved venous

Deakin CD, Nolan JP, Soar J, et al. European Resuscitation Council Guidelines for Resuscitation 2010 Section 4. Adult advanced life support. Resuscitation 2010;81:1305-52

Ventilation

- set the initial FiO2 at 100%,
- TV at 6–8 ml/kg
- RR at 10 breaths/min
- Do not use PEEP

Circulation

6) Ensure intravenous or intraosseous access immediately and give sodium chloride 0.9%

- Avoid lactate in prolonged cardiac arrest or cold environment

Considerations for rescuers

- Be fit

8) Use supplemental oxygen above 4900 ft (1500 m)

9) Switch about every **1 min** to prevent a decrease in compression quality due to rescuer fatigue

Considerations for rescuers

- Before travel to high altitude, any rescuer with potentially significant pulmonary hypertension (COPD, someone with high CV risk, or an otherwise healthy patient with a history of high-altitude problems), should be evaluated with Doppler if possible

11) A positive screening result could guide **acetazolamide** prophylaxis, extra care in acclimatization, and avoidance of excess exertion at any time

The deficit in plasma volume, as with other physiological changes occurring after exposure to high altitude, does not return to baseline until 3–4 months after returning at sea level


THANK YOU
ANY QUESTIONS?