

AKOMA / ACP Regional Conference Exercise At Altitude

Living, Training and OF COURSE Playing

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Home: 2200 m, 7200 ft.

Vail 8150 ft, 2500 m

Disclosures

Still None ☹

Objectives

- 1. Know the general classification of altitudes
- 2. Recognize Altitude Illness
- 3. Treat Altitude Illness
- 4. List Effects of Living and Training at Altitude

Of Course You Can't Breathe!!



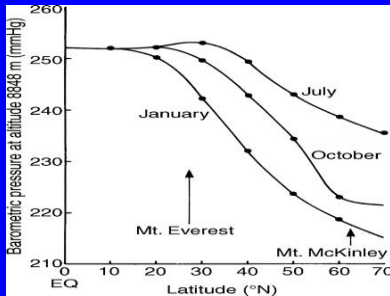
Classification Of Altitudes

Low:	1610 m	5280 ft.	Denver
Intermediate:	2500 m	8150 ft.	Vail
High:	6194 m	20,322ft.	Denali
Extreme:	8000 m	26,246ft.	Big Peaks

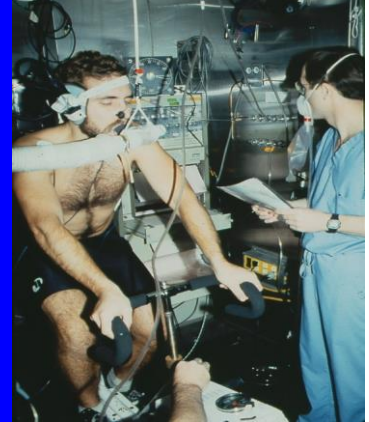
Barometric Pressure and Altitude

Altitude		Standard pressure		Model atmosphere	
Kilometers	Feet	Barometric pressure	Inspired Po ₂	Barometric pressure	Inspired Po ₂
0	0	760	149	760	149
1	3281	674	131	679	132
2	6562	596	115	604	117
3	9843	526	100	537	103
4	13 123	462	87	475	90
5	16 404	405	75	420	78
6	19 685	354	64	369	67
7	22 966	308	54	324	58
8	26 247	267	46	284	50
9	29 528	231	38	247	42
10	32 810	199	31	215	35

Everest 8848m Seasonal Variation



Operation Everest II Simulated 28,029 ft.



Arrival Days 1-3/4

- **Prior History: Trouble will Repeat**
- **Breathing:** Increases in minutes, Hypoxic drive
- **Hb Increases, diuresis (Plasma Volume)**
- **Then EPO (Red cell Mass - weeks)**

Arrival Days 1-3/4

- Exercise performance drops rapidly
- HR Increases in minutes, Then falls over weeks BUT:
- HRV increases and STAYS HIGH

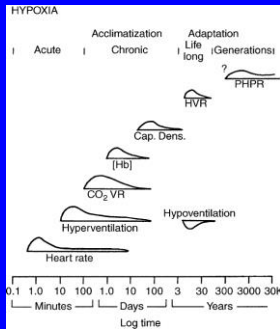
Normo vs. Hypo Baric exposure

- Controversy:
 - VERY SMALL studies
 - Hypo Baric air less dense, less resistance
 - AMS more common in Hypo-Baric
 - Lower SaO₂, PaO₂
 - Aspetar Hospital- Doha, Qatar
- Intermittent Hypoxia: Altitude Chambers
? Legal, ? Ethical, "Is it Legal blood Doping"?

Home Altitude Chamber to Train or Sleep



Acclimatization



AMS - Definition

(The Lake Louise Consensus Committee)

- **Headache with one or more of the below:**
 1. anorexia, nausea or vomiting
 2. fatigue or weakness
 3. dizziness or lightheadedness
 4. difficulty sleeping
- **Occur in the setting of recent arrival to altitude ($\geq 2500\text{m}$)**

AMS – Prevention

- Depends on Rate of Ascent
- Necessity
- Prior Experience
- Acetazolamide **Remember WADA if athlete**
- Nifedipine
- Decadron
- Sildenafil
- Home acclimatization

AMS – Treatment

- Much the Same
- May need higher doses
- Oxygen
- Gamov Bag
- Get down

Training at Altitude

- Leadville: Whole new economy
- Summer houses for rent
- LT 100 Options
 - Arrive night before, race 0400 until ? But rapid decrease in performance
 - Arrive > 4 days

Join the Crazy's



The Athlete at Altitude

- Sports: Limit Altitudes of Competition
- Training usually at or near Comp Altitude
 - e.g. For Sochi many to Seiser Alm IT. 1650-2000 m
 - Over All How High for How long is UNKOWN
 - "Frequently Wrong but Never in Doubt"
- Sprint events: Faster – less air resistance
- Endurance events: slower – Lower VO2 max

The Athlete at Altitude

- Acclimatization causes Paradox
 - Better O2 delivery and utilization
 - Lower Intensity of Training
 - VO2 max Decreases 2 % per 300 m elevation 1900
 - LARGE INDIVIDUAL VARIATION

The Athlete at Altitude

- Training to race at Sea Level or Altitude?
- Sea Level?
 - Unclear How Long or High
 - When to Descend?

Physiologic Adaptations

- **Increased** HYPOXIC Ventilatory response
- **Increased** EF and Increased HRV BUT DECREASED CO
- **Increased** EPO release
 - **Increased Hb** over weeks

Adaptations cont.

VARIABLE RESULTS

Gore et.al. 1998 **NO change** in VO2max OR Hb at 2650 m

Time / Altitude **Threshold** for EPO, Hb, Aerobic performance, Red Cell mass, volume etc. **BUT VARIABLE**

Possible Downside: Training at Altitude

Hb Limits for Competing
FIS Men Hb 18.0 Women 17.0
"Increased risk of Stroke" etc.
Why would men and women stroke at different levels?
AMS HAPE HACE

Other Adaptations

- 2001 Vogt et al. 3850 m
- Increased HIF-1alpha, myoglobin, VEGF, oxidative enzymes
- Increased mitochondrial and capillary density
- Increased VO2 max.

Operation Everest III

30 Days in Altitude Chamber

Gradual “Ascent” to top Everest

Return to “Sea Level”

Hb back to normal in 4 days

Subjects: less energetic 2-3 days

How About Competing at 2300 m?

8 Elite Cyclists at 2340 m

2007 Schuler et al.

Variables Stabilized at 21 days

THEREFORE Recommendations came forth to stay at Comp Altitude for 3 weeks

The Athlete at Altitude

- OVERALL Most evidence and anecdotes agree
- Altitude training: Sea level performance Improves
- Acclimatization Required to Compete at Altitude
- **BUT How Long - How High???**

Study and Training Designs Often Normo-Baric Hypoxic Environ.

- LHTL: Live High, Train Low
 - Levine and Stray-Gundersen 1997 Subseq. +/- “Responders”
 - 2012 Siebenmann: “RCT” No Diff.
- LHTH
- LLTH
- LLTL

Conclusion

- Variations in Studies
- Small Rarely Controlled
 - eg. 10 Subjects at Various altitudes Various Durations
- High Intensity Training-Altitude
 - NO benefit with “Short Term” Exposure

Questions?

