ULTRA SPORTS SCIENCE
STIMULATE ULTRA HEALTH

Prof. Gregoire P Millet

UNIL | Université de Lausanne
Institut des sciences du sport de l'Université de Lausanne (ISSUL)
bâtiment Géopolis
CH-1015 Lausanne

Recommendations for Prevention and Medical treatment of altitude-induced diseases - Gonga Trail

1. Altitude-induced risks - Pathological symptoms and Prevalence

There are 3 diseases associated to Acute exposure to high-altitude

- Acute mountain sickness (AMS)
- High altitude cerebral edema (HACE)
- High altitude pulmonary edema (HAPE)

1.1. - Acute mountain sickness (AMS)

AMS Symptoms *(Hackett, NEJM 2001 ; Bartsch 2004)*

- Headache
- Loss of appetite, nausea, vomiting
- Dizziness
- Sleep disturbance
- Peripheral edema

AMS is not a life-threatening disease *per se* but many mechanisms can lead the runner to falls, edema, underperformance, withdraw, dehydration or undernutrition.. and associated more serious potential consequences (hypothermia; hypoglycemia; …)

Ultra-trail runners at higher AMS risk

Possibility of progression to HACE: possible when no adequate therapy, usually not below 4000 m – risks increased in case of dehydration and/or exhaustion.

Ultra-trail runners at risk of progression to HACE

AMS Prevalence

Threshold altitude: around 2000m (at rest)

Non-acclimatized low-residents

20-25% at 2500m

30-40% at 3000m

Above 4000m (unclear – likely vast majority! ultratrail runners are at higher risks)

AMS Evolution *(Schneider, 2002 ; Bartsch NEJM 2013)*

Delayed onset: 4-8 hours.

Treatment: Day of rest.

Persistence of symptoms: descent.

Maximum: day 2 - 3 at given altitude

Spontaneous complete remission within 2 - 3 days, rarely persistence of symptoms

AMS risk factors *(Schneider, 2002 ; Bartsch NEJM 2013)*

Increased risk factors

Previous AMS experience: AMS risk is increased.

Rate of ascent: Very important AMS risk factor ! ultra-trail runners at higher AMS risk (competition)

Exertion: AMS risk is increased. Ultra-trail runners at higher AMS risk (exercise)

Dehydration : AMS risk is increased. Ultra-trail runners at higher AMS risk (exercise)

Anxiety : AMS risk is increased. Ultra-trail runners at higher AMS risk due to competitive anxiety.

Aerobic fitness: AMS risk is increased. Ultra-trail runners at higher AMS risk due to higher fitnedd

Migraine headache: to be checked by a physician

Low chemosensitivity to hypoxia – to be checked by a "mountain consultation"

Obesity – lung disease: AMS risk is increased. Very unlikely in Ultra-trail runners

Decreased risk factors

Previous experience of high-altitude exposure: AMS risk is decreased.

Altitude of residence < 900 m: AMS risk is decreased. Low-altitude (urban) resident at at higher AMS risk

UNIL | Université de Lausanne
Institut des sciences du sport de l'Université de Lausanne (ISSUL)
bâtiment Géopolis
CH-1015 Lausanne

Pre-acclimatization to altitude: AMS risk is decreased. Pre-acclimatization is more effective if performed in real altitude than in hypoxic chamber/tent *(Fulco, ESSR 2013)*

Ultratrail runners are at higher risk of AMS due to rapid ascent (higher vertical velocity, competitive setup, dehydration, exhaustion, anxiety) – Specific checkup and strategies are needed (see below)

AMS treatment

Paracetamol, aspirin

Important - **Acetazolamide**, sold under the trade name **Diamox**, is the most common medication for preventing AMS. This is not an option in competition since Acetazolamide is in the "prohibited at all times" World Anti-Doping Agency list as a diuretics **and** masking agents.

https://www.wada-ama.org/en/prohibited-list/prohibited-at-all-times/diuretics-and-masking-agents

1.2.- High altitude cerebral edema (HACE)

HACE Symptoms

Deterioration of AMS (not compulsory!)

Ataxia (assistance for walking) – can be confounded with exercise-induced exhaustion.

Low consciousness followed by coma

Often fever > 38°C

Usually rapid deterioration

Death within 1-2 days if untreated

HACE Prevalence

Rarely below 4000 m

Above 4500 m: 0.5 - 1%

Same additional risk factors for HACE than for AMS (all increased in ultra-trail runners)

Rapid ascent ; exhaustion; dehydration; anxiety; low chemosensitivity to hypoxia.

UNIL | Université de Lausanne
Institut des sciences du sport de l'Université de Lausanne (ISSUL)
bâtiment Géopolis
CH-1015 Lausanne

HACE treatment

Corticoids 8 mg then 4 mg dexamethasone / 6h

Rapid descent (hyperbaric compression bag with supplemental oxygen)

Mannitol : 0.25 to 0.5 g/kg bolus

1.3.- High altitude pulmonary edema (HAPE)

HAPE Symptoms *(Bartsch, JAP 2005)*

Preceded of AMS (not compulsory!)

Dyspnea, cough, decreased exercise performance - can be confounded with exercise-induced cough in cold environmental conditions.

Gurgling, pink frothy sputum

Usually rapid deterioration but rapid complete resolution after descent

High mortality without treatment

HAPE Prevalence

Rarely below 3000 m in subjects without chronic pulmonary diseases.

Above 5000 m: 1-2% - likely increased in cold weather and with exhaustion

Mostly in **young and healthy subjects** and **during the first 3 nights at high-altitude**

Same additional risk factors for HAPE than for AMS (all increased in ultra-trail runners)

Rapid ascent ; exhaustion; dehydration; anxiety; low chemosensitivity to hypoxia.

HAPE treatment

Pulmonary vasodilators (nifedipine; PDE-5 inhibitors); Sildenafil

Rapid descent (hyperbaric compression bag with supplemental oxygen)

UNIL | Université de Lausanne
Institut des sciences du sport de l'Université de Lausanne (ISSUL)
bâtiment Géopolis
CH-1015 Lausanne

2. Pre-competition screening and recommendations

2.1. Compulsory screening

Medical check-up -> Contraindications

Absolute contraindications

Coronary Diseases
Severe hypertension
Heart failure, severe rhythms disorder
Cyanogenic heart disease
Pulmonary arterial hypertension, regardless of origin
Chronic respiratory insufficiency
Cerebral ischemic history
Arteriopathy of the lower limbs
Severe coagulation disorders
Homozygous sickle cell anemia, severe anemia
Renal failure
Repeated experiences of HAPE or HACE.

Relative contraindications

Serious scoliosis
Asthma of stress or cold
A history of respiratory disorders at night
Epilepsy, true migraine
Pregnancy (especially the third trimester)
Heterozygous sickle cell anemia, moderate anemia

UNIL | Université de Lausanne
Institut des sciences du sport de l'Université de Lausanne (ISSUL)
bâtiment Géopolis
CH-1015 Lausanne

2.2. Not compulsory but highly recommended in subjects at potential risks or without altitude experience - "Mountain consultation"

<u>Tolerance test to hypoxia</u> *(Rathat 1992 ; Richalet AJRCCM 2012)*

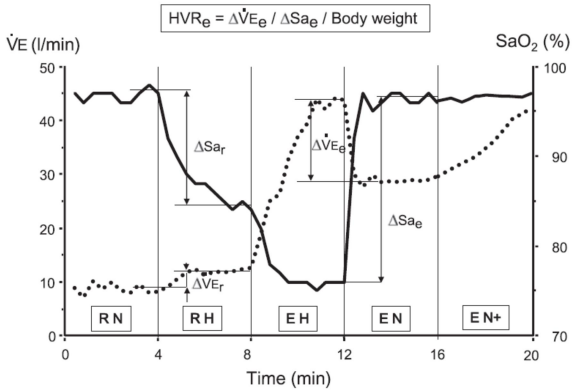

Figure 1. Hypoxia exercise test. RN, RH, EH, and EN represent, respectively, rest in normoxia, rest in hypoxia, exercise in hypoxia, and exercise in normoxia. Hypoxia was produced by breathing a normobaric hypoxic gas mixture (fraction of inspired oxygen, 0.115). Exercise was performed at approximately 30% of maximal power output in phases EH and EN. In phase EN+, power output was adjusted so that the heart rate reached the same value as in EH. HVR_e = ventilatory response to hypoxia during exercise; Sa, Sa_{O2} = arterial oxygen saturation; Sa_e = arterial oxygen saturation during exercise; Sa_r = arterial oxygen saturation at rest; $\dot{V}_E$ = pulmonary ventilation; $\dot{V}_{E_e}$ = pulmonary ventilation during exercise. *Dotted line*, $\dot{V}_E$; *solid line*, Sa.

Desaturation at rest: ΔSar = Sarn – Sarh (%)

Desaturation at exercise: ΔSae = Saen – Saeh (%)

Ventilatory response at rest: HVRr = (VErh – VErn)/ΔSar/BW X 100 (L/min/kg)

Ventilatory response at exercise: HVRe = (VEeh – VEen)/ ΔSae/BW X 100 (L/min/kg)

Cardiac response at rest: HCRr = (HRrh – HRrn)/ ΔSar (beats/min/%)

Cardiac response during exercise: HCRe = (HReh – HRen)/ ΔSae (beats/min/%)

<u>Subjects at higher AMS risks detected by this test</u>

Young trained subjects

High values of ΔSae (>22%)

Low values of HCRe (<0.84 beats/min/%)

Low values of HVRe (<0.78 L/min/kg)

History of migraine

UNIL | Université de Lausanne
Institut des sciences du sport de l'Université de Lausanne (ISSUL)
bâtiment Géopolis
CH-1015 Lausanne

2.3. Recommendations for the runners.

Prior competition

Mountain consultation with the tolerance test to hypoxia

Regular training in altitude (> 3000 m) in the 3 months prior competition.

Pre-acclimatization in mountain (sleeping in altitude) in the 3 months prior competition.

Arrival to the race at least 4 days prior the start.

During competition

Having a portable oximeter to check saturation (>80%)

'Slower-than-usual' start (maintain saturation > 80%)

Slower ascent of the steepest hills (km 10-15 ; km 85-90 ; km 150-155).

Hydration' higher-than-usual'

Carbohydrate intake 'higher-than-usual'

2.4. Recommendations for the organisation committee

To require at least 3 nights on site prior start (important AMS and HAPE risk decrease).

Having medics and decompression hyperbaric bags at the top of the main hills (km 15 ; km 90 ; km 155).

Check saturation and HR as often possible above 3500m.