CARDIOVASCULAR IMPACT OF SPORT IN EXTREME CONDITIONS

Sport’s Cardiology Webinar
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Sport’s and environment cardiovascular stresses

Exercise intensity duration

Environment
Altitude
Cold weather
Hot weather

Cardiovascular responses

Heart
CO (HR and SV)
Blood pressure
«Cardiac fatigue »

Vessels
Muscular blood flow
Cutaneous blood flow
Selection of environment conditions
Long distance running
Endurance heart rate drift

Dehydration
Thermoregulation
Neuro-hormonal changes
Cardiac fatigue
Energy cost of running

Paris semi-marathon 2005, Courtesy from V. Billat PhD
Cardiac fatigue, signs

La Gerche A et al. Eur Heart J 2012; 33:998–1006

Echocardiographic signs

Cardiac biomarkers

Carré F in cardiologie du sport 2013
**Cardiac fatigue, summary**

**Echocardiographic signs**

Inconsistent, transient and mild changes of LV and RV systolic and diastolic functions with quickly correction

**Cardiac biomarkers**

Moderate elevation with quick normalisation (<24 h)

They present with a poor repetability

They are more marked if low training level

**ISOLATED ALTERATIONS WITHOUT ANY ABNORMAL CLINICAL OR ECG SIGN**

**THESE OBSERVATIONS LOOK PHYSIOLOGICAL**

**EVEN IF WE HAVE NO LONGITUDINAL STUDY**
Long distance running AND hot weather

Bad Water Race
Hyperthermia and body blood distribution

Cardiovascular drift

Heart Rate bpm

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Heart Rate</th>
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<tbody>
<tr>
<td>0</td>
<td>60</td>
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<tr>
<td>3-5</td>
<td>130</td>
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<tr>
<td>30-80</td>
<td>130</td>
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<td>&gt;20°</td>
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<td>10-20°</td>
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1. Rest
2. Adaptation
3. Steady state
4. Drift

Adaptation
Steady state
Drift
Cardiovascular effect of dehydration

Modifié d'après Rowell 1977
Heat acclimatization

- **Body temperature (°C)** and **Exercise duration (min)**
  - Non-acclimatized heart
  - Acclimatized heart

- **Heart rate (bpm)** and **Exercise duration (min)**
Environmental constraints of altitude

Barometric pressure decrease

- Inspiratory $O_2$ pressure decrease

- Température Decrease
- Wind effect ++

- Humidity
- Désydratation ++

- Radiation
- UV
- Ionizing

- Air density decrease
Cardiovascular and nervous adaptations during altitude exposure

4000 m

Changes from low altitude [%]

Days at altitude

- Pulmonary artery pressure
- Mean systemic blood pressure
- Heart rate
- Cerebral blood flow
- Cardiac output
- Stroke volume

Sympathetic activity
Cardiovascular responses to altitude

Tachycardia with decreased HR max.

SV is decreased

Maximum cardiac output decreases

VO2 max decrease with altitude level

Arterial hypertension with acute exposure
Systolic-diastolic hypertension during exercise

Pulmonary hypertension at rest and ++ during exercise → chronic pulmonary hypertension

Unbalanced cardiac patients and altitude, caution

Equilibrated cardiac patients ≤ 2000 m rest and moderate exercise OK

Cardiac patients > 2000 m → specific test
Snorkeling and scuba diving
Snorkeling

Immersion:
Blood Shift $\rightarrow$ Preload' increase
Facial stimulation $\rightarrow$ Bradycardia
Cold $\rightarrow$ Bradycardia $\uparrow$
  $\rightarrow$ Vasoconstriction $\uparrow$
  $\rightarrow$ BP and afterload increase

Descent:
Bradycardia
Preload $\uparrow\uparrow$
Stabilized level
Hypoxia
Acidosis $\uparrow$

Ascent:
Intense exercise
Preload increase
Mild tachycardia

Surface:
Marked tachycardia
Blood acidosis

No snorkeling with cardiac disease including arterial hypertension
Scuba diving

Immersion

Descent:
- Bradycardia
- Hyperoxia
- Coronary and peripheral vasoconstriction

Stay in depth:
- Ventilatory work ++
- After load increase

Ascent:
- Must be slow and progressive
- Oxygen desaturation

Heart disease or unbalanced HTA = caution

Low depth = false security
Take home messages

Extreme conditions specific constraints on cardiovascular system are added to the exercise one.

Some alterations induced by extreme conditions can simulate pathologies. We must therefore first keep a clinical analysis and not be limited to biological and/or imaging data.

However, if normal cardiovascular system well supports these constraints, cardiovascular pathology can limit their tolerance specially during physical exercise which reveals the limits of the patient's adaptations.