Training according to CPET results

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Clinical range of exercise prescription
Clinical range of exercise prescription

Why do we need EXERCISE PRESCRIPTION?

- Improving exercise capacity
- Improving quality of life
- Improving clinical outcome
- Preparing treatment
- Ensuring safe exercise
- Increasing adherence
- Supporting behaviour change

ATHLETE

Improving performance

PATIENT
CPET-variables for exercise prescription

Heart rate or \( \text{VO}_2 \) reserve:
\(((\text{Max} - \text{Rest}) \times \%) + \text{Rest})\)

- \( \text{VO}_2\text{peak} \)
- \( \text{HR}_{\text{max}} \)
- Borg scale
- Thresholds
Common intensities for exercise

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<th>Low</th>
<th>Moderate</th>
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VO$_2$peak for exercise prescription

Advantages:

- Most common, internationally recognized exercise parameter used in cardiovascular sports medicine research
- Gold standard for assessment of exercise capacity
- Reflects capacity of whole „system“
- Is thus directly related to physiological exercise capacity
- Can easily be translated to MET [-hours]
- Can be compared to other trials

“VO$_2$peak is defined as the highest VO$_2$, averaged over a 20 to 30-s period, achieved at presumed maximal effort during an incremental exercise test”

“\( \dot{V}O_2 \text{peak} \) is defined as the highest \( \dot{V}O_2 \), averaged over a 20 to 30-s period, achieved at presumed maximal effort during an incremental exercise test”

### SpiroErgometrie - Tabelle

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Prescribing moderate exercise (50-60%)

- 71-75 bpm
- 7.0 – 8.5 ml/kg/min
- 14.2 ml/kg/min
VO$_2$peak for exercise prescription

Pitfalls:

- VO$_2$peak does in most cases not represent true maximum capacity
- May be influenced by medication
- In subjects with low exercise capacity: recommended exercise intensities may be lower than resting value!
- Is dependant on a successful CPET
- Must be continuously updated / adjusted
- Not practical for monitoring exercise
- Limited in oscillatory ventilation
**HR_{max} for exercise prescription**

**Advantages:**
- Easy to determine and read out
- May also roughly be estimated by formulas (not my recommendation…)
- Appropriate for exercise prescription in healthy individuals

**Pitfalls:**
- Strongly influenced by medication or disease (chronotropic incompetence)
- Limited in arrhythmias
- Not linearly correlated with VO\(_2\)
- Requires full exhaustion
- In subjects with low exercise capacity: recommended exercise intensities may be lower than resting value!

Limitations are partly overcome by using „reserve models“ (HRR)
### Prescribing moderate exercise (50-60%)

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- **58 – 67 bpm**
- **71 – 75 bpm**
- **7.1 – 8.5 ml/kg/min**
- **96 bpm**
- **14.2 ml/kg/min**
Prescribing moderate exercise (50-60%)

(96-48) x 50% + 48 = 72
(96-48) x 60% + 48 = 77
Borg Scale for exercise prescription

6  No exertion at all
7  Extremely light
8  Very light
9  Light
10 Somewhat hard
11 Hard (heavy)
12
13 Very hard
14
15 Extremely hard
16
17 Maximal exertion

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<th>Borg CR10 scale</th>
<th>Borg RPE scale</th>
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<td>Just noticeable</td>
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<tr>
<td>Light</td>
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<td>Heavy</td>
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Borg RPE scale
Borg Scale: association with metabolism

n = 2560 patients (healthy and diseased)

Borg Scale for exercise prescription

Aerobic

- 6: No exertion at all
- 7: Extremely light
- 8: Very light
- 9: Light
- 10: Somewhat hard

Aerobic - anaerobic

- 11: Light
- 12: Somewhat hard
- 13: Somewhat hard
- 14: Hard (heavy)
- 15: Very hard
- 16: Extremely hard
- 17: Extremely hard
- 18: Maximal exertion

Anaerobic

- 19: Extremely hard
- 20: Maximal exertion

LT1: 4 mmol

Borg Scale for exercise prescription

Advantages:
• Easy to determine
• Overcomes limitations in subjects with low exercise capacity
• Independant of medication
• Does not require full exhaustion

Pitfalls:
• May strongly over- or underestimate true intensity in some
• Preferable for monitoring rather than prescribing exercise

Thresholds for prescribing exercise

Advantages:
• Do not require full exhaustion
• Directly reflect energy supply during exercise
• Allow for more precise, individualized exercise recommendations
• Independant of medication

Pitfalls:
• Require correct determination of thresholds, which may be challenging in some
• Data on training effects in patient populations is scarce
Thresholds for prescribing exercise

- **Low**
  - Regeneration / compensation:
    - Exercise for „recovery“ or long-distance training
    - Stabilizing rather than increasing performance
    - No threshold shift
    - Continuous exercise

- **Moderate to vigorous**
  - Aerobic performance I & II:
    - Exercise for improving basic aerobic fitness
    - Shift of thresholds to higher intensities
    - Either as continuous (I) or interval-based exercise (II)

- **High**
  - Anaerobic, maximal capacity:
    - Exercise for improving peak performance
    - Usually no relevant threshold shift
    - Increasing „lactate tolerance“
    - Performed as interval exercise

![Graph showing biological parameters over time](image-url)
Prescribing high-intensity interval training

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- **50-60% VO₂peak**
- **80-90% VO₂peak**
- **VO₂peak**
Training protocols

Intensity, % $HR_{\text{max}}$

- bis 30 sec
- 4 min
- 4 min
- 4 min
- 4 min

Pressler A, Herzmedizin 2013;2:24
Physiologie during intervals
Monitoring interval exercise
Always monitor and adjust intensities!
Summary and conclusion

• In patient populations and cardiac rehabilitation, CPET with determination of VO$_2$peak is the key component of prescribing exercise at different intensities

• Threshold concepts are less well established in rehabilitation but probably allow for a more precise, individualized recommendation (more data needed)

• Concepts based on maximal heart rate are limited by medication or the disease itself and should not be used in patient populations

• The Borg Scale is a helpful tool to calculate and monitor intensities that cannot be determined by objective means

• Exercise intensities need monitoring and regular adjustment particular in research settings
Kontakt

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