Should we encourage ICD patients to exercise?

Viviane M Conraads
Antwerp University Hospital – Belgium

-There is no conflict of interest-
Should we encourage ICD patients to exercise?

1. Why?- is it evidence based?
2. What about combined devices?
3. Magnitude of the problem vs participation
4. Conclusion and Future
Should we encourage ICD patients to exercise?

1. Why? - is it evidence based?
2. What about combined devices?
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Should we encourage ICD patients to exercise?

Managing total CVD risk - PHYSICAL ACTIVITY

1. Stress that the positive health benefits occur with almost any increase in activity; small amounts of exercise have an additive effect; exercise opportunities exist in the workplace, for example by using stairs instead of the lift.

2. Try to find leisure activities that are positively enjoyable.

3. 30 minutes of moderately vigorous exercise on most days of the week will reduce risk and increase fitness.

4. Exercising with family or friends tends to improve motivation.

5. Added benefits include a sense of well being, weight reduction and better self esteem.

6. Continued physician encouragement and support may help in the long-term.


Ischemic patients

Chronic Heart Failure

Symptomatic

ICD

Ischemic patients
Goals

**General**
- reduce mortality
- improve ex capacity
- improve quality of life

**Specific**
- safe
- reduce arrhythmia
- psychological effects
Exercise-based rehabilitation for coronary heart disease.


Main results

This systematic review has allowed analysis of an increased number of patients from approximately 4500 in earlier meta-analyses to 8440 (7683 contributing to the total mortality outcome).

The pooled effect estimate for total mortality for the exercise only intervention shows a 27% reduction in all cause mortality (random effects model OR 0.73 95% confidence interval 0.54 to 0.96). Comprehensive cardiac rehabilitation reduces all cause mortality by a lesser degree (OR 0.87 95% confidence interval 0.71 to 1.05). Total cardiac mortality was reduced by 31% (random effects model OR 0.69 95% confidence interval 0.58 to 0.82) and 20% (random effects model OR 0.81 95% confidence interval 0.57 to 0.96) in the exercise only and comprehensive cardiac rehabilitation groups respectively. We found no evidence of an effect of the interventions on the occurrence of non-fatal myocardial infarction. There was a significant net reduction in total cholesterol (pooled WMD random effects model -0.57 mmol/l 95% confidence interval -0.83 to -0.31) and LDL (pooled WMD random effects model -0.51 mmol/l 95% confidence interval -0.82 -0.19) in the comprehensive cardiac rehabilitation group.
Exercise rehabilitation for heart failure.

Main results
Twenty-nine studies met the inclusion criteria, with 1126 patients randomised. The majority of studies included both patients with primary and secondary heart failure, NYHA class II or III. Only one study specifically examined the effect of exercise training on mortality and morbidity. Exercise training significantly increased VO₂ max by (WMD random effects model) 2.16 ml/kg/min (95% CI 2.82 to 1.49), exercise duration increased by 2.38 minutes (95% CI 2.85 to 1.9), work capacity by 15.1 Watts (95% CI 17.7 to 12.6) and distance on the six minute walk by 40.9 metres (95% CI 64.7 to 17.1). Improvements in VO₂ max were greater for training programmes of greater intensity and duration. HRQoL improved in the seven of nine trials that measured this outcome.
Efficacy and safety of exercise training in patients with CHF: HF-ACTION randomized controlled trial.
O’Connor CM, et al. JAMA 2009;301:1439-1450

Protocol: subject flow

Timeline (Months)
0
Baseline Visit: Echo, 6MW, CPX, DNA, QoL
Randomization
Control = Usual Care
Intervention = 36 Training Sessions
Clinic Visit: CPX
3+ Clinic Visit (q 3mth)
CPX (12,24mths)

N=2331

NYHA II-IV
LVEF < 35%
Efficacy and safety of exercise training in patients with CHF: HF-ACTION randomized controlled trial.

O’Connor CM, et al. JAMA 2009;301:1439-1450

**Figure 2. Time to All-Cause Mortality or All-Cause Hospitalization and to All-Cause Mortality**

- **All-Cause Mortality or All-Cause Hospitalization**
  - HR, 0.93 (95% CI, 0.84-1.02); P = .13
  - Adjusted HR, 0.89 (95% CI, 0.81-0.99); P = .03

- **All-Cause Mortality**
  - HR, 0.96 (95% CI, 0.79-1.17); P = .70

<table>
<thead>
<tr>
<th>Event Rate</th>
<th>Time From Randomization, y</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>0</td>
</tr>
<tr>
<td>0.2</td>
<td>1</td>
</tr>
<tr>
<td>0.3</td>
<td>2</td>
</tr>
<tr>
<td>0.4</td>
<td>3</td>
</tr>
<tr>
<td>0.5</td>
<td>4</td>
</tr>
<tr>
<td>0.6</td>
<td>5</td>
</tr>
<tr>
<td>0.7</td>
<td>6</td>
</tr>
<tr>
<td>0.8</td>
<td>7</td>
</tr>
</tbody>
</table>

No. at risk
- Usual care: 1172, 651, 337, 146
- Exercise training: 1159, 666, 352, 167

CI indicates confidence interval; HR, hazard ratio.

*Adjusted for key prognostic factors.
Efficacy and safety of exercise training in patients with CHF: HF-ACTION randomized controlled trial.

O’Connor CM, et al. JAMA 2009;301:1439-1450

**Table 4. Change in 6-Minute Walk Test and Cardiopulmonary Exercise Test Results**

<table>
<thead>
<tr>
<th></th>
<th>Median (IQR)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Usual Care</td>
<td>Exercise Training</td>
</tr>
<tr>
<td>Baseline to 3 mo(^a)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance of 6-minute walk, m (n = 1835)</td>
<td>5 (-28 to 37)</td>
<td>20 (-15 to 57)</td>
</tr>
<tr>
<td>Cardiopulmonary exercise time, min (n = 1914)</td>
<td>0.3 (-0.6 to 1.4)</td>
<td>1.5 (0.3 to 3.0)</td>
</tr>
<tr>
<td>Peak oxygen consumption, mL/kg/min (n = 1870)</td>
<td>0.2 (-1.2 to 1.4)</td>
<td>0.6 (-0.7 to 2.3)</td>
</tr>
<tr>
<td>Baseline to 12 mo(^b)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance of 6-minute walk, m (n = 1444)</td>
<td>12 (-30 to 55)</td>
<td>13 (-28 to 61)</td>
</tr>
<tr>
<td>Cardiopulmonary exercise time, min (n = 1476)</td>
<td>0.2 (-1.0 to 1.7)</td>
<td>1.5 (0 to 3.2)</td>
</tr>
<tr>
<td>Peak oxygen consumption, mL/kg/min (n = 1442)</td>
<td>0.1 (-1.5 to 1.8)</td>
<td>0.7 (-1.0 to 2.5)</td>
</tr>
</tbody>
</table>

Abbreviation: IQR, interquartile range.
\(^a\)Complete case analysis. Expected 2284 patients at 3 months.
\(^b\)Complete case analysis. Expected 2159 patients at 12 months.
Efficacy and safety of exercise training in patients with CHF: HF-ACTION randomized controlled trial.

O’Connor CM, et al. JAMA 2009;301:1439-1450
Efficacy and safety of exercise training in patients with CHF: HF-ACTION randomized controlled trial.

O’Connor CM, et al. JAMA 2009;301:1439-1450

Unadjusted Kaplan-Meier Curves of the Primary Endpoint by Quartiles of MET-hr/wk

1 MET=3.5ml/kg/min O2 consumption
Chronic Heart Failure and QoL

Effects of Exercise Training on Health Status in Patients With Chronic Heart Failure: HF-ACTION Randomized Effects.


Figure 2. Predicted Mean Health Status Trajectories by Treatment Group

- **Ischemic Heart Failure Etiology**
  - Exercise training: 596, 547, 511, 472, 470
  - Usual care: 599, 514, 481, 471, 431

- **Nonischemic Heart Failure Etiology**
  - Exercise training: 551, 505, 480, 440, 436
  - Usual care: 572, 472, 436, 430, 419

- Time, mo: Baseline, 3, 6, 9, 12, 24, 36

No. of participants:
- Exercise training: 596, 547, 511, 472, 470, 277, 131
- Usual care: 599, 514, 481, 471, 431, 285, 151

- **P** = .001 for treatment effect for both ischemic and nonischemic heart failure. Error bars indicate standard errors at each time point.
Goals

General
• reduce mortality
• improve ex capacity
• improve quality of life

Specific
• safe
• reduce arrhythmia
• psychological effects
<table>
<thead>
<tr>
<th>Severe Impairment</th>
<th>Moderate</th>
<th>Mild Impairment</th>
</tr>
</thead>
<tbody>
<tr>
<td>VO2peak</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 10 ml/kg/min</td>
<td>10-18 ml/kg/min</td>
<td>&gt; 18 ml/kg/min</td>
</tr>
</tbody>
</table>

### Intensity (% VO2peak)
- 40-50%
- 60-80%

### Duration
- 5-10’ (1 or several times/d)
- 15’ (1-2/d)
- 30’ (3-5/wk)

### 5-10’ cooling-down

- **HR response to exercise**
- **Exercise induced arrhythmia**
- **Patient reassurance**
- **Exercise prescription**

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Exercise training in heart failure: practical guidance. Conraads V, Beckers P. Heart 2010;96:2025
Safety of symptom-limited cardiopulmonary exercise testing in patients with chronic heart failure due to severe left ventricular systolic dysfunction.


N=4411 CPET

40% ICD

293 ICDs fired once
688 discharges/2.5yr

1 VFib - next day
1 Sust. VTach - next day
No ex-related discharge

Precautions: stop early if 3-5 beats runs, 5-10 beats below treatment zone, deactivate ICD or increase ventricular discharge rate
Effect of exercise training in patients with an implantable cardioverter defibrillator. 


2 centres
Leuven, Leiden

N=106, eligible

4 dropouts,
6 non CV morbidity
4 V tach

N=92 ICD
N=473 matched controls (1942)

Exercise training - 3 months - 3x90min/week
CPET: baseline/after 3 months
ICD: HR limit 20 beats below threshold

<table>
<thead>
<tr>
<th>Variable</th>
<th>Control</th>
<th>ICD</th>
<th>p-Value</th>
<th>Total cohort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients (m/f)</td>
<td>473 (428/45)</td>
<td>92 (79/13)</td>
<td>0.18</td>
<td>1942 (1797/145)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>56 ± 7.8</td>
<td>57 ± 12</td>
<td>0.37</td>
<td>55 ± 9.3</td>
</tr>
<tr>
<td>Body mass index (kg m⁻²)</td>
<td>25.4 ± 2.8</td>
<td>25.9 ± 3.5</td>
<td>0.79</td>
<td>25.4 ± 3.1</td>
</tr>
<tr>
<td>Underlying heart disease</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ischaemic heart disease</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AMI</td>
<td>351 (74%)</td>
<td>63 (68%)</td>
<td>0.26</td>
<td>1277 (66%)</td>
</tr>
<tr>
<td>CABG</td>
<td>116 (25%)</td>
<td>20 (22%)</td>
<td>0.57</td>
<td>712 (37%)</td>
</tr>
<tr>
<td>PTCA</td>
<td>109 (23%)</td>
<td>25 (27%)</td>
<td>0.39</td>
<td>558 (29%)</td>
</tr>
<tr>
<td>Valvular disease</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(artificial replacement)</td>
<td>29 (6%)</td>
<td>6 (5%)</td>
<td>0.80</td>
<td>101 (5%)</td>
</tr>
<tr>
<td>Cholesterol level (mg/100 ml)</td>
<td>226 ± 48</td>
<td>212 ± 40</td>
<td>0.009</td>
<td>223 ± 44</td>
</tr>
<tr>
<td>History of hypertension</td>
<td>115 (24%)</td>
<td>19 (20.6%)</td>
<td>0.45</td>
<td>495 (25.5%)</td>
</tr>
<tr>
<td>Family history for IHD</td>
<td>88 (19%)</td>
<td>14 (15%)</td>
<td>0.44</td>
<td>415 (21.4%)</td>
</tr>
<tr>
<td>ST-depression during exercise testing</td>
<td>80 (17%)</td>
<td>2 (2%)</td>
<td>0.001</td>
<td>288 (15%)</td>
</tr>
<tr>
<td>Smoking habits</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current smoking</td>
<td>32 (7%)</td>
<td>7 (8%)</td>
<td>0.77</td>
<td>116 (6%)</td>
</tr>
<tr>
<td>Past smoking</td>
<td>371 (78%)</td>
<td>54 (59%)</td>
<td>0.001</td>
<td>1450 (75%)</td>
</tr>
<tr>
<td>Complaints in daily life</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dyspnœa</td>
<td>71 (15%)</td>
<td>27 (29%)</td>
<td>0.001</td>
<td>335 (17%)</td>
</tr>
<tr>
<td>Angina pectoris</td>
<td>30 (6%)</td>
<td>3 (3%)</td>
<td>0.25</td>
<td>110 (6%)</td>
</tr>
</tbody>
</table>

LVEF only in 1/3 ICD patients
LVEF < 40%: 68% vs 13% (p < 0.001)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Control group (n = 473)</th>
<th>ICD group (n = 92)</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data at rest and submaximal exercise</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart rate (beats min^{-1})</td>
<td>67 ± 12</td>
<td>67 ± 13</td>
<td>0.91</td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>129 ± 19</td>
<td>132 ± 24</td>
<td>0.24</td>
</tr>
<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td>80 ± 12</td>
<td>81 ± 12</td>
<td>0.31</td>
</tr>
<tr>
<td>Heart rate at 80 W (beats min^{-1})</td>
<td>105 ± 16</td>
<td>101 ± 19</td>
<td>0.10</td>
</tr>
<tr>
<td>Data at peak exercise</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VO_{2} (ml min^{-1})</td>
<td>1705 ± 466</td>
<td>1417 ± 539</td>
<td>0.0001</td>
</tr>
<tr>
<td>VO_{2} (ml min^{-1} kg^{-1})</td>
<td>22.2 ± 5.6</td>
<td>17.7 ± 6.1</td>
<td>0.0001</td>
</tr>
<tr>
<td>Oxygen pulse (ml beat^{-1})</td>
<td>13.3 ± 3.1</td>
<td>12.4 ± 4.9</td>
<td>0.0002</td>
</tr>
<tr>
<td>Heart rate (beats min^{-1})</td>
<td>128 ± 22</td>
<td>117 ± 23</td>
<td>0.0001</td>
</tr>
<tr>
<td>RER (VCO_{2}/VO_{2})</td>
<td>1.10 ± 0.10</td>
<td>1.08 ± 0.13</td>
<td>0.10</td>
</tr>
<tr>
<td>V_{E}O_{2} (V_{E}/VO_{2})</td>
<td>36.2 ± 6.7</td>
<td>39.6 ± 8.4</td>
<td>0.0002</td>
</tr>
</tbody>
</table>

Data are presented as mean ± SD and as the p-value of the difference in the baseline result between both groups. Comparisons between groups are made by means of unpaired t test or Wilcoxon signed rank test. ICD, implantable cardioverter defibrillator; VO_{2}, oxygen uptake; RER, respiratory gas exchange ratio; VCO_{2}, carbon dioxide output; V_{E}VO_{2}, ventilatory equivalent for oxygen; V_{E}, ventilation.

2 centres
Leuven, Leiden

N=106, eligible

4 dropouts,
6 non CV morbidity
4 V tach

N=92 ICD
N=473 matched controls

<table>
<thead>
<tr>
<th>17-20%</th>
<th>VPB (2-3-runs)</th>
<th>10-10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VT-shock-CPET</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>VT-shock-Training</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Inter-ex shocks</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Inappr shock</td>
<td></td>
</tr>
</tbody>
</table>

2 centres
Leuven, Leiden

N=106, eligible
4 dropouts, 6 non CV morbidity
4 V tach

N=92 ICD  N=473 matched controls

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<tr>
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<td>VT-shock-CPET</td>
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</tr>
<tr>
<td>6</td>
<td>Inter-ex shocks</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Inappr shock</td>
<td></td>
</tr>
<tr>
<td>55%</td>
<td>Beta-blocker</td>
<td>78%</td>
</tr>
</tbody>
</table>
Risk of Ventricular Arrhythmia After Implantable Defibrillator Treatment in Anxious Type D Patients


N=391
Prim/sec prevention: 57/43%
STAI, BDI, DS14

Table 3  Multivariable Predictors of Ventricular Arrhythmias

<table>
<thead>
<tr>
<th>Predictor</th>
<th>HR</th>
<th>95% CI</th>
<th>p Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>1.02</td>
<td>0.56–1.86</td>
<td>0.94</td>
</tr>
<tr>
<td>Age</td>
<td>0.98</td>
<td>0.96–1.01</td>
<td>0.16</td>
</tr>
<tr>
<td>Secondary prevention</td>
<td>1.91</td>
<td>1.14–3.20</td>
<td>0.014</td>
</tr>
<tr>
<td>Nonischemic etiology</td>
<td>1.08</td>
<td>0.61–1.92</td>
<td>0.80</td>
</tr>
<tr>
<td>Severely decreased ejection fraction†</td>
<td>1.30</td>
<td>0.63–2.67</td>
<td>0.47</td>
</tr>
<tr>
<td>Prolonged QRS duration‡</td>
<td>0.98</td>
<td>0.59–1.61</td>
<td>0.92</td>
</tr>
<tr>
<td>No prescription of angiotensin-converting enzyme inhibitor</td>
<td>1.05</td>
<td>0.62–1.76</td>
<td>0.86</td>
</tr>
<tr>
<td>No prescription of beta-blocker</td>
<td>1.54</td>
<td>0.89–2.66</td>
<td>0.12</td>
</tr>
<tr>
<td>Anxious Type D cluster</td>
<td>1.72</td>
<td>1.03–2.89</td>
<td>0.039</td>
</tr>
</tbody>
</table>
**Figure 1** Kaplan-Meier Curve for Time to First Ventricular Arrhythmia in Type D Patients With Increased Anxiety (p = 0.012)

Other groups (blue line); anxious Type D patients (green line).
The Effect of Exercise Training on Anxiety Symptoms Among Patients

A Systematic Review

Matthew P. Herring, MS, MEd; Patrick J. O'Connor, PhD; Rodney K. Dishman, PhD

Background: Anxiety often remains unrecognized or untreated among patients with a chronic illness. Exercise training may help improve anxiety symptoms among patients. We estimated the population effect size for exercise training effects on anxiety and determined whether selected variables of theoretical or practical importance moderate the effect.

Methods: Articles published from January 1995 to August 2007 were located using the Physical Activity Guidelines for Americans Scientific Database, supplemented by additional searches through December 2008 of the following databases: Google Scholar, MEDLINE, PsycINFO, PubMed, and Web of Science. Forty English-language articles in scholarly journals involving sedentary adults with a chronic illness were selected. They included both an anxiety outcome measured at baseline and after exercise training and random assignment to either an exercise intervention of 3 or more weeks or a comparison condition that lacked exercise. Two co-authors independently calculated the Hedges $d$ effect sizes from studies of 2914 patients and extracted information regarding potential moderator variables. Random effects models were used to estimate sampling error and population variance for all analyses.

Results: Compared with no treatment conditions, exercise training significantly reduced anxiety symptoms by a mean effect $Δ$ of 0.29 (95% confidence interval, 0.23-0.36). Exercise training programs lasting no more than 12 weeks, using session durations of at least 30 minutes, and an anxiety report time frame greater than the past week resulted in the largest anxiety improvements.

Conclusion: Exercise training reduces anxiety symptoms among sedentary patients who have a chronic illness.

Arch Intern Med. 2010;170(4):321-331
Comprehensive cardiac rehabilitation programme for implantable cardioverter-defibrillator patients: a randomised controlled trial

N=16, training 12wks - detraining 12wks

Figure 3  Hospital anxiety and depression (HAD) scores for anxiety. Values are means for the 11 patients who completed the comprehensive cardiac rehabilitation (CCR) and all the exercise tests. Error bars = SD.
Should we encourage ICD patients to exercise?

1. Why?- is it evidence based?
2. What about combined devices?
3. Magnitude of the problem vs participation
4. Conclusion and Future
The effect of endurance training on exercise capacity following cardiac resynchronization therapy in chronic heart failure patients; a pilot trial.


**Fig. 2**

Evolution of \( \text{Vo}_{2}\text{max} \) for the CRT+ (pharmacological therapy plus exercise training programme; ○) and CRT− (pharmacological therapy only; □) groups.
Should we encourage ICD patients to exercise?

1. Why? - is it evidence based?
2. What about combined devices?
3. Magnitude of the problem vs participation
4. Conclusion and Future
European utilization of the implantable defibrillator: has 10 years changed the ‘enigma’?


Figure 1 Implantable cardioverter defibrillator/CRT-D implantations per million of the population in Europe and the USA from 1990 to 2006.
European utilization of the implantable defibrillator: has 10 years changed the ‘enigma’?


Figure 4 Percentage of patients fulfilling the criteria for the major randomized implantable cardioverter defibrillator (ICD) trials, which actually get implanted with ICDs in Western Europe. The histograms represent the total number of patients (W. Europe), who fulfil the study criteria. [In case of overlapping criteria, the patients are only counted once (the earlier indication); patients with high co-morbidity due to cancer or other diseases have been excluded.] The triangles represent the actual number of patients, corresponding to a given study, who were implanted with ICDs in the years indicated. Analysis from Ref. 17.
Should we encourage ICD patients to exercise?

1. Why? - is it evidence based?
2. What about combined devices?
3. Magnitude of the problem vs participation
4. Conclusion and Future


2 groups CHF patients

<table>
<thead>
<tr>
<th>TeleCR (n=77)</th>
<th>StandCR (n=75)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LVEF</td>
<td></td>
</tr>
<tr>
<td>30.2 + 8.2%</td>
<td>30.8 + 6.7%</td>
</tr>
<tr>
<td>NYHA II/III</td>
<td></td>
</tr>
<tr>
<td>50/50%</td>
<td>55/45%</td>
</tr>
<tr>
<td>VO2peak (ml/kg/min)</td>
<td></td>
</tr>
<tr>
<td>17.8 + 4.1</td>
<td>17.9 + 4.4</td>
</tr>
</tbody>
</table>

8 weeks

ICD patients are “trainable” and to a large extent, these are CHF patients with a “surplus”.

Exercise training “seems” safe in ICD patients.

The growing number of patients calls for alternatives.

Sufficiently powered randomized trials are necessary.