

# Reproducibility of measurement of skeletal muscle tissue oxygenation in patients with chronic heart failure.

Gepubliceerd: 15-12-2011 Laatste bijgewerkt: 13-12-2022

Chronic heart failure (CHF) is a clinical syndrome resulting from a decreased cardiac output, insufficient to maintain adequate tissue oxygenation. Eventually, inadequate tissue oxygenation will lead to pathological alterations, especially at the...

<b>Ethische beoordeling</b>	Positief advies
<b>Status</b>	Werving gestart
<b>Type aandoening</b>	-
<b>Onderzoekstype</b>	Observationeel onderzoek, zonder invasieve metingen

## Samenvatting

### ID

NL-OMON19931

### Bron

Nationaal Trial Register

### Verkorte titel

Reproducibility of skeletal muscle TSI in CHF

### Aandoening

Chronic Heart Failure, Exercise intolerance, Skeletal muscle impairment.  
Chronisch hartfalen, inspanningsintolerantie, skeletspierbeperking

## Ondersteuning

**Primaire sponsor:** Maxima Medical Center

**Overige ondersteuning:** Maxima Medical Center

## Onderzoeksproduct en/of interventie

## Uitkomstmaten

### Primaire uitkomstmaten

Difference (paired T-test when normally distributed) and agreement (intra-class correlation coefficients, limits of agreement and coefficients of variation) of the rate of muscle deoxygenation at exercise onset between two days (rate of decrease of muscle tissue saturation index expressed as MRT-TSI).

## Toelichting onderzoek

### Achtergrond van het onderzoek

#### Rationale:

Patients with chronic heart failure (CHF) suffer from a decreased cardiac output and impaired skeletal muscle function. Skeletal muscle alterations can ultimately have a predominant role in the pathophysiology of exercise intolerance in CHF. However, research indicates that not all CHF patients are impaired in a similar manner, which might explain the large number of non-responders to various types of treatment. Near Infrared Spectroscopy (NIRS) is a promising non-invasive tool that has the ability to discern between impairments of O<sub>2</sub> delivery and O<sub>2</sub> utilization at the skeletal muscle level. In order to be able to use NIRS as a routine measurement in a clinical setting the issue of reproducibility needs to be addressed. Additionally, by comparing data from healthy subjects with CHF patients, the understanding of the pathophysiology of heart failure might be improved.

#### Objective:

The main objective of the study is to investigate the reproducibility of NIRS measurements during submaximal exercise in CHF patients. The secondary objective is to investigate the differences in changes of muscle oxygenation during and after exercise between healthy subjects and CHF patients.

#### Study design:

Prospective observational study without invasive measurements.

#### Study population:

Twenty patients with stable systolic CHF (left ventricular ejection fraction  $\leq$  40%) and twenty age- and BMI-matched healthy control subjects who are able and motivated to perform cycling exercise.

Main study parameters/endpoints:

Difference and agreement of the rate of muscle deoxygenation at exercise onset between two days (rate of decrease of muscle tissue saturation index expressed as MRT-TSI).

Secondary study parameters/endpoints: Difference of VO<sub>2</sub> kinetics and NIRS kinetics (MRT-TSI) between healthy subjects and CHF patients during the first submaximal exercise test.

Nature and extent of the burden and risks associated with participation, benefit and group relatedness:

No adverse effects of submaximal cycling exercise performed by CHF patients or healthy subjects have been reported in literature, nor in our clinical experience. Near infrared spectroscopy is a non-invasive measurement and therefore place no additional burden on the subjects. In order to set intensity for the submaximal exercise test, all subjects perform a maximal cardiopulmonary exercise test at baseline, excluding patients with myocardial ischaemia and ventricular arrhythmias during exercise.

By performing these measurements, we will be able to evaluate the reproducibility of NIRS and pathophysiological mechanisms of slowed VO<sub>2</sub> kinetics. This study will provide knowledge on the applicability of NIRS in routine clinical assessment of CHF patients, and eventually, will contribute to a more individualized exercise prescription, specifically aimed at the patients individual limitations.

## **Doel van het onderzoek**

Chronic heart failure (CHF) is a clinical syndrome resulting from a decreased cardiac output, insufficient to maintain adequate tissue oxygenation. Eventually, inadequate tissue oxygenation will lead to pathological alterations, especially at the skeletal muscle level. Several studies indicated that, especially in severe heart failure, skeletal muscle alterations can have a predominant role in the pathophysiology of exercise intolerance.(26, 32) In other words, these patients with severe heart failure appear not to be limited mainly by impaired tissue oxygenation but more so by slowed skeletal muscle metabolism. However, the degree of skeletal muscle impairment shows large inter-individual variation, indicating that certainly not all CHF patients are limited in a similar manner.

The continuing appearance of novel treatment modalities in the field of CHF has beneficial effects on group outcome. However, rising costs and potential adverse effects of these treatments call for a more individualized approach to medical treatment. The ability to discern different types of limitations and to tailor treatment, like physical training and cardiac resynchronization therapy, has the potential of reducing the large number of non-responders (30-50%) to these interventions. Ideally, to disclose the nature of the limitation, a reliable and preferably non-invasive test should be available to guide the clinician dealing with CHF treatment.

Near Infrared Spectroscopy (NIRS) is a promising tool in exercise physiology, as it has the ability to monitor changes in tissue oxygenation in a totally non-invasive setup. The technique is based on the relative tissue transparency for light in the near-infrared region and on the oxygen-dependent absorption changes of haemoglobin and myoglobin. Changes in concentrations of oxygenated haemoglobin (O<sub>2</sub>Hb) and deoxygenated haemoglobin (HHb) can be measured, reflecting local O<sub>2</sub> delivery relative to O<sub>2</sub> utilization. In this way, the speed of adaptation of oxygenation to a certain level of exercise reflects the intrinsic pathophysiology of exercise intolerance, as for instance slow deoxygenation at exercise onset indicates a metabolic limitation (utilization), while fast deoxygenation coincides with a limitation in oxygen delivery.

In order to be able to use NIRS as a routine measurement in a clinical setting, some issues need to be addressed. First, to our knowledge, reproducibility of NIRS measurements during exercise has not yet been evaluated in the CHF population. Furthermore, research on differences in exercise-related changes in muscle oxygenation between CHF patients and healthy subjects is scarce. Yet, investigating these differences might contribute to a better understanding of the pathophysiology of heart failure.

### **Onderzoeksopzet**

1. (t<sub>0</sub>) Baseline assessment;
2. (t<sub>1</sub>=t<sub>0</sub> + 2-7days) Submaximal exercise test 1;
3. (t<sub>2</sub>=t<sub>1</sub> + 2-7days) Submaximal exercise test 2.

### **Onderzoeksproduct en/of interventie**

The study is designed as a prospective observational study without invasive measurements. After informed consent is obtained, a baseline assessment will be performed. The first part of this assessment consists of a physical examination, echocardiography and maximal exercise testing with respiratory gas analysis. The second part of the assessment consists two six minute submaximal exercise test with simultaneous near infrared spectroscopy (NIRS) measurements.

## **Contactpersonen**

### **Publiek**

Postbus 7777  
V. Niemeijer  
de Run 4600  
Veldhoven 5500 MB

The Netherlands  
+31 (0)40 88888200

## **Wetenschappelijk**

Postbus 7777  
V. Niemeijer  
de Run 4600  
Veldhoven 5500 MB  
The Netherlands  
+31 (0)40 88888200

## **Deelname eisen**

### **Belangrijkste voorwaarden om deel te mogen nemen (Inclusiecriteria)**

1. Written informed consent;
2. Systolic heart failure secondary to ischemic or dilated cardiomyopathy;
3. New York Heart Association (NYHA) class II or III (without change in class or medication < 3 months prior to inclusion);
4. Left ventricular ejection fraction of  $\leq 40\%$  (assessed within 3 months before inclusion by echocardiography, MRI or radionuclear measurement).

### **Belangrijkste redenen om niet deel te kunnen nemen (Exclusiecriteria)**

1. Myocardial infarction or unstable angina less than 3 months prior to inclusion;
2. Clinical signs of decompensated heart failure;
3. Ventricular tachycardia or ischemia during exercise;
4. Participation in a training program ( $\geq 2$ /week) in the last year;
5. Intracardiac shunts or congenital heart disease limiting exercise capacity;
6. Orthopaedic, vascular, pulmonary, neuromuscular and other disease limiting exercise capacity.

## Onderzoeksopzet

### Opzet

Type:	Observationeel onderzoek, zonder invasieve metingen
Onderzoeksmodel:	Parallel
Toewijzing:	N.v.t. / één studie arm
Blinding:	Open / niet geblindeerd
Controle:	N.v.t. / onbekend

### Deelname

Nederland	
Status:	Werving gestart
(Verwachte) startdatum:	01-02-2012
Aantal proefpersonen:	40
Type:	Verwachte startdatum

## Ethische beoordeling

Positief advies	
Datum:	15-12-2011
Soort:	Eerste indiening

## Registraties

### Opgevolgd door onderstaande (mogelijk meer actuele) registratie

Geen registraties gevonden.

### Andere (mogelijk minder actuele) registraties in dit register

Geen registraties gevonden.

## In overige registers

Register	ID
NTR-new	NL3049
NTR-old	NTR3197
CCMO	NL38993.015.11
ISRCTN	ISRCTN wordt niet meer aangevraagd.

## Resultaten

### Samenvatting resultaten

Kemps HM, Schep G, Zonderland ML, Thijssen EJ, De Vries WR, Wessels B, Doevendans PA, Wijn PF. Are oxygen uptake kinetics in chronic heart failure limited by oxygen delivery or oxygen utilization? International journal of cardiology 142: 138-44, 2010.<br>

Kemps HMC, Prompers JJ, Wessels B, de Vries WR, Zonderland ML, Thijssen EJM, Nicolay K, Schep G, Doevendans AFM. Skeletal muscle metabolic recovery following submaximal exercise in chronic heart failure is limited more by O2 delivery than O2 utilization. Clin.Sci.(Lond) 118: 203-210, 2010.