

# Cardiopulmonary exercise testing is predictive of return to work in cardiac patients after rehabilitation

Heinz Völler<sup>1,2</sup>, Annett Salzwedel<sup>1</sup>, Rona Reibis<sup>3</sup>, Stefan Kaminski<sup>2</sup>, Hermann Buhlert<sup>2</sup>, Sarah Eichler<sup>1</sup>, Karl Wegscheider<sup>4</sup>

## Introduction

Cardiopulmonary exercise testing (CPX) has an independent prognostic value, especially in cardiovascular patients. We aimed to evaluate parameters of CPX as predictors for return to work (RTW) at discharge of cardiac rehabilitation (CR).

## Hypothesis

Besides psychosocial as well as clinical parameters CPX variables are independent predictors of return to work in patients with cardiovascular diseases.

## Methods

We analyzed sociodemographic and clinical data from a prospective registry of 489 patients (mean age 51.5±6.9 years, 87.9% men), who were referred to short-term (3 weeks) inpatient CR between 06/2009 to 12/2011, predominantly after PCI (62.6%), CABG (17.2%) and heart valve replacement (9.0%). At admission, patients underwent noninvasive cardiac diagnostic (2D echocardiography, bicycle stress test, 6-minute walk test) and a psychodiagnostic screening (Hospital Anxiety and Depression Scale). CPX was performed at discharge for defining fitness. Follow up was realized by linking the RTW data from the German Pension Insurance with the collected data. The primary endpoint was analyzed with Cox Regression.

Table 1. Characteristics of patients with and without return to work

Return to Work	Yes (n = 373)	No (n = 116)	p-Value
<b>Sociodemographic data</b>			
Age (years)	51.0	53.1	0.004
Gender (m)	87.9 %	87.9 %	0.999
BMI (kg/m <sup>2</sup> )	27.5	28.7	0.003
<b>Main diagnosis</b>			
PCI/Stent with ACS	60.3 %	54.3 %	0.250
PCI/Stent without ACS	4.6 %	0.9 %	0.065
CABG with ACS	4.3 %	3.4 %	0.689
CABG without ACS	11.3 %	19.0 %	0.032
Heart valve replacement	9.4 %	7.8 %	0.593
Other cardiac disease	10.2 %	14.7 %	0.183
<b>Comorbidities</b>			
No.	0.44	0.76	<0.001
Psychological impairments	7.5 %	16.4 %	<0.001
Orthopedic impairments	47.7 %	71.6 %	<0.001
<b>HADS-D-Anxiety Score</b>			
> 10	12.1 %	3.9 %	0.036

BMI, Body Mass Index; PCI, Percutaneous Coronary Intervention; ACS, Acute Coronary Syndrome; CABG, Coronary Artery Bypass Surgery; HADS, Hospital Anxiety and Depression Scale

Table 2. Functional parameters depending on return to work

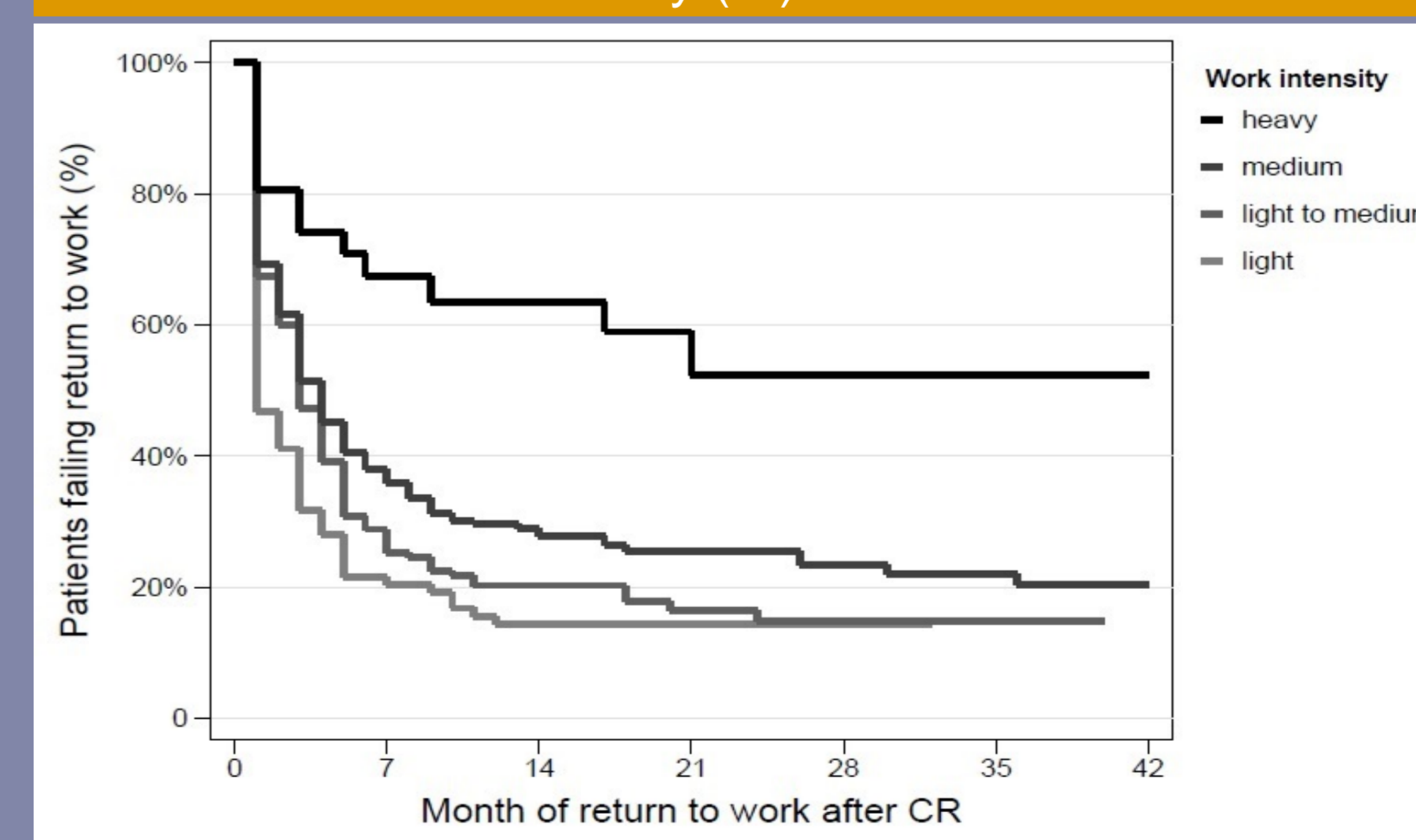
Return to Work	Yes (n = 373)	No (n = 116)	p-Value
NYHA I / II at discharge	98.8 %	98.1 %	0.578
<b>6MWT (m)</b>			
Admission	397	391	0.496
Discharge	497	489	0.334
EF (%)	55.5	52.7	0.004
Bicycle stress test at admission (Watt)	120	103	<0.001
<b>CPX</b>			
Capacity at termination (Watt)	167	139	<0.001
VO <sub>2</sub> peak (ml/min/kg body weight)	24.7	21.0	<0.001
VO <sub>2</sub> AT (ml/min/kg body weight)	15.7	13.6	<0.001
VE/VCO <sub>2</sub> -Slope (%)	28.3	30.6	0.001
VE/VCO <sub>2</sub> -Slope >31 (%)	23.7	31.9	0.167
O <sub>2</sub> /HR (ml)	16.3	14.7	<0.001
RER at termination (load >1.10)	1.20	1.10	0.049

NYHA, New York Heart Association; 6MWT, 6-Minute Walk Test, EF, Ejection Fraction; CPX, Cardiopulmonary Exercise Testing

## Results

In the univariate analysis patients without RTW were older (p=0.004) and had a higher BMI (p=0.003) (Table 1). Furthermore, exercise capacity in bicycle stress test at admission (p<0.001) and most of the CPX variables differ significantly (Table 2). During a mean follow up of 26.5±11.9 months 373 (76.3%) patients returned to work, 116 (23.7%) did not and 60 (12.3%) were retired. Depending on work intensity, time of RTW was significantly different. While 70% of CR participants with light work intensity returned to work within 3 months, only in 25.8% with heavy work intensity resumption of work was possible (Figure 1).

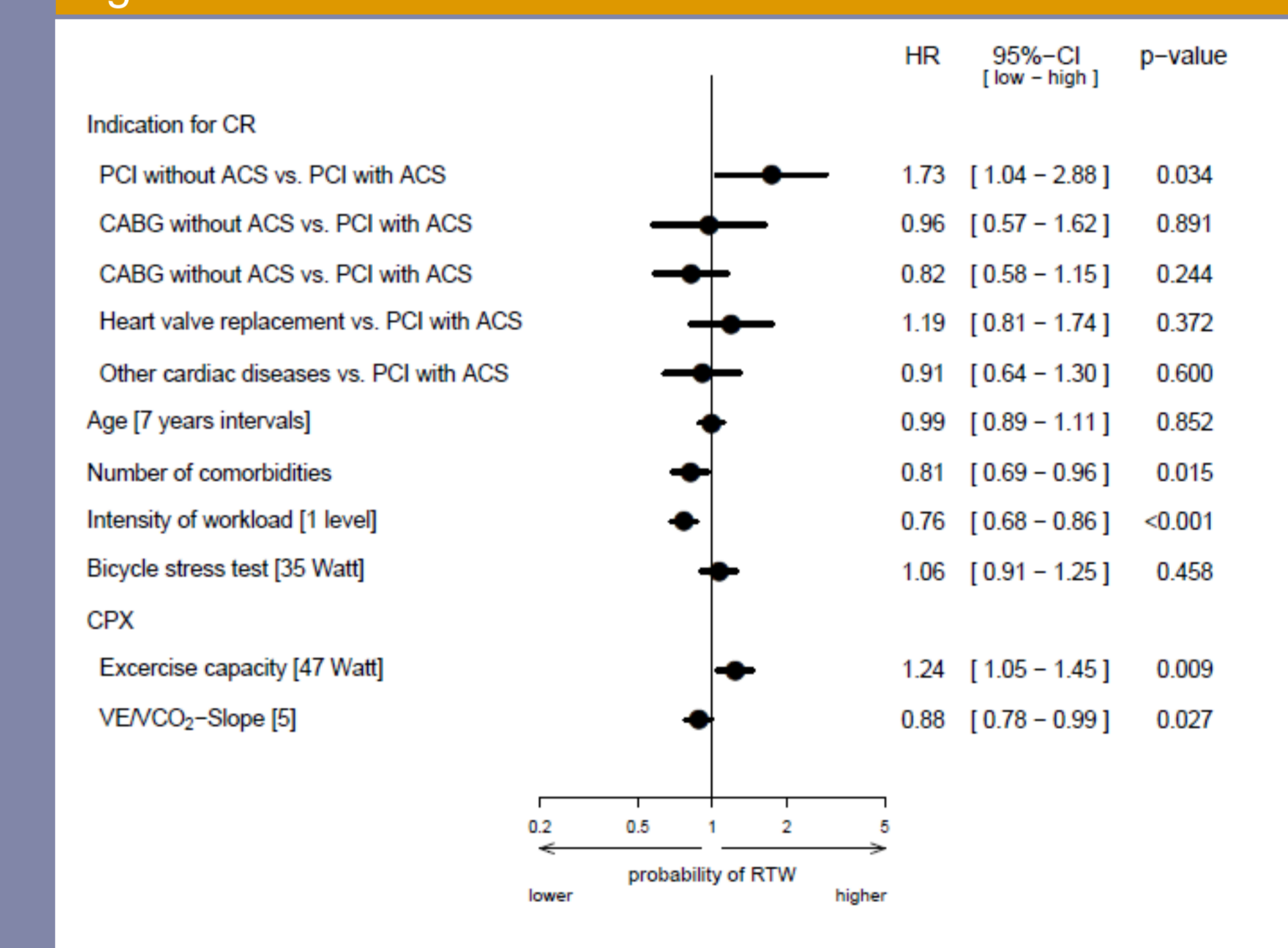
Figure 1. Percentage of patients without return to work after inpatient rehabilitation depending on work intensity (%)



In the multivariate analysis a higher number of comorbidities (p=0.011) and heavy work (p<0.001) were negatively associated with RTW, whereas a higher exercise capacity at

entry of CR (p<0.001) and elective PCI (p=0.02) increased the probability of RTW. After adjustment for covariates max. work load (Watt) at CPX termination and the VE/VCO<sub>2</sub>-slope had an independent prognostic significance for RTW. A higher work load increased (p=0.009) while a higher VE/VCO<sub>2</sub>-slope decreased (p=0.027) the probability of RTW (Figure 2). Even for retirement, CPX had a prognostic value: the likelihood of retirement was smaller with increasing VO<sub>2</sub>AT (p=0.016).

Figure 2. Predictors of return to work



CR, Cardiac Rehabilitation; PCI, Percutaneous Coronary Intervention; ACS, Acute Coronary Syndrome; CABG, Coronary Artery Bypass Surgery; CPX, Cardiopulmonary Exercise Testing

## Conclusions

CPX is a meaningful tool to assess patients' ability for return to work. Therefore, it should be an essential part of functional assessment in CR for predicting participation in employment during two years after CR.

1 Center of Rehabilitation Research, University of Potsdam, Germany

2 Klinik am See, Rüdersdorf, Germany

3 Kardiologische Gemeinschaftspraxis am Park Sanssouci, Potsdam, Germany

4 Department of Medical Biometry and Epidemiology, University Medical Center, Hamburg-Eppendorf, Germany