Impact of cardiac power output, invasively measured by right heart catheterization, on exercise capacity and clinical outcomes in patients with chronic heart failure

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**Background:** Cardiac power output (CPO) is a novel hemodynamics parameter that is derived from both flow and pressure, and therefore it represents the cardiac pumping ability. CPO is strongly associated with outcomes in patients with cardiogenic shock. Nevertheless, less data is available about the impact of CPO on exercise capacity or clinical outcomes in patients with chronic heart failure (CHF).

**Purpose:** The present study aimed to investigate the impact of CPO on exercise intolerance or morbidity and mortality in patients with CHF who underwent invasive right heart catheterization.

**Methods:** The study enrolled 280 consecutive patients with CHF who underwent cardiopulmonary exercise testing and right heart catheterization between 2013 and 2018. The primary outcome was composite of heart failure hospitalization and death. CPO was calculated as (mean arterial pressure $\times$ cardiac output [CO])/451. Study population was divided into 2 groups according to the established cut-off value of CPO ($= 0.53$ W).

**Results:** Patients with low CPO ($n = 99$) were older and lower body mass index and displayed poorer kidney function, higher plasma brain natriuretic peptide (BNP) levels and lower left ventricular ejection fraction (LVEF) as compared to patients with high CPO ($n = 181$). CPO was correlated with peak oxygen consumption (Peak VO\(_2\)), peak workload achievement, and ventilatory efficiency ($V\dot{E}/V\dot{CO}_2$ slope) (Figure 1), while each of CO or mean arterial pressure was not. There were 48 patients with events over a median follow-up period of 3.5 (Interquartile range 1.0-6.0) years. Patients with low CPO had a 2.0-fold higher risk of events as compared to those with high CPO (HR 1.97; 95%CI, 1.12-3.48, $P = 0.02$, Figure 2). In multivariable Cox regression, 0.1-decreased in CPO was associated with 19% increased adverse events even after adjustment for gender, BNP, renal function, LVEF, and pulmonary capillary wedge pressure (HR 0.81; 95%CI, 0.67-0.99, $P = 0.04$).

**Conclusions:** CPO was associated with reduced exercise capacity and poor clinical outcomes, suggesting that CPO is useful for risk stratification in patients with CHF. Further study is required to identify therapies targeting CPO to improve the exercise capacity or clinical outcomes in patients with CHF.

**Figure 1**

\[\text{Figure1}\]
Figure 2

Composit of Heart Failure Hospitalization or Death

- Low CPO $\leq 0.53$ W
- High CPO $>0.53$ W

HR 1.97 (95% CI 1.12-3.48), $p=0.02$

Cumulative incidence

Follow-up Time (Years)

No. at risk

- Low CPO: 99, 66, 34, 19
- High CPO: 181, 129, 88, 52

Figure 2