# [Impaired right ventricular reserve predicts adverse cardiac outcomes in adults with congenital right heart disease.](https://www.ncbi.nlm.nih.gov/pubmed/30030334)

DeFaria Yeh D, Stefanescu Schmidt AC, Eisman AS, Serfas JD, Naqvi M, Youniss MA, Ryfa AD, Khan AA, Safi L, Tabtabai SR, Bhatt AB, Lewis GD.

Heart. 2018 Dec;104(24):2044-2050. doi: 10.1136/heartjnl-2017-312572. Epub 2018 Jul 20.

PMID: 30030334

[Similar articles](https://www.ncbi.nlm.nih.gov/pubmed?linkname=pubmed_pubmed&from_uid=30030334)

**Take Home Points:**

* There is an epidemic of right heart failure in ACHD patients that often goes undiagnosed until it is severe and often too late to treat.
* Better tools are needed to identify subtle signs of right heart failure when it is more amenable to treatment.
* Adding radionuclide imaging to routine CPET was shown in this study to predict clinical outcomes, even in patients with reasonably good peak VO2 (≥20mL/kg/min) or normal resting RVEF.
* Impaired RV reserve predicted adverse outcomes in the majority of patients in this study and was independent of other variables.
* Radionuclide imaging could be easily added at many centers, so this study should be validated on a multicenter basis.



***Commentary from Dr. W. Aaron Kay (Indianapolis), section editor of ACHD Journal Watch:* This was an elegant prospective study evaluating the combined use of CPET with radionuclide angiography to determine contractile reserve in RV in patients with both systemic and subpulmonary RV.** Radionuclide angiography is more accurate than echocardiography at quantifying RVEF and it is generally easier to add radionuclide imaging to an exercise test than to perform an exercise cardiac MRI, as no special nonferrometallic exercise equipment is needed for nuclear imaging.

**Both subpulmonary and systemic RV anatomies were included;** Patients with significant resting oxygen desaturation and/or single ventricles were excluded. Out of 147 patients, 128 had subpulmonary RV and the rest had systemic RV. Of the 128 with subpulmonary RV, 30 had RV pressure overload, 78 had RV volume overload, and 20 were myopathic without residual pressure or volume overload.

MRI and TTE on patients before/after CPET were reviewed for resting measurements of biventricular size and function and other key variables. If a cardiac intervention/surgery happened between CPET and imaging, the imaging performed after CPET was excluded for analysis. Clinical data was then reviewed to evaluate for a composite including clinical HF, arrhythmia, transplantation, or death. Those with multiple outcomes were censored after the first key outcome. Cardiac surgery was not included as an adverse event given that CPET data may influence a clinician regarding the timing of elective CHD surgery.

An RV reserve score (0-5, 0 normal, 5 severely impaired) was developed, including dynamic exercise systolic function, peak exercise RV systolic function, and change in RVEF from rest to peak exertion. Normal was defined as peak exercise RVEF > 45% with augmentation of > 5% with exercise or exercise RVEF > 50%.

Impaired RV reserve was found in 103/147 of patients (70%) of which 32% were asymptomatic. Nearly half (48%) of patients with normal resting RVEF had at least mildly impaired exercise RV reserve. Patients with severe impairment of RV reserve, when compared with those with normal RV reserve, were more likely to have a larger RV size by TTE/MRI and more likely to have NYHA > I symptoms. Resting LVEF was lower in those with severe versus normal RV reserve. RVEF by radionuclide correlated very well with MRI data (p < 0.001). All patients with myopathic RV had impaired RV reserve, and only 7/19 systemic RV patients had normal RV reserve.

Those with severely impaired RV reserve had lower peak VO2. Unfavorable clinic outcomes were found in 7% of patients with peak VO2 > 20 mL/kg/min, but in 41% with peak VO2 < 20 mL/kg/min. Interestingly, all 5 patients who had an adverse clinical outcome despite a peak VO2 > 20 mL/kg/min had impaired RV reserve. Also, of 50 patients with normal RVEF and peak VO2 > 20, 46% were found to have impaired RV reserve. After adjusting for other key variables including peak VO2, type of RV pathology, and degree of CHF symptoms, severe impairment of RV reserve remained a significant independent predictor of shorter event-free survival. Only 4/44 of patients with normal RV reserve had a clinical cardiovascular outcome of interest, and it was a non-life-threatening event in all 4 cases.

Overall, this study very nicely shows that adding stress radionuclide imaging improves the ability to predict adverse outcomes above and beyond resting imaging or CPET without exercise imaging added. It will be interesting to see if radionuclide imaging with stress testing becomes adopted at more centers. Also, it would be interesting to see if a similar study using MRI with a non-ferrometallic MRI could show similar results. Certainly, radionuclide angiography with existing treadmill/cycle equipment would be easier to implement on a widespread basis given that most hospitals already have both MUGA technology and a stress lab.



****

Figure 1 RV reserve and clinical outcomes. Kaplan-Meier curves evaluated cumulative incidence of the primary composite clinical endpoint (HF, arrhythmia, cardiac transplantation or death) by RV reserve group, censored at 2 years of follow-up. HF, heart failure; RV, right ventricle.