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**Value of Baseline Cardiac Magnetic Resonance Imaging for Predicting Adverse Outcomes in Treatment-Naïve Pulmonary Hypertension Patients**

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**Background:** Treatment with targeted pulmonary vasodilator therapy has been shown to benefit patients with pulmonary hypertension (PH), but identifying characteristics that predict treatment response has been challenging. Cardiac Magnetic Resonance Imaging (cardiac MRI) is the superior noninvasive testing modality for investigating cardiac structure and function, and may have prognostic value in pulmonary hypertension patients. We sought to evaluate the role of baseline cardiac MRI in predicting clinical outcomes in treatment naïve PH patients.

**Methods:** A retrospective analysis of all consecutive adults with newly diagnosed treatment-naïve PH undergoing cardiac MRI testing at a single center was performed. Cox proportional hazards models were constructed to assess the relationship between clinical and demographic information (including baseline cardiac MRI testing results) and clinical worsening.

**Results:** A total of 38 patients were included in the final analysis, of which 12 (32%) experienced the primary outcome of clinical worsening during the study period. In the multivariable models, cardiac MRI testing had significant and independent value in predicting clinical worsening, and a combination of cardiac MRI and echocardiographic testing had a 100% specificity in identifying patients who subsequently developed clinical worsening.

**Conclusions:** In treatment-naïve PH patients, baseline cardiac MRI testing may have an important role in predicting therapeutic response and identifying those at risk of treatment failure. These results support the role of cardiac MRI testing in these patients, and further investigation is warranted.



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Figure 1. Univariable Proportional Hazards Models

Variable	Odds Ratio	95% CI	P-value
Age	1	0.95-1.05	0.947
Gender (Female)	0.66	0.18-2.47	0.542
Race (White)	0.86	0.27-2.74	0.805
WHO Group (WHO-1)	0.86	0.23-3.20	0.826
cMRI RVEF	0.93	0.88-0.98	0.004
cMRI RVEDV	1.01	1.00-1.01	0.006
cMRI RVEDVI	1.02	1.00-1.03	0.006
cMRI RVESV	1.01	1.00-1.02	0.002
cMRI RVESVI	1.02	1.01-1.03	0.002
cMRI LVEDVI/RVEDVI	0.01	0.0004-0.24	0.005
cMRI (RVSV/RVESV)	0.09	0.01-0.68	0.020
Echo TR velocity	2.27	1.05-4.92	0.038
Echo PASP	1.05	1.02-1.08	0.003
Echo (TAPSE/PASP)	0.06	0.01-0.36	0.002
RHC RAP	1.08	1.00-1.16	0.042
RHC PAs	1.05	1.01-1.09	0.008
RHC PAd	1.08	1.04-1.13	<0.001
RHC mPAP	1.11	1.04-1.19	0.002
RHC CI	0.44	0.19-1.01	0.051
RHC PVR	1.34	1.15-1.57	<0.001
RHC PVRI	1.19	1.09-1.30	<0.001
Baseline NT-proBNP	1.34	0.99-1.79	0.051
Stratified cMRI CI (<2.5, or ≥ 2.5)	0.14	0.04-0.55	0.005
Stratified RHC CI (<2.5, or ≥ 2.5)	0.23	0.07-0.74	0.014
Stratified baseline 6MWT (≤ 165, 166-380, > 380)	0.88	0.31-2.53	0.813
Baseline 6MWT lowest oxygen saturation	0.94	0.89-1.00	0.059
Therapy strength (Monotherapy)	1.22	0.39-3.85	0.737

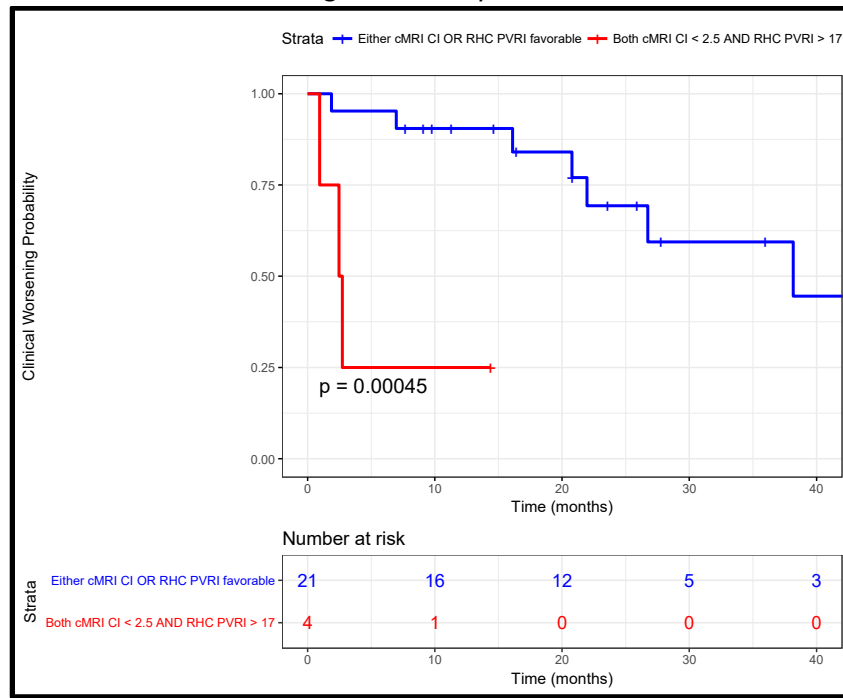
Abbreviations: cMRI = cardiac magnetic resonance imaging, Echo = echocardiography, RHC = right heart catheterization, RVEF = right ventricular ejection fraction, RVEDV = right ventricular end-diastolic volume, RVEDVI = RVEDV indexed for body surface area, RVESV = right ventricular end-systolic volume, RVESVI = RVESV indexed for body surface area, RVSV = right ventricular stroke volume, LVEDV = left ventricular end-diastolic volume, LVEDVI = LVEDV indexed for body surface area, CI = cardiac index, TR = tricuspid regurgitant jet, PASP = estimated pulmonary artery systolic pressure, TAPSE = tricuspid annular plane systolic excursion, RAP = right atrial pressure, PAs = pulmonary artery systolic pressure, PAd = pulmonary artery diastolic pressure, mPAP = mean pulmonary artery pressure, PVR = pulmonary vascular resistance, PVRI = PVR indexed for body surface area, NT-proBNP = N-terminal pro-B-type natriuretic peptide, 6MWT = six-minute walk test, WHO-1 = World Health Organization Group 1 (Pulmonary Arterial Hypertension)

Figure 2. Multivariable Proportional Hazards Models and Sensitivity Analysis

<b>Combined Cox Model</b>					
<b>Variables</b>	<b>Odds Ratio</b>	<b>95% CI</b>	<b>P-value</b>	<b>SSR</b>	
RHC PVRI	1.17	1.05-1.30	0.004	0.641	
Stratified cMRI CI	0.15	0.03-0.71	0.017	0.872	
				Global = 0.894	
<b>Combined Cox Models - Noninvasive</b>					
<b>Variables</b>	<b>Odds Ratio</b>	<b>95% CI</b>	<b>P-value</b>	<b>SSR</b>	
Stratified cMRI CI	0.05	0.007-0.353	0.003	0.68	
Echo TR Velocity	5	1.28-19.51	0.02	0.192	
				Global = 0.377	
Stratified cMRI CI	0.032	0.003-0.328	0.004	0.797	
Echo PASP	1.09	1.03-1.15	0.003	0.891	
				Global = 0.966	
<b>Sensitivity Analysis of Combined Models</b>					
<b>Predictive Value of Cutoffs</b>		<b>Sensitivity</b>	<b>Specificity</b>	<b>PPV</b>	<b>NPV</b>
Echo TR Velocity > 3.6 and cMRI CI < 2.5		33%	92%	75%	67%
RHC PVRI > 17 and cMRI CI < 2.5		30%	93%	75%	67%
Echo PASP > 40, cMRI CI < 2.5		44%	100%	100%	78%

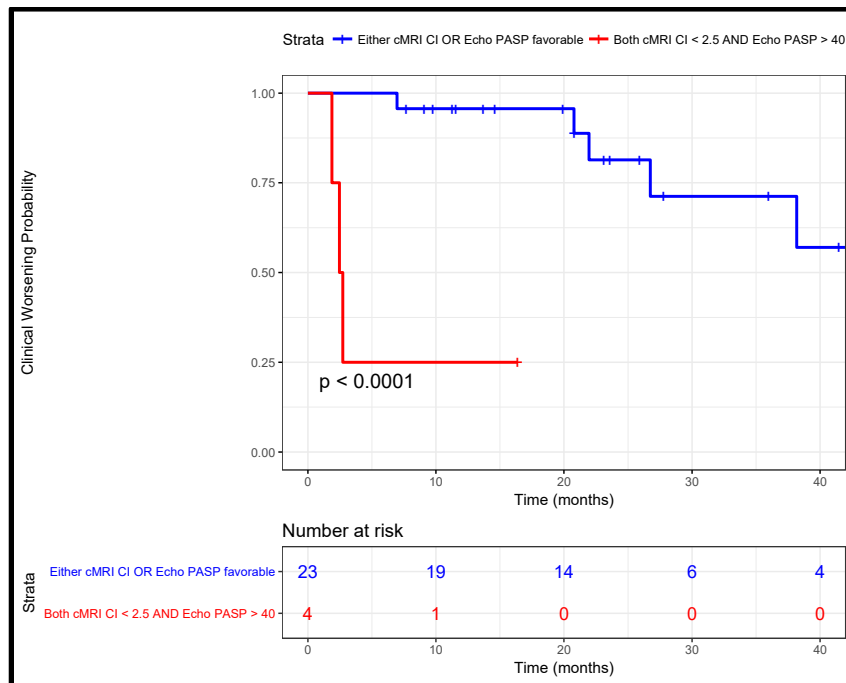
Abbreviations: cMRI = cardiac magnetic resonance imaging, Echo = echocardiography, RHC = right heart catheterization, PVR = pulmonary vascular resistance, PVRI = PVR indexed for body surface area, CI = cardiac index, TR = tricuspid regurgitant jet, PASP = estimated pulmonary artery systolic pressure, SSR = scaled Schoenfeld Residuals, PPV = predictive value positive, NPV = predictive value negative

Figure 3. Kaplan-Meier Curves for Clinical Worsening Stratified by Baseline Invasive and Noninvasive Testing



Legend: cMRI = Cardiac Magnetic Resonance Imaging, CI = Cardiac Index, RHC = Right Heart Catheterization, PVRI = Pulmonary Vascular Resistance indexed for body surface area

Figure 4. Kaplan-Meier Curves for Clinical Worsening Stratified by Baseline Noninvasive Testing Alone



Legend: cMRI = Cardiac Magnetic Resonance Imaging, CI = Cardiac Index, Echo = Echocardiography, PASP = Estimated Pulmonary Artery Systolic Pressure