Stress Echocardiography

Predicting heart failure transition and progression: a weighted risk score from bio-humoral, cardiopulmonary and echocardiographic stress testing

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Aims. We tested the prognostic role of a risk score including bio-humoral evaluation, cardiopulmonary-echocardiographic stress (CPET-ESE) and lung ultrasound, in patients with heart failure (HF) with reduced and preserved ejection fraction (HFrEF and HFpEF), and subjects at risk of developing HF (American College of Cardiology/American Heart Association Stages A and B).

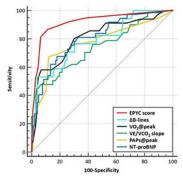
Methods and results. We evaluated 318 subjects: 94 in Stages A-B, 194 in Stage C (85 HFpEF and 109 HFrEF), and 30 age and sexmatched controls (Stage 0). During a median follow-up of 18.5 months, we reported 40 urgent HF visits, 31 HF hospitalisations and 10 cardiovascular deaths. Cox proportional-hazards regression for predicting adverse events identified five independent predictors and each was assigned a number of points proportional to its regression coefficient: Δstress-rest B-lines >10 (3 points), peak oxygen consumption <16 mL/kg/min (2 points), minute ventilation/carbon dioxide production slope ≥36 (2 points), peak systolic pulmonary artery pressure ≥50 mmHg (1 point) and resting N-terminal pro-brain natriuretic peptide (NT-proBNP) >900 pg/mL (1 point). We defined three risk categories: low-risk (<3 points), intermediate-risk (3-6 points), and high-risk (>6 points). The event-free survival probability for these three groups were 93%, 52% and 20%, respectively. Hazard Ratio was 4.55 for each risk category upgrade (95% confidence interval [CI], 3.44-5.93). The area-under-curve for the scoring system to predict events was 0.92 (95% CI 0.88-0.96).

Conclusion. A multiparametric risk score including indices of exercise-induced pulmonary congestion, markers of cardiopulmonary dysfunction and NT-proBNP identifies patients at increased risk for HF events across the HF spectrum.

Table 1

Variable	EPYC score	EPYC score <3 (low risk) n = 217	EPYC score 3-6 (intermediate risk) n = 70	, U	p-value (between risk categories)
Event-free $(n = 244)$	0 (0 - 2)	210 (97)	32 (46)	2 (6)	< 0.0001
With events $(n = 74)$	6 (4 - 9)	7 (3)	38 (54)	29 (94)	< 0.0001
p-value (event-free vs with events)	< 0.0001	<0.0001	< 0.0001	<0.0001	
Stage 0-Controls (n = 30)	0 (0 - 1)	30	0	0	< 0.0001
Stages A-B (n = 94)	1 (0 - 2)	85 (45)	6 (9)	3 (10)	< 0.0001
Stage C-HFpEF (n = 85)	3 (1 - 6)*†	46 (25)	29 (41)	10 (32)	< 0.0001
Stage C-HFrEF (n = 109)	4 (2 - 7)*†	56 (30)	35 (50)	18 (58)	< 0.0001
p-value (between HF Stages)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	

Values are mean \pm standard deviation, n (%), or median [25th quartile, 75th quartile]. * p < 0.01 vs Stage 0-Controls; † p < 0.01 vs Stages A-B. Abstract Figure 1



Variable	Cut-off	AUC (95% CI)	Sensitivity (%)	Specificity (%)	
EPYC score	23	0.92 (0.88 - 0.96)	87	89	
Δ8-lines	>10	0.77 (0.72 - 0.82)	68	85	
VO ₂ , mL/min/kg@peak	<16	0.80 (0.74 - 0.84)	66	86	
VE/VCO ₂ slope	≤36	0.75 (0.69 - 0.80)	55	89	
PAPs, mmHg⊜peak	≥50	0.72 (0.62 - 0.80)	81	67	
NT-proBNP, pg/mL	>900	0.81 (0.75 - 0.86)	68	85	