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 sex-matched 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).

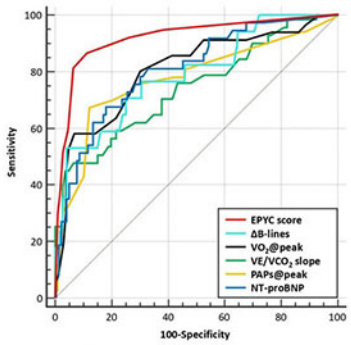
Conclusion. A multiparametric risk score including indices of exercise-induced pulmonary congestion, markers of cardiopulmonary dysfunction and NT-proBNP identifies patients at increased risk for HF events across the HF spectrum.

Table 1

Variable	EPYC score	EPYC score <3 (low risk) n = 217	EPYC score 3-6 (intermediate risk) n = 70	EPYC score >6 (high risk) n = 31	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 ± 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	≥3	0.92 (0.88 – 0.96)	87	89
ΔB-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