Derivation and Validation of a Novel **Right-Sided Heart Failure** Model After Implantation of Continuous Flow **Left Ventricular Assist Devices**: ***the EUROMACS-RHF Risk Score***

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On behalf of the EUROMACS investigators

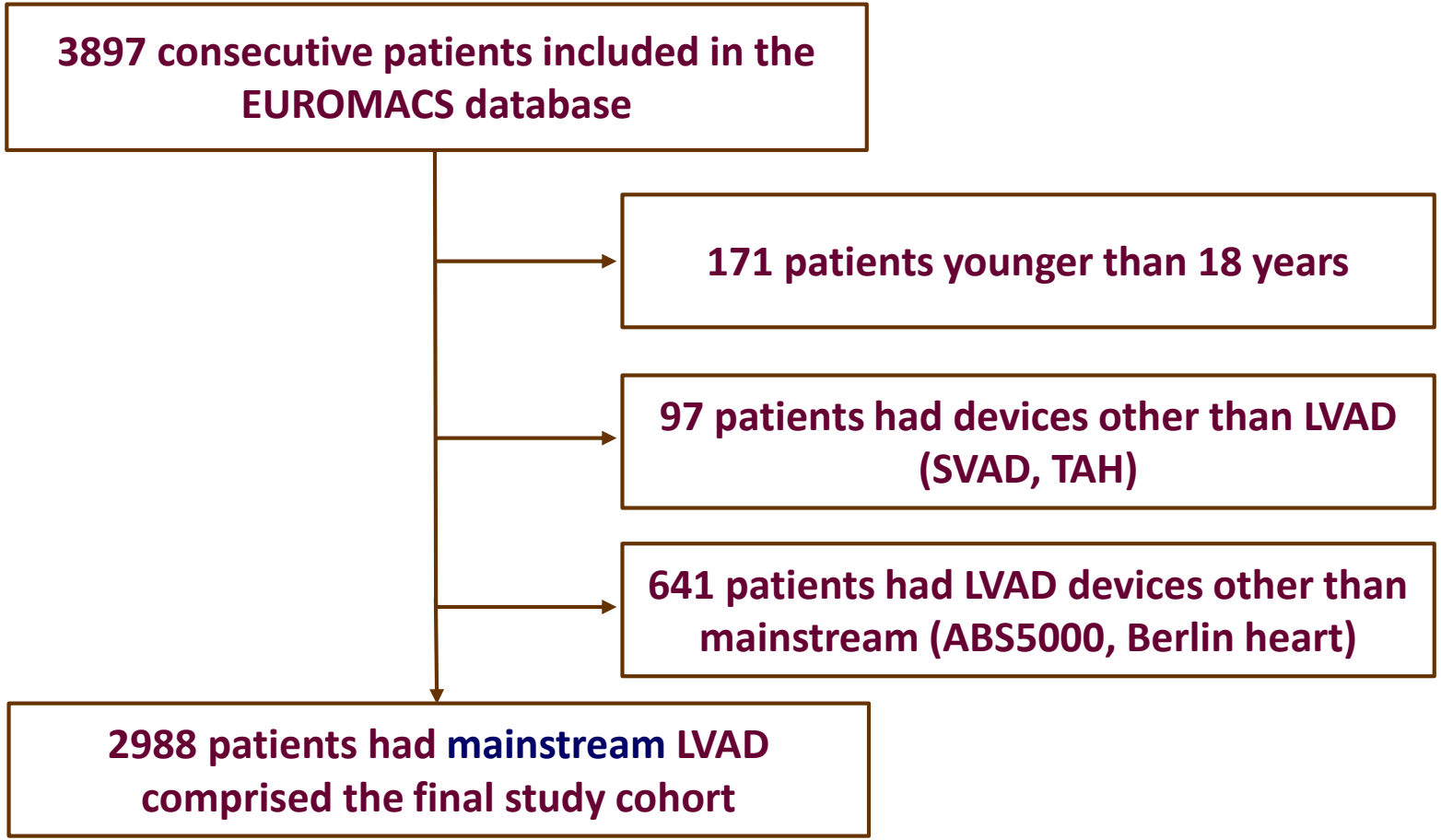
Http://www.rhfriskscore.com

Background

- **Left ventricular assist devices** (**LVADs**) are increasingly used for patients with end-stage heart failure as a bridge-to-HTx or destination therapy.
- **Right-sided heart failure** (**RHF**) is a frequent complication early after LVAD implantation and associated with high **morbidity** and **mortality**.

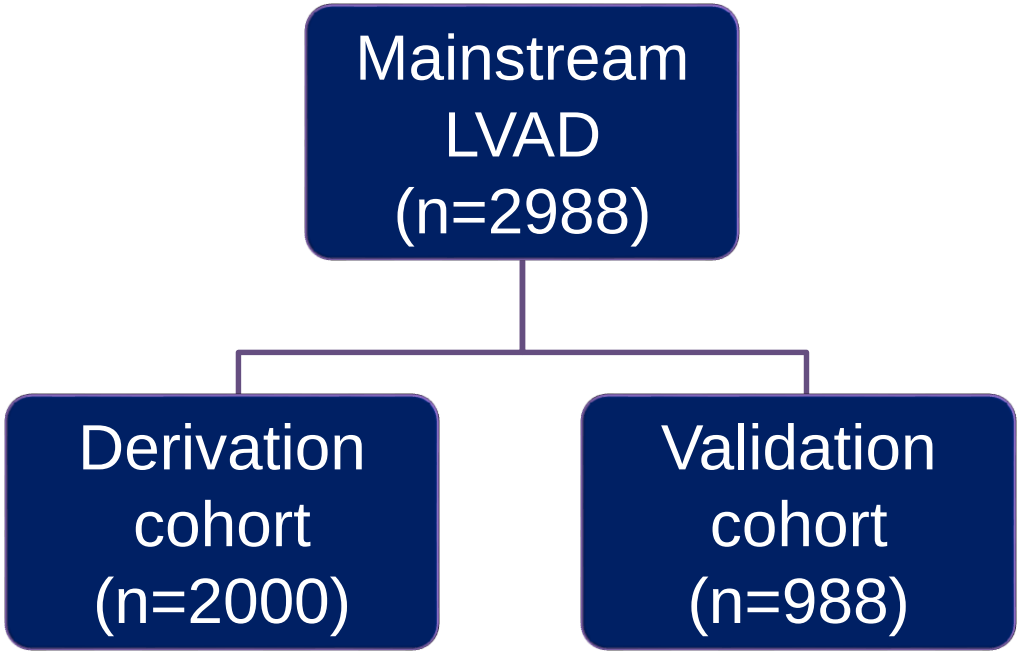
Objective

- To derive and validate **a Novel Risk Score** for early **Right-sided Heart Failure (RHF)** after LVAD implantation from **The European Registry for Patients with Mechanical Circulatory Support (EUROMACS Registry).**


3897 consecutive patients included in the EUROMACS database
171 patients younger than 18 years
97 patients had devices other than LVAD (SVAD, TAH)
641 patients had LVAD devices other than mainstream (ABS5000, Berlin heart)
2988 patients had mainstream LVAD comprised the final study cohort

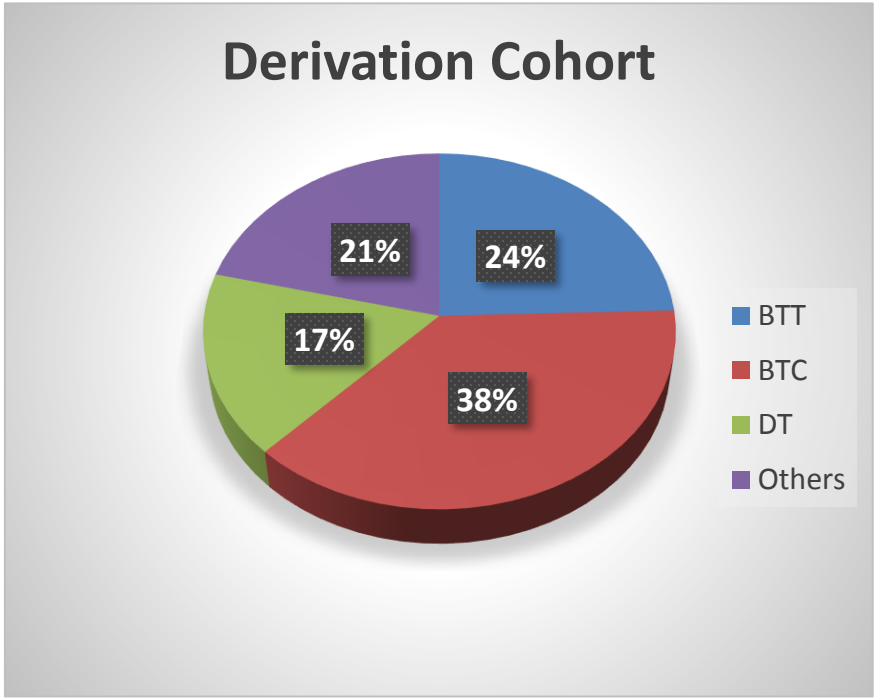
Study endpoints

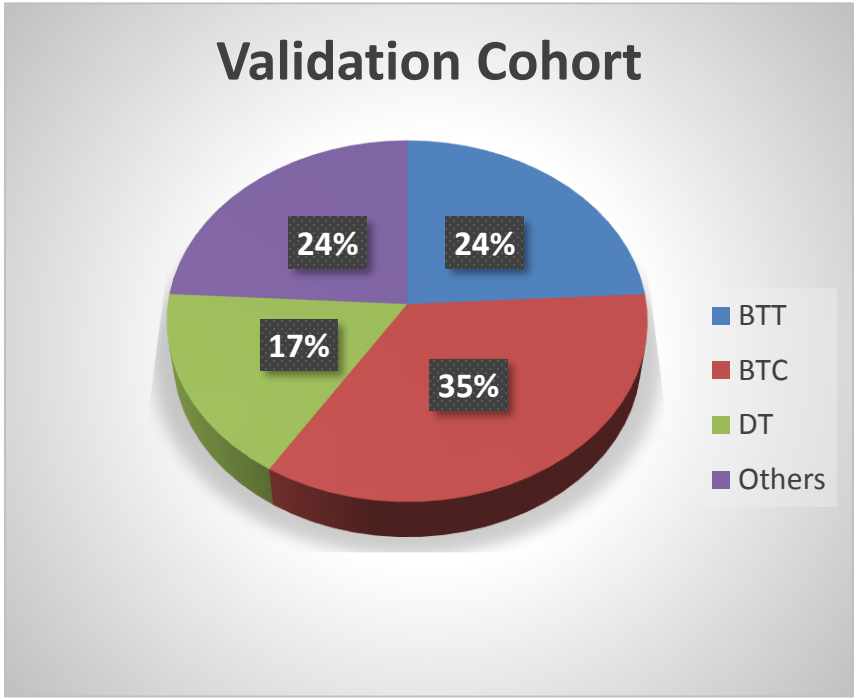
- **Early** (<30 days) **severe** postoperative **RHF**,
  - defined as patients receiving short or long-term right-sided circulatory support (**RVAD**) and/or
  - continuous **inotropic** support for ≥14 days, and/or
  - **nitric oxide** ventilation for ≥48h.
- Secondary outcome was all-cause **mortality** and length of **stay** in the intensive care unit (ICU).



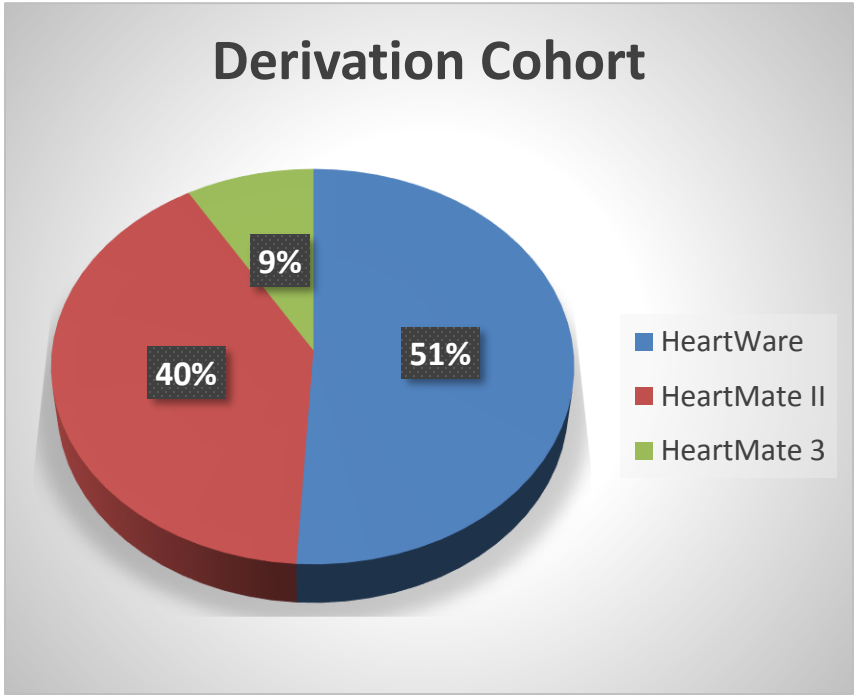
Randomly selected, balanced in preoperative (clinical, laboratory, echocardiographic, hemodynamic) and operative characteristics

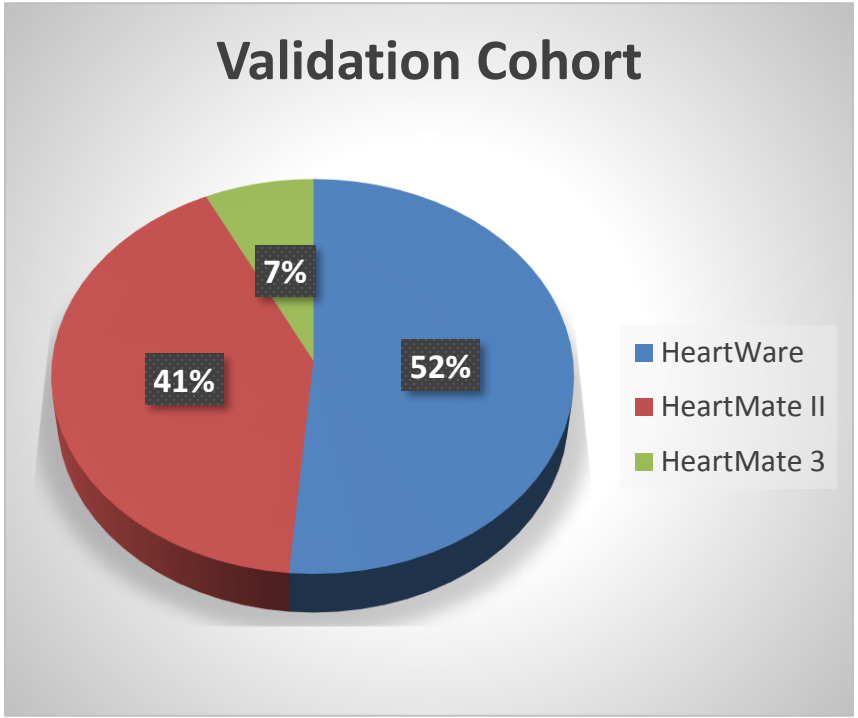
LVAD strategy



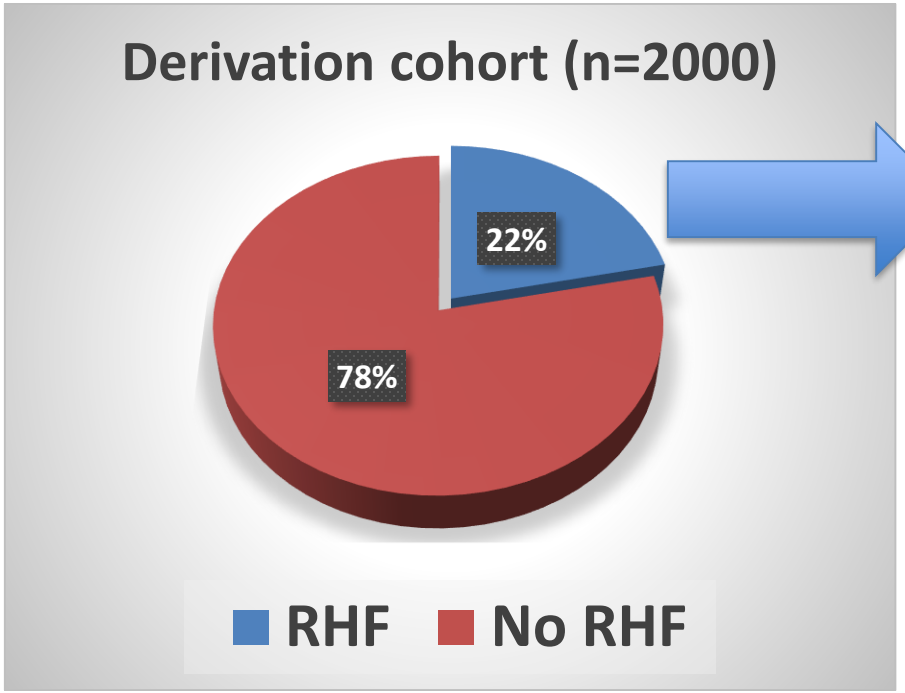


Mainstream LVAD brands





Primary Outcome (RHF components)



Right-Sided Heart Failure Components	(n=433)
Inotropic ≥14 days	327 (76%)
RVAD need	141 (33%)
NO ≥48 hrs use	17 (4%)

The multivariable EUROMACS model for RHF

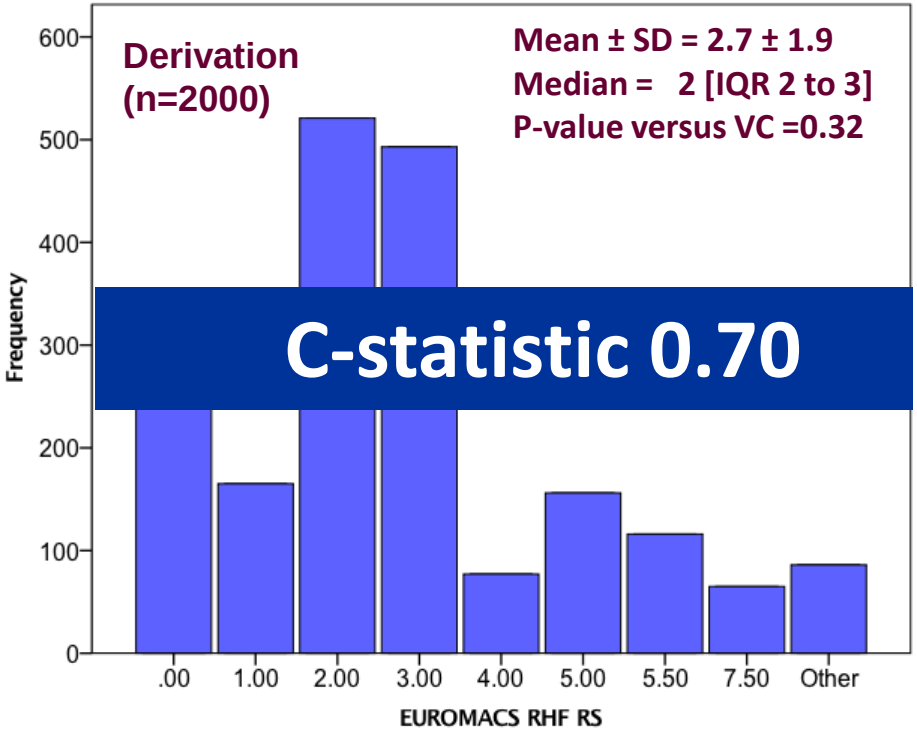
Variables	Odds ratio	Lower 95%CI	Upper 95%CI	Coefficients	Score
RA to PCWP >0.54	2.075	1.412	3.112	0.730	2
Hemoglobin ≤10 g/dL	1.611	1.544	2.502	0.477	1
Multiple (≥3) IV inotropes	3.197	1.712	5.524	1.162	2.5
INTERMACS Class 1-3	2.903	1.946	4.893	1.066	2
Severe RV dysfunction	2.055	1.193	3.57	0.720	2
CPB time >100 min	**2.032**	**1.296**	**3.184**	**0.709**	**1**

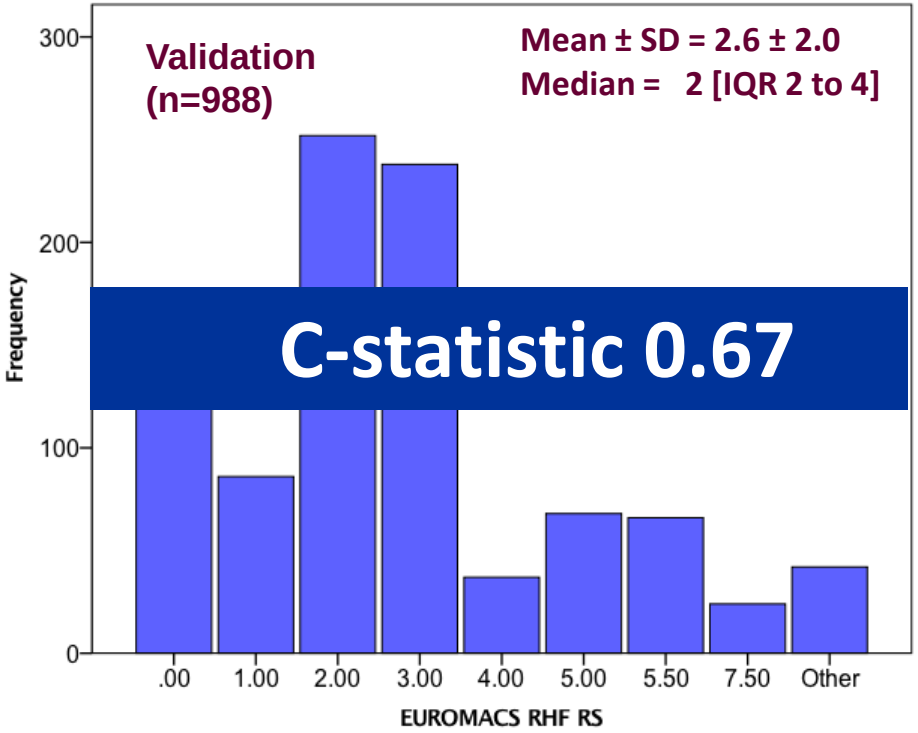
EUROMACS-RHF RISK SCORE VALIDATION

Validation cohort (n=988)

- Validation in independent population
- Validation against known predictors

EUROMACS-RHF RISK SCORE VALIDATION





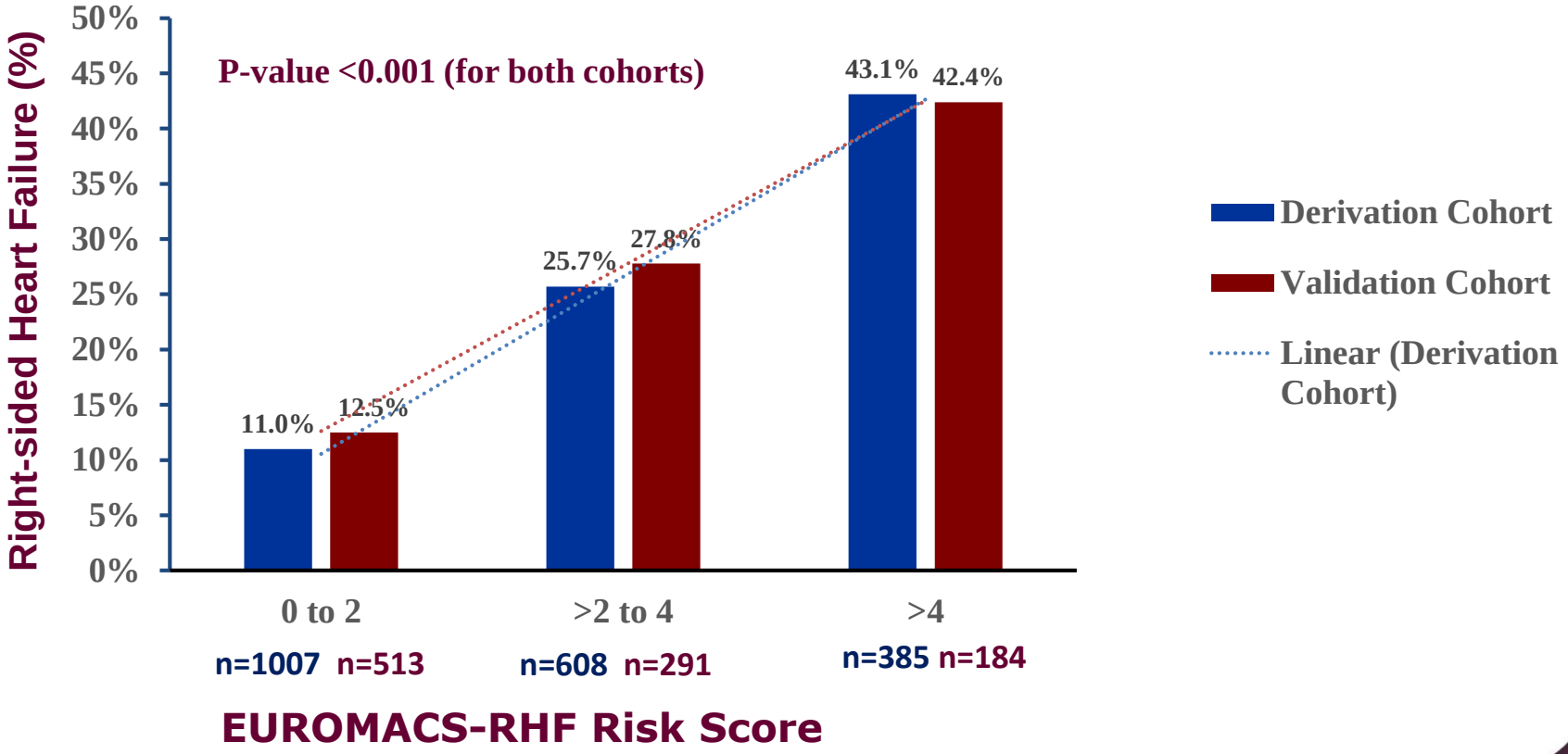
Performance of the EUROMACS-RHF score

Derivation cohort (n=2000)

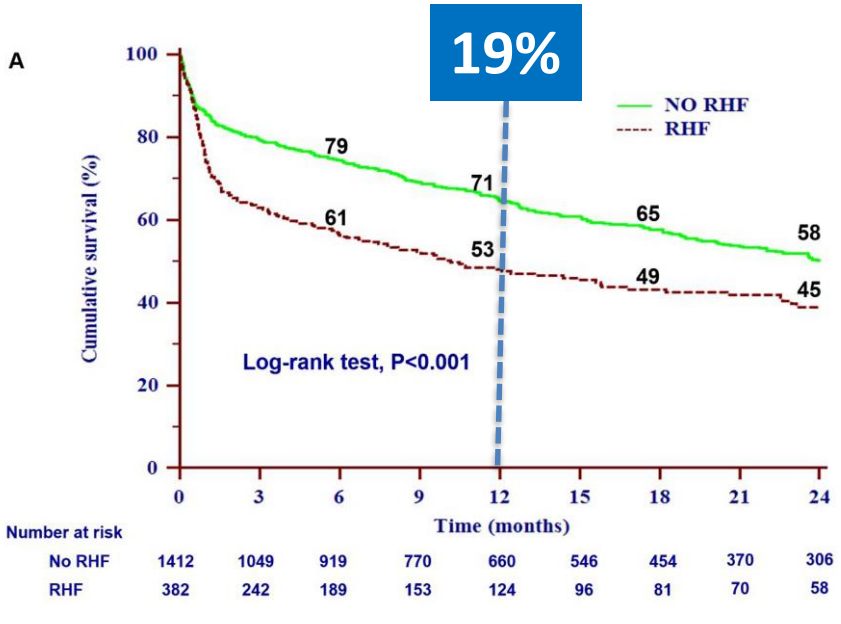
Predictors for right-sided heart failure	C (95% CI)	p-value
Risk scores		
• **EUROMACS-RHF risk score**	**0.70 (0.67 to 0.73)**	**1 - reference**
• **Postoperative (+CPB) EUROMACS-RHF risk score**	**0.71 (0.68 to 0.74)**	**0.41**
• Kormos et al. score[1]	0.58 (0.54 to 0.61)	**<0.0001**
• CRITT score[2]	0.63 (0.60 to 0.66)	**<0.0001**
Hemodynamic parameters		
• RA pressure, mmHg	0.60 (0.55 to 0.65)	**<0.0001**
• TPG, mmHg	0.55 (0.50 to 0.61)	**<0.0001**
• PVR, woods unit	0.56 (0.51 to 0.61)	**<0.0001**
• RVSWI, g/m2/beat	0.52 (0.47 to 0.56)	**<0.0001**
• Severe RV dysfunction	0.57 (0.52 to 0.61)	**<0.0001**

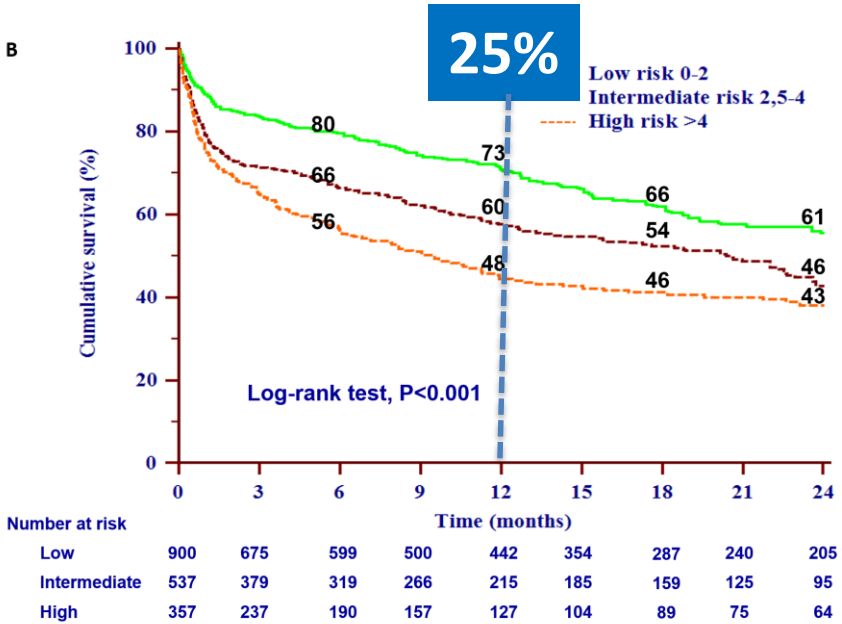
[1]*Kormos et al. J Thorac Cardiovasc Surg. 2010;139:1316–1324.* [2]*Alturi et al. Ann Thorac Surg. 2013;96:857–863*

Incidence of Right-Sided HF

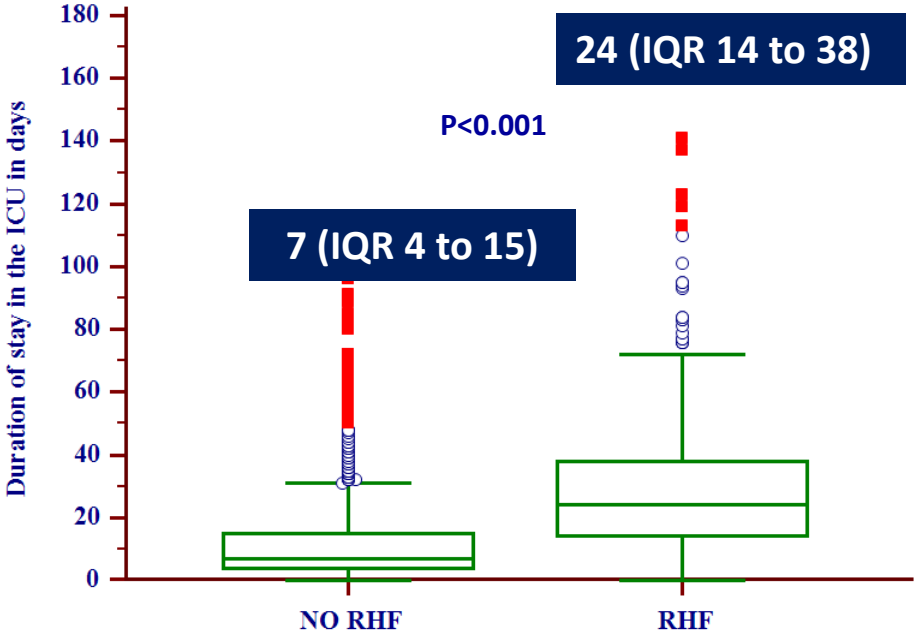


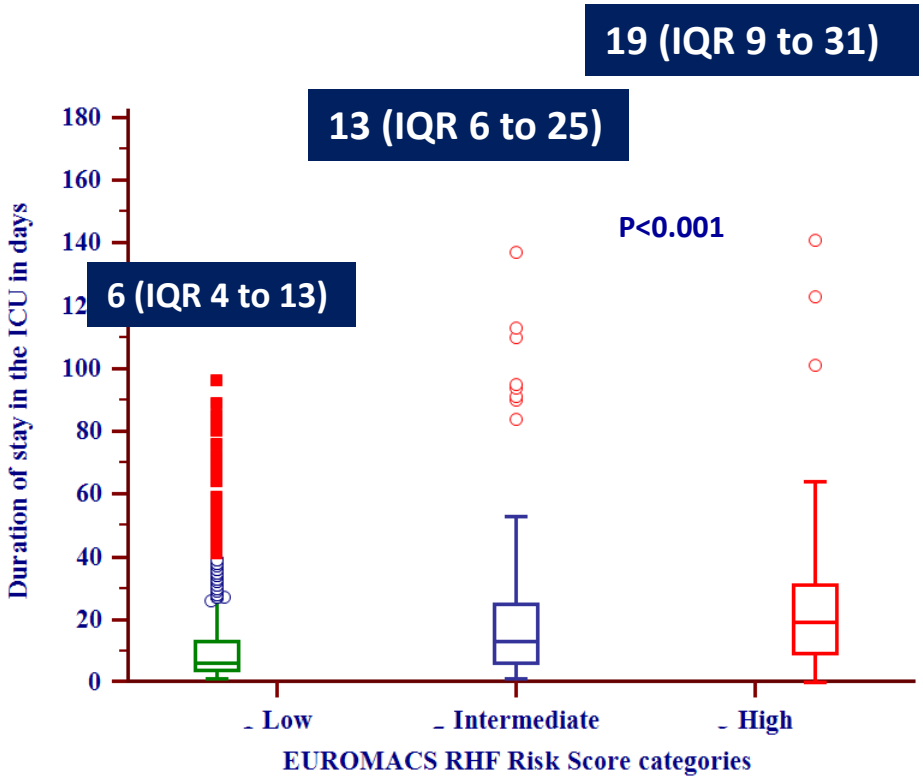
Survival


A
19%
NO RHF
RHF
Cumulative survival (%)
100
80
60
40
20
0
79
71
65
58
61
53
49
45
Log-rank test, P<0.001
0
3
6
9
12
15
18
21
24
Time (months)
Number at risk
No RHF 1412 1049 919 770 660 546 454 370 306
RHF 382 242 189 153 124 96 81 70 58

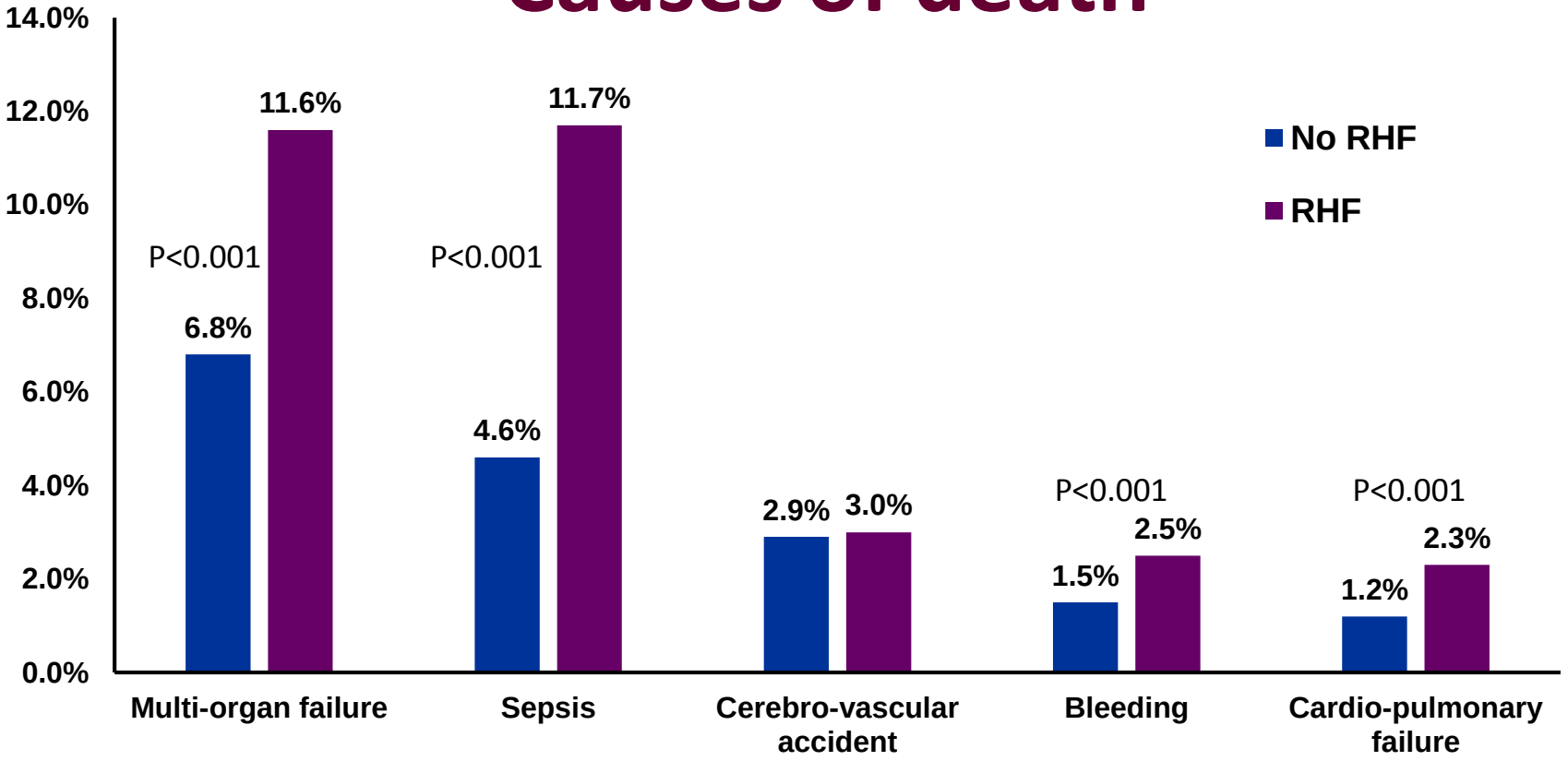

B
25%
Low risk 0-2
Intermediate risk 2,5-4
High risk >4
Cumulative survival (%)
100
80
60
40
20
0
80
73
66
61
66
60
54
46
56
48
46
43
Log-rank test, P<0.001
0
3
6
9
12
15
18
21
24
Time (months)
Number at risk
Low 900 675 599 500 442 354 287 240 205
Intermediate 537 379 319 266 215 185 159 125 95
High 357 237 190 157 127 104 89 75 64

ICU stay (days)





Causes of death



Take home message (1/2) – the score

- We derived and validated a novel and simple **risk score** for **RHF** in 2988 adults undergoing **LVAD** implantation with mainstream devices in the **EUROMACS Registry**
- This model included:
  - Need of ≥3 **inotropic** agents,
  - **INTERMACS** class 1 to 3,
  - **Severe RV dysfunction**,
  - **RA to PCWP** ratio >0.54
  - **Anemia (Hb** ≤10 g/dL).
- **CPB time** >100 minutes for the postoperative risk calculator.

Take home message (1/2) – clinical application

- This novel **EUROMACS-RHF Risk Score** is highly predictive, **outperforming** currently known risk scores and clinical predictors of early post-LVAD RHF.
- This score may help to target future optimal strategies aiming at **early and intensive RHF management** for high risk subgroups of the LVAD patients.
- **Future studies** should determine whether early RVAD implantation and/or intensive RHF medication can improve survival and reduce ICU stay among LVAD candidates at high risk for RHF.

ORIGINAL RESEARCH ARTICLE

Derivation and Validation of a Novel Right-Sided Heart Failure Model After Implantation of Continuous Flow Left Ventricular Assist Devices

The EUROMACS (European Registry for Patients with Mechanical Circulatory Support) Right-Sided Heart Failure Risk Score

ORIGINAL RESEARCH ARTICLE

Q1

Editorial, see p XXX

BACKGROUND: The aim of the study was to derive and validate a novel risk score for early right-sided heart failure (RHF) after left ventricular assist device implantation.

METHODS: The European Registry for Patients with Mechanical Circulatory Support (EUROMACS) was used to identify adult patients undergoing continuous-flow left ventricular assist device implantation with mainstream devices. Eligible patients (n=2988) were randomly divided into derivation (n=2000) and validation (n=988) cohorts. The primary outcome was early (<30 days) severe postoperative RHF, defined as receiving short- or long-term right-sided circulatory support, continuous inotropic support for ≥14 days, or nitric oxide ventilation for ≥48 hours. The secondary outcome was all-cause mortality and length of stay in the intensive care unit. Covariates found to be associated with RHF (exploratory univariate $P<0.10$) were entered into a multivariable logistic regression model. A risk score was then generated using the relative magnitude of the exponential regression model coefficients of independent predictors at the last step after checking for collinearity, likelihood ratio test, c index, and clinical weight at each step.

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On behalf of the EURO-MACS Investigators

- **The paper will be simultaneously published in Circulation at the day of presentation**
- **Risk score calculator is available online**

Http://www.RHFriskscore.com

Acknowledgements

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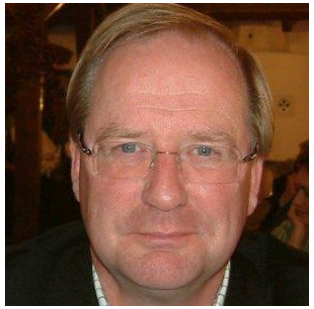
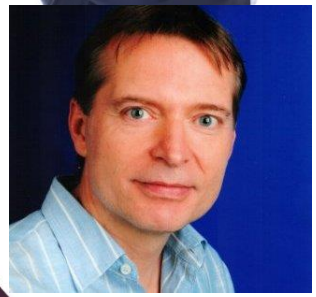
- EUROMACS Investigational sites and their principal investigators
- Contributing authors






Thank you!!!