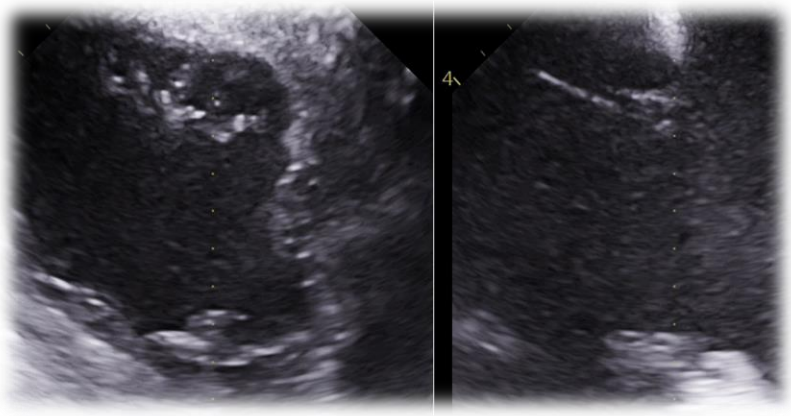
Tricuspid Regurgitation.

You Should Care About It

We might have to Treat it !

Risk scoring in TR: a game changer



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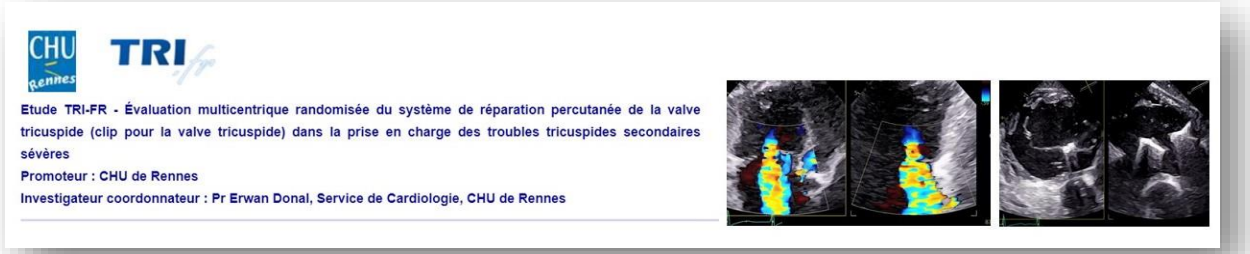
CENTRE HOSPITALIER UNIVERSITAIRE DE RENNES

Disclosure Statement of Financial Interest

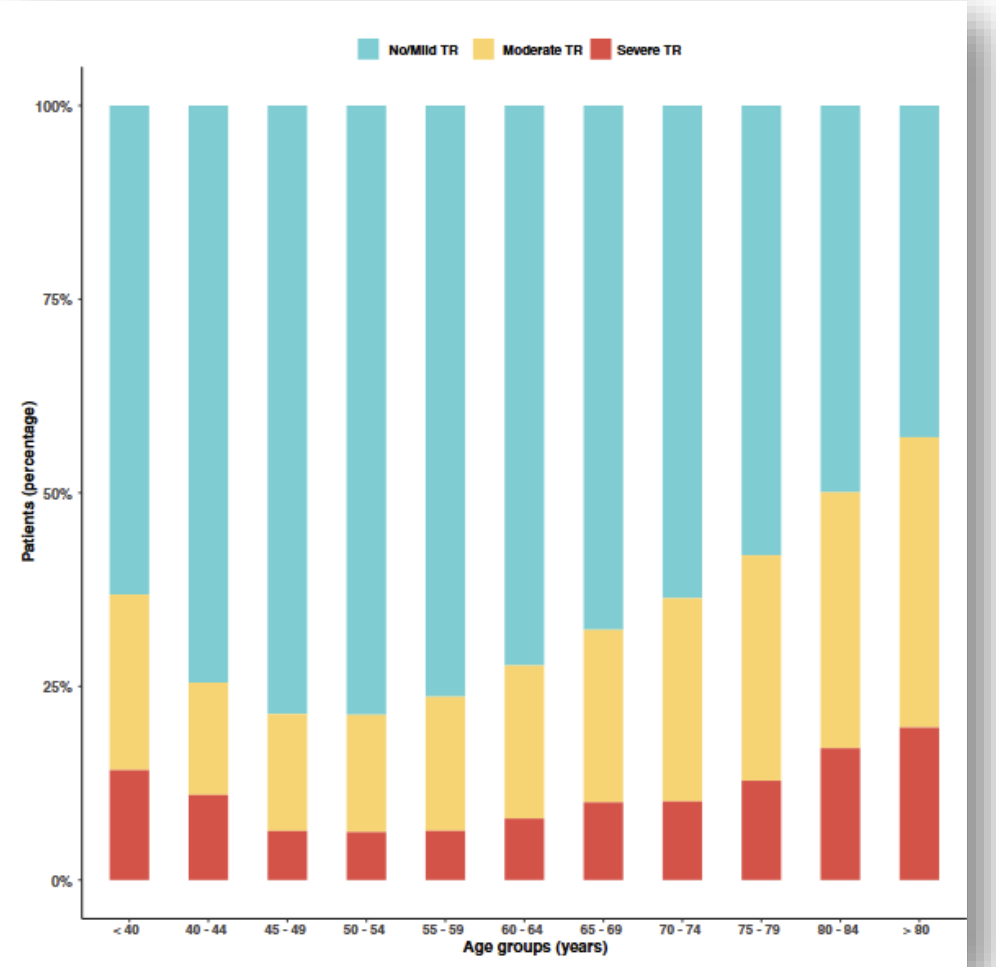
Speaker's name: Erwan DONAL

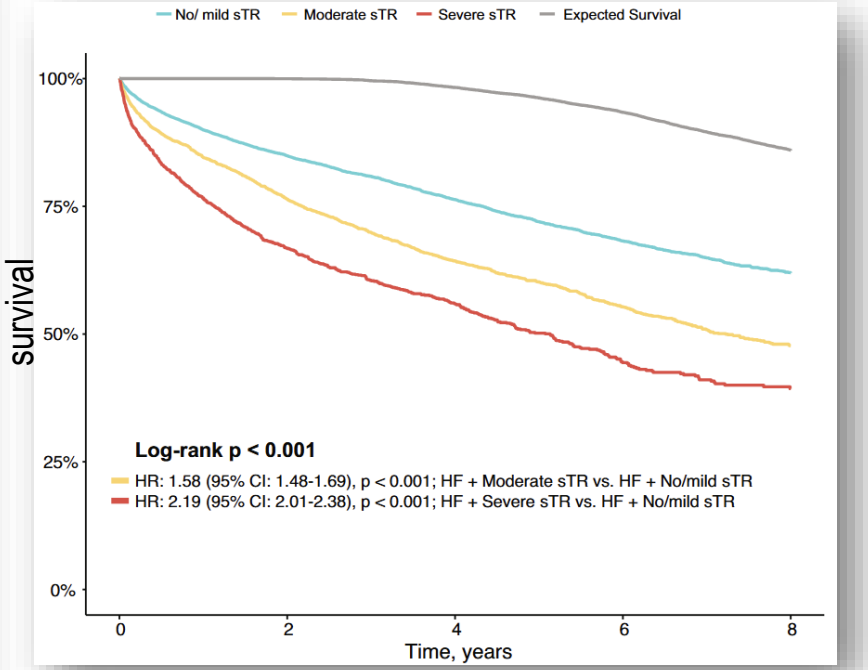
☑ **I have potential conflict of interest to declare :**
Pr E DONAL receive research facilities from GE Healthcare and from Abbott Medical

Pr Erwan DONAL is PI for the Tri.fr randomized study (academic study)
Pr Erwan DONAL is in charge of an accredited *Imaging CoreLab* working for Abbott, academic studies & Genscare



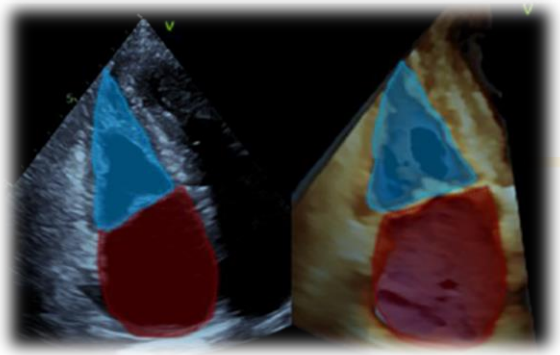
Background





- Right-sided HF and TR are commun and strongly associated with poor quality of life and an increased risk of HF-hospitalizations and death
- Patients who might benefit from tricuspid valve interventions are yet unknown, as is the ideal time for these treatments given the paucity of clinical evidence.

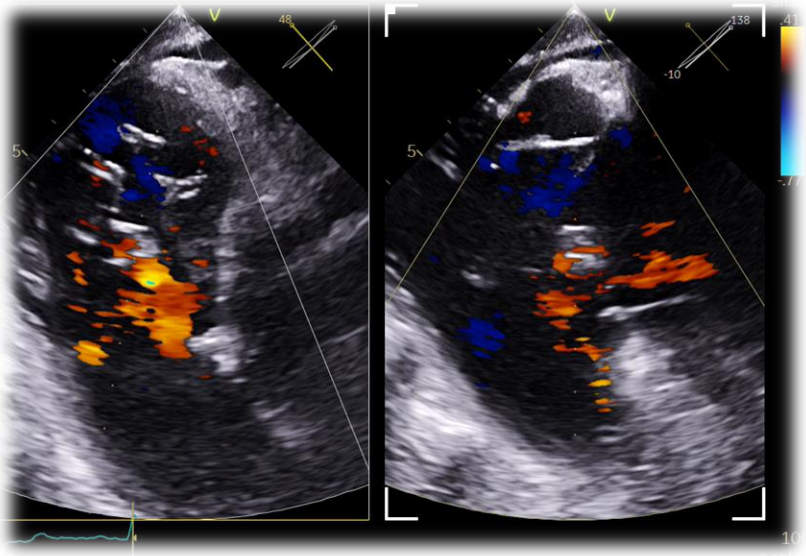
Heitzinger et al. European Journal of Heart Failure (2024) **26**, 18–33

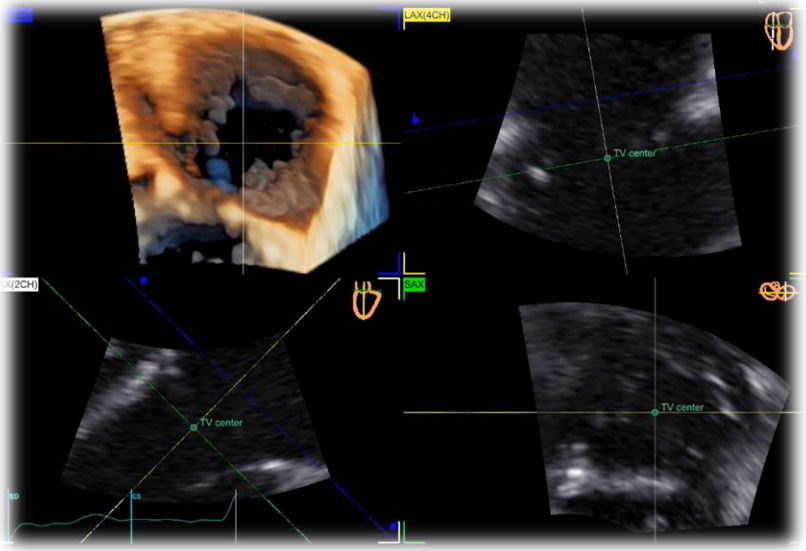


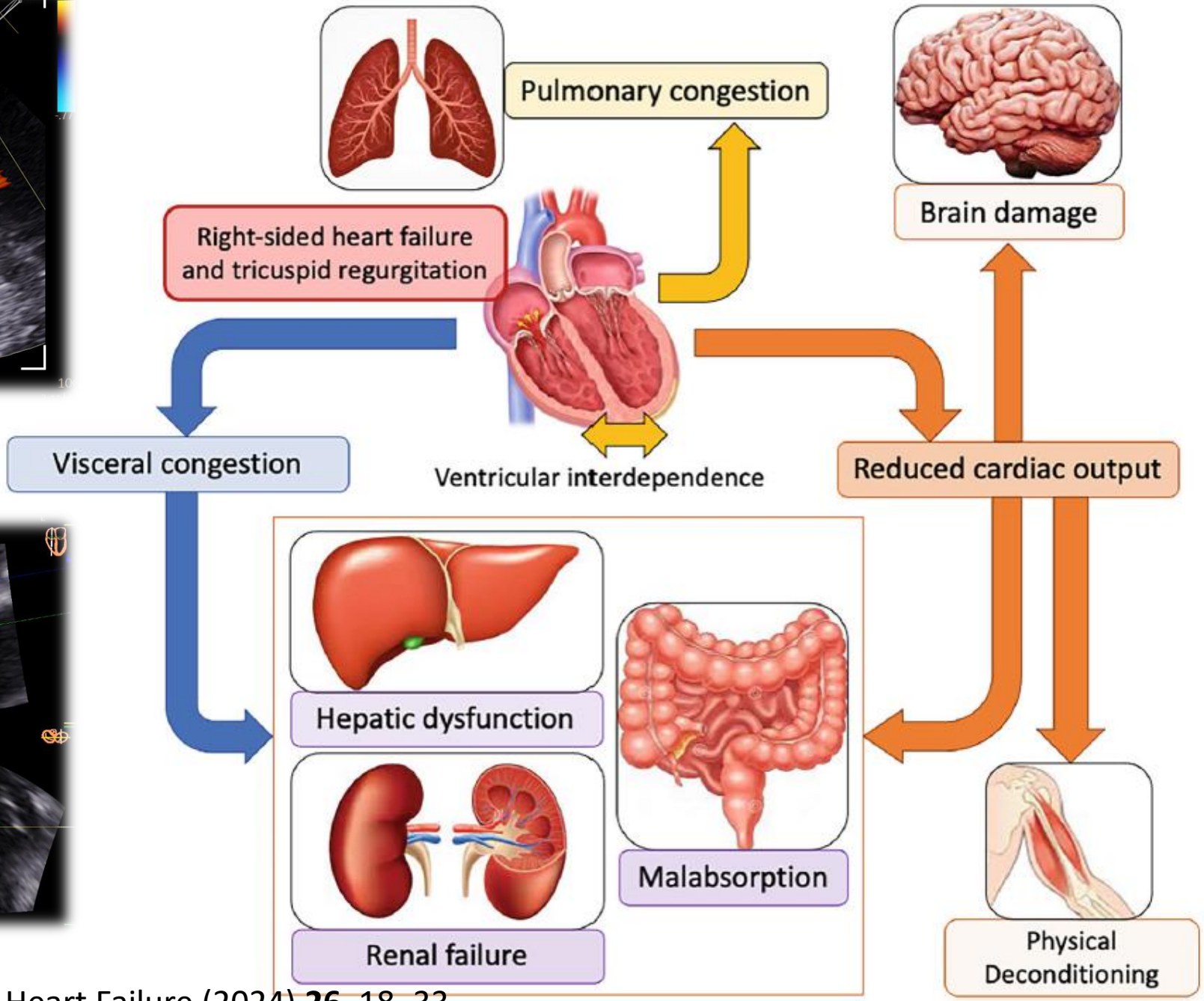
Functional (secondary TR) What is it about?

- **Tricuspid Regurgitation**
  - **Primary**
    - TR Due to the Intrinsic Abnormalities of TV Apparatus
      - Prolapse
      - Flail
      - Rheumatic
      - Carcinoid
      - Trauma
      - Endocarditis
      - Congenital
  - **Secondary**
    - TR Due to the Remodeling of Right Heart Chambers
      - **Atrial**
        - Atrial fibrillation
        - RA myopathy
        - HFpEF
      - **Ventricular**
        - Pulmonary hypertension
        - Left-sided VHD
        - RV myopathy
        - HFrEF/HFmrEF
  - **CIED**
    - TR in the Presence of Pacemaker or Defibrillator Lead
      - **Induced**
        - Leaflet impingement
        - Leaflet perforation
        - Lead entanglement
        - Lead adherence
      - **Associated**
        - Passive lead not causing TR

Hahn et al. JACC Cardiovasc Imaging. 2025;-:-–-)







European Journal of Heart Failure (2024) **26**, 18–33

A

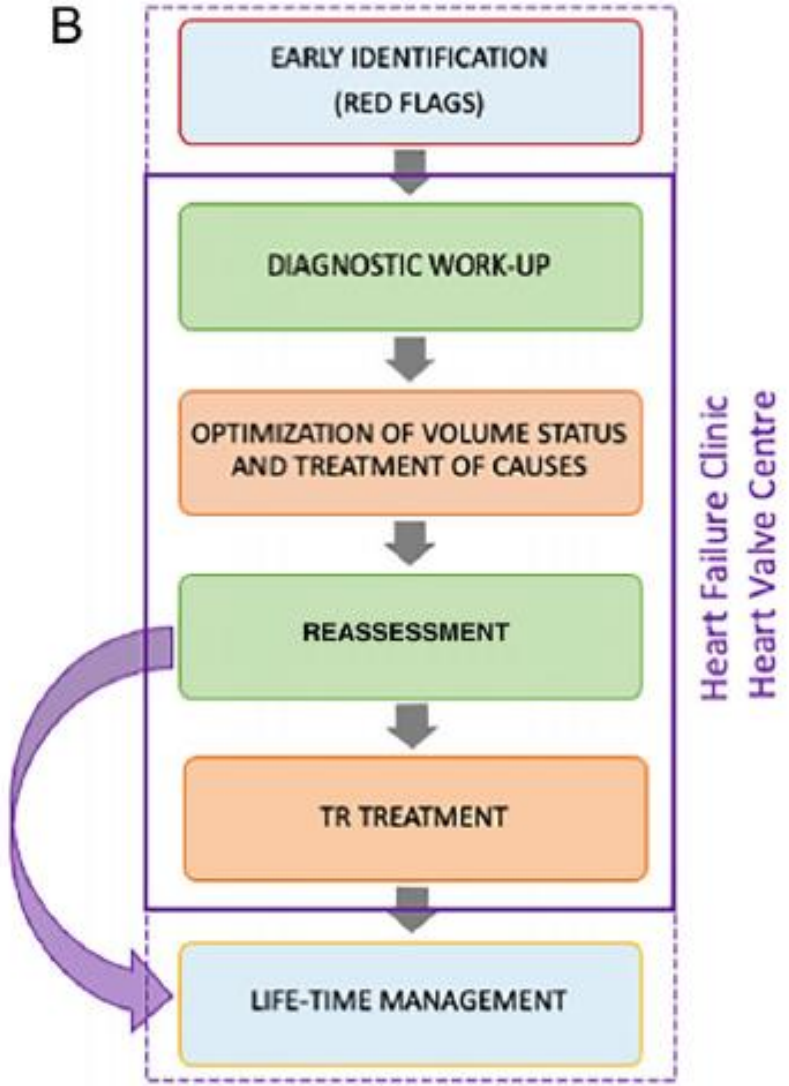
SUSPECTED RHF/TR
Clinical history
Symptoms/signs
Laboratory tests

ECHOCARDIOGRAPHY
RV function/dimension
RA dimension
TR grade

REFER TO
A HF clinic with a Heart Valve Centre for specific diagnostic work-up and possible treatment

RED FLAGS FOR THE EARLY IDENTIFICATION OF RHF/TR
Atrial fibrillation
PM or ICD/CRT
Prior left-sided VHD intervention
History or risk factors for LV diastolic or systolic dysfunction
Prior pulmonary embolism
Pulmonary disorders
Need for oral diuretic
Dyspepsia/abdominal distension
Fatigue
Signs of RHF (i.e. peripheral oedema)
Systolic murmur
Impaired renal function
High cholestatic markers

B



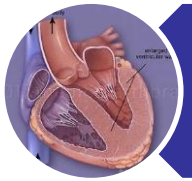
- Atrial arrhythmia
- Fatigue, reduce exercise capacity
- Increase in NT proBNP, liver dysfunction….

→ **Do an ECHO, look at the right heart**

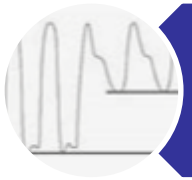
& then refer to the heart valve center if there is a significant TR

European Journal of Heart Failure (2024) **26**, 18–33

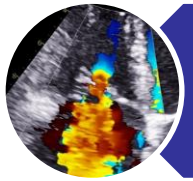
Clinical risk assessment: tricky and time consuming: response to pharmacological treatment could take time



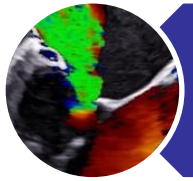
RV: size and function



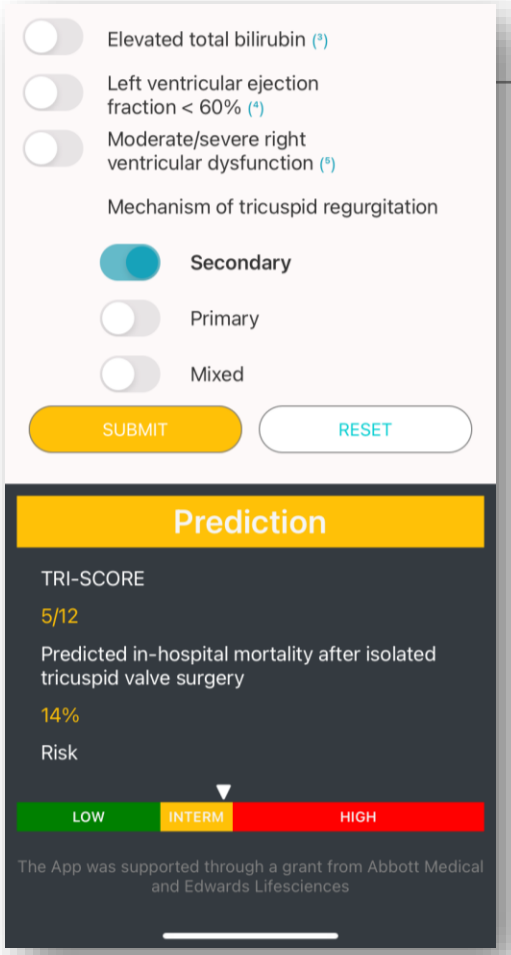
Pulmonary pressures



Degree of tricuspid regurgitation



Other valvular heart diseases: Multi-valve disease issue



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TRI-SCORE Calculator

TRI-SCORE

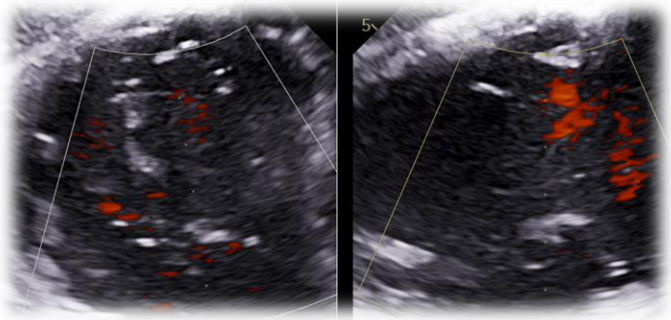
www.tri-score.com

Parameters

- [ ] Age ≥ 70 years
- [ ] Female
- [ ] NYHA functional class III or IV
- [ ] Right-sided heart failure signs (1)
- [ ] Prior left-sided heart valve intervention
- [ ] Permanent pacemaker / defibrillator
- [ ] Atrial fibrillation / flutter
- [ ] Daily dose of furosemide ≥ 125 mg
- [ ] Glomerular filtration rate < 30 ml/min (2)
- [ ] Elevated total bilirubin (3)
- [ ] Left ventricular ejection fraction < 60% (4)
- [ ] Moderate/severe right ventricular dysfunction (5)

Mechanism of tricuspid regurgitation

- [ ] Secondary
- [ ] Primary
- [ ] Mixed



SUBMIT RESET

Prediction

TRI-SCORE

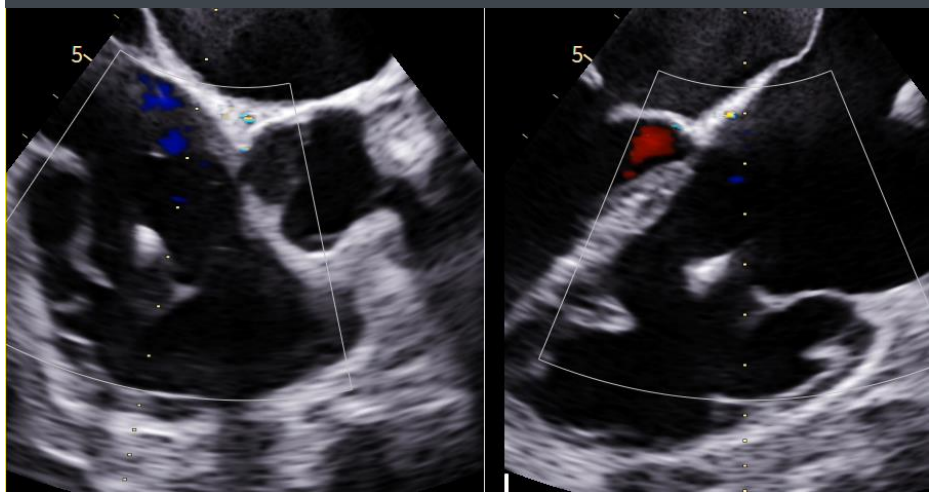
6/12

Predicted in-hospital mortality after isolated tricuspid valve surgery

22%

Risk

LOW | INTERM | HIGH



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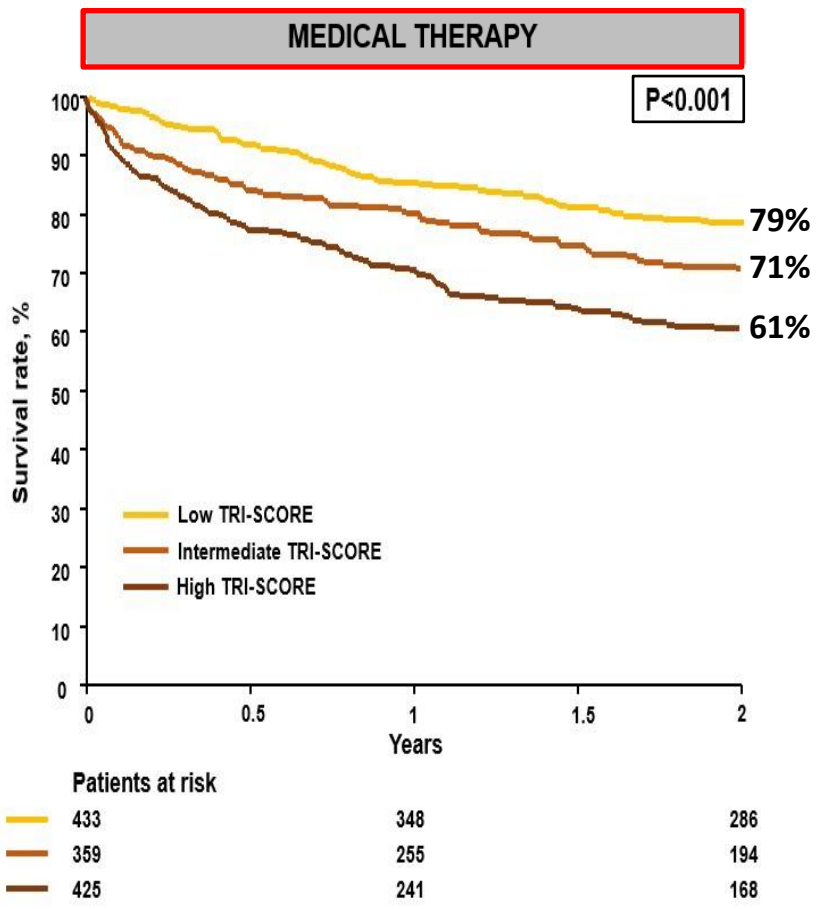
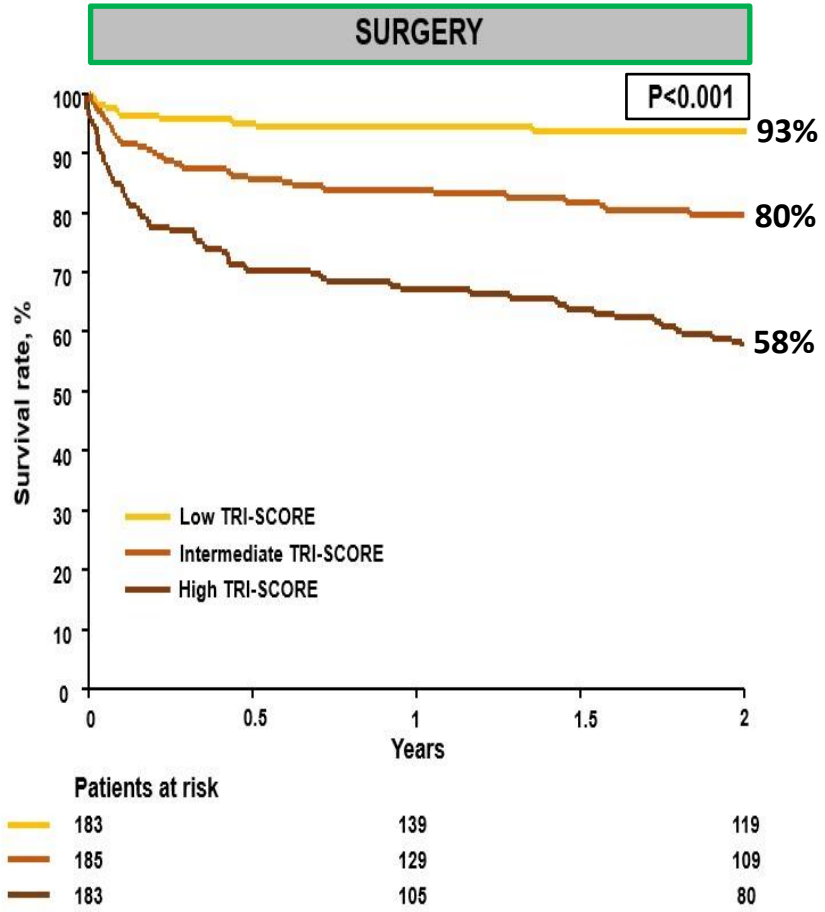
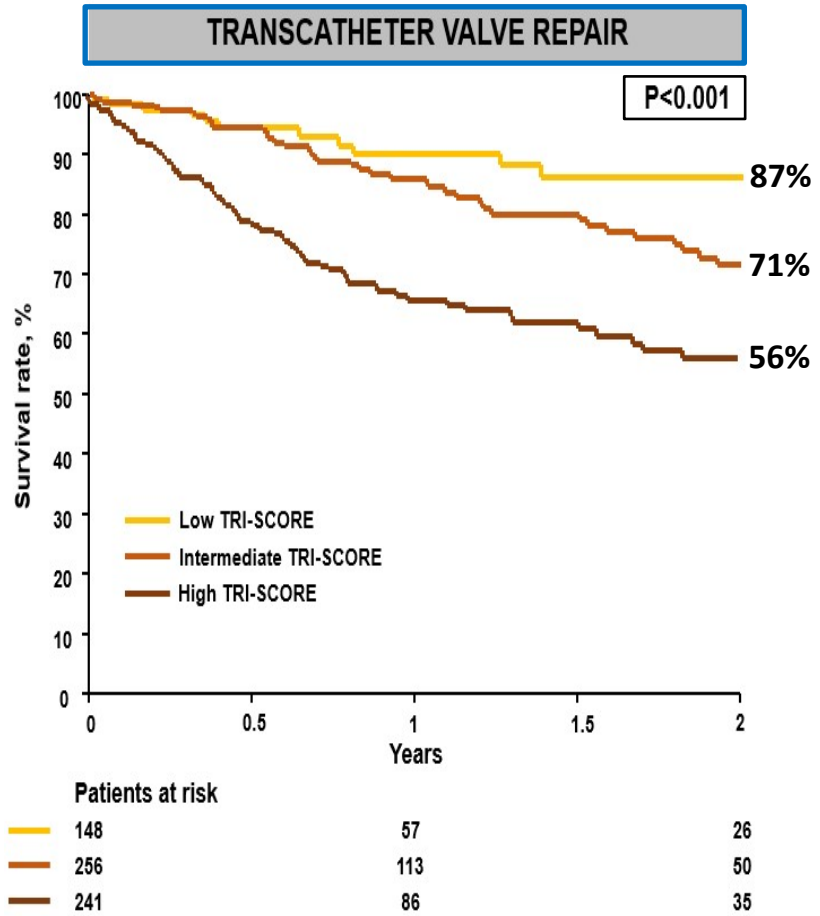
TRIGISTRY: IMPACT OF TRI-SCORE







Results remained unchanged after adjustment for age, sex, atrial fibrillation and comorbidities* (all P<0.001)

*diabetes, chronic lung disease, coronary artery disease, and prior left heart valve intervention

Dreyfus J et al. EHJ 2023

Tricuspid Regurgitation (TR) Disease Stage and Survival After T-TEER

Patients

Significant TR, N = 1,885

- Conservative treatment n = 585
- T-TEER n = 1,300

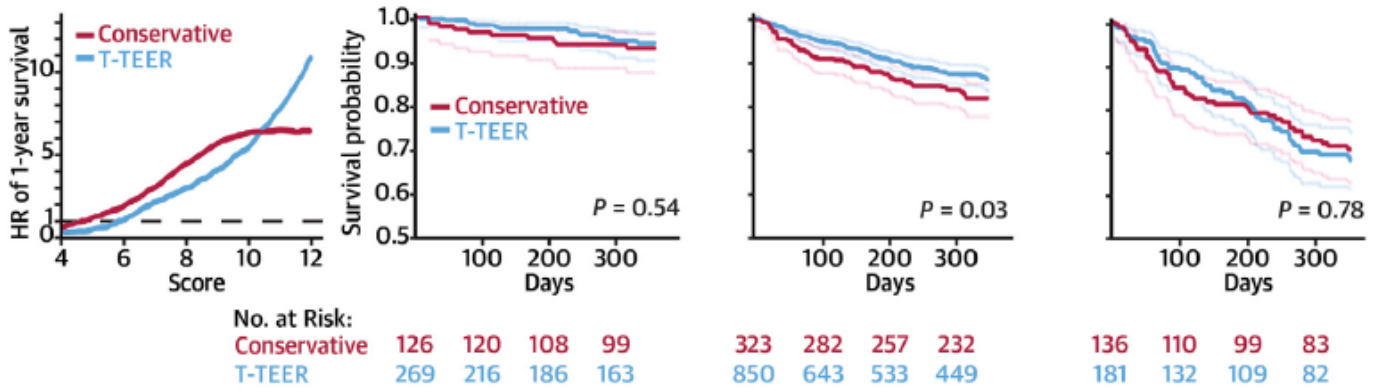
Early Disease n = 395 | Intermediate Disease n = 1,173 | Advanced Disease n = 317

Classification of Disease Stage

Score	1 point	2 points	3 points
LVEF (%)	≥50	40-49	<40
TAPSE (mm)	>17	13-17	<13
eGFR (mL/min/1.73 m²)	>60	30-60	<30
NT-pro-BNP or BNP (pg/mL)	<125 or 35	125-1,249 or 35-349	≥1,250 or 350
Early disease stage	4-6 points		
Intermediate disease stage	7-9 points		
Advanced disease stage	10-12 points		

1-Year Survival

All Patients | Early Disease | Intermediate Disease | Advanced Disease



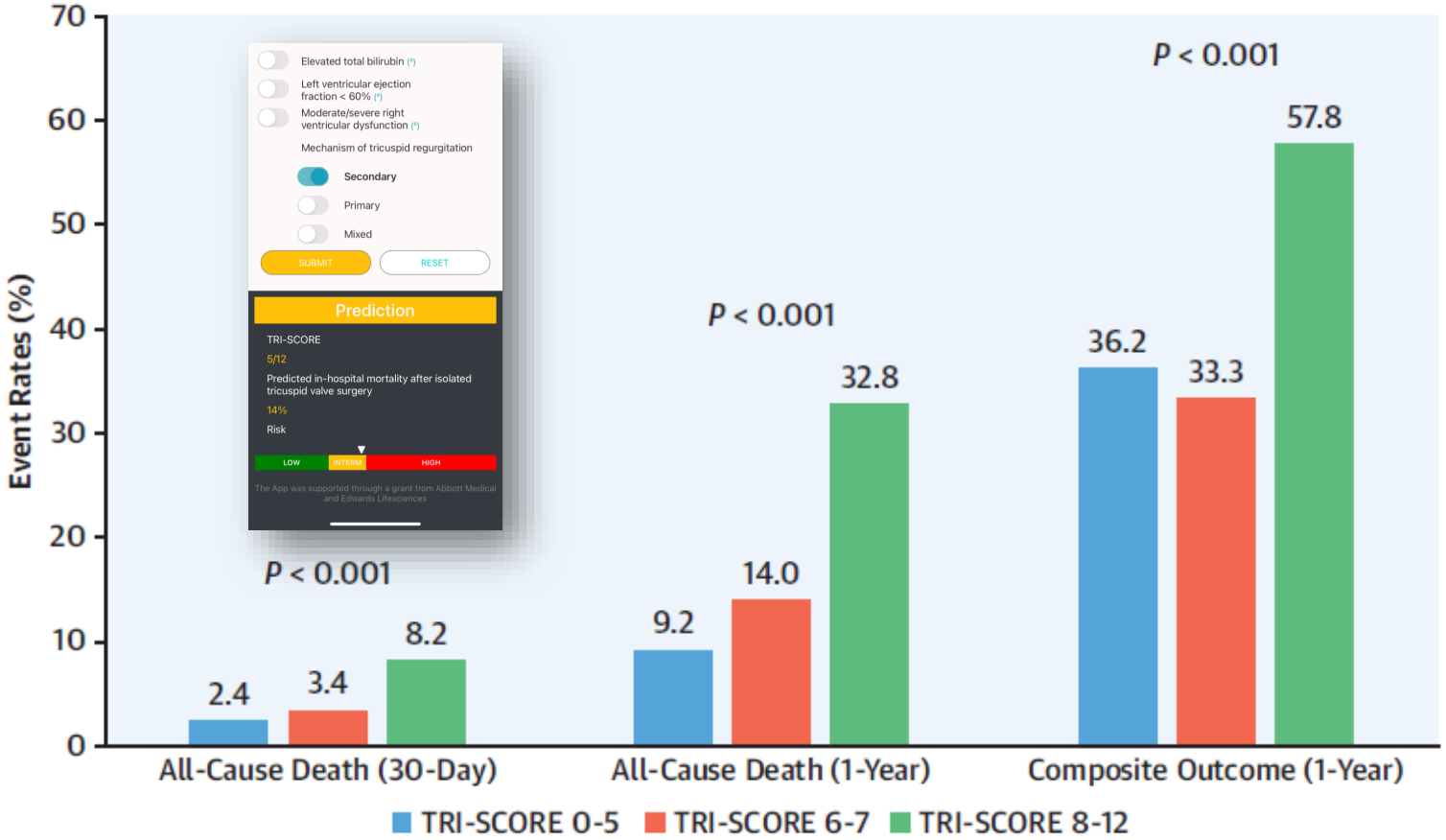
- In patients with early or advanced disease, mortality did not differ between interventional and conservative treatment (early stage HR: 0.78; *P* = 0.54; advanced stage HR: 1.06; *P* = 0.78)
- T-TEER in patients with an intermediate TR disease stage is associated with improved 1-year survival (HR: 0.73; *P* = 0.03) and may inform patient selection and clinical trial design

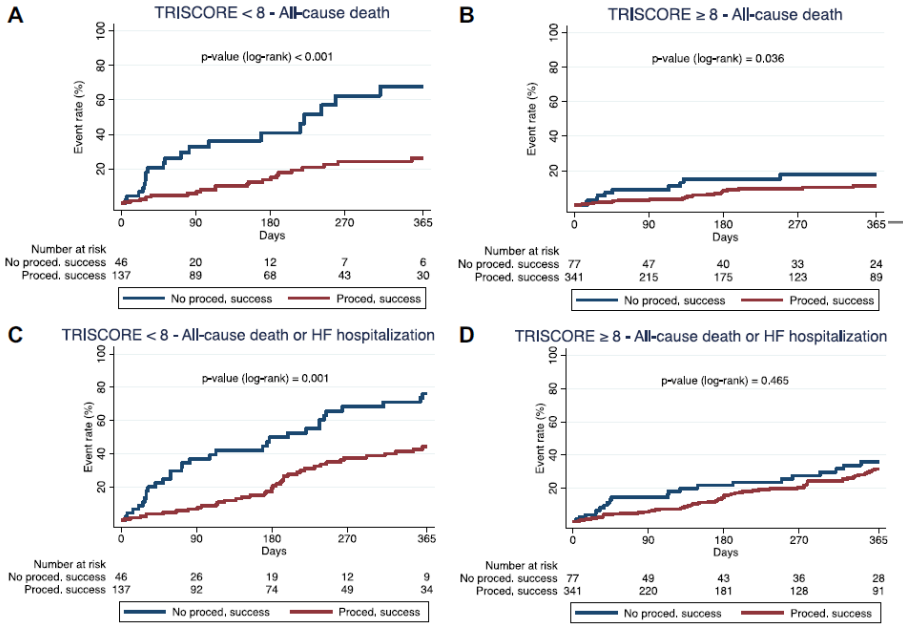
Schlotter F, et al. JACC Cardiovasc Interv. 2025;18(3):339-348.

Compared to medically treated controls, T-TEER was associated with 1-year survival at intermediate stage disease but not at early or advanced disease stages.

The timing of T-TEER with regard to disease stages might be crucial to optimize treatment benefits.

JACC Cardiovasc Interv. 2025;18:339–348





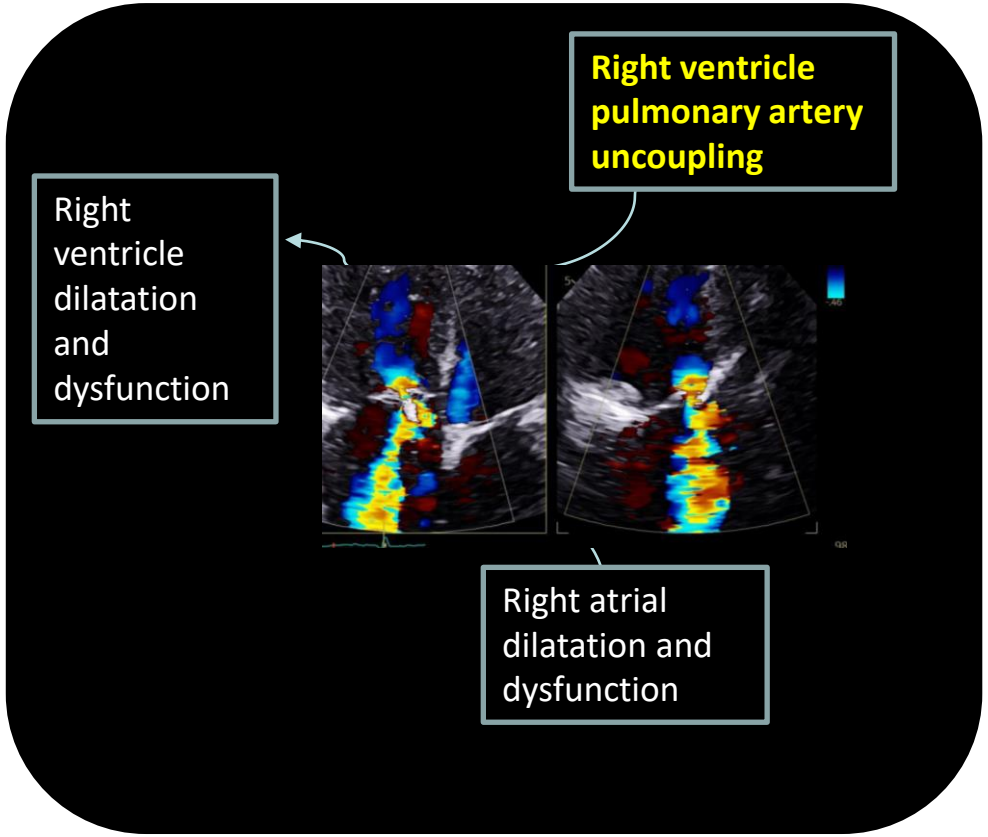
Outcomes	TRI-SCORE ≥8 vs <8 (adjusted for procedural success and STS-PROM)		TRI-SCORE ≥8 vs <8 (adjusted for procedural success and EuroSCORE II)	
	OR/HR	95% CI	OR/HR	95% CI
All-cause death (30-day)	1.62	0.66-3.97	2.32	1.00-5.36
All-cause death (1-year)	2.39	1.49-3.84	2.47	1.59-3.83
Composite outcome (1-year)	1.95	1.42-2.67	2.13	1.59-2.86

- The TRI-SCORE has suboptimal discrimination and calibration in predicting clinical events of patients undergoing TTVI.
- **However, a TRI-SCORE ≥8% is independently associated with an increased risk of mortality and heart failure hospitalization.**
- **A prognostic advantage of a successful TTVI was observed only in patients with a TRI-SCORE <8.**

Adamo M, et al. J Am Coll Cardiol Intv. 2024;17(7):859-870.

For Better characterization of secondary TR

Consequences of secondary TR – cardiac remodeling

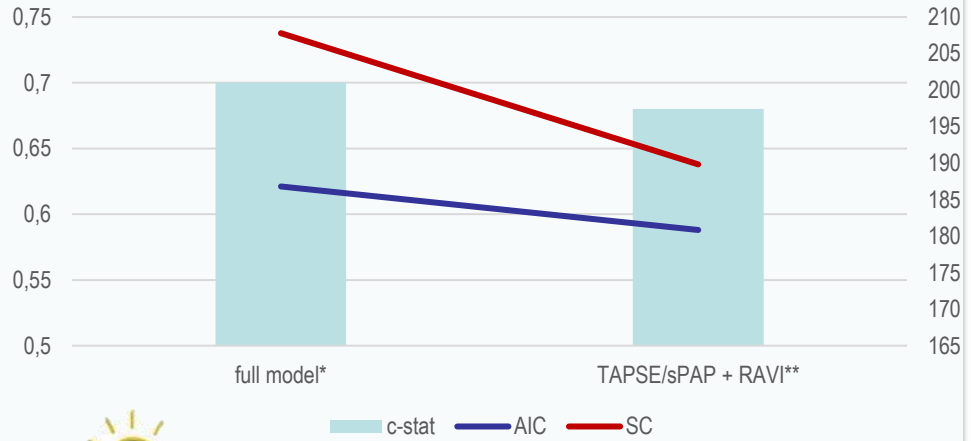


Many available echo parameters

How to simplified ?

Speckle tracking | 2D | 3D | Doppler

Multivariate model of association between baseline echo parameter and clinical event



RAVI > 60mL/m²

TAPSE/sPAP < 0.4 mm/mm Hg

Lower is better
Back to basic

Is there a place for monitoring ?

Group*time effect ?

No group*time effect

No time to wait

L'official, Donal et al. ESC-HF 2022

Echocardiographic Outcomes After T-TEER in Patients With Isolated TR

Tri.fr trial
n=300

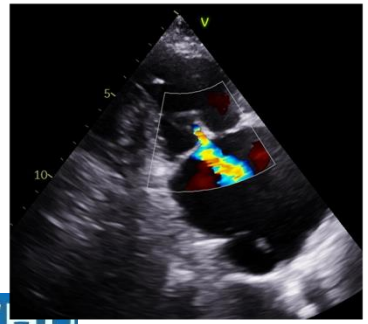
TEER + GDMT
n=152

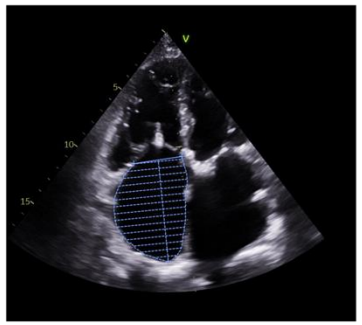
GDMT
n=148

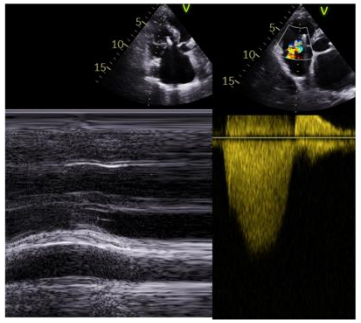
Corelab evaluation at 1-year
RV longitudinal parameters
RV circumferential parameters
RAVi
RV-PA coupling

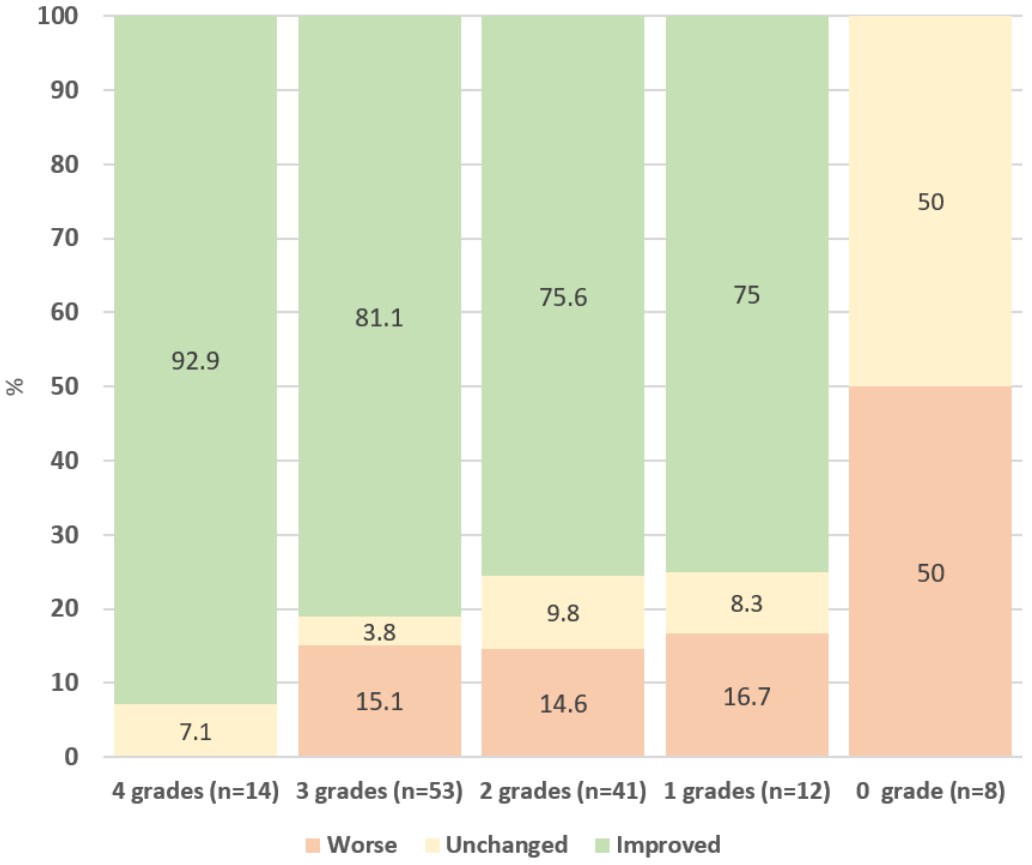
Factors associated with Improved Clinical Composite Score at 1-year

Residual TR severity	RA Vol at 1-year	Baseline TAPSE/SPAP



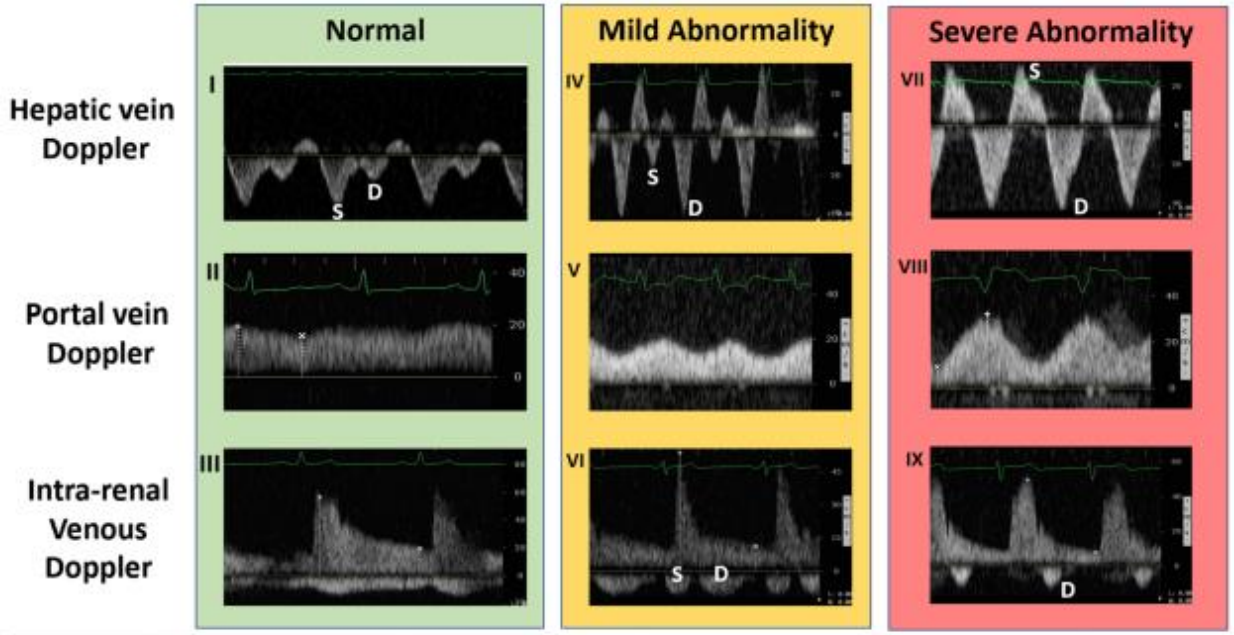






Coisne…Donal. Tri-Fr echo data. JACC im (in press)

Use of the Echo capabilities to optimize the medical managment



	VExUS A	VExUS B	VExUS C	VExUS D	VExUS E
Grade 0	IVC < 2 cm	IVC < 2 cm	IVC < 2 cm		
Grade 1	IVC ≥ 2 cm **Normal** patterns *(All three of : I, II, III)*	IVC ≥ 2 cm **Normal** patterns *(All three of : I, II, III)*	IVC ≥ 2 cm **Normal** patterns **or** **mild** abnormalitie(s) *(Any combination of : I, II, III, IV, V, VI)*	**Normal** patterns *(All three of : I, II, III)*	**Normal** patterns **or** **mild** abnormalitie(s) *(Any combination of : I, II, III, IV, V, VI)*
Grade 2: Mild congestion	IVC > 2 cm **Mild** abnormality in **at least one** pattern *(At least one of : IV, V, VI)*	IVC > 2 cm **Mild** **or** **severe** abnormality in **at least one** pattern *(At least one of : IV, V, VI, VII, VIII, IX)*	IVC > 2 cm **Severe** abnormalities in **at least one** pattern *(At least one of : VII, VIII, IX)*	**Mild** **or** **severe** abnormalities **in at least one** pattern *(At least one of : IV, V, VI, VII, VIII, IX)*	**Severe** abnormalities **in at least one** pattern *(At least one of : VII, VIII, IX)*
Grade 3: Severe congestion	IVC > 2 cm **Severe** abnormalities **in at least one** pattern *(At least one of : VII, VIII, IX)*	IVC > 2 cm **Mild** **or** **severe** abnormalities **in multiple** patterns *(At least two of : IV, V, VI, VII, VIII, IX)*	IVC > 2 cm **Severe** abnormalities **in multiple** patterns *(At least two of : VII, VIII, IX)*	**Mild** **or** **severe** abnormalities **in multiple** patterns *(At least two of : IV, V, VI, VII, VIII, IX)*	**Severe** abnormalities **in multiple** patterns *(At least two of : VII, VIII, IX)*

Regular echo-clinical follow-up after an T-TEER

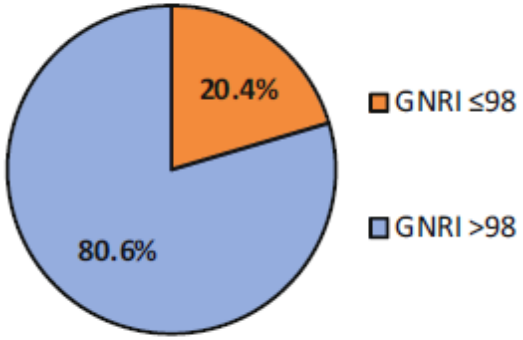
- **LV**: LVEF, GLS, size
- **RV**: TAPSE/sPAP, RV free-wall strain, RV–PA coupling
- **Atria**: LA Volume/strain, RA volume/strain
- Residual regurgitation more than MPG

EACVI
European Association of Cardiovascular Imaging
European Society of Cardiology

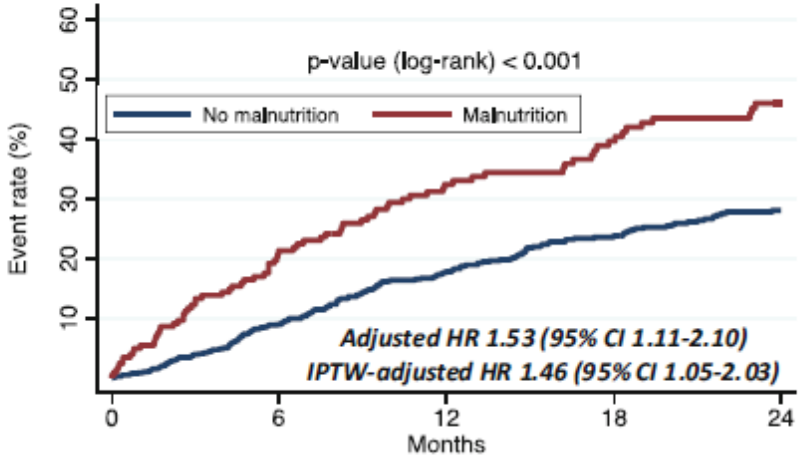
Malnutrition and outcomes after T-TEER

An analysis on 1,034 patients from EuroTR

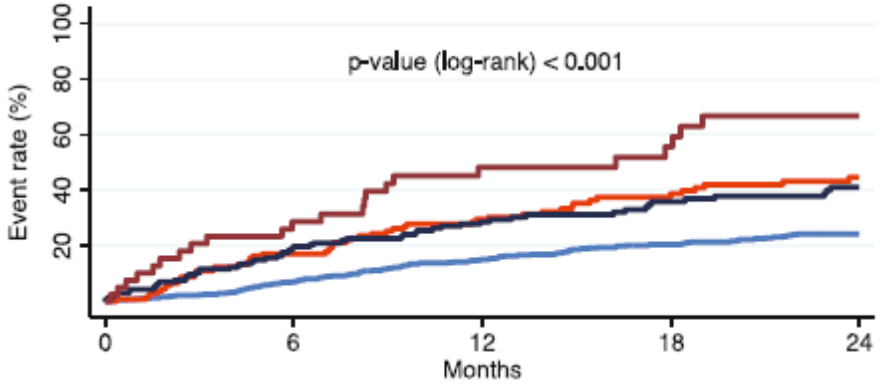
Prevalence of malnutrition (GNRI ≤98)



Impact of malnutrition on all-cause mortality



Association of successful T-TEER with lower mortality in patients with and without malnutrition



No interaction between residual TR and malnutrition
($p_{interaction}$ = 0.947)

FIB – 4 = (age (years) × aspartate aminotransferase (IU/L) / platelet count (10_9/L)) × √ alanine aminotransferase (IU/L)

4919 patients with echocardiography-confirmed atrial fibrillation and complete liver profile from 2010 ~ 2022

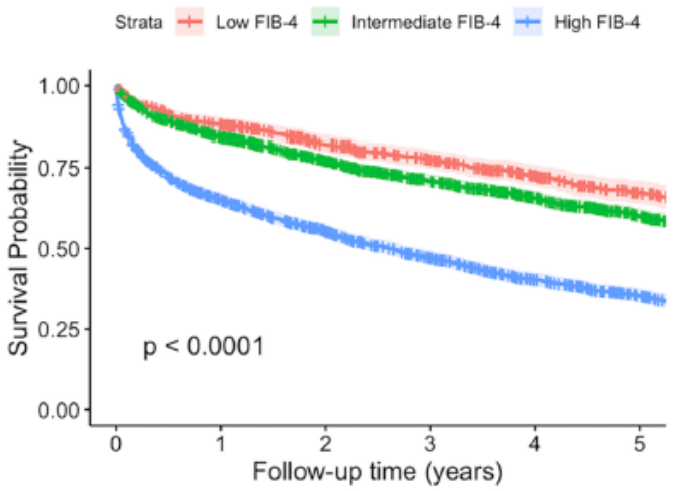
Median follow-up: 3.9 years

- **Correlation of FIB-4 index and echocardiography**
- **FIB-4 and risk of all-cause mortality**

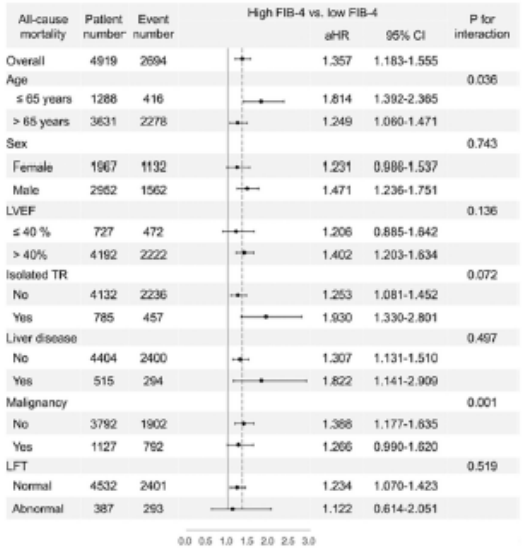
FIB-4 index associated with significant TR

Parameters	Beta coefficient	Standard error	P value
Age, per 1 increase	0.10	0.03	<0.001
Male vs. female	-.064	0.74	0.388
Significant MR	-0.56	0.86	0.517
Significant TR	1.71	0.84	0.041
LVEF, per 1 increase	-0.14	0.02	<0.001

FIB-4 index predicts risk of all-cause mortality



Subgroup analysis showed consistent results



- FIB-4 was positively associated with TR severity, and an increased risk of all-cause mortality.
- FIB-4 serves as a simple, non-invasive tool for prognostic stratification of TR

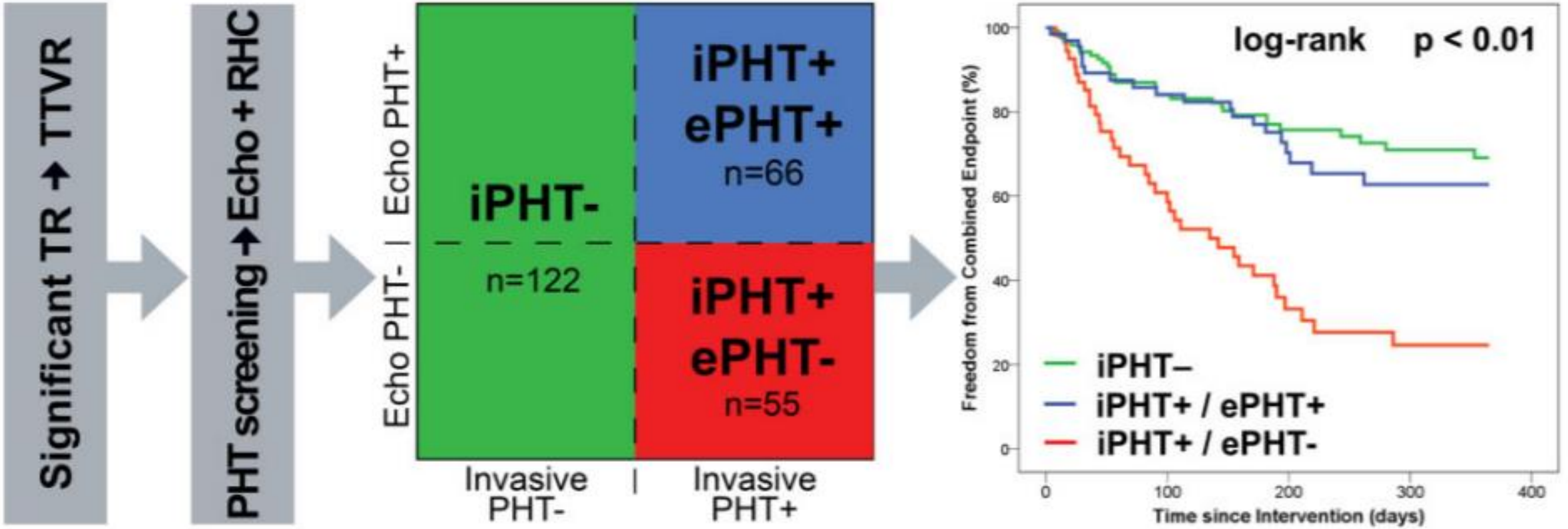
European Journal of Heart Failure (2025) doi:10.1002/ejhf.3761

Need for a systematic Right Heart Cath after having optimized the volemia and the diuretics.

Make sure that the PCWP is normal and that sPAP ≤ 60 mmHg.

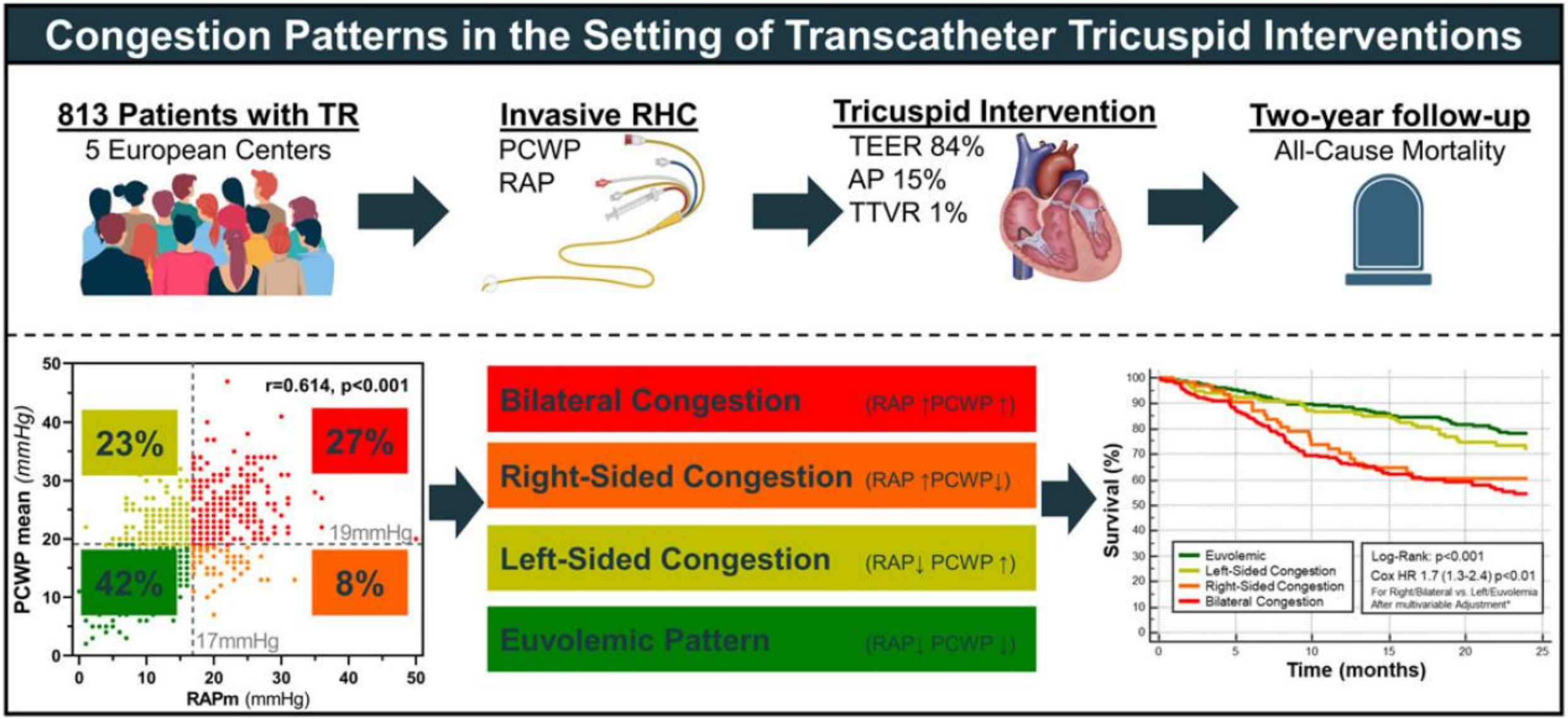
& value is the discordant echocardiographic and invasive diagnosis of PHT in severe TR.

It predicts outcomes after TTVR.



Lurz et al. European Heart Journal (2020) 41, 2785–2795

Pulmonary pressures

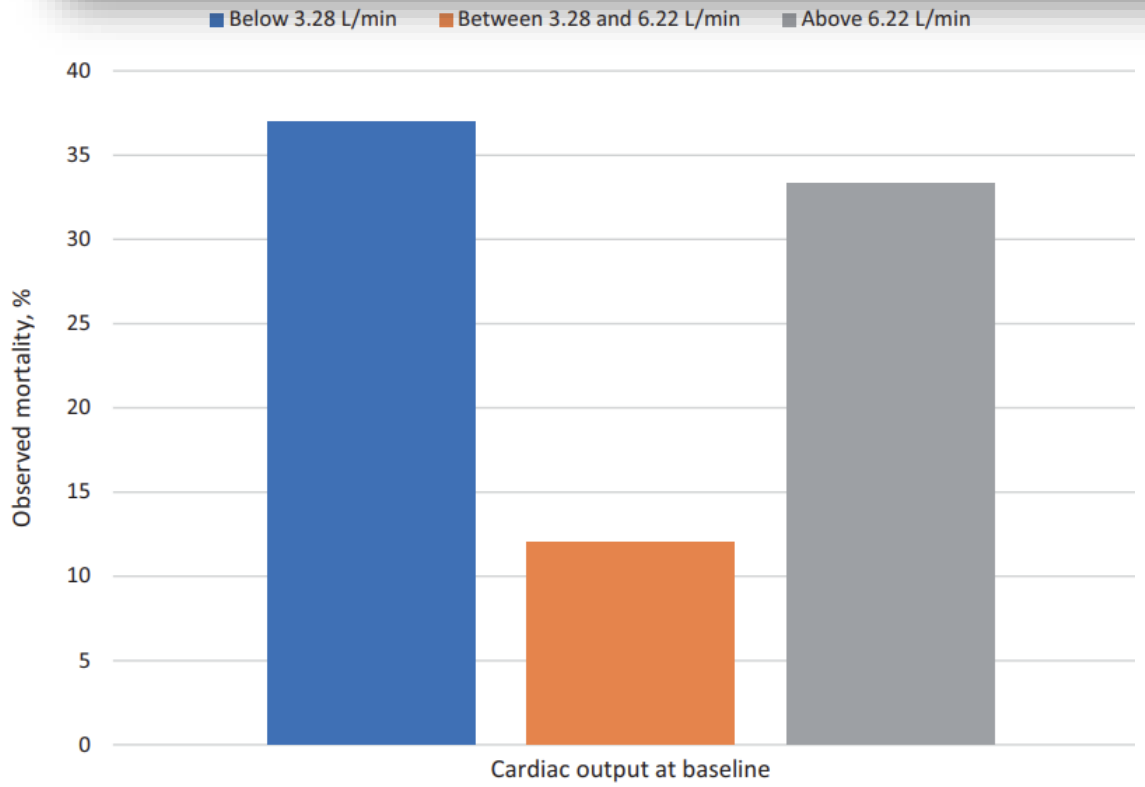


Rommel et al. European Journal of Heart Failure (2024) **26**, 1004–1014

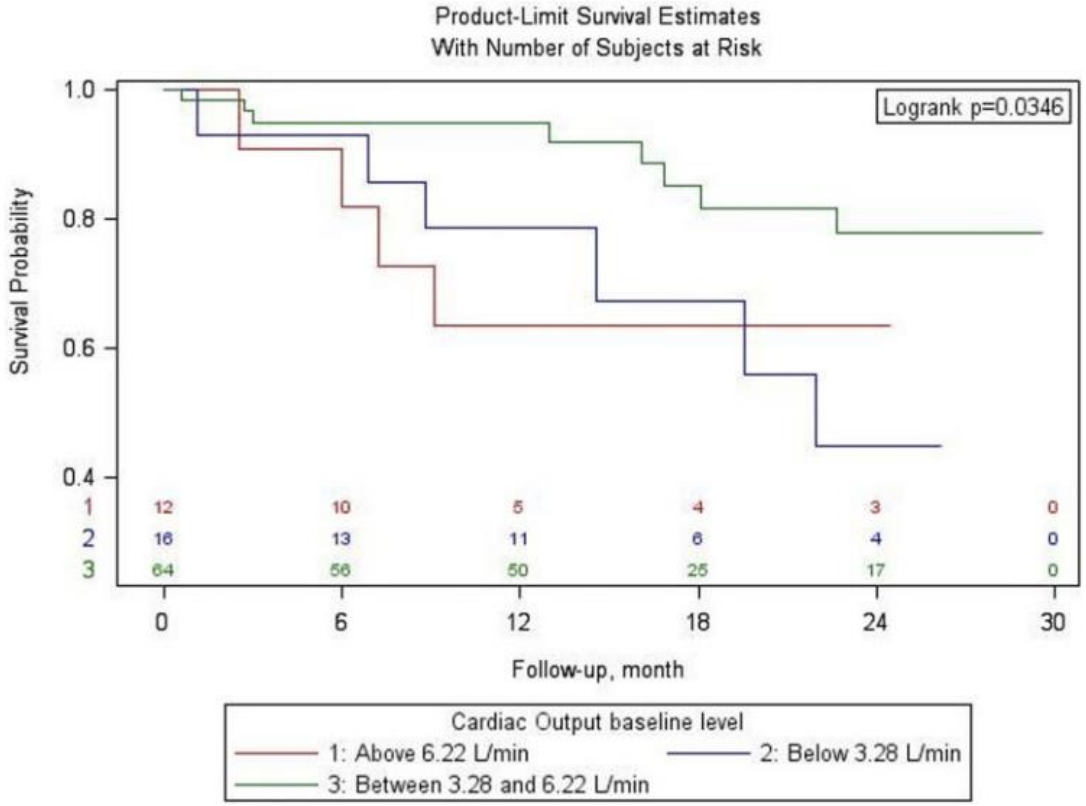
Natural history of functional tricuspid regurgitation: impact of cardiac output

Elisabeth Chen[1], Guillaume L'official[1], Anne Guérin[1], Julien Dreyfus[2], Yoan Lavie-Badie[3], Catherine Sportouch[4], Jean-Christophe Eicher[5], Sylvestre Maréchaux[6], Thierry Le Tourneau[7], Emmanuel Oger[8], and Erwan Donal [1]*

Significant isolated secondary TR was associated with 19% of mortality. It is also associated with higher long-term mortality if CO is abnormal



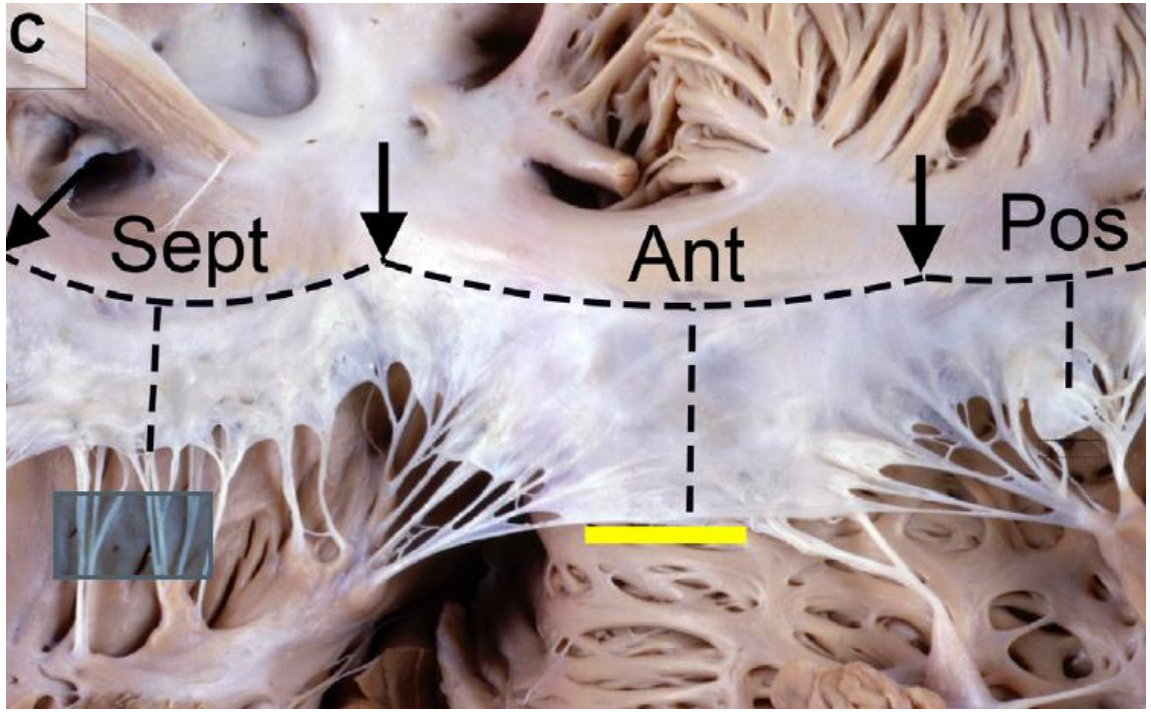
Observed mortality in the cohort based on the different CO groups.

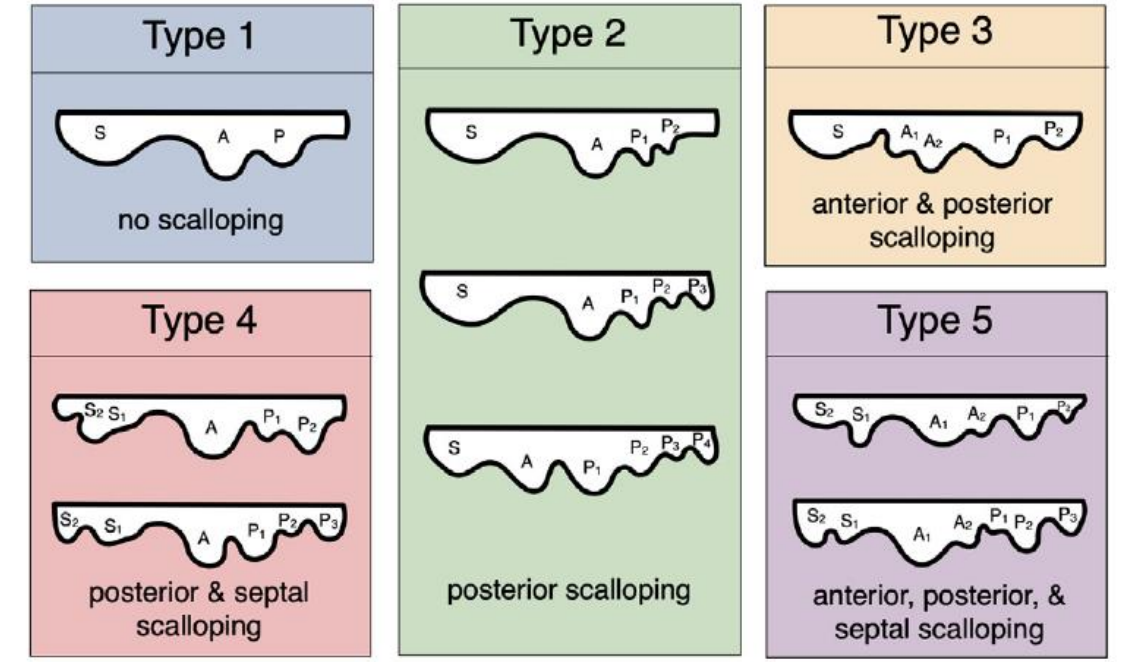


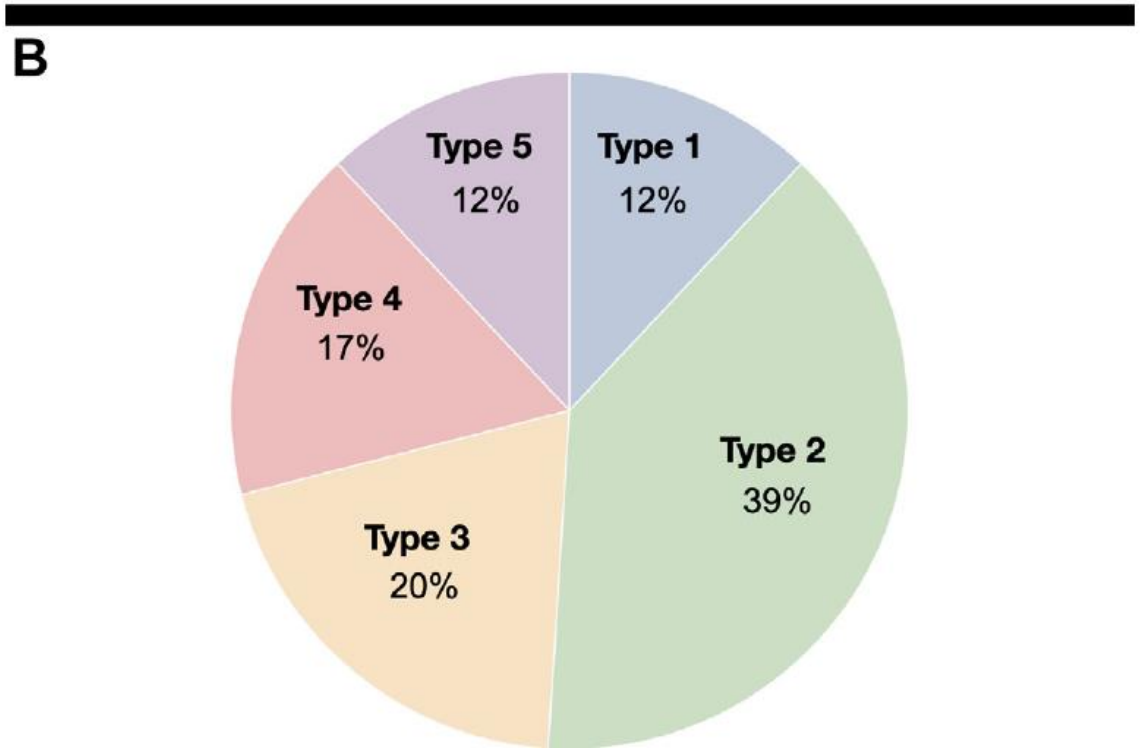
European Heart Journal - Cardiovascular Imaging (2021) **22**, 878–885
doi:10.1093/ehjci/jeab070

The Morphologic Spectrum of the Tricuspid Valve

Anatomical Implications for Transcatheter Edge-to-Edge Repair







De Gaspari et al JACC Cvint

Conclusions

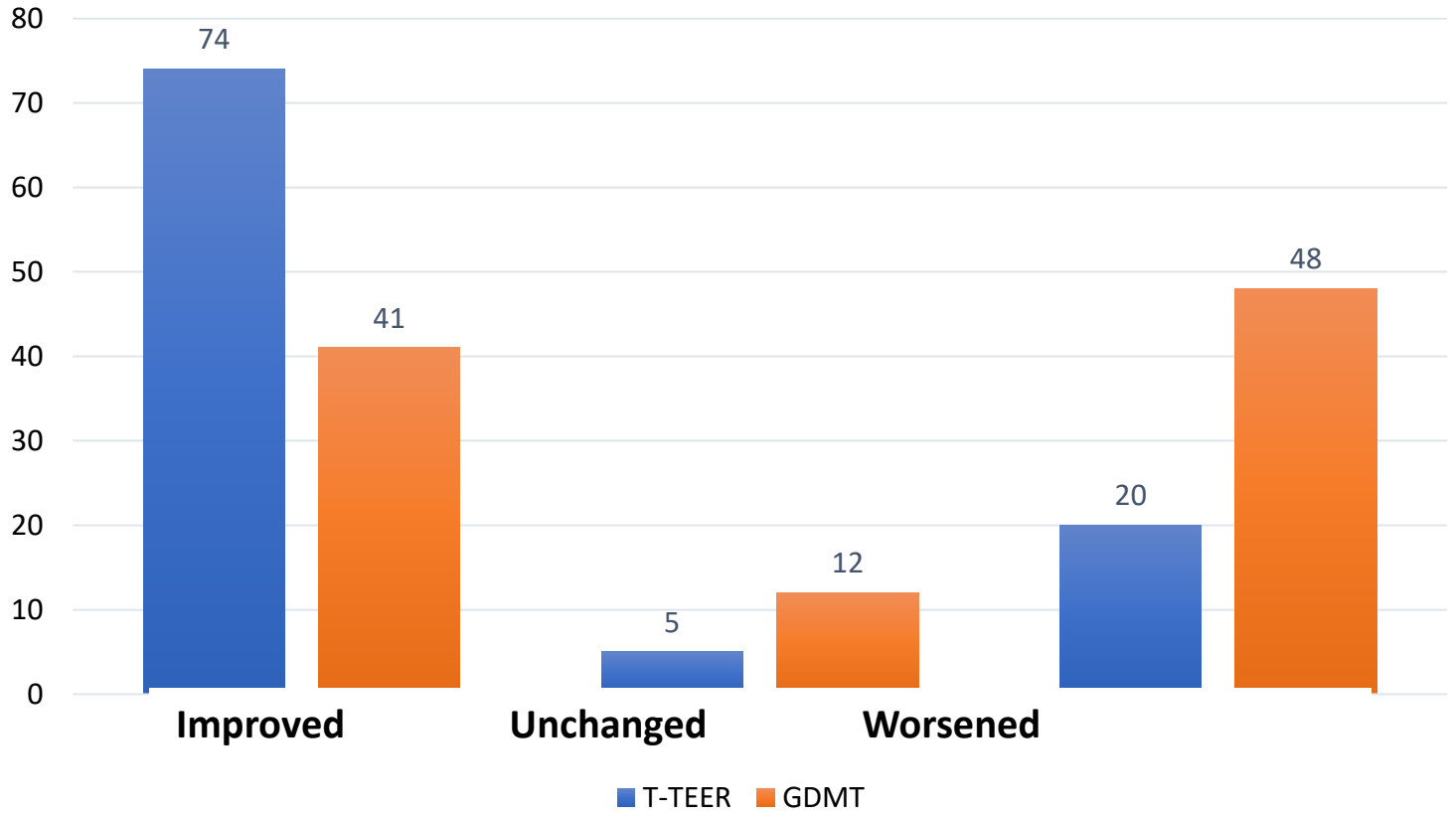
- **Tricuspid Regurgitation.**
- **You Should Care About It**
- **We might have to Treat it !**

•**TR is not benign** – Severe TR is associated with high morbidity and mortality, independent of left-sided disease.

•**Early recognition is key** – Symptoms are often non-specific; timely diagnosis and referral before advanced right ventricular dysfunction is essential. (Tri-score for a better referal)

•**Specialized evaluation is required** – Management decisions demand multiparametric imaging, hemodynamic assessment, and integration into a structured, « expert » pathway.

Primary endpoint result (ITT)



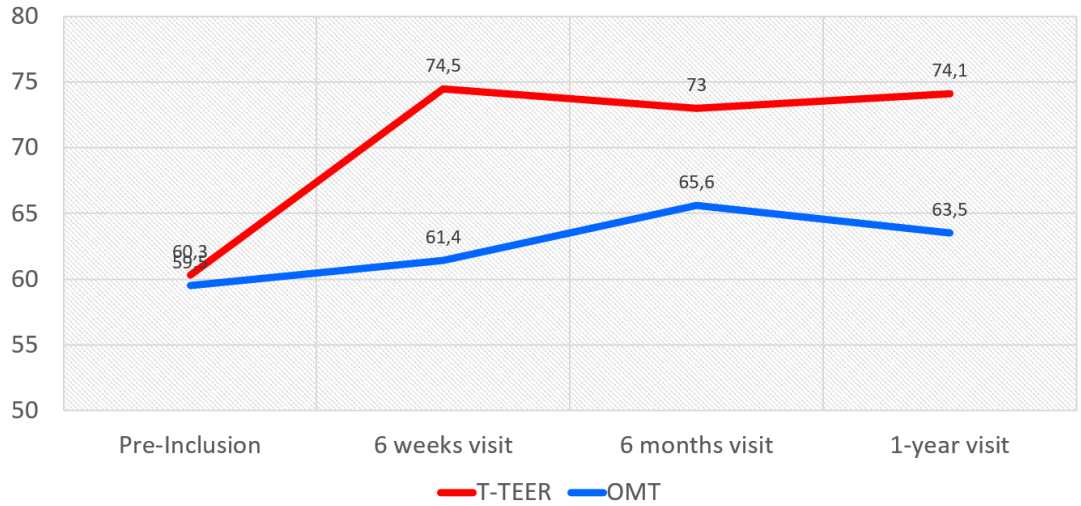
At 1-year follow-up

109 patients (74.1%) in the T-TEER group improved compared to 58 patients (40.6%) in the GDMT group

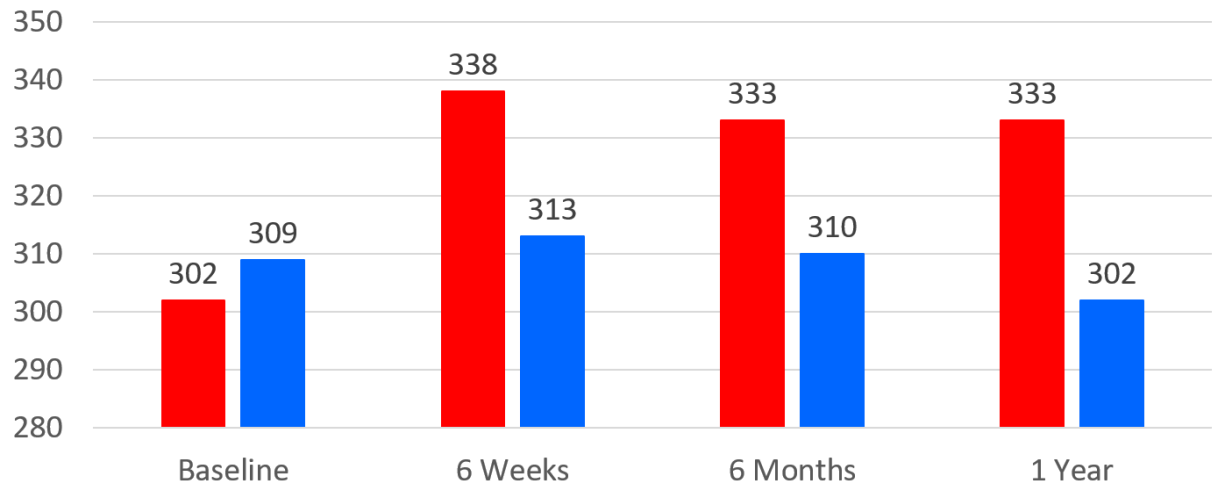
Better rank probability of T-TEER of 0.67 (95%CI 0.61-0.72) P<.0001

Donal et al. JAMA 2024

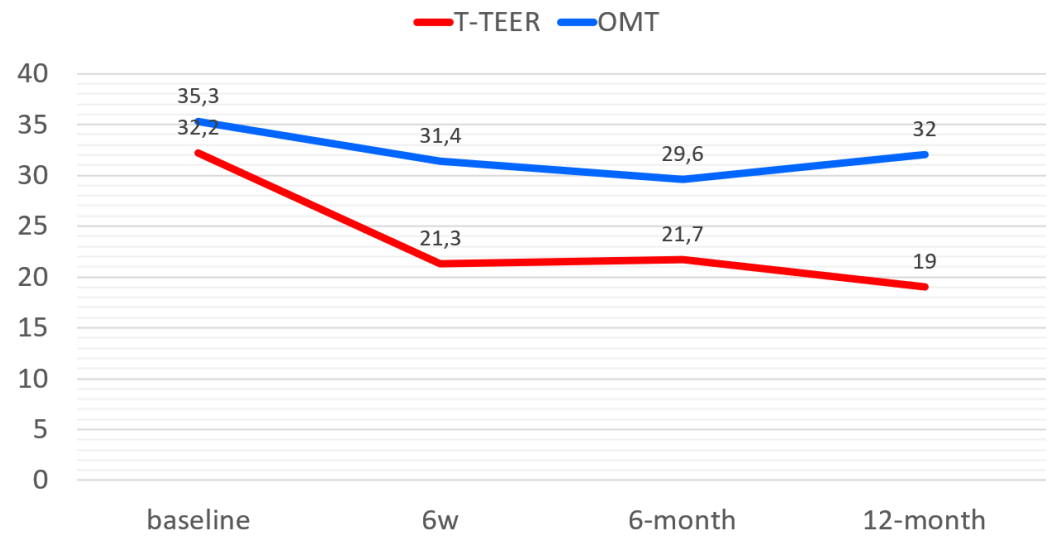
KCCQ overall

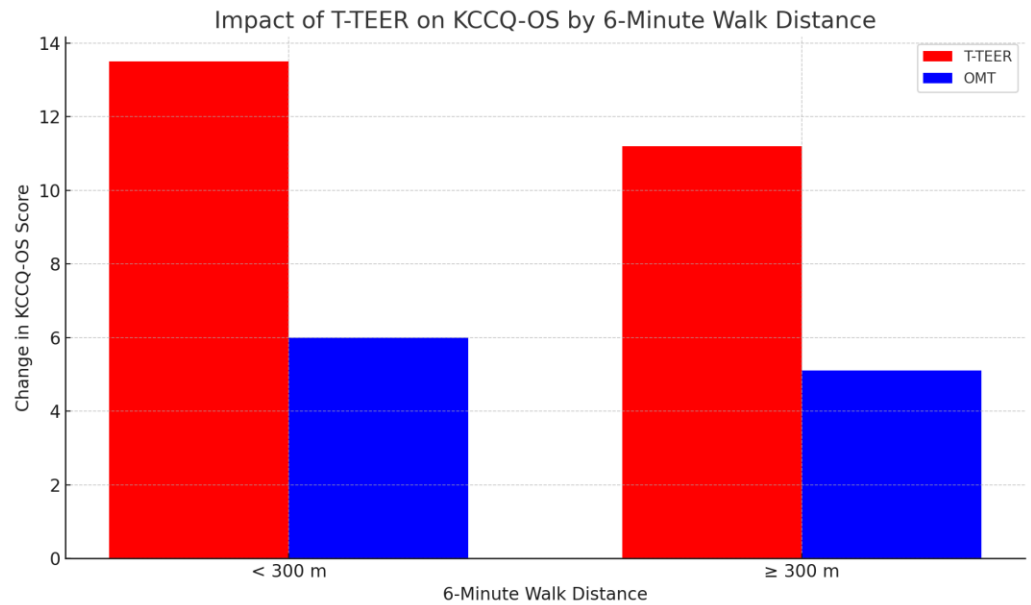


6'walk test distance (m)



Changes of the Minesota Living HF Score (MLHF)

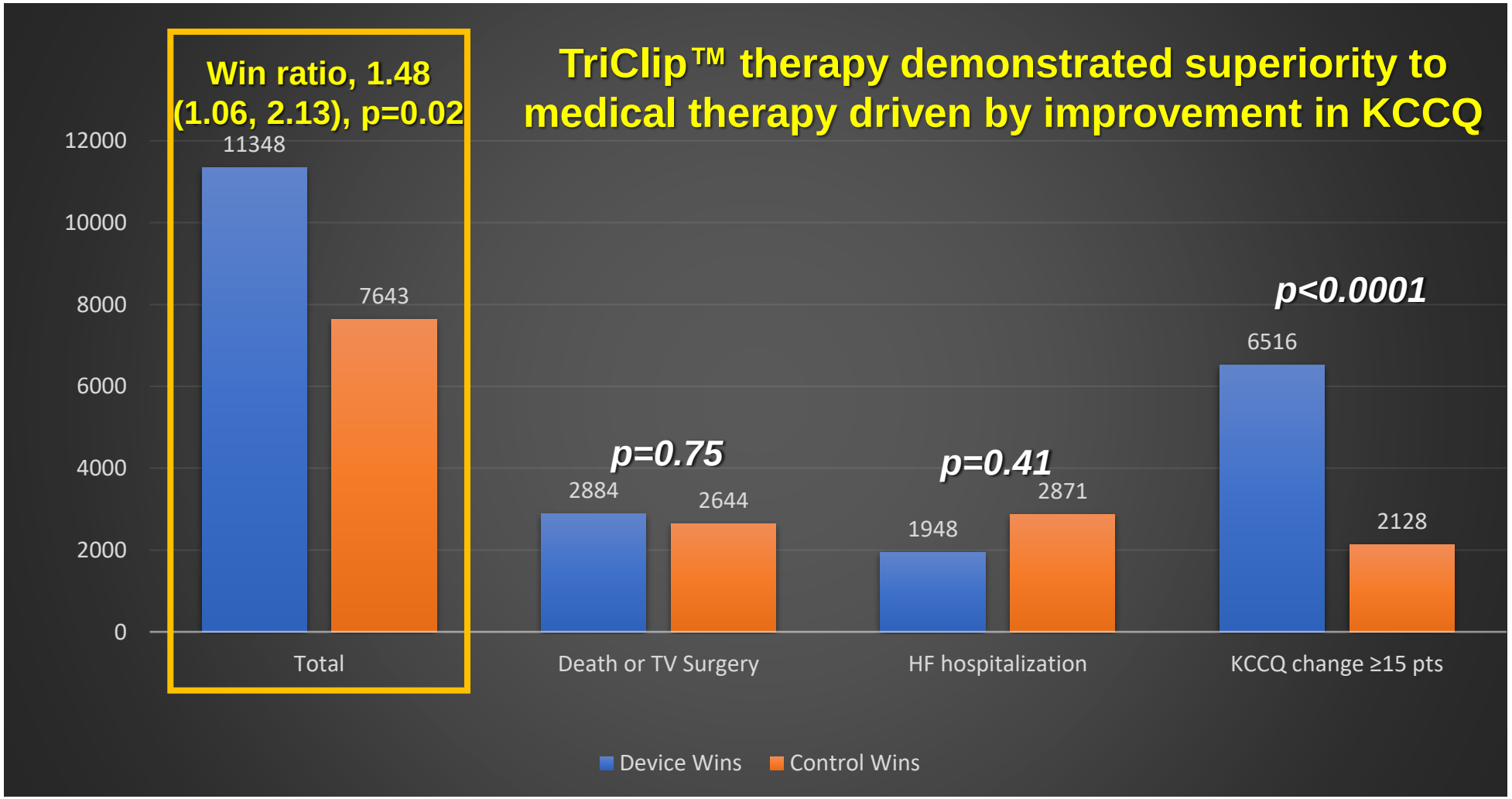




Donal E *et al*. Transcatheter Edge-to-Edge Repair for Severe Isolated Tricuspid Regurgitation: The Tri.Fr Randomized Clinical Trial. JAMA. 2025 Jan 14;333(2):124-132. doi: 10.1001/jama.2024.21189.

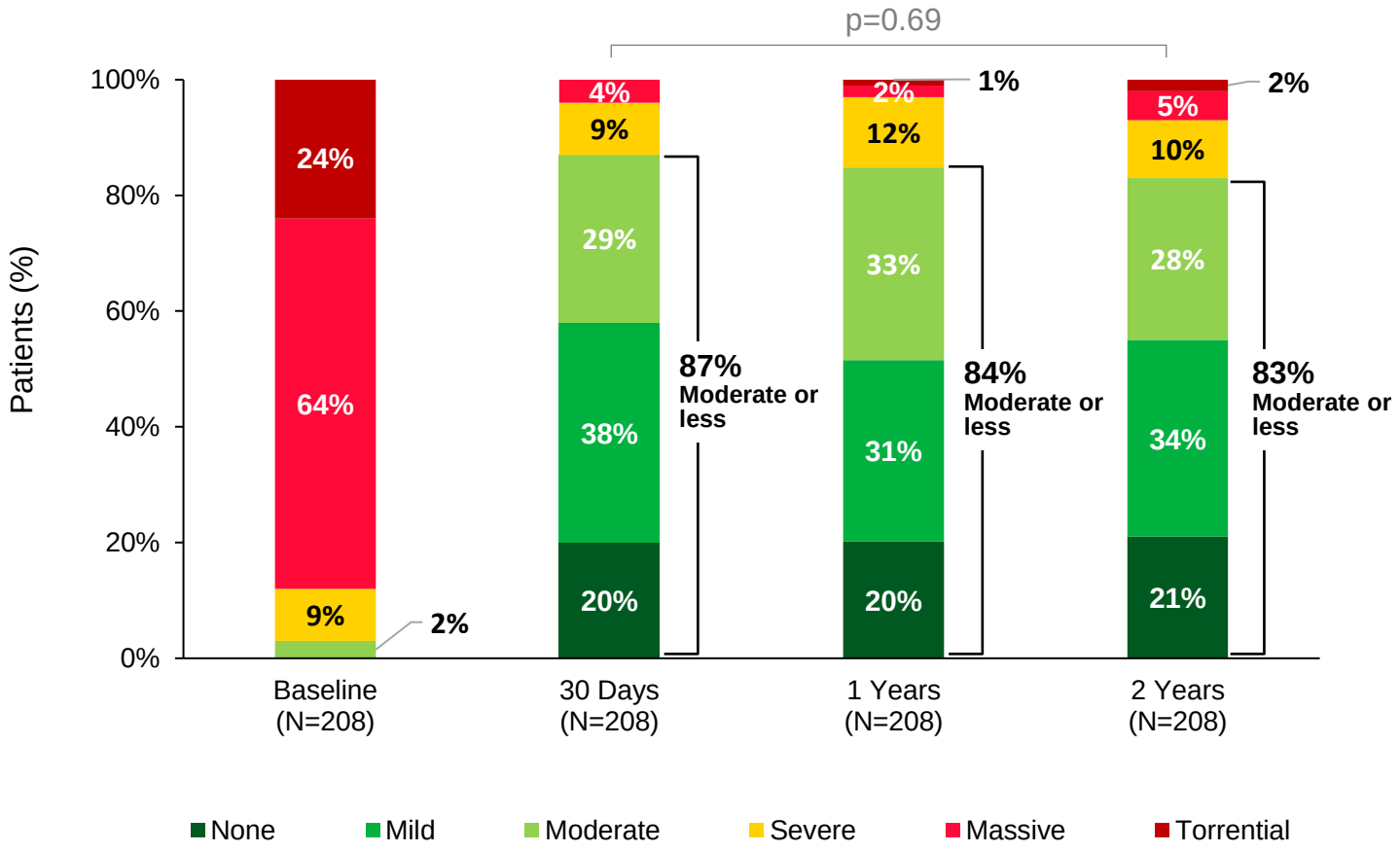
Primary Endpoint

TRILUMINATE™ PIVOTAL TRIAL



Reduction in TR Severity (Paired)

Substantial and sustained TR reduction through 2 years

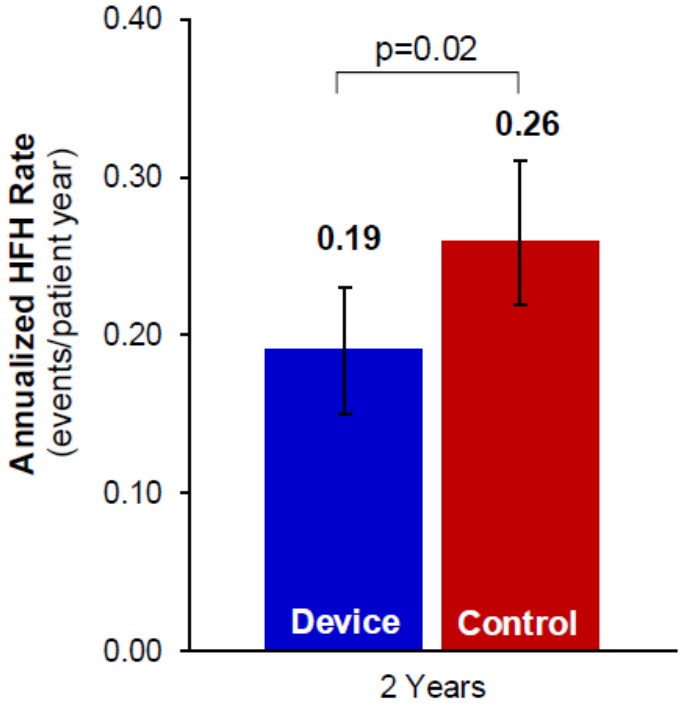


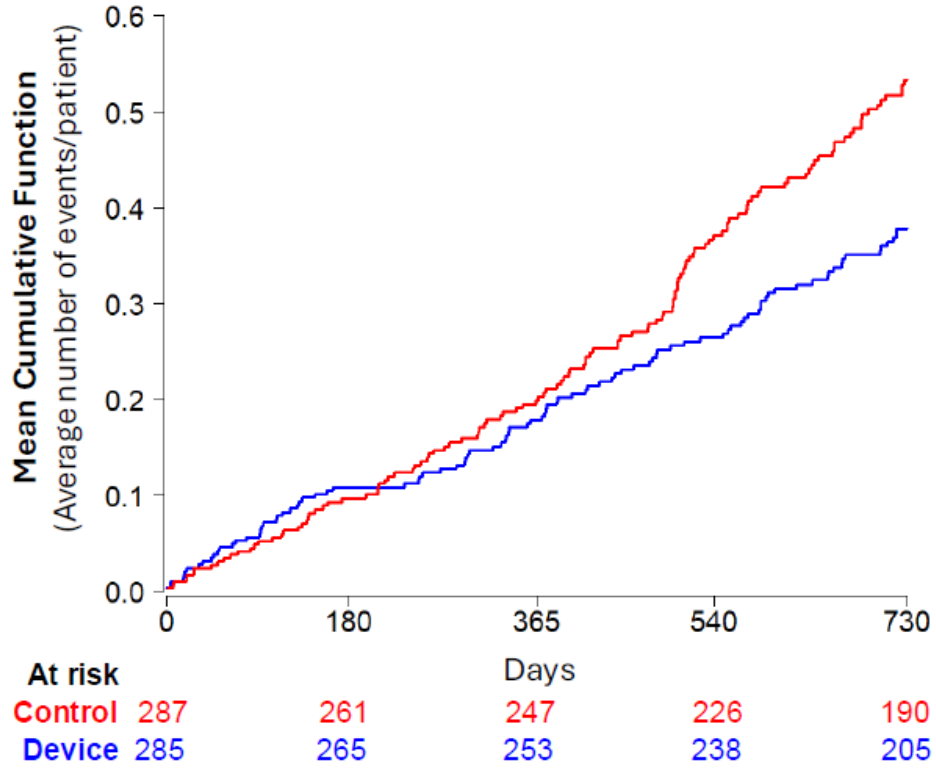
Paired analysis shown. *If 30-day TR was unavailable, discharge was used.

INTENTION-TO-TREAT

TRILUMINATE PIVOTAL TRIAL

Prespecified Endpoint: Recurrent Heart Failure Hospitalizations



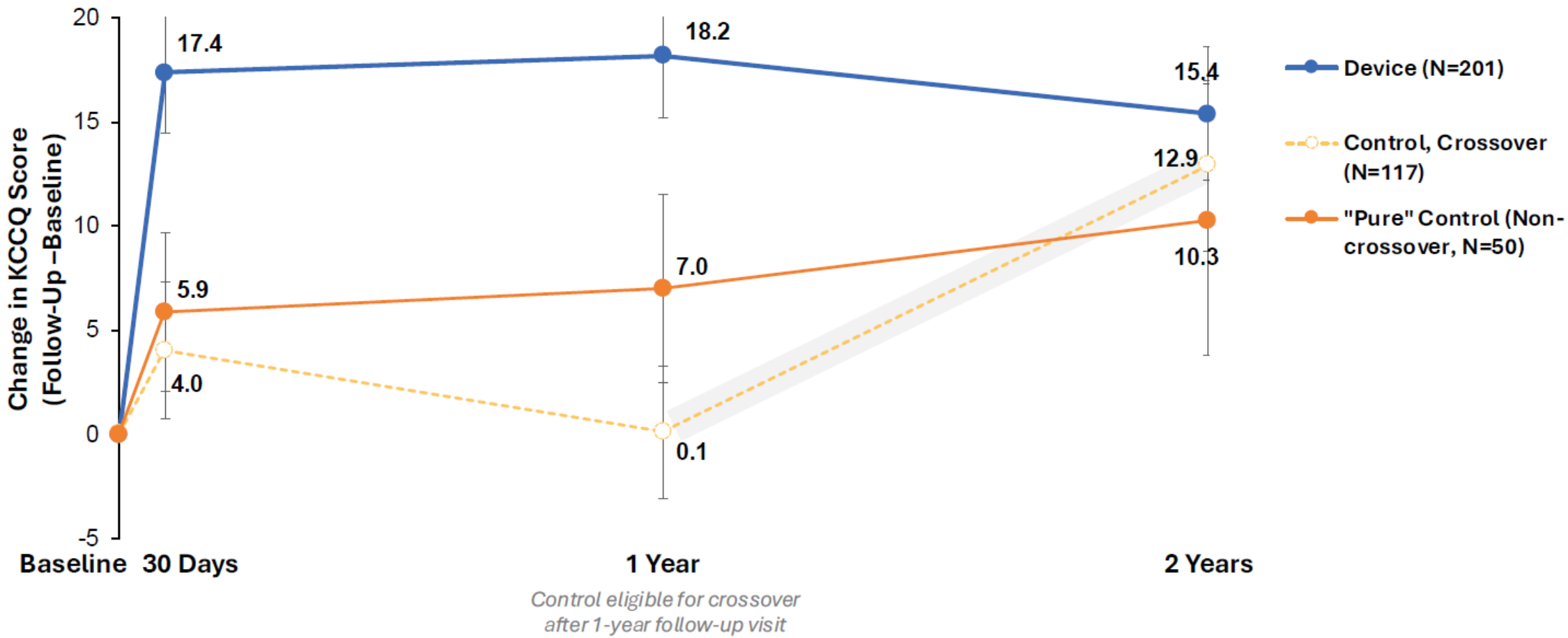


Hazard ratio=0.72 (one-sided upper confidence limit of 0.93, p=0.02), indicating a **relative risk reduction of 28% with device treatment.**

10.1161/CIRCULATIONAHA.125.074536

TRILUMINATE
PIVOTAL TRIAL

Health Status Through 2 Years

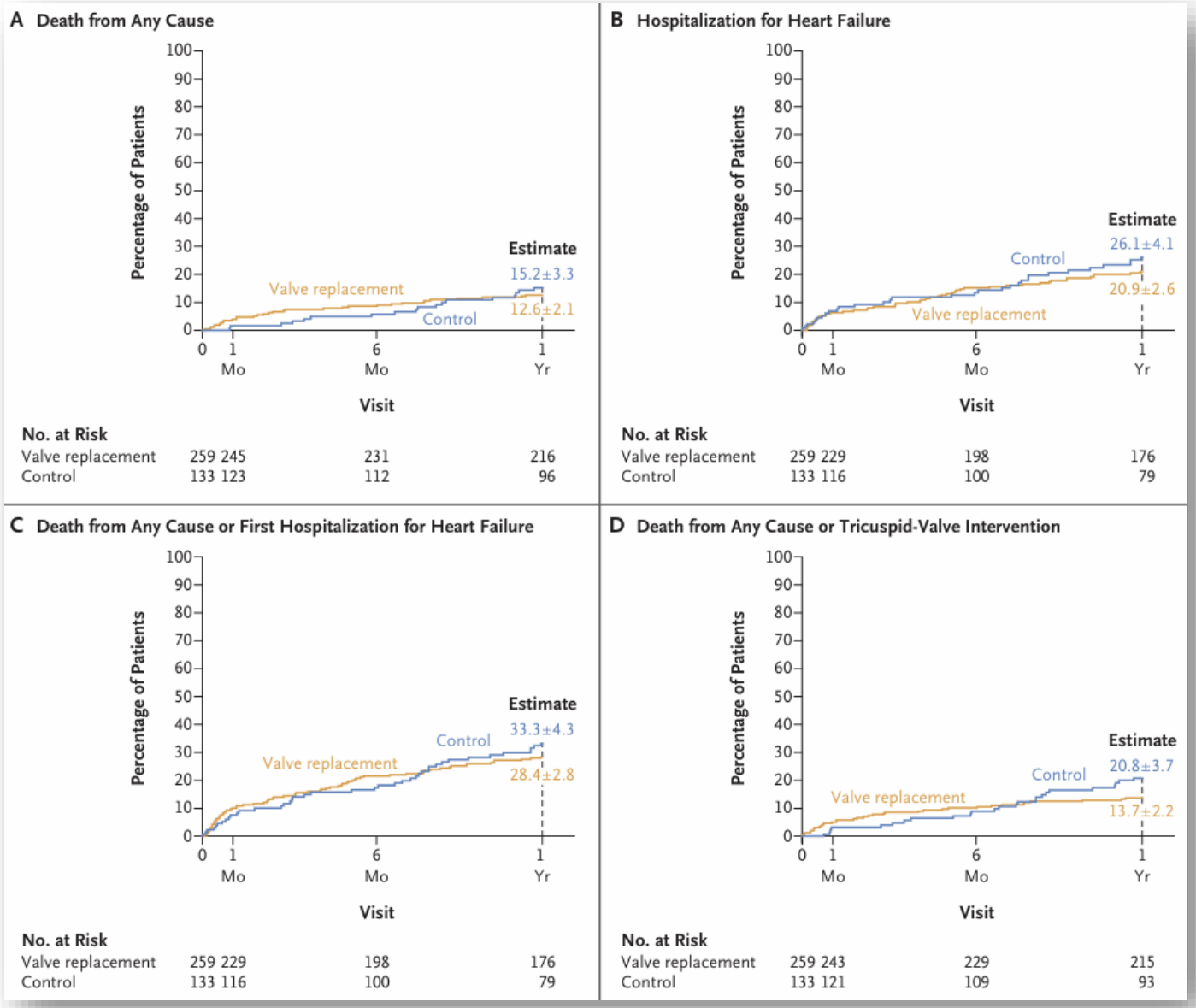


Control eligible for crossover after 1-year follow-up visit

10.1161/CIRCULATIONAHA.125.074536

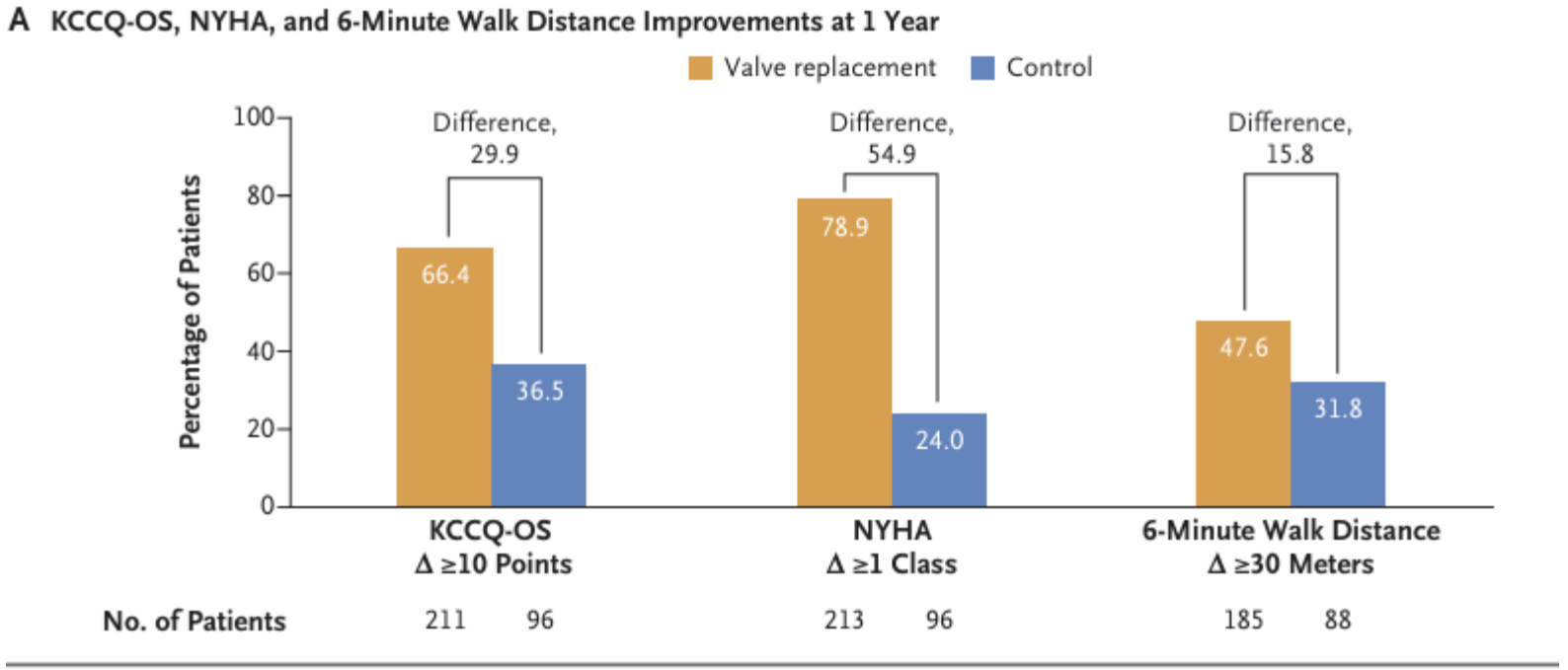
TRISCEND II Trial

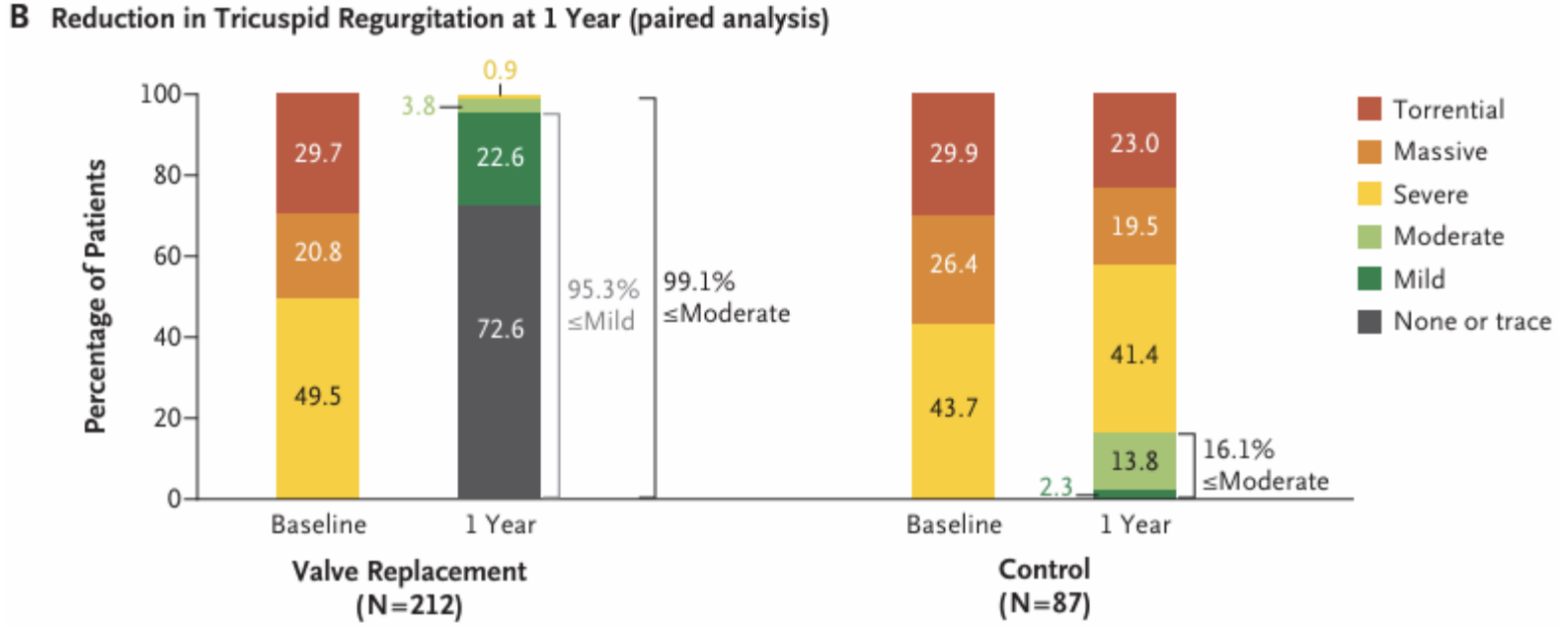
Hahn et al. New Engl J Med 2024 Oct 30. doi: 10.1056/NEJMoa2401918.



- Severe bleeding occurred in 15.4% of the valve-replacement group and in 5.3% of the control group (P = 0.003);
- new permanent pacemakers were implanted in 17.4% and 2.3%, respectively (P<0.001).

For patients with severe tricuspid regurgitation, transcatheter tricuspid-valve replacement was superior to medical therapy alone for the primary composite outcome, driven primarily by improvements in symptoms and quality of life.

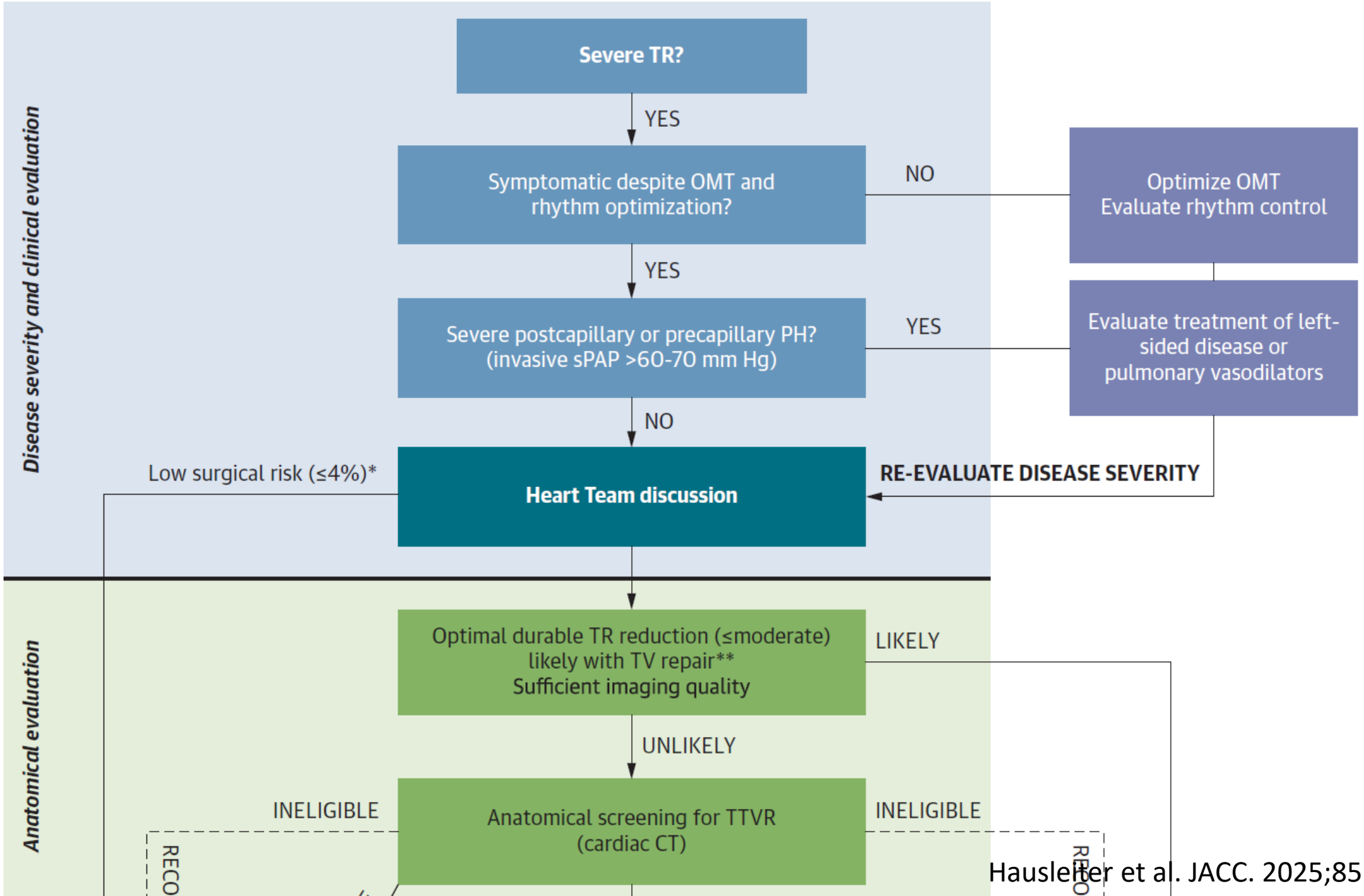




Hahn et al. New Engl J Med 2024 Oct 30. doi: 10.1056/NEJMoa2401918.

Severe TR		Clinical Outcomes	Massive/Torrential TR	
TTVR	Control		TTVR	Control
1.64	—	Primary safety and effectiveness endpoint at 1 year (Win ratio)	2.20	—
95.2%	2.6%	TR grade ≤ mild at 1 year	95.3%	2.0%
13.6%	13.5%	All-cause mortality at 18 months	17.9%	23.6%
23.6%	13.7%	Heart failure hospitalisation at 18 months	23.6%	38.8%
14.6 points	7.4 points	Δ KCCQ-OS score baseline to 1 year	22.2 points	-0.67 points
13.9%	4.0%	Severe bleeding at 1 year	16.8%	6.0%
19.7%	4.0%	Arrhythmia requiring new pacemaker at 1 year	16.1%	1.2%

Lurz et al EHJ (in press)



Hausleiter et al. JACC. 2025;85:265–291

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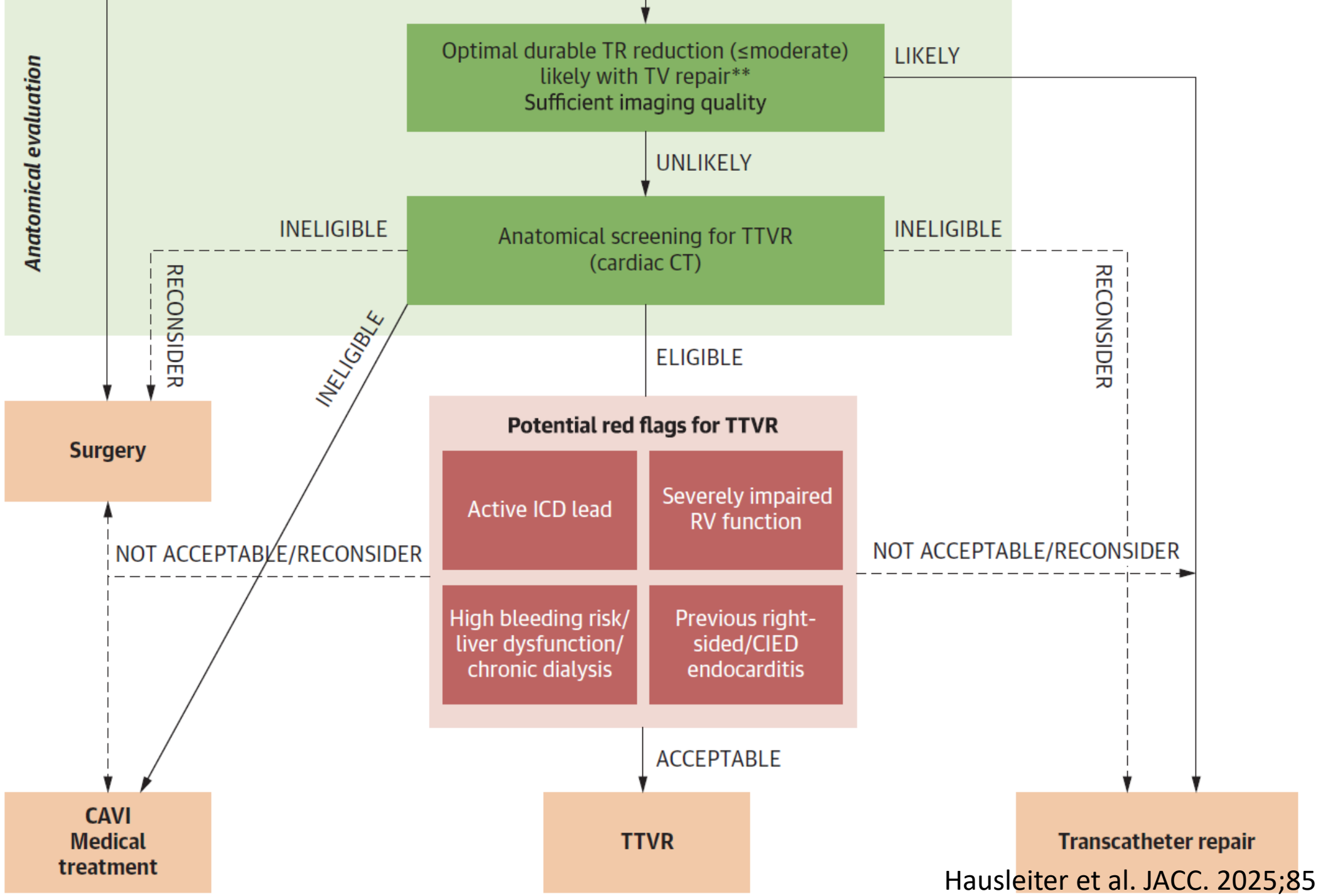

Hausleiter et al. JACC. 2025;85:265–291

Favorable anatomy for T-TEER

- Small septolateral coaptation gap ≤7 mm
- Anteroseptal jet location
- Localized prolapse or flail
- Bileaflet or trileaflet morphology
- No CIED lead
- Good echocardiographic window for leaflet visualization

Feasible anatomy for T-TEER

- Septolateral coaptation gap >7 but ≤8.5 mm
- Posteroseptal jet location
- Multiple leaflets (>3)
- Lead-associated TR without permanent leaflet interaction
- Sufficient echocardiographic window for leaflet visualization

Criteria favoring replacement

- Large septolateral coaptation gap >8.5 mm
- Anteroposterior jet location
- Multiple leaflets (>3) and indentations
- Leaflet thickening/shortening (rheumatic, carcinoid)/perforation
- Pronounced leaflet tethering
- CIED-related TR (impingement, adhesion, perforation, subvalvular entanglement)
- Insufficient echocardiographic leaflet visualization

Hausleiter et al. JACC. 2025;85:265–291