



CUORE
E NON SOLO
INTERVENTIONAL
CARDIOLOGY
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GENOVA

**CORONARY IMAGING & PHYSIOLOGY
INNOVATION IN TRANSCATHETER
INTERVENTIONS**

Trattamento della patologia tricuspidale: Attualità e prospettive

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Disclosures

M. Adamo received speaker honoraria from Abbott and Medtronic

Tricuspid regurgitation and long-term clinical outcomes

Ehud Chorin^{1†}, Zach Rozenbaum^{1†}, Yan Topilsky¹, Maayan Konigstein¹,
Tomer Ziv-Baran², Eyal Richert¹, Gad Keren¹, and Shmuel Banai^{1*}

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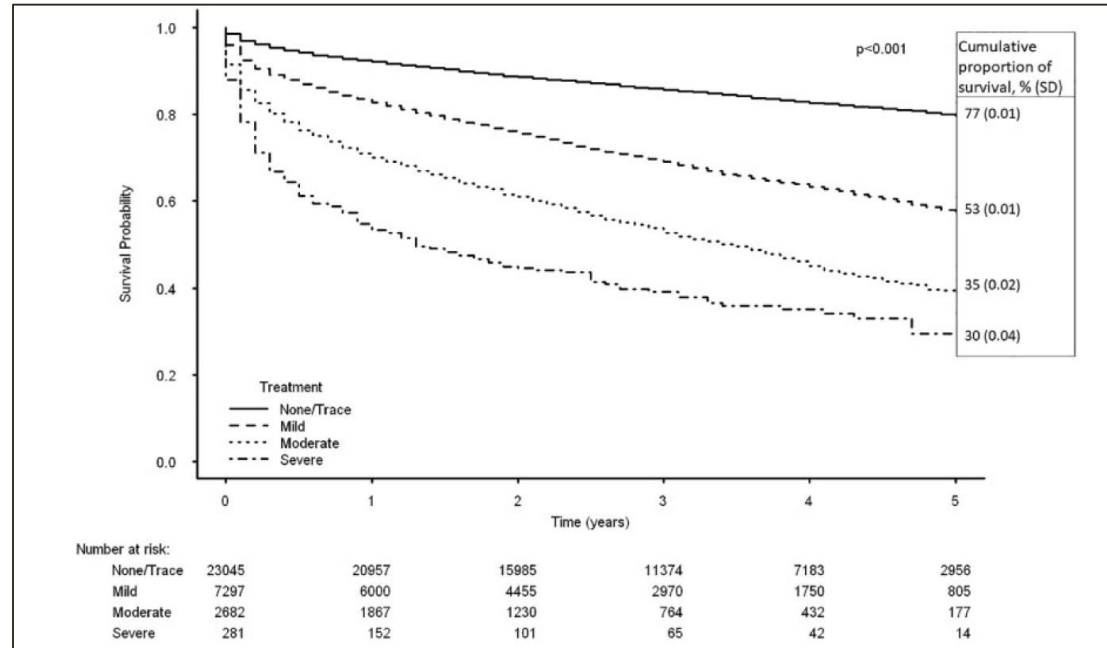
Received 3 December 2018; editorial decision 9 August 2019; accepted 21 August 2019; online publish-ahead-of-print 23 September 2019

N=33305

TR_≥1+ in 31%

Moderate/severe TR in 9%

Mean age: 67 years



Excess Mortality Associated With Functional Tricuspid Regurgitation Complicating Heart Failure With Reduced Ejection Fraction

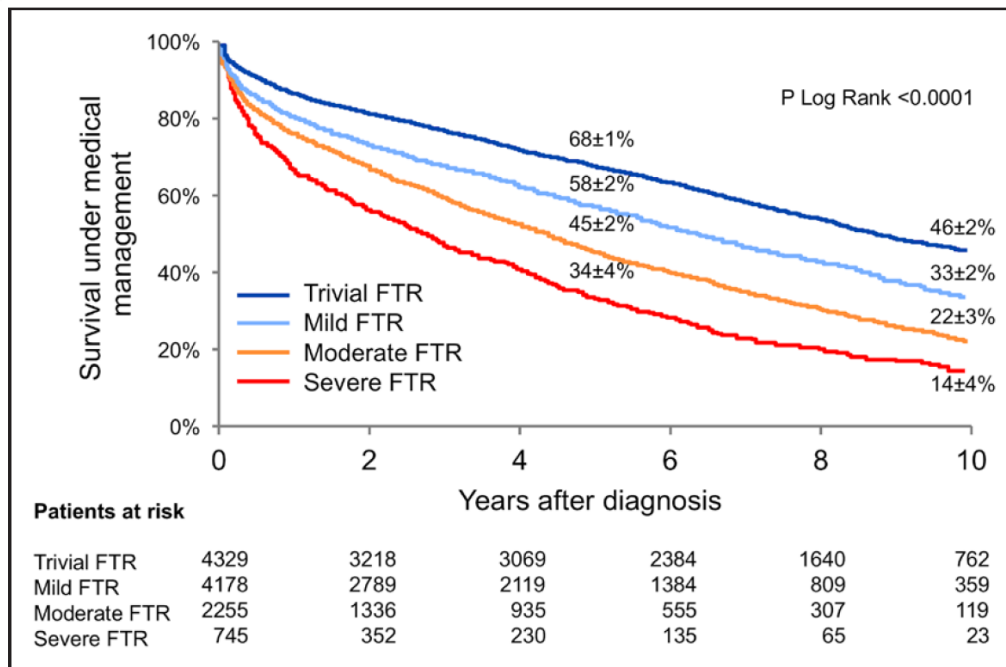
N=13026

TR in 55%

Moderate/severe 23%

Mean age: 68 years

Benfari et al. Circulation 2019 140(3):196-206





Tricuspid regurgitation is associated with increased mortality independent of pulmonary pressures and right heart failure: a systematic review and meta-analysis

Nelson Wang¹, Jordan Fulcher^{2,3}, Nishan Abey Suriya⁴, Michele McGrady², Ian Wilcox^{1,2}, David Celermajer^{1,2}, and Sean Lal^{1,2*}

¹Sydney Medical School, University of Sydney, Sydney, New South Wales, Australia; ²Department of Cardiology, Royal Prince Alfred Hospital, Sydney, New South Wales, Australia; ³NHMRC Clinical Trials Centre, University of Sydney, Sydney, New South Wales, Australia; and ⁴University of Queensland, Brisbane, Queensland, Australia

Received 22 May 2018; revised 9 July 2018; editorial decision 20 September 2018; accepted 15 October 2018; online publish-ahead-of-print 22 October 2018

Risk of All-cause Mortality



TR classification

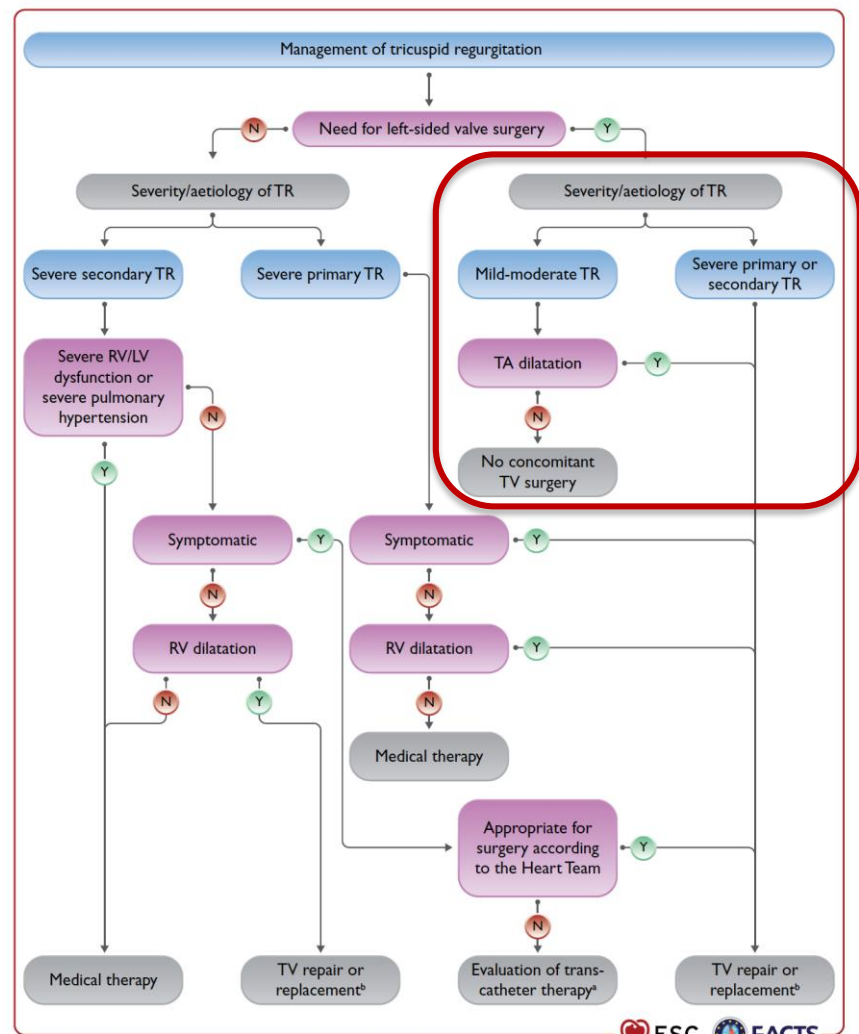
	Leaflet structure	Pathophysiology	Aetiology	Imaging
Secondary (functional)				
A. Atrial	Normal	RA enlargement and dysfunction leading to significant isolated annular dilation; RV often normal*	Carpentier I: Atrial fibrillation/flutter ¹⁰¹ Age ¹⁰² Heart failure with preserved ejection fraction ^{103,104}	Marked TV annular dilation is the dominant mechanism TV leaflet tethering is absent or minimal (except for late stages with secondary RV dysfunction) TV leaflet mobility is typically normal (Carpentier type I) RA is significantly dilated RV volume is typically normal (except in late stages)
B. Ventricular	Normal	RV enlargement and/or dysfunction leading to significant leaflet tethering and annular dilation	Carpentier IIIB: Left-sided ventricular or valve disease ^{11,12} Pulmonary hypertension ¹⁰² RV cardiomyopathy RV infarction	Marked TV leaflet tethering is the dominant mechanism TV leaflet mobility is typically restricted in systole (Carpentier type IIIB) TV annulus, RV and RA are dilated and/or dysfunctional
CIED-related	Normal/ abnormal	Leaflet impingement Leaflet/chordal entanglement/ chordal rupture Leaflet adherence Leaflet laceration/perforation Leaflet avulsion (following lead extraction)	Pacemaker Implantable cardiac defibrillator (ICD) Cardiac resynchronisation therapy (CRT) devices ¹⁰⁵⁻¹⁰⁸	TV leaflet structural abnormalities may be present TV leaflet mobility is variable (all Carpentier types) TV annulus, RV and RA are typically dilated (except for acute TR)
Primary (organic)	Abnormal	Lack of leaflet coaptation due to intrinsic changes leading to restricted or excessive leaflet mobility or leaflet perforation	Carpentier I: Congenital Endocarditis Carpentier II: Myxomatous disease Traumatic Post biopsy Carpentier IIIA: Carcinoid ¹⁰⁹ Rheumatic Radiotherapy Tumours	TV leaflet structural abnormalities characteristic of each primary aetiology are the dominant mechanisms TV leaflet mobility is variable (all Carpentier types) TV annulus, RV and RA are typically dilated (except in acute TR)
* RV basal diameter may appear abnormal due to the conical RV shape. CIED: cardiac implantable electronic device; CRT: cardiac resynchronisation therapy; ICD: implantable cardiac defibrillator; RA: right atrium; RV: right ventricle; TR: tricuspid regurgitation; TV: tricuspid valve				

Indications for TV interventions

2021 ESC/EACTS Guidelines for the management of valvular heart disease

Developed by the Task Force for the management of valvular heart disease of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS)

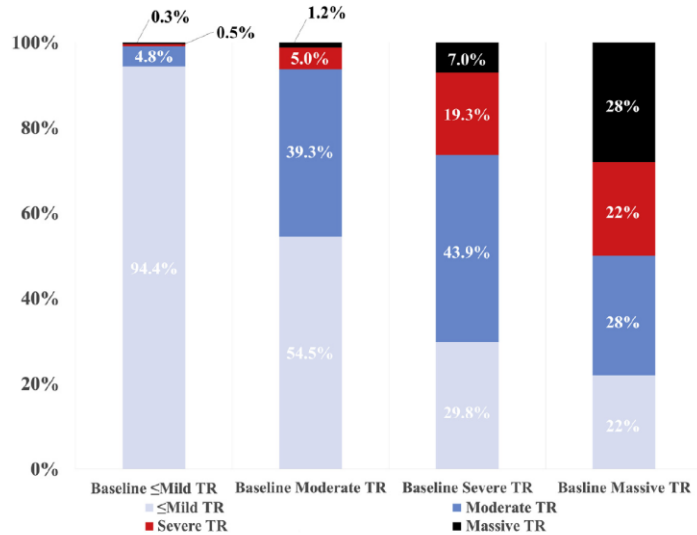
Authors/Task Force Members: Alec Vahanian * (ESC Chairperson) (France), Friedhelm Beyersdorf[†] (EACTS Chairperson) (Germany), Fabien Praz (ESC Task Force Coordinator) (Switzerland), Milan Milojevic¹ (EACTS Task Force Coordinator) (Serbia), Stephan Baldus (Germany), Johann Bauersachs (Germany), Davide Capodanno (Italy), Lenard Conradi¹ (Germany), Michele De Bonis¹ (Italy), Ruggero De Paulis¹ (Italy), Victoria Delgado (Netherlands), Nick Freemantle¹ (United Kingdom), Martine Gilard (France), Kristina H. Haugaa (Norway), Anders Jeppsson¹ (Sweden), Peter Jüni (Canada), Luc Pierard (Belgium), Bernard D. Prendergast (United Kingdom), J. Rafael Sádaba¹ (Spain), Christophe Tribouilloy (France), Wojtek Wojakowski (Poland), ESC/EACTS Scientific Document Group



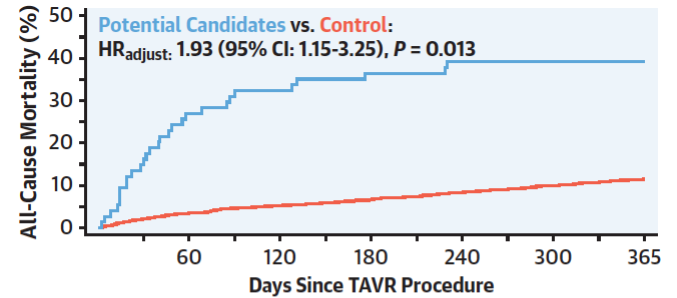
Tricuspid regurgitation after TAVI

Prevalence of severe TR
in TAVI candidates = 2.8%

FIGURE 1 Severity of TR After Transcatheter Aortic Valve Replacement Stratified by Baseline TR Severity

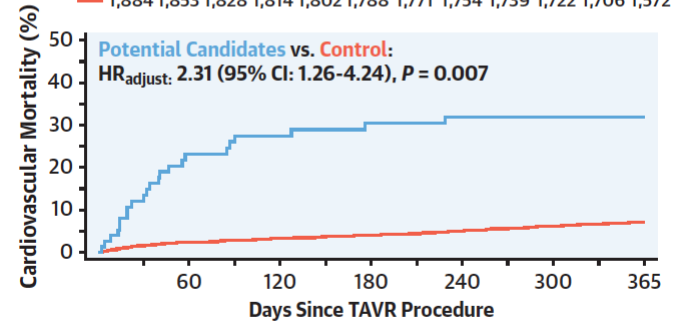


About 70% improvement of at least 1 grade



No. at risk:

— 63 54 51 50 48 47 47 45 45 45 45 40
— 1,884 1,853 1,828 1,814 1,802 1,788 1,771 1,754 1,739 1,722 1,706 1,572



No. at risk:

— 63 54 51 50 48 47 47 45 45 45 45 40
— 1,884 1,853 1,828 1,814 1,802 1,788 1,771 1,754 1,739 1,722 1,706 1,572

— Potential Candidates for TTVI — Control

Tricuspid regurgitation after M-TEER

Prevalence of severe TR in M-TEER candidates = 27%

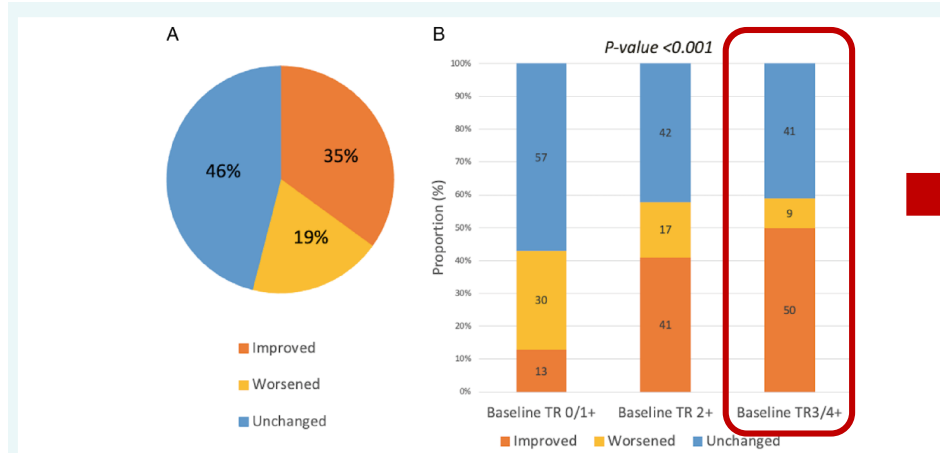
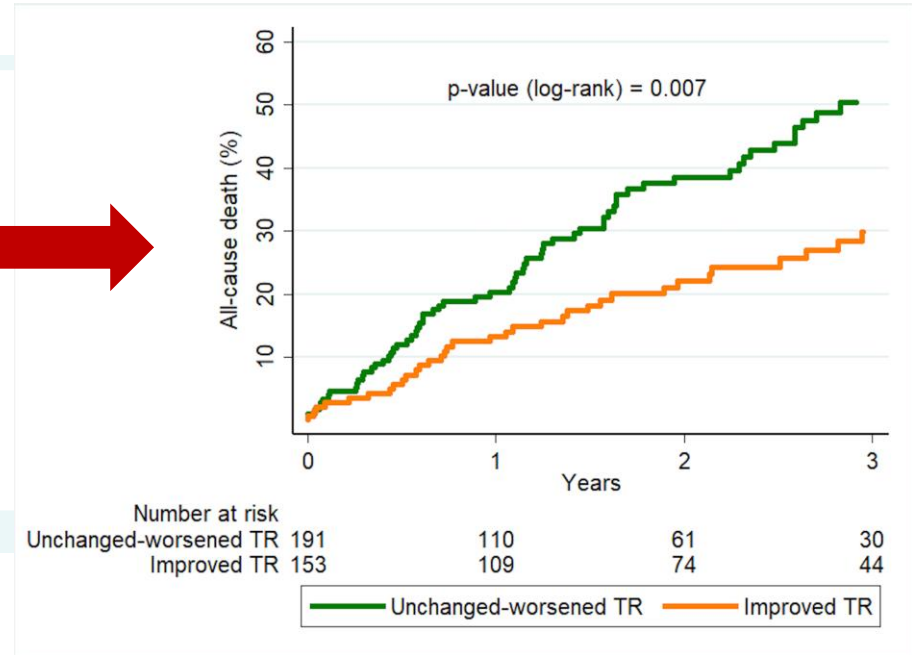


Figure 1 Evolution of tricuspid regurgitation (TR) in the overall population (A) and in the population stratified by baseline TR (B).

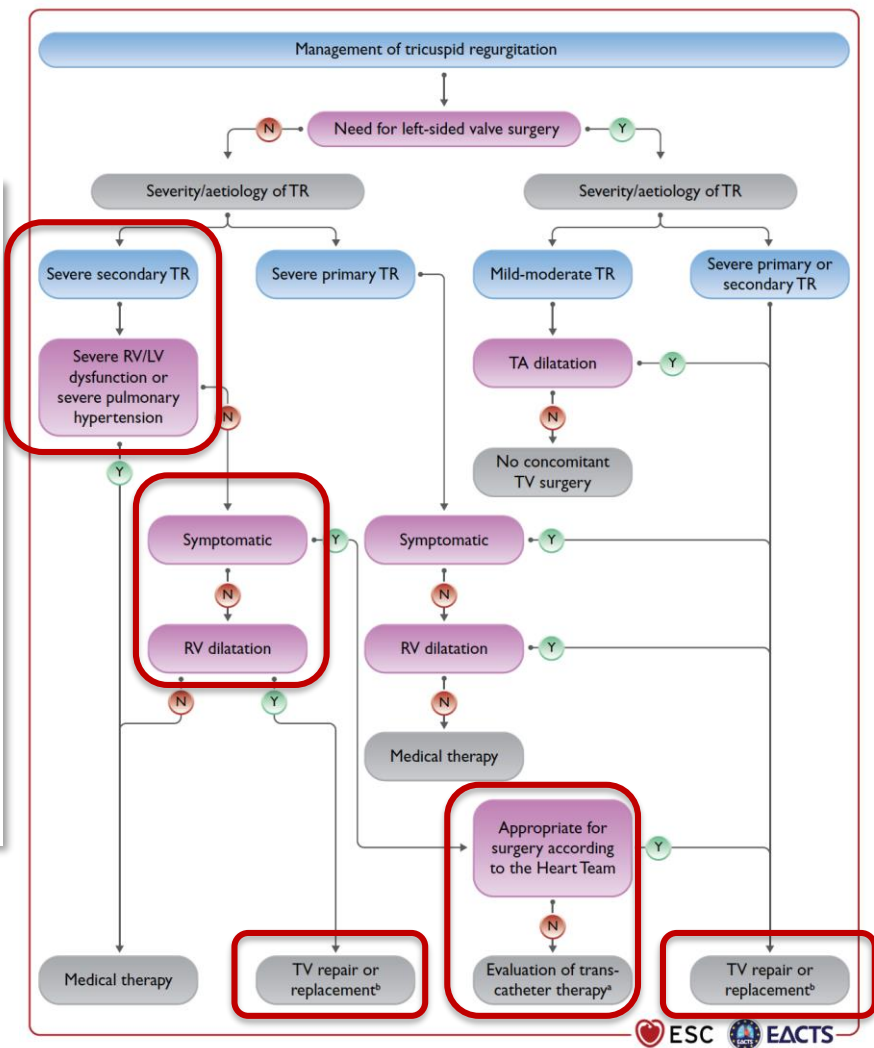


Indications for TV interventions

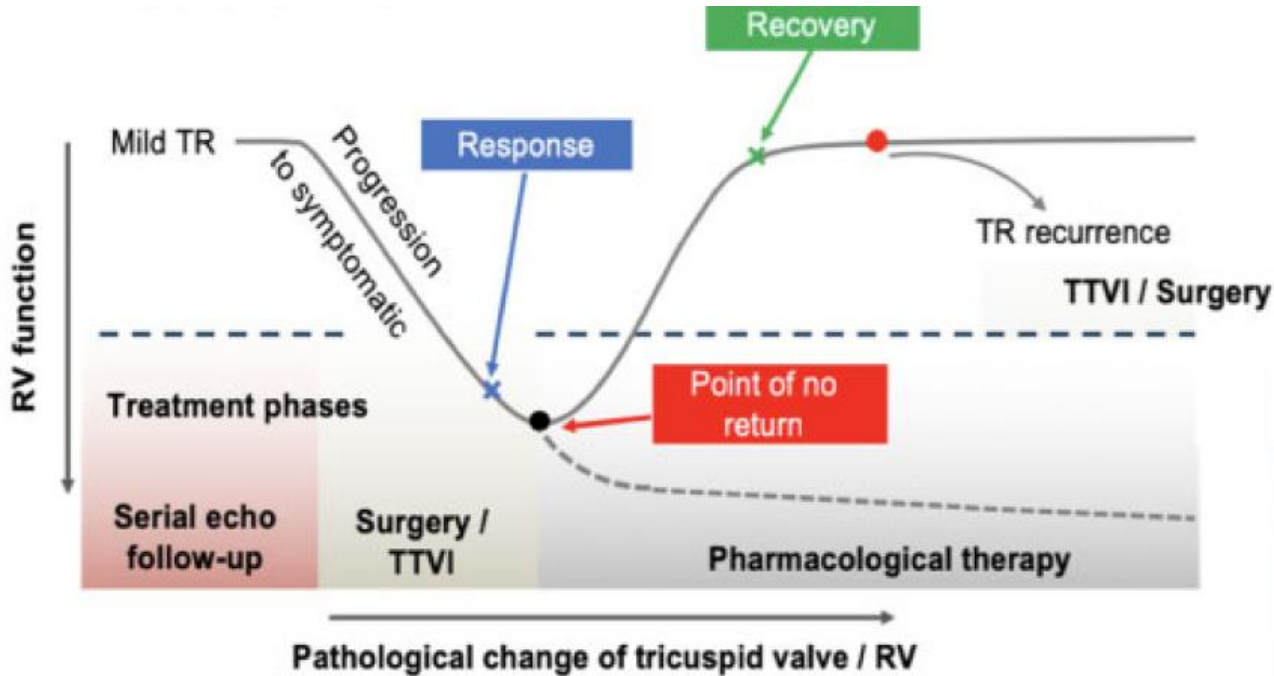
2021 ESC/EACTS Guidelines for the management of valvular heart disease

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Authors/Task Force Members: Alec Vahanian * (ESC Chairperson) (France), Friedhelm Beyersdorf¹ (EACTS Chairperson) (Germany), Fabien Praz (ESC Task Force Coordinator) (Switzerland), Milan Milojevic¹ (EACTS Task Force Coordinator) (Serbia), Stephan Baldus (Germany), Johann Bauersachs (Germany), Davide Capodanno (Italy), Lenard Conradi¹ (Germany), Michele De Bonis¹ (Italy), Ruggero De Paulis¹ (Italy), Victoria Delgado (Netherlands), Nick Freemantle¹ (United Kingdom), Martine Gilard (France), Kristina H. Haugaa (Norway), Anders Jeppsson¹ (Sweden), Peter Jüni (Canada), Luc Pierard (Belgium), Bernard D. Prendergast (United Kingdom), J. Rafael Sádaba¹ (Spain), Christophe Tribouilloy (France), Wojtek Wojakowski (Poland), ESC/EACTS Scientific Document Group



Clinical course of TR & Late presentation



- Limited time window
- Aspecific symptoms
- Low awareness

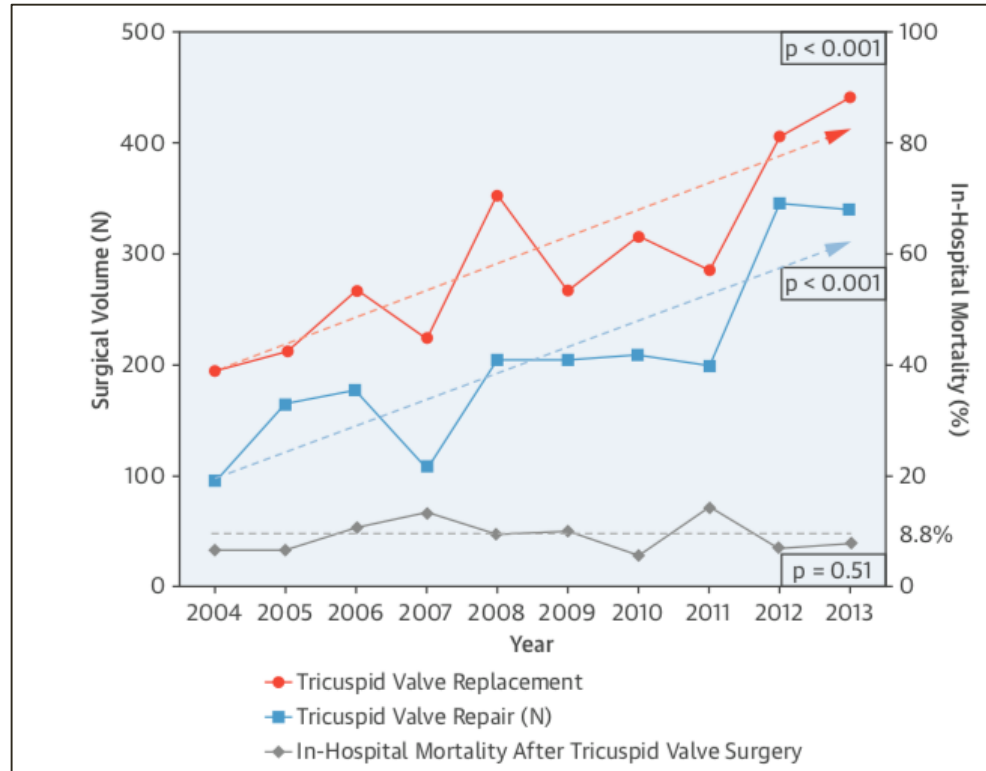
Treatment of patients with tricuspid regurgitation

Medical therapy is very limited and possibly ineffective



Surgery is burdened by a high intra-operative risk

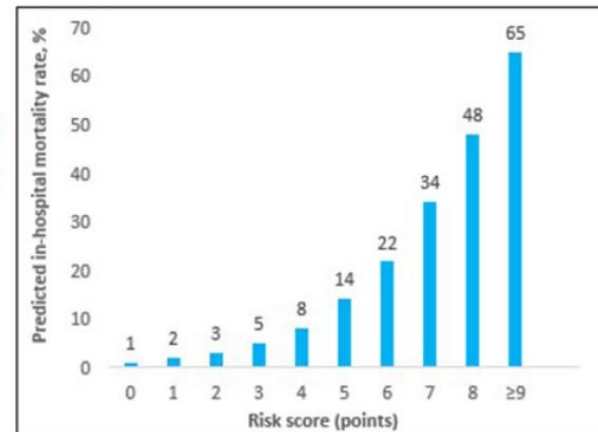
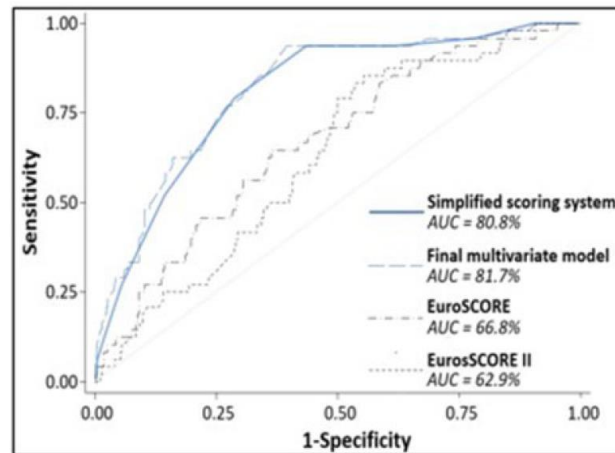
Surgery for isolated tricuspid regurgitation



Zack et al JACC 2017; 70 (24)

TRI-SCORE: a new risk score for in-hospital mortality prediction after isolated tricuspid valve surgery

Julien Dreyfus ^{1,*†}, Etienne Audureau^{2,3,†}, Yohann Bohbot^{4,5},
 Augustin Coisne ^{6,7}, Yoan Lavie-Badie ⁸, Maxime Bouchery⁹,
 Michele Flagiello ¹⁰, Baptiste Bazire ¹¹, Florian Eggenspieler¹²,
 Florence Viau¹³, Elisabeth Riant ^{1,14}, Yannick Mbaki¹⁵, Damien Eyharts ⁸,
 Thomas Senage¹⁶, Thomas Modine⁶, Martin Nicol ¹, Fabien Doguet ^{17,18},
 Virginia Nguyen¹, Thierry Le Tourneau¹⁹, Christophe Tribouilloy ^{4,5},
 Erwan Donal ¹⁵, Jacques Tomasi ²⁰, Gilbert Habib ^{13,21},
 Christine Selton-Suty ¹², Richard Raffoul²², Bernard Lung ²³,
 Jean-François Obadia ¹⁰, and David Messika-Zeitoun ^{24*}



N=466

In-hospital mortality=10%

Mean age 60 years

Risk factors (final model from multivariate analysis)	Scoring
Age ≥ 70 years	1
NYHA functional class III-IV	1
Right-sided heart failure signs	2
Daily dose of furosemide ≥ 125mg	2
Glomerular filtration rate < 30 ml/min	2
Elevated total bilirubin	2
Left ventricular ejection fraction < 60%	1
Moderate/severe right ventricular dysfunction	1
Total	12

Treatment of patients with tricuspid regurgitation

Medical therapy is very limited and possibly ineffective



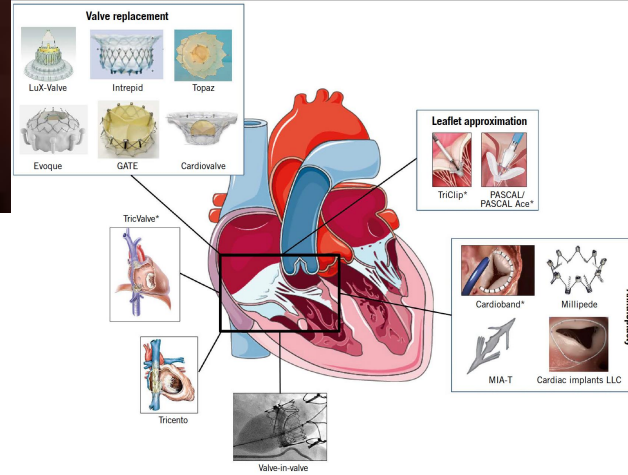
Surgery is burdened by a high intra-operative risk

Transcatheter TV intervention to fill an unmet need

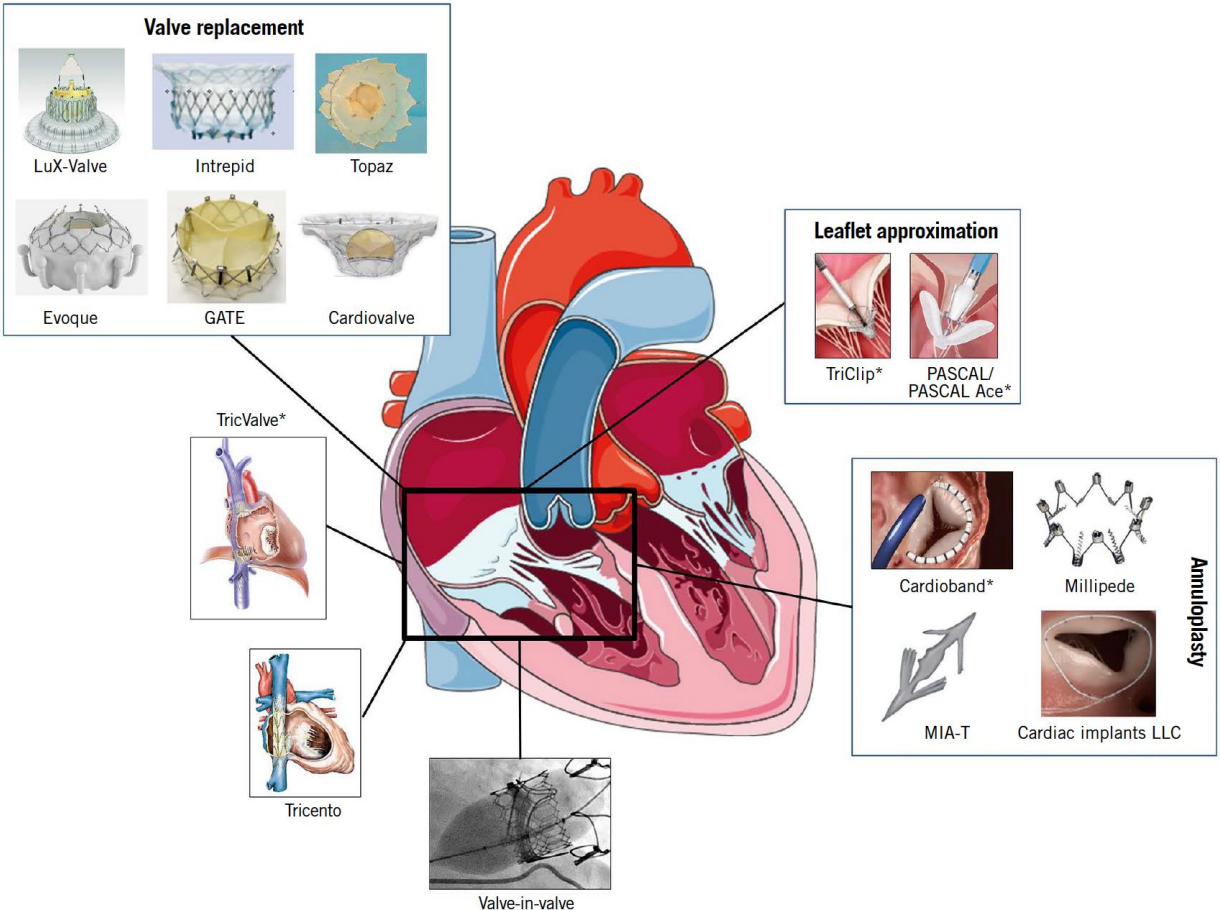
Medical therapy is very limited and possibly ineffective



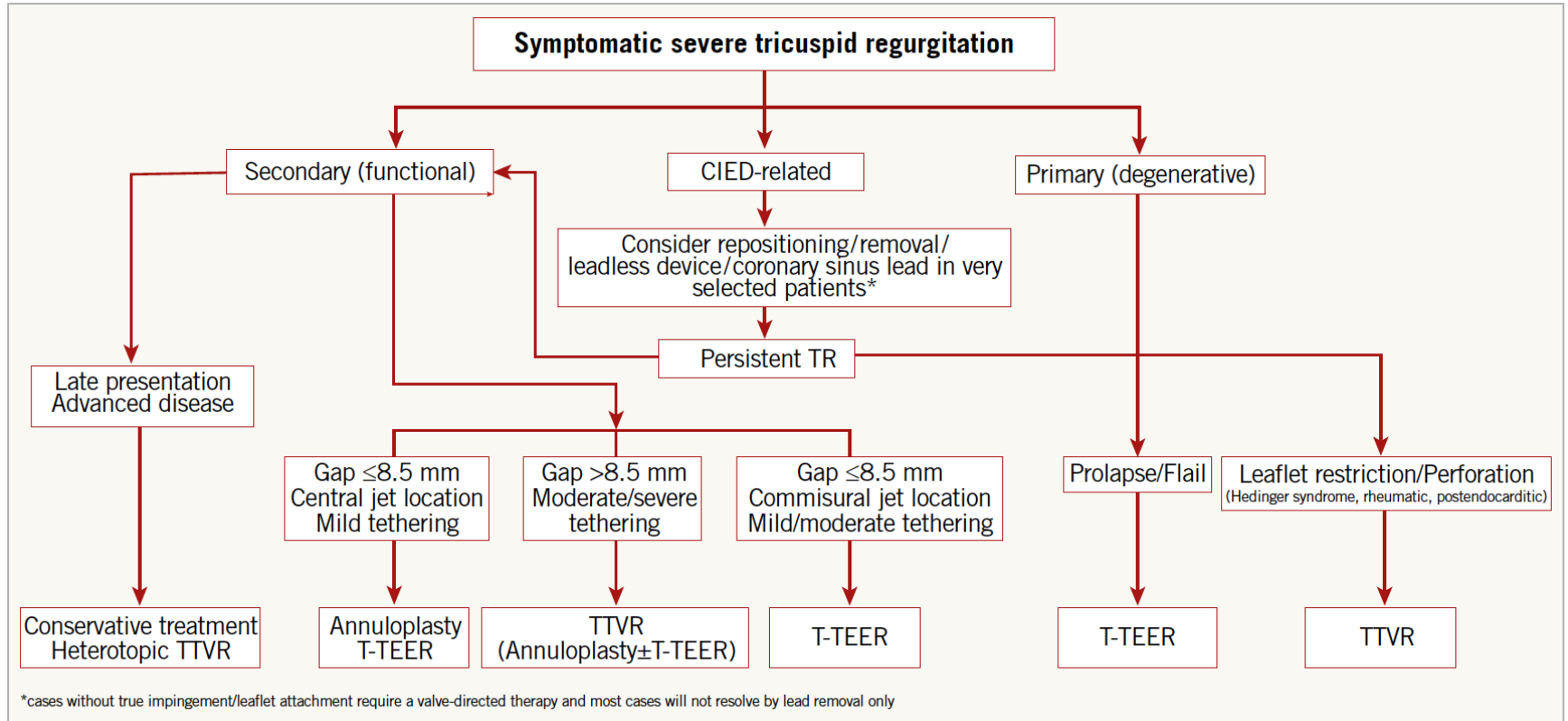
Surgery is burdened by a high intra-operative risk



Transcatheter devices for TR



Selection of transcatheter devices for TR



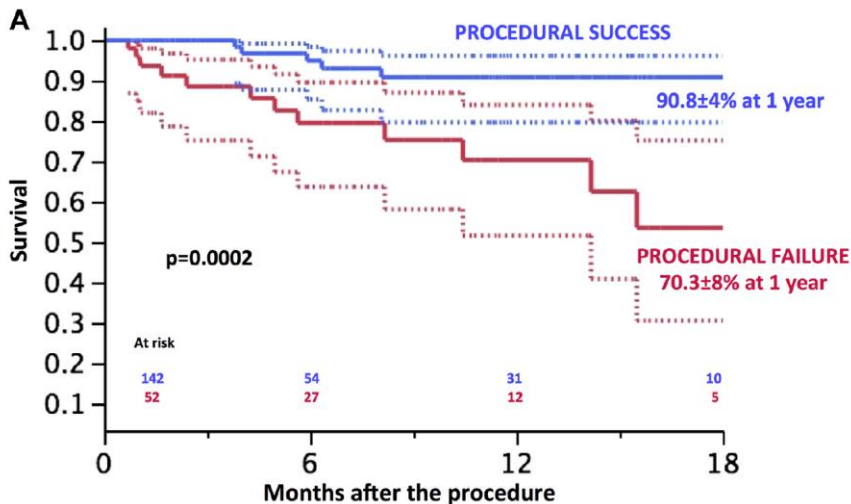
Outcomes After Current Transcatheter Tricuspid Valve Intervention



Mid-Term Results From the International TriValve Registry

Maurizio Taramasso, MD, PhD,^a Hannes Alessandrini, MD,^b Azeem Latib, MD,^c Masahiko Asami, MD,^d Adrian Attinger-Toller, MD,^e Luigi Biasco, MD,^f Daniel Braun, MD,^g Eric Brochet, MD,^h Kim A. Connelly, MD,ⁱ Paolo Denti, MD,^c Florian Deuschl, MD,^j Andrea Englmeier, MD,^g Neil Fam, MD,ⁱ Christian Frerker, MD,^b Jörg Hausleiter, MD,^g Dominique Himbert, MD,^h Edwin C. Ho, MD,^{a,j} Jean-Michel Juliard, MD,^h Ryan Kaple, MD,^k Felix Kreidel, MD,^b Karl-Heinz Kuck, MD,^b Marco Ancona, MD,^c Alexander Lauten, MD,^l Philipp Lurz, MD,^m Michael Mehr, MD,^g Tamin Nazif, MD,ⁿ Georg Nickening, MD,^o Giovanni Pedrazzini, MD,^f Alberto Pozzoli, MD,^a Fabien Praz, MD,^q Rishi Puri, MD,^p Josep Rodés-Cabau, MD,^p Ulrich Schäfer, MD,^l Joachim Schofer, MD,^q Horst Sievert, MD,^r Kolja Sievert, MD,^r Gilbert H.L. Tang, MD, MSc, MBA,^s Felix C. Tanner, MD,^a Alec Vahanian, MD,^h John G. Webb, MD,^e Stephan Windecker, MD,^d Ermela Yzeiray, MD,^q Michel Zuber, MD,^a Francesco Maisano, MD,^a Martin B. Leon, MD,ⁿ Rebecca T. Hahn, MDⁿ

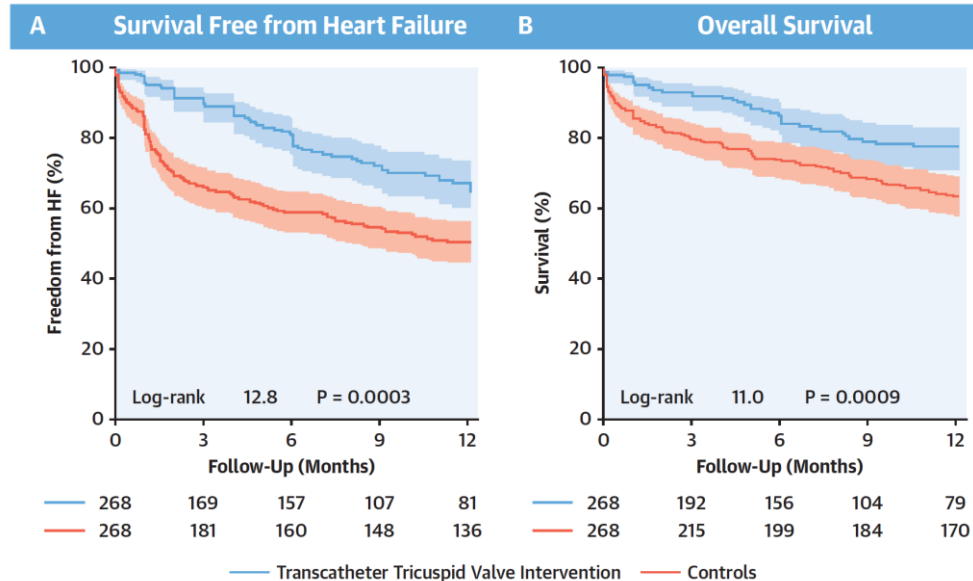
PROCEDURAL SUCCESS
reduction in at least 1 TR degree



Transcatheter Versus Medical Treatment of Patients With Symptomatic Severe Tricuspid Regurgitation



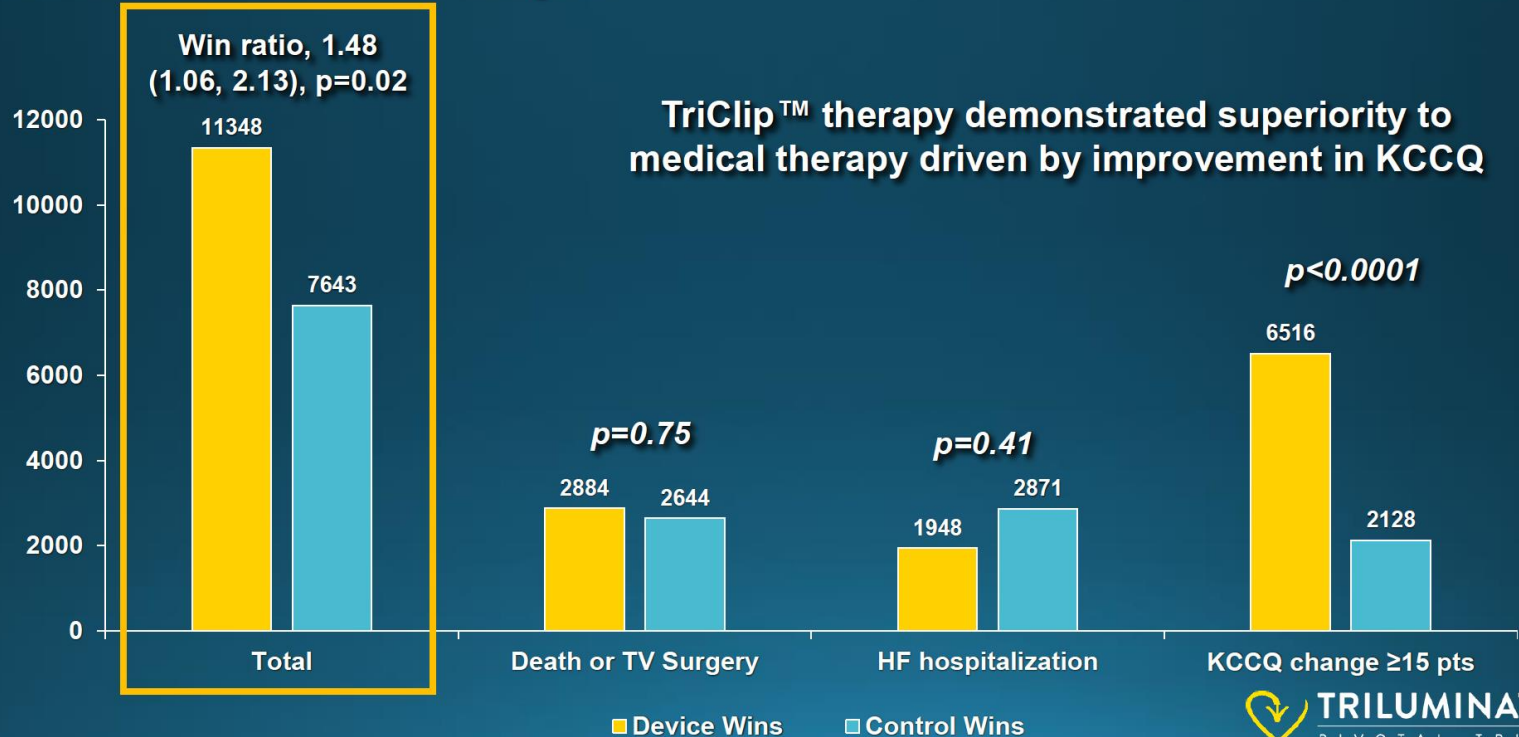
*TRIVALVE
versus
control cohort*



TRILUMINATE-PIVOTAL RCT

Primary Endpoint

Finkelstein-Schoenfeld Analysis



TRILUMINATE-PIVOTAL RCT

Safety Profile

Major Adverse Event (MAE) Through 30 Days Post-Procedure – no.(%)	Device N=172†
Total	3 (1.7%)
Cardiovascular mortality	1 (0.6%)
Endocarditis requiring surgery	0 (0%)
New-onset renal failure	2 (1.2%)
Non-elective CV Surgery, TVRS for device-related AE	0 (0%)

Other Clinical Safety Endpoints Through 30 Days Post-Procedure– no.(%)	Device N=172†
Any-cause mortality	1 (0.6%)
Tricuspid valve surgery	1 (0.6%)
Tricuspid valve re-intervention	3 (1.7%)
Major bleeding [#]	8 (4.7%)
Tricuspid mean gradient \geq 5mmHg	8 (4.7%)
Single leaflet device attachment (SLDA)*	12 (7.0%)
Stroke	1 (0.6%)
Myocardial Infarction	0 (0%)
Embolization*	0 (0%)
Thrombosis	0 (0%)
New CRT/CRT-D/ICD/perm. pacemaker [^]	1 (0.6%)

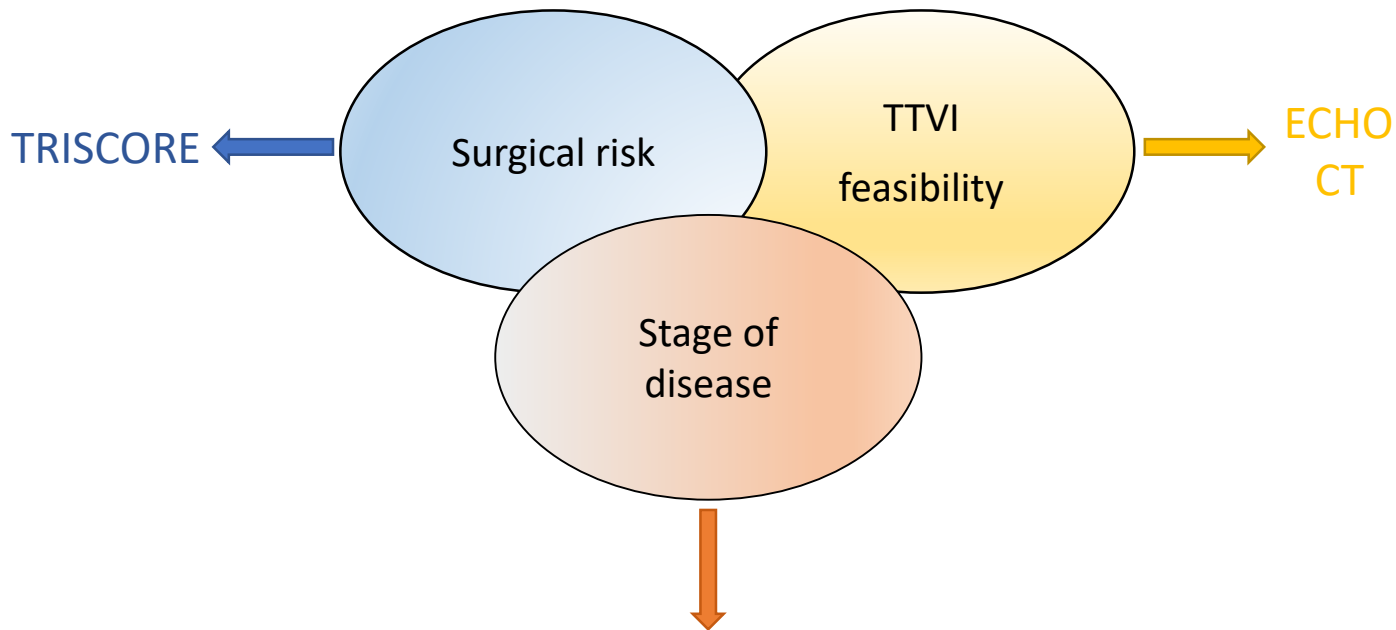
†Attempted procedure population (3 subjects randomized to Device withdrew consent prior to index procedure)

[#]Defined as bleeding \geq Type 3 based on a modified Bleeding Academic Research Consortium (BARC) definition

*SLDA and embolization evaluated through 30-day follow-up

[^]Assessed through adverse event reporting

Patient selection for treatment of isolated TR



- 1) Right ventricular function (global evaluation)
- 2) Congestion/organ damage (renal and hepatic markers)
- 3) Pulmonary hypertension (RHC)

Right ventricular function (global evaluation)

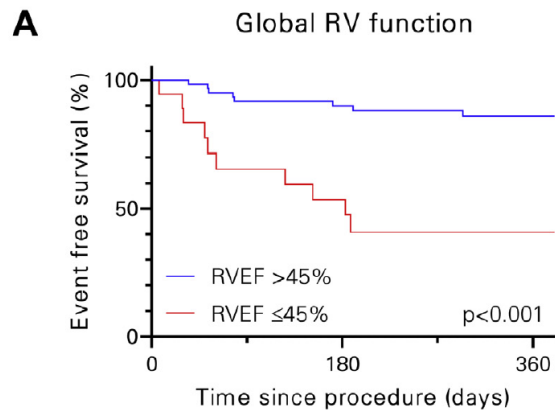
JACC: CARDIOVASCULAR INTERVENTIONS
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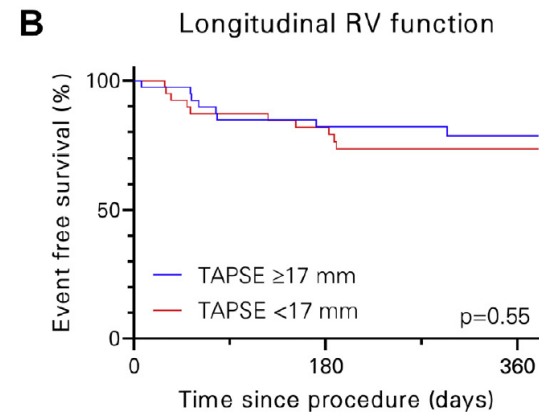
Right Ventricular Contraction Patterns in Patients Undergoing Transcatheter Tricuspid Valve Repair for Severe Tricuspid Regurgitation



Karl-Patrik Kresoja, MD,^a Karl-Philipp Rommel, MD,^a Christian Lücke, MD,^b Matthias Unterhuber, MD,^a Christian Besler, MD,^a Maximilian von Roeder, MD,^a Anne Rebecca Schöber, MD,^a Thilo Noack, MD,^c Matthias Gutberlet, MD,^b Holger Thiele, MD,^{a,*} Philipp Lurz, MD, PhD^{a,**}



No. at risk	RVEF >45 %	61	52	31
	RVEF ≤45 %	18	9	4



No. at risk	TAPSE ≥17 mm	39	31	21
	TAPSE <17 mm	40	30	19

Congestion/organ damage

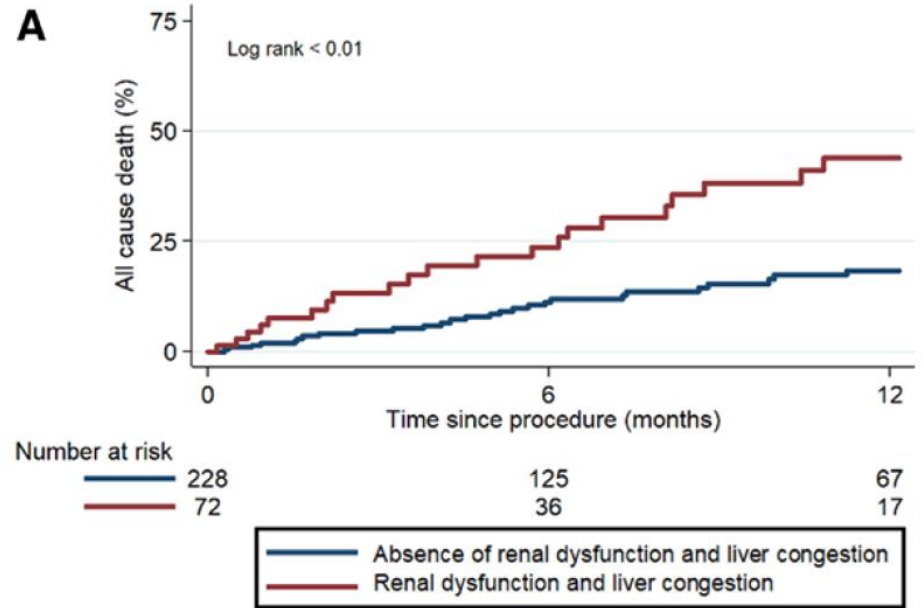
Circulation: Cardiovascular Interventions

ORIGINAL ARTICLE

Transcatheter Tricuspid Valve Intervention in Patients With Right Ventricular Dysfunction or Pulmonary Hypertension

Insights From the TriValve Registry

A



Muntané-Carol et al. Circ Cardiovasc Interv. 2021;14(2):e009685

Pulmonary hypertension (RHC)

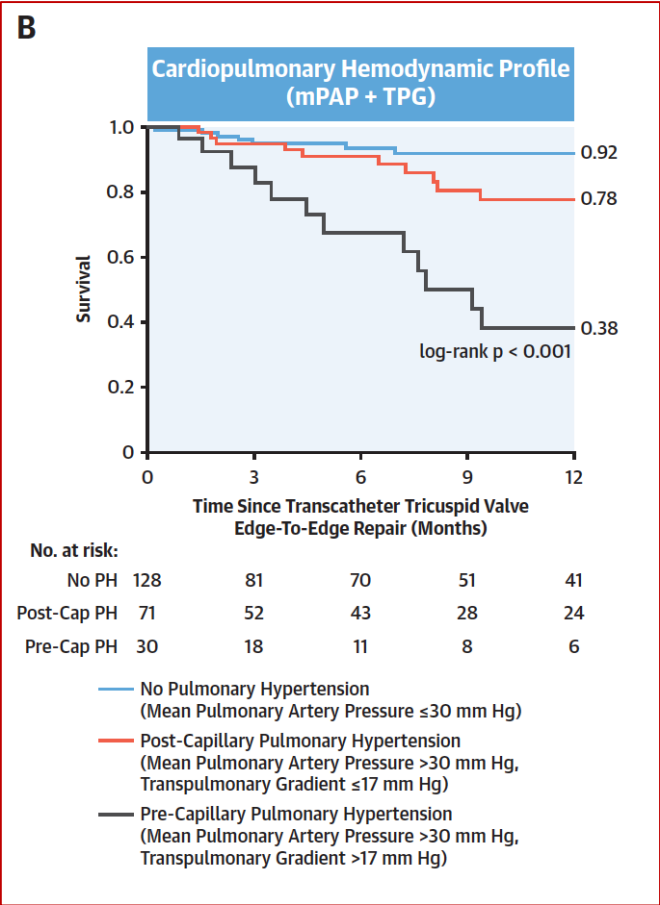
JACC: CARDIOVASCULAR INTERVENTIONS
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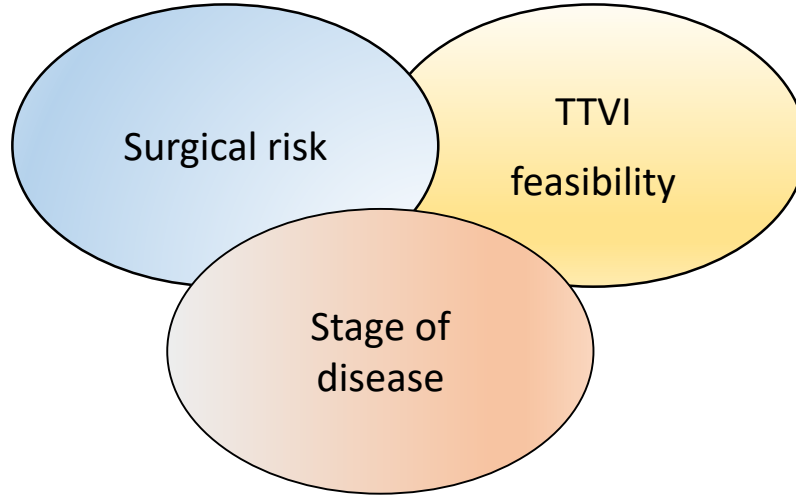
Cardiopulmonary Hemodynamic Profile Predicts Mortality After Transcatheter Tricuspid Valve Repair in Chronic Heart Failure



Thomas J. Stocker, MD,^{a,b} Helene Hertell,^{a,b} Mathias Orban, MD,^{a,b} Daniel Braun, MD,^{a,b} Karl-Philipp Rommel, MD,^c Tobias Ruf, MD,^d Geraldine Ong, MD,^e Michael Nabauer, MD,^{a,b} Simon Deseive, MD,^{a,b} Neil Fam, MD,^e Ralph S. von Bardeleben,^d Holger Thiele, MD,^c Steffen Massberg, MD,^{a,b} Philipp Lurz, MD, PhD,^{c,*} Jörg Hausleiter, MD^{a,b,*}



Patient selection for TR treatment



No/mild RV dysfunction
Mild symptoms
Severe TR
Fluctuant TR

Moderate RV dysfunction
RHF signs and symptoms
Impaired QoL
Massive TR

Severe RV Dysfunction
Precapillary PH, Low CO
Cachexia
Torrential TR

