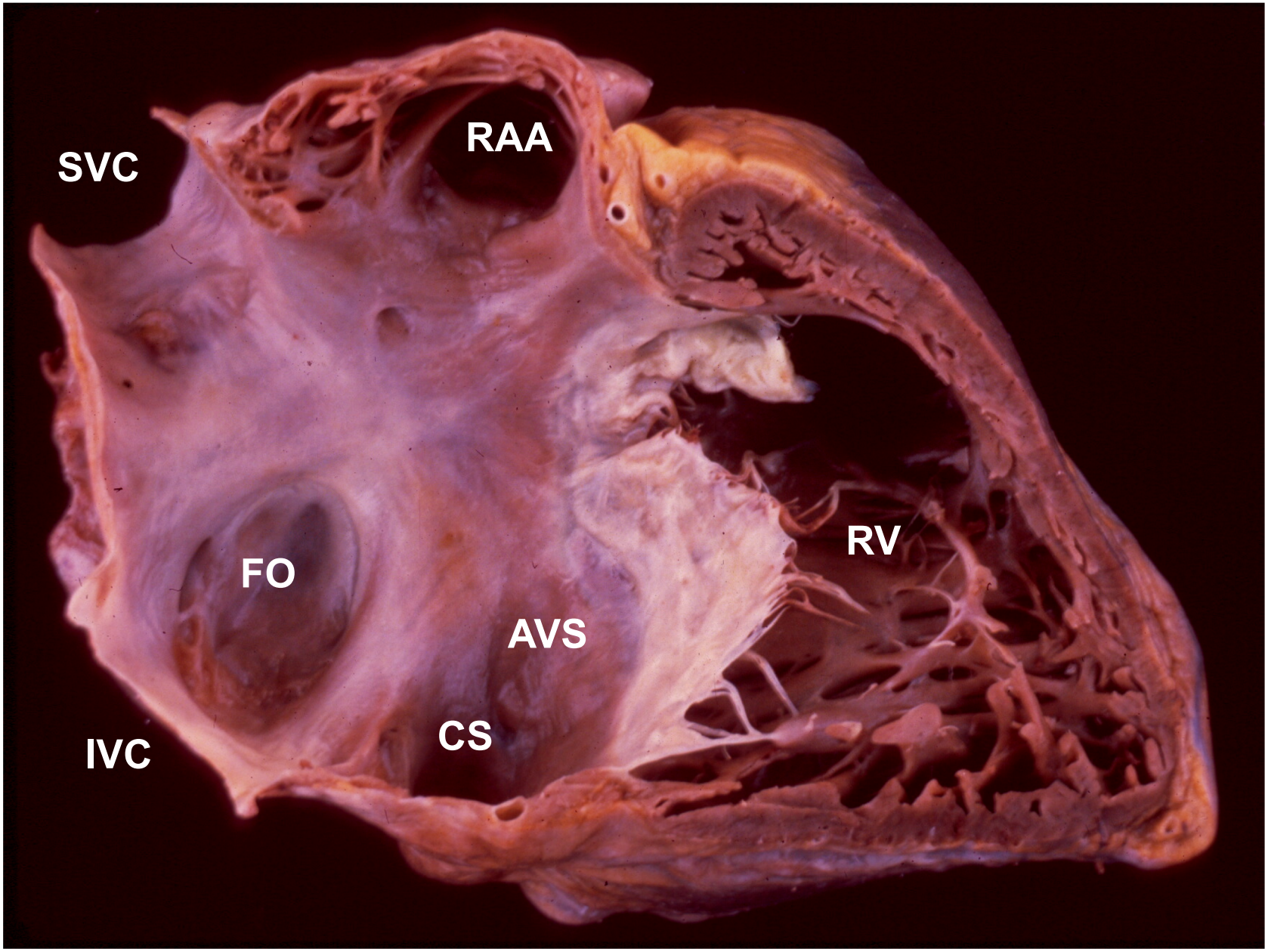
/ Tricuspid Regurgitation /

Etiologies / Grading / Management

Benjamin Essayagh, MD
Cannes Hospital, FR / Mayo Clinic, Rochester, MN

No disclosures



MAYO CLINIC

3.8.3. Management

Class I

1. **Tricuspid valve repair is beneficial for severe TR in patients with MV disease requiring MV surgery.** ***(Level of Evidence: B)***

Class IIa

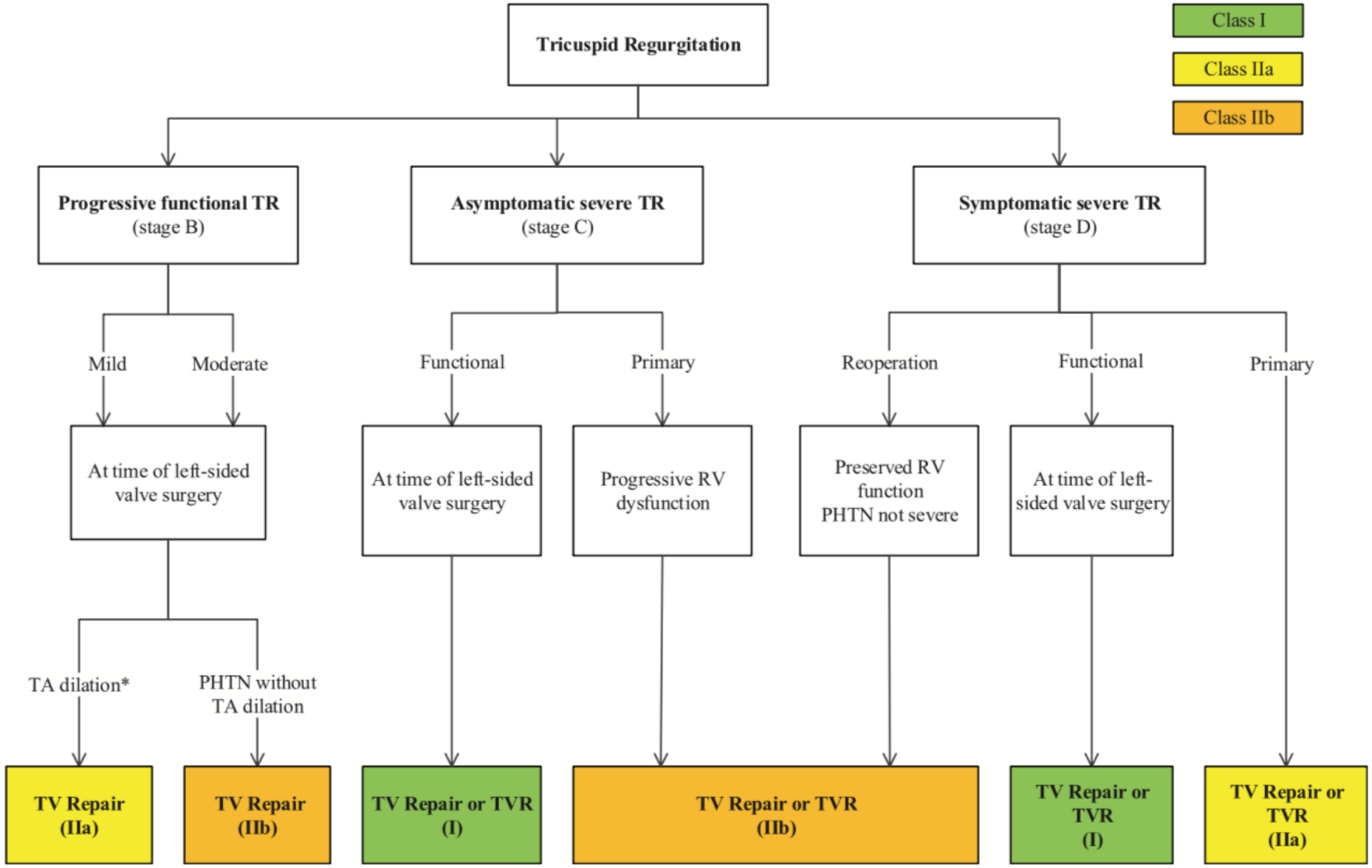
1. **Tricuspid valve replacement or annuloplasty is reasonable for severe primary TR when symptomatic.** ***(Level of Evidence: C)***
2. **Tricuspid valve replacement is reasonable for severe TR secondary to diseased/abnormal tricuspid valve leaflets not amenable to annuloplasty or repair.** ***(Level of Evidence: C)***

Class IIb

1. **Tricuspid annuloplasty may be considered for less than severe TR in patients undergoing MV surgery when there is pulmonary hypertension or tricuspid annular dilatation.** ***(Level of Evidence: C)***

Class III

1. **Tricuspid valve replacement or annuloplasty is not indicated in asymptomatic patients with TR whose pulmonary artery systolic pressure is less than 60 mm Hg in the presence of a normal MV.** ***(Level of Evidence: C)***
2. **Tricuspid valve replacement or annuloplasty is not indicated in patients with mild primary TR.** ***(Level of Evidence: C)***



/ What is the burden of tricuspid regurgitation? /

MAYO CLINIC

HÔPITAL DE CANNES

Prevalence and Clinical Determinants of Mitral, Tricuspid, and Aortic Regurgitation (The Framingham Heart Study)

Jagmeet P. Singh, MD, DPhil, Jane C. Evans, MPH, Daniel Levy, MD, Martin G. Larson, ScD, Lisa A. Freed, MD, Deborah L. Fuller, RDCS, Birgitta Lehman, RDCS, and Emelia J. Benjamin, MD, ScM

TABLE IIa Prevalence of Valvular Regurgitation Stratified by Age and Severity in Men

	Age (yr)				
	26–39	40–49	50–59	60–69	70–83
Tricuspid regurgitation	(n = 77)	(n = 289)	(n = 320)	(n = 260)	(n = 66)
None (%)	14.3	17.8	19.0	18.3	16.7
Trace (%)	72.7	72.5	71.5	59.8	47.0
Mild (%)	13.0	9.4	9.2	21.9	25.8
≥Moderate (%)	0.0	0.3	0.3	0.0	1.5

MEN

e of Valvular Regurgitation Stratified by Age and Severity in

	Age (yr)				
	26–39	40–49	50–59	60–69	70–83
	(n = 84)	(n = 371)	(n = 414)	(n = 300)	(n = 71)
	20.5	16.0	14.5	10.4	14.1
	65.1	70.0	70.7	62.2	56.4
	13.2	13.5	14.1	25.7	23.9
	1.2	0.5	0.7	1.7	5.6

WOMEN

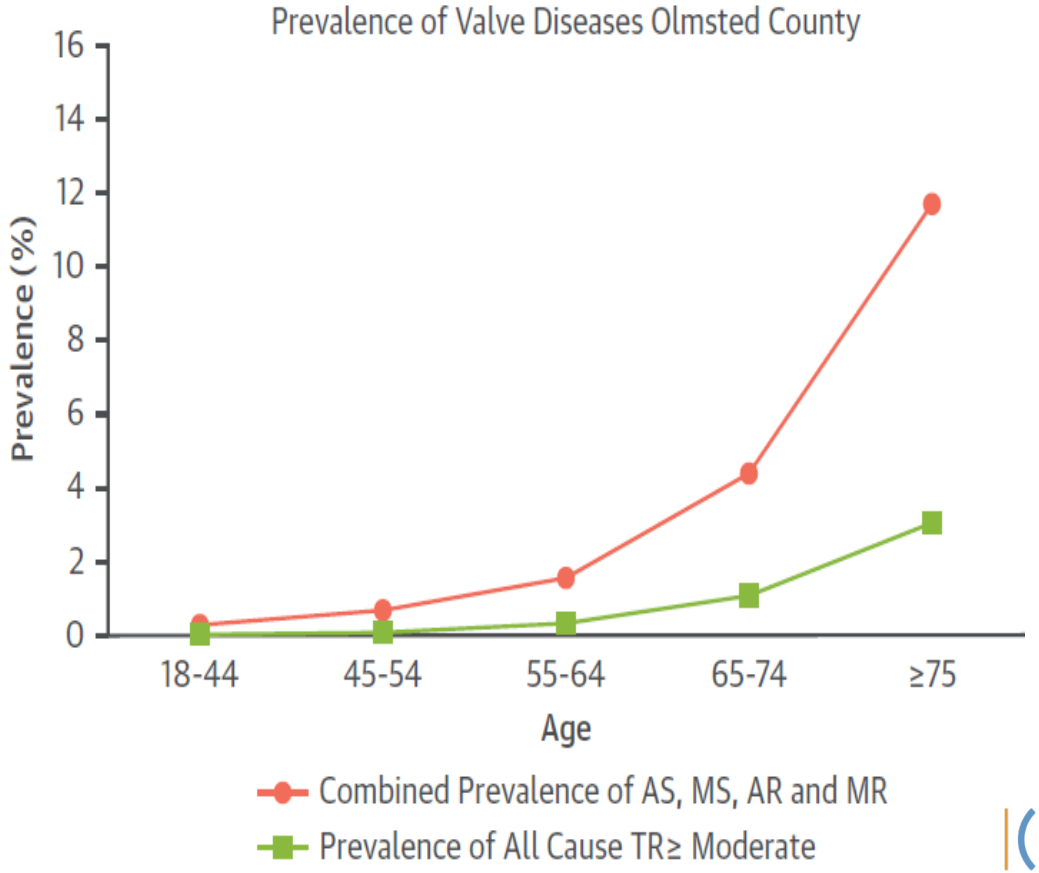
JACC: CARDIOVASCULAR IMAGING VOL. ■, NO. ■, 2018

PUBLISHED BY ELSEVIER

Burden of Tricuspid Regurgitation in Patients Diagnosed in the Community Setting

Yan Topilsky, MD,[a] Simon Maltais, MD,[b] Jose Medina Inojosa, MD,[c] Didem Oguz, MD,[c] Hector Michelena, MD,[c] Joseph Maalouf, MD,[c] Douglas W. Mahoney, MSc,[d] Maurice Enriquez-Sarano, MD[c]

Sex	Age Adjusted U.S. Burden
Female	0.59 (0.52-0.67)
Male	0.47 (0.39-0.55)
Overall	0.55 (0.50-0.60)



Tricuspid regurgitation

What is the National Burden of moderate/severe TR ?

1.6 Million US citizens

3 Million EU citizens

Tricuspid regurgitation

What is the incidence of moderate/severe TR ?

≥ 160,000 new cases/year

Yearly mortality ≥10%

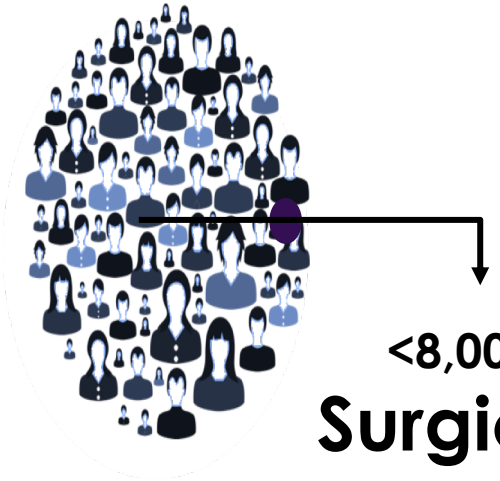
MAYO CLINIC

HÔPITAL DE CANNES

Tricuspid regurgitation is frequent but rarely treated

USA: 1.6M

Moderate to severe TR prevalence



<8,000

Surgical procedures annually

Burden of Tricuspid Regurgitation in Patients Diagnosed in the Community Setting

Patients ever treated by Tricuspid Valve Surgery 2.4%

MAYO CLINIC

HÔPITAL DE CANNES

/ Why is TR management so vague and poorly defined ? /

MAYO CLINIC

HÔPITAL DE CANNES

Tricuspid Regurgitation Uncertain management

Reason #1

Heterogeneity

A buffet of strange etiologies

MAYO CLINIC

HÔPITAL DE CANNES

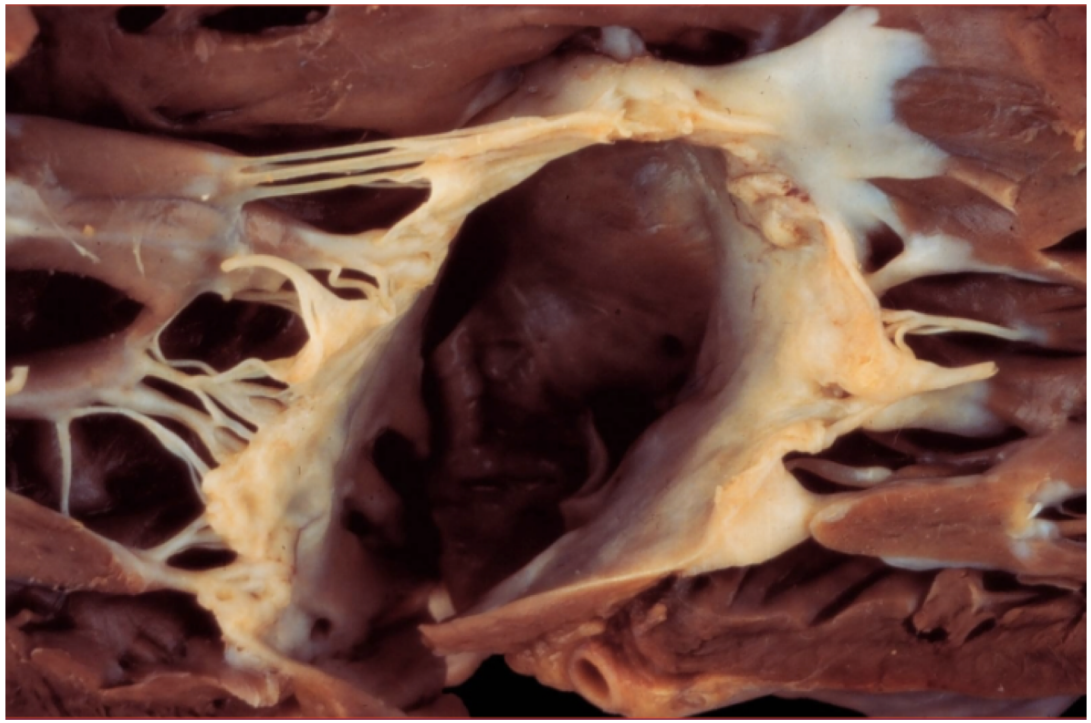
Tricuspid Regurgitation

Rheumatic Valve Disease

Surgical Specimen

Tricuspid Regurgitation

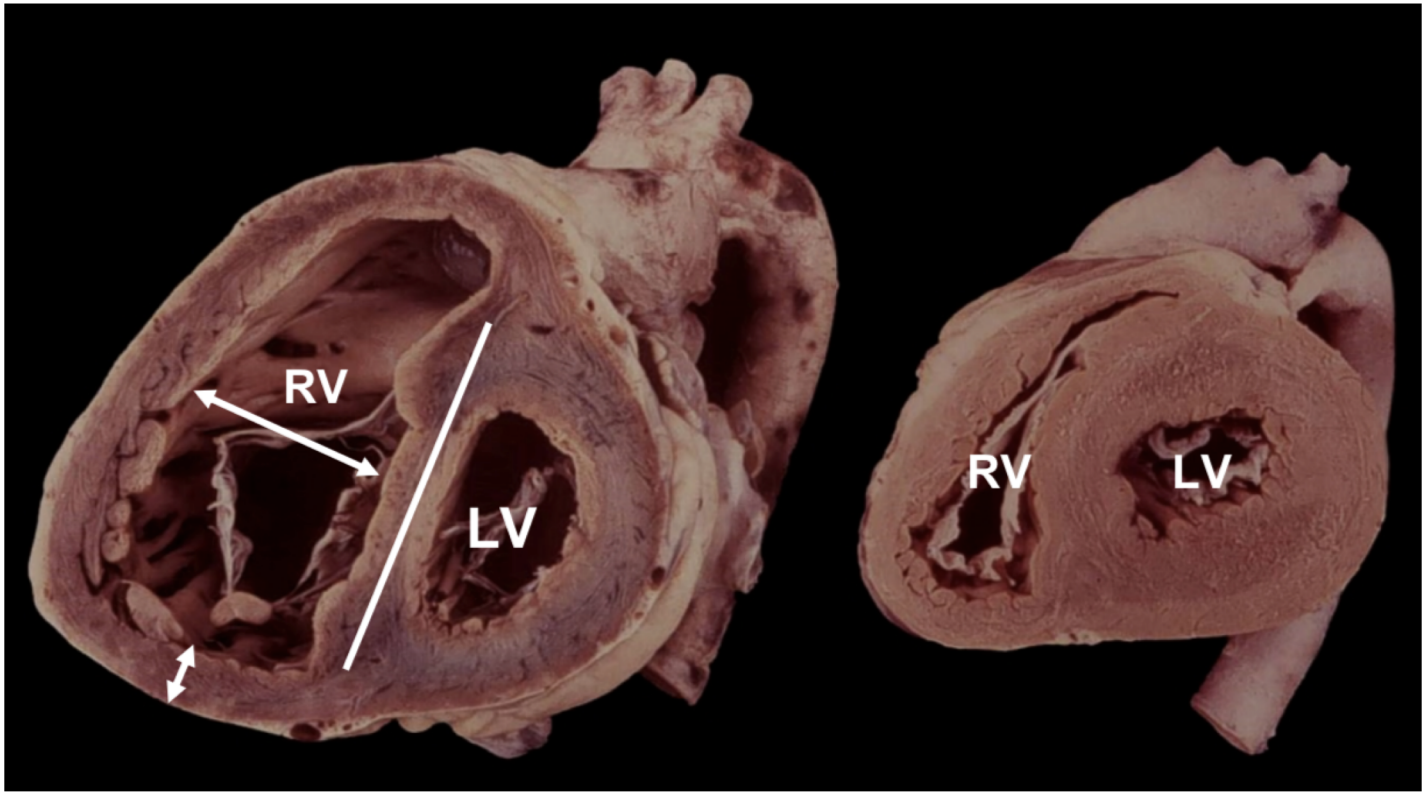
Carcinoid Heart Disease



Autopsy Specimen (from RV Apex)

Tricuspid Regurgitation

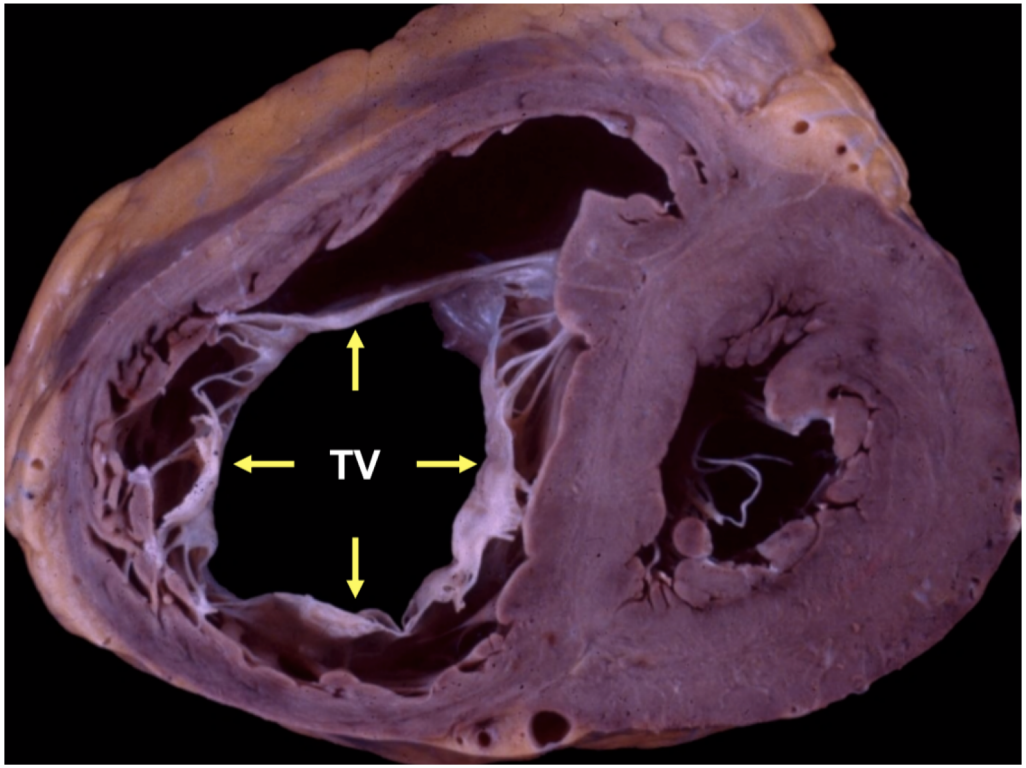
Pulmonary Hypertension



Autopsy Specimen

Tricuspid Regurgitation

Dilated annulus



Autopsy Specimen

MAYO CLINIC

HÔPITAL DE CANNES

JACC: CARDIOVASCULAR IMAGING

PUBLISHED BY ELSEVIER

Burden of Tricu
in Pati

FIGURE 3 Distri nity

Challenge #1

TR is Heterogenious

Identifying TR etiology is crucial

				ated With LV Systolic Dysfunction (n = 141)	Associated With PHTN (n = 252)	Isolated (n = 89)
Age			79 ± 11¶	76 ± 12¶	75 ± 12¶	75 ± 15¶
Fema		52	63§‖¶	40*‡‖	74‡§	72‡§
BMI, kg	25.6 ± 6	24.1 ± 6	25.6 ± 15	26.2 ± 6	28.8 ± 6	24.7 ± 6
AF	39*†‡§‖	58¶	65¶	63¶	68¶	68¶

Why is TR management so vague and poorly defined ?

Reason #2

Grading Uncertainty

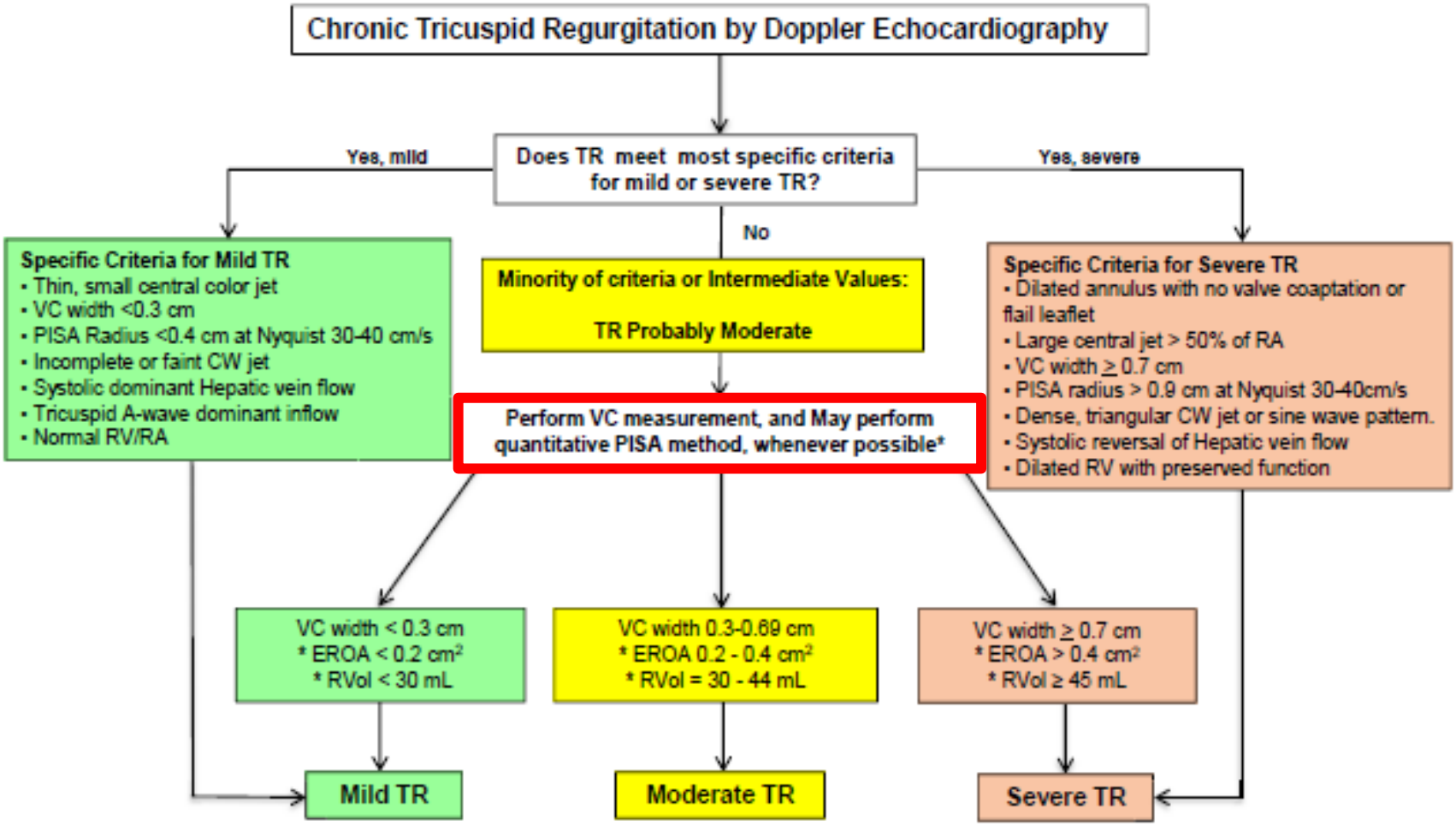
Assessment of TR severity is difficult

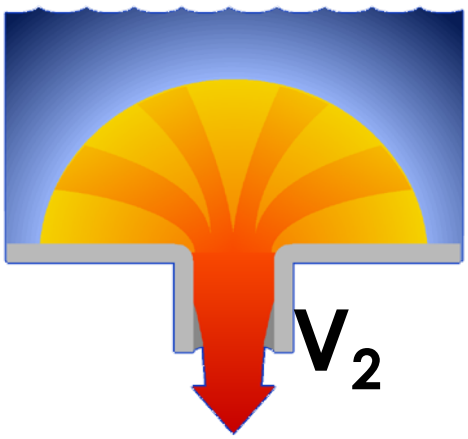
ASE GUIDELINES AND STANDARDS

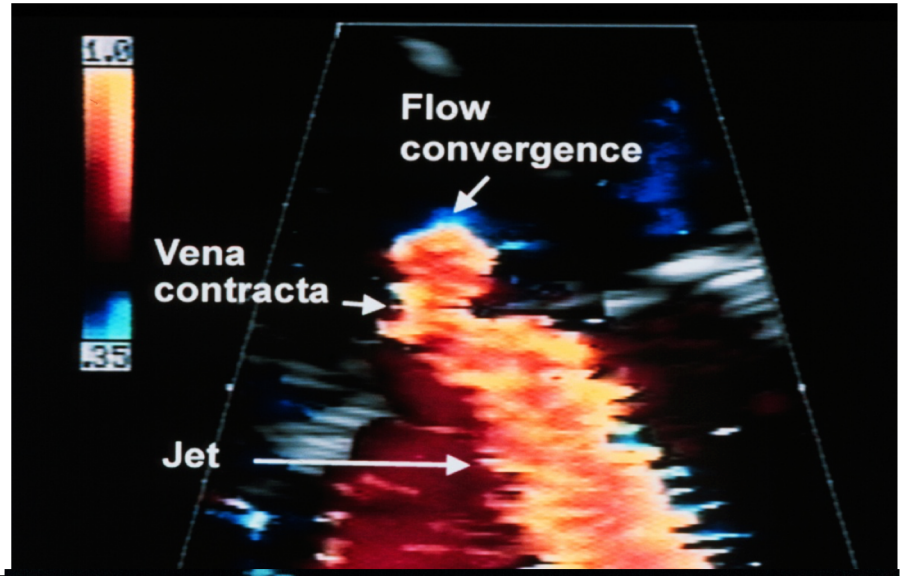
Recommendations for Noninvasive Evaluation of Native Valvular Regurgitation

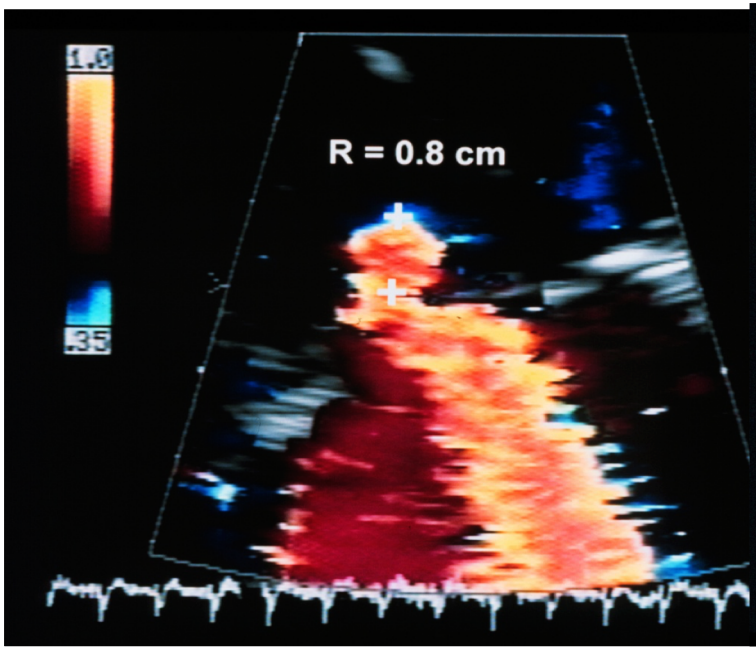
A Report from the American Society of Echocardiography Developed in Collaboration with the Society for Cardiovascular Magnetic Resonance

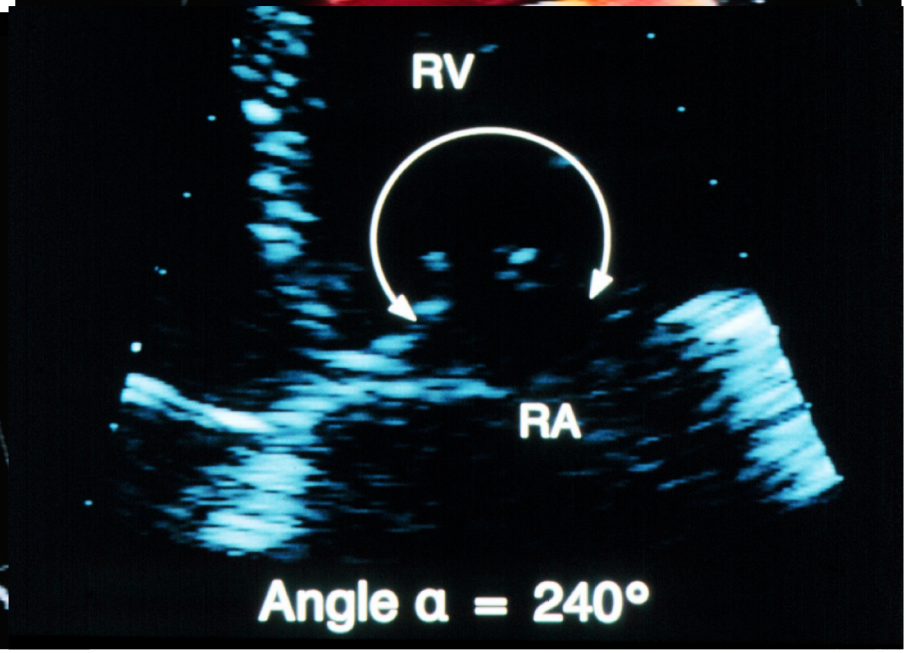
William A. Zoghbi, MD, FASE (Chair), David Adams, RCS, RDCS, FASE, Robert O. Bonow, MD, Maurice Enriquez-Sarano, MD, Elyse Foster, MD, FASE, Paul A. Grayburn, MD, FASE, Rebecca T. Hahn, MD, FASE, Yuchi Han, MD, MMSc,* Judy Hung, MD, FASE, Roberto M. Lang, MD, FASE, Stephen H. Little, MD, FASE, Dipan J. Shah, MD, MMSc,* Stanton Shernan, MD, FASE, Paaladinesh Thavendiranathan, MD, MSc, FASE,* James D. Thomas, MD, FASE, and Neil J. Weissman, MD, FASE, *Houston and Dallas, Texas; Durham, North Carolina; Chicago, Illinois; Rochester, Minnesota; San Francisco, California; New York, New York; Philadelphia, Pennsylvania; Boston, Massachusetts; Toronto, Ontario, Canada; and Washington, DC*

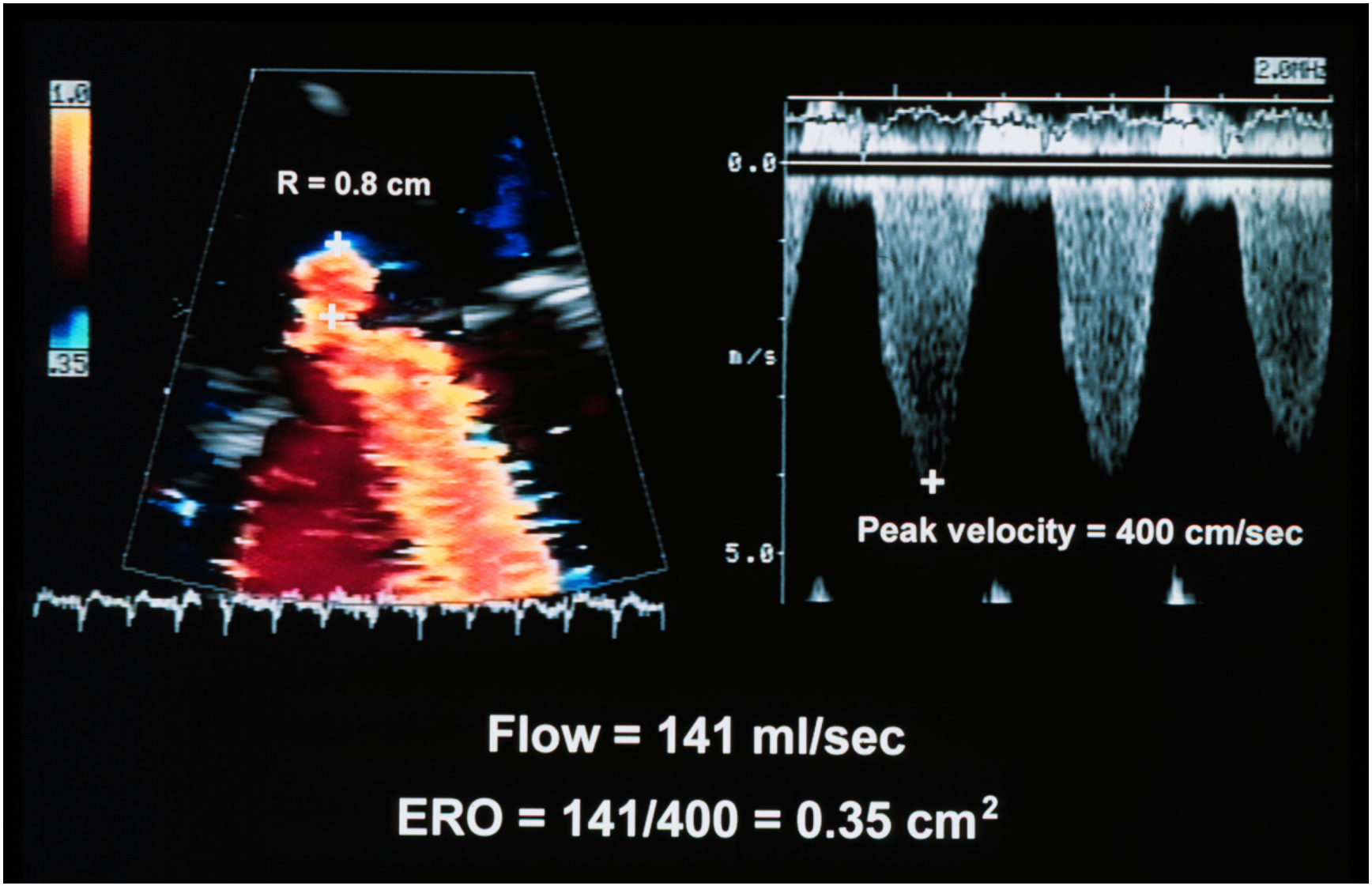








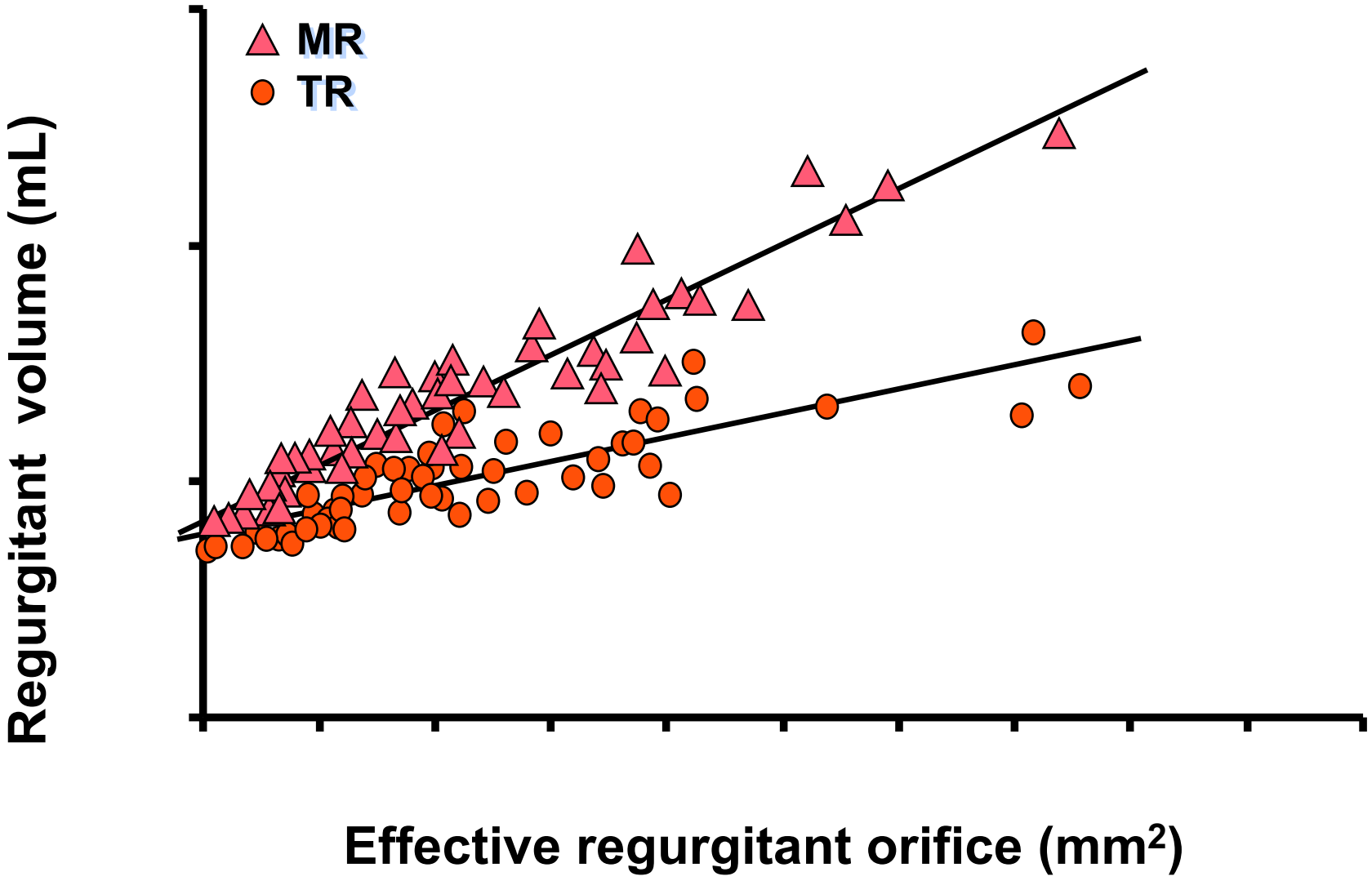




MAYO CLINIC

HÔPITAL DE CANNES

Comparison MR-TR



MAYO CLINIC

Quantification of Regurgitations Criteria for Severe Regurgitation

	AR	MR	TR
ERO (mm2)	30	40	40
Rvol (mL)	60	60	45

TR Severity Assessment

ESC European Society of Cardiology

European Heart Journal - Cardiovascular Imaging (2017) **18**, 1342–1343
doi:10.1093/ehjci/jex139

EDITORIAL

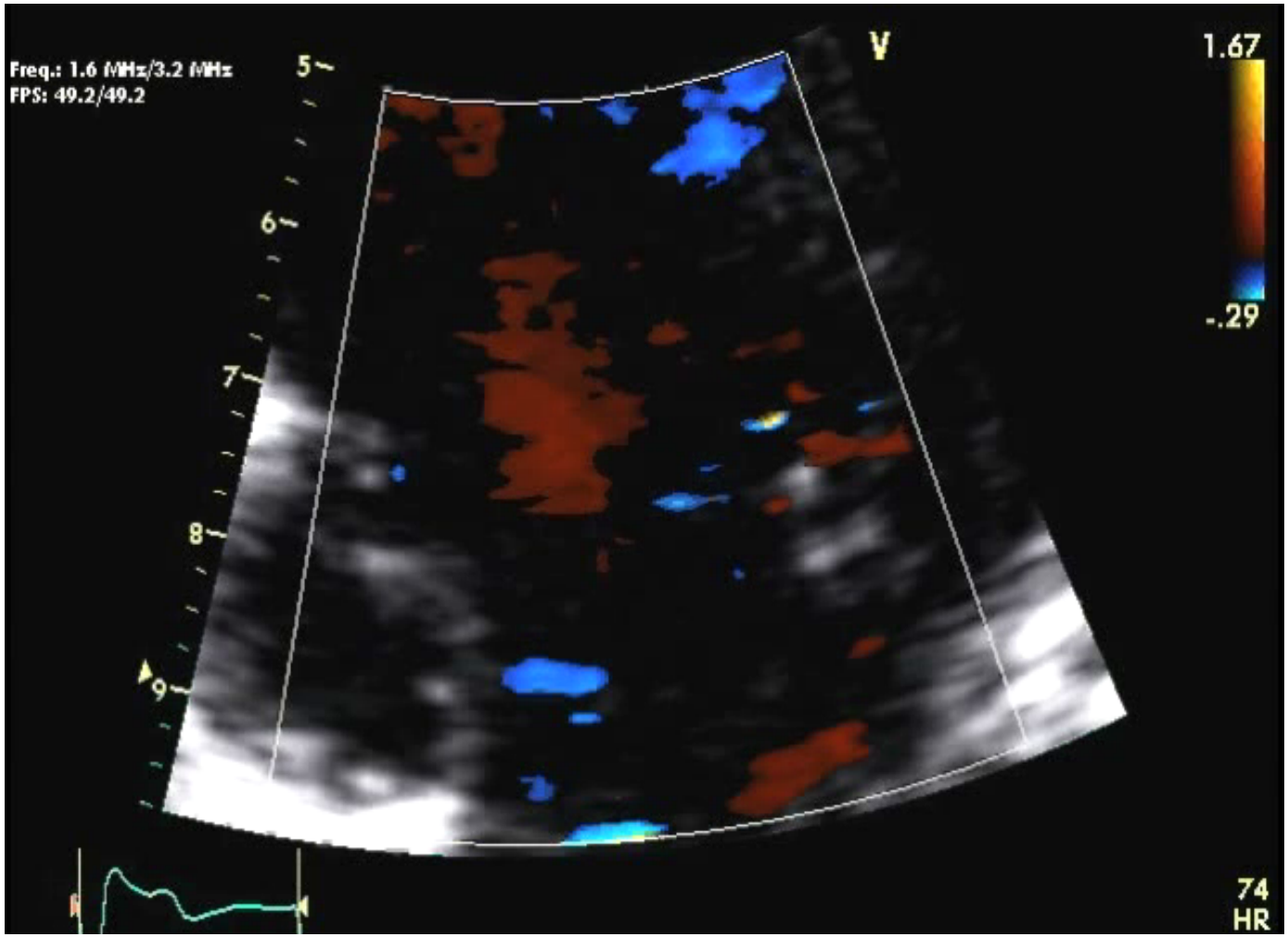
The need for a new tricuspid regurgitation grading scheme

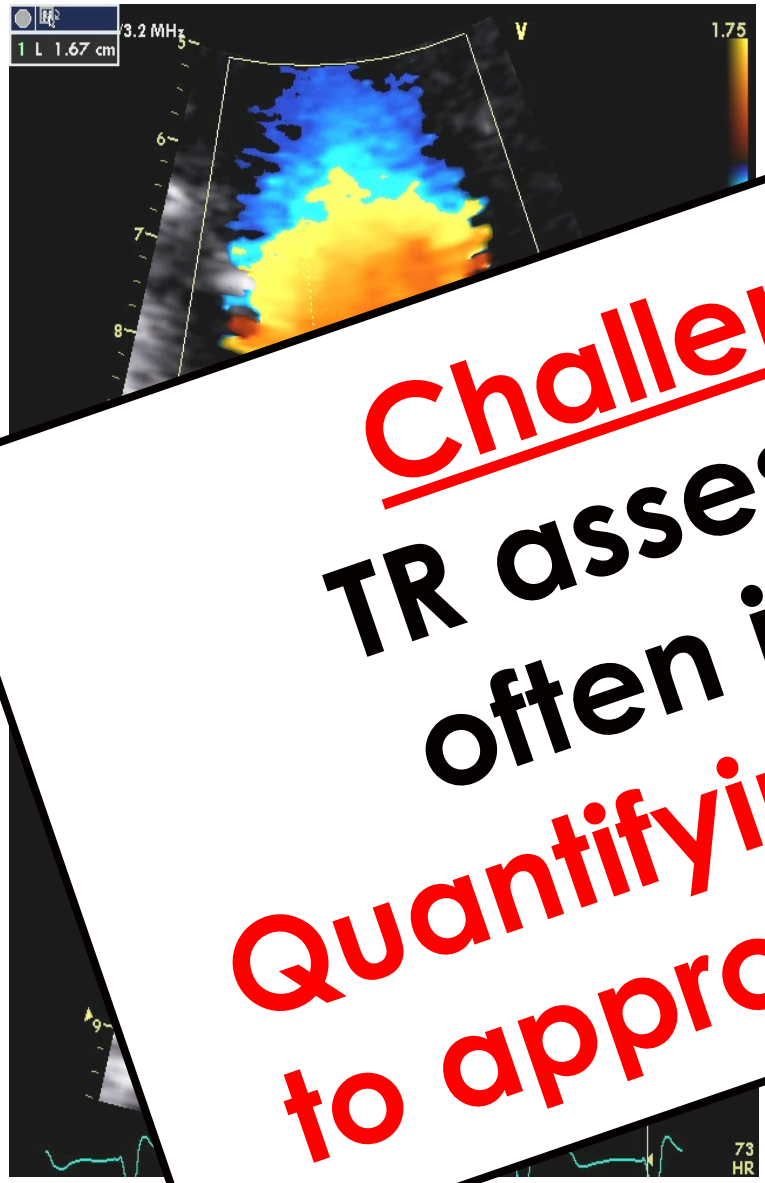
Rebecca T. Hahn[1] and Jose L. Zamorano[2]*

Table I Proposed expansion of the 'Severe' grade

Variable	Mild	Moderate	Severe	Massive	Torrential
VC (biplane)	<3 mm	3-6.9 mm	7–13 mm	14–20 mm	≥21 mm
EROA (PISA)	<20 mm^2	20–39 mm^2	40–59 mm^2	60–79 mm^2	≥80 mm^2
3D VCA or quantitative EROA[a]			75–94 mm^2	95–114 mm^2	≥115 mm^2

TR Quantification





Challenge #2

TR assessment is often imprecise

Quantifying TR is crucial to appropriate Imaging

TR Effect of respiration

Pathophysiology of Tricuspid Regurgitation

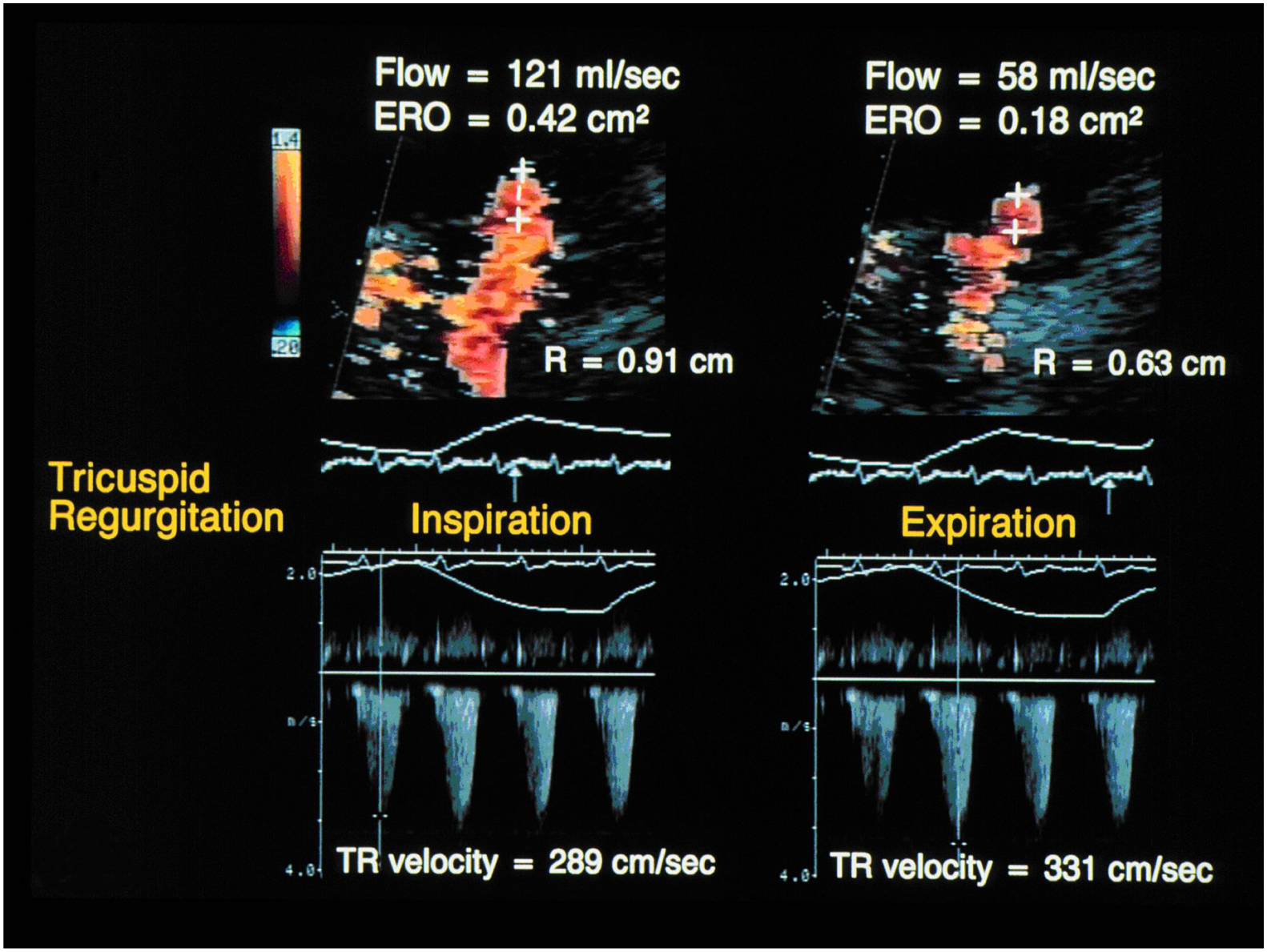
Quantitative Doppler Echocardiographic Assessment of Respiratory Dependence

Yan Topilsky, MD; Christophe Tribouilloy, MD; Hector I. Michelena, MD; Sorin Pislaru, MD; Douglas W. Mahoney, MS; Maurice Enriquez-Sarano, MD

Background—Respiratory dependence of tricuspid regurgitation (TR), a long-held concept suggested by murmur variation, remains unproven and of unclear mechanisms.

Methods and Results—In 41 patients with mild or greater TR (median age, 67 years), we performed triple Doppler echocardiographic quantification (TR severity, right ventricular, and right atrial quantification) with simultaneous respirometer recording of respiratory phases. Expiration to inspiration changes (median) affected TR peak velocity (−40 cm/s; 25th to 75th percentile, −60 to −30 cm/s), duration (−12 milliseconds; 25th to 75th percentile, −45 to 2 milliseconds), and time-velocity integral (−17 cm; 25th to 75th percentile, −23.4 to −10 cm; all $P<0.001$), consistent with decreased TR driving force. Nevertheless, inspiratory TR augmentation was demonstrated by increased effective regurgitant orifice (0.21 cm^2; 25th to 75th percentile, 0.09 to 0.34 cm^2) and volume (18 mL per beat; 25th to 75th percentile, 10 to 25 mL per beat; all $P<0.001$) infrequently detected clinically (2 of 41, 5%). As a result of reduced TR driving force, regurgitant volume increased less than effective regurgitant orifice (120% [25th to 75th percentile, 78.6% to 169%] versus 169% [25th to 75th percentile, 12.9% to 226.1%]; $P<0.001$). During inspiration, right ventricular area increased (diastolic, 27.8 [25th to 75th percentile, 22.6 to 36.3] versus 26.5 [21.1 to 31.9]; $P<0.0001$) with widening of right ventricular shape (length-to-width ratio, 1.6 [25th to 75th percentile, 1.37 to 1.95] versus 1.7 [1.46 to 2.1]; $P<0.0001$), increased systolic annular diameter ($P=0.003$), valve tenting height ($P<0.0001$) and area ($P<0.0001$), and reduced valvular-to-annular ratio ($P=0.006$). Effective regurgitant orifice during inspiration was independently determined by inspiratory valvular-to-annular ratio ($P=0.026$) and inspiratory change in right ventricular length-to-width ratio ($P=0.008$) and valve tenting area ($P=0.015$).

Conclusions—TR is dynamic with almost universal respiratory changes of large magnitude and complex pathophysiology. During inspiration, a large increase in effective regurgitant orifice causes, despite a decline in regurgitant gradient, a notable increase in regurgitant volume. Effective regurgitant orifice changes are independently linked to inspiratory annular enlargement (decreased valvular coverage) and to inspiratory right ventricular shape widening with increased valvular tenting. These novel physiological insights into TR respiratory dependence underscore right-side heart plasticity and are important for clinical TR severity evaluation. **(*Circulation*. 2010;122:1505-1513.)**



Tricuspid Regurgitation

Physiologically

Annular Plasticity &
Valve Tenting
cause TR variability

Pathologically

do these mechanisms play a role in functional TR **?**

Clinical Context and Mechanism of Functional Tricuspid Regurgitation in Patients With and Without Pulmonary Hypertension

Yan Topilsky, MD; Amber Khanna; MD; Thierry Le Tourneau; MD; Soon Park; MD; Hector Michelena; MD; Rakesh Suri; MD, DPhil; Douglas W. Mahoney; MS; Maurice Enriquez-Sarano, MD

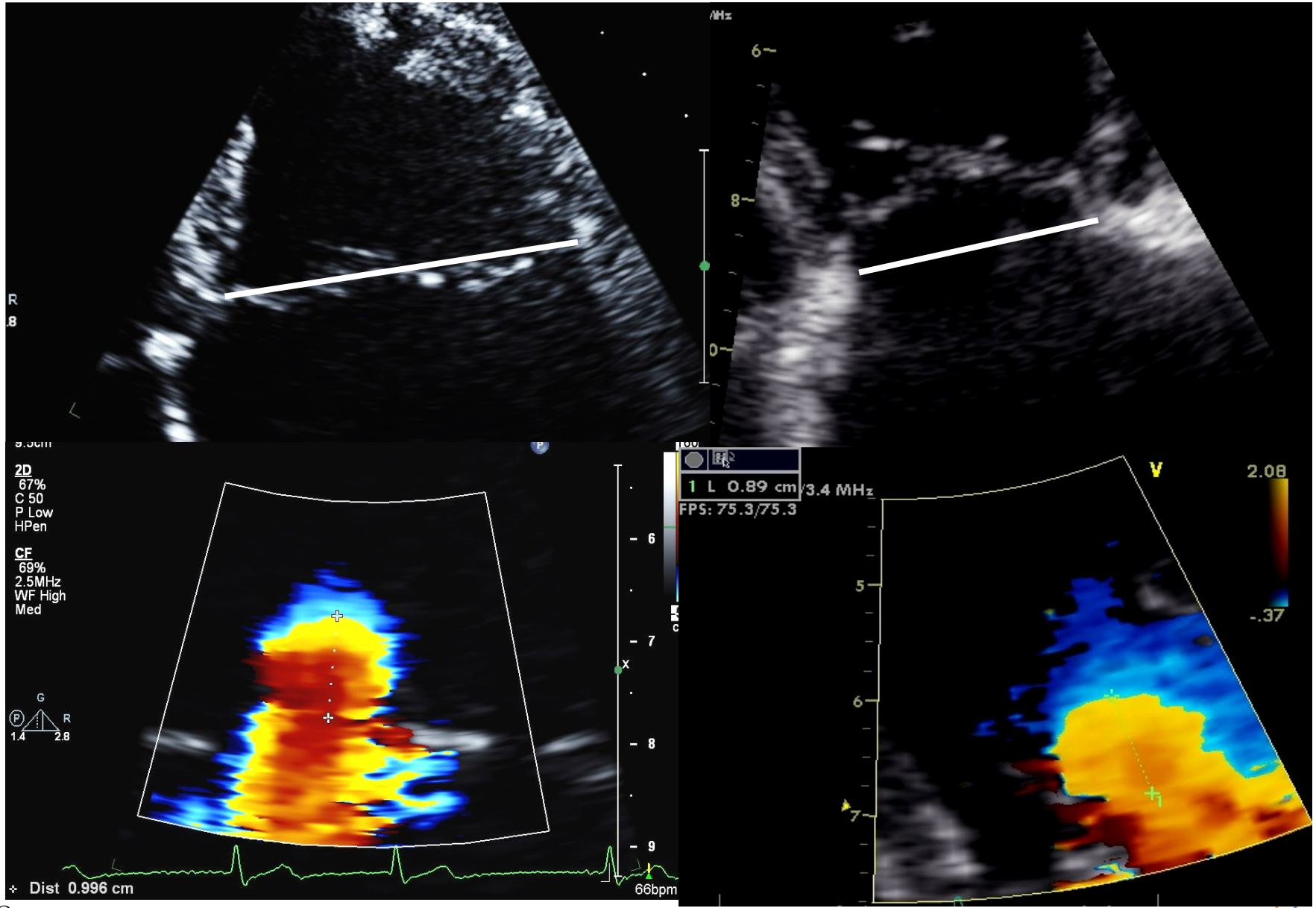
Background—Functional tricuspid regurgitation (FTR) with structurally normal valve is of poorly defined mechanisms. Prevalence and clinical context of idiopathic FTR (Id-FTR) (without overt TR cause) are unknown.

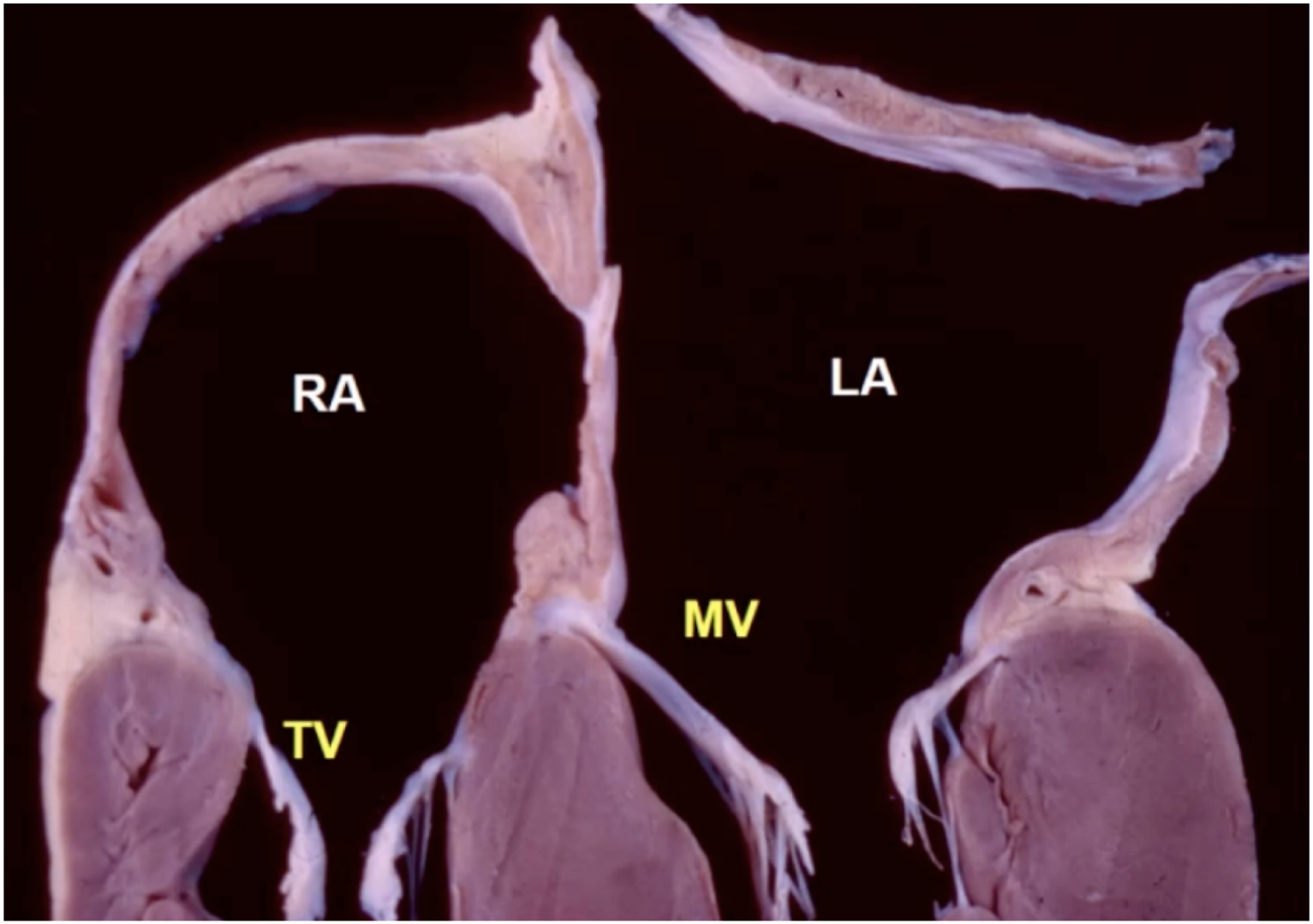
Methods and Results—To investigate prevalence, clinical context, and mechanisms specific to FTR types, Id-FTR versus pulmonary hypertension-related (PHTN-FTR, systolic pulmonary pressure ≥50 mm Hg), we analyzed 1161 patients with prospectively quantified TR. Id-FTR (prevalence 12%) was associated with aging and atrial fibrillation. For mechanistic purposes, we measured valvular and right ventricular (RV) remodeling in 141 Id-FTR matched to 140 PHTN-FTR and to 99 controls with trivial TR for age, sex, atrial fibrillation, and ejection fraction. PHTN-FTR and Id-FTR were also matched for TR effective-regurgitant-orifice (ERO). Id-FTR valvular alterations (versus controls) were largest annular area (3.53±0.6 versus 2.74±0.4 cm^2, $P<0.0001$) and lowest valvular/annular coverage ratio (1.06±0.1 versus 1.45±0.2, $P<0.0001$) but normal valve tenting height. PHTN-FTR had mild annular enlargement but excessive valve tenting height (0.8±0.3 versus 0.35±0.1 cm, $P<0.0001$). Valvular changes were linked to specific RV changes, largest basal dilatation, and normal length (RV conical deformation) in Id-FTR versus longest RV with elliptical/spherical deformation in PHTN-FTR. With increasing FTR severity (ERO ≥40 mm^2), changes specific to each FTR type were accentuated, and RV function (index of myocardial performance) was consistently reduced.

Conclusions—Id-FTR is frequent, linked to aging and atrial fibrillation, can be severe, and is of unique mechanism. In Id-FTR, excess annular and RV-basal enlargement exhausts valvular/annular coverage reserve, and RV conical deformation does not cause notable valvular tenting. Conversely, PHTN-FTR is determined by valvular tethering with tenting linked to RV elongation and elliptical/spherical deformation. These specific FTR-mechanisms may be important in considering surgical correction in FTR. (***Circ Cardiovasc Imaging***. 2012;5:314-323.)

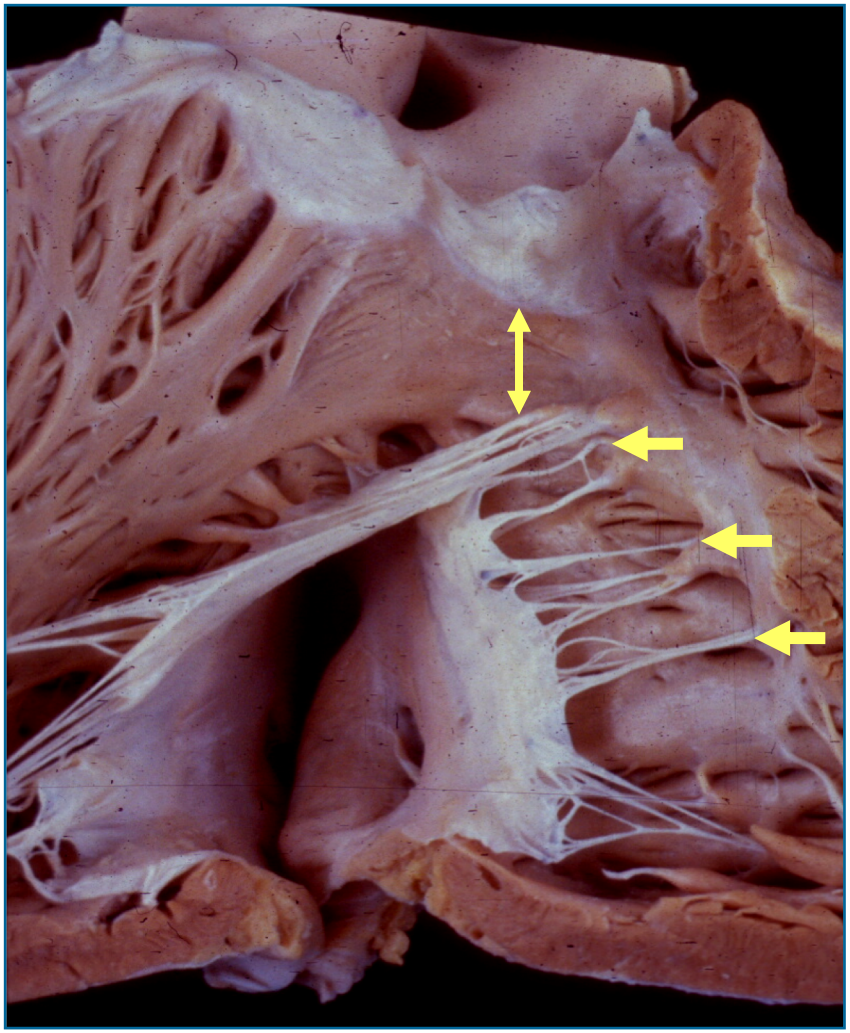
MAYO CLINIC

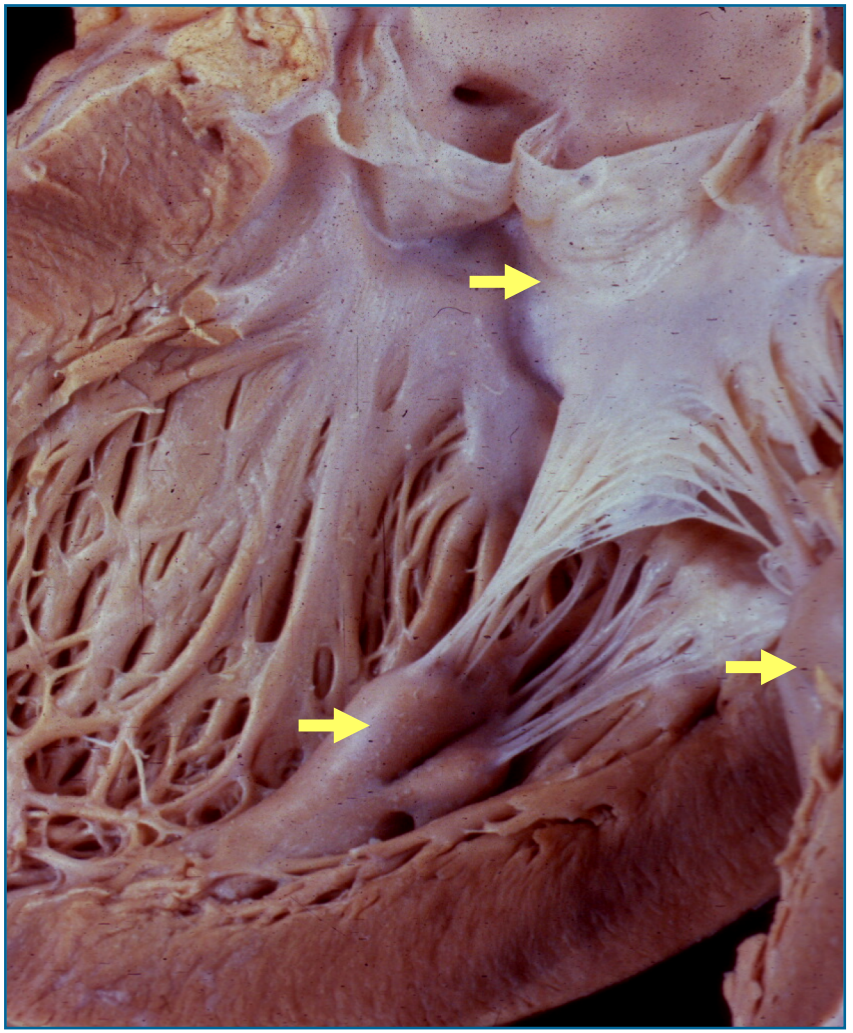
HÔPITAL DE CANNES





Atrio-ventricular valves





MAYO CLINIC

Cardiovascular Surgery

Tricuspid Valve Tethering Predicts Residual Tricuspid Regurgitation After Tricuspid Annuloplasty

Shota Fukuda, MD; Jong-Min Song, MD; A. Marc Gillinov, MD; Patrick M. McCarthy, MD; Masao Daimon, MD; Vorachai Kongsaerepong, MD; James D. Thomas, MD; Takahiro Shiota, MD

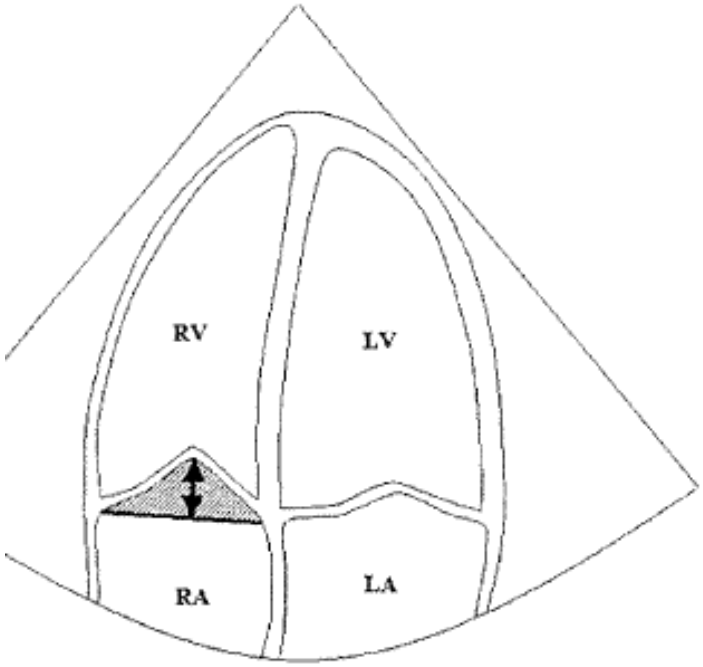


TABLE 1. Effect of Characteristic and Echocardiographic Findings on Residual TR After TV Annuloplasty

	r	Univariate *P*	Multivariate *P*
Age	0.28	<0.001	<0.001
LV ejection fraction	0.19	0.005	0.6
RV fractional area change	0.18	0.01	0.5
RA area	0.02	0.8	
RV systolic pressure	0.02	0.8	
TV annulus diameter	0.07	0.3	
TV tethering distance	0.56	<0.001	<0.001
TV tethering area	0.52	<0.001	0.4
Preoperative %TR	0.32	<0.001	<0.001

patients and 4 techniques of annuloplasty, we used 1-way ANOV. We used logistic regression to correlate variables of interest. Mul variate stepwise regression analysis was performed to identi factors of severity of residual TR (measured continuously as %TR

Challenge #2

TR assessment is often imprecise

Addressing TR mechanism is crucial for treatment

Why is TR management so vague and poorly defined ?

Reason #3

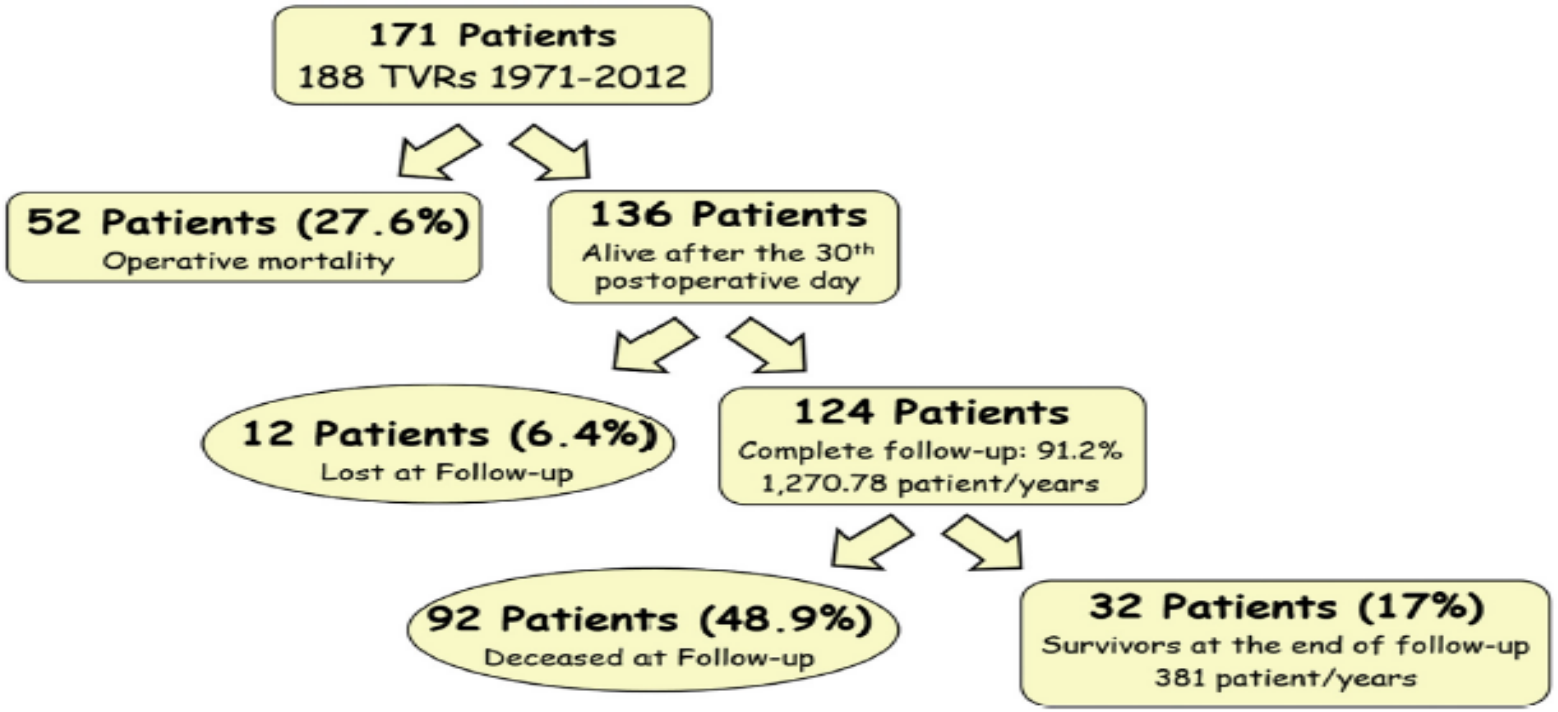
Surgery uncertainty

TR surgery has a bad reputation

TR Surgery: Bad reputation

Appraisal of Long-Term Outcomes of Tricuspid Valve Replacement in the Current Perspective

Amedeo Anselmi, MD, PhD, Vito Giovanni Ruggieri, MD, PhD, Majid Harmouche, MD, PhD, Erwan Flécher, MD, PhD, Hervé Corbineau, MD, Thierry Langanay, MD, Bernard Lelong, MD, Jean-Philippe Verhoye, MD, PhD, and Alain Leguerrier, MD

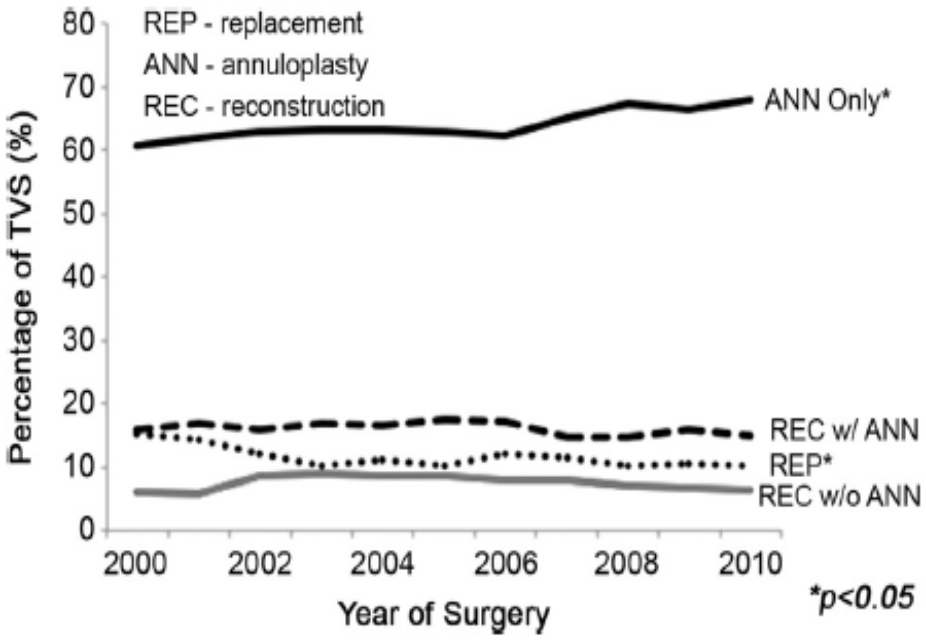


TR Surgery: Bad reputation

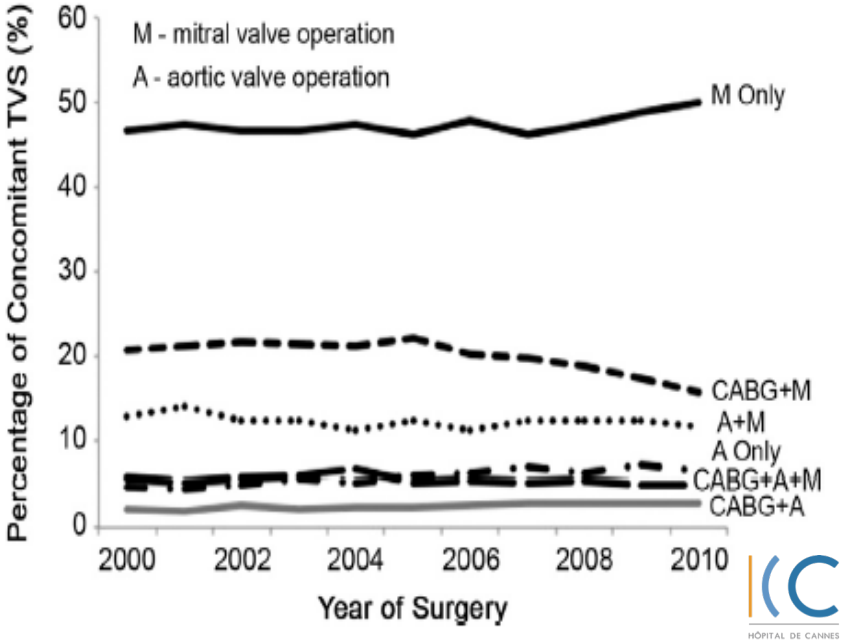
Trends and Outcomes of Tricuspid Valve Surgery in North America: An Analysis of More Than 50,000 Patients From The Society of Thoracic Surgeons Database

Arman Kilic, MD, Paramita Saha-Chaudhuri, PhD, J. Scott Rankin, MD, and John V. Conte, MD

Mostly Repairs



Only 14% Isolated



MAYO CLINIC

TR Surgery: Bad reputation

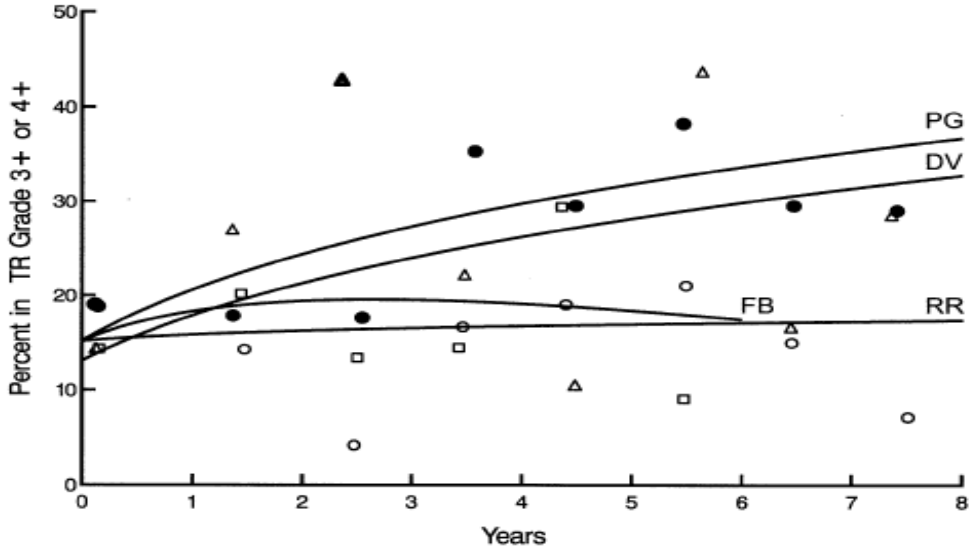
Tricuspid valve repair: Durability and risk factors for failure

Patrick M. McCarthy, MD
Sunil K. Bhudia, MD
Jeevanantham Rajeswaran, MSc
Katherine J. Hoercher, RN
Bruce W. Lytle, MD
Delos M. Cosgrove, MD
Eugene H. Blackstone, MD

TR 3-4+

5 years post op

17-32%

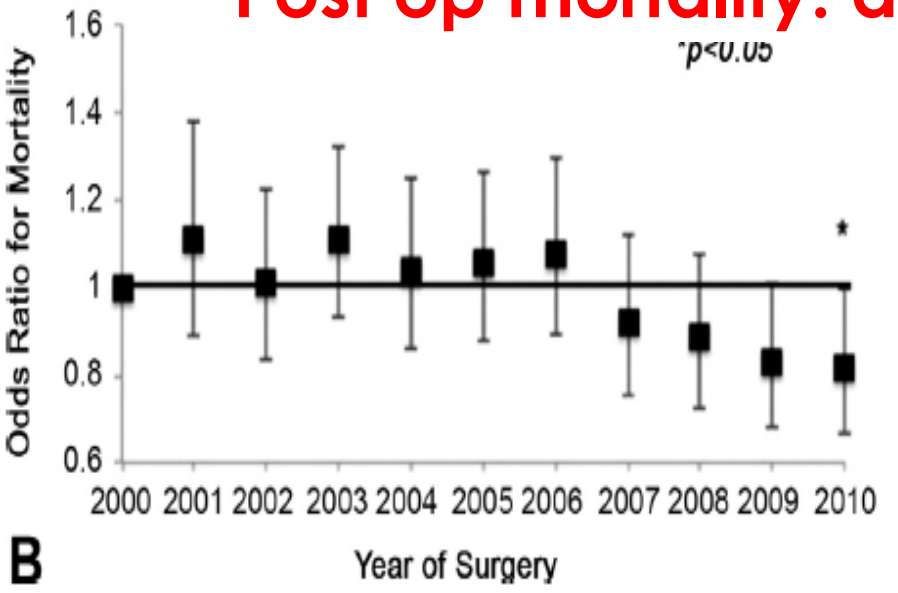


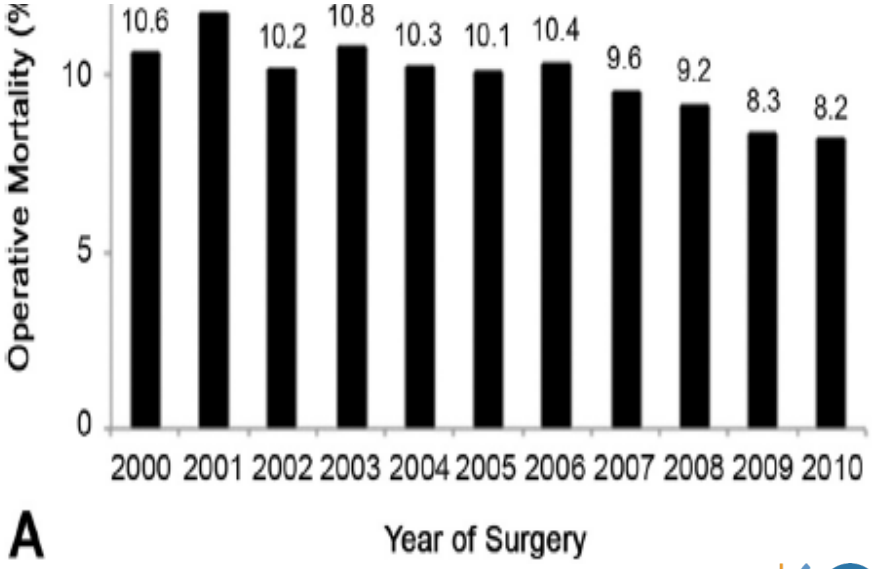
TR Surgery: Bad reputation

Trends and Outcomes of Tricuspid Valve Surgery in North America: An Analysis of More Than 50,000 Patients From The Society of Thoracic Surgeons Database

Arman Kilic, MD, Paramita Saha-Chaudhuri, PhD, J. Scott Rankin, MD, and John V. Conte, MD

Post op mortality: declining but still high





MAYO CLINIC

Outcome of TR surgery at Mayo

TR of Flail Leaflets

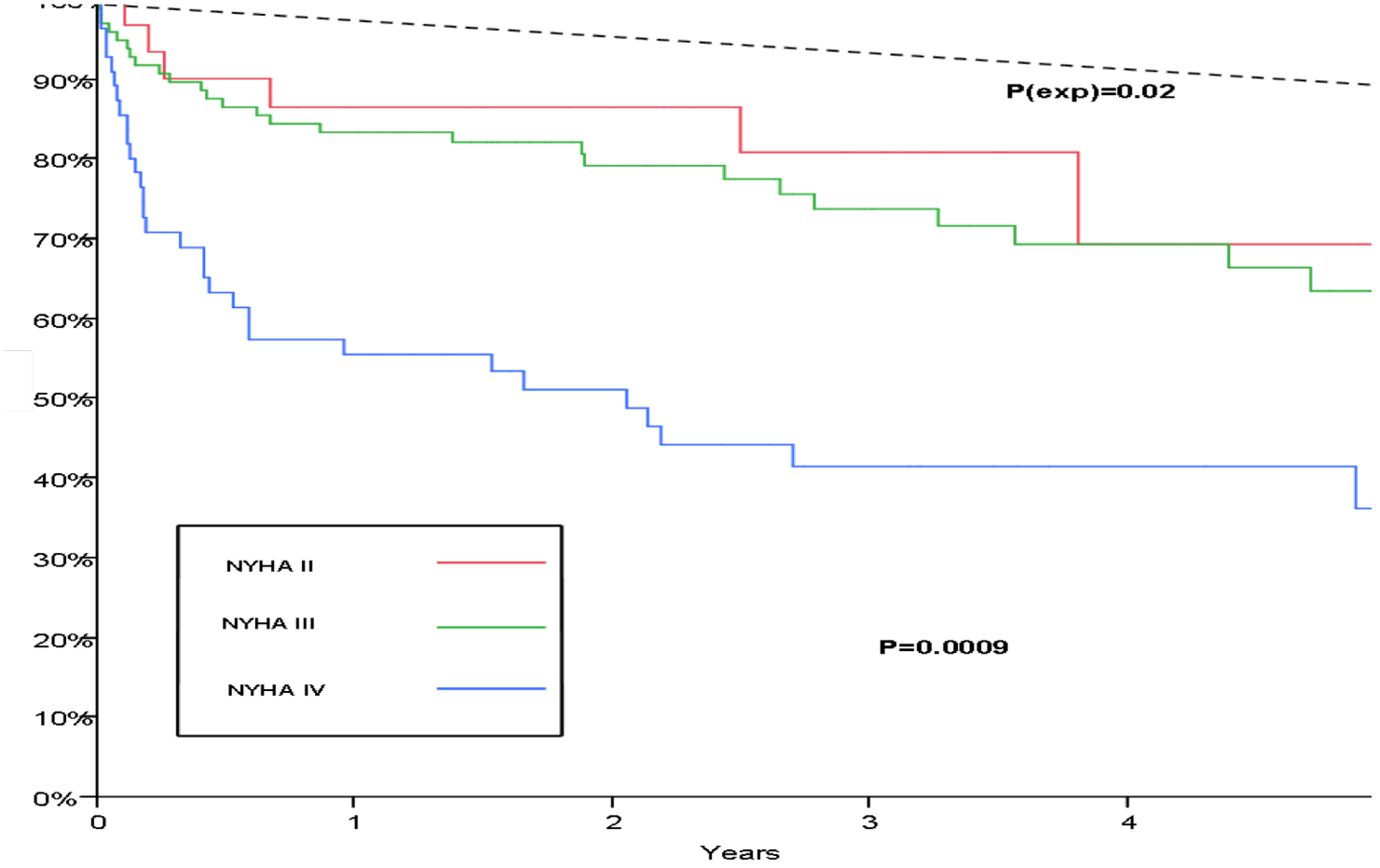
- Surgery: 33 patients
  - 55% 5 years after diagnosis
- Type of surgery: Repair in 82%
- Operative mortality: **3%** (1 patient)
- Residual TR > mild: 2/27 repairs
- Symptomatic improvement: 88%
- Rhythm:
  - Pre-op AF: remained in AF
  - Pre-op SR: new AF in 32% 5-yrs post

MAYO CLINIC

HÔPITAL DE CANNES

Outcome of TR surgery at Mayo

Isolated TV Replacement



Topilsky et al Circulation. 2011;123:1929-39.

ESC European Society of Cardiology
European Heart Journal (2020) **00**, 1–14
doi:10.1093/eurheartj/ehaa643

CLINICAL RESEARCH
Valvular heart disease

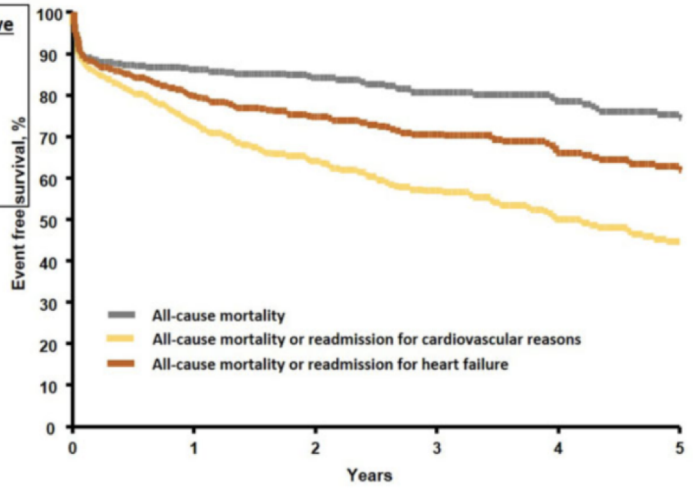
Isolated tricuspid valve surgery: impact of aetiology and clinical presentation on outcomes

Julien Dreyfus [1]*, Mi
Florence Viau [5], Elisa
Damien Eyharts [10], T
Fabien Doguet [13,14], Vir
Yoan Lavie-Badie [10],
Jacques Tomasi [17], G
Richard Raffoul [19], Ber
David Messika-Zeitoun

Isolated Tricuspid Valve Surgery on Native Valve (N=466)
- Functional tricuspid regurgitation (N=229)
  - Prior left-sided heart valve surgery (N=101)
  - Isolated (N=128)
- Organic tricuspid regurgitation (N=237)
  - Infective endocarditis (N=142)
  - Other (N=95)

Pre-operative presentation
- **Clinical** (NYHA class III/IV, right heart failure signs)
- **Biological** (lower prothrombin time, lower glomerular filtration rate)
- **Echocardiography** (moderate/severe RV dysfunction or dilatation)

Outcome
- In-hospital death: 10%
- In-hospital major complications: 31%
- Overall survival, survival free of cardiovascular readmission and survival free of heart failure readmission at 5 years were 75%, 44% and 62%.



Isolated tricuspid valve surgery is associated with high mortality and morbidity, both in-hospital and during follow-up, predicted by the severity of the pre-operative clinical, biological and echocardiographic presentation but not by etiology or the mechanism tricuspid regurgitation mechanism

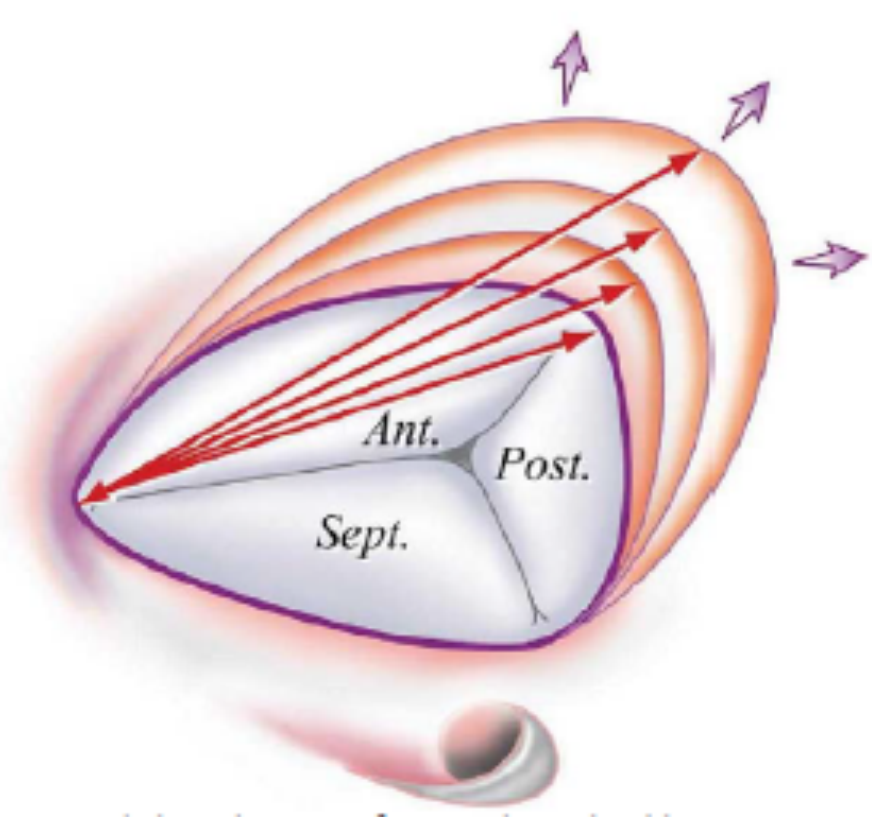
MAYO CLINIC

HÔPITAL DE CANNES

Secondary Tricuspid Regurgitation or Dilatation: Which Should Be the Criteria for Surgical Repair?

Gilles D. Dreyfus, MD, Pierre J. Corbi, MD, K. M. John Chan, AFRCS, and Toufan Bahrami, MD

Department of Cardiothoracic Surgery, Royal Brompton and Harefield NHS Trust, Harefield Hospital, Harefield, Middlesex, United Kingdom



Secondary Tricuspid Regurgitation or Dilatation: Which Should Be the Criteria for Surgical Repair?

Gilles D. Dreyfus, MD, Pierre J. Corbi, MD, K. M. John Chan, AFRCS, and Toufan Bahrami, MD

Department of Cardiothoracic Surgery, Royal Brompton and Harefield NHS Trust, Harefield Hospital, Harefield, Middlesex, United Kingdom

	Before Surgery		After Surgery	
	Group 1 (MVR)	Group 2 (MVR + TVR)	Group 1 (MVR)	Group 2 (MVR + TVR)
Grade 0	54	38	8	102
Grade 1	102	92	33	41
Grade 2	7	16	67	4
Grade 3	0	2	40	1
Grade 4	0	0	15	0
Mean TR grade	0.7 ± 0.5[a]	0.9 ± 0.6[a]	2.1 ± 1.0[b]	0.4 ± 0.6[b]

Table 5. Comparison of Late Follow-Up Data (Mean Follow-Up 4.8 ± 2.9 Years)

	Group 1 (MVR)	Group 2 (MVR + TVR)	Test	*p* Value
n	160	147		
NYHA class	1.59 ± 0.84	1.11 ± 0.31	MW	<0.0001
MR grade	0.41 ± 0.54	0.60 ± 0.66	MW	0.015
LVESD (mm)	36.6 ± 6.1	38.0 ± 7.1	*t*	0.070
EF (%)	67.1 ± 11.0	64.3 ± 13.2	MW	0.083
PAP (mm Hg)	29.3 ± 7.2	28.2 ± 7.0	MW	0.33
PAP > 50 mm Hg	28.1%	27.7%	χ^2	0.91
Mean TR grade	2.07 ± 0.97	0.36 ± 0.61	MW	0.001
Change in TR grade	+1.35 ± 1.12	−0.52 ± 0.89	MW	<0.001
Late reoperation	3	3		

MAYO CLINIC

HÔPITAL DE CANNES

Guidelines on the management of valvular heart disease (version 2012)

The Joint Task Force on the Management of Valvular Heart Disease of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS)

Table 16 Indications for tricuspid valve surgery

	Class [a]	Level [b]
Surgery is indicated in symptomatic patients with severe TS.[c]	I	C
Surgery is indicated in patients with severe TS undergoing left-sided valve intervention.[d]	I	C
Surgery is indicated in patients with severe primary or secondary TR undergoing left-sided valve surgery.	I	C
Surgery is indicated in symptomatic patients with severe isolated primary TR without severe right ventricular dysfunction.	I	C
Surgery should be considered in patients with moderate primary TR undergoing left-sided valve surgery.	IIa	C
Surgery should be considered in patients with mild or moderate secondary TR with dilated annulus (≥40 mm or >21 mm/m²) undergoing left-sided valve surgery.	IIa	C

MAYO CLINIC

HÔPITAL DE CANNES

Tricuspid Sur

Whil

- ...putation
- ...ry in isolated
- ...ery remains high
- ...id repair often fails with frequent recurrent TR

Challenge #3

TR surgery has a poor reputation

TR treatment needs more clinical trials

MAYO CLINIC

Why is TR management so vague and poorly defined ?

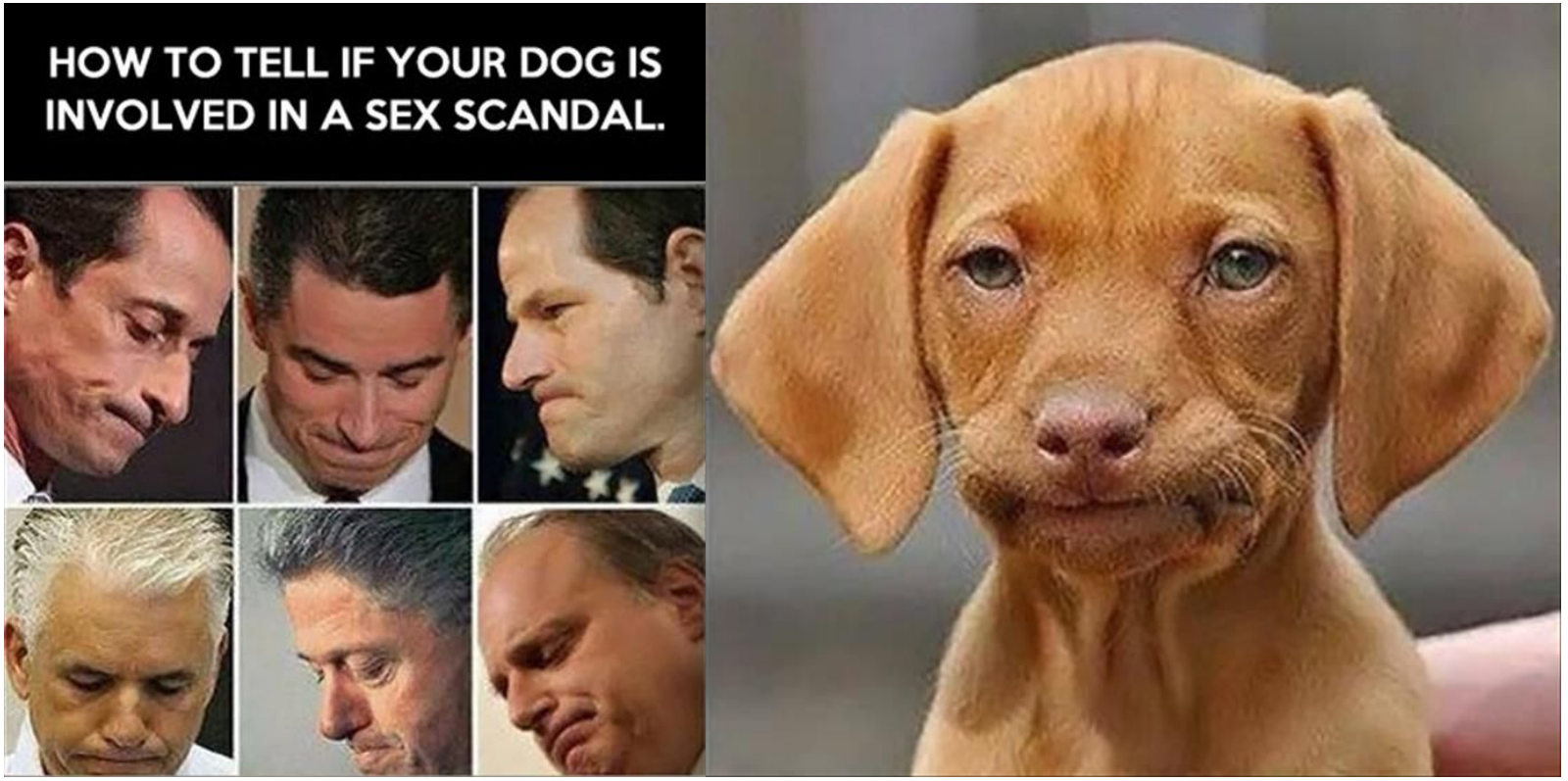
Reason #4

Outcome and management uncertainty

Do we know the outcome of TR **?**

MAYO CLINIC

HÔPITAL DE CANNES



MAYO CLINIC

HÔPITAL DE CANNES

Why is TR management so vague and poorly defined ?

Reason #4

Outcome and management uncertainty

Do we know the outcome of TR **?**

MAYO CLINIC

HÔPITAL DE CANNES

3.8.3. Management

Class I

1. **Tricuspid valve repair is beneficial for severe TR in patients with MV disease requiring MV surgery.** ***(Level of Evidence: B)***

Class IIa

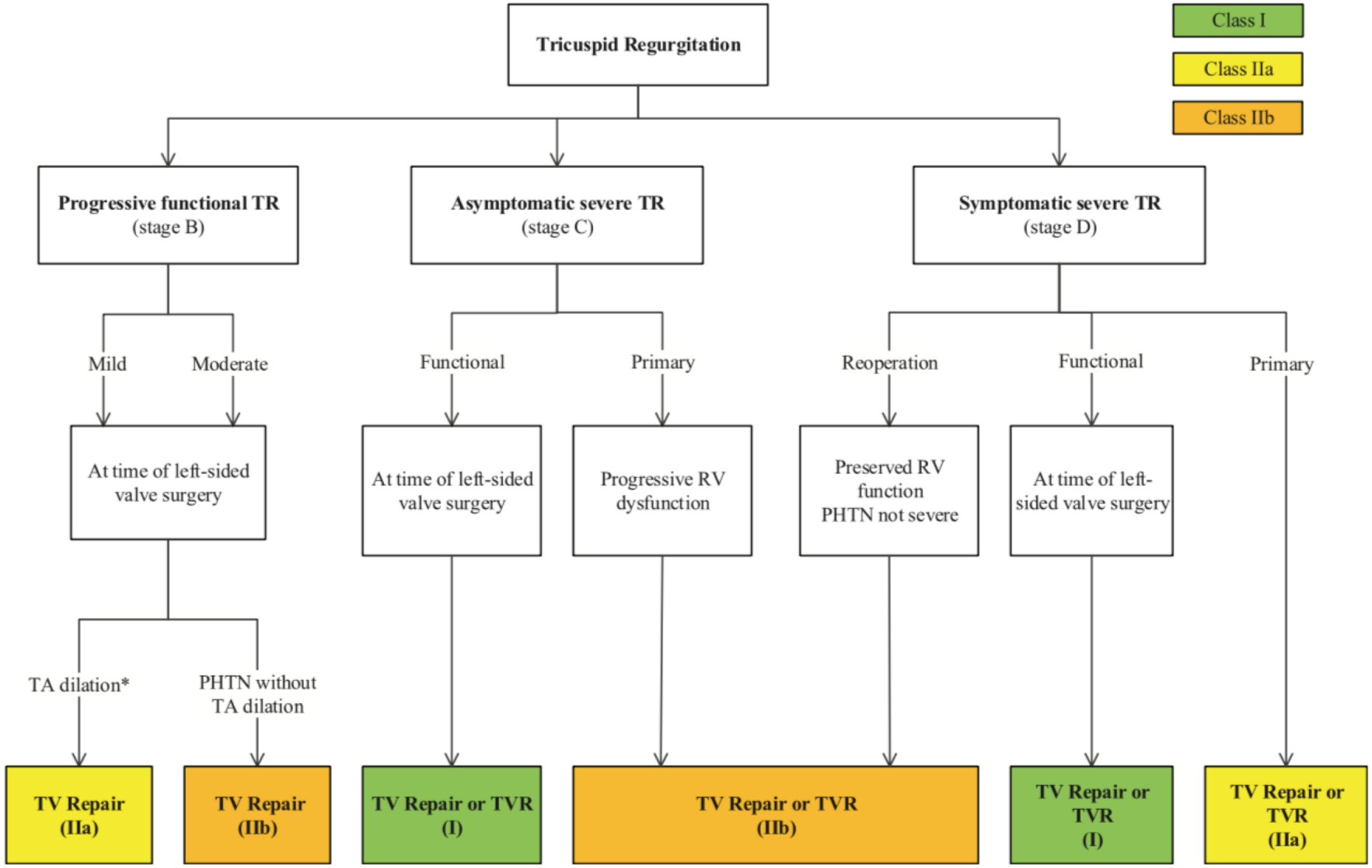
1. **Tricuspid valve replacement or annuloplasty is reasonable for severe primary TR when symptomatic.** ***(Level of Evidence: C)***
2. **Tricuspid valve replacement is reasonable for severe TR secondary to diseased/abnormal tricuspid valve leaflets not amenable to annuloplasty or repair.** ***(Level of Evidence: C)***

Class IIb

1. **Tricuspid annuloplasty may be considered for less than severe TR in patients undergoing MV surgery when there is pulmonary hypertension or tricuspid annular dilatation.** ***(Level of Evidence: C)***

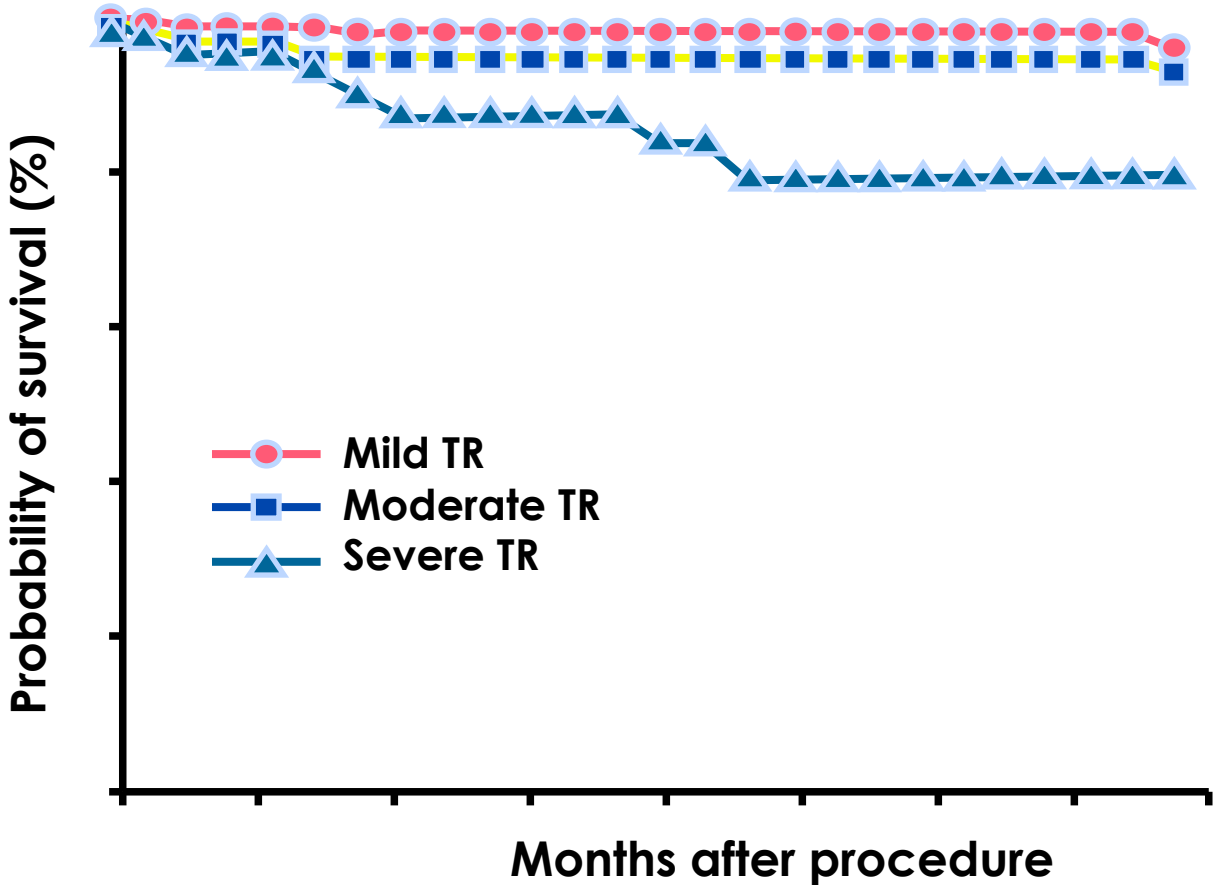
Class III

1. **Tricuspid valve replacement or annuloplasty is not indicated in asymptomatic patients with TR whose pulmonary artery systolic pressure is less than 60 mm Hg in the presence of a normal MV.** ***(Level of Evidence: C)***
2. **Tricuspid valve replacement or annuloplasty is not indicated in patients with mild primary TR.** ***(Level of Evidence: C)***



TR Outcome Uncertainty

Survival post-PBMV

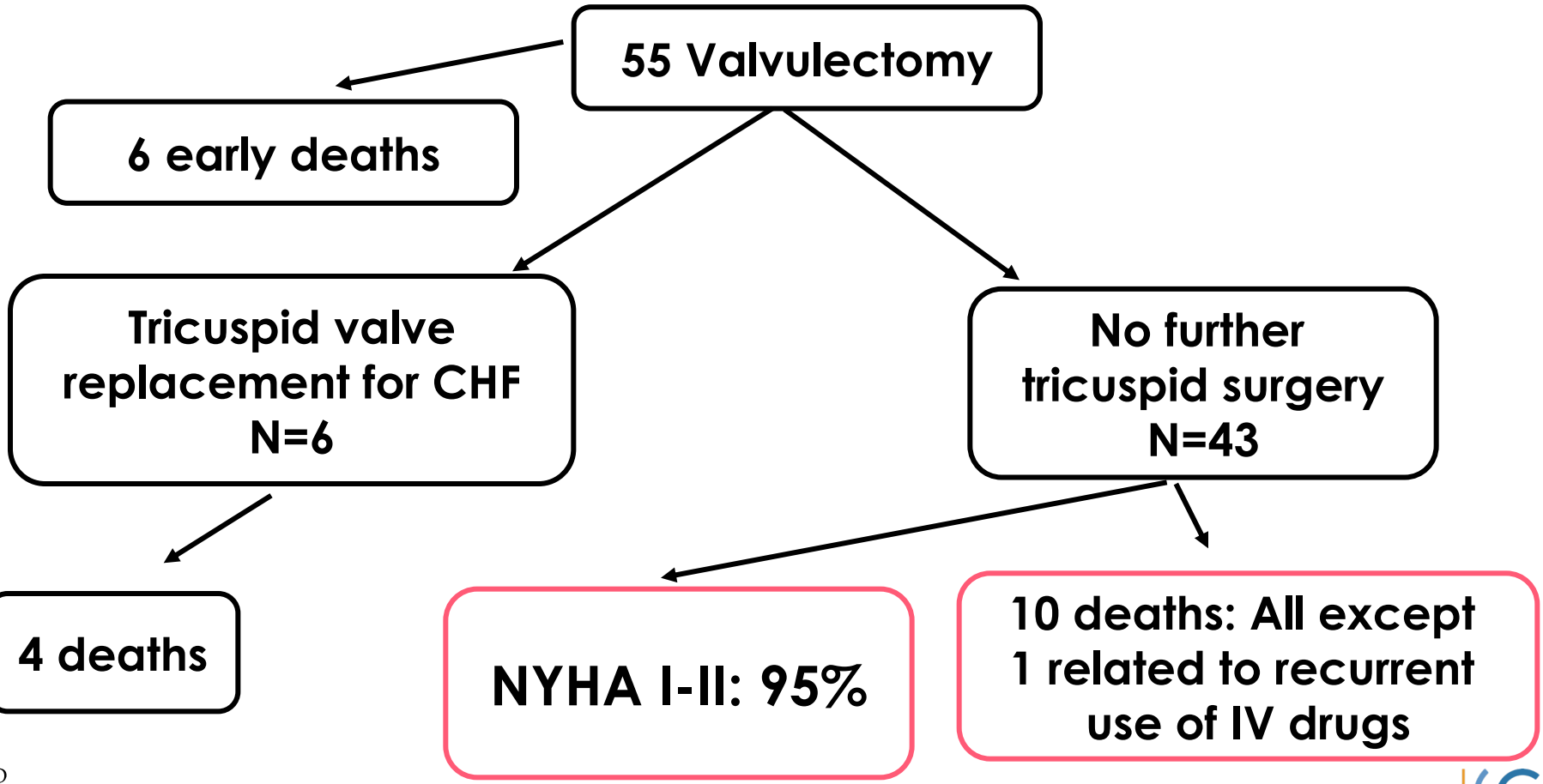


Sagie et al JACC 1994; 24:696

TR Outcome Uncertainty

Valvulectomie without replacement

Drug-addict patients with intractable right-sided endocarditis



Arbulu et al J Thorac CV Surg 1991

TR Outcome Uncertainty

The independent effect of TR on outcome remains unclear

A serious problem

or

An important color spot, surrogate of the causal condition ?

TR Outcome

Journal of the American College of Cardiology
© 2004 by the American College of Cardiology Foundation
Published by Elsevier Inc.

Vol. 43, No. 3, 2004
ISSN 0735-1097/04/$30.00
doi:10.1016/j.jacc.2003.09.036

Impact of Tricuspid Regurgitation on Long-Term Survival

Jayant Nath, MD,*
Palo Alto and San F

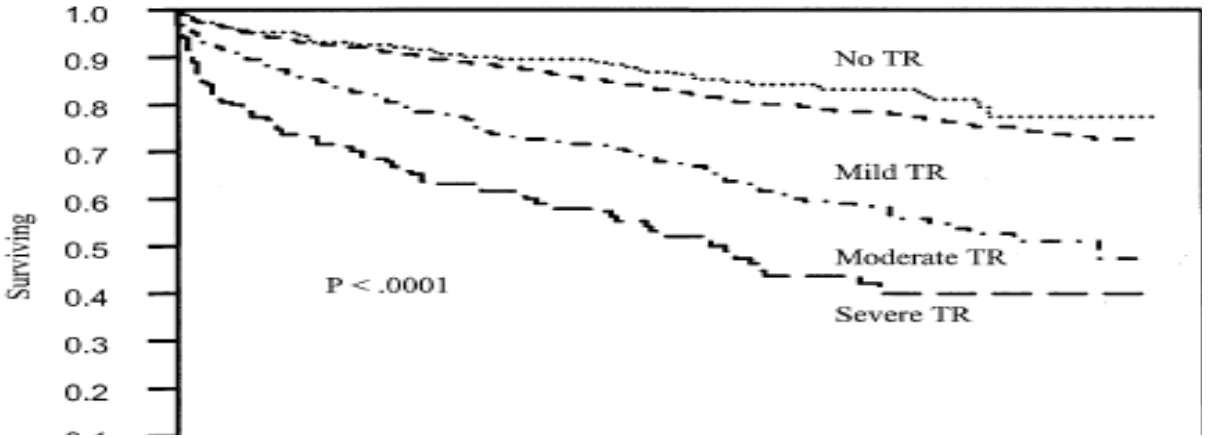


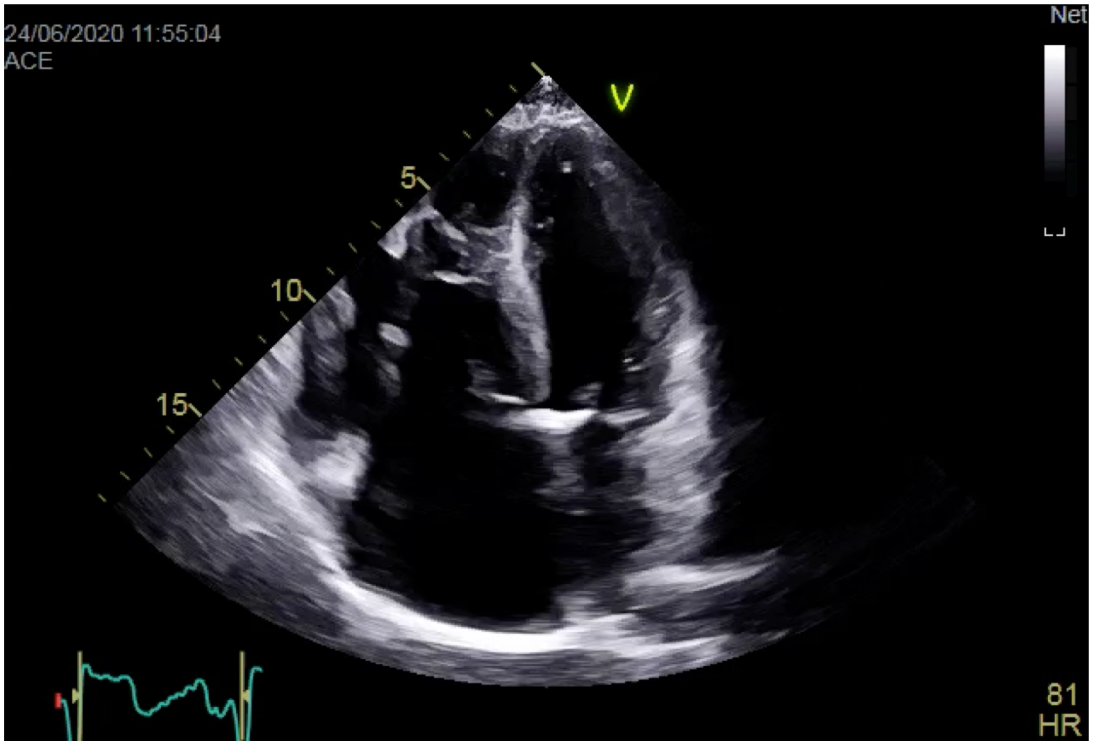
Table 1. Clinical and Echocardiographic Features of Patients With Tricuspid Regurgitation

	No TR (n = 600)	Mild TR (n = 3,804)	Moderate TR (n = 620)	Severe TR (n = 199)	p Value
Age (yrs)	62.2 ± 12.8	66.0 ± 12.6	71.9 ± 11.7	71.9 ± 12.4	< 0.0001
LVEF (%)	57.3 ± 9.1	55.4 ± 11.6	47.1 ± 15.6	40.4 ± 17.2	< 0.0001
RV dilation	8%	11%	35%	66%	< 0.0001
RV dysfunction	3%	8%	30%	61%	< 0.0001
Dilated IVC	6%	11%	44%	76%	< 0.0001

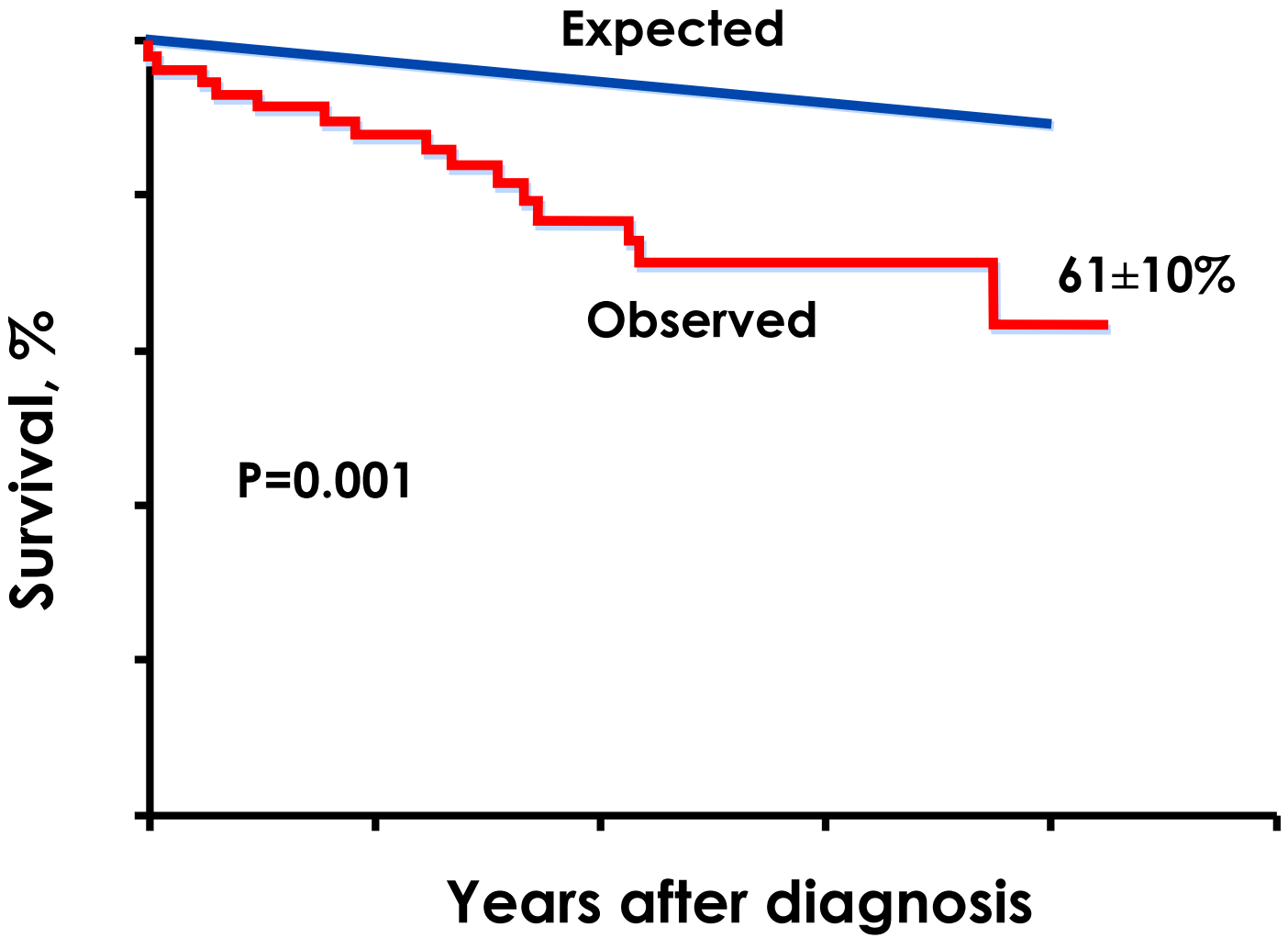
TR of Flail Leaflet Outcome

Medical and surgical outcome of tricuspid regurgitation caused by flail leaflets

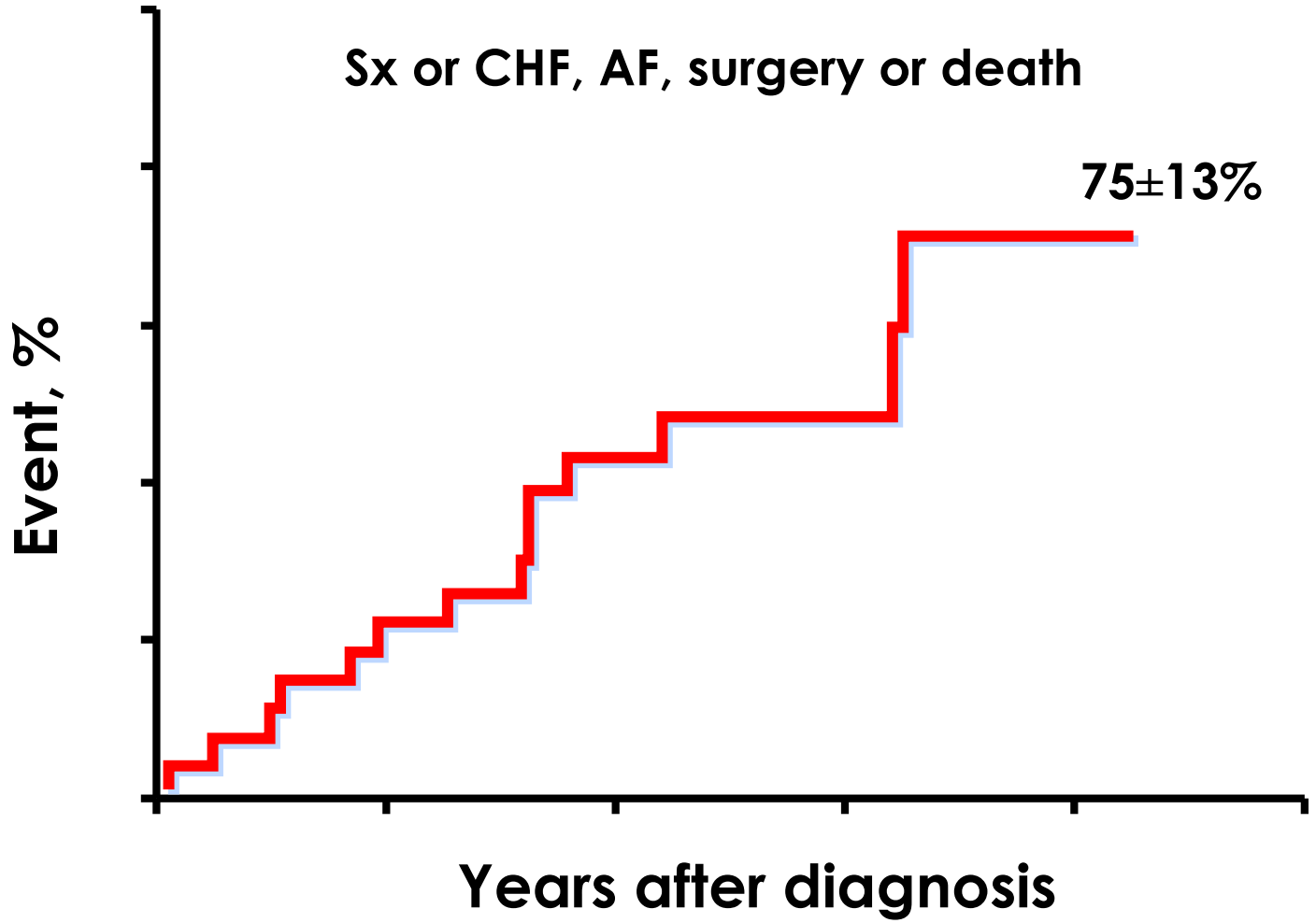
David Messika-Zeitoun, MD[a]
Helen Thomson, MD[a]
Michael Bellamy, MD[a]
Christopher Scott, MS[b]
Christophe Tribouilloy, MD[a]
Joseph Dearani, MD[c]
A. Jamil Tajik, MD[a]
Hartzell Schaff, MD[c]
Maurice Enriquez-Sarano, MD[a]



TR of Flail Leaflet Outcome



TR of Flail Leaflet Outcome



MAYO CLINIC

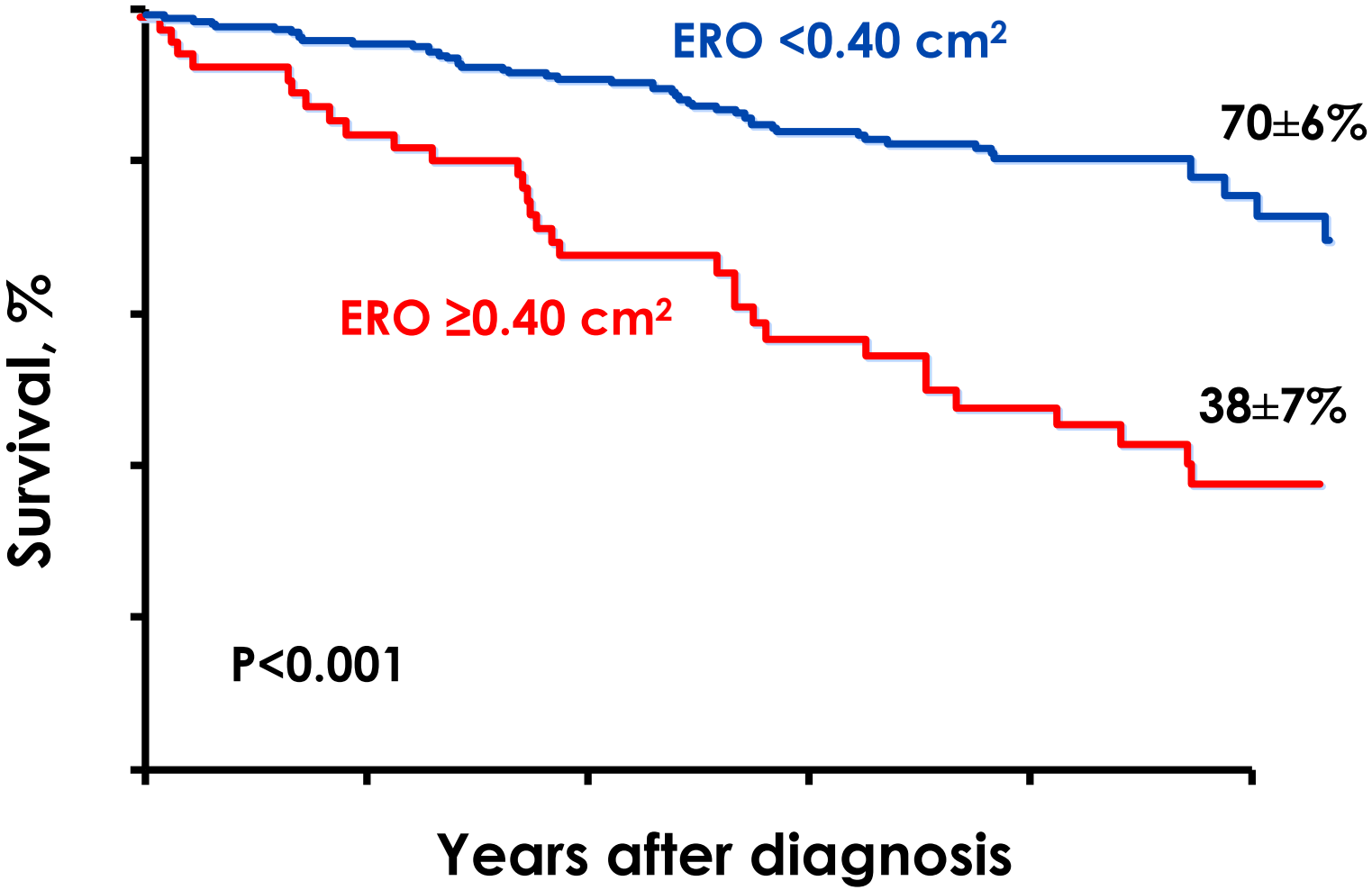
Isolated TR Outcome

ORIGINAL RESEARCH

Clinical Outcome of Isolated Tricuspid Regurgitation

Yan Topilsky, MD,* Vuyisile T. Nkomo, MD,† Ori Vatury, MD,† Hector I. Michelena, MD,† Thierry Letourneau, MD,† Rakesh M. Suri, MD, DPHIL,‡ Sorin Pislaru, MD,† Soon Park, MD,† Douglas W. Mahoney, MSc,§ Simon Biner, MD,* Maurice Enriquez-Sarano, MD†

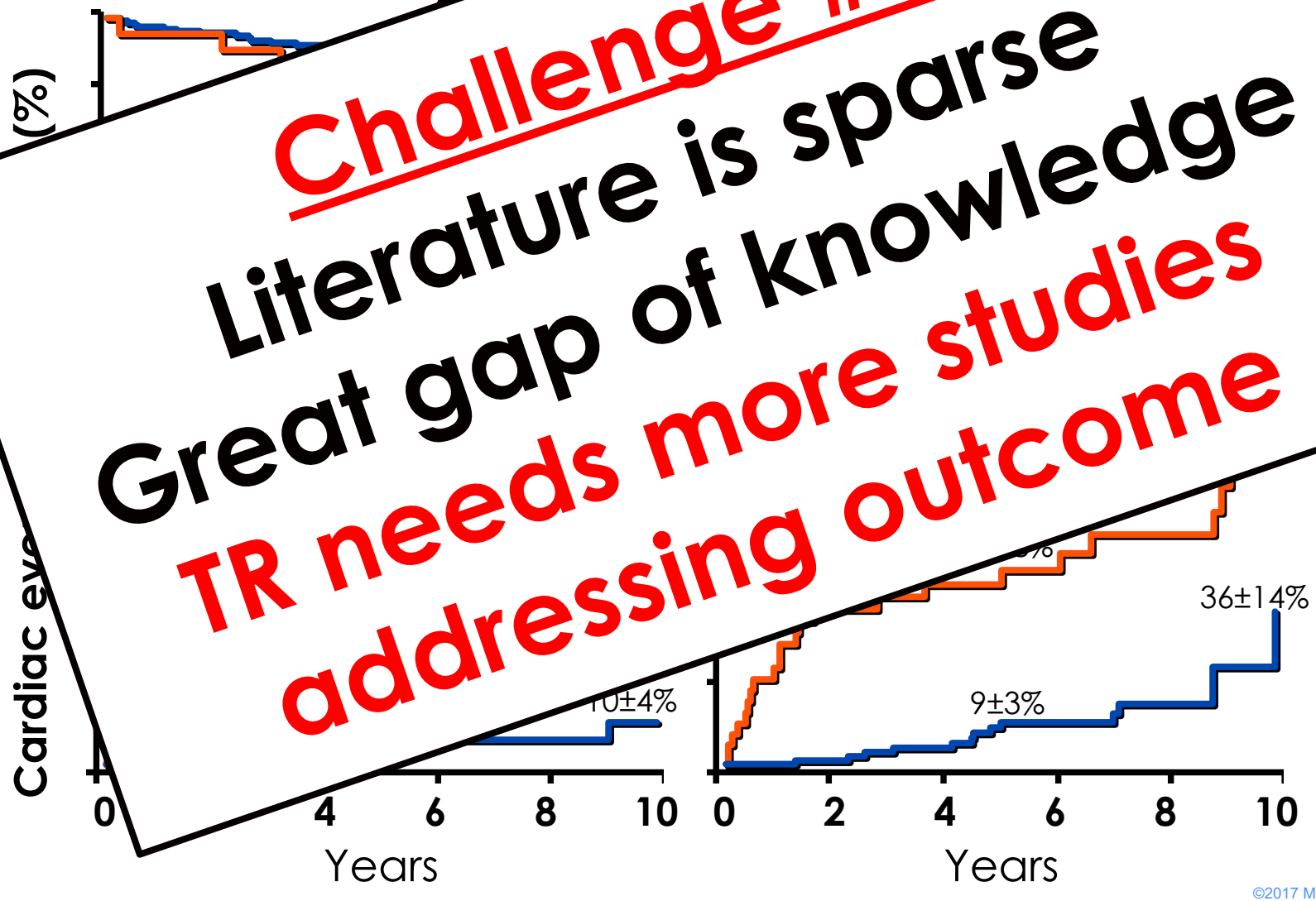
Isolated TR Outcome



MAYO CLINIC

Isolated TR Out

Sinus Rhythm

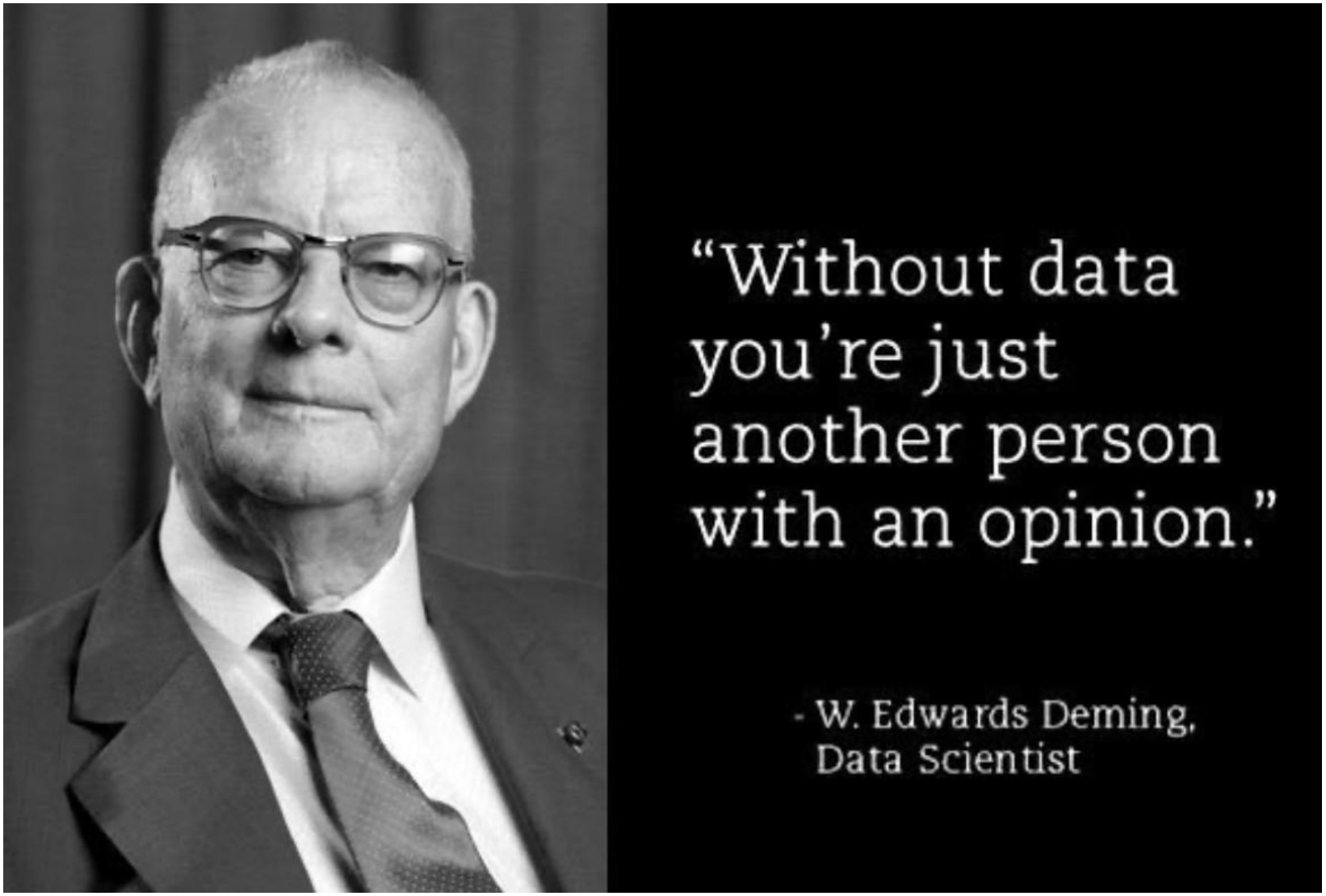


Challenge #4

Literature is sparse

Great gap of knowledge

TR needs more studies addressing outcome



MAYO CLINIC

HÔPITAL DE CANNES

ESC European Society of Cardiology

European Heart Journal (2020) **0**, 1–13
doi:10.1093/eurheartj/ehaa192

CLINICAL RESEARCH

Functional tricuspid regurgitation of degenerative mitral valve disease: a crucial determinant of survival

Benjamin Essayagh[1], Clémence Antoine [1], Giovanni Benfari [1], Joseph Maalouf [1], Hector I. Michelena [1], Juan A. Crestanello[1], Prabin Thapa [1], Jean-François Avierinos[2], and Maurice Enriquez-Sarano [1]*

[1]Department of Cardiovascular Medicine, Mayo Clinic, 200 First St SW, Rochester, MN 55905, USA; and [2]Department of Cardiology, APHM, La Timone Hospital, Bd Jean Moulin, 13005 Marseille, France

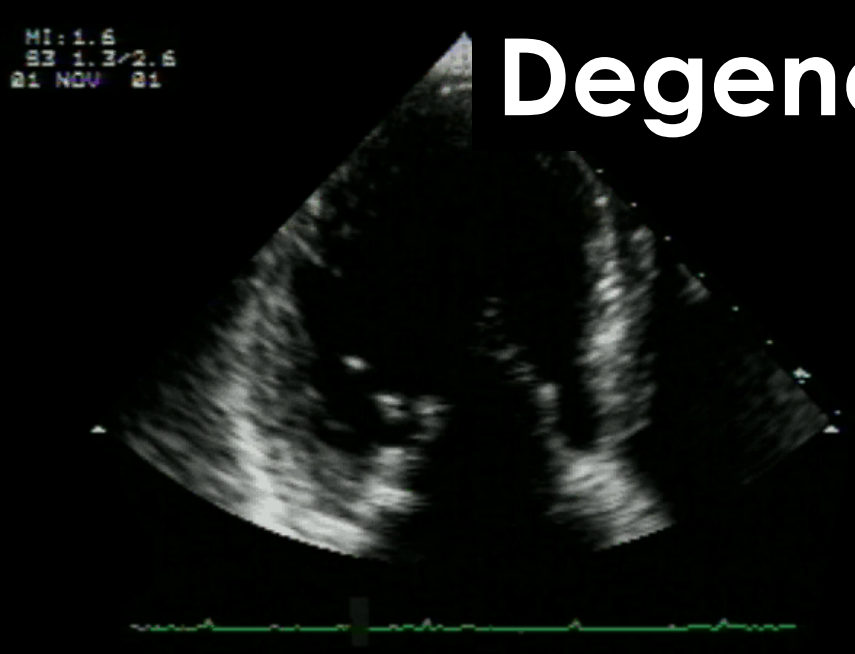
Received 30 July 2019; revised 24 September 2019; editorial decision 4 March 2020; accepted 4 March 2020

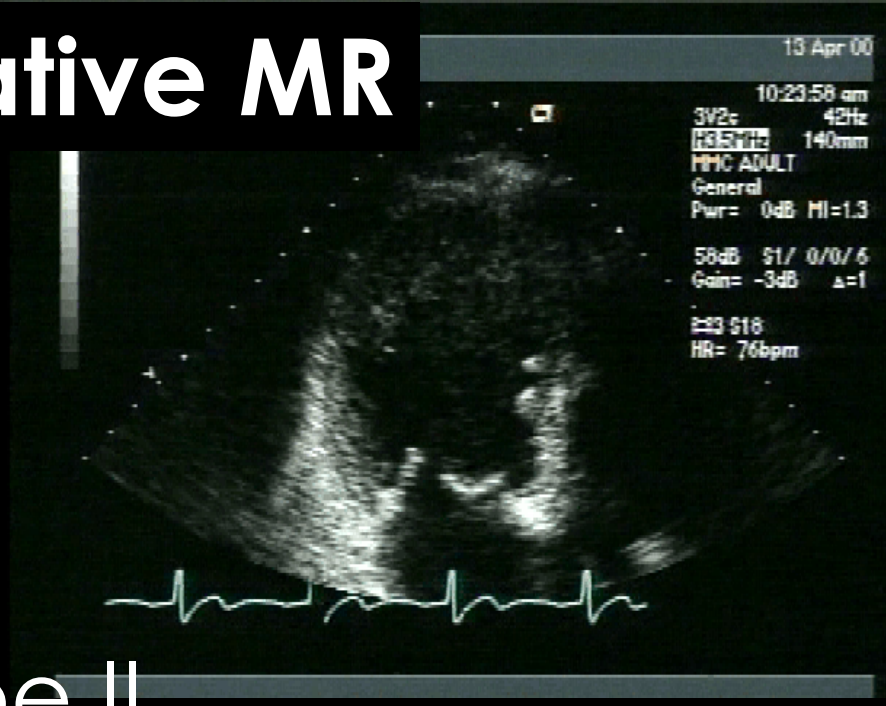
MAYO CLINIC

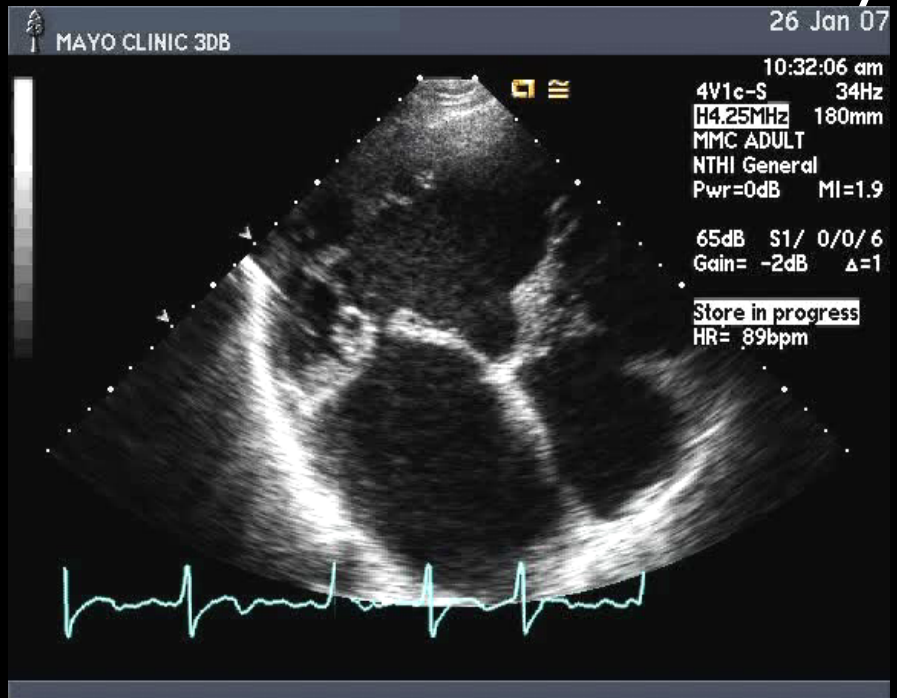
HÔPITAL DE CANNES

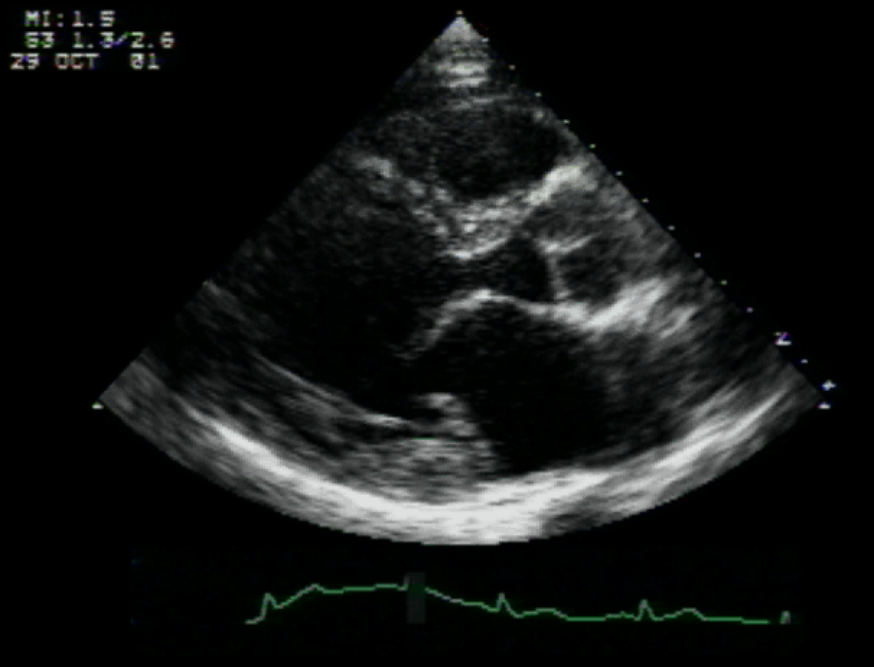
Degenerative MR

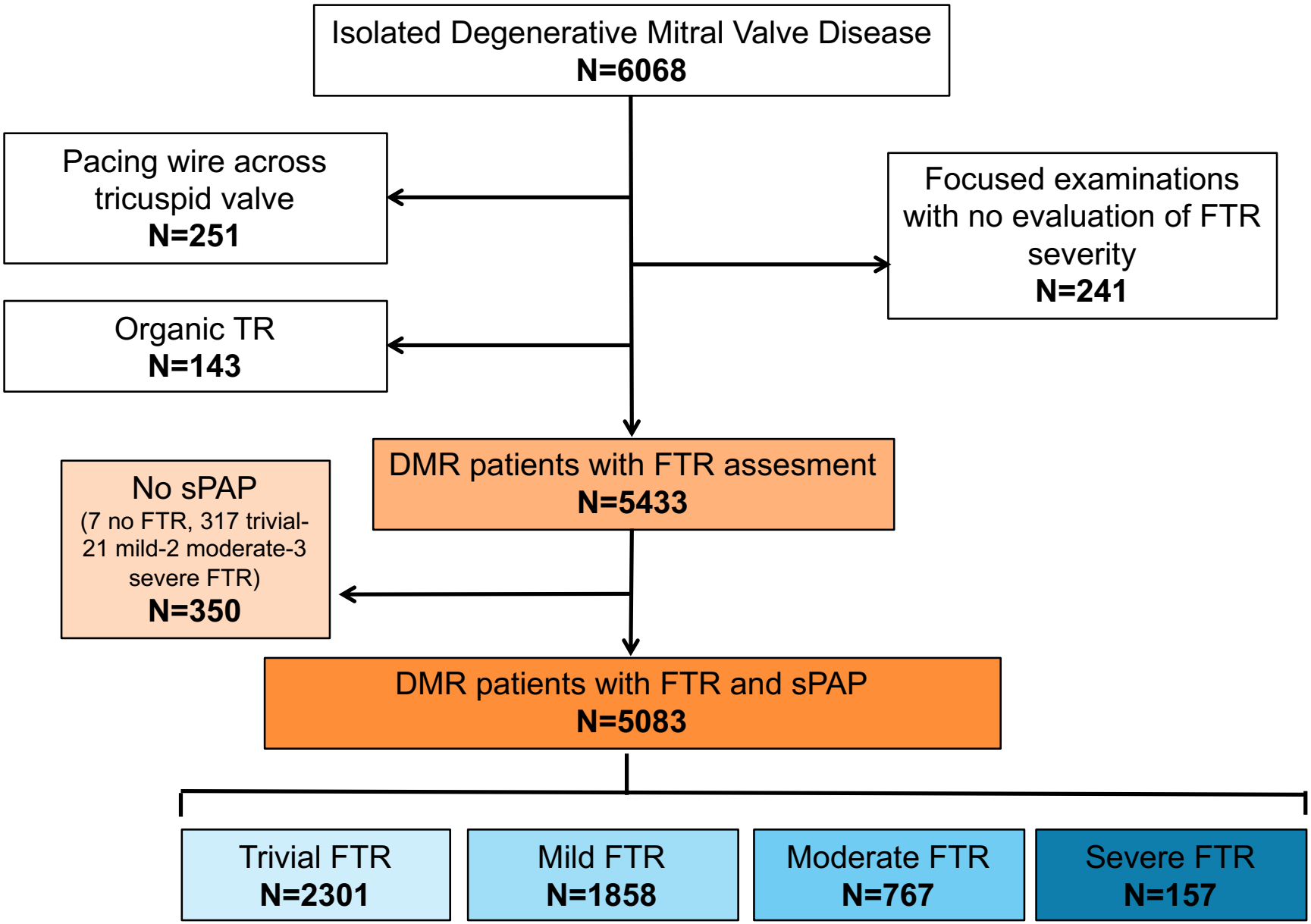
Type II



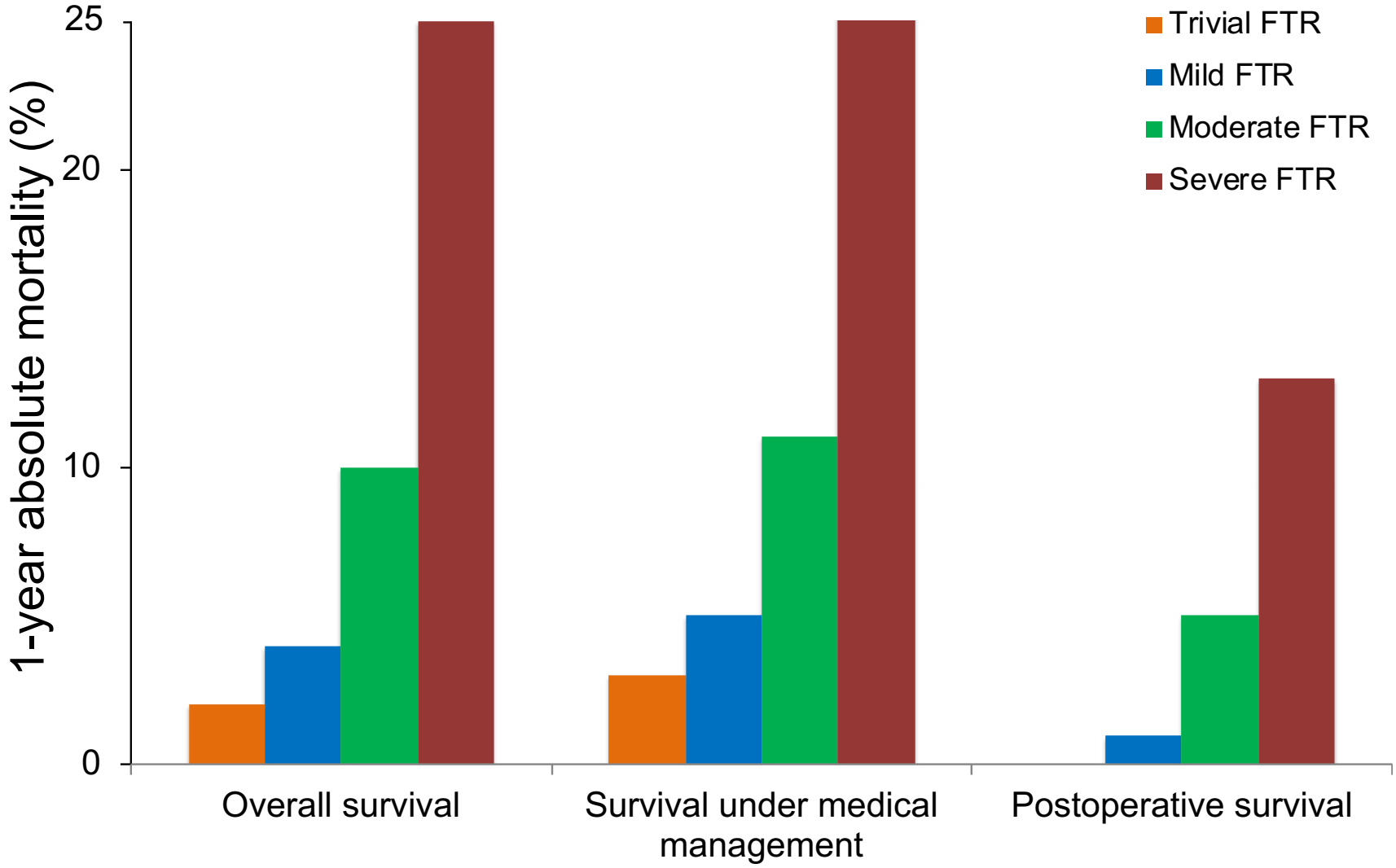






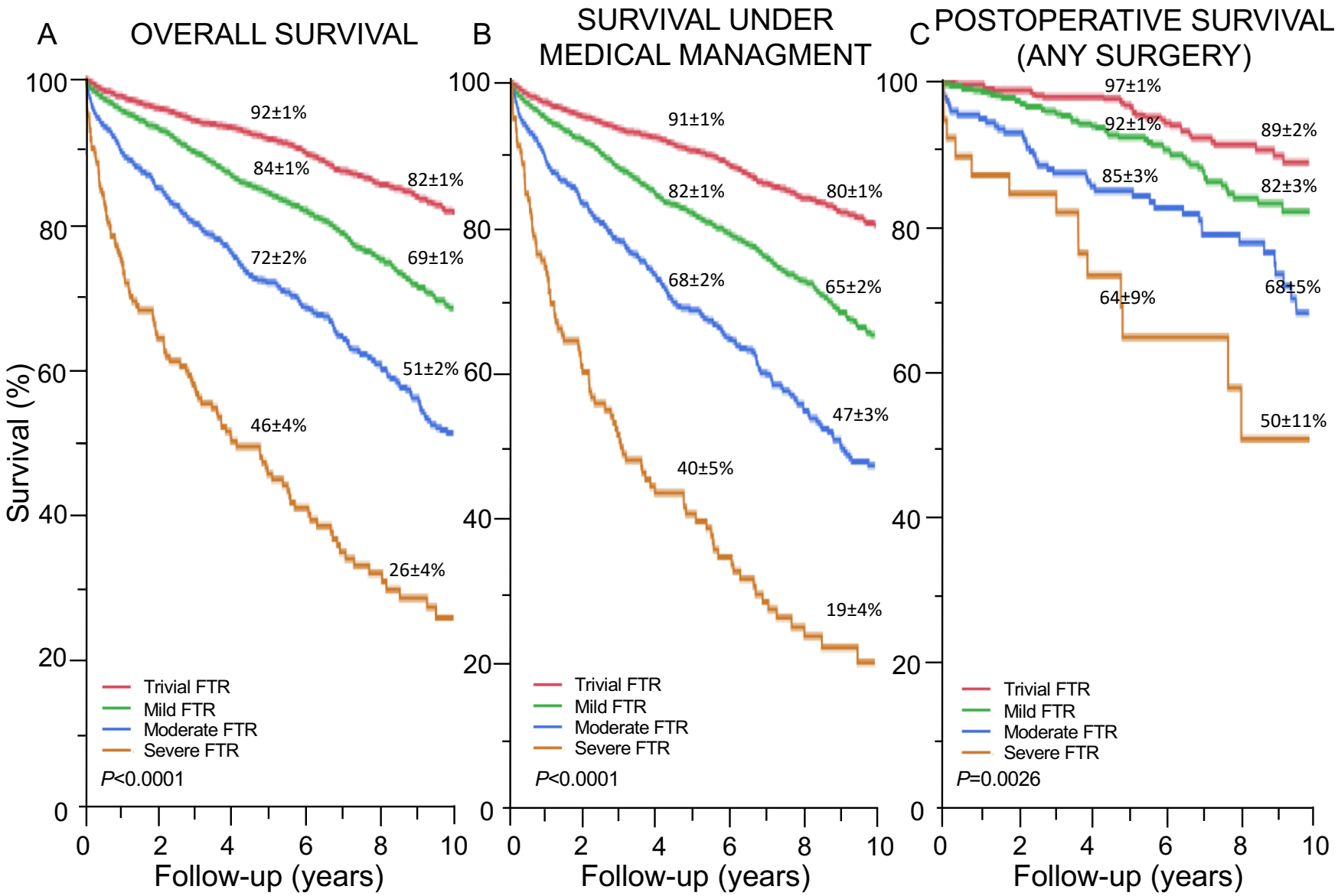


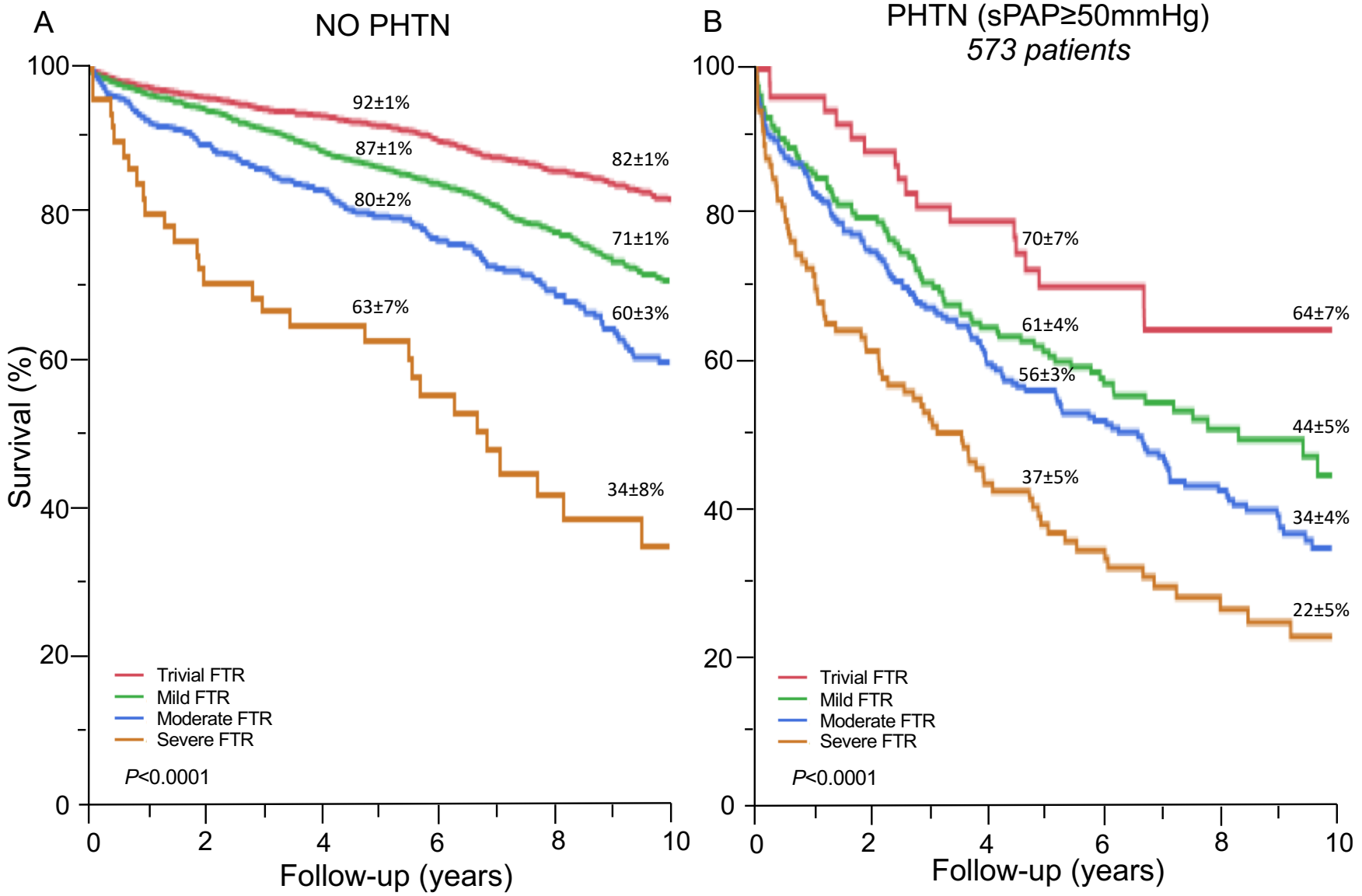
FTR IS A STRONG DETERMINENT OF SURVIVAL

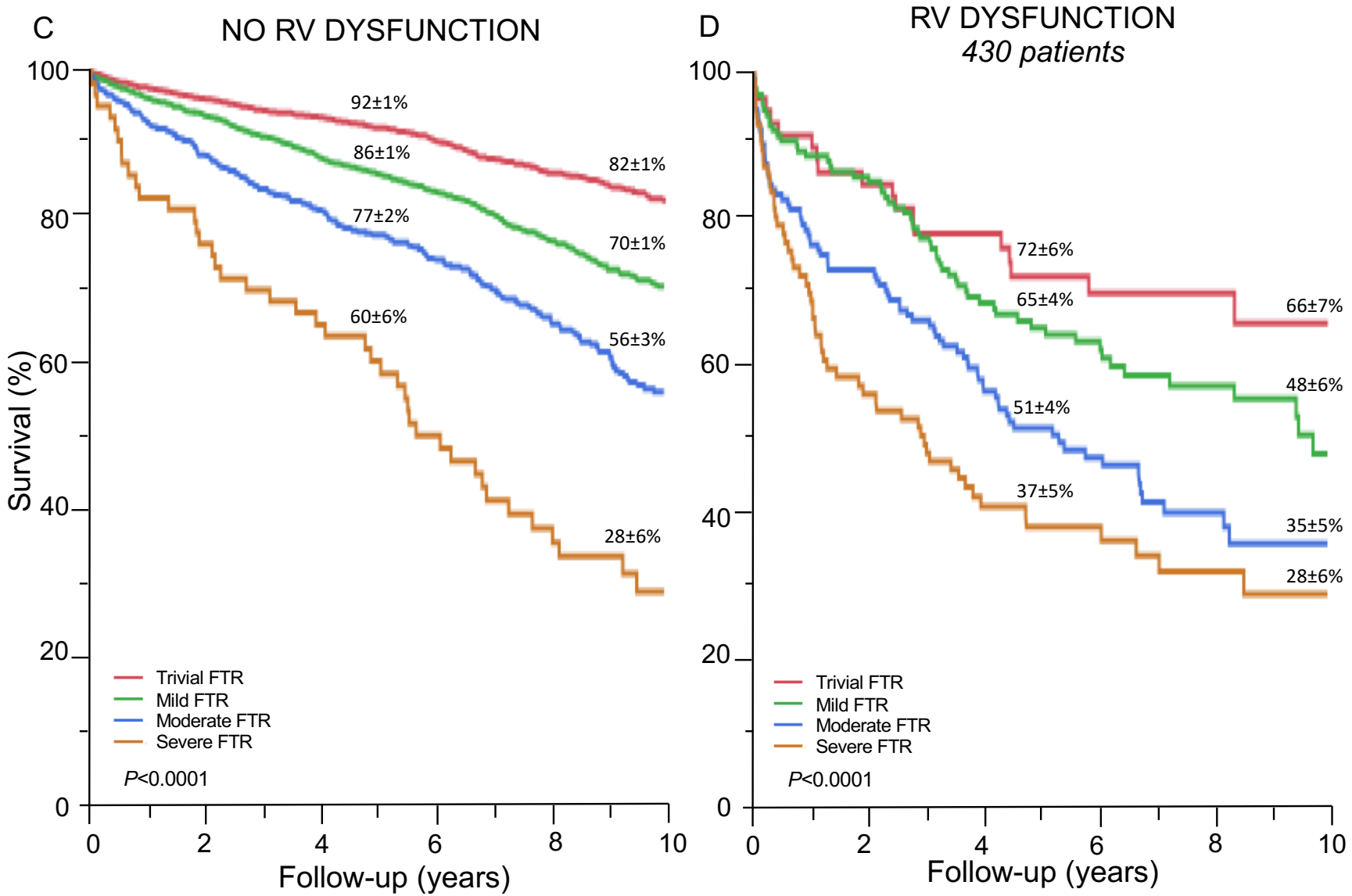


MAYO CLINIC

B. Essayagh *et al.*







FUNCTIONAL TRICUSPID REGURGITATION

MORE SEVERE HEART FAILURE

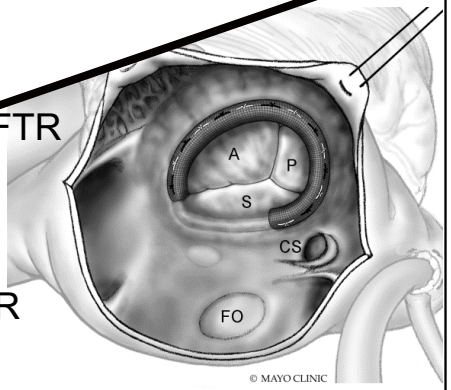
↑ edema
↓ stroke

B. Essayagh *et al.*

Challenge #4

TR is associated with poor clinical outcome *independent* of comorbidity, MR severity, RV dysfunction, or PHTN

With DMR surgery
6% moderate FTR
21% severe FTR



B. Essayagh *et al.*

Circulation

ORIGINAL RESEARCH ARTICLE

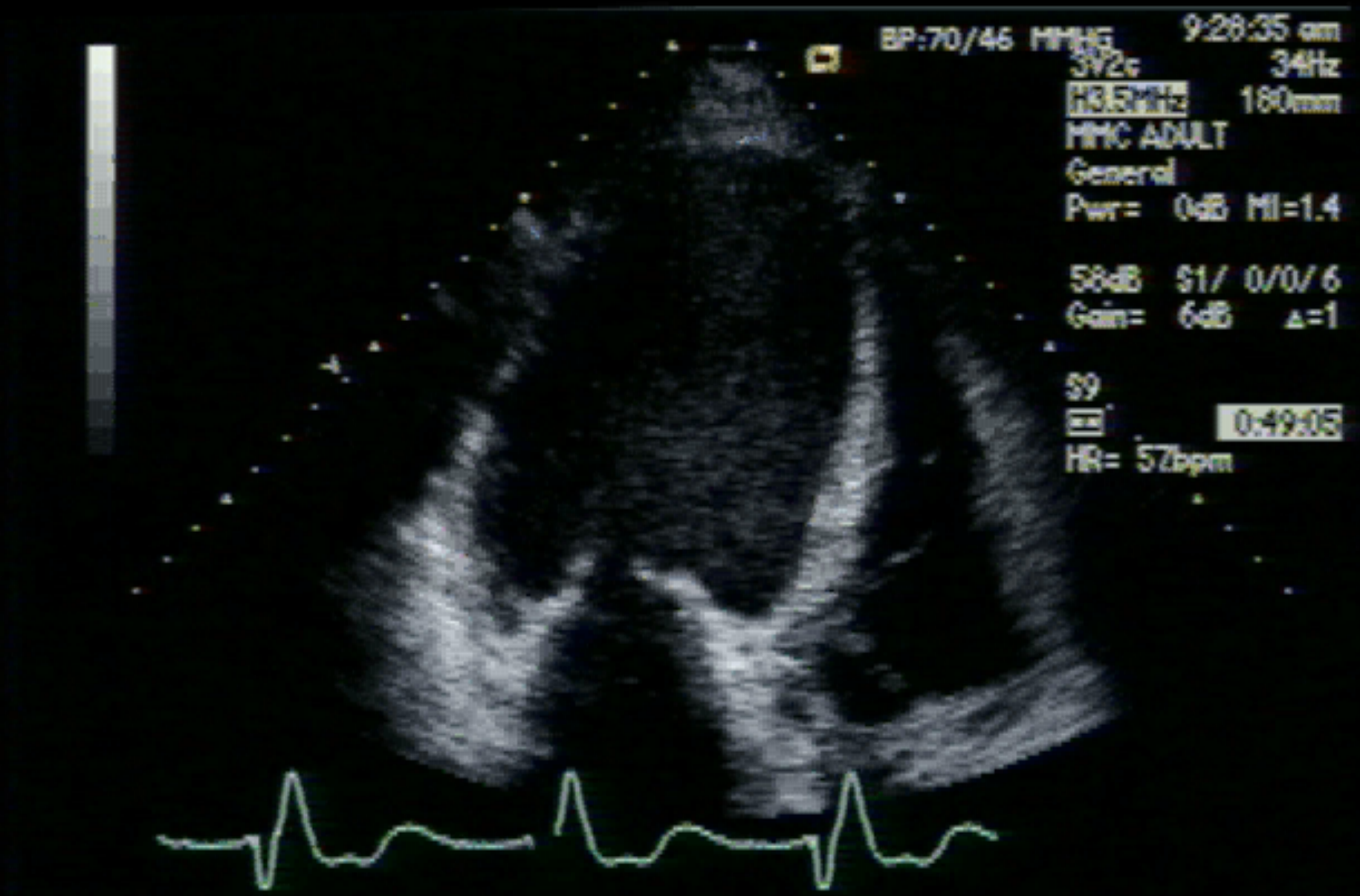
Excess Mortality Associated With Functional Tricuspid Regurgitation Complicating Heart Failure With Reduced Ejection Fraction

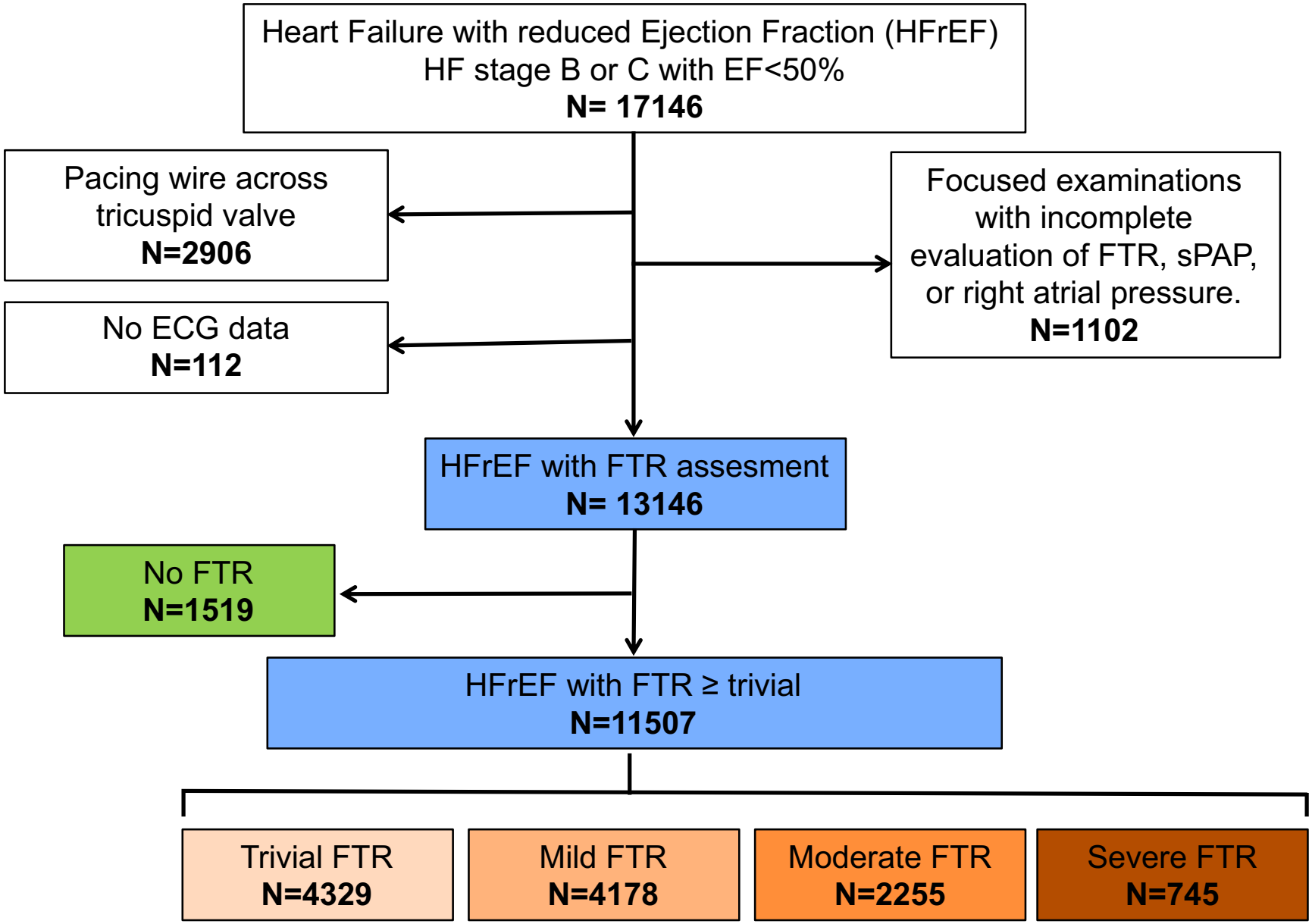
BACKGROUND: Functional tricuspid regurgitation (FTR) is common in heart failure with reduced ejection fraction and mostly consequent to pulmonary hypertension. However, the intrinsic clinical implications of FTR are not fully understood.

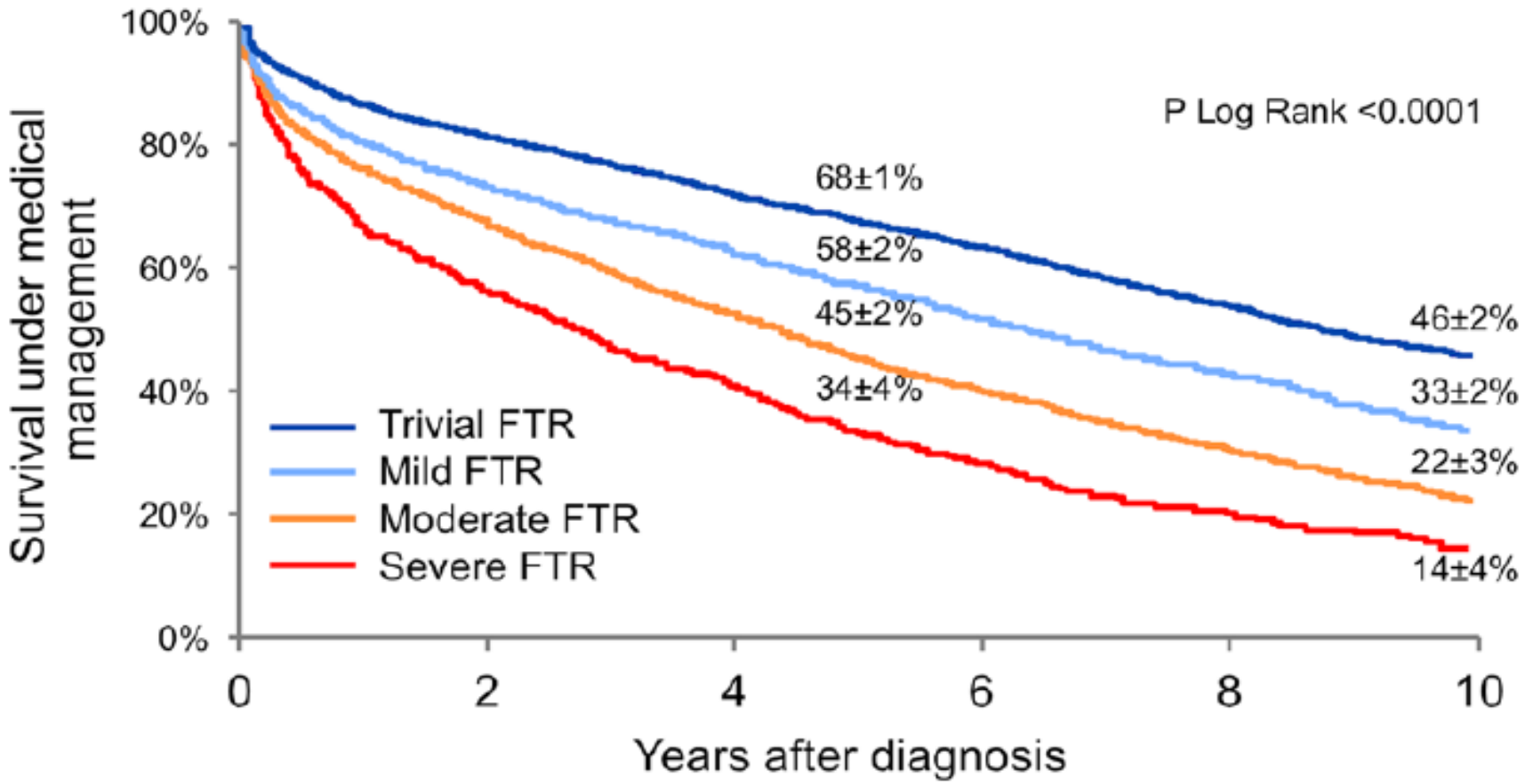
METHODS: The cohort of all Mayo Clinic patients from 2003 to 2011 diagnosed with heart failure stage B-C and ejection fraction<50%, with FTR grading and systolic pulmonary artery pressure estimation by Doppler echocardiography was identified and outcomes were analyzed. Patients with pacemakers/defibrillators, organic valve disease, or previous valve

Giovanni Benfari, MD
Clemence Antoine, MD
Wayne L. Miller, MD, PhD
Prabin Thapa, BS
Yan Topilsky, MD
Andrea Rossi, MD
Hector I. Michelena, MD
Sorin Pislaru, MD
Maurice Enriquez-Sarano, MD

TR associated with LV dysfunction

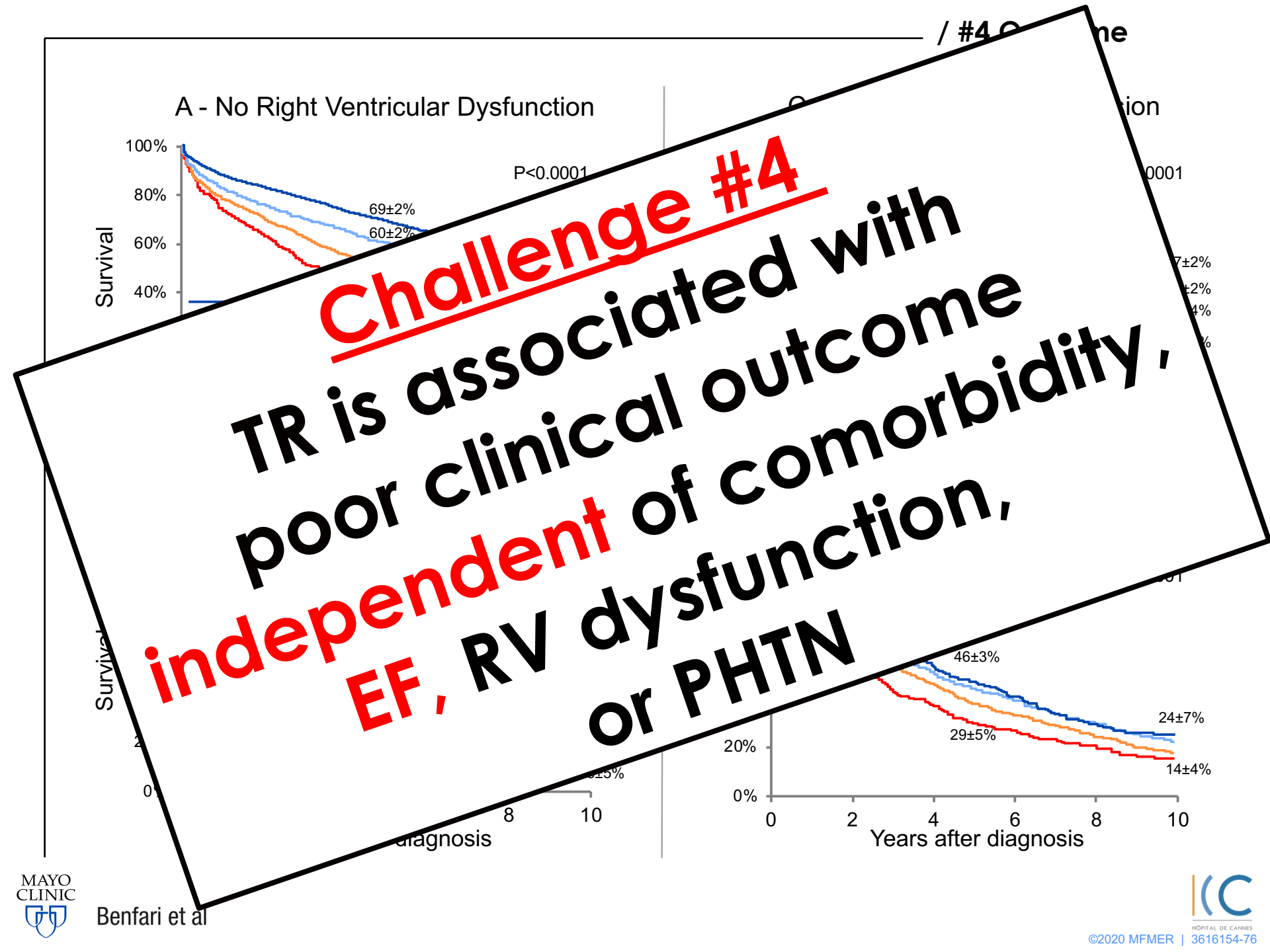






MAYO CLINIC

Benfari et al



Challenge #4

TR is associated with poor clinical outcome *independent* of comorbidity, EF, RV dysfunction, or PHTN

Benfari et al

Tricuspid Regurgitation

A serious condition

in all clinical contexts

What about Tricuspid Interventions ?

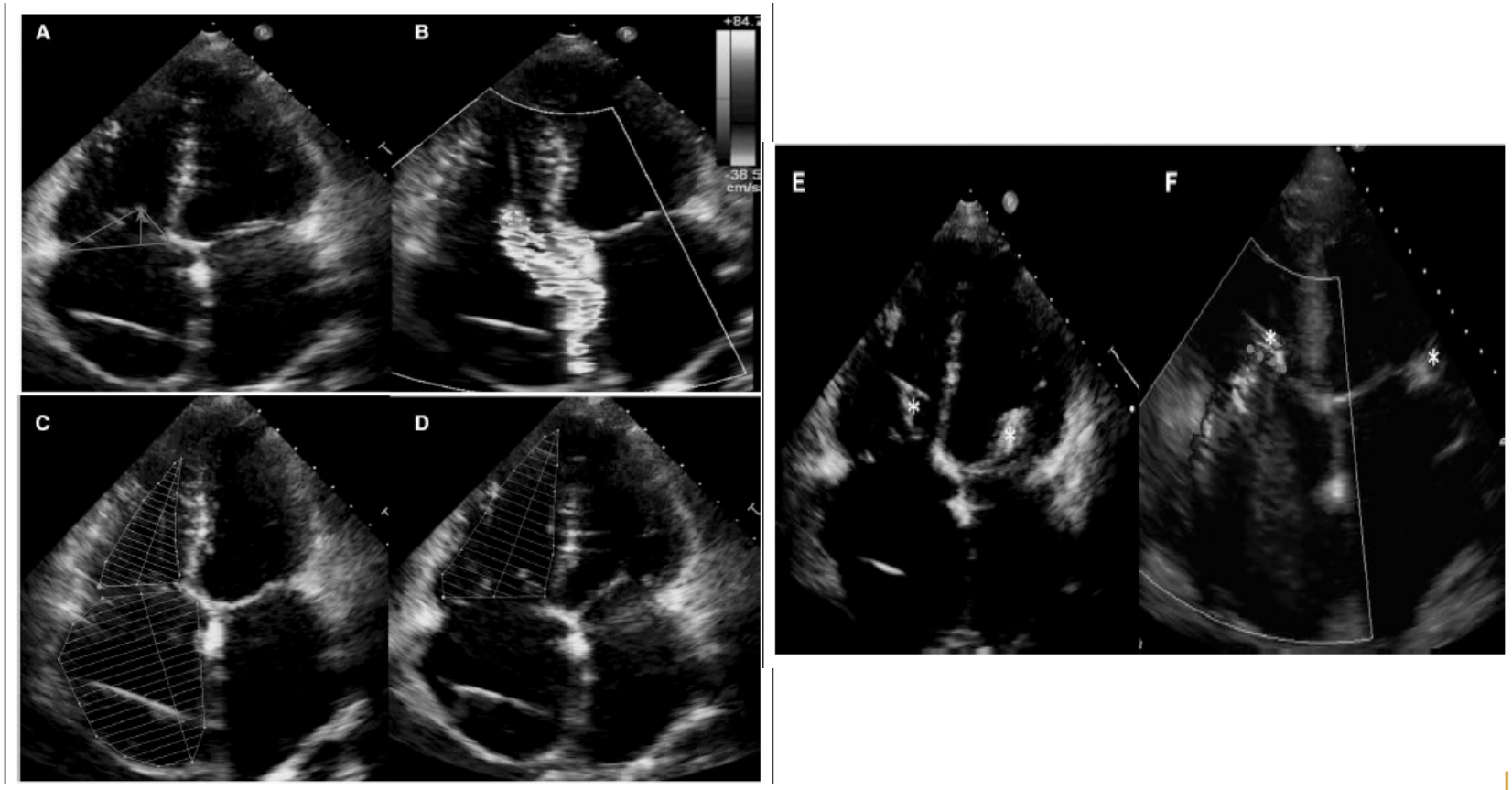
Transcatheter therapies

MAYO CLINIC

HÔPITAL DE CANNES

ORIGINAL RESEARCH ARTICLE

Transcatheter Treatment of Severe Tricuspid Regurgitation With the Edge-to-Edge MitraClip Technique



ORIGINAL RESEARCH ARTICLE

Transcatheter Treatment of Severe Tricuspid Regurgitation With the Edge-to-Edge MitraClip Technique

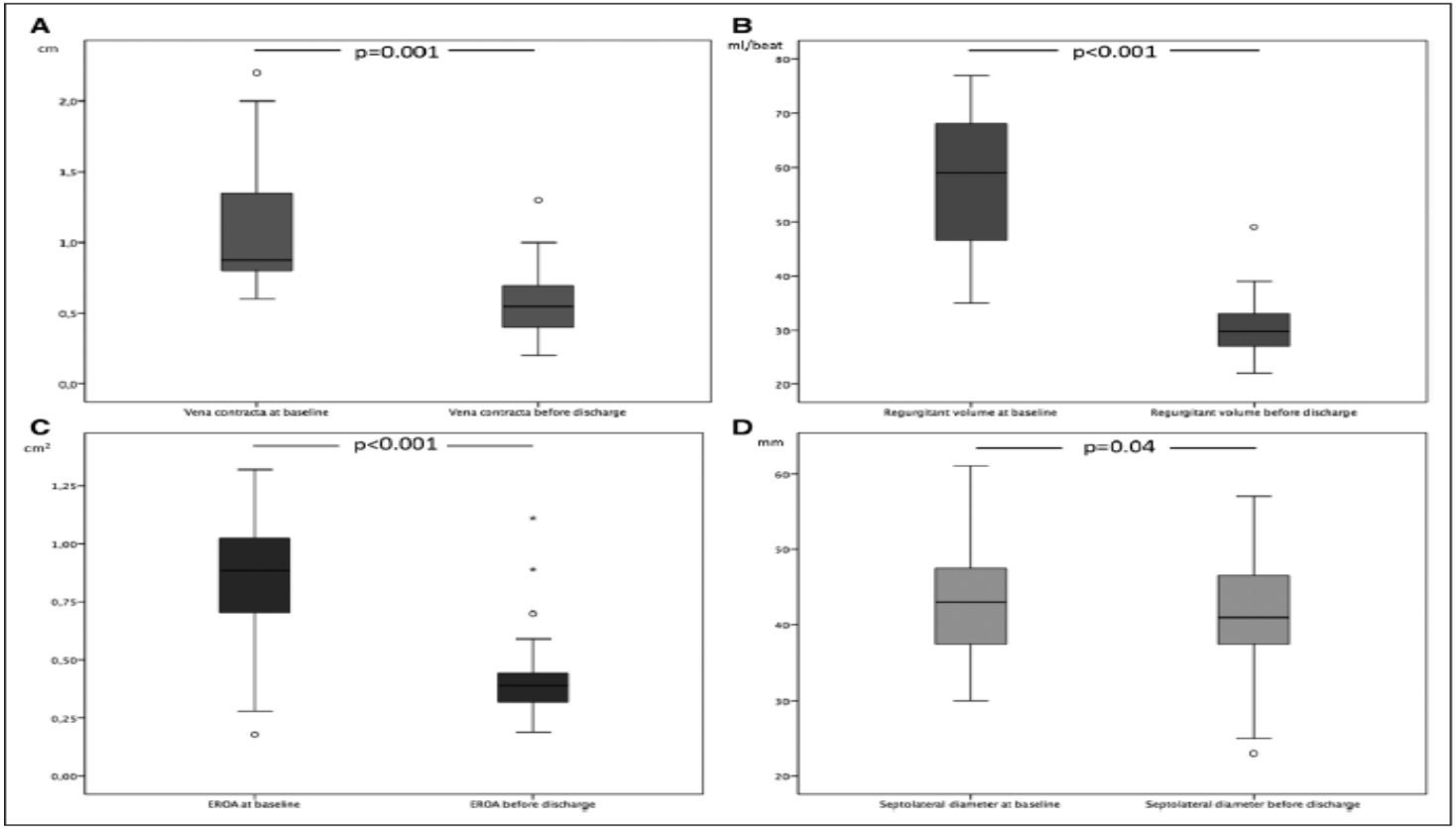
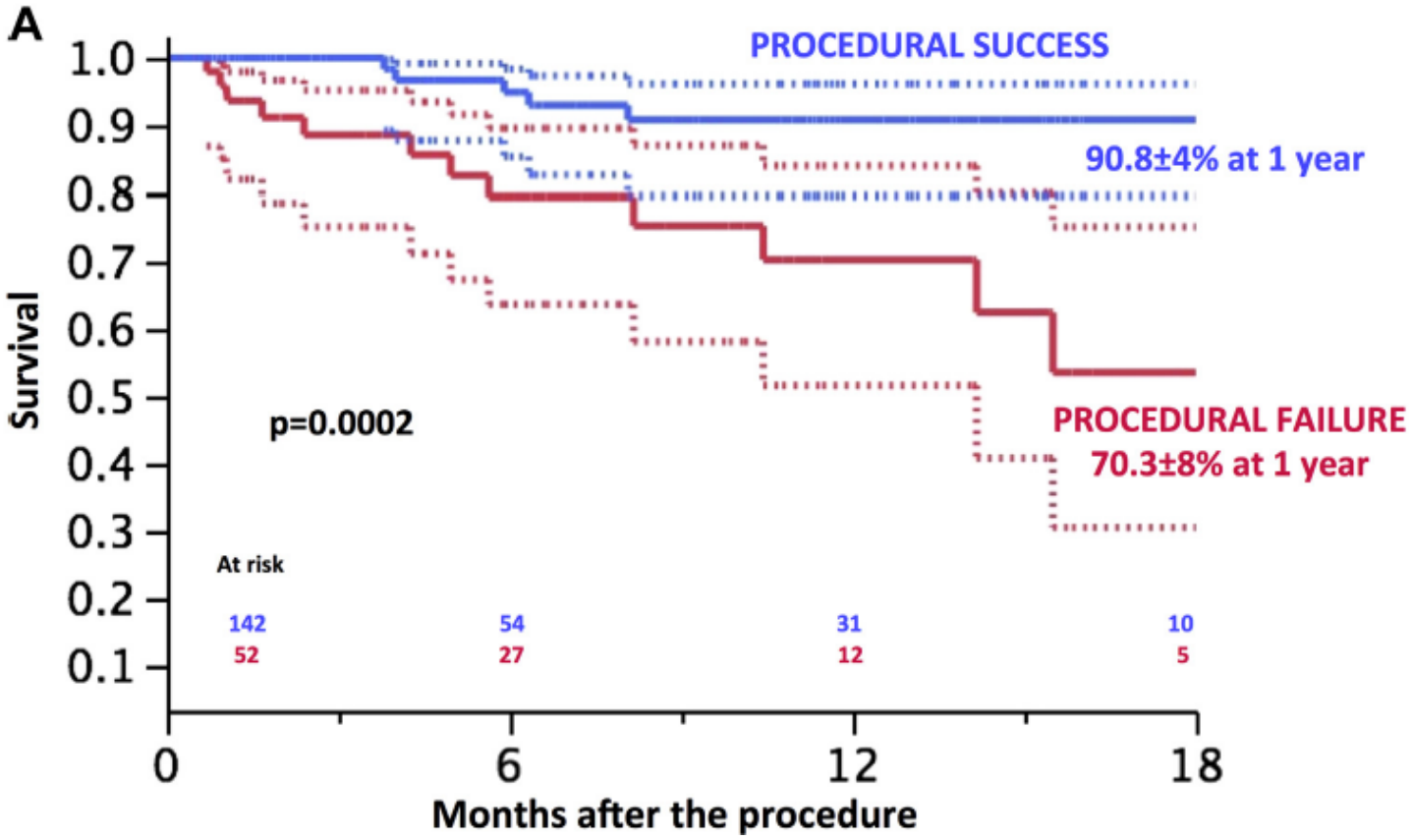


Figure 6. Boxplot diagrams of changes in tricuspid regurgitation defining echocardiographic parameters.
A, Vena contracta width at baseline and before discharge. **B,** Regurgitant volume at baseline and before discharge. **C,** Effective regurgitant orifice area at baseline and before discharge. **D,** Septolateral diameter at baseline and before discharge. *Statistical outlier.

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 Atti
Paolo Dent
Jörg Hausl
Felix Kreid
Michael Me
Fabien Pra
Horst Sieve
John G. We
Martin B. I



ABSTRA

OBJECT
transcath

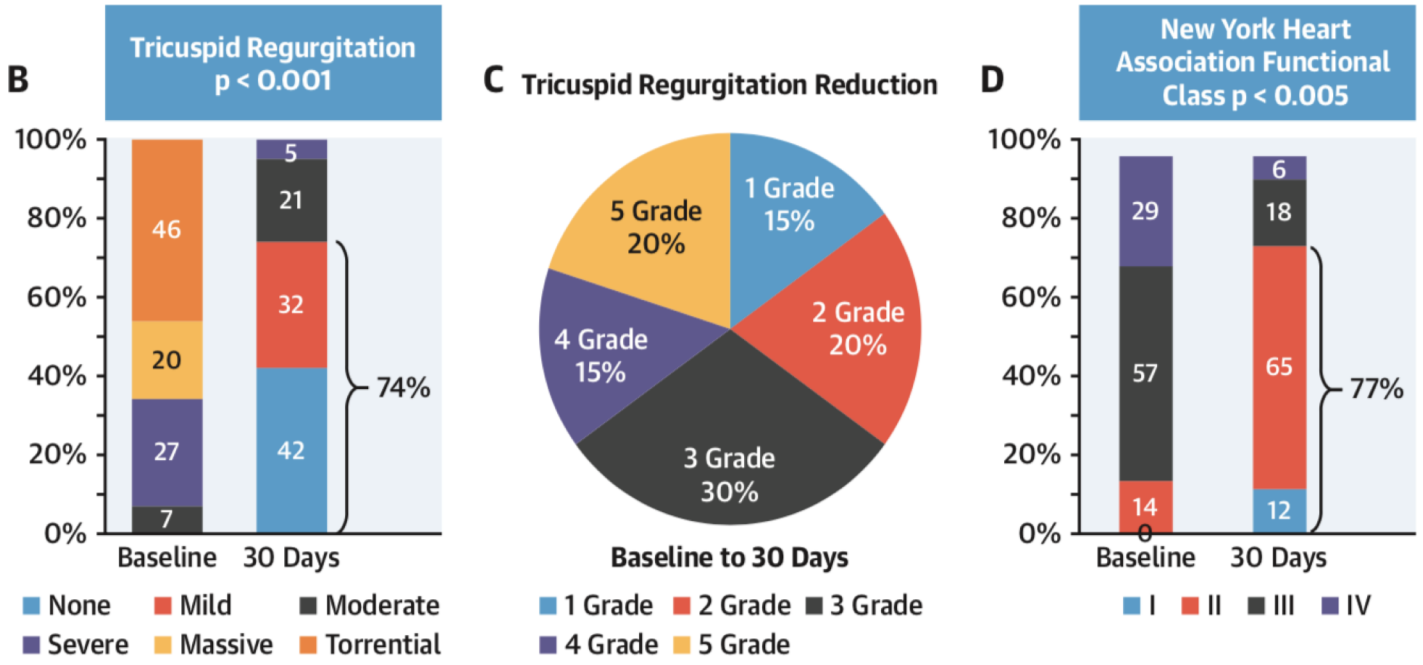
BACKGR
therapeut

JACC: CARDIOVASCULAR INTERVENTIONS
VOL. 13, NO. 21, 2020

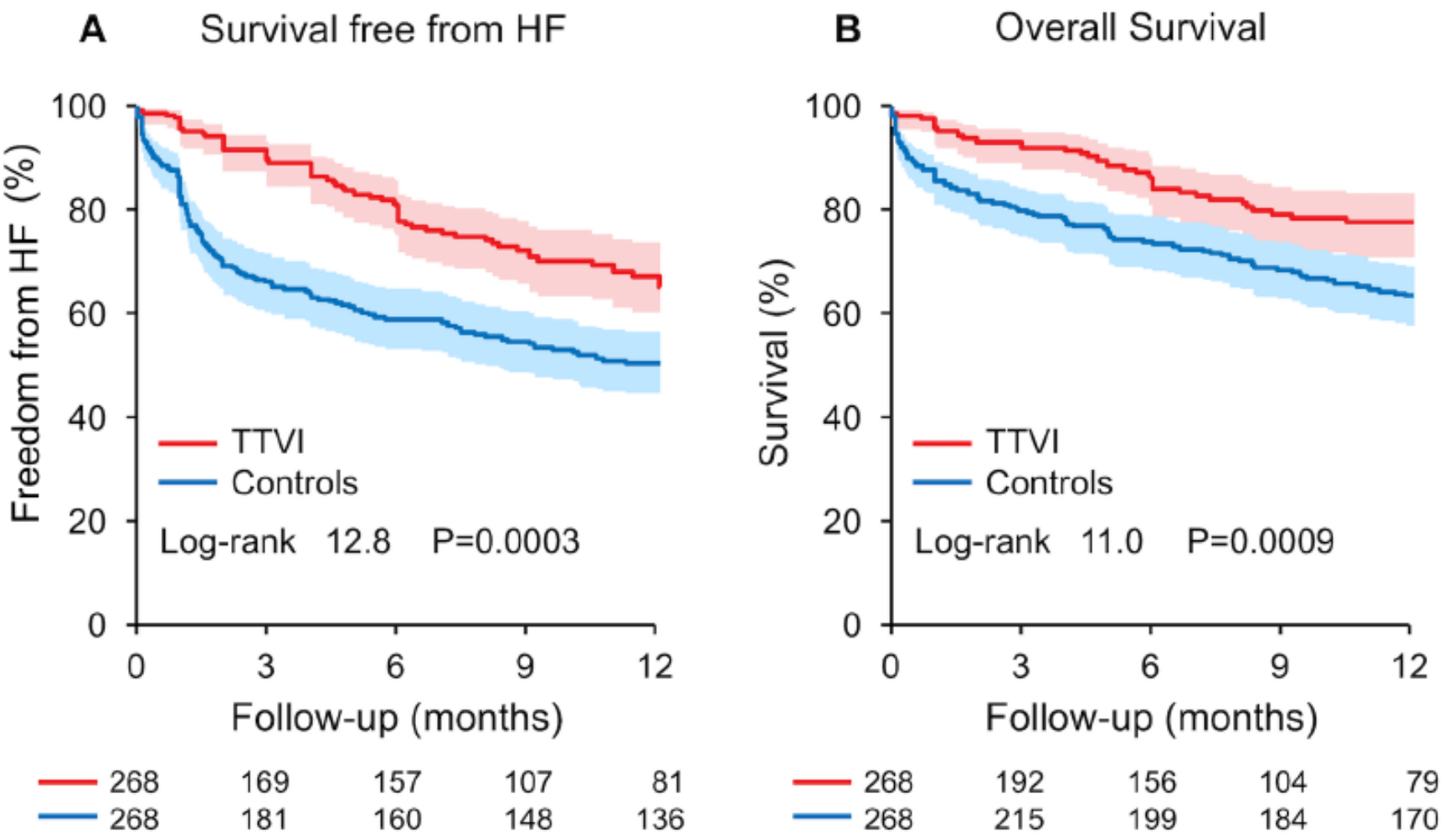
PUBLISHED BY ELSEVIER

Early Multinational Experience of Transcatheter Tricuspid Valve Replacement for Treating Severe Tricuspid Regurgitation

Rebecca T. Hahn, MD,[a] Susheel Kodali, MD,[a] Neil Fam, MD,[b] Vinayak Bapat, MBBS, MS, MCh,[a]



Hahn, R.T. et al. J Am Coll Cardiol Intv. 2020;13(21):2482-93.



Taramasso M, Benfari G, van der Bijl P et al. Transcatheter versus medical treatment of symptomatic severe tricuspid regurgitation. J Am Coll Cardiol 2019.

TR: the forgotten valve ?

/ TR is poorly understood: comprehensive mechanism and quantification is key to management

/ Moderate and Severe TR adversely affects clinical outcome in all clinical contexts

/ We need to address TR severe undertreatment

MAYO CLINIC

HÔPITAL DE CANNES

ESC European Society of Cardiology

European Heart Journal (2020) **41**, 1930–1931
doi:10.1093/eurheartj/ehaa255

EDITORIAL

The tricuspid tragedy: from Cinderella to celebrity

Georg Nickenig and Johanna Vogelhuber*

Heart Center Bonn, Bonn, Germany

Online publish-ahead-of-print 26 April 2020

This editorial refers to 'Functional tricuspid regurgitation of degenerative mitral valve disease: a crucial determinant of survival' by B. Essayagh *et al.*, on page 1918.

Mild tricuspid regurgitation (TR) can be found frequently in the general population; it is considered benign and mostly an incidental finding

inclusion of DMR and FTR of all grades, and the long follow-up period of 6.8 ± 3.1 years.

Increasing FTR severity led to profound clinical consequences in DMR patients and was associated with older age, female sex, more symptoms, more extensive medical therapy, and a worse renal func-

TR represents a public health crisis

Progress in Cardiovascular Diseases

Tricuspid regurgitation is a public health crisis☆

Maurice Enriquez-Sarano *, David Messika-Zeitoun, Yan Topilsky, Christophe Tribouilloy, Giovanni Benfari, Hector Michelena

Cardiovascular Department, University of Ottawa, Canada
Cardiovascular Department, University of Tel-Aviv, Israel
Cardiovascular Department, University of Amiens, France

ARTICLE INFO

Article history:
23 October 2019
23 October 2019

ABSTRACT

Tricuspid regurgitation (TR) has long been a forgotten valve disease of benign reputation. However, TR deserves higher attention and represents a growing public health crisis. Indeed, recent epidemiological data suggest that 1.6 million US residents are affected by moderate or severe TR. Furthermore, large recent cohorts demonstrate

What makes a public health crisis ?

/ The condition has to be frequent

/ Associated with serious outcome consequences

/ Treatment is either unknown or not administrated

What makes a public health crisis ?

/ TR occurs with a high incidence

/ TR is link very with serious outcome consequences

/ The current (surgical) TR treatment is high-risk and is severely underused

/ Tricuspid Regurgitation /

An imperious need to address undertreatment

/ Thank you /