



Essentials: Episode 4

Multiple Valvular Heart Disease
Mixed Valvular Heart Disease
Endocarditis

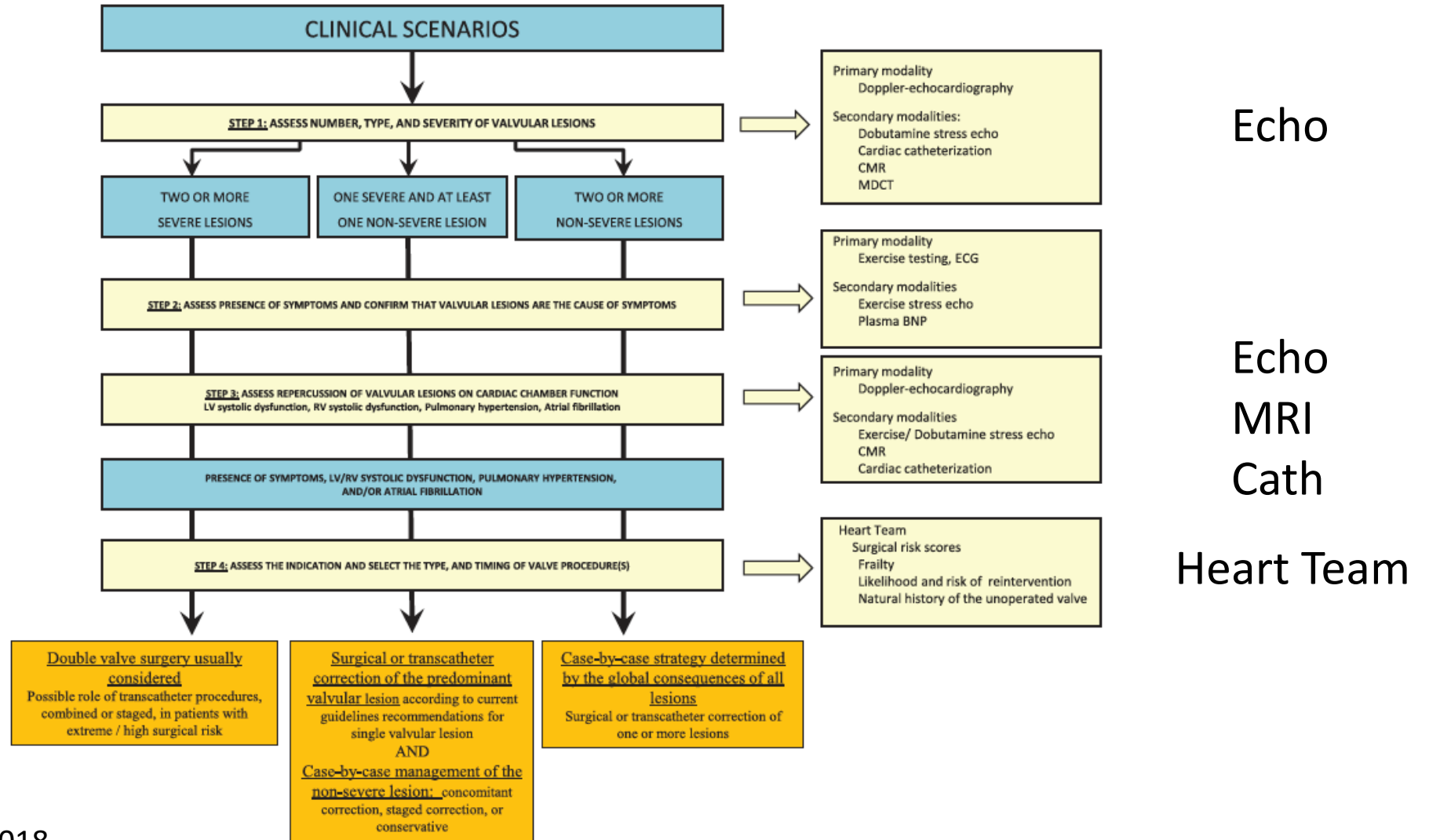
General approach for multiple and mixed VHD

1. Number/type VHD

2. Symptoms

3. Repercussion

4. Procedure



Echo

Echo

MRI

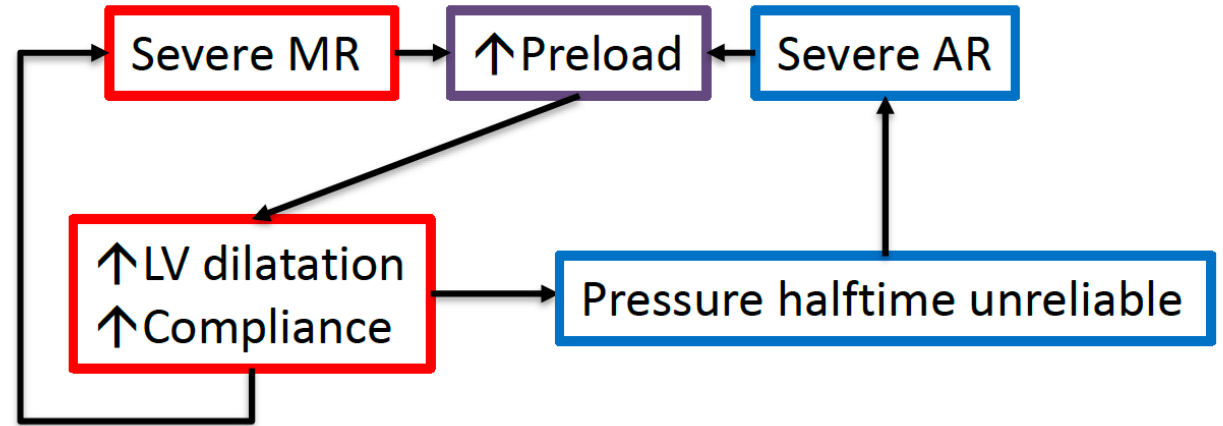
Cath

Heart Team

Unger P, Circ Cardiovasc Imag 2018

Prevalence of combined AR/MR

- Rare among young adults
- Prevalence 8-10.7%
- 3rd most frequent combination when multivalvular disease
- Rheumatic disease, the leading cause (51%) (EuroHeart Survey)
- Increasing frequency of degenerative disease
- MR can be primary or secondary (uncommon, mechanism of compensation)



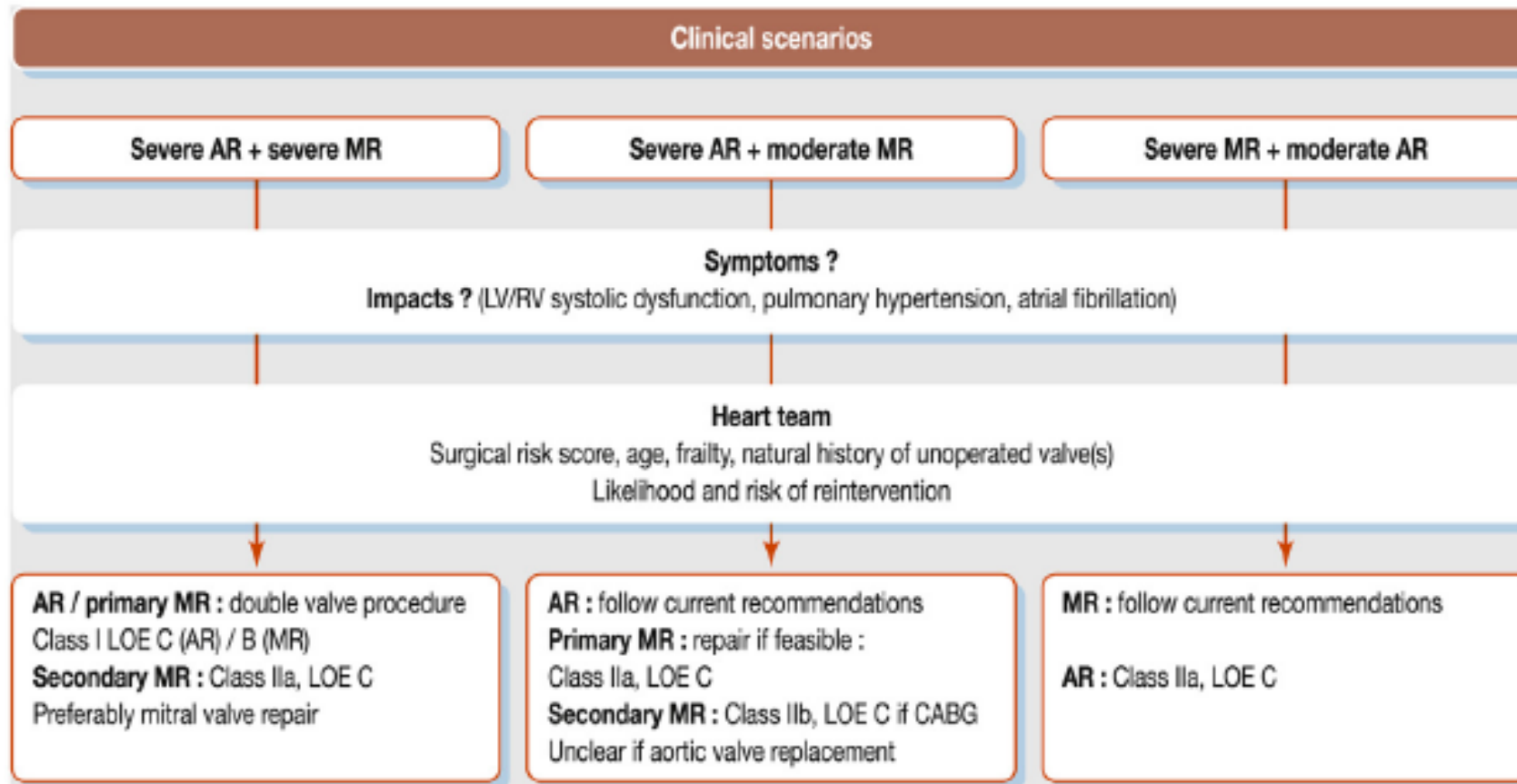
- Severe AR and MR:
 - poorly tolerated hemodynamically
 - Postoperative LV dysfunction more likely to occur

Andell P, Heart 2017;103:1696–703

Iung B, Curr Probl Cardiol 2007;32:609–61

Goldberg SH, J Am Coll Cardiol 2007;50:1205–13.

Approach MR/AR: 3 scenarios



Oriented to surgery

Unger P, Archives Cardiovascular disease 2019

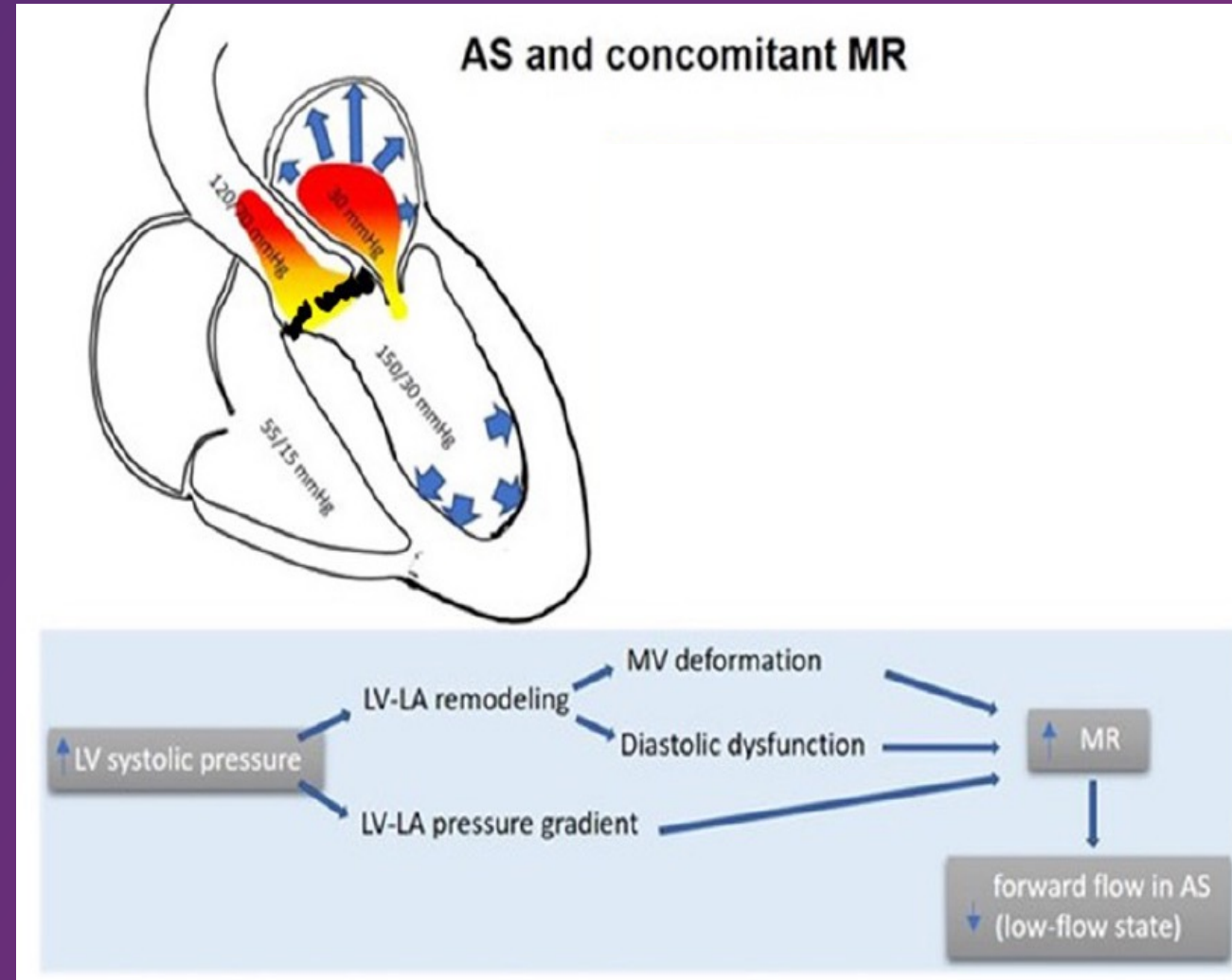
AS and concomitant MR

Presence and severity of MR, reduces SV → **low-flow** condition even with PEF.

Hence AS severity can be underestimated as flow through aortic valve ↓

Expected pathophysiological consequence of volume overload in MR → LV enlargement, to maintain SV.

But remodeling led by AS → LVH, small cavity, ↓ subendocardial LV function with ↓ longitudinal contraction

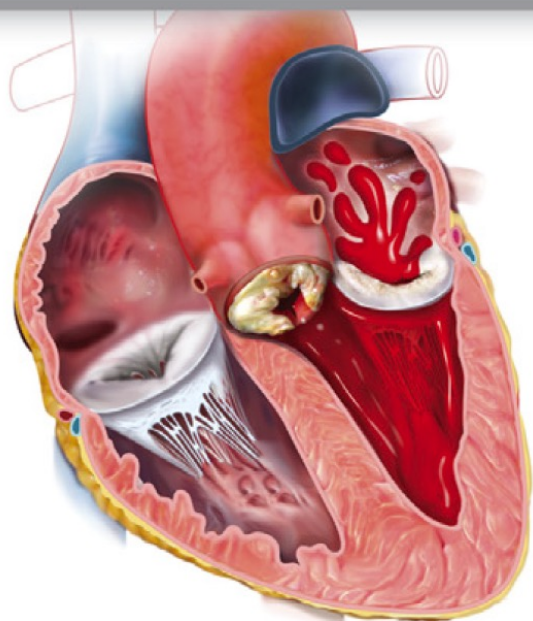


Take home messages: AS + MR

- ✓ The particular **interaction** of these two valve lesions makes echocardiographic evaluation challenging
- ✓ AS severity can be **underestimated** in the presence of MR due to a **low flow state**
- ✓ Color Doppler and RVol can overestimate severity of MR
- ✓ Advanced imaging can help in the correct evaluation of valve lesions
- ✓ **Calcium score of AV** is helpful when echocardiography is inconclusive

Severe AS + significant MR

Severe AS with
≥ moderate MR



- Low LVEF
- Functional MR
- Absence of AF
- Absence of pulmonary hypertension

Yes

TAVR
(~50% chance
of MR
improvement)

Symptomatic
severe MR
persists

Percutaneous or
surgical mitral
intervention

No

Surgical
candidate

Yes

Surgical
treatment of
both valves

No

TAVR +
percutaneous
mitral intervention

Khan F, et al. J Am Coll Cardiol Interv 2020;13:1503–14.

TAVI and TEER

- In high-risk or inoperable patients with severe AS and severe MR, combined (or more often sequential) TAVI and TEER may be feasible, but there is insufficient experience to allow robust recommendations
- In patients with severe primary MR, TEER should be considered early if the patient remains symptomatic and MR is still severe after TAVI
- In patients with severe secondary MR, TAVI should be followed by careful clinical and echocardiographic reassessment to determine whether further mitral intervention is required

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

Left sided VHD and TR

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Concomitant Tricuspid Repair in Patients with Degenerative Mitral Regurgitation

J.S. Gammie, M.W.A. Chu, V. Falk, J.R. Overbey, A.J. Moskowitz, M. Gillinov, M.J. Mack, P. Voisine, M. Krane, B. Yerokun, M.E. Bowdish, L. Conradi, S.F. Bolling, M.A. Miller, W.C. Taddei-Peters, N.O. Jeffries, M.K. Parides, R. Weisel, M. Jessup, E.A. Rose, J.C. Mullen, S. Raymond, E.G. Moquete, K. O'Sullivan, M.E. Marks, A. Iribarne, F. Beyersdorf, M.A. Borger, A. Geirsson, E. Bagiella, J. Hung, A.C. Gelijns, P.T. O'Gara, and G. Ailawadi, for the CTSN Investigators*

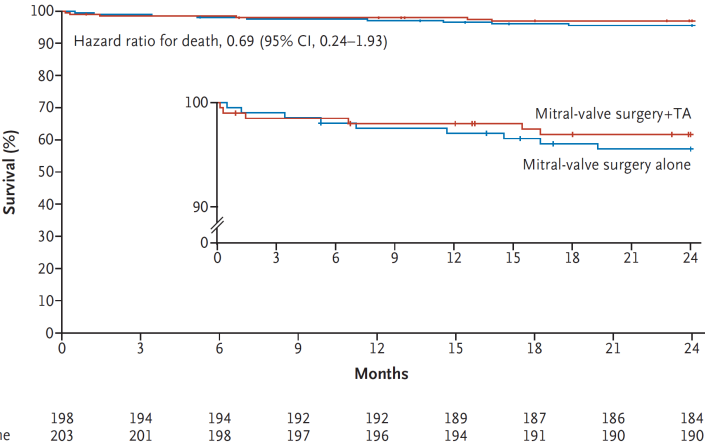


Figure 1. Overall Survival.

Shown are Kaplan-Meier estimates of overall survival during the 2 years after randomization among patients with moderate or less-than-moderate tricuspid regurgitation who were undergoing mitral-valve surgery alone or surgery with placement of a tricuspid annuloplasty (TA) ring. The inset shows the same data on an expanded y axis. The tick marks indicate censored data.

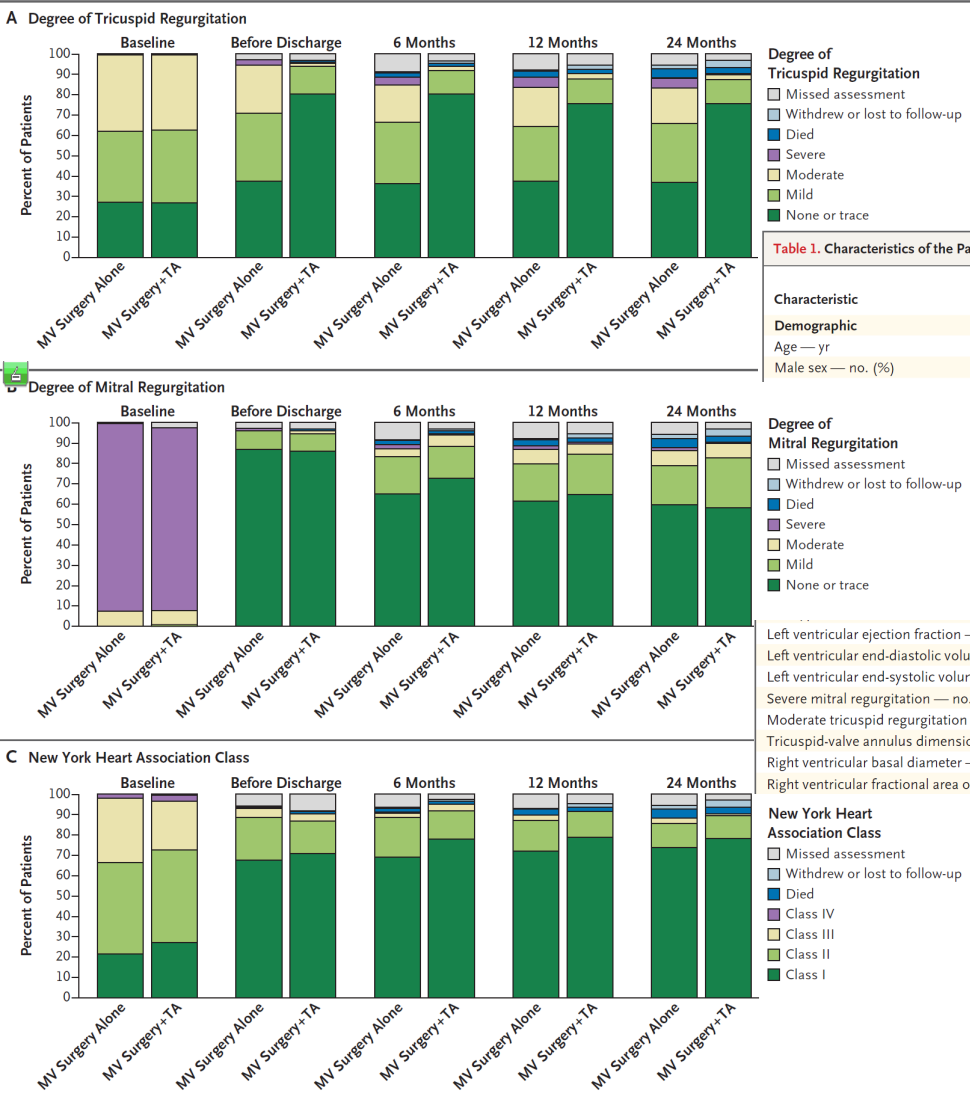
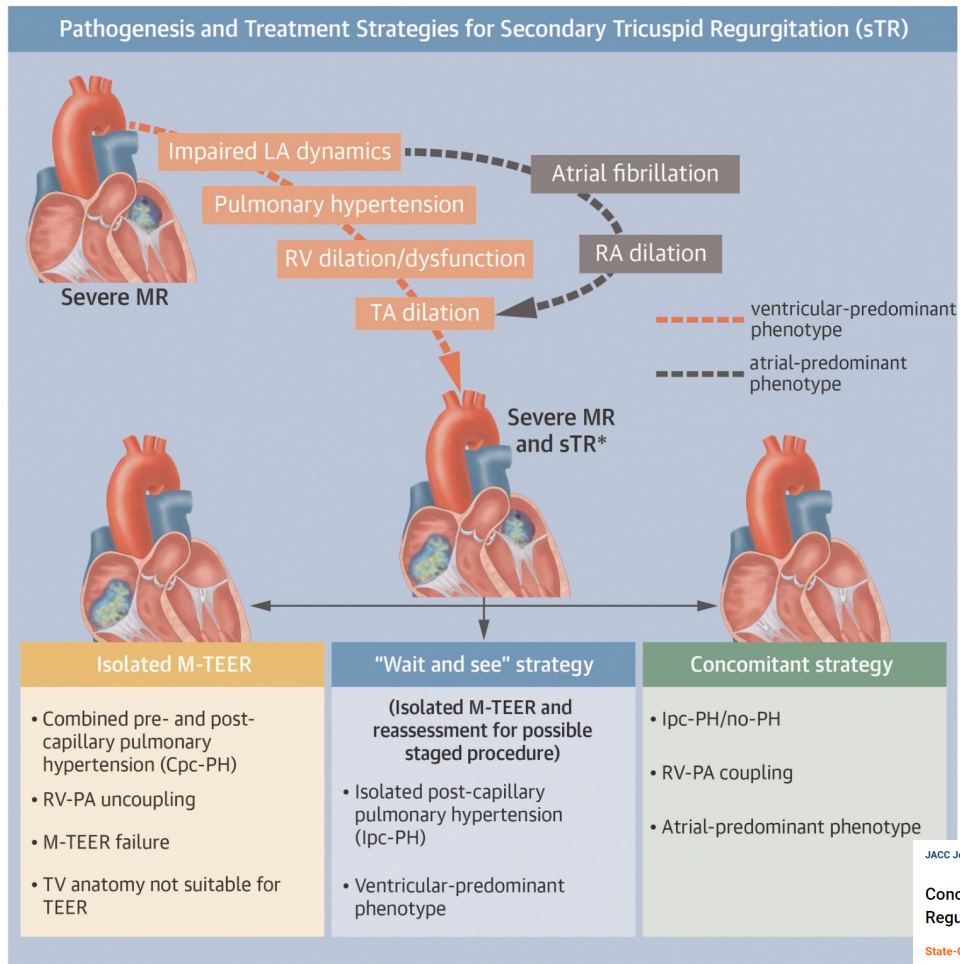


Figure 2. Echocardiographic and Functional Status.

Left sided VHD influences TR development and severity

CENTRAL ILLUSTRATION: Pathogenesis of sTR and Treatment Strategies in Patients With Suitable Anatomy Undergoing M-TEER



Sisinni A, et al. J Am Coll Cardiol Interv. 2023;16(2):127-139.

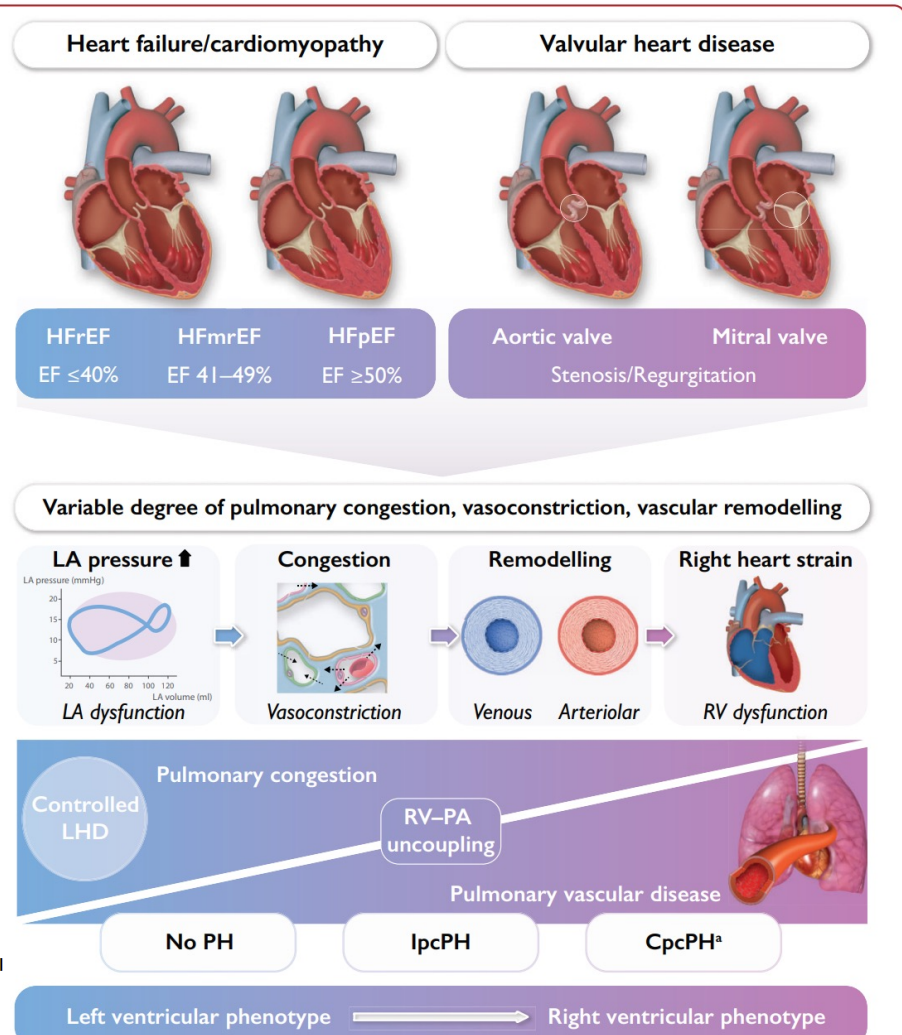
JACC Journals • JACC: Interventions • Archives • Vol. 16 No. 2

Concomitant Transcatheter Edge-to-Edge Treatment of Secondary Tricuspid and Mitral Regurgitation: An Expert Opinion [GET ACCESS](#)

State-Of-The-Art Review

Antonio Sisinni, Maurizio Taramasso, Fabien Praz, Marco Metra, Eustachio Agricola, Alberto Margonato, Neil Fam, Rodrigo Estevez-Loureiro, Azeem Latib, David Messika-Zeitoun, Lenard Conradi, Ralph Stephan von Bardeleben, Paul Sorajja, Rebecca T. Hahn, Sergio Caravita, Francesco Maisano, Marianna Adamo, and Cosmo Godino [SEE FEWER AUTHORS](#)

J Am Coll Cardiol Interv. 2023 Jan, 16 (2) 127-139



ESC ERS

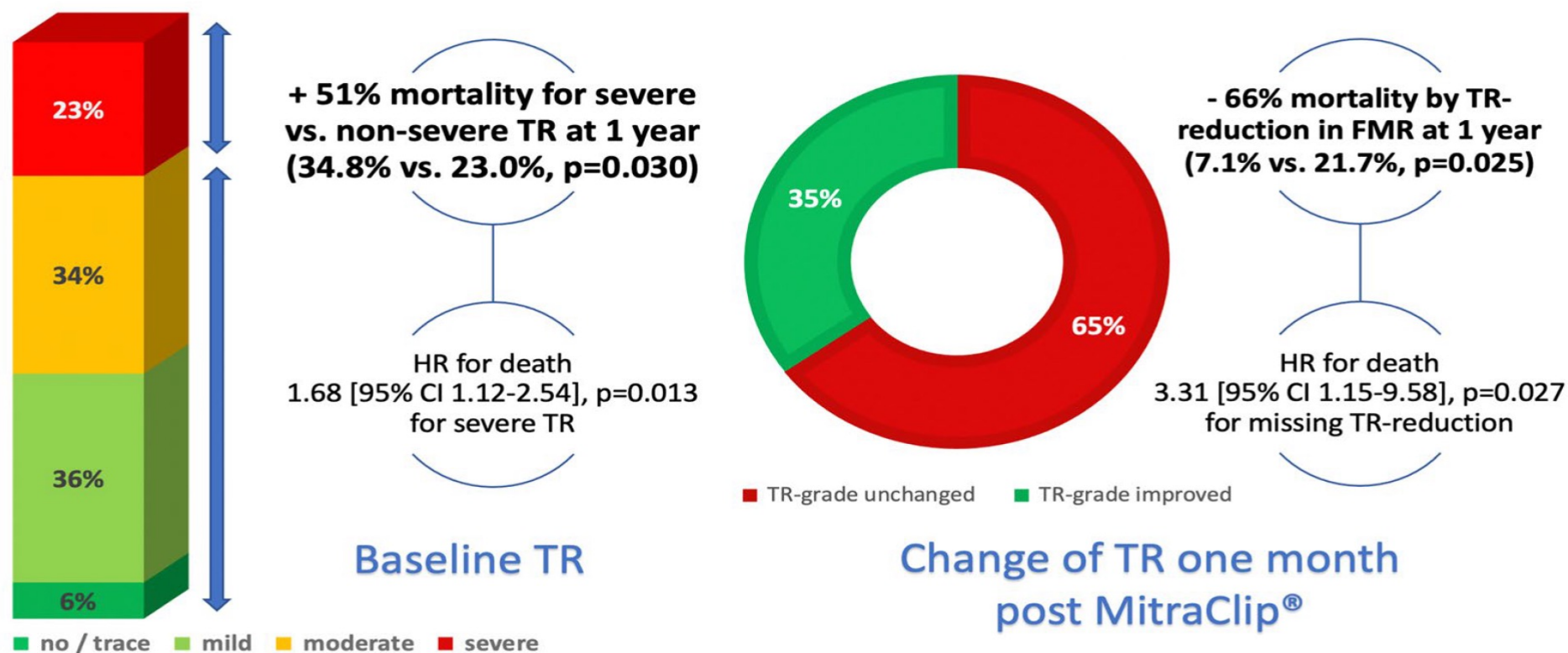
Improvement of secondary TR with left VHD treatment?

Graphic abstract

Concomitant tricuspid regurgitation severity and its secondary reduction determine long-term prognosis after transcatheter mitral valve edge-to-edge repair

Martin Geyer¹ · Karsten Keller^{1,2,3} · Kevin Bachmann¹ · Sonja Born¹ · Alexander R. Tamm¹ · Tobias Friedrich Ruf¹ · Felix Kreidel¹ · Omar Hahad^{1,4} · Aniela Petrescu¹ · Michaela Hell¹ · Andres Beiras-Fernandez² · Angela Kornberger⁵ · Eberhard Schulz¹ · Thomas Münzel^{1,4} · Ralph Stephan von Bardeleben¹

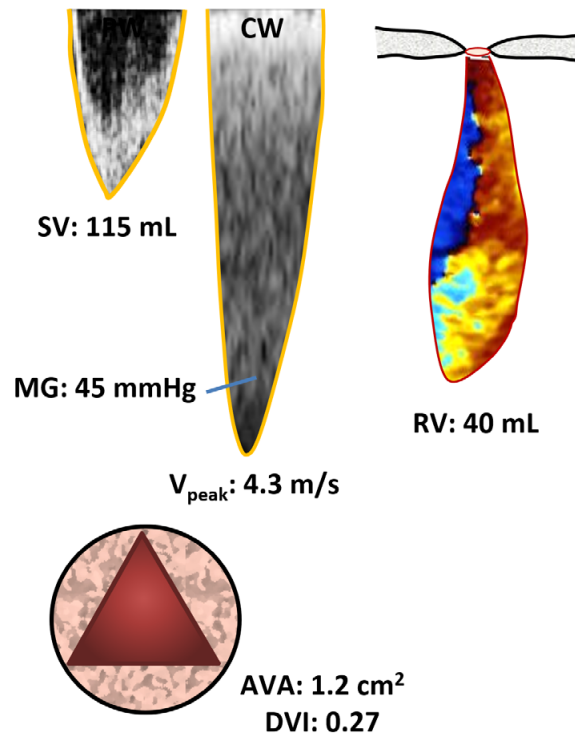
Baseline TR and procedural reduction at one month predict survival after TMVR with MitraClip®



Aortic stenosis and aortic regurgitation: diagnostic challenges

Echocardiographic diagnostic limitations. AS & AR

MODERATE AS and MODERATE AR



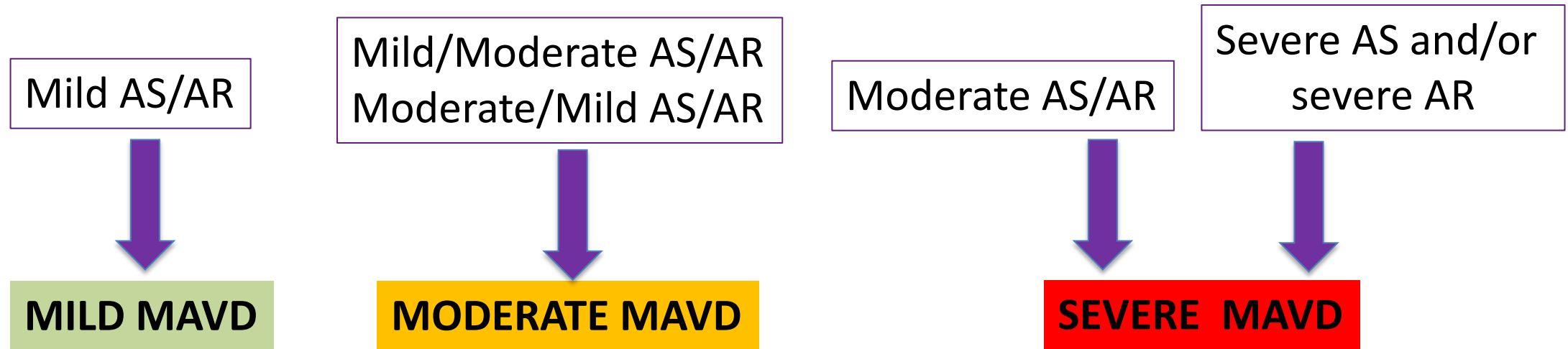
AORTIC STENOSIS AND AORTIC REGURGITATION

- Peak aortic jet velocity and mean gradient are the best parameters to assess the overall haemodynamic severity of MAVD.
- Peak aortic jet velocity and mean gradient may underestimate MAVD severity in presence of low flow state.

Heart 2019;**105**:1515–1522

Aortic stenosis and aortic regurgitation: diagnostic challenges

ACCORDING TO AS AND AR EVALUATION, DEFINE AND GRADE MAVD



Prognosis modifiers: older age, more severe AS and/or AR at baseline, larger LV mass index, more pronounced LV concentric remodelling and advanced LV diastolic dysfunction.

Heart 2019;**105**:1515–1522

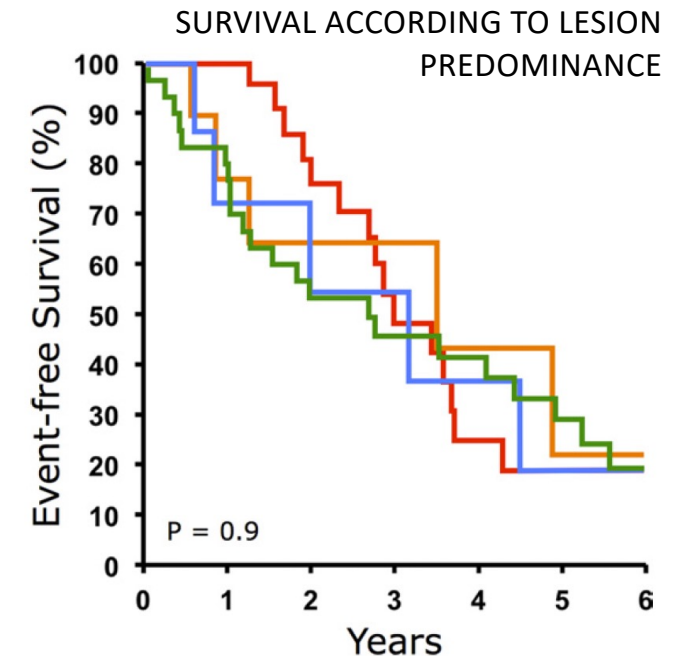
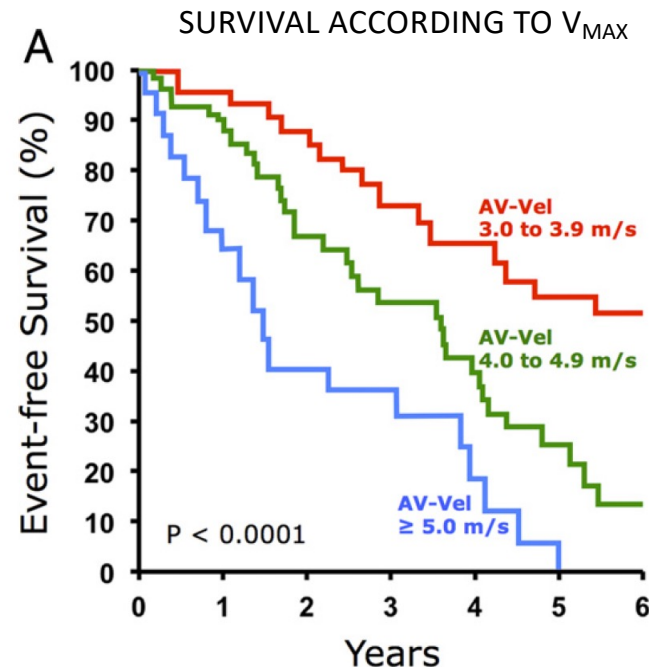
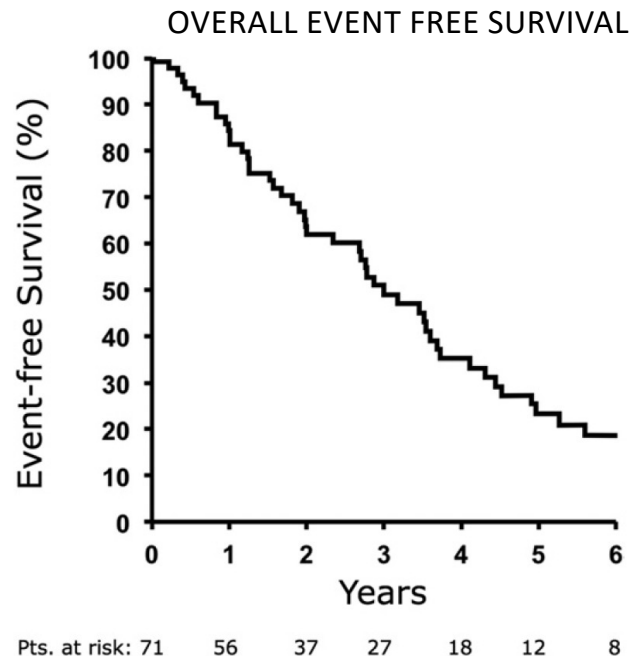
Natural History of Mixed Aortic Valve Disease

Valve Disease

Outcome of Combined Stenotic and Regurgitant Aortic Valve Disease

Robert Zilberszac, MD,* Harald Gabriel, MD,* Michael Schemper, PhD,†
David Zahler, MD,* Martin Czerny, MD,‡ Gerald Maurer, MD,* Raphael Rosenhek, MD*
Vienna, Austria; and Berne, Switzerland

- 71 patients (21 female), mean age 52 years
- 50% bicuspid aortic valves
- At least moderate AS plus moderate AR
- Good LV function
- Median FU 8.9 years



Indications for Surgery

Indications for surgery	Class ^a	Level ^b
A) Severe aortic regurgitation		
Surgery is recommended in symptomatic patients regardless of LV function. ^{105–109}	I	B
Surgery is recommended in asymptomatic patients with LVESD >50 mm or LVESD >25 mm/m ² BSA (in patients with small body size) or resting LVEF ≤50%. ^{107,108,112,114,115}	I	B
Surgery may be considered in asymptomatic patients with LVESD >20 mm/m ² BSA (especially in patients with small body size) or resting LVEF ≤55%, if surgery is at low risk.	IIb	C
Surgery is recommended in symptomatic and asymptomatic patients with severe aortic regurgitation undergoing CABG or surgery of the ascending aorta or of another valve.	I	C
Aortic valve repair may be considered in selected patients at experienced centres when durable results are expected.	IIb	C

Also consider:

- Increase in LVEDD (> 65mm)
- Fall in LV function
- Raised BNP

Medical Therapy:

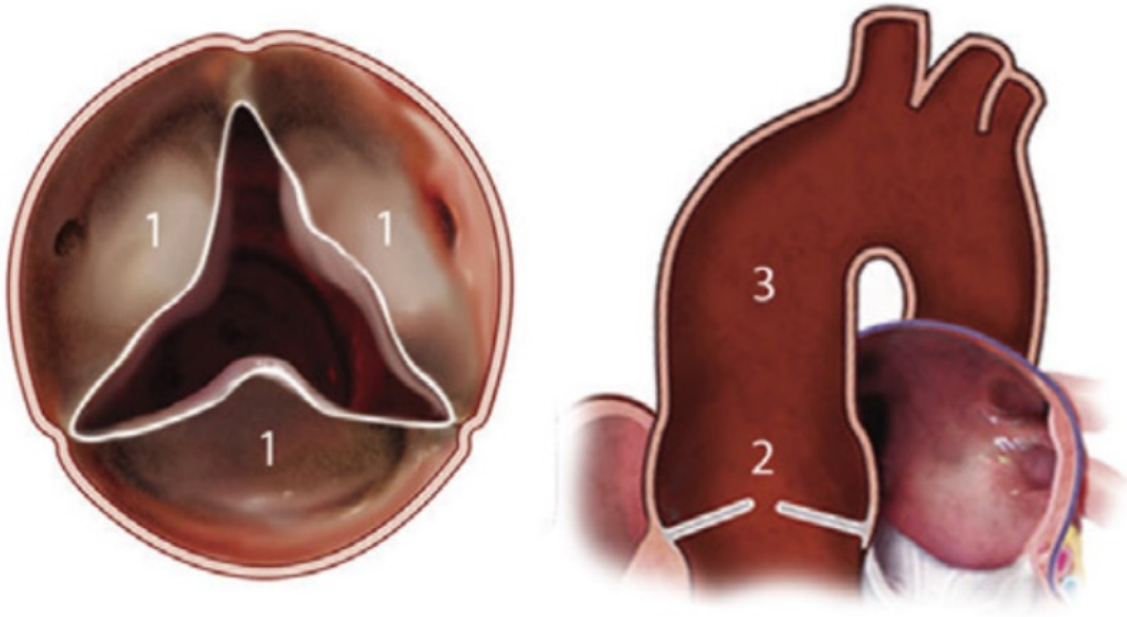
The role of ACE inhibitors (or other vasodilators) in delaying surgery or improving symptoms is not established

ESC/EACTS Guidelines 2021

Challenges for TAVI in AR

Aortic Valve Regurgitation

- 1- Minimal or absent cusp calcification
- 2- Dilated aortic root
- 3- Frequent coexistence of dilated ascending aorta

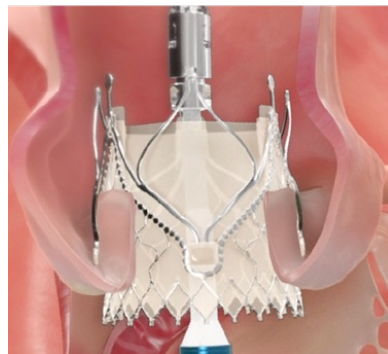


- **No anchoring**
 - Embolism
 - Migration
 - **No sealing**
 - Residual AR
- Oversizing strategy**

Franzone, Pilgrim *et al* 2016

New devices tailored to the anatomy of pure AR

THE TRILOGY™ Heart Valve System



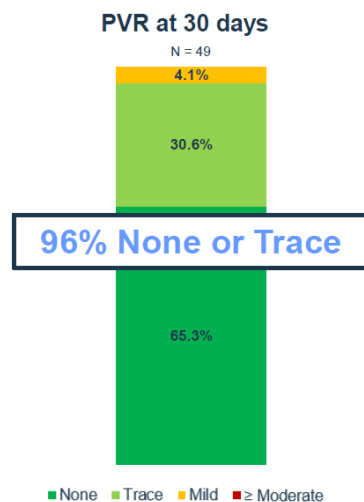
Early EU Experience – Multicenter Study

Patient characteristics:

- 58 patients:
 - mean age: 76y
 - Female: 36%
 - EuroSCORE: 6.7%

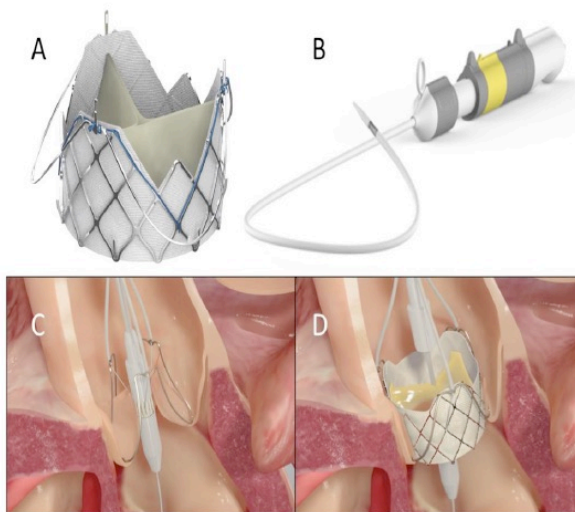
Outcome:

- **Technical success (VARC-3): 100%**
- **2nd valve required: 0%**
- **30-day mortality: 1.7%**
- **Moderate or severe AR: 0%**



Transfemoral J-Valve

- Porcine pericardial leaflets
- Self-expanding nitinol frame
- Three U-shaped anchor rings which allow grasping of native valve leaflets



Aortic valve disease and Aortopathy

When aortic stenosis or regurgitation become severe with symptoms or asymptomatic meeting other criteria should undergo AVR irrespective of aortic dilation

ESC
European Society
of Cardiology

ESC/EACTS GUIDELINES

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)

Vahanian A. European Heart Journal (2022) 43, 561–632

When surgery is primarily indicated for the aortic valve, replacement of the aortic root or tubular ascending aorta should be considered when ≥ 45 mm.^f

IIa

C

f) Considering age, BSA, aetiology of the valvular disease, presence of a bicuspid aortic valve, and intraoperative shape and thickness of the ascending aorta should be considered for individual decisions

ACC/AHA CLINICAL PRACTICE GUIDELINE

2022 ACC/AHA Guideline for the Diagnosis and Management of Aortic Disease: A Report of the American Heart Association/American College of Cardiology Joint Committee on Clinical Practice Guidelines

Isselbacher EM. *Circulation*. 2022;146:e334–e482.

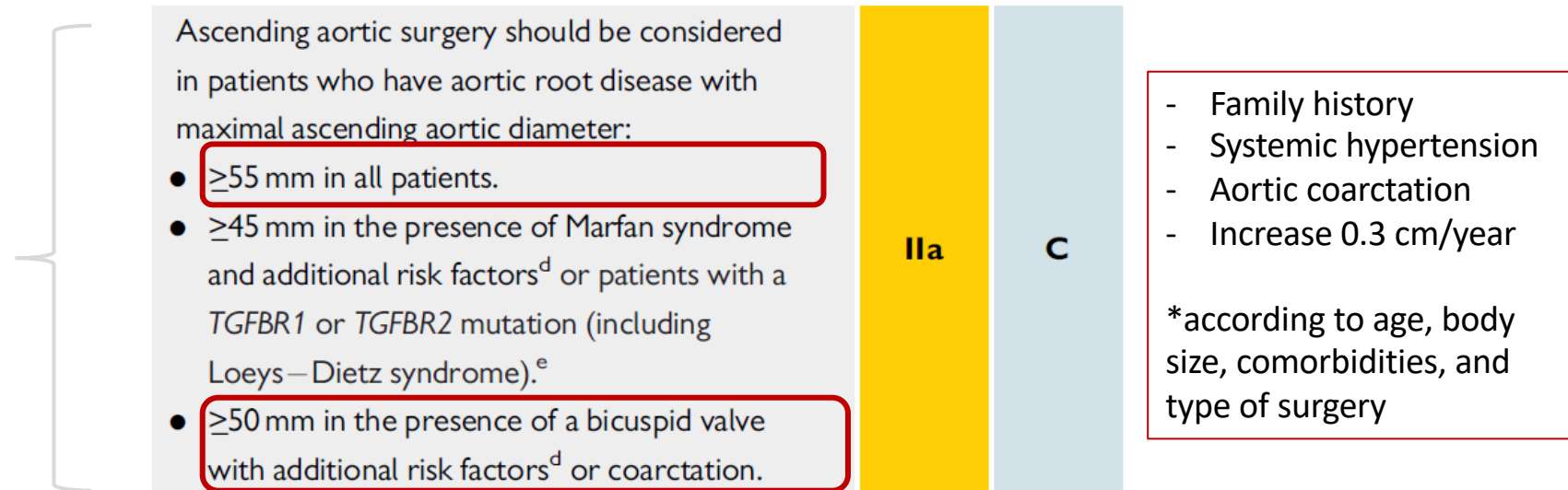
2a

B-NR

4. In patients with a BAV who are undergoing surgical aortic valve repair or replacement, and who have a diameter of the aortic root or ascending aorta of ≥ 4.5 cm, concomitant replacement of the aortic root, ascending aorta, or both is reasonable, when performed by experienced surgeons in a Multidisciplinary Aortic Team.^{1,6}

Aortic valve disease and Aortopathy

Surgery should be performed in patients with a BAV, who have a maximal aortic diameter ≥ 55 mm



ACC/AHA CLINICAL PRACTICE GUIDELINE

2022 ACC/AHA Guideline for the Diagnosis and Management of Aortic Disease: A Report of the American Heart Association/American College of Cardiology Joint Committee on Clinical Practice Guidelines

Isselbacher EM. *Circulation*. 2022;146:e334–e482.

Table 14. Risk Factors for Aortic Dissection

Family history of aortic dissection
Aortic growth rate ≥ 0.3 cm/y
Aortic coarctation
“Root phenotype” aortopathy

Does the aortic root deserves special attention?

Location of Aortic Enlargement and Risk of Type A Dissection

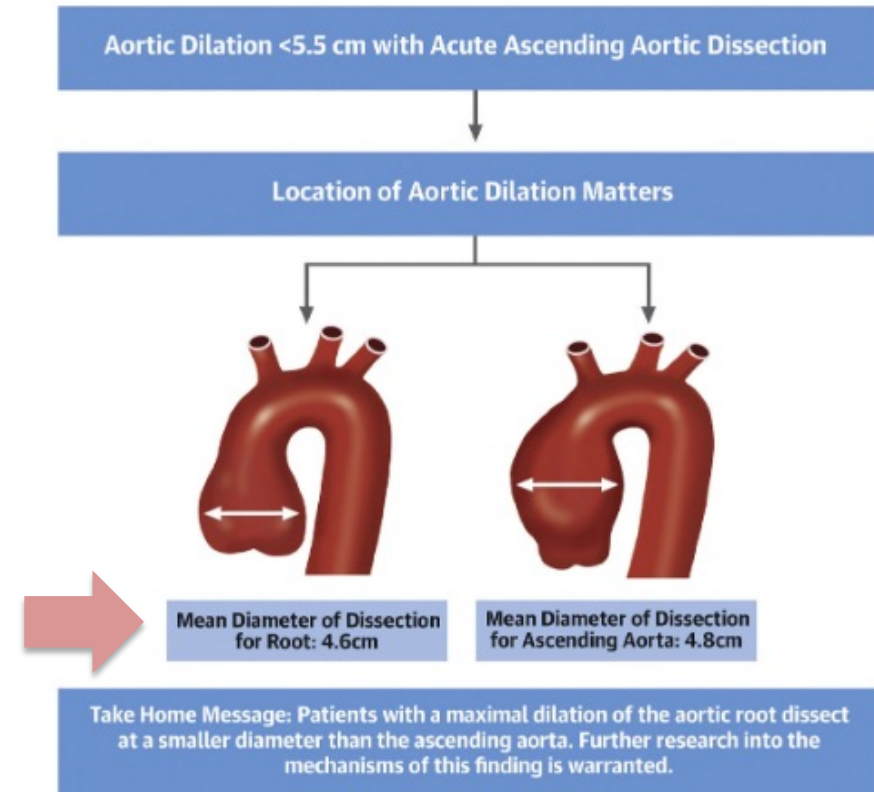


Asvin M. Ganapathi, MD,^a David N. Ranney, MD,^b Mark D. Peterson, MD, PhD,^c Mark E. Lindsay, MD, PhD,^d Himanshu J. Patel, MD,^e Reed E. Pyeritz, MD, PhD,^f Santi Trimarchi, MD, PhD,^g Stuart Hutchison, MD,^h Kevin M. Harris, MD,ⁱ Kevin L. Greason, MD,^j Takeyoshi Ota, MD, PhD,^k Daniel G. Montgomery, BS,^l Christoph A. Nienaber, MD,^m Kim A. Eagle, MD,^l Eric M. Isselbacher, MD,^d G. Chad Hughes, MD^b

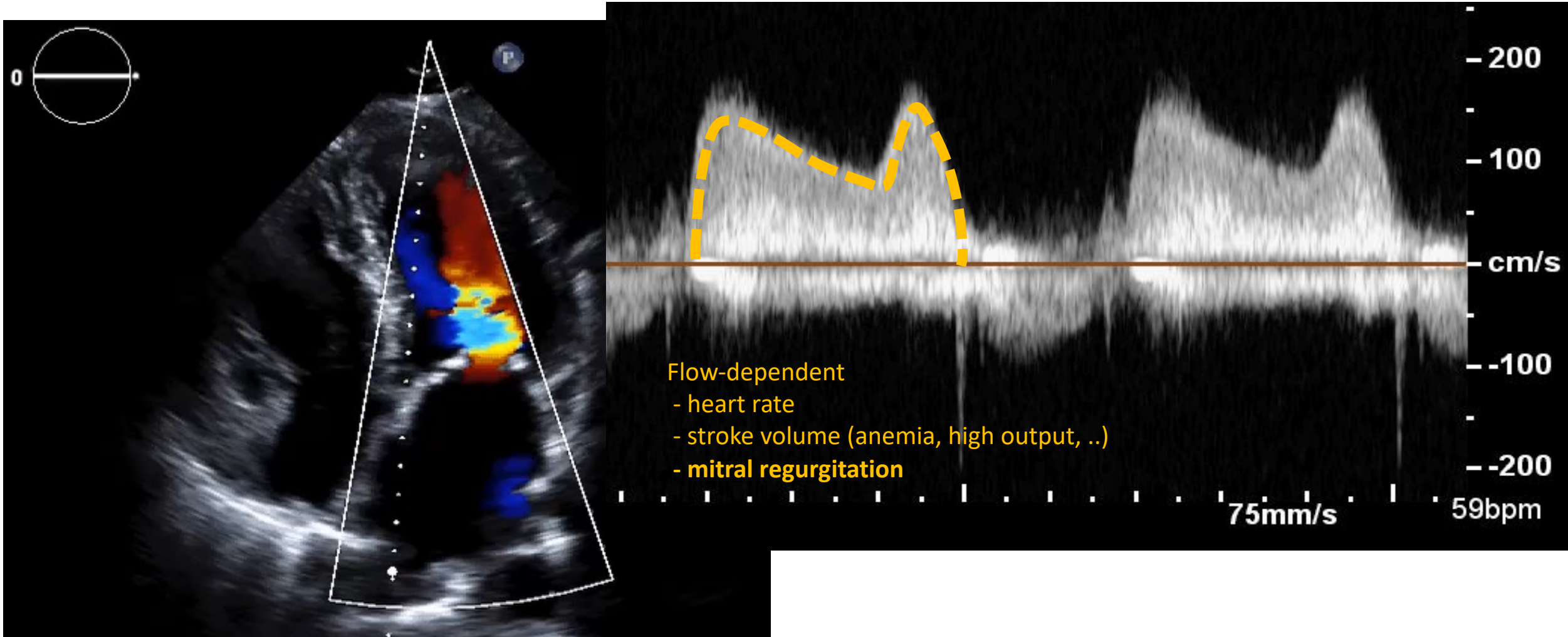
J Am Coll Cardiol 2022;79:1890–1897

Acute type A aortic dissection appears to occur at smaller diameters in patients with modest dilation in the aortic root vs. the ascending aorta

CENTRAL ILLUSTRATION: Maximal Aortic Dilation Location in Acute Type A Aortic Dissection



Mitral stenosis and regurgitation



$$\text{MVA} = \frac{\text{Stroke Volume}}{\text{MV VTI}}$$

→ MVA is underestimated

Mixed MS/MR in MAC

FIGURE 7 Proposed Definition of Severe MAC-Related Mitral Valve Dysfunction

Severe MAC-Related Mitral Valve Dysfunction				
<i>Stenosis</i>	<i>OR</i>	<i>Mixed Valve Disease</i>	<i>OR</i>	<i>Regurgitation</i>
MVA $\leq 1.5 \text{ cm}^2$		TMG $> 8\text{-}10 \text{ mm Hg}$		MR $> \text{Moderate}$

Proposed framework for defining "severe" mitral annular calcification (MAC)-related mitral valve dysfunction with the goal of integrating stenotic, regurgitant, and mixed valve disease. TMG = transmitral gradient. Other abbreviations as in [Figures 1, 3, and 5](#).

Churchill TW.. Bertrand PB, J Am Coll Cardiol. 2022;80(7):739-751

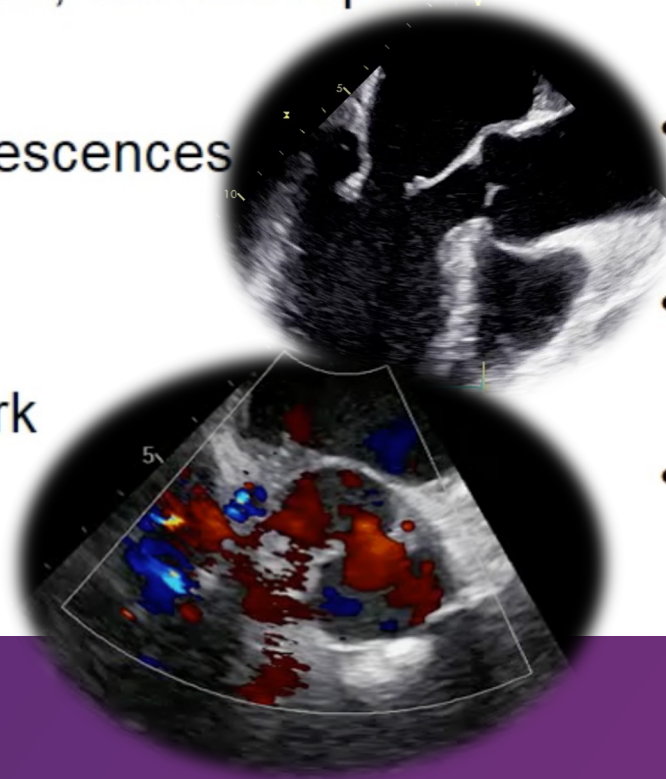
Take Home Messages : Mixed MS/MR

- Separate evaluation of MR severity and MS severity whenever possible.
- MVA quantification challenging, esp. in degenerative MS/MR.
- Mean MV gradient = overall hemodynamic burden of combined valve lesion.
= prognostic impact in MAC population.
- Treatment of mixed MS/MR demands a Heart Team approach.

Challenges in the Echo Diagnosis of Infective endocarditis

FALSE POSITIVES

- Native valve disease: leaflet thickening, myxomatous changes, flail leaflet, chordal rupture
- Tumours (fibroelastoma)
- Thrombi, strands, Lambl's excrescences
- Non-infectious endocarditis
- Healed vegetations
- Eustachian valve, Chiari network
- Healed abscesses

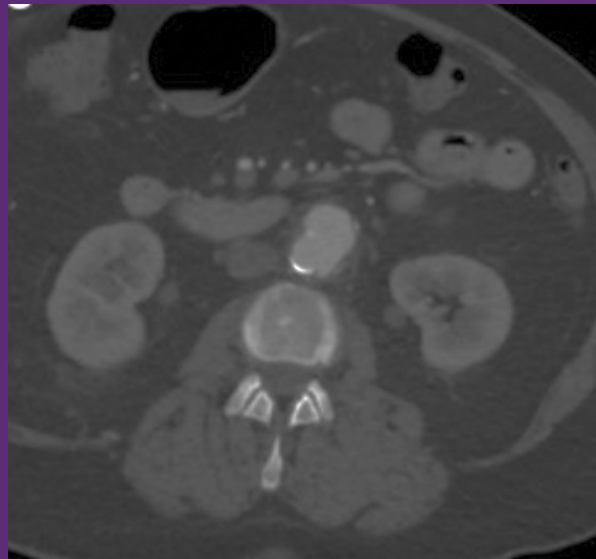
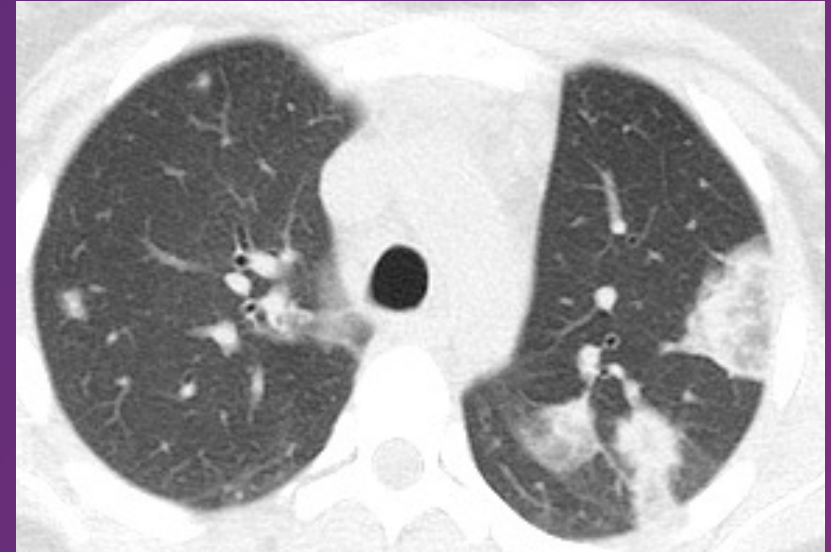


FALSE NEGATIVES

- Suboptimal image quality
- Small or absent vegetation (early in the course of infection)
- motionless or atypically located vegetations
- Native valve thickening masking vegetations
- Shadowing due to calcification

MDCT in NVE

- Added value of CT
 - **Pulmonary infarcts/ Abscesses** →
 - **Coronary anatomy** (*Opolski MP, JACCI 2016;9:1059*)
 - **Peripheral embolism/ Mycotic aneurysm** ↘



Abdominal Ao MA



Aortic pseudo aneurysm & CA.

Addition of Positive PET/CTA in the Diagnosis of NVE

➤ Useful in suspected cases having possible IE

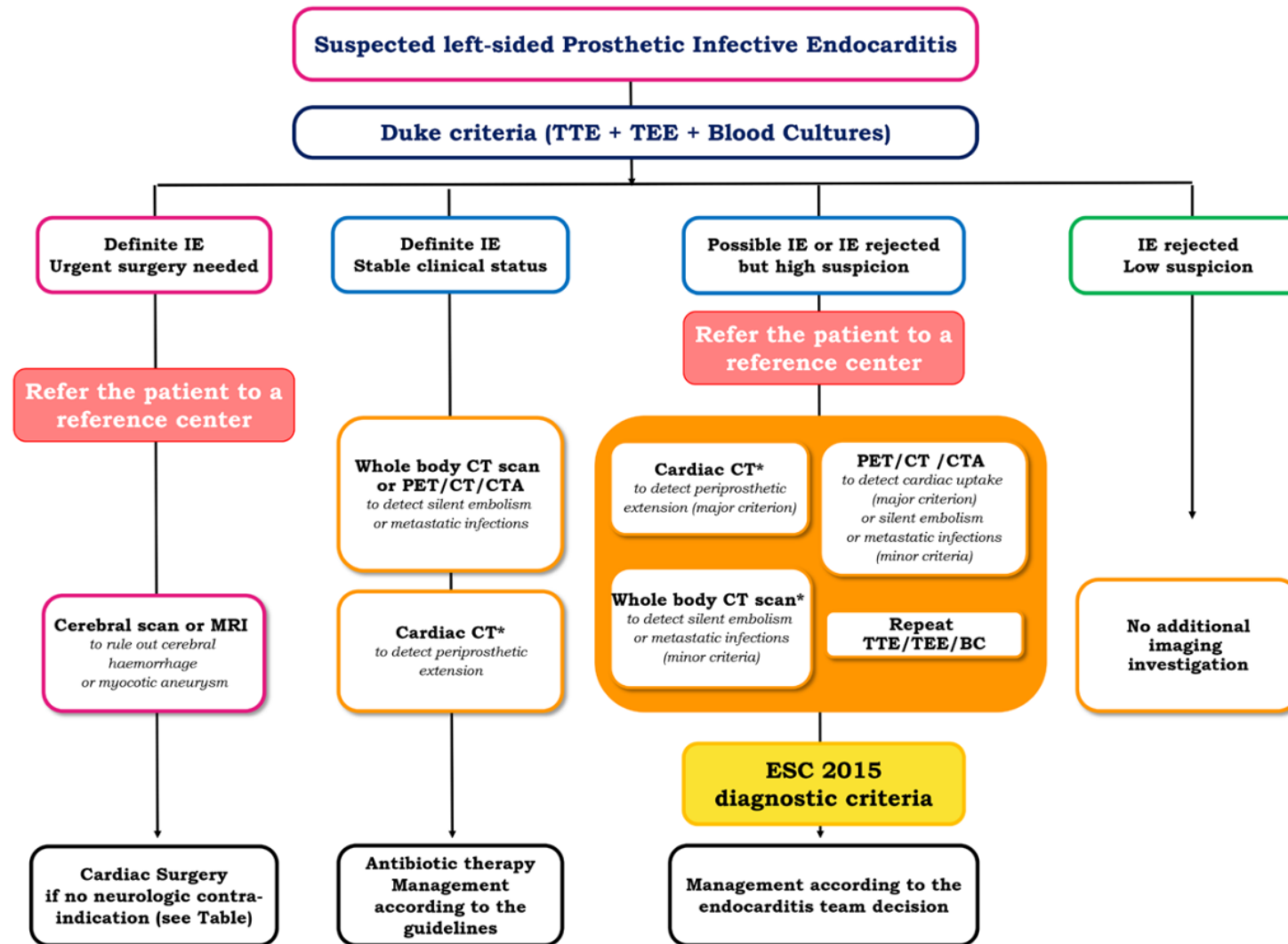
Native valves (n=115)	Sens	Spec	PPV	NPV	AC
Admission echocardiography	70 (56-83)	93 (87-99)	86 (75-98)	82 (74-91)	83.5%
PET/CT cardiovascular focal uptake	22 (10-34)	100 (100)	100 (100)	66 (57-75)	68.7%
Admission DC*	54 (40-69)	91 (85-98)	81 (67-95)	75 (66-84)	76.5%
Admission DC* + PET/CT major criteria	65 (51-79)	91 (85-98)	83 (71-96)	80 (71-89)	80.9%
Admission DC* + PET/CT major criteria + emboli**	78 (66-90)	91 (85-98)	86 (75-96)	86 (78-94)	86%

KEY MESSAGES: MMI in IE

- MDCT, MRI, FDG-PET should NOT be used as a substitute for clinical, microbiological, or echocardiographic evaluation.
- MMI adds major and minor criteria to MDC and makes the definite diagnosis in “possible” IE.
- Incomplete outcome evidence exists to advocate whole body screening (CT, MRI, PET) in asymptomatic patients with NVE.



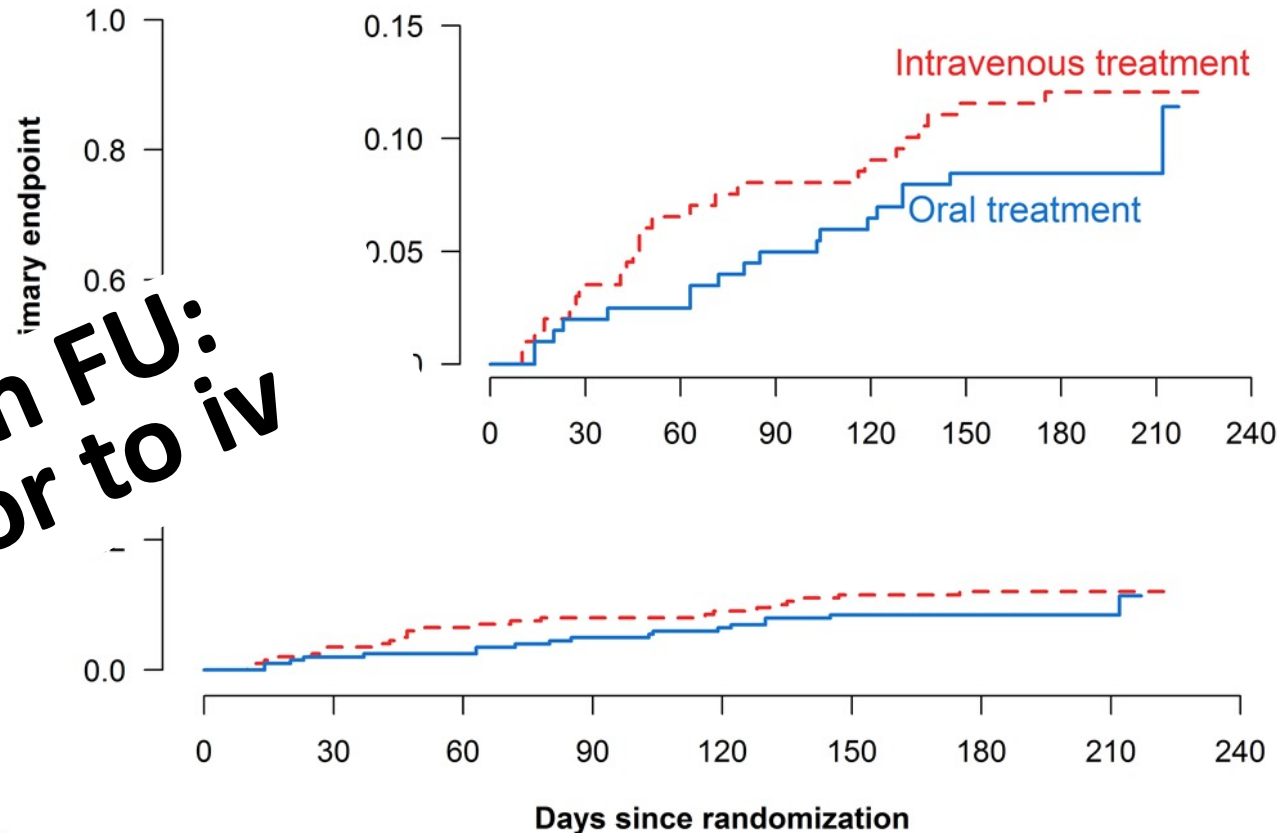
Multimodality imaging assessment of PVE



Erba et al, Circ, 2019

POET (oral vs IV antibiotic treatment): death, emboli, unplanned surgery, relapse

Difference 3.1%, 95% CI: -3.4% - 9.6%, Non-inferiority met



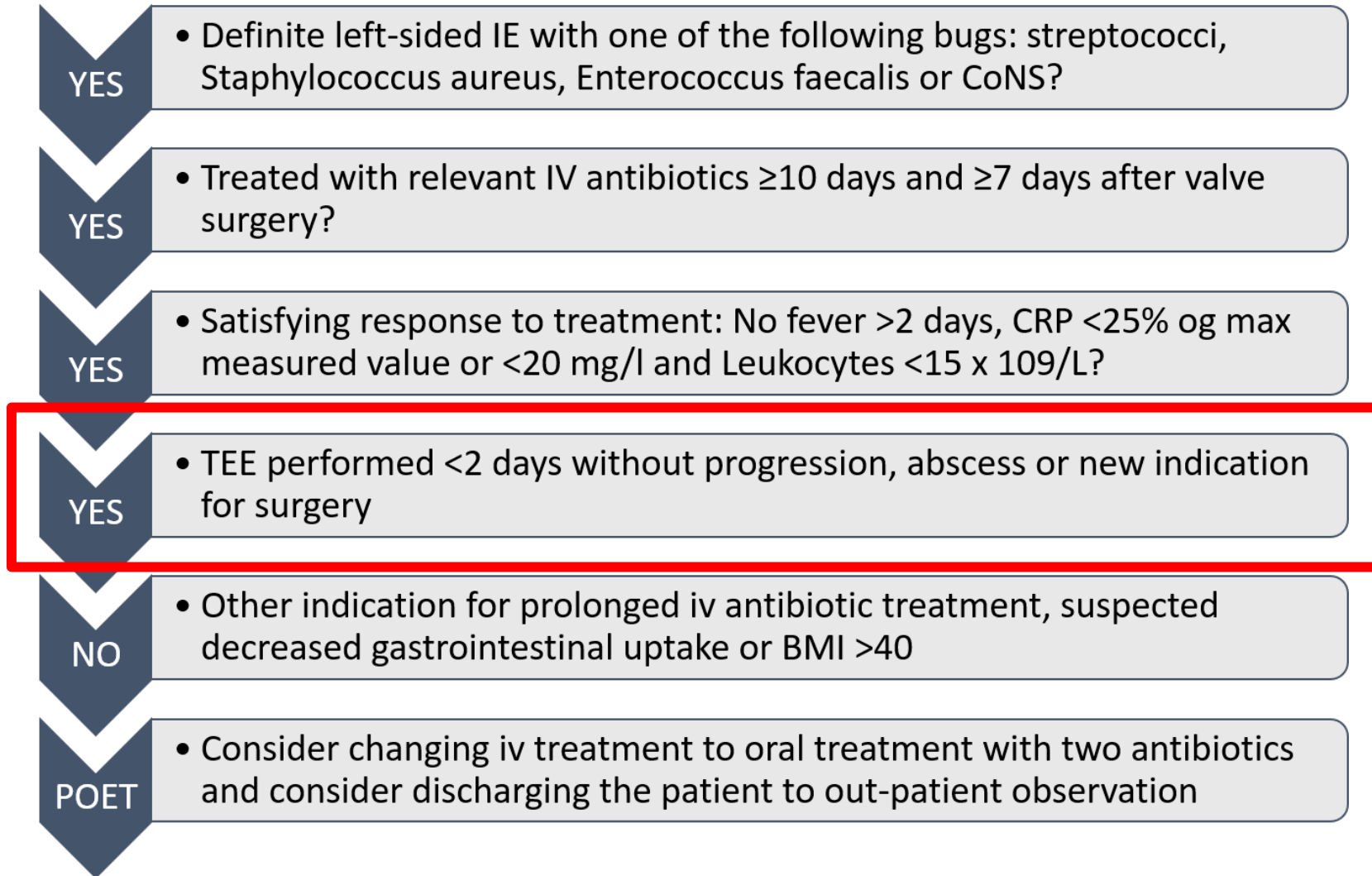
No. at Risk

Intravenous treatment	199	192	186	183	181	176	174	28	0
Oral treatment	201	197	196	191	188	184	183	36	0

5-years mean FU:
Oral superior to iv

Oral group
discharged 17
days earlier

POET criteria for shifting



TAVI & Endocarditis – Some evidence ?

JACC: CARDIOVASCULAR INTERVENTIONS
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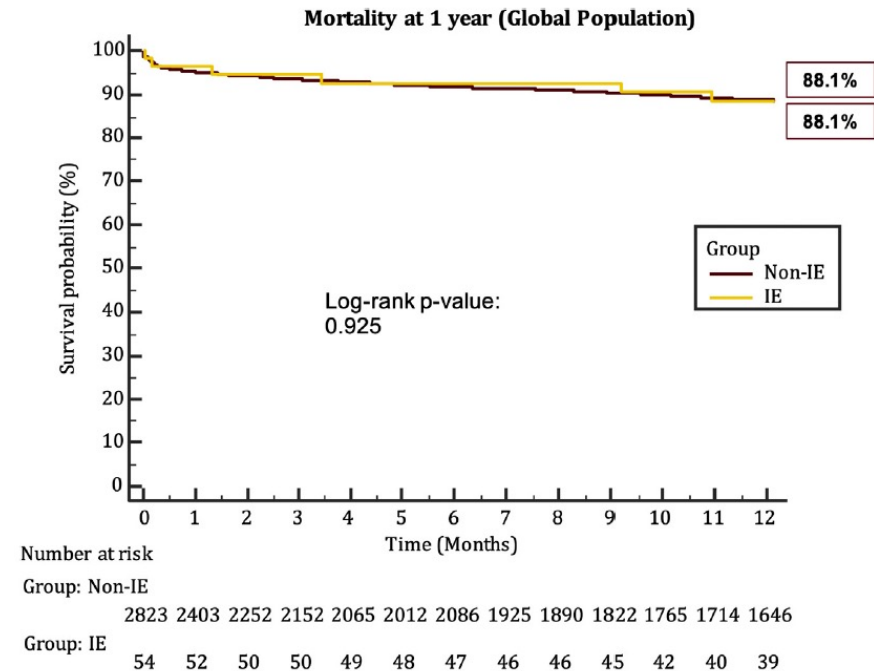
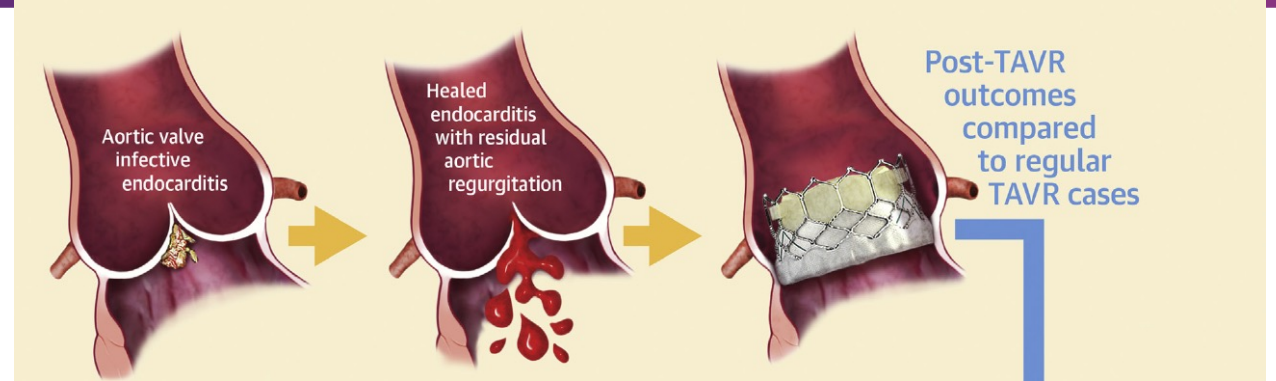
VOL. 13, NO. 17, 2020

Transcatheter Aortic Valve Replacement for Residual Lesion of the Aortic Valve Following “Healed” Infective Endocarditis



Sandra Santos-Martínez, MD,^{a,b} Abdullah Alkhodair, MD,^c Luis Nombela-Franco, MD, PhD,^d Francesco Saia, MD,^e Antonio J. Muñoz-García, MD, PhD,^f Enrique Gutiérrez, MD, PhD,^g Ander Regueiro, MD, PhD,^h Victor A. Jimenez-Díaz, MD, PhD,ⁱ Fernando Rivero, MD, PhD,^j Rafael Romaguera, MD,^k Javier Gómez-Herrero, MD,^a Tania Rodríguez-Gabella, MD,^{a,b} Janarthanan Sathananthan, MD,^c Itziar Gómez Salvador, MSc,^b Manuel Carrasco-Moraleja, MSc,^b Josep Rodés-Cabau, MD, PhD,^l John Webb, MD, PhD,^c Javier López, MD, PhD,^{a,b} J. Alberto San Román, MD, PhD,^{a,b} Ignacio J. Amat-Santos, MD, PhD^{a,b}

10 centers – 54 patients with AoV possible (26) or definitive IE (28)
Healed infection & severe AoV dysfunction – TAVR
Healed: 3 (-) BC & free clinical/lab signs of sepsis & no vegetations or abscess
Mean time from IE to TAVR: 90 days (21-411 days)



Conclusions

- “Healed” IE is not an absolute contraindication for percutaneous therapies
- When conventional surgical aortic valve replacement is rejected, TAVI in patients with healed IE is feasible, safe, and with a comparable mortality to standard ones, although with higher rates of AR and sepsis
- In patients with severe HF or cardiogenic shock and prohibited risk, decisions should be performed on a case-to-case basis