Corewell Health™

Elevated Gradients Early After TAVR: HALT or PPM? Diagnosis and Management

Amr E Abbas, MD, MSc, FACC, FSCAI, FASE, FSVM, RPVI
Director, Cardiovascular Research
Director, Structural Heart
CHE- William Beaumont University Hospital
Professor, OUWB School of Medicine

2025 TCT

Disclosure of Relevant Financial Relationships

Within the prior 24 months, I have had a financial relationship with the ineligible companies listed below:

Nature of Financial Relationship	Ineligible Company
Grant/Research Support	Edwards Lifesciences
Consultant Fees/Honoraria	Edwards Lifesciences Anteris Medical

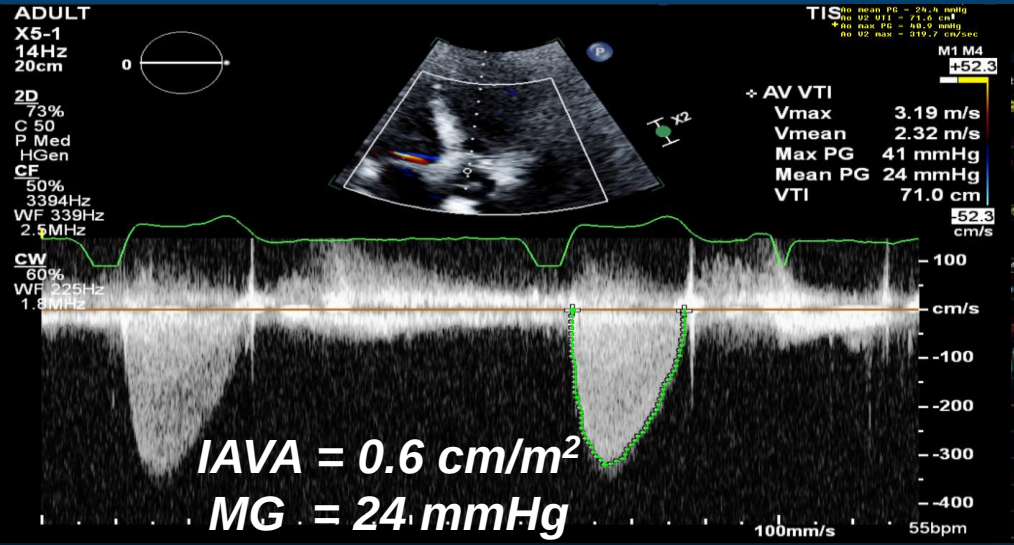
All Financial Relationships have been mitigated.
Faculty disclosure information can be found on the app

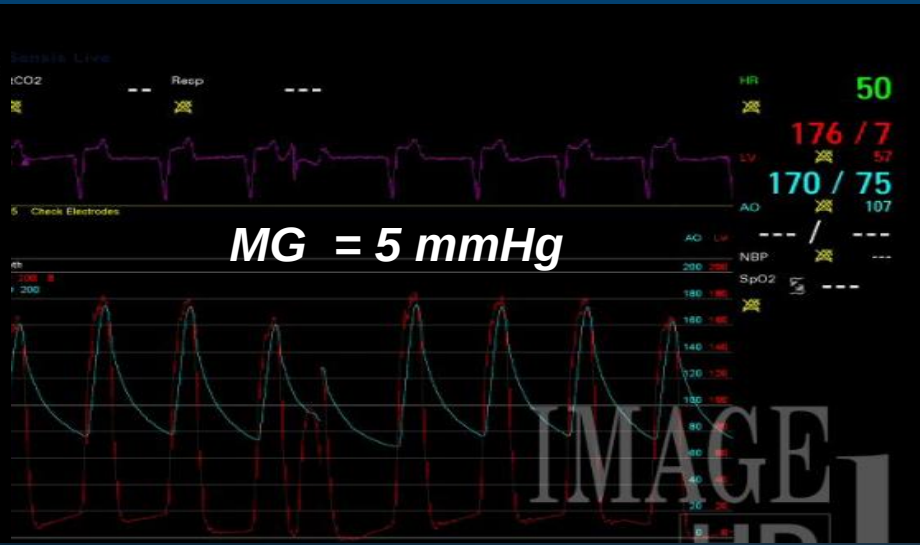
Elevated Gradients EARLY After TAVR

- Etiology:
  - Physiological: Improved flow and ejection fraction, Discordance
  - Leaflet mobility: HALT/Thrombus, Early SVD, leaflet abnormality
  - Valve flow/design/size: Prosthesis patient mismatch, valve recoil
- Timing
  - Procedure: Discordance, PPM, Under expansion, leaflet abnormality, Recoil
  - Discharge– 30 Days: + Improved flow and EF
  - 30 Days – 1 Year: + HALT/Thrombus, Early SVD

Case 1: Failed 21 mm Trifecta

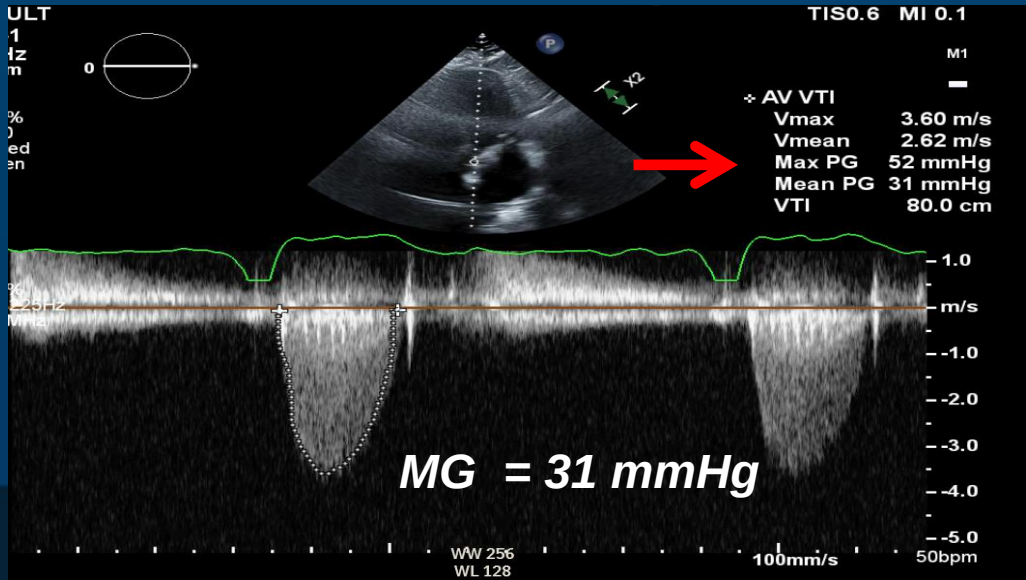
- 65 Y/O with 21 mmHg Trifecta 2014
- NYHA Class III, recent decrease in EF 40%, negative Cath
- Severe prosthetic valve regurgitation and stenosis
  - 20 mm S3





Discharge Echocardiogram

- No Symptoms
- Improved EF 55%
- increased SVI to 40 ml/m^2
- iAVA 0.7 cm/m^2
- ?iAVA? 0.6 cm/m^2
- Now What?
- Severe PPM?
- SVD?



Echocardiographic vs Invasive Hemodynamics

Journal of the American Heart Association

ORIGINAL RESEARCH

Greater than 800 patients

Comparison of Transvalvular Aortic Mean Gradients Obtained by Intraprocedural Echocardiography and Invasive Measurement in Balloon and Self-Expanding Transcatheter Valves

Amr E. Abbas, MD; Ramy Mando, MD; Amer Kadri, MD; Houman Khalili, MD; George Hanzel, MD; Francis Shannon, MD; Karim Al-Azizi, MD; Thomas Waggoner, MD; Safwan Kassas, MD; Thomas Pilgrim, MD; Taishi Okuno, MD; Alexander Camacho, PhD; Alexandra Selberg, MA; Sammy Elmariah, MD; Anthony Bavry, MD; Julien Ternacle, MD; Jared Christensen, MD; Neil Gheewala, MD; Philippe Pibarot, PhD, DVM; Michael Mack, MD

Predictors of High Echocardiographic Gradients

Predictors of Gradients ≥ 20 mmHg			
Echocardiographic	**OR**	**95% CI**	**P-Value**
Age	0.957	0.917-0.999	0.045
Pre TAVR Gradient	1.033	1.013-1.054	0.001
Pre TAVR SV	1.015	1.001-1.030	0.038

Echocardiographic Versus Invasive Aortic Valve Gradients in Different Clinical Scenarios

Amr E. Abbas, MD, Houman Khalili, MD, Luai Madanat, MD, Sammy Elmariah, MD, Francis Shannon, MD, Karim Al-Azizi, MD, Thomas Waggoner, MD, Thomas Pilgrim, MD, Taishi Okuno, MD, Anthony Bavry, MD, Julien Ternacle, MD, Jared Christensen, MD, Josep R. Cabau, MD, Michael Mack, MD, and Philippe Pibarot, PhD, DVM, *Royal Oak and Auburn Hills, Michigan; Delray Beach and Gainesville, Florida; Boston, Massachusetts; Plano, Texas; and Tucson, Arizona; Bern, Switzerland; and Québec, Ontario, Canada*

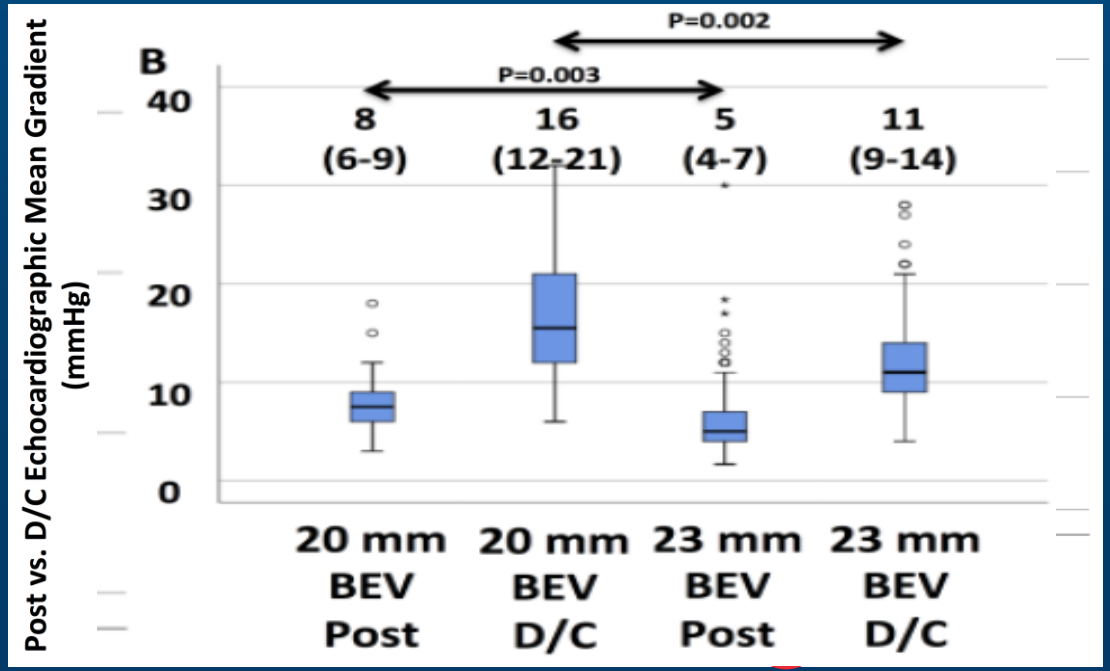
Predictors of High Invasive Gradients

Predictors of Gradients ≥ 20 mmHg			
Invasive	**OR**	**95% CI**	**P-Value**
Age*	0.969	0.942-0.997	0.03
BMI	1.068	1.010-1.129	0.02
Pre TAVR Gradient	1.031	1.013-1.049	0.001
Pre TAVR SV	1.015	1.001-1.030	0.038
Small Valve Size*	2.152	1.104-4.196	0.025
Valve in Valve	9.033	3.292-24.786	<0.001
BEV	**0.308**	**0.130-0.731**	**0.008**
Accurate Neo	8.066	1.428-45.545	0.018

* Univariate Analysis

Gradient Change: Post Versus Discharge BEV vs. SEV

BEV = *Balloon Expandable Valve, SEV = Self Expanding Valve.* Small BEV ≤ 23 mm *and small SEV ≤ 26 mm*



- *Gradients:*
  - *Discharge Echo > Immediate Post-TAVR*
  - *? Flow, BP, Sedation*
- *More in smaller BEV!*
  - *? Design Specific Response to Flow*

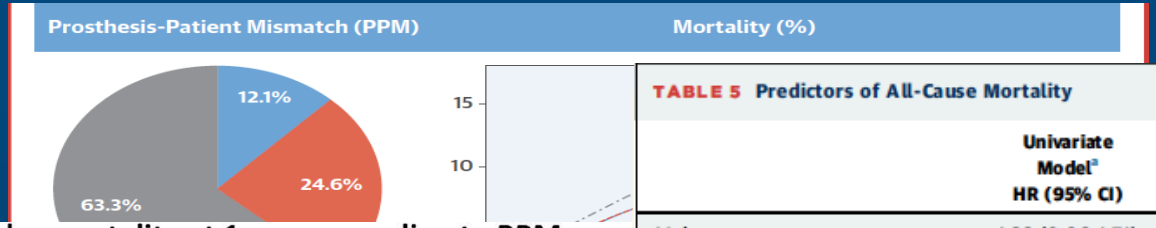
This is NOT Discordance

Abbas et al: Comparison of Transvalvular Aortic Gradients Obtained by Intra-procedural Echocardiography and Invasive Measurement in Balloon and Self-Expanding Transcatheter Valves. JAHA

Corewell Health™

Hemodynamics, PPM and Outcomes

Is TAVR Prosthesis Patient Mismatch Bad?



Cardiovascular mortality at 1 year according to PPM

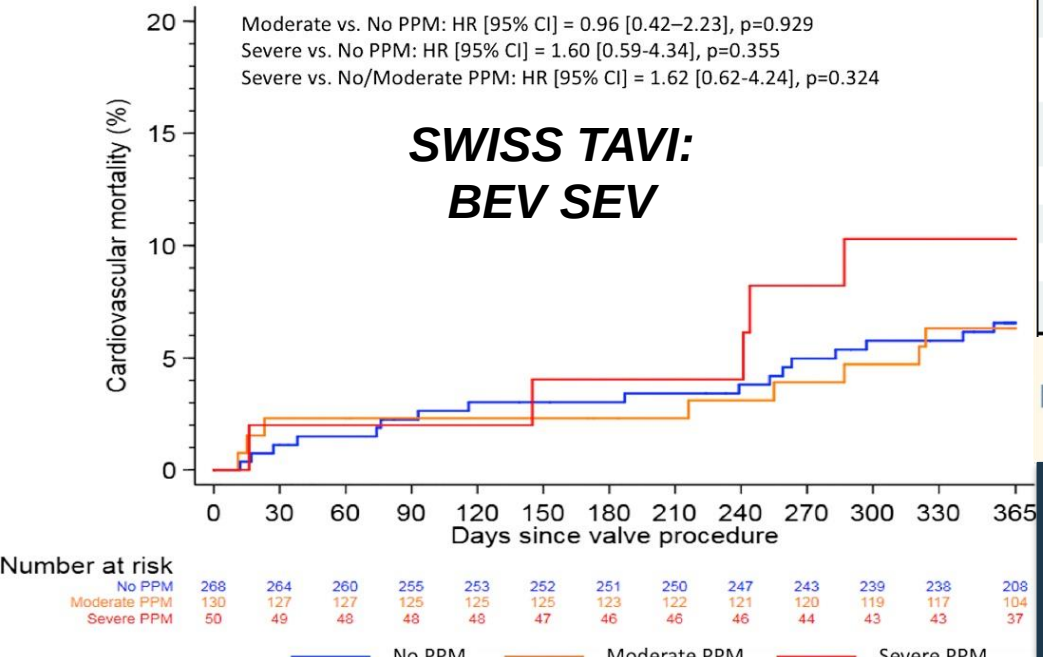


TABLE 5 Predictors of All-Cause Mortality

	Univariate Model[a] HR (95% CI)	*P* Value	Multivariate Model[a] HR (95% CI)	*P* Value
Male	1.23 (0.88-1.71)	0.22	1.75 (1.23-2.50)	0.002
STS score	1.06 (1.04-1.09)	<0.0001	1.07 (1.04-1.10)	<0.0001
XT valve size (23 mm vs 26 mm)	1.54 (1.08-2.20)	0.02	1.68 (1.15-2.43)	0.007
Prior surgical valve size (21 mm vs >25 mm)	1.36 (0.78-2.37)	0.28	–	–
Prior surgical valve size (23-25 mm vs >25 mm)	1.32 (0.79-2.21)	0.29	–	–
Stenosis vs regurgitation	0.79 (0.55-1.13)	0.20	–	–
Mixed vs regurgitation	0.81 (0.51-1.27)	0.36	–	–
Transfemoral vs transapical	0.93 (0.65-1.31)	0.66	–	–
Moderate to severe PPM vs no PPM	1.14 (0.60-2.18)	0.68	–	–

5-Year Follow-Up From the PARTNER 2 Aortic Valve-in-Valve Registry for Degenerated Aortic Surgical Bioprostheses

Rebecca T. Hahn, MD,[a] John Webb, MD,[b] Philippe Pibarot, DVM, PHD,[c] Julien Ternacle, MD, PHD,[c,d] Howard C. Herrmann, MD,[e] Rakesh M. Suri, MD,[f] Danny Dvir, MD,[g] Jonathon Leipsic, MD,[b] Philipp Blanke, MD,[b] Wael A. Jaber, MD,[f] Susheel Kodali, MD,[a] Samir Kapadia, MD,[f] Raj Makkar, MD,[h] Vinod Thourani, MD,[i] Mathew Williams, MD,[i,j] Erwan Salaun, MD, PHD,[c] Flavien Vincent, MD,[k,l] Ke Xu, PHD,[m] Martin B. Leon, MD,[a,k] Michael Mack, MD[n]

Is TAVR Prosthesis Patient Mismatch Bad?

JACC: CARDIOVASCULAR INTERVENTIONS VOL. 1
© 2025 BY THE AMERICAN COLLEGE OF CARDIOLOGY FOUNDATION
PUBLISHED BY ELSEVIER

ORIGINAL RESEARCH

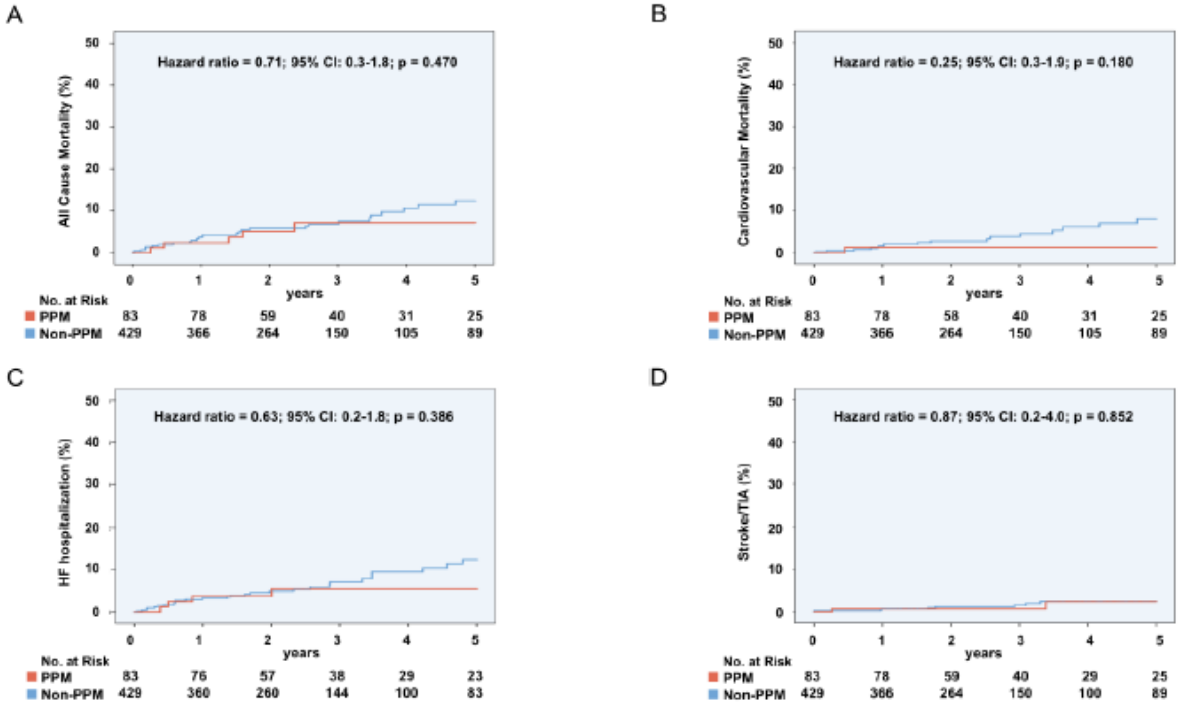
STRUCTURAL

Prosthesis-Patient Mismatch in Young and Low-Risk Patients After Newer Generation Balloon-Expandable Transcatheter Aortic Valve Replacement

Kazuki Suruga, MD,[a] Vivek Patel, MS,[a] Takashi Nagasaka, MD,[a,b] Yuchao Guo, MD,[a,c] Prateek Madaan, Ofir Koren, MD,[a,d] Dhairya Patel, MPH,[a] Izabela Harutyunyan, MSN,[a] Aakriti Gupta, MD,[a] Tarun Chakra Wen Cheng, MD,[a] Hasan Jilaihawi, MD,[a] Mamoo Nakamura, MD,[a] Raj R. Makkar, MD[a]

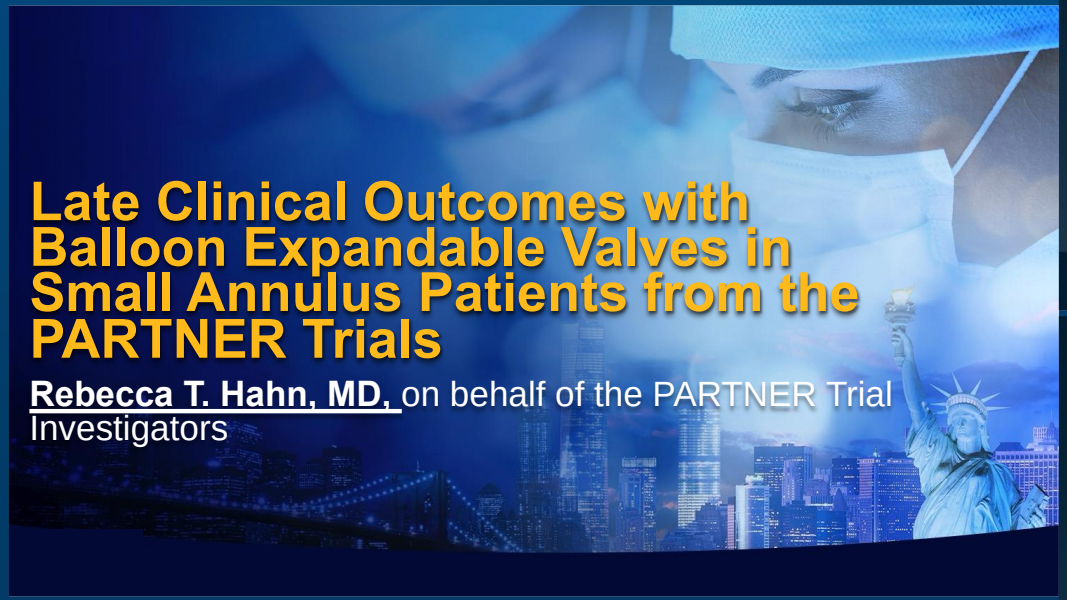
Non-PPM Moderate PPM Severe PPM

Supplemental Figure 3. Kaplan-Meier Analysis of Time-to-Event Outcomes Based on Predicted PPM



Echocardiographic Hemodynamics and Outcomes

BEV

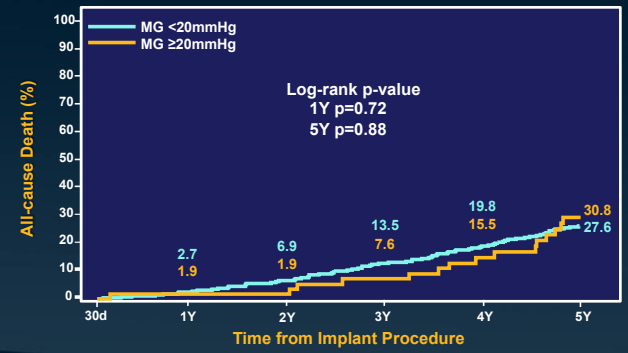


Late Clinical Outcomes with Balloon Expandable Valves in Small Annulus Patients from the PARTNER Trials

Rebecca T. Hahn, MD, on behalf of the PARTNER Trial Investigators

All-cause Death

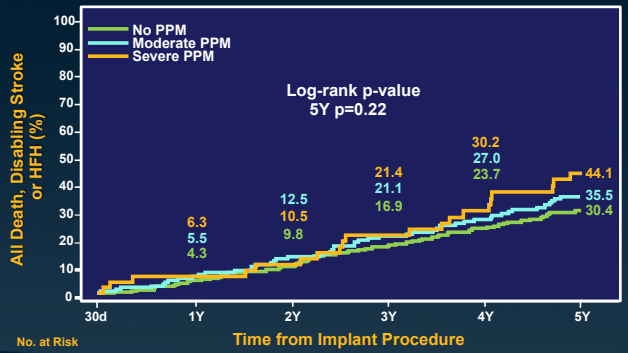
Small Annulus, MG <20 vs ≥20mmHg @ 30 Days



No. at Risk						
<20mmHg	414	396	372	335	298	225
≥20mmHg	54	53	52	48	41	28

Primary Endpoint

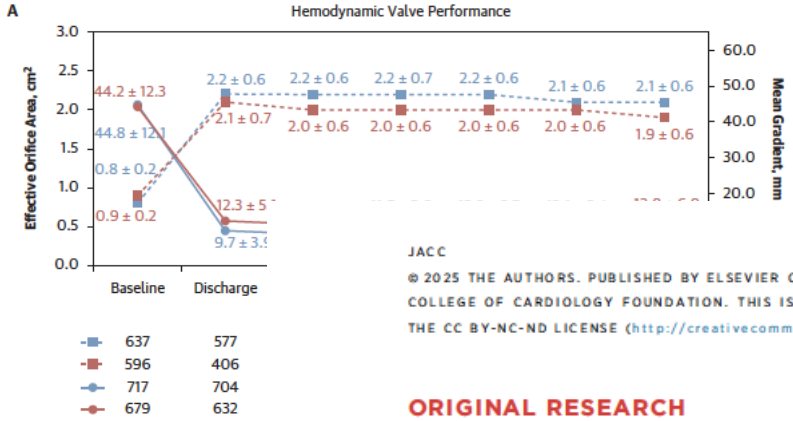
Small Annulus, 30-day PPM

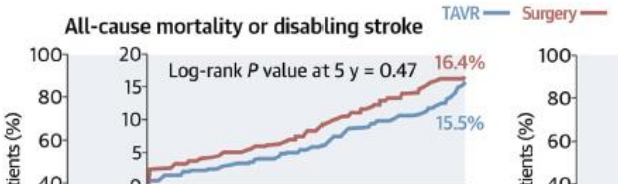


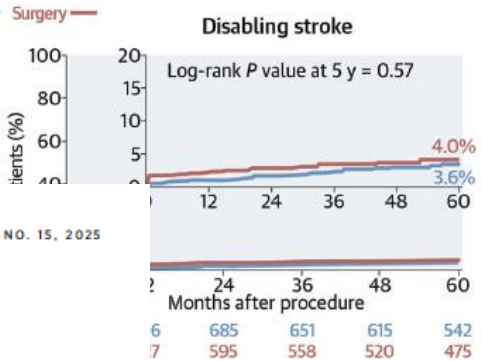
No. at Risk						
None	238	225	207	186	162	124
Moderate	146	136	125	108	98	75
Severe	48	45	42	36	30	21

CRF® TCT®

SEV versus SAVR

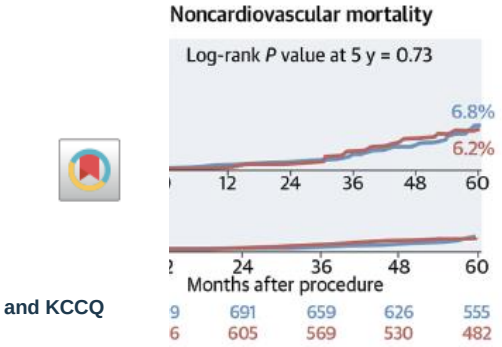


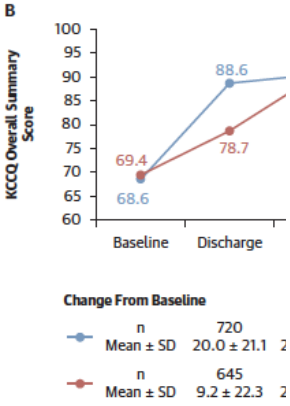




JACC VOL. 85, NO. 15, 2025

ORIGINAL RESEARCH





5-Year Outcomes After Transcatheter or Surgical Aortic Valve Replacement in Low-Risk Patients With Aortic Stenosis

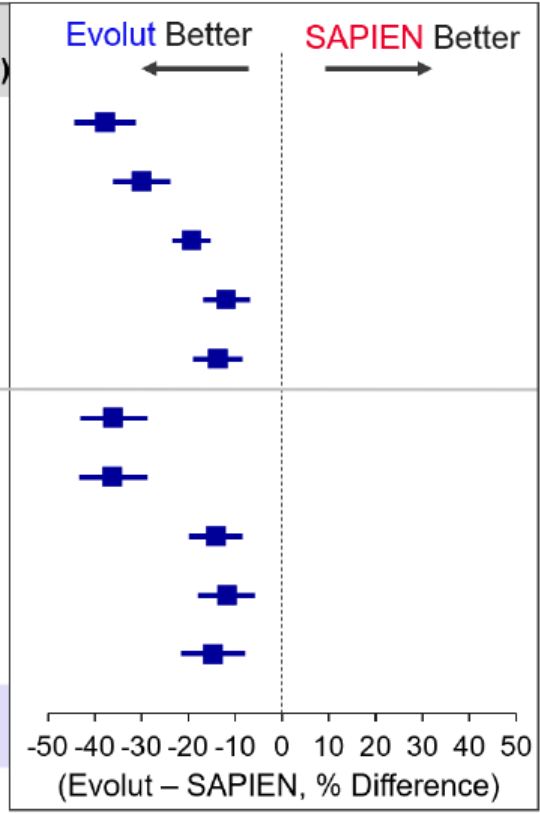
and KCCQ

John K. Forrest, MD,[a] Steven J. Yakubov, MD,[b] G. Michael Deeb, MD,[c] Hemal Gada, MD,[d] Mubashir A. Mumtaz, MD,[d] Basel Ramlawi, MD,[e] Tanvir Bajwa, MD,[f] John Crouch, MD,[f] William Merhi, DO,[g] Stephane Leung Wai Sang, MD,[g] Neal S. Kleiman, MD,[h] George Petrossian, MD,[i] Newell B. Robinson, MD,[i] Paul Sorajja, MD,[j] Ayman Iskander, MD,[k] Pierre Berthoumieu, MD,[l] Didier Tchétché, MD,[l] Christopher Feindel, MD,[m] Eric M. Horlick, MD,[m] Shigeru Saito, MD,[n] Jae K. Oh, MD,[o] Yoojin Jung, PHD,[p] Michael J. Reardon, MD,[h] the Low Risk Trial Investigators*

e rates of all-cause mortality or
r 5 years

BEV vs SEV RCT: SMART 2-Year

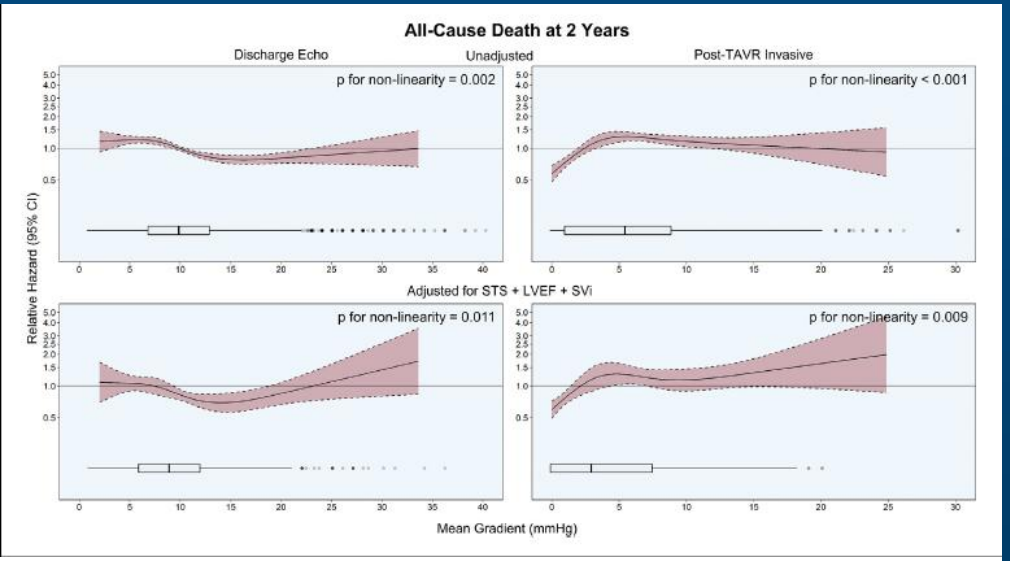
Alternative definition (Cumulative rates through 2 years)		Evolut (N=350)	SAPIEN (N=365)	Difference	P Value (Superiority)
Individual Component Definitions	Mean gradient ≥20 mmHg	4.7%	42.4%	-37.7%	<0.001
	Mean gradient ≥22.5 mmHg[1]	2.6%	32.5%	-29.9%	<0.001
	Mean gradient ≥25 mmHg	2.4%	21.7%	-19.2%	<0.001
	Severe PPM through 1Y (VARC-3)[2]	4.9%	16.7%	-11.8%	<0.001
	Severe PPM through 1Y (VARC-2)[3]	5.9%	19.6%	-13.6%	<0.001
Composite Definitions	SMART BVD[4]	12.5%	48.4%	-35.9%	<0.001
	EAPCI/ESC/EACTS BVD[5]	14.5%	50.6%	-36.1%	<0.001
	VARC-3 Mod Hemo[2]	10.1%	24.2%	-14.1%	<0.001
	Evolut SVD[6]	1.3%	12.9%	-11.7%	<0.001
	Evolut BVD[7]	5.3%	20.1%	-14.7%	<0.001

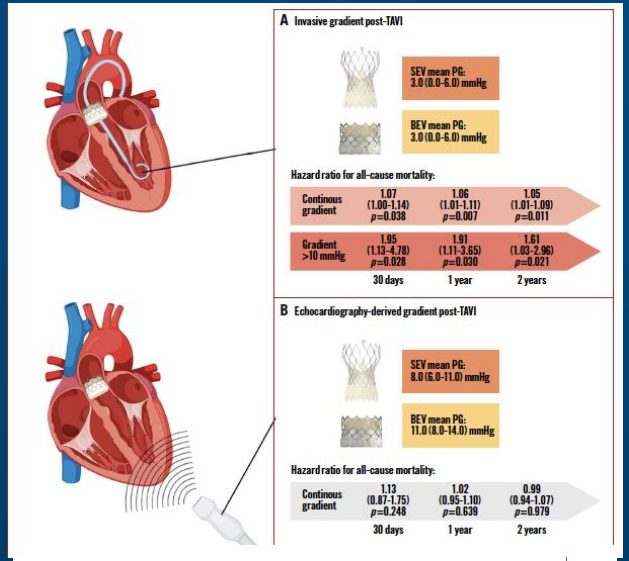


Evolut was superior to SAPIEN for all hemodynamic and composite BVD endpoint definitions tested

[1]Playford D, et al. J Am Soc Echocardiogr 2020;33(9):1077-1086.e1. [2]Genereux P, et al. J Am Coll Cardiol 2021;77(21):2717-2746. [3]Kappetein AP, et al. Eur J Cardio-Thorac Surg 2012;42:S45-S60. [4]Herrmann HC, et al. NEJM 2024;390(21):1959-1971. [5]Capodanno D, et al. Eur Heart J 2017;38(45):3382-390. [6]O'Hair D, et al. JAMA Cardiol 2023;8(2):111-119. [7]Yakubov SJ, et al. 2024, Presentation NY Valve 2024, Manuscript in press.

Invasive Gradients and Outcomes





JACC: CARDIOVASCULAR INTERVENTIONS
VOL. 15, NO. 18, 2022

PUBLISHED BY ELSEVIER

Transvalvular Pressure Gradients and All-Cause Mortality Following TAVR

A Multicenter Echocardiographic and Invasive Registry

Houman Khalili, MD,[a] Philippe Pibarot, PhD, DVM,[b] Rebecca T. Hahn, MD,[c] Sammy Elmariah, MD, MPH,[d] Thomas Pilgrim, MD,[e] Anthony A. Bavry, MD,[f] Brijeshwar Maini, MD,[a] Taishi Okuno, MD,[e] Karim Al-Azizi, MD,[g] Thomas E. Waggoner, DO,[h] Michael Mack, MD,[g] Joseph Rodès-Cabau, MD,[b] Amr E. Abbas, MD[i,j]

EuroIntervention
2025;21:e411-e425
published online e-edition April 2025
DOI: 10.4244/EIJ-D-24-00341

ORIGINAL RESEARCH

Prognostic value of invasive versus echocardiography-derived aortic gradient in patients undergoing TAVI

Mark M.P. van den Dorpel, MD; Sayantan Chatterjee[1], BSc; Rik Adrichem[1], MD; Sarah Verhemel[1], MD; Isabella Kardys[1], MD, PhD; Jurgen Ruiter[1], MD, PhD; Jan Nuis[1], MD, PhD; Joost Daemen[1], MD, PhD; Claire Ben Rein[1], MD, PhD; Alexander Hirsch[1,2], MD, PhD; Marcel L. Geleijnse[1], MD, PhD; Nicolas M. Van Mieghem[1]*, MD, PhD

*Correspondence author: Department of Cardiology, Thoraxcenter, Erasmus University Medical Center, office Nt-645, Dr. Molewaterplein 40-3015 GD, Rotterdam, the Netherlands. E-mail: n.vanmieghem@erasmusmc.nl

This article also includes supplementary data published online at: https://eurointervention.pcronline.com/doi/10.4244/EIJ-D-24-00341

Corewell Health™

Delta Change in Echocardiographic Outcomes?

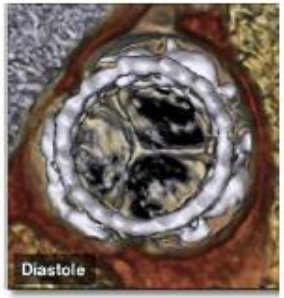
Invasive Gradient – 19 mmHg

"Reclassified" to normal THV function and ongoing routine follow-up

Centre for Cardiovascular Innovation
Centre d'Innovation Cardiovasculaire

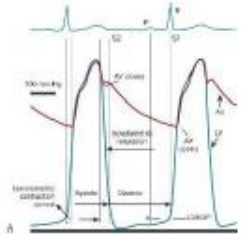
DISCORDANCE TAVR

Elevated MG ≥ 20 mmHg on
REPEAT TTE
OR VARC-3 criteria for ≥ Stage 2
(Moderate) Hemodynamic Valve
Deterioration



Cardiac CT

No Valve Thrombosis
Standardized
Invasive Hemodynamics



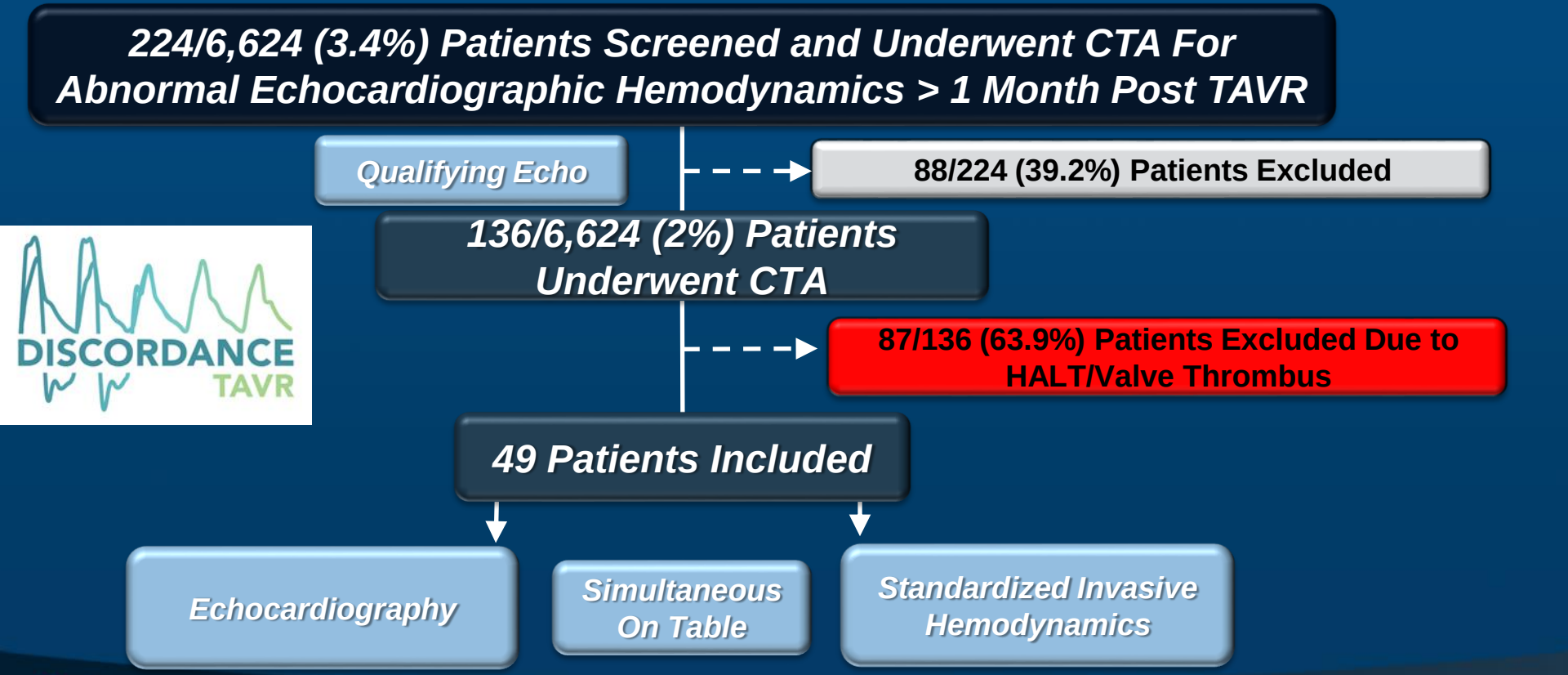
Concordance
Consider Reintervention

Discordance
Acceptable valve function

Valve Thrombosis
Anticoagulation

Patient Pathway (8 North American Centers/4Years)

DISCORDANCE TAVR



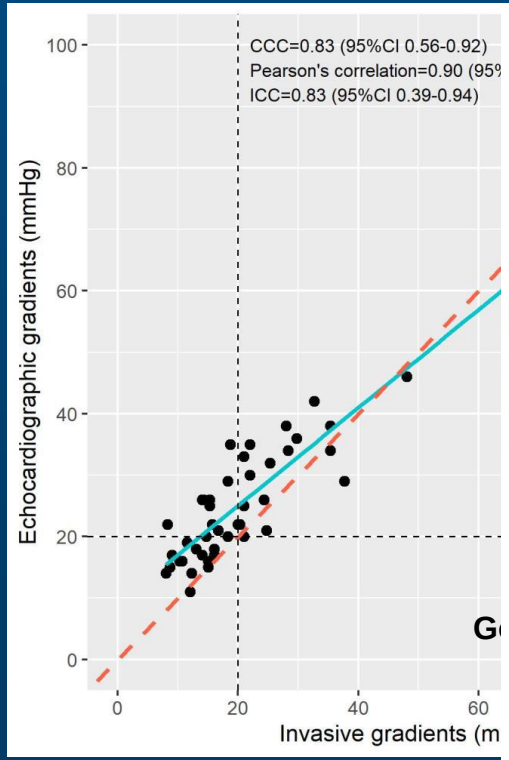
DISCORDANCE TAVR

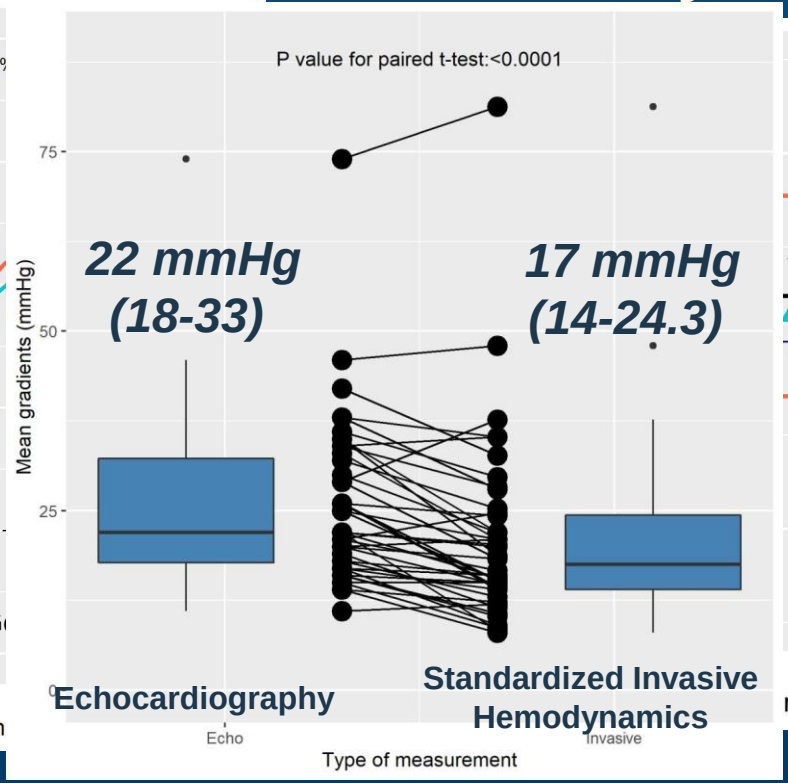
CRF TCT

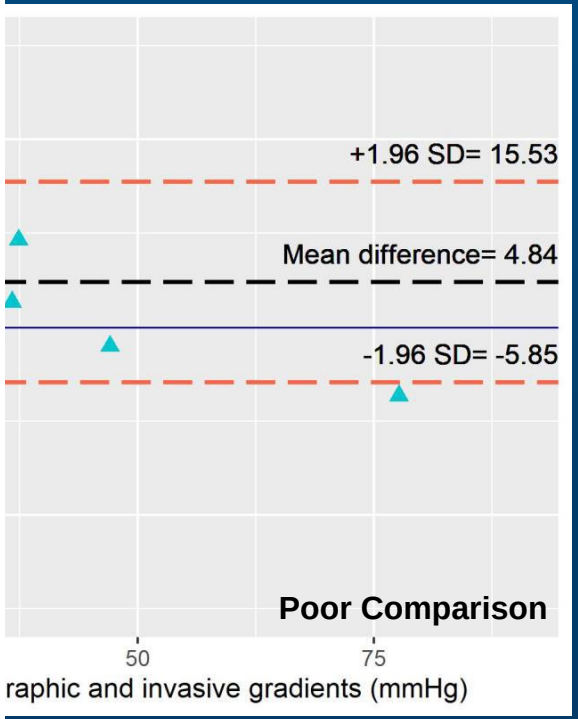
PI: David Wood, Co-PI Amr Abbas

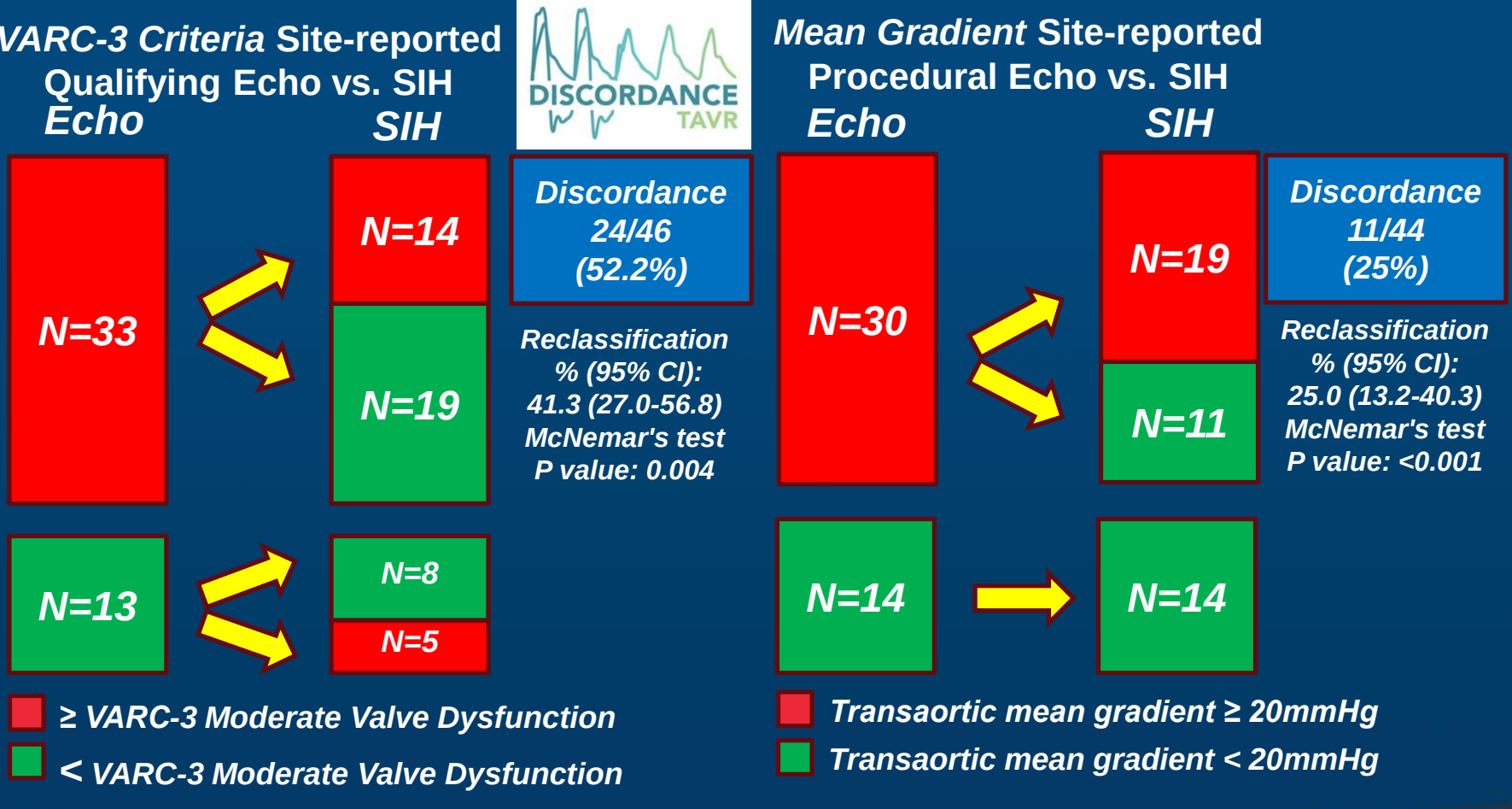
CCI-CIC Centre for Cardiovascular Innovation / Centre d'Innovation Cardiovasculaire

Site Reported Echocardiography Versus Site Reported Invasive Gradients By SIH

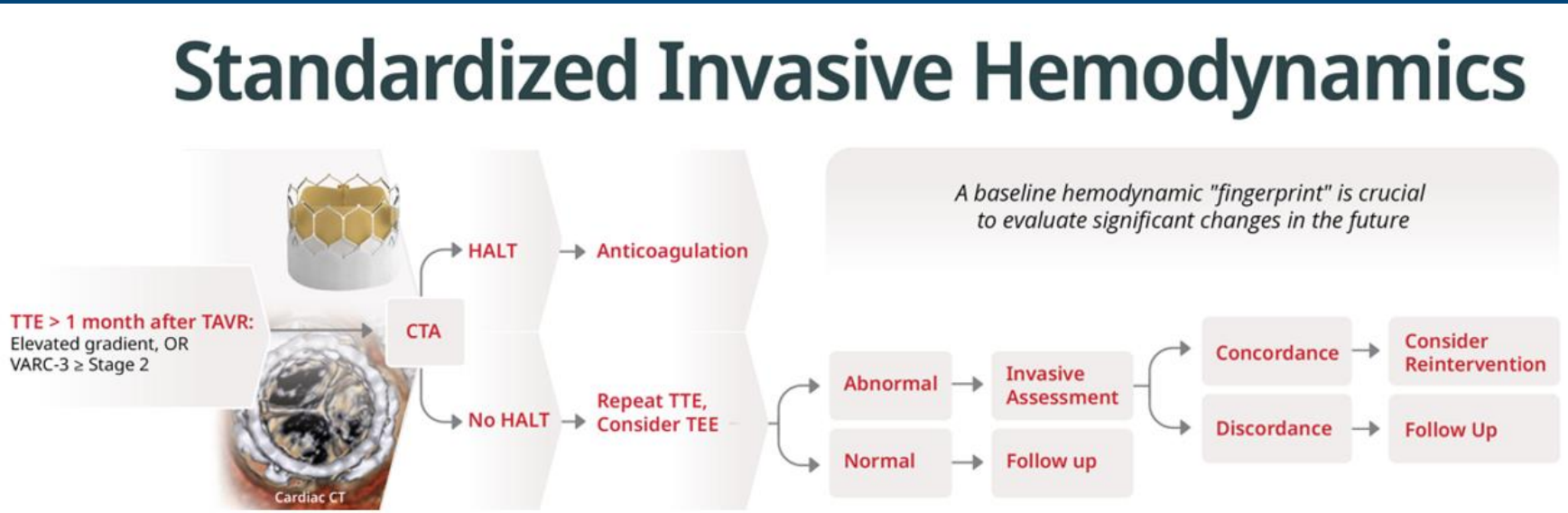







VARC-3 Criteria Site-reported Qualifying Echo vs. SIH
Echo
SIH
N=33
N=14
N=19
Discordance 24/46 (52.2%)
Reclassification % (95% CI): 41.3 (27.0-56.8) McNemar's test P value: 0.004
N=13
N=8
N=5
≥ VARC-3 Moderate Valve Dysfunction
< VARC-3 Moderate Valve Dysfunction
DISCORDANCE TAVR
Mean Gradient Site-reported Procedural Echo vs. SIH
Echo
SIH
N=30
N=19
N=11
Discordance 11/44 (25%)
Reclassification % (95% CI): 25.0 (13.2-40.3) McNemar's test P value: <0.001
N=14
N=14
Transaortic mean gradient ≥ 20mmHg
Transaortic mean gradient < 20mmHg

Working Up Elevated Echocardiographic Gradients



Conclusions

- Elevated gradients EARLY after TAVR
  - Discharge - 30 Days:
    - Flow and EF improvement
    - PPM: ? Impact on outcomes, check EF and SVI
  - > 30 Days: CTA Rule out HALT/Thrombus
  - CT negative
    - Repeat Echo
    - Symptoms
    - Consider invasive gradients before reintervention is decided
- Late increase in gradient and/or VARC-3 $\geq$ 2: SVD