ASSESSMENT OF PVR (Paravalvular Regurgitation) and Prognostic impact After TAVI

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AP Valve 2016 Korea

Conflicts of Interest

- I have **NOTHING** to disclose concerning this presentation

Outlines

- Causes of PVR
- Incidence
- Prognostic Impact
- Assessment methods for PVR
- Treatment Modalities
- Conclusion

Characteristics Features of PVR Post TAVI

Location

- Outside of Bioprosthesis Stent Strut

Etiology

- Incomplete Apposition of Stent Strut
- Inaccurate Position (Too High or Too low)
- Calcification of Native Valve Leaflet

-> Usually PVR Site Anatomy: complex

Incidences of PVR after TAVI

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Incidence, Predictors, and Outcomes of Aortic Regurgitation After Transcatheter Aortic Valve Replacement

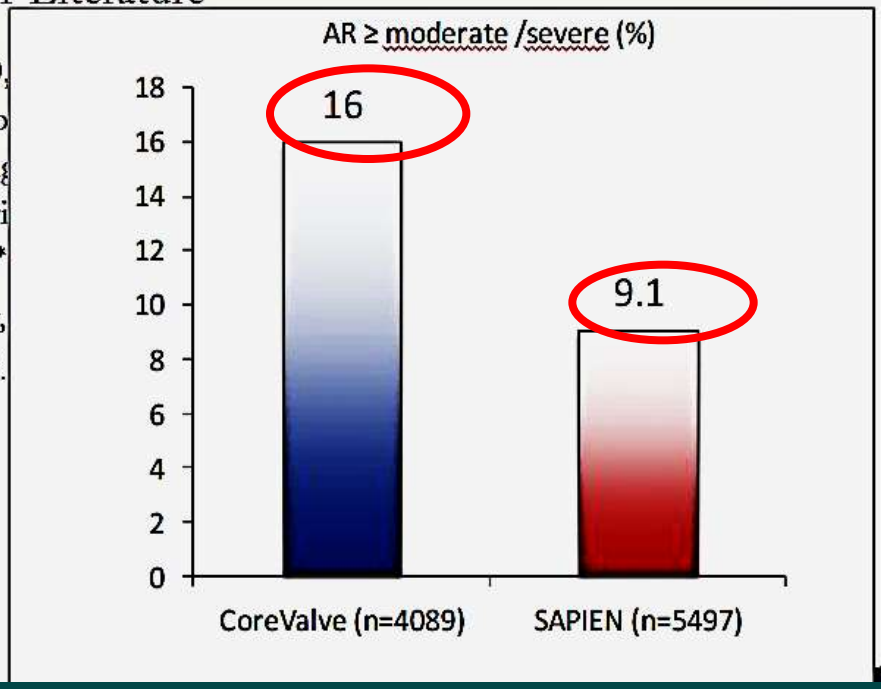
Meta-Analysis and Systematic Review of Literature

Ganesh Athappan, MD,*† Eshan Patvardhan, MD,
Lars Georg Svensson, MD, PHD,‡ Pedro A. Lemo
Giuseppe Tarantini, MD, PHD,‖ Jan-Malte Sinning
Davide Capodanno, MD, PHD,# Corrado Tamburi
Antonio Colombo, MD,** Samir R. Kapadia, MD*

Cleveland, Ohio; São Paulo, Brazil; Padova, Catania,

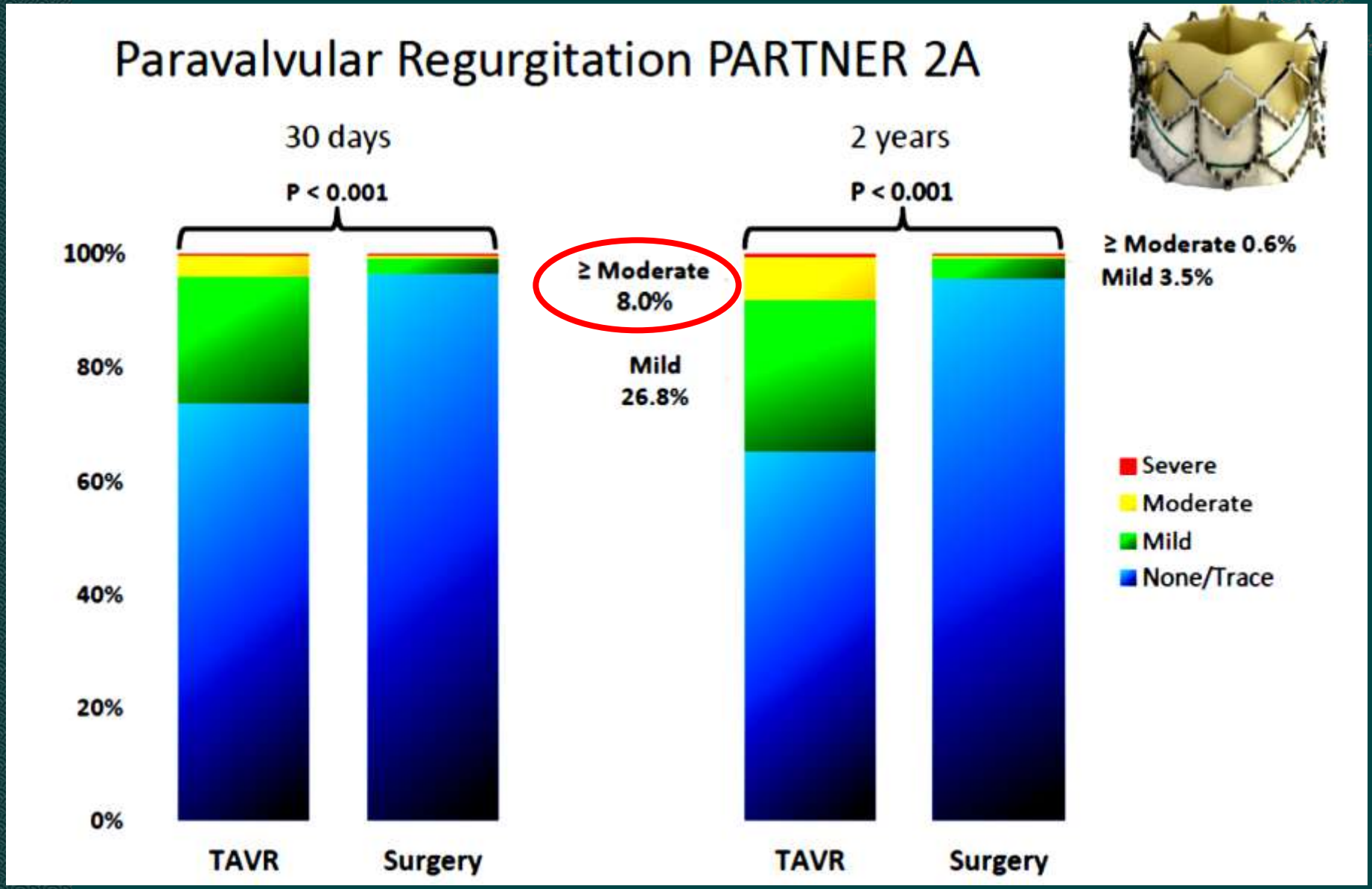
25 studies reported on predictors of post-TAVR AR.
7,279 SAPIEN pts and 5,261 CoreValve pts
Predictors include ($r = 0.47$, $p < 0.001$)

1. Implantation depth
2. Valve undersizing
3. Agatston calcium score



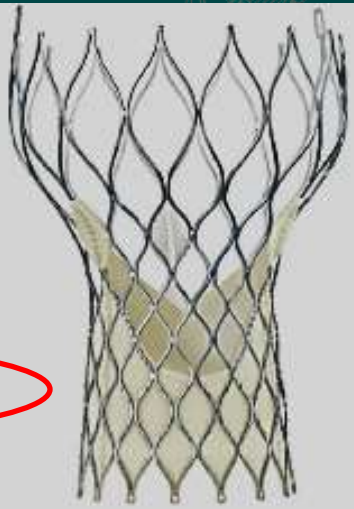
JACC 2013;61; 1585-95

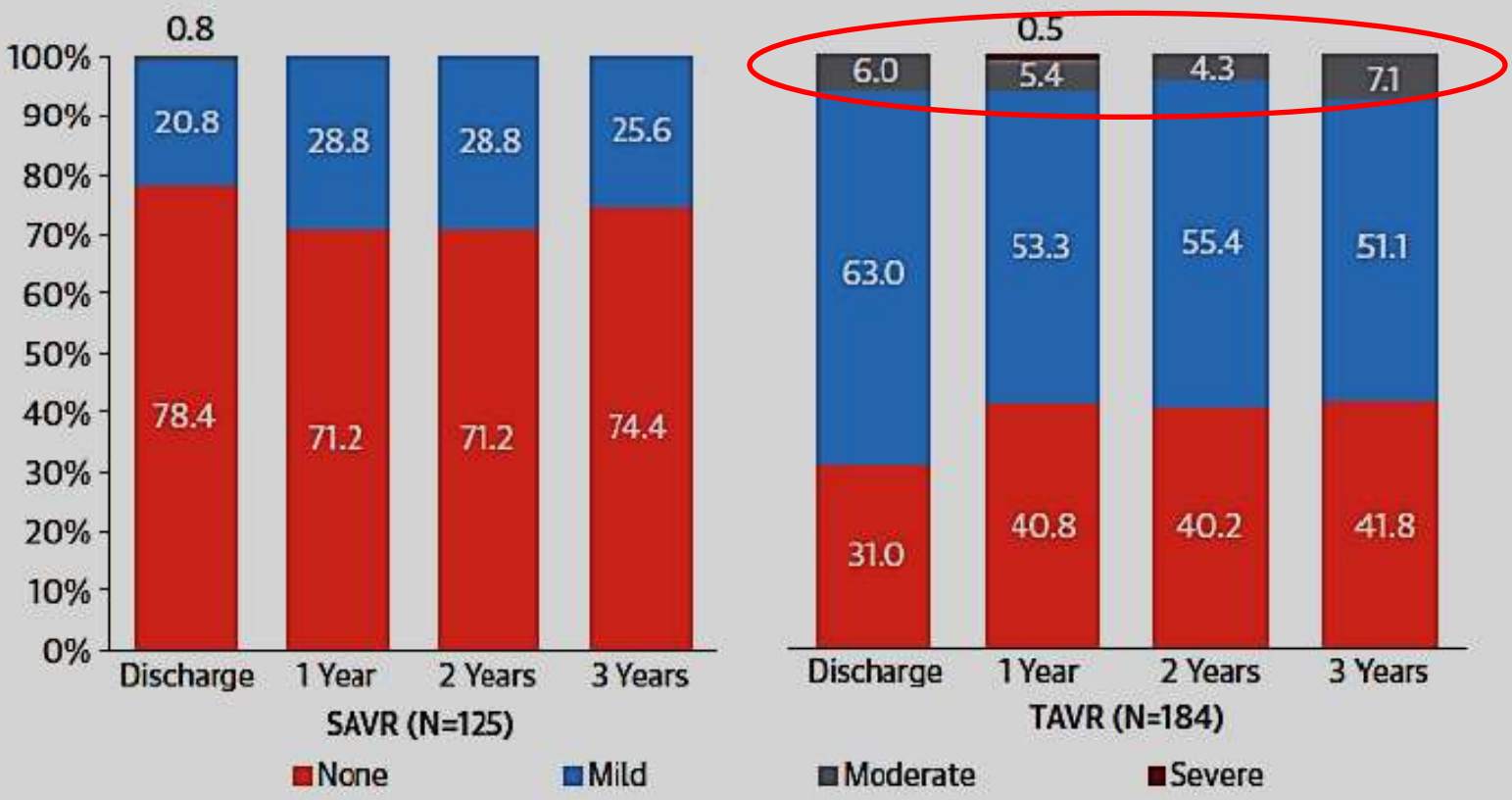
Incidences of PVR after TAVI



Incidences of PVR after TAVI

PVL over 3 years in CoreValve US Pivotal Trial



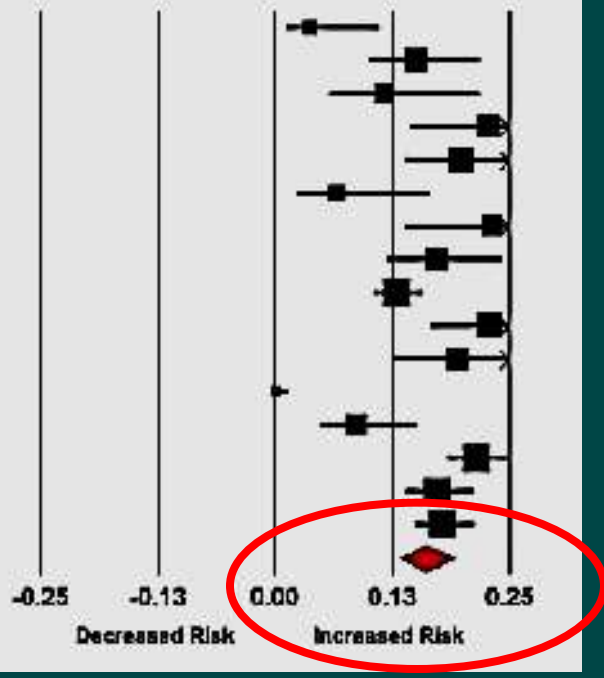


Prognostic Impact of PVR

Incidence, Predictors, and Outcomes of Aortic Regurgitation After Transcatheter Aortic Valve Replacement

A Moderate or Severe AR Post TAVR: CoreValve

Study Names	Event rate	Lower limit	Upper limit	Z-Value	p-Value	Events/Sample Size
Lemos	0.038	0.012	0.111	-5.491	0.000	3 / 79
Sinning	0.151	0.101	0.218	-7.475	0.000	22 / 146
Leber	0.118	0.060	0.218	-5.353	0.000	8 / 68
Chorianopoulos	0.229	0.145	0.341	-4.273	0.000	16 / 70
Grube	0.199	0.140	0.274	-6.492	0.000	27 / 136
Grube E	0.067	0.025	0.165	-5.099	0.000	4 / 60
Sherif	0.232	0.140	0.360	-3.779	0.000	13 / 56
Gotzmann	0.172	0.119	0.243	-7.135	0.000	25 / 145
Tamburino	0.130	0.106	0.158	-16.468	0.000	86 / 663
Garcia	0.229	0.168	0.305	-8.118	0.000	33 / 144
Jabbour	0.195	0.125	0.292	-5.234	0.000	17 / 87
Piazza	0.001	0.000	0.012	-5.064	0.000	0 / 646
Buellesfeld	0.087	0.049	0.151	-7.437	0.000	11 / 126
Girald Core	0.215	0.185	0.248	-13.482	0.000	138 / 642
Moats Core	0.173	0.141	0.211	-12.396	0.000	76 / 439
Wahab Core	0.179	0.150	0.212	-14.096	0.000	104 / 582
All	**0.160**	**0.134**	**0.190**	**-15.65**	**0.000**	**583/4089**

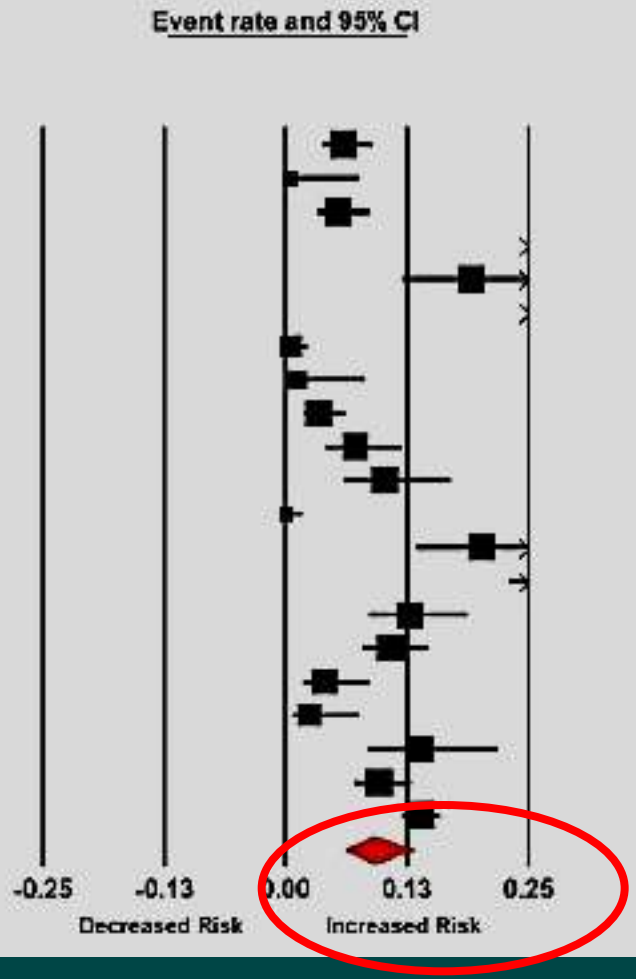


JACC 2013;61; 1585-95

Prognostic Impact of PVR

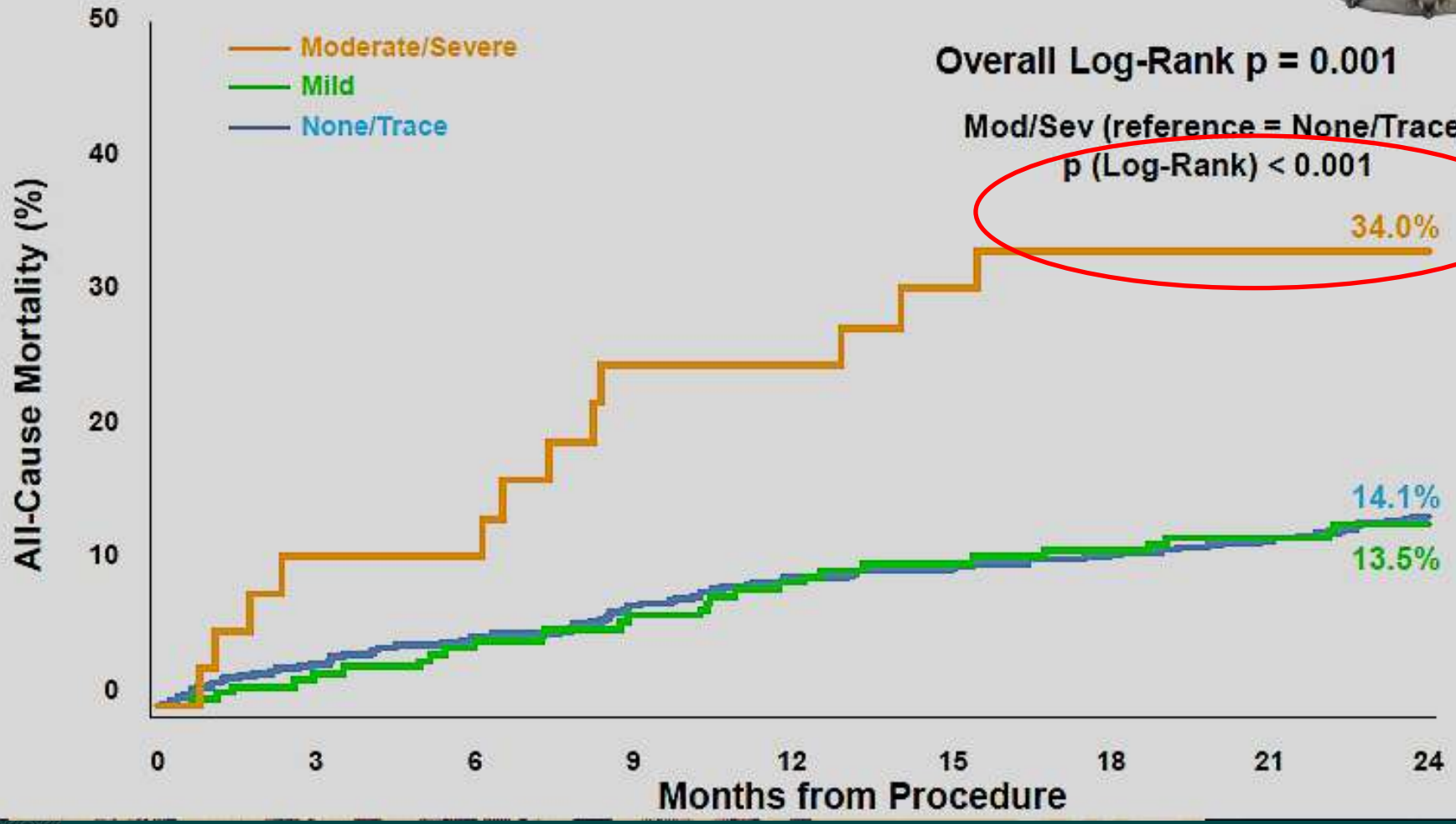
B Moderate or Severe AR Post TAVR: Edward Valve

Study Names	Event rate	Lower limit	Upper limit	Z-Value	p-Value	Events/Sample Size
Cabau	0.059	0.038	0.090	-12.014	0.000	20 / 339
Bagur	0.005	0.000	0.074	-3.741	0.000	0 / 100
Gurvitch	0.055	0.034	0.086	-11.412	0.000	17 / 310
Lefe'vre	0.469	0.385	0.555	-0.701	0.483	61 / 130
Attias	0.193	0.122	0.292	-5.147	0.000	16 / 83
Hayashida	0.308	0.255	0.366	-6.035	0.000	80 / 260
Unbehaun	0.006	0.001	0.022	-7.308	0.000	2 / 358
Conradi	0.012	0.002	0.081	-4.368	0.000	1 / 82
Walther	0.033	0.018	0.061	-10.458	0.000	10 / 299
Puls	0.072	0.042	0.120	-8.866	0.000	13 / 180
Amabile	0.103	0.061	0.170	-7.384	0.000	13 / 126
D'Onofrio	0.001	0.000	0.016	-4.888	0.000	0 / 504
Ewe	0.202	0.136	0.290	-5.626	0.000	21 / 104
REVIVAL	0.345	0.232	0.479	-2.254	0.024	19 / 55
Makkar	0.128	0.087	0.186	-8.571	0.000	23 / 179
Kodali	0.109	0.080	0.147	-12.212	0.000	38 / 348
Dworakowski	0.040	0.018	0.086	-7.645	0.000	6 / 151
Wendler	0.025	0.008	0.075	-6.266	0.000	3 / 120
Wahab Edw	0.139	0.085	0.218	-6.557	0.000	15 / 108
Moats Edw	0.096	0.071	0.129	-13.293	0.000	39 / 405
Giraldi Edw	0.139	0.121	0.159	-22.375	0.000	174 / 1256
All	**0.091**	**0.062**	**0.131**	**-11.03**	**0.000**	**571/5497**



JACC 2013;61; 1585-95

Severity of PVR at 30 Days and All-cause Mortality at 2 Years - PARTNER 2A



Incidence, Predictors, and Outcomes of Aortic Regurgitation After Transcatheter Aortic Valve Replacement

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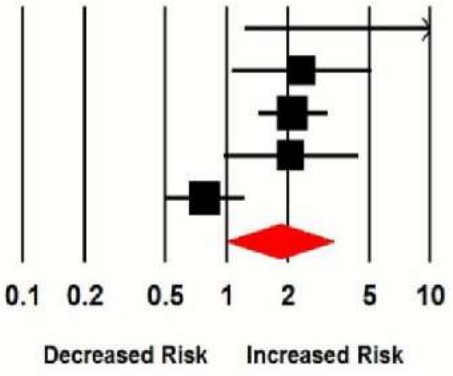
Lars Georg Svensson, MD, PhD,‡ Pedro A. Lemos, MD,§ Chiara Fraccaro, MD, PhD,‖
Giuseppe Tarantini,
Davide Capodanno,
Antonio Colombo,]

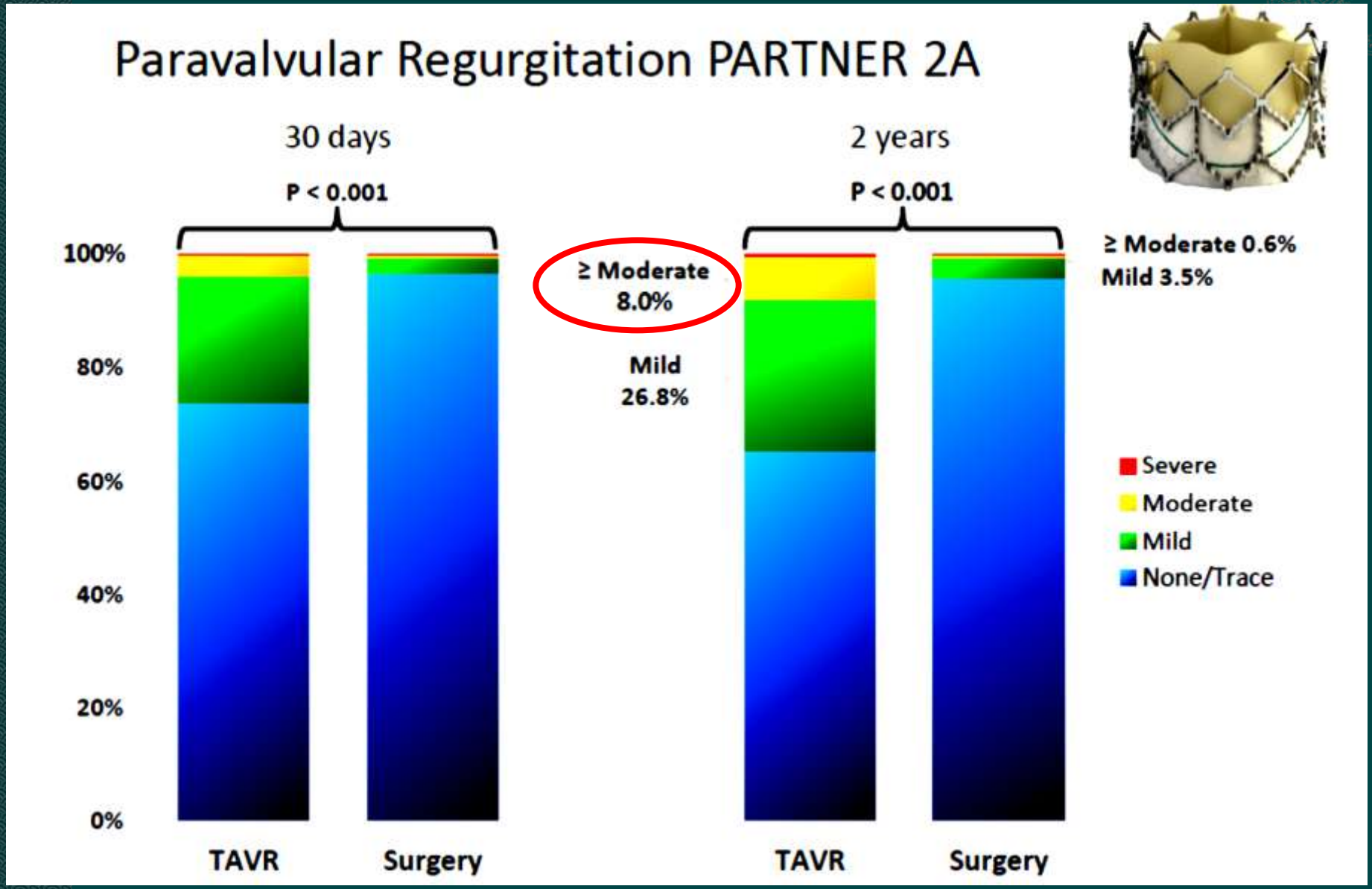
Impact of Mild AR on Mortality

Study name	Hazard ratio	Lower limit	Upper limit	Z-Value	p-Value
Lemos	10.080	1.229	82.673	2.152	0.031
Sinning	2.342	1.066	5.145	2.119	0.034
Kodali	2.110	1.433	3.107	3.782	0.000
Fraccaro	2.064	0.968	4.400	1.876	0.061
Tamburino	0.780	0.499	1.218	-1.092	0.275
All (N=1620)	**1.829**	**1.005**	**3.329**	**1.975**	**0.048**

Statistics for each study



Incidences of PVR after TAVI



Assessment of PVR post TAVI

EXPEDITED REVIEW Heart Valve Disease

Updated Standardized Endpoint Definitions for Transcatheter Aortic Valve Implantation

The Valve Academic Research Consortium-2 Consensus Document†

A. Pieter Kappetein,* Stuart J. Head, Philippe Généreux, Nicolo Piazza, Nicolas M. van Mieghem, Eugene H. Blackst... Rebecca T. Hal... Roxan... Patrick... *Rotter...*

Standardized grading system necessary to more clearly understand the incidence of PVR and its clinical impact

EROA (cm^2)	0.10 cm^2	0.10–0.29 cm^2	≥0.30 cm^2

*In conditions of normal or near normal stroke volume (50–70 ml). †These parameters are more affected by flow, including concomitant aortic regurgitation. ‡For LVOT >2.5 cm, significant stenosis criteria is <0.20. §Use in setting of BSA ≥1.6 cm^2 (note: dependent on the size of the valve and the size of the native annulus). ||Use in setting of BSA <1.6 cm^2. ¶Use in setting of BMI <30 kg/cm^2. #Use in setting of BMI ≥30 kg/cm^2. **Not well-validated and may overestimate the severity compared with the quantitative Doppler.

EROA = effective regurgitant orifice area; PW = pulsed wave.

Angiographic Assessment of PAR Severity

- Qualitative; Easy to-use
- Recent TAVI studies, the angiographically (qualitative) degree of PAR correlated well with echocardiography in TAVI patients *

Classification : (Adapt to Valve Academic Research Consortium 2 criteria)

- **Mild** (reflow of contrast in LVOT and mid-part of the LV, clear with EACH beat)
- **Moderate** (contrast fill whole LV with incomplete washout in a single beat and faint opacification of the entire LV over several beats)
- **Severe** (opacify entire LV with the same intensity as in the aorta and persistence of contrast after a single beat)

Drawback :

- Regurgitant flow within each grade varies widely, and a considerable overlap
- Contrast Volume

* Sinning JM, Hammerstingl C, Vasa-Nicotera M, et al..J Am Coll Cardiol 2012;59:1134–41
Vasa-Nicotera M, Sinning JM, Chin D, J Am Coll Cardiol Intv 2012;5:858–65

Echocardiographic Assessment of PAR

- remains challenging
- imprecise in practice, especially implant situation
  1) acute hemodynamic changes during TAVI affect doppler and color flow assessment
  2) semiquantitative parameters of AR severity, eg. jet width, vena contracta, or P 1/2 time, are best applied in central jets
     (**Not ideal** for eccentric, circumferential PAR)
  3) acoustic shadowing by prosthesis and native calcification may obscure PAR jets
- **TEE preferred** for accurate assessment (TransV. AR vs PAR; mechanisims – Supra-skirt vs Infra-skirt etc)
  (BUT Most cases are NOW under LA or light sedation only)

ECHO Parameters for PAR

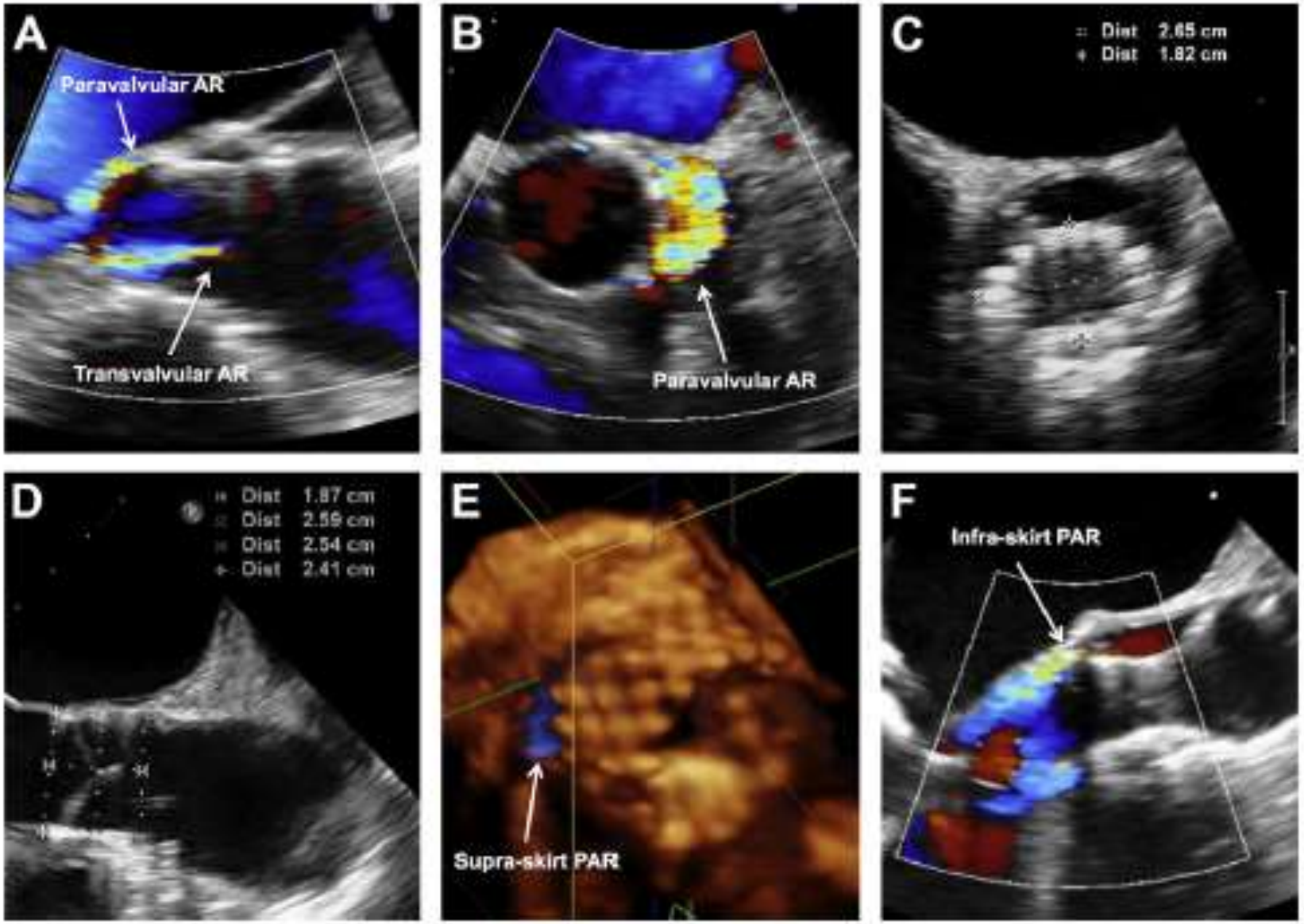
Semi-Quantitative : Diastolic Flow Reversal
Circumferential extent (≥ 30% severe)

Quantitative Parameter : Regurgitant Volume
Regurgitant fraction
EROA(Effective Regurg Orifice Area)

	Prosthetic aortic valve regurgitation		
	Mild	Moderate	Severe
Semiquantitative parameters			
Diastolic flow reversal in the descending aorta—PW	Absent or brief early diastolic	Intermediate	Prominent, holodiastolic
Circumferential extent of prosthetic valve paravalvular regurgitation (%)**	<10%	10%-29%	≥30%
Quantitative parameters‡			
Regurgitant volume (mL/beat)	<30 mL	30-59 mL	≥60 mL
Regurgitant fraction (%)	<30%	30-49%	≥50%
EROA (cm^2)	0.10 cm^2	0.10-0.29 cm^2	≥0.30 cm^2

PW, Pulsed wave; *EROA*, effective regurgitant orifice area. *In conditions of normal or near normal stroke volume (50-70 mL). †These parameters are more affected by flow, including concomitant aortic regurgitation. ‡For LVOT >2.5 cm, significant stenosis criteria is <0.20. §Use in setting of BSA ≥1.6 cm^2 (note: dependent on the size of the valve and the size of the native annulus). ‖Use in setting of BSA <1.6 cm^2. ¶Use in setting of BMI <30 kg/cm^2. #Use in setting of BMI ≥30 kg/cm^2. **Not well-validated and may overestimate the severity compared with the quantitative Doppler.

Valve ARC2 Consensus



Sinning et al JACC 2013;62

Hemodynamic Assessment -PAR

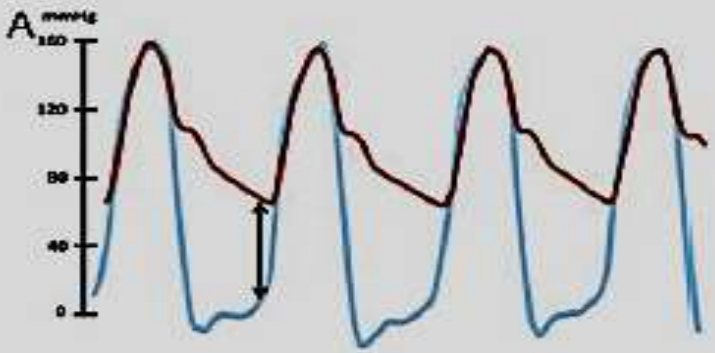
- Aortic Regurgitation index (ARI) = (DBP– LVEDP)/SBP X 100
- Cutoff value of 25
- Predictor of the 1-year mortality
- **(ARI >25) :** GOOD Negative predictive value (95 - 100%) for more than mild PAR, when used complementary to the angio - or echo -
- ARI still has to be validated in larger and controlled trial
- Or just simply compare the baseline and post TAVI AO diastolic and LVEDP

TIPS in measuring ARI :

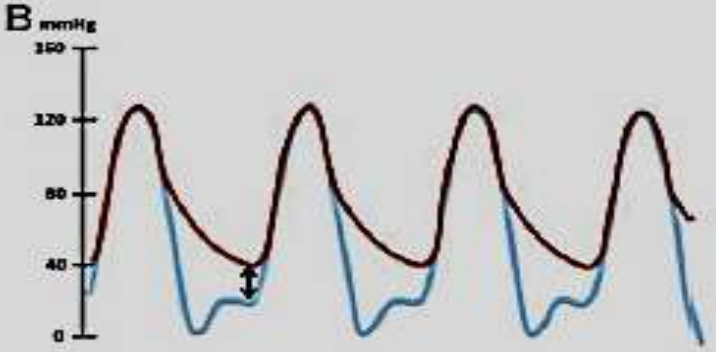
- Measure ARI appr. 10 min after valve deployment
  (Prevent confounding by an increased LVEDP due to myocardial ischemia and/or diastolic dysfunction after rapid pacing / balloon valvuloplasty
- ARI measured as mean value over several cycles (especially AF pats)
- Measure with HR of 60 to 80 /min and without PVC
  (Inc HR - the diastolic pressure in the aorta increases and lead to a false-negative ARI)

Rodés-Cabau J. Transcatheter aortic valve implantation: current and future approaches. Nature Pub Group 2011:1–15.
Gotzmann M, Korten M, Bojara W, et al. Long-term outcome of patients with moderate and severe prosthetic aortic valve regurgitationafter transcatheter aortic valve implantation. Am J Cardiol 2012;110: 1500–6.

AR Index



AR index 34.4



AR index 15.4

AR index=(DBP-LVEDP)/SBPx100

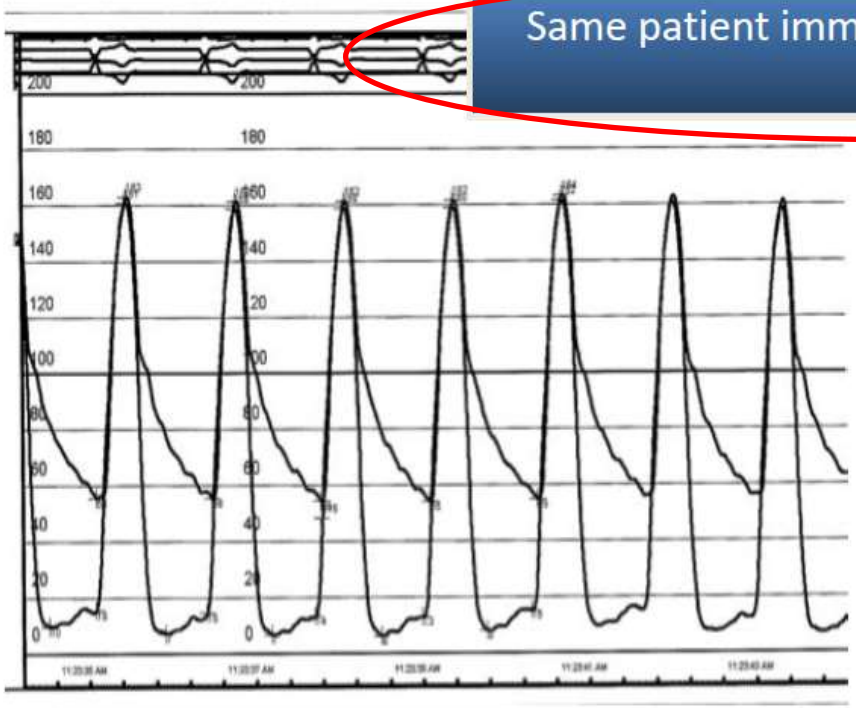
	AR Index <25	AR Index ≥25	P-value
1-year Mortality	46.0%	16.7%	<0.001

Sinning et al JACC 2012

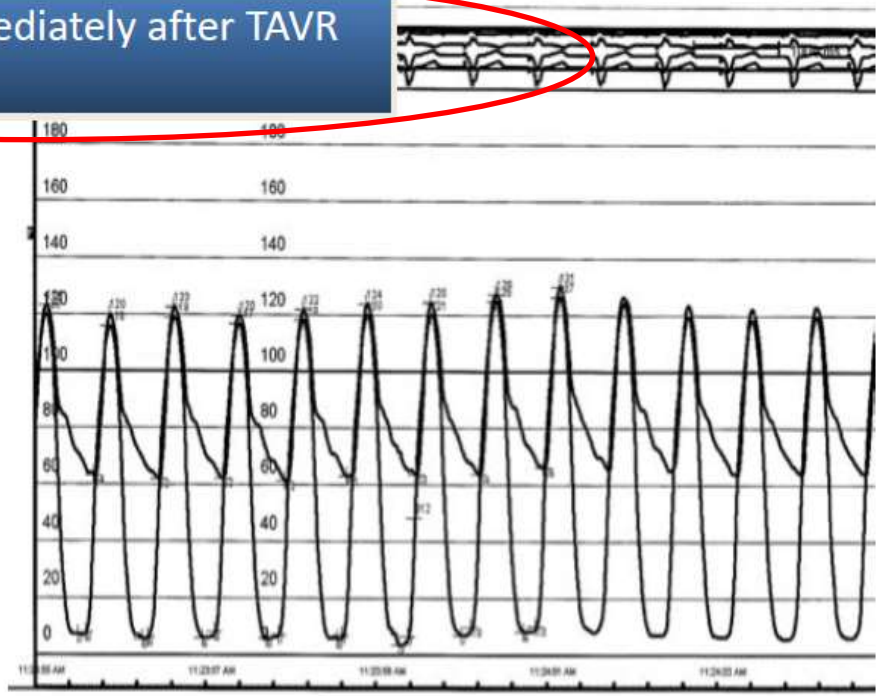
Heart Rate Dependence of AR Index

AR Index : ⟦ (DBP – LVEDP) / SBP ⟧ x 100

Same patient immediately after TAVR



HR 50
AR Index =24



HR 80
AR Index = 42

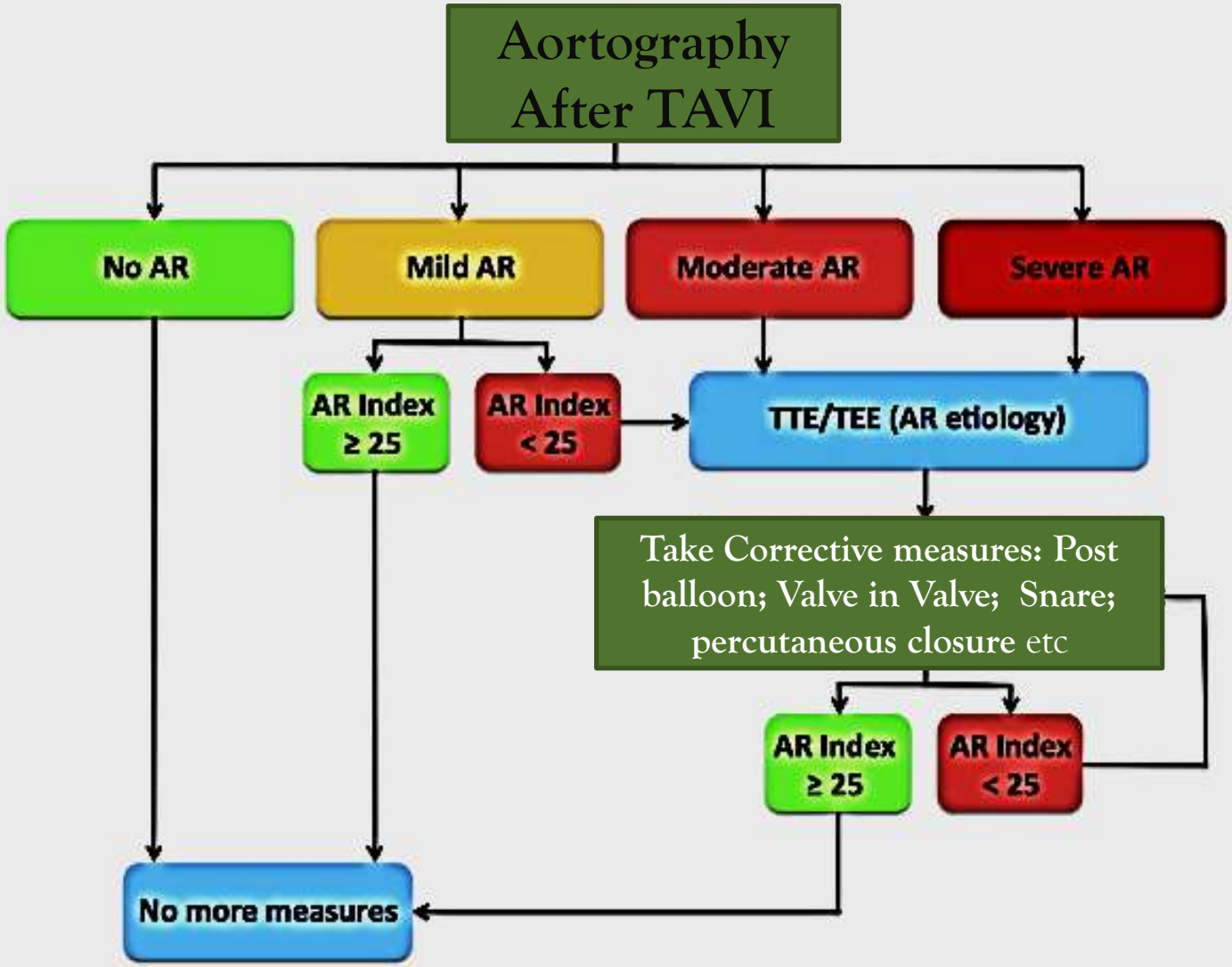
Treatment Options for Post TAVI PVR

- Prevention is **MUCH Better** than Cure :
  - Accurate Annulus assessment and Valve sizing
  - 3 D Multimodality Imagings x planning (esp MSCT)
  - Meticulous technique for Accurate Valve position

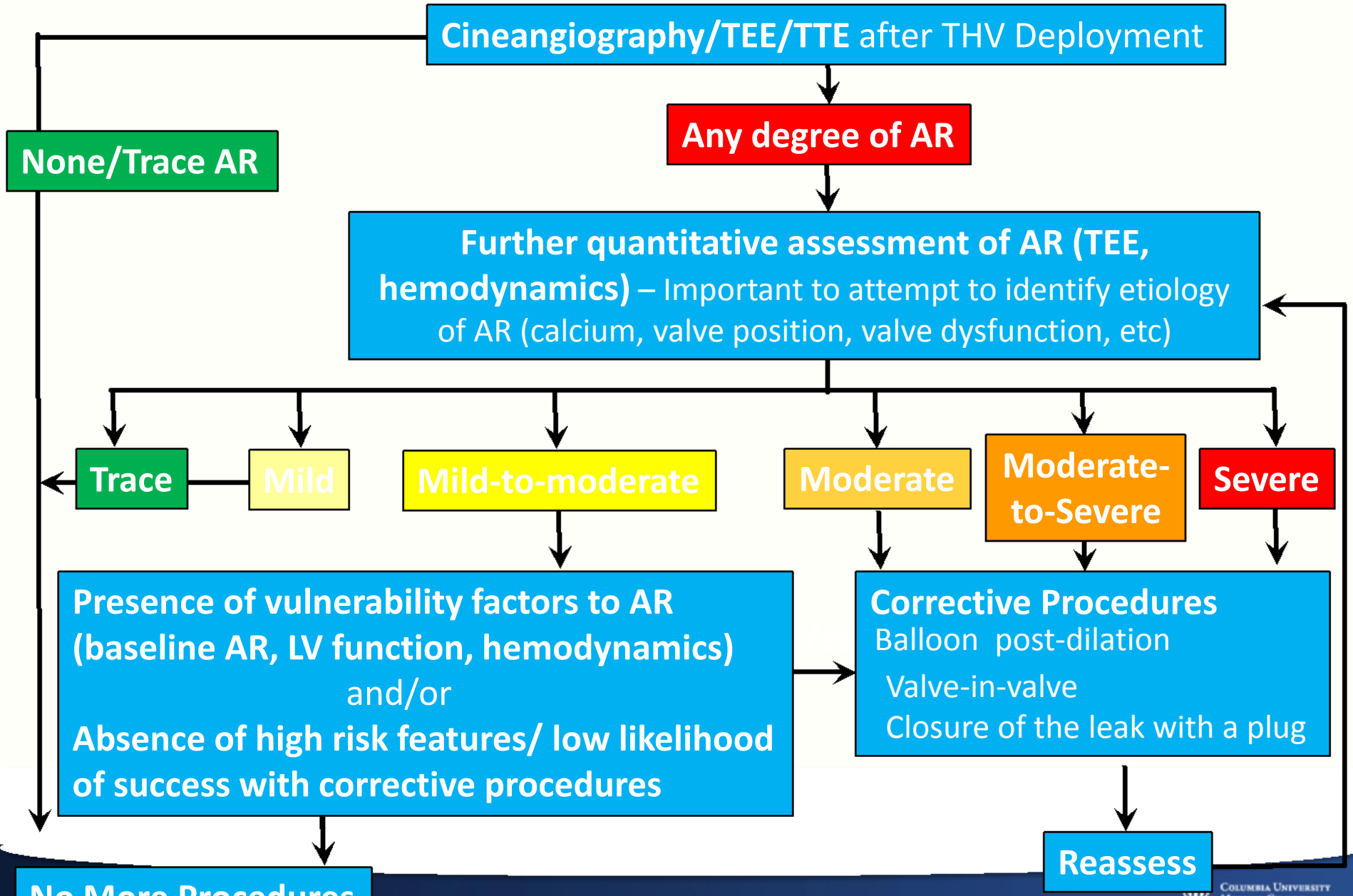
Treatment : Depend on PAR etiology

- Post Balloon Dilatation
- Valve in Valve
- Trans- catheter closure of PVR eg Vascular Plugs

Practical Approach- Complimentary



Sinning et al. JACC Vol. 62, No. 1, 2013
Paravalvular Aortic Regurgitation After TAVR July 2, 2013:11–20



Courtesy R. Hahn, MD

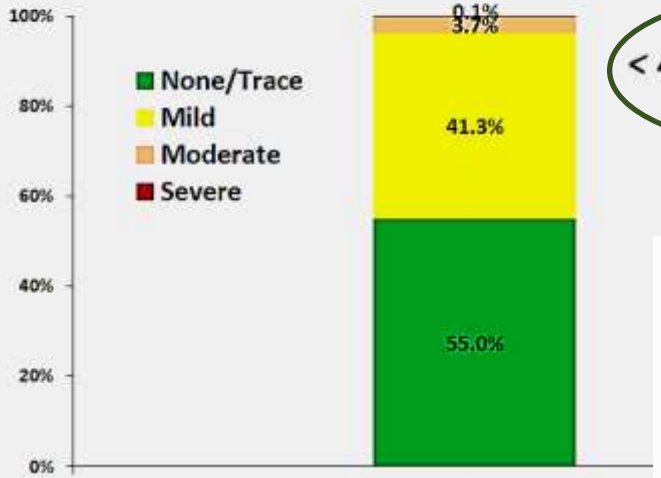
Paravalvular AR Assessment
New 5-Class Grading System

3-CLASS GRADING SCHEME	TRACE	MILD		MODERATE		SEVERE
4-CLASS GRADING SCHEME	1	1	2	2	3	4
NEW 5-CLASS GRADING SCHEME	TRACE	MILD	MILD-TO-MODERATE	MODERATE	MODERATE-TO-SEVERE	SEVERE
CINEANGIOGRAPHY						
	Grade 1	Grade 1	Grade 1	Grade 2	Grade 3	Grade 4
INVASIVE HEMODYNAMICS						
Aortic regurgitation index‡	>25	>25	>25	10-25	10-25	<10
ECHOCARDIOGRAPHY/DOPPLER						
Structural Parameters						
• Valve stent	Usually normal	Usually normal	Normal/ abnormal*	Normal/ abnormal†	Usually abnormal†	Usually abnormal†
Doppler parameters (qualitative or semi-quantitative)						
• Jet features‖						
Extensive/wide jet origin	Absent	Absent	Absent	Present	Present	Present
Multiple jets	Possible	Possible	Often Present	Often Present	Usually present	Usually present
Jet path visible along the stent	Absent	Absent	Possible	Often Present	Usually present	Present
Proximal flow convergence visible	Absent	Absent	Absent	Possible	Often present	Often present
○ Vena contracta width (mm)*	<2	<2	2-4	4-5	5-6	>6
○ Vena contracta area (mm²) β	<5	<5	5-10	10-20	20-30	>30
• Jet width at its origin (%LVOT diameter): color Doppler*	Narrow (<5)	Narrow (5-15)	Intermediate (15-30)	Intermediate (30-45)	Large (45-60)	Large (>60)
○ Jet density: CW Doppler	Incomplete or faint	Incomplete or faint	Variable	Dense	Dense	Dense
○ Jet deceleration rate (PHT, ms): CW Doppler ‖‖	Slow (>500)	Slow (>500)	Slow (>500)	Variable (200-500)	Variable (200-500)	Steep (<200)
○ Diastolic flow reversal in the descending aorta: PW Doppler‖‖	Absent	Absent or brief early diastolic	Intermediate	Intermediate	Holodiastolic (end-diast. vel.>20 cm/s)	Holodiastolic (end-diast. vel.>25 cm/s)
• Circumferential extent of PVR(%)	<10	<10	10-20	20-30	>30	>30
Doppler parameters (quantitative)						
○ Effective regurgitant orifice area (mm²)¶	<5	<5	5-10	10-20	20-30	>30
○ Regurgitant fraction (%)	<15	<15	15-30	30-40	40-50	>50
CARDIAC MAGNETIC RESONANCE IMAGING						
Regurgitant Orifice Area (mm²)	<10	<10	10-20	20-30	20-30	>30
Regurgitant fraction (%)#	<15	<15	15-30	30-40	40-50	>50

Future Perspectives – Newer Valves

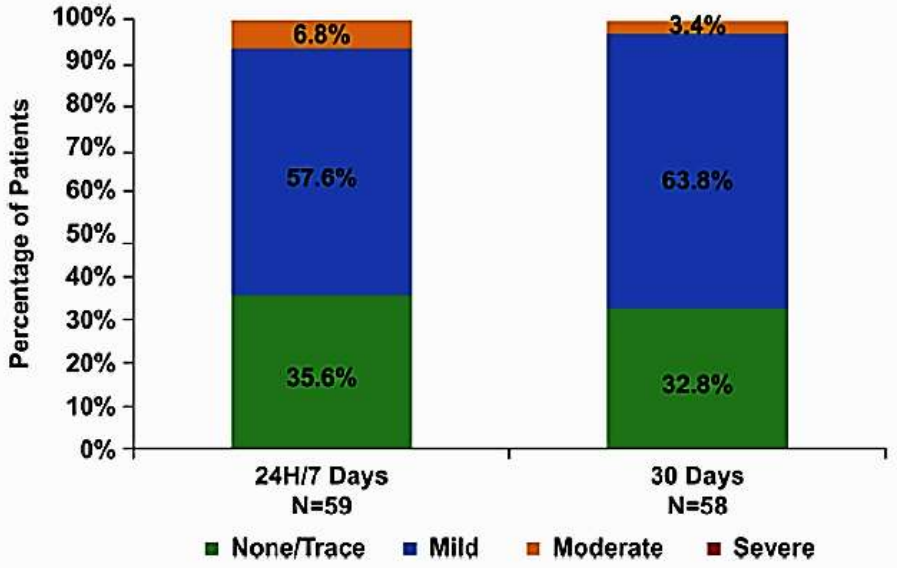
Low Rates of PVL at 30 Days

PARTNER II – Sapien 3



< 4% significant PVL

PVL with CoreValve Evolut R

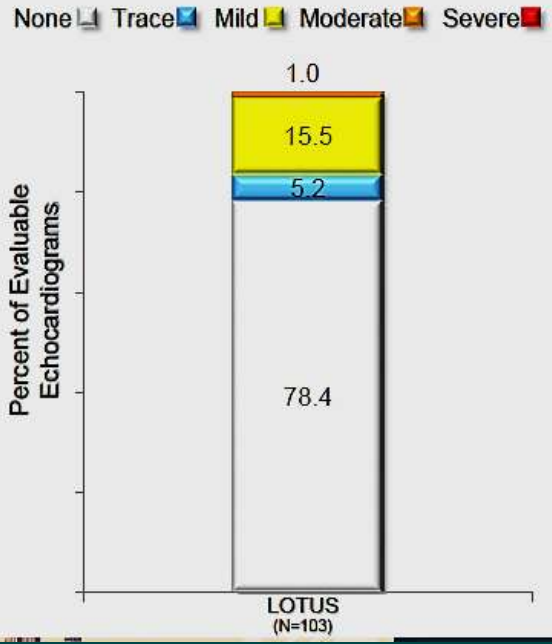


Manoharan et al., J Am Coll Cardiol Intv 2015;8:1359–67

Torsten Vhal , TVT 2016

LOTUS TAVR (REPRISE II)

PVR at 30 days (n=103)



Direct Flow TAVR (DISCOVER)

PVR thru 1 year (n=100)

Torsten Vhal , TVT 2016

Conclusion

- Immediate Post -TAVI PVR needs **Accurate Assessment** as moderate to severe PAR carries significant **Mortality and Morbidity**
- **A Complimentary Practical approach** with Angiography; Hemodynamic assessment and Echocardiography (TTE/3D TEE) is important for accurate assessment, New VARC3 definition
- Prevention (pre -procedure planning; accurate sizing; accurate deployment) is **Most important** to prevent moderate / severe PAR
- Newer generation devices with sealing skirts ; Repositionability and Retrievability may Reduce the occurrence of PVR and improve outcomes esp if we want to mimic our surgical counterpart's results

- Thank you!