

# PARTNER 3

Transcatheter or Surgical Aortic Valve Replacement in  
Low Risk Patients with Aortic Stenosis



**Martin B. Leon, MD &  
Michael J. Mack, MD**

on behalf of the PARTNER 3 Trial Investigators

10 mins

# Disclosures - Martin B. Leon, MD

*TCTAP 2019; Seoul, Korea; April 27-30, 2019*

Within the past 12 months, I or my spouse/partner have had a financial interest/arrangement or affiliation with the organization(s) listed below.

## Financial Relationship

- Research Support
- Consulting Fees\*
- Other

## Company

Abbott, Boston Scientific,  
Edwards Lifesciences, Medtronic

Abbott, Boston Scientific, Gore,  
Medtronic, Meril Life Sciences

Edwards Lifesciences\*\*

\*Medical or scientific advisory board meetings

\*\* Co-PI PARTNER 3 Trial; travel-related expenses only

# Background (2)



## PARTNER 3

- RCT 1:1
- vs. Surgery
- N = 1000 pts

Low Risk

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### Transcatheter Aortic-Valve Implantation for Aortic Stenosis in Patients Who Cannot Undergo Surgery

Martin B. Leon, M.D., Craig R. Smith, M.D., Michael Mack, M.D., D. Craig Miller, M.D., Jeffrey W. Moses, M.D., Lars G. Svensson, M.D., Ph.D., E. Murat Tuzcu, M.D., John G. Webb, M.D., Gregory P. Fontana, M.D., Raj R. Makkar, M.D., David L. Brown, M.D., Peter C. Block, M.D., Robert A. Guyton, M.D., Augusto D. Pichard, M.D., Joseph E. Bavaria, M.D., Howard C. Herrmann, M.D., Pamela S. Douglas, M.D., John L. Petersen, M.D., Jodi J. Akin, M.S., William N. Anderson, Ph.D., Duolao Wang, Ph.D., and Stuart Pocock, Ph.D., for the PARTNER Trial Investigators\*

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### Transcatheter or Surgical Aortic-Valve Replacement in Intermediate-Risk Patients

Martin B. Leon, M.D., Craig R. Smith, M.D., Michael J. Mack, M.D., Raj R. Makkar, M.D., Lars G. Svensson, M.D., Ph.D., Susheel K. Kodali, M.D., Vinod H. Thourani, M.D., E. Murat Tuzcu, M.D., D. Craig Miller, M.D., Howard C. Herrmann, M.D., Darshan Doshi, M.D., David J. Cohen, M.D., Augusto D. Pichard, M.D., Samir Kapadia, M.D., Todd Dewey, M.D., Vasilis Babaliarios, M.D., Wilson Y. Szeto, M.D., Mathew R. Williams, M.D., Dean Kereiakes, M.D., Alan Zajarias, M.D., Kevin L. Greason, M.D., Brian K. Whisenant, M.D., Robert W. Hodson, M.D., Jeffrey W. Moses, M.D., Alfredo Trento, M.D., David L. Brown, M.D., William F. Fearon, M.D., Philippe Pibarot, D.V.M., Ph.D., Rebecca T. Hahn, M.D., Wael A. Jaber, M.D., William N. Anderson, Ph.D., Maria C. Alu, M.M., and John G. Webb, M.D., for the PARTNER 2 Investigators\*

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### Transcatheter and Surgical Aortic-Valve Replacement in High-Risk Patients

Craig R. Smith, M.D., Martin B. Leon, M.D., Michael J. Mack, M.D., D. Craig Miller, M.D., Jeffrey W. Moses, M.D., Lars G. Svensson, M.D., Ph.D., E. Murat Tuzcu, M.D., John G. Webb, M.D., Gregory P. Fontana, M.D., Raj R. Makkar, M.D., Mathew Williams, M.D., Todd Dewey, M.D., Samir Kapadia, M.D., Vasilis Babaliarios, M.D., Vinod H. Thourani, M.D., Paul Corso, M.D., Augusto D. Pichard, M.D., Joseph E. Bavaria, M.D., Howard C. Herrmann, M.D., Jodi J. Akin, M.S., William N. Anderson, Ph.D., Duolao Wang, Ph.D., and Stuart J. Pocock, Ph.D., for the PARTNER Trial Investigators\*

# PARTNER 3 Study Design

**Symptomatic Severe Aortic Stenosis**

**Low Risk/TF ASSESSMENT by Heart Team  
(STS < 4%)**

**1:1 Randomization  
1000 Patients**

**TAVR  
(SAPIEN 3 THV)**

**Surgery  
(Surgical Bioprosthetic Valve)**

**Follow-up: 30 day, 6 mos, and annually through 10 years**

**PRIMARY ENDPOINT:  
Composite of all-cause mortality, stroke, or CV re-hospitalization  
at 1 year post-procedure**

# PARTNER 3 Clinical Sites



**1 site**

St. Paul's Hospital  
Vancouver, BC  
University of Washington Seattle  
Seattle, WA

Providence Heart & Vascular  
Institute Portland  
Portland, OR

Kaiser San Francisco  
Medical Center  
San Francisco, CA

Intermountain  
Medical Center  
Murray, UT

Medical Center of the Rockies  
Loveland, CO

Sutter Medical Center, Sacramento  
Walnut Creek, CA

Mills-Peninsula Health Services  
Burlingame, CA

Stanford University Medical Center  
Stanford, CA

Cedars-Sinai Medical Center  
Los Angeles, CA

UCLA  
Los Angeles, CA

Hoag Memorial  
Hospital  
Newport Beach, CA

Banner University  
Medical Center  
Phoenix, AZ

The Queen's  
Medical Center  
Honolulu, HI

**HAWAII**



**65 sites**

**CANADA**

NorthShore University  
Health System Research  
Institute Evanston  
Evanston, IL

Northwestern  
University  
Chicago, IL

University of Buffalo -  
Kaleida Health  
Buffalo, NY

Dartmouth-Hitchcock  
Medical Center  
Lebanon, NH

Central Maine  
Medical Center  
Lewistown, ME

University of Minnesota  
Medical Center  
Minneapolis, MN

University of Wisconsin  
Madison, WI

Mayo Clinic  
Rochester, MN

The Cleveland  
Clinic Foundation  
Cleveland, OH

Newark  
Beth Israel  
Medical Center  
Newark, NJ

Albany Medical College  
Albany, NY

Brigham and Women's Hospital  
Boston, MA

University of Iowa  
Hospitals and Clinics  
Iowa City, IA

Henry Ford  
Hospital  
Detroit, MI

Mount Carmel  
Health System  
Columbus, OH

University at Buffalo  
Buffalo, NY

York Hospital  
York, PA

Hartford Hospital  
Hartford, CT

Winthrop-University  
Hospital Mineola  
Mineola, NY

Nebraska Heart  
Institute  
Lincoln, NE

Rush University  
Medical Center  
Chicago, IL

Prairie Education  
and Research  
Cooperative  
Springfield, IL

Allegheny-Singer  
Research  
Institute  
Pittsburgh, PA

Columbia University  
Medical Center  
New York, NY

Cornell (New York Hospital)  
New York, NY

St. Luke's Hospital  
Kansas City, MO

Washington  
University/  
Barnes-Jewish  
Hospital Saint Louis  
Saint Louis, MO

Cardiovascular Research  
Institute of Kansas  
Wichita, KS

The Christ Hospital  
Cincinnati, OH

University of Virginia  
Charlottesville  
Charlottesville, VA

New York  
Presbyterian Hospital  
New York, NY

NYU Langone Medical Center  
New York, NY

Oklahoma  
Cardiovascular  
Research Group  
Oklahoma City, OK

Baptist  
Memorial Hospital  
Memphis, TN

University of Alabama  
Birmingham, AL

Emory University  
Atlanta  
Atlanta, GA

Morristown  
Morristown, NJ

Lankenau Medical Center  
Wynnewood, PA

University of Pennsylvania  
Philadelphia  
Philadelphia, PA

Inova Heart and  
Vascular Institute  
Falls Church, VA

Medical City Dallas  
Dallas, TX

The Heart Hospital  
Baylor Plano  
Plano, TX

Ochsner Clinic  
Foundation  
New Orleans, LA

University of Florida  
Gainesville, FL

Florida  
Hospital  
Orlando, FL

JFK Medical  
Center  
Atlantis, FL

Mount Sinai  
Medical Center  
Miami Beach, FL

Sentara Cardiovascular  
Research Institute, Norfolk  
Norfolk, VA

NC Heart and Vascular  
Raleigh, NC

Carolina's Health System  
Charlotte, NC

Austin Heart  
Austin, TX

The University of Texas Health  
Science Center at Houston  
Houston, TX



**3 sites**

**JAPAN**

Osaka University  
Hospital  
Osaka

Keio University Hospital  
Tokyo

Teikyo University Hospital  
Tokyo



**1 site**

**AUSTRALIA**

Royal Adelaide  
Hospital  
Adelaide SA

Auckland City  
Hospital  
Grafton, Auckland

**NEW ZEALAND**



**1 site**

# Key Inclusion Criteria

## Severe Calcific Aortic Stenosis

- $AVA \leq 1.0 \text{ cm}^2$  or  $AVA \text{ index} \leq 0.6 \text{ cm}^2/\text{m}^2$
- Jet velocity  $\geq 4.0 \text{ m/s}$  or mean gradient  $\geq 40 \text{ mmHg}$ , AND
  - NYHA Functional Class  $\geq 2$ , OR
  - Abnormal exercise test with severe SOB, abnormal BP response, or arrhythmia, OR
  - Asymptomatic with LVEF  $< 50\%$

## Low Surgical Risk

- Determined by multi-disciplinary heart team
- STS  $< 4\%$
- Adjudicated by case review board



# Key Exclusion Criteria

## Anatomic

- Aortic annulus diameter  $< 16$  mm or  $> 28$  mm (3D imaging)
- Bicuspid valve (CT imaging)
- Severe AR ( $> 3+$ ) or MR ( $> 3+$ )
- Severe LV dysfunction (LVEF  $< 30\%$ )
- Severe calcification of aortic valvar complex (esp. LVOT)
- Vascular anatomy not suitable for safe femoral access
- Complex CAD: ULM, Syntax score  $> 32$ , or not amenable for PCI
- Low coronary takeoff (high risk for obstruction)

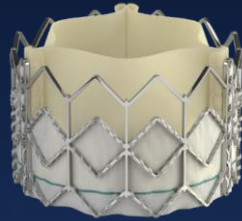
## Clinical

- Acute MI within 1 month
- Stroke or TIA within 90 days
- Renal insufficiency (eGFR  $< 30$  ml/min) and/or renal replacement Rx
- Hemodynamic or respiratory instability
- Frailty (objective assessment;  $> 2/4+$  metrics)

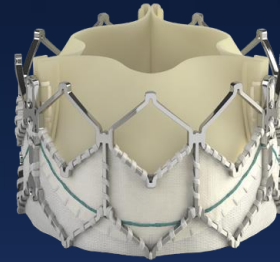
# SAPIEN Valve Evolution

## Valve Technology

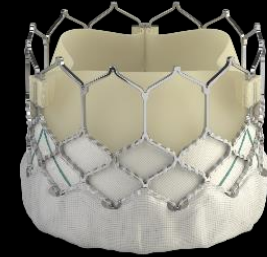
SAPIEN



SAPIEN XT



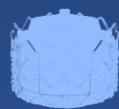
SAPIEN 3



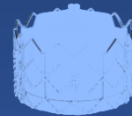
## Sheath Compatibility



## Available Valve Sizes



23 mm



26 mm



23 mm



26 mm



29 mm



20 mm



23 mm



26 mm



29 mm

**PARTNER 1**  
2011

**PARTNER 2**  
2014

**PARTNER 3**  
2015



# Primary Endpoint

- **Non-hierarchical composite of all-cause mortality, all strokes, or CV re-hospitalization at 1 year**
  - Primary analysis was non-inferiority, followed by superiority
  - Analysis cohort was the ‘as-treated’ (AT) population, defined as all randomized patients in whom the procedure was initiated.
  - Multiple sensitivity analyses performed

# Statistical Methods

- **Non-inferiority Testing for Primary Endpoint**
  - Upper bound of the 95% CI for the risk difference (TAVR-surgery) less than the pre-specified non-inferiority margin of 6%
- **Superiority Testing for Primary Endpoint**
  - If non-inferiority hypothesis met, superiority testing performed using a 2-sided alpha 0.05
- **Superiority Testing for Secondary Endpoints**
  - 1) Pre-specified in hierarchical order with multiplicity adjustments and 2) all others (P-values hypothesis generating)

# Study Flow and Follow-Up

1520 patients with severe symptomatic AS at low surgical risk consented between March 25, 2016 and October 26, 2017 at 71 sites in the US, Canada, Japan, ANZ

Excluded from  
Randomization  
N=520

Eligible for Enrollment  
and Randomized  
N=1000 at 71 sites

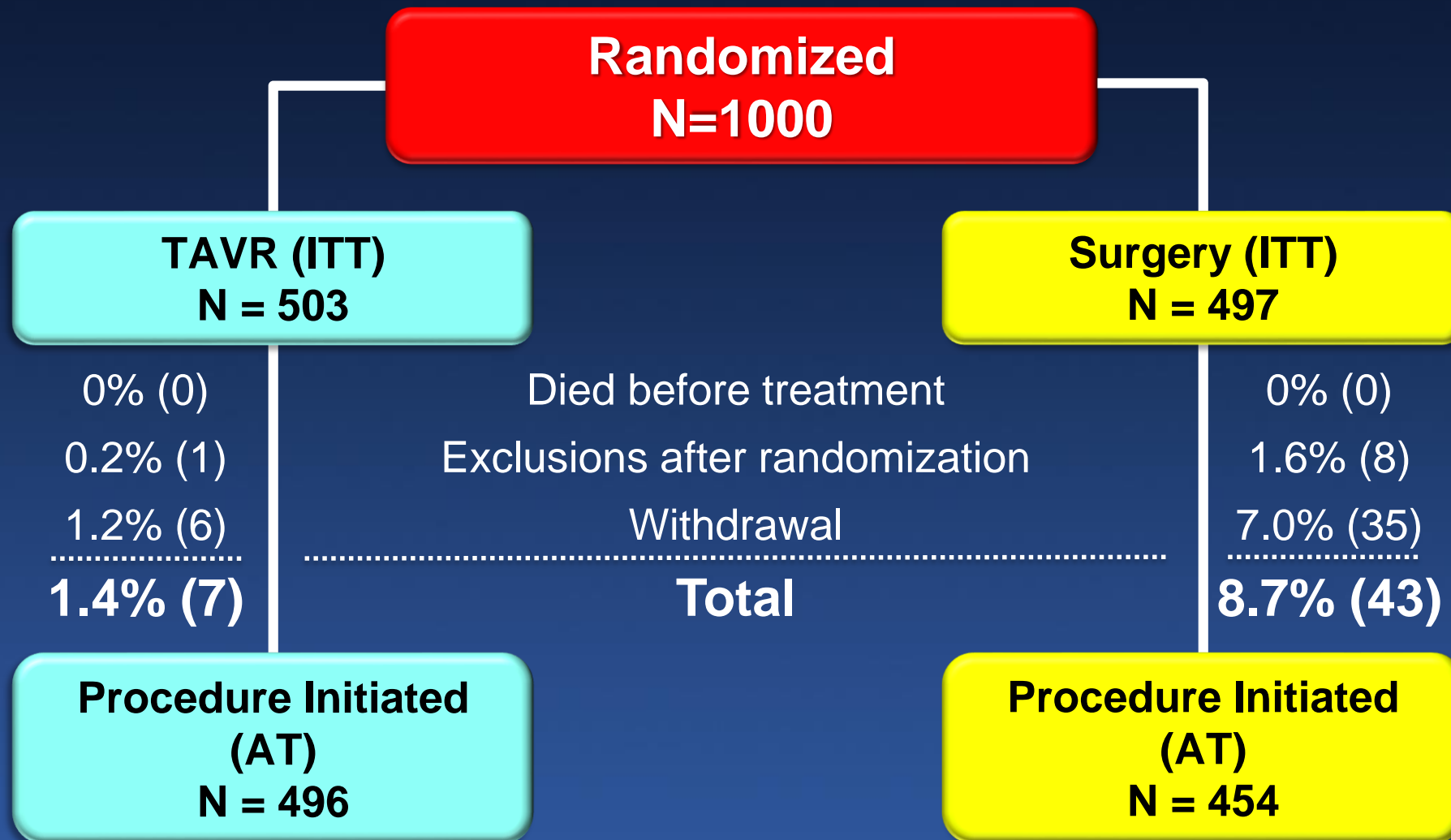
- Anatomic exclusions (n=308)
- Clinical exclusions (n=89)
- Other exclusions (n=38)
- Incomplete screening (n=85)

TAVR  
N=503

Surgery  
N=497

# Study Populations

## *ITT to AT Patient Cohorts*



# Baseline Patient Characteristics

% or mean  $\pm$  SD

<b>Demographics &amp; Vascular Disease</b>	<b>TAVR (N=496)</b>	<b>Surgery (N=454)</b>	<b>Other Co-Morbidities</b>	<b>TAVR (N=496)</b>	<b>Surgery (N=454)</b>
Age (years)	73.3 $\pm$ 5.8	73.6 $\pm$ 6.1	Diabetes	31.3%	30.2%
Male	67.5%	71.1%	COPD (any)	5.1%	6.2%
BMI – kg/m <sup>2</sup>	30.7 $\pm$ 5.5	30.3 $\pm$ 5.1	Pulmonary Hypertension	4.6%	5.3%
STS Score	1.9 $\pm$ 0.7	1.9 $\pm$ 0.6	Creatinine > 2mg/dL	0.2%	0.2%
NYHA Class III or IV*	31.3%	23.8%	Frailty (overall; > 2/4+)	0	0
Coronary Disease	27.7%	28.0%	Atrial Fibrillation (h/o)	15.7%	18.8%
Prior CABG	3.0%	1.8%	Permanent Pacemaker	2.4%	2.9%
Prior CVA	3.4%	5.1%	Left Bundle Branch Block	3.0%	3.3%
Peripheral Vascular Disease	6.9%	7.3%	Right Bundle Branch Block	10.3%	13.7%

\*p = 0.01

# Procedural & Hospital Findings

% or mean ± SD

Variable	TAVR (N=496)	Surgery (N=454)	P-value
Conscious Sedation	65.1%	NA	NA
Procedure Time (min)	58.6 ± 36.5	208.3 ± 62.2	<0.001
Fluoroscopy Time (min)	13.9 ± 7.1	NA	NA
Aortic Cross-Clamp Time (min)	NA	74.3 ± 27.8	NA
Total CPB Time (min)	NA	97.7 ± 33.8	NA
Median ICU Stay (days)	2.0	3.0	<0.001
Median Total LOS (days)	3.0	7.0	<0.001
Discharge to Home/Self-care	96.0%	73.1%	<0.001
Concomitant Procedures	7.9%	26.4%	<0.001



# Procedural Complications

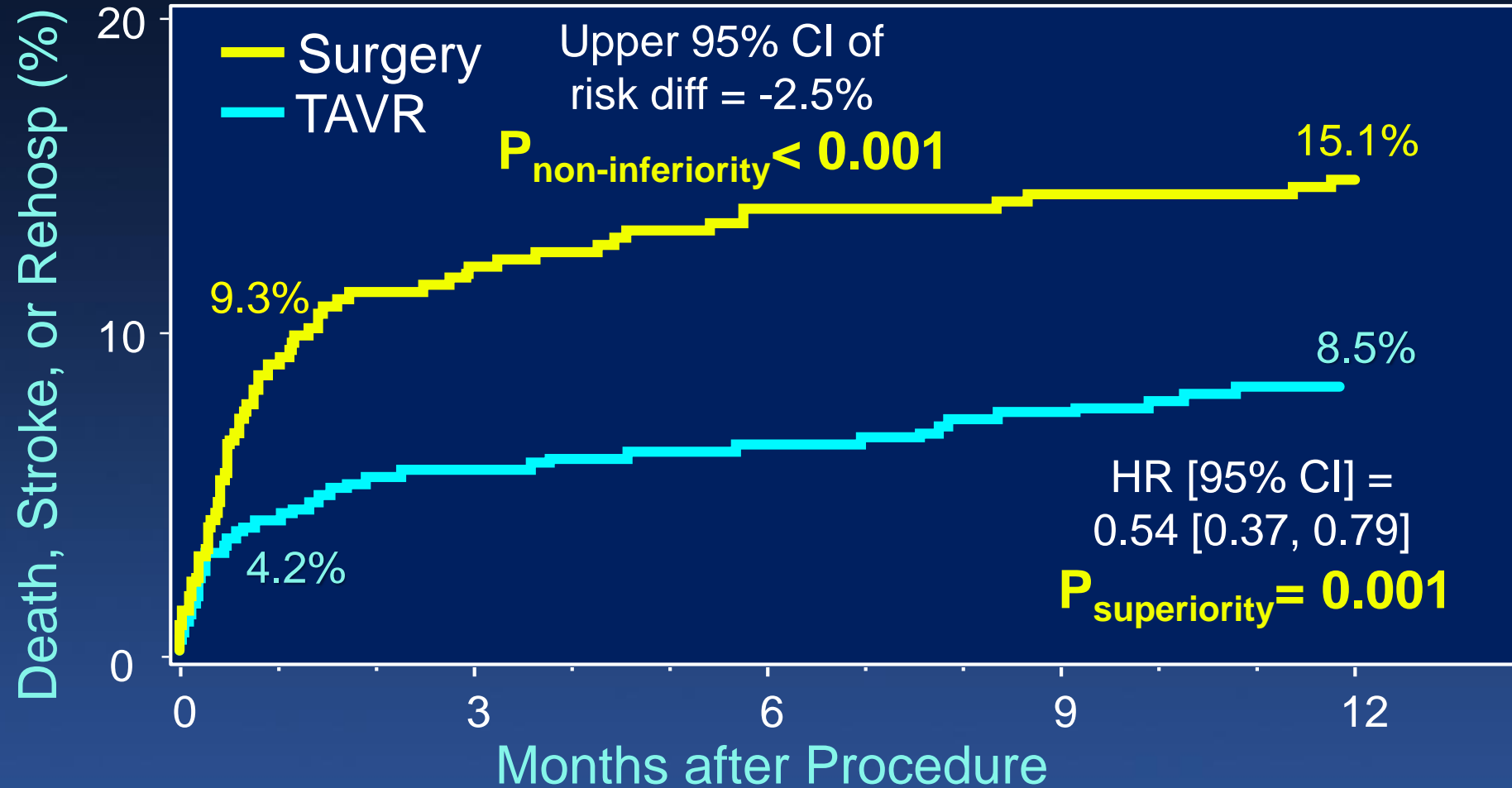
## *In-Hospital*

% or mean  $\pm$  SD

Complication	TAVR (N=496)	Surgery (N=454)	P-value
In-hospital Death	0.4% (2)	0.9% (4)	0.43
$\geq$ 2 Transcatheter Valves Implanted*	0.2% (1)	NA	NA
Valve Embolization	0	NA	NA
Aortic Dissection	0	NA	NA
Annular Rupture	0.2% (1)	NA	NA
Ventricular Perforation	0.2% (1)	0.4% (2)	0.61
Coronary Obstruction	0.2% (1)	0.4% (2)	0.61
Access Site Infections	0.4% (2)	1.3% (6)	0.16

\*Valve-in-valve

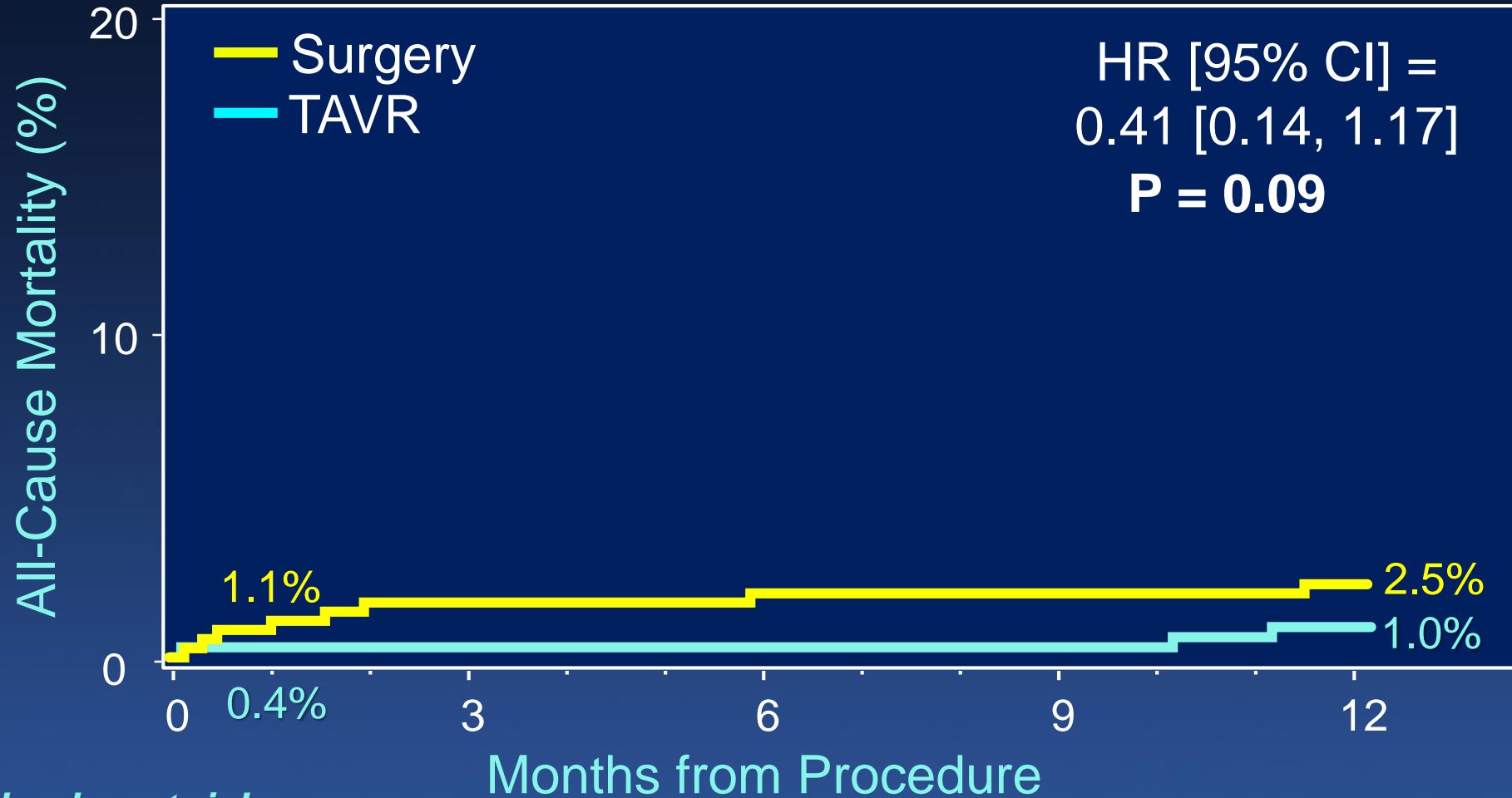
# Primary Endpoint



**Number at risk:**

Surgery	454	408	390	381	377	374
TAVR	496	475	467	462	456	451

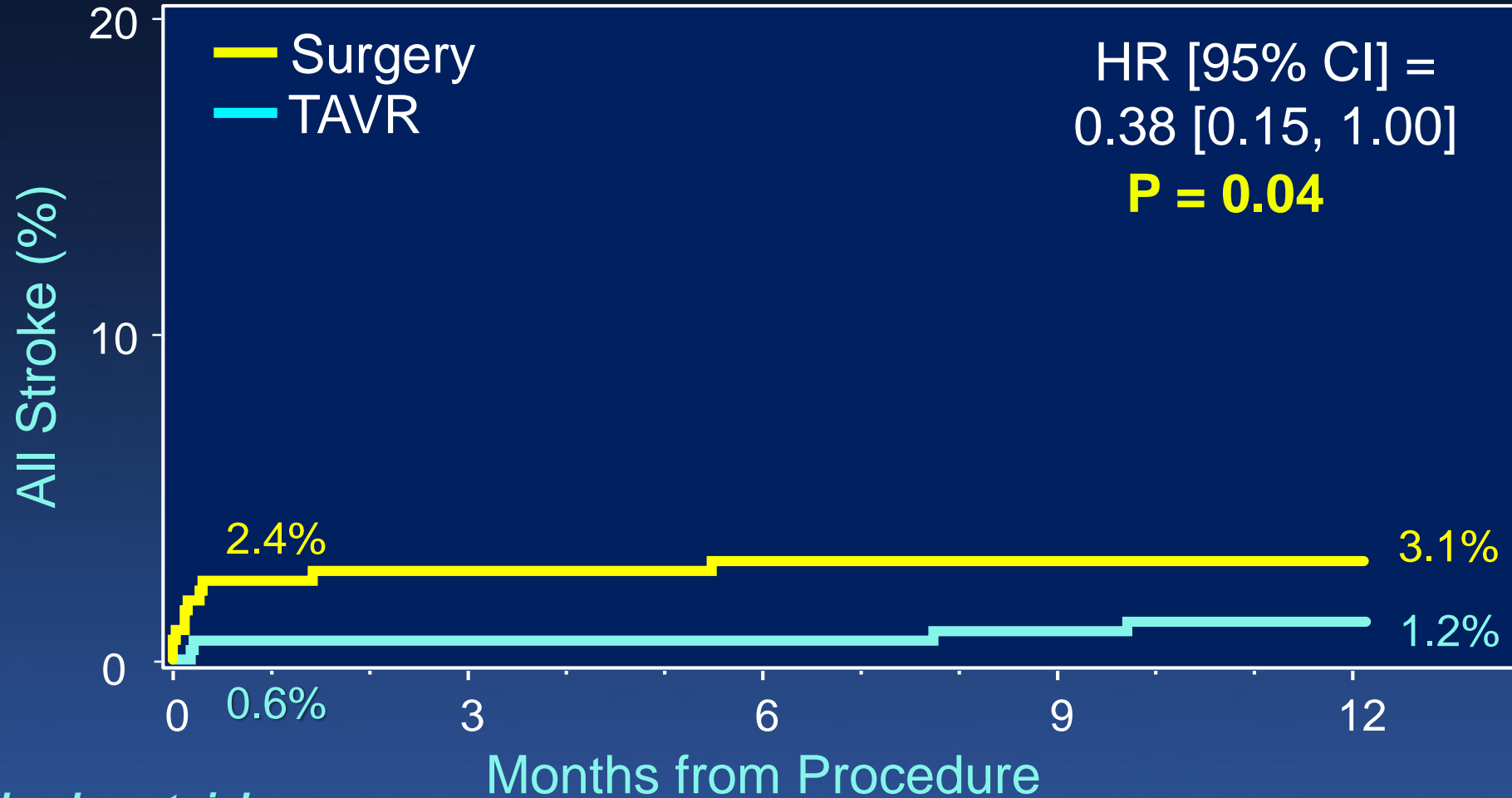
# All-Cause Mortality



**Number at risk:**

Surgery	454	445	438	433	431	427
TAVR	496	494	494	493	492	488

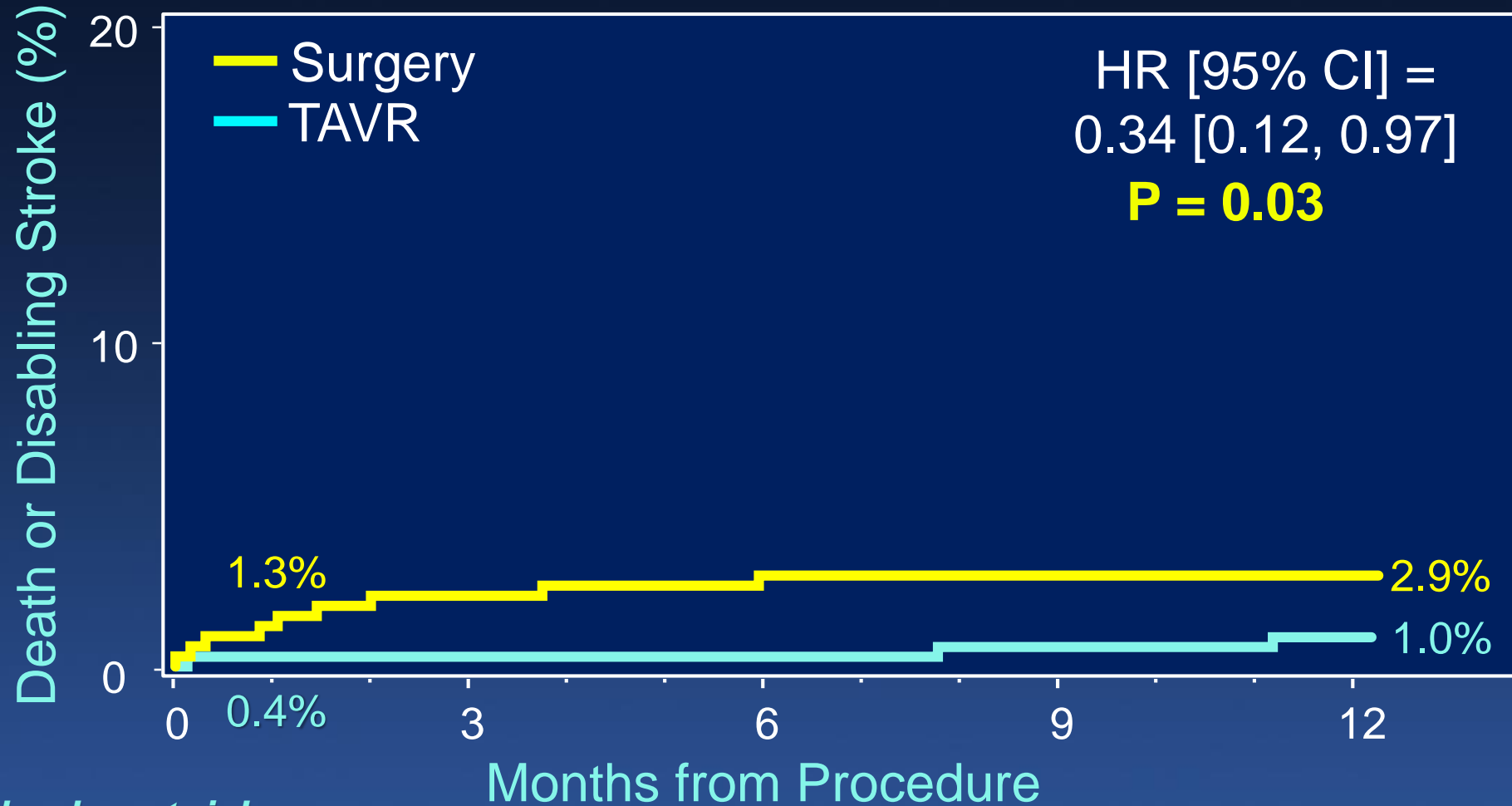
# All Stroke



**Number at risk:**

Surgery	454	435	427	423	421	417
TAVR	496	491	491	489	487	484

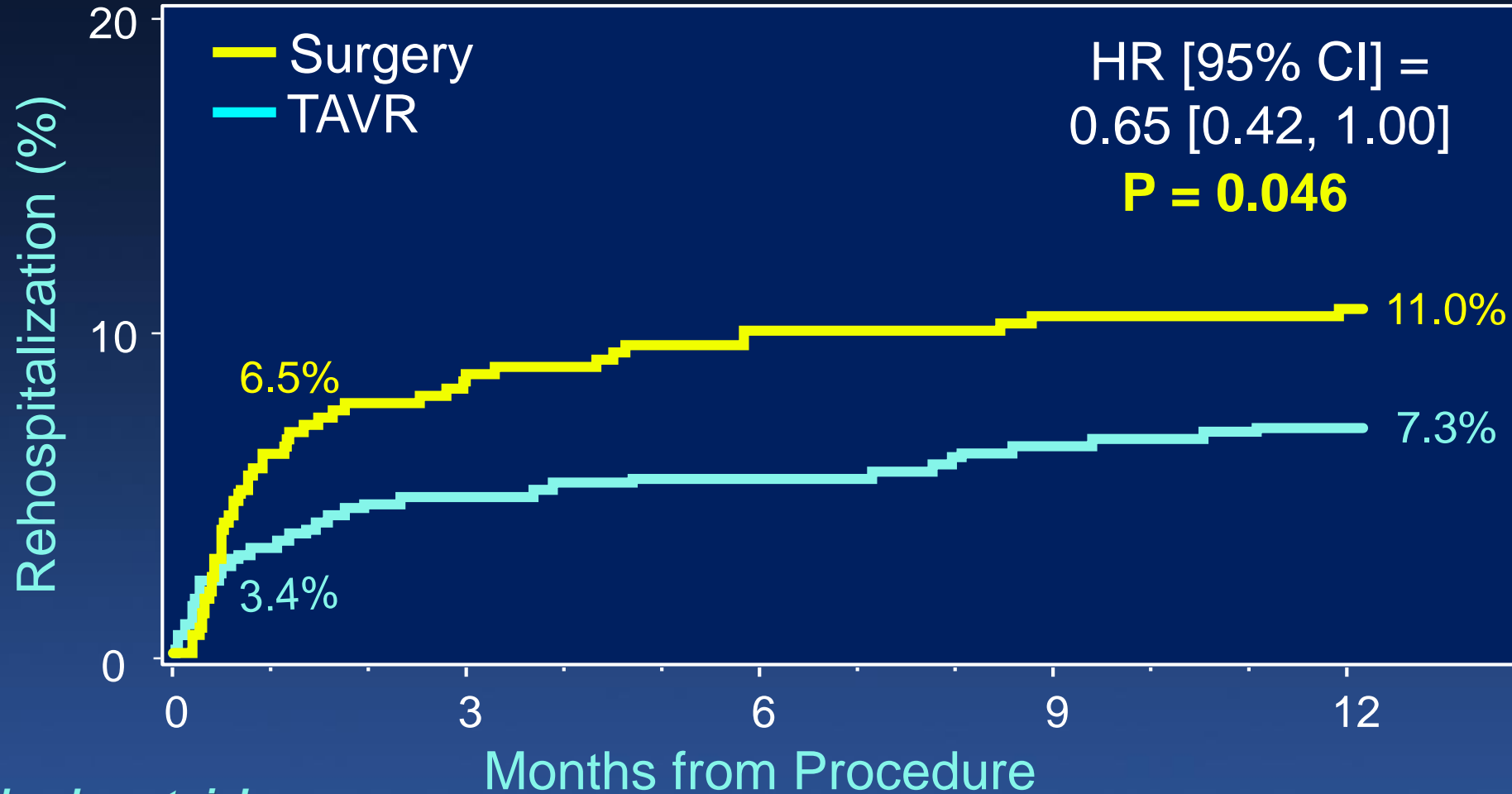
# Death or Disabling Stroke



**Number at risk:**

Surgery	454	444	436	432	430	426
TAVR	496	494	494	493	491	488

# Rehospitalization


















*Number at risk:*

Surgery	454	416	399	389	385	382
TAVR	496	477	469	465	459	453



# Primary Endpoint - Subgroup Analysis

Subgroup	TAVR	Surgery		Diff [95% CI]	P-value*
<b>Overall</b>	<b>8.5</b>	<b>15.1</b>		<b>-6.6 [-10.8, -2.5]</b>	
<b>Age</b>					
≤ 74 (n=516)	10.6	14.9		-4.3 [-10.1, 1.5]	<b>0.21</b>
> 74 (n=434)	5.8	15.3		-9.5 [-15.3, -3.7]	
<b>Sex</b>					
Female (n=292)	8.1	18.5		-10.4 [-18.3, -2.5]	<b>0.27</b>
Male (n=658)	8.7	13.8		-5.1 [-9.9, -0.3]	
<b>STS Score</b>					
≤ 1.8 (n=464)	9.1	15.7		-6.7 [-12.6, -0.7]	<b>0.98</b>
> 1.8 (n=486)	8.0	14.5		-6.5 [-12.2, -0.8]	
<b>LV Ejection Fraction</b>					
≤ 65 (n=384)	9.6	17.2		-7.6 [-14.5, -0.7]	<b>0.48</b>
> 65 (n=524)	8.0	12.4		-4.4 [-9.6, 0.7]	
<b>NYHA Class</b>					
I/II (n=687)	6.8	14.5		-7.8 [-12.4, -3.2]	<b>0.54</b>
III/IV (n=263)	12.3	16.9		-4.7 [-13.5, 4.1]	
<b>Atrial Fibrillation</b>					
No (n=786)	7.9	14.0		-6.1 [-10.5, -1.7]	<b>0.67</b>
Yes (n=163)	11.6	20.3		-8.7 [-19.9, 2.5]	
<b>KCCQ Overall Summary Score</b>					
≤ 70 (n=407)	10.5	19.9		-9.4 [-16.5, -2.4]	<b>0.27</b>
> 70 (n=536)	6.5	11.2		-4.6 [-9.4, 0.2]	

Event rates are KM estimates (%)

\* P-value is for interaction



# Pre-specified Secondary Endpoints

## *Subject to Multiplicity Adjustment*

Order of Testing	Endpoint	TAVR (N=496)	Surgery (N=454)	Treatment Effect [95% CI]	P-value
1	New onset atrial fibrillation at 30 days	5.0%	39.5%	0.10 [0.06, 0.16]	
2	Length of index hospitalization (days)	3.0 (2.0, 3.0)	7.0 (6.0, 8.0)	-4.0 [-4.0, -3.0]	
3	All-cause death, all stroke, or rehospitalizations at 1 year	8.5%	15.1%	0.54 [0.37, 0.79]	
4	Death, KCCQ < 45 or KCCQ decrease from baseline ≥ 10 points at 30 days	3.9%	30.6%	-26.7% [-31.4%, -22.1%]	
5	Death or all stroke at 30 days	1.0%	3.3%	0.30 [0.11, 0.83]	
6	All stroke at 30 days	0.6%	2.4%	0.25 [0.07, 0.88]	

\* P-value is Log-Rank test for items 1, 3, 5 and 6; P-value is Wilcoxon Rank-Sum Test for item 2; P-value is Fisher's Exact test for item 4

# Pre-specified Secondary Endpoints

## *Subject to Multiplicity Adjustment*

Order of Testing	Endpoint	TAVR (N=496)	Surgery (N=454)	Treatment Effect [95% CI]	P-value
1	New onset atrial fibrillation at 30 days	5.0%	39.5%	0.10 [0.06, 0.16]	<0.001
2	Length of index hospitalization (days)	3.0 (2.0, 3.0)	7.0 (6.0, 8.0)	-4.0 [-4.0, -3.0]	<0.001
3	All-cause death, all stroke, or rehospitalizations at 1 year	8.5%	15.1%	0.54 [0.37, 0.79]	0.001
4	Death, KCCQ < 45 or KCCQ decrease from baseline ≥ 10 points at 30 days	3.9%	30.6%	-26.7% [-31.4%, -22.1%]	<0.001
5	Death or all stroke at 30 days	1.0%	3.3%	0.30 [0.11, 0.83]	0.01
6	All stroke at 30 days	0.6%	2.4%	0.25 [0.07, 0.88]	0.02

\* P-value is Log-Rank test for items 1, 3, 5 and 6; P-value is Wilcoxon Rank-Sum Test for item 2; P-value is Fisher's Exact test for item 4

# Other Secondary Endpoints

Outcomes % (no. of pts)	30 Days			1 Year		
	TAVR (N=496)	Surgery (N=454)	P-value	TAVR (N=496)	Surgery (N=454)	P-value
<b>Bleeding - Life-threat/Major</b>	3.6% (18)	24.5% (111)	<0.001	7.7% (38)	25.9% (117)	<0.001
<b>Major Vascular Complics</b>	2.2% (11)	1.5% (7)	0.45	2.8% (14)	1.5% (7)	0.19
<b>AKI - stage 2 or 3*</b>	0.4% (2)	1.8% (8)	0.05	0.4% (2)	1.8% (8)	0.05
<b>New PPM (incl baseline)</b>	6.5% (32)	4.0% (18)	0.09	7.3% (36)	5.4% (24)	0.21
<b>New LBBB</b>	22.0% (106)	8.0% (35)	<0.001	23.7% (114)	8.0% (35)	<0.001
<b>Coronary Obstruction</b>	0.2% (1)	0.7% (3)	0.28	0.2% (1)	0.7% (3)	0.28
<b>AV Re-intervention</b>	0% (0)	0% (0)	NA	0.6% (3)	0.5% (2)	0.76
<b>Endocarditis</b>	0% (0)	0.2% (1)	0.29	0.2% (1)	0.5% (2)	0.49
<b>Asymp Valve Thrombosis</b>	0.2% (1)	0% (0)	0.34	1.0% (5)	0.2% (1)	0.13

Event rates are KM estimates (%) and p-values are based on Log-Rank test

\* Event rates are incidence rates and p-value is Fisher's Exact test

# Echocardiography Findings

## Mean Gradient



No. of Echos

Surgery 441 426

TAVR 483 490

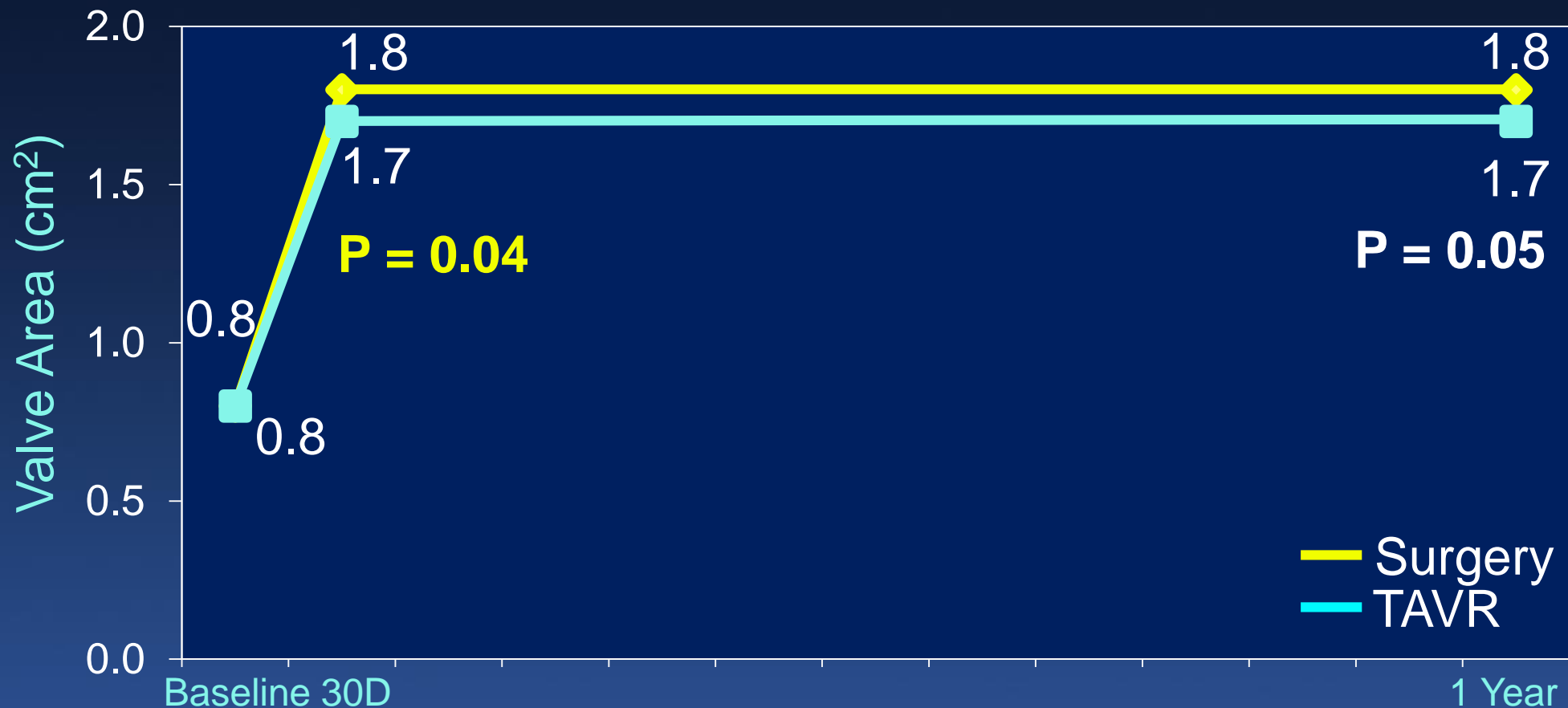
390

469

P-values are based on the ANCOVA for TAVR vs Surgery adjusted by baseline.

# Echocardiography Findings

## Aortic Valve Area



### No. of Echos

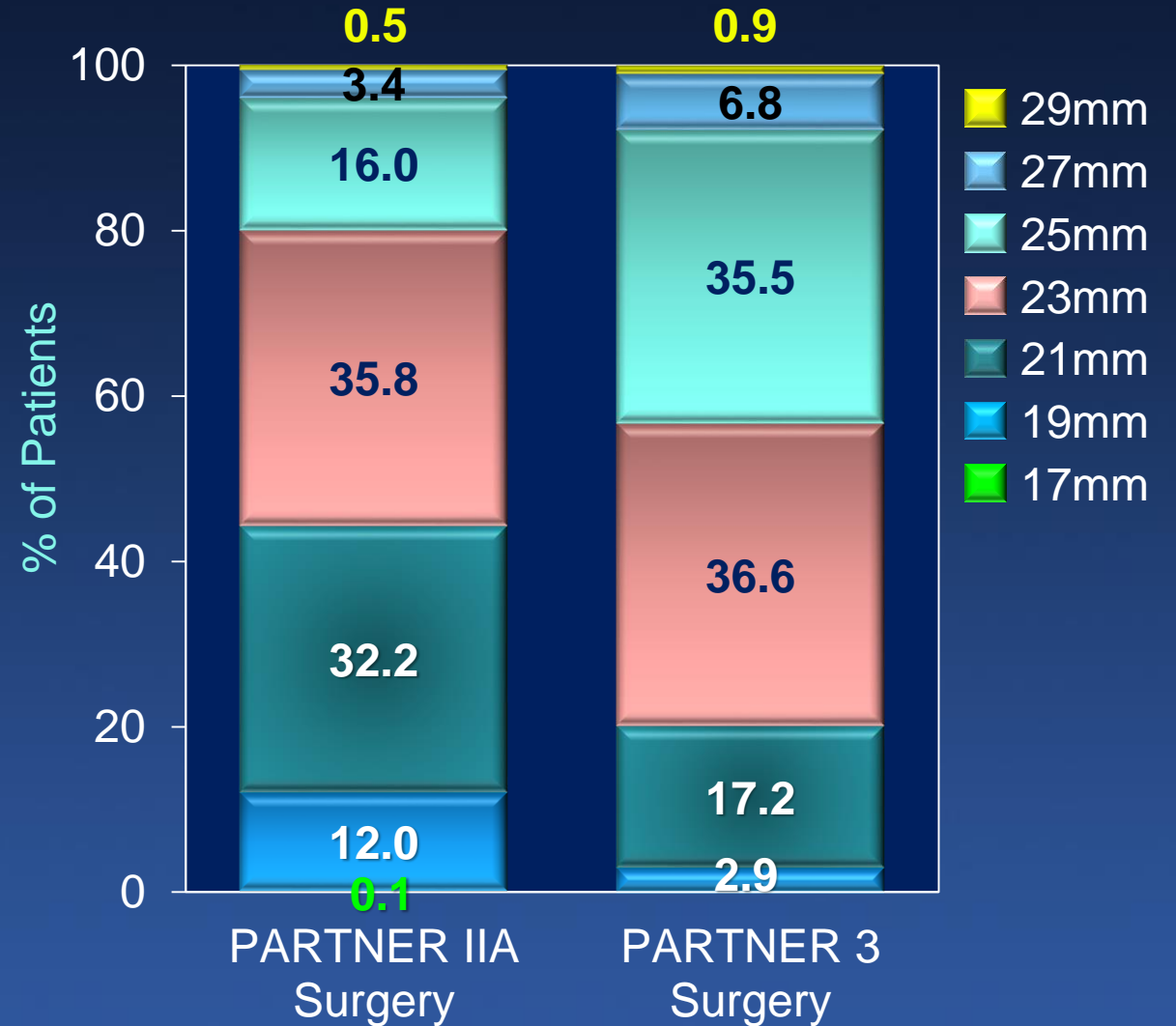
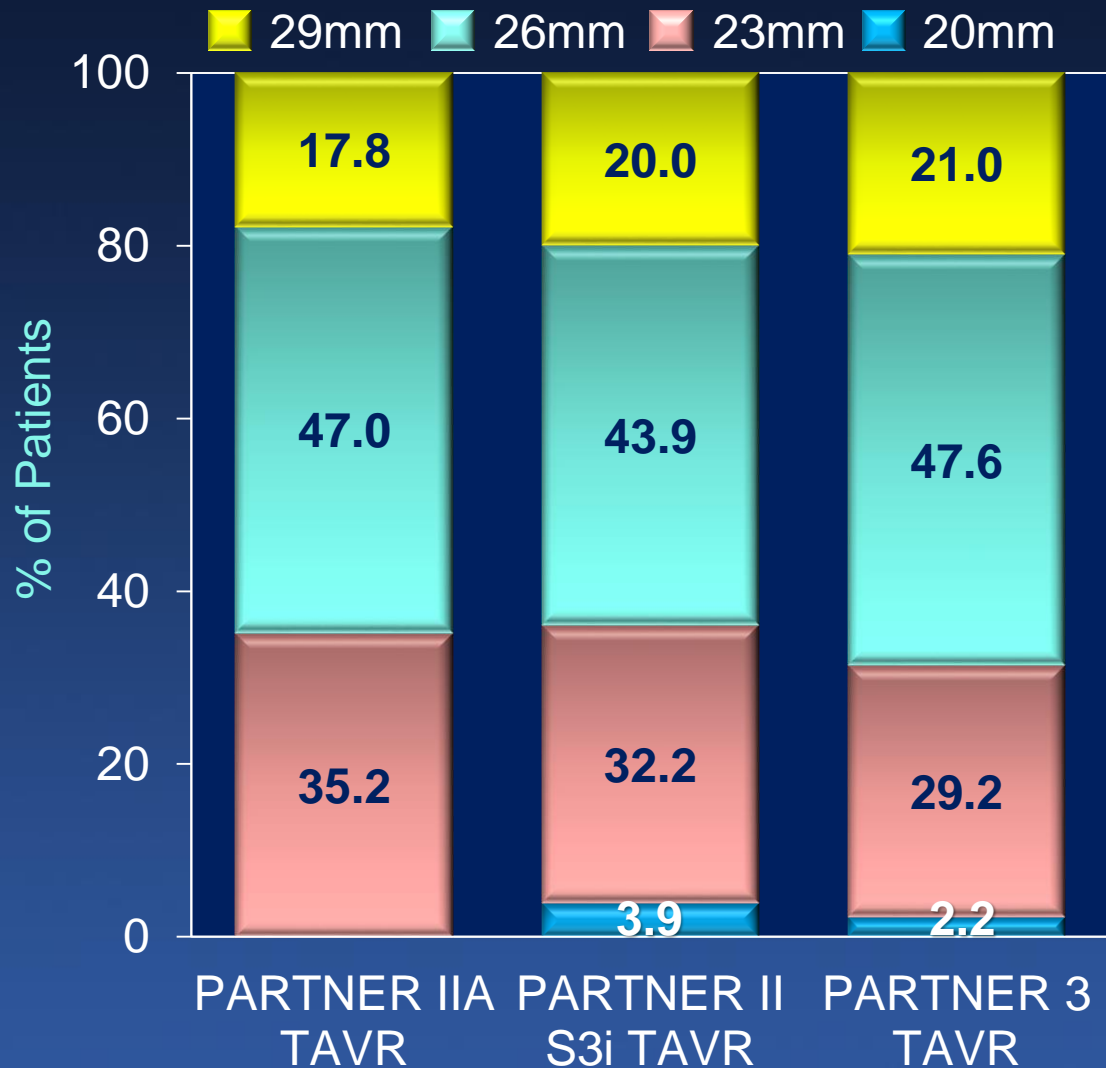
Surgery	423	395	371
TAVR	458	470	446

P-values are based on the ANCOVA for TAVR vs Surgery adjusted by baseline.



# The PARTNER Trials

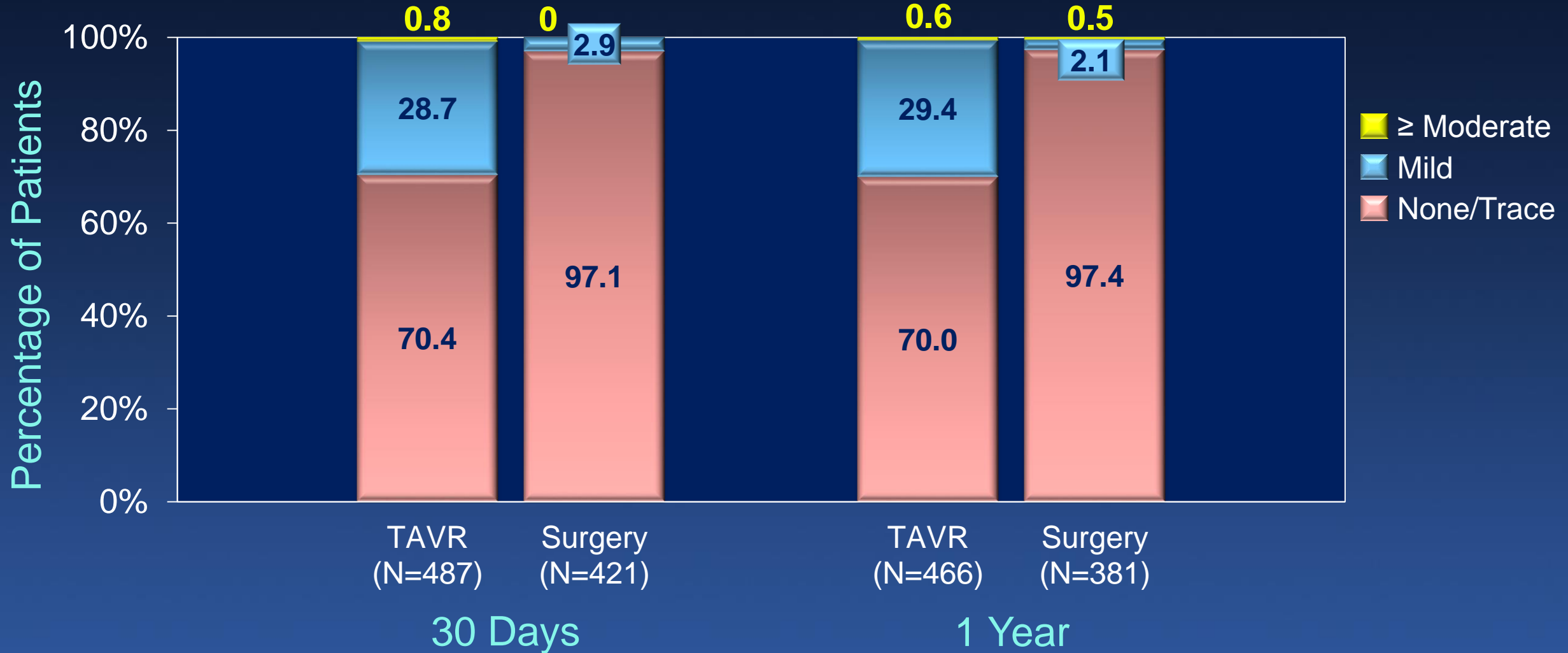
## Valve Size Distribution



# Paravalvular Regurgitation

**≥ mod PVR: P = 0.13**

**≥ mod PVR: P = 1.00**

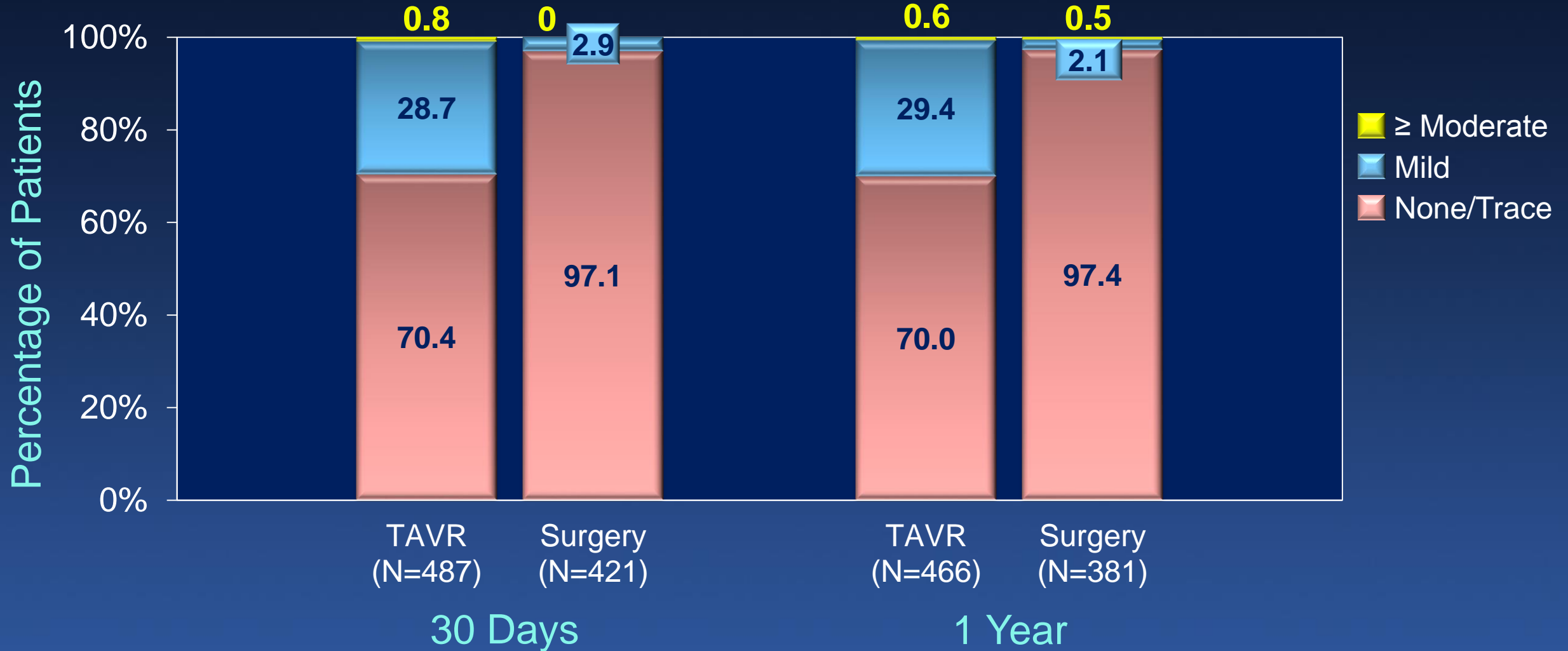


P-values are based on the Wilcoxon rank-sum test.

# Paravalvular Regurgitation

mild PVR:  $P < 0.001$

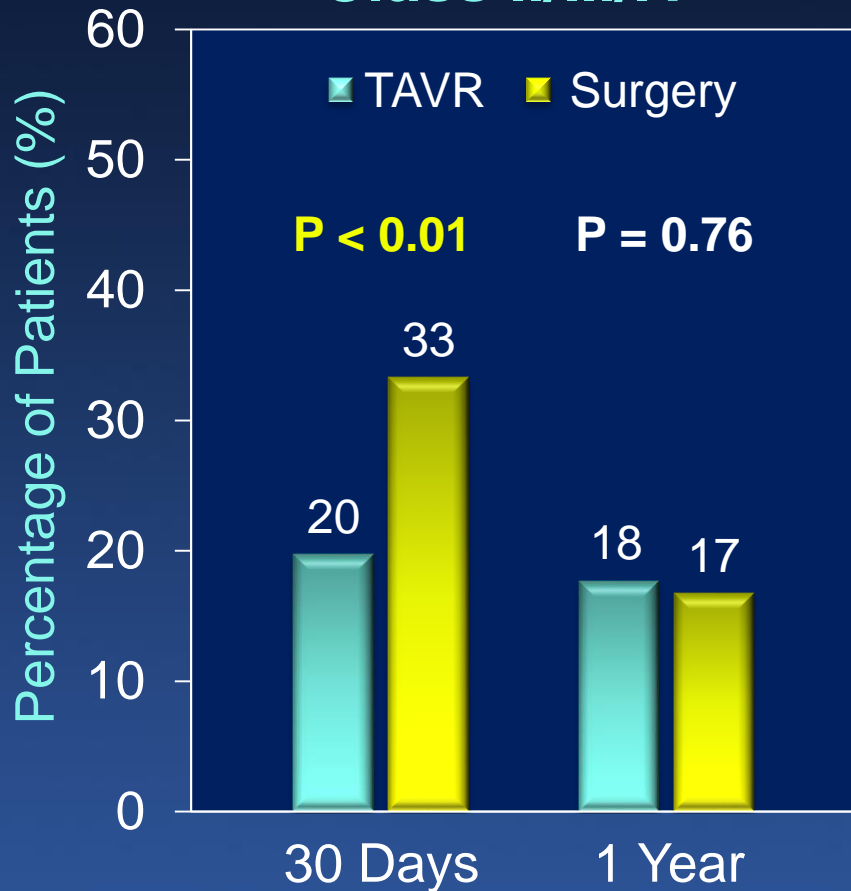
mild PVR:  $P < 0.001$



P-values are based on the Wilcoxon rank-sum test.

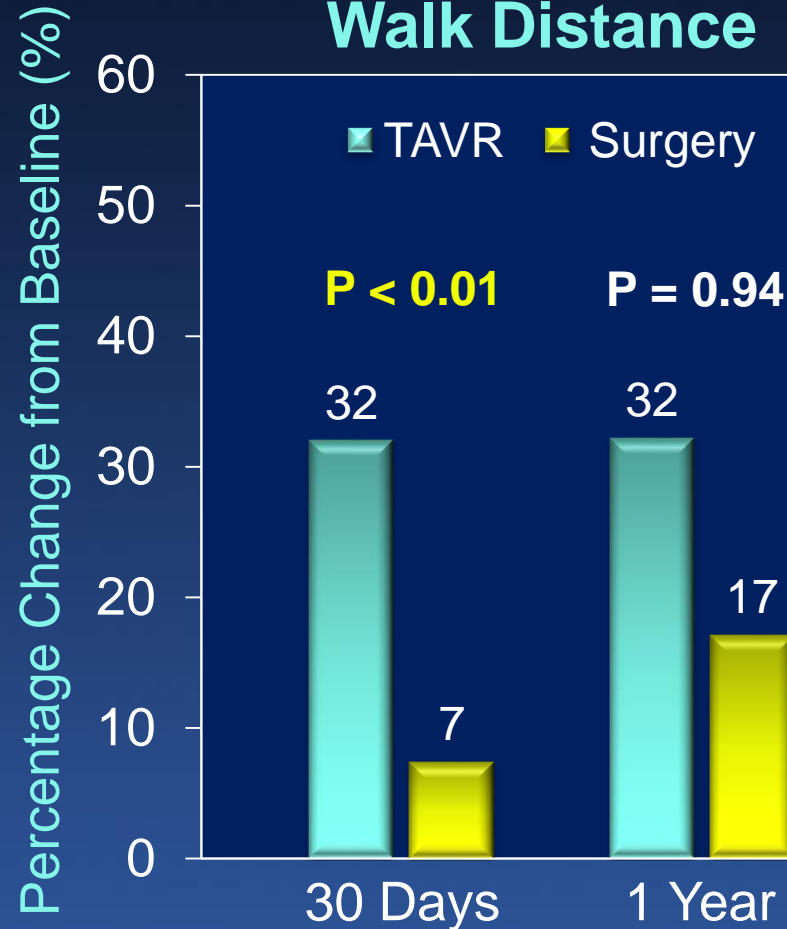
# Functional Assessments

## NYHA Class II/III/IV



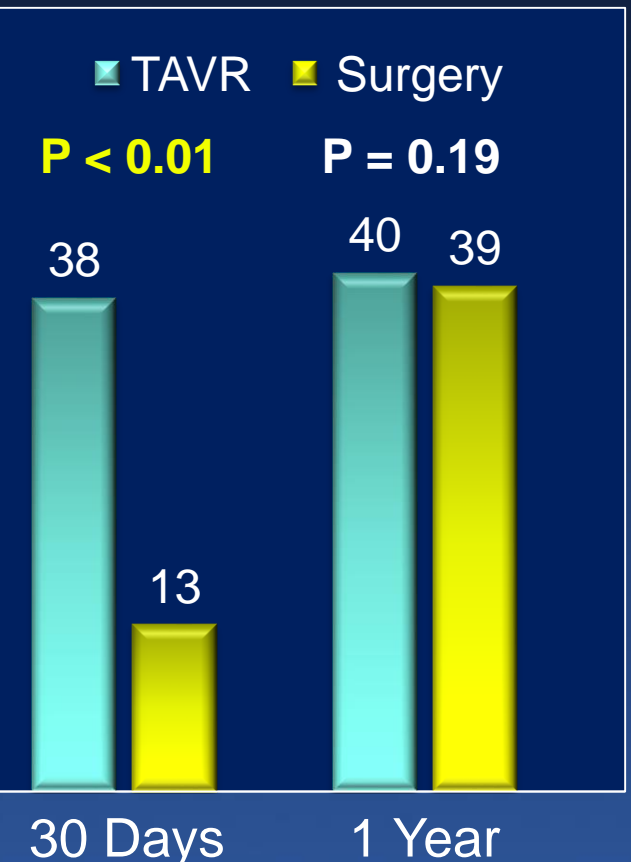
P-values are based on Fisher's Exact test.

## Six-Minute Walk Distance



P-values are based on the ANCOVA for TAVR vs Surgery adjusted by baseline.

## KCCQ Overall Summary Score



# The PARTNER 3 Trial

## Conclusions (1)

*In a population of severe symptomatic aortic stenosis patients who were at low surgical risk, TAVR (using the SAPIEN 3 valve) compared to surgery:*

- Significantly reduced the primary endpoint of death, stroke, or rehospitalization by 46% at 1-year.
  - Components of the primary endpoint favored TAVR, both at 30 days and 1 year
  - Multiple sensitivity analyses confirmed robustness of the primary endpoint findings

# The PARTNER 3 Trial

## *Conclusions (2)*

- Secondary endpoints adjusted for multiple comparisons indicated that TAVR reduced new-onset AF, index hospitalization days, and a measure of poor treatment outcome (death or low KCCQ score at 30 days).
- Other secondary endpoint analyses also showed reduced bleeding after TAVR and no differences in the need for new permanent pacemakers, major vascular complications, coronary obstruction, and mod-severe PVR.
- Some secondary endpoints favored surgery, including reduced new LBBB, reduced mild PVR, and lower aortic valve gradients.



# The PARTNER 3 Trial

## *Conclusions (3)*


- TAVR had more rapid post-procedure improvement in patient-oriented functional indices, including NYHA class, 6-minute walking distance, and KCCQ scores.

# The PARTNER 3 Trial

## *Clinical Implications*

- *Based upon these findings, TAVR, through 1-year, should be considered the preferred therapy in low surgical risk aortic stenosis patients!*
- *PARTNER randomized trials over the past 12 years, clearly indicate that the relative value of TAVR compared with surgery is independent of surgical risk profiles.*
- *The choice of TAVR vs. surgery in aortic stenosis patients should be a shared-decision making process, respecting patient preferences, understanding knowledge gaps (esp. in younger patients), and considering clinical and anatomic factors.*

# The PARTNER 3 Trial



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**Transcatheter Aortic-Valve Replacement with a Balloon-Expandable Valve in Low-Risk Patients**

M.J. Mack, M.B. Leon, V.H. Thourani, R. Makkar, S.K. Kodali, M. Russo, S.R. Kapadia, S.C. Malaisrie, D.J. Cohen, P. Pibarot, J. Leipsic, R.T. Hahn, P. Blanke, M.R. Williams, J.M. McCabe, D.L. Brown, V. Babaliaros, S. Goldman, W.Y. Szeto, P. Genereux, A. Pershad, S.J. Pocock, M.C. Alu, J.G. Webb, and C.R. Smith, for the PARTNER 3 Investigators\*

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**Transcatheter Aortic-Valve Implantation for Aortic Stenosis in Patients Who Cannot Undergo Surgery**

Martin B. Leon, M.D., Craig R. Smith, M.D., Michael Mack, M.D., D. Craig Miller, M.D., Jeffrey W. Moses, M.D., Lars G. Svensson, M.D., Ph.D., E. Murat Tuzcu, M.D., John G. Webb, M.D., Gregory P. Fontana, M.D., Raj R. Makkar, M.D., David L. Brown, M.D., Peter C. Block, M.D., Robert A. Guyton, M.D., Augusto D. Pichard, M.D., Joseph E. Bavaria, M.D., Howard C. Herrmann, M.D., Pamela S. Douglas, M.D., John L. Petersen, M.D., Jodi J. Akin, M.S., William N. Anderson, Ph.D., Duolao Wang, Ph.D., and Stuart Pocock, Ph.D., for the PARTNER Trial Investigators\*

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**Transcatheter or Surgical Aortic-Valve Replacement in Intermediate-Risk Patients**

Martin B. Leon, M.D., Craig R. Smith, M.D., Michael J. Mack, M.D., Raj R. Makkar, M.D., Lars G. Svensson, M.D., Ph.D., Susheel K. Kodali, M.D., Vinod H. Thourani, M.D., E. Murat Tuzcu, M.D., D. Craig Miller, M.D., Howard C. Herrmann, M.D., Darshan Doshi, M.D., David J. Cohen, M.D., Augusto D. Pichard, M.D., Samir Kapadia, M.D., Todd Dewey, M.D., Vasilis Babaliaros, M.D., Wilson Y. Szeto, M.D., Mathew R. Williams, M.D., Dean Kereiakes, M.D., Alan Zajarias, M.D., Kevin L. Greason, M.D., Brian K. Whisenant, M.D., Robert W. Hodson, M.D., Jeffrey W. Moses, M.D., Alfredo Trento, M.D., David L. Brown, M.D., William F. Fearon, M.D., Philippe Pibarot, D.V.M., Ph.D., Rebecca T. Hahn, M.D., Wael A. Jaber, M.D., William N. Anderson, Ph.D., Maria C. Alu, M.M., and John G. Webb, M.D., for the PARTNER 2 Investigators\*

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**Transcatheter and Surgical Aortic-Valve Replacement in High-Risk Patients**

Craig R. Smith, M.D., Martin B. Leon, M.D., Michael J. Mack, M.D., D. Craig Miller, M.D., Jeffrey W. Moses, M.D., Lars G. Svensson, M.D., Ph.D., E. Murat Tuzcu, M.D., John G. Webb, M.D., Gregory P. Fontana, M.D., Raj R. Makkar, M.D., Mathew Williams, M.D., Todd Dewey, M.D., Samir Kapadia, M.D., Vasilis Babaliaros, M.D., Vinod H. Thourani, M.D., Paul Corso, M.D., Augusto D. Pichard, M.D., Joseph E. Bavaria, M.D., Howard C. Herrmann, M.D., Jodi J. Akin, M.S., William N. Anderson, Ph.D., Duolao Wang, Ph.D., and Stuart J. Pocock, Ph.D., for the PARTNER Trial Investigators\*