Ross Procedure Provides Survival Benefit over Mechanical Valve in Adults:

A Propensity-Matched Nationwide Analysis

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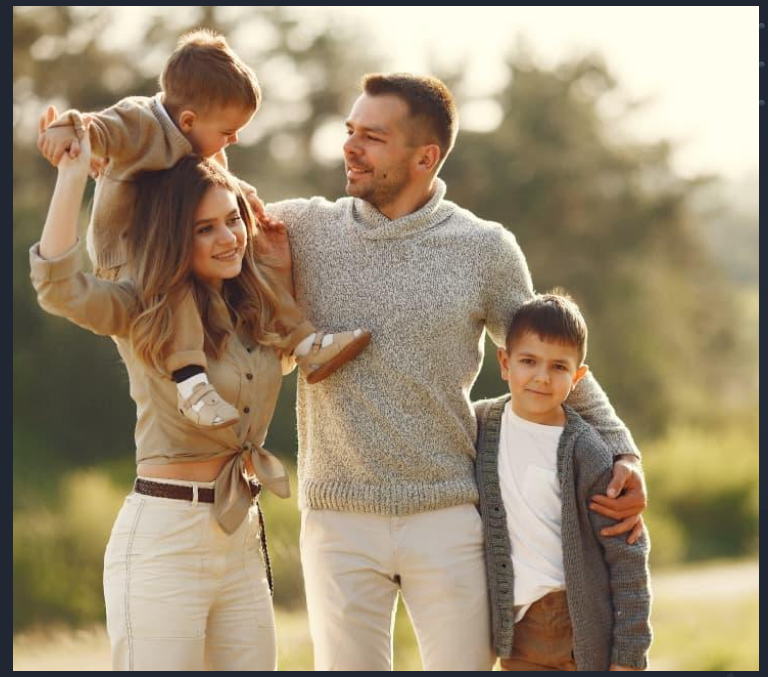
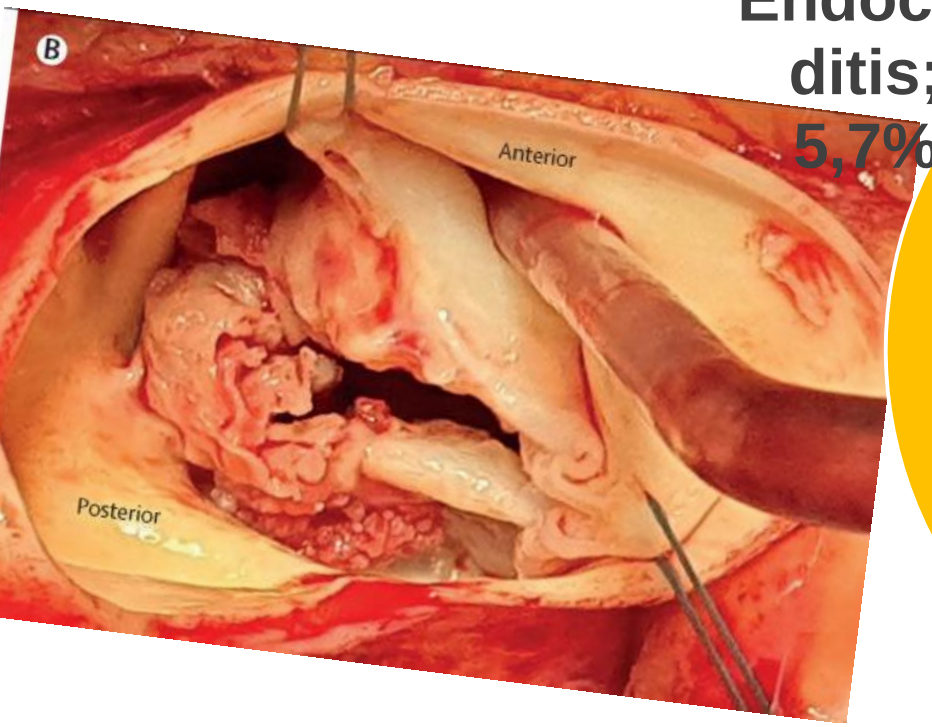
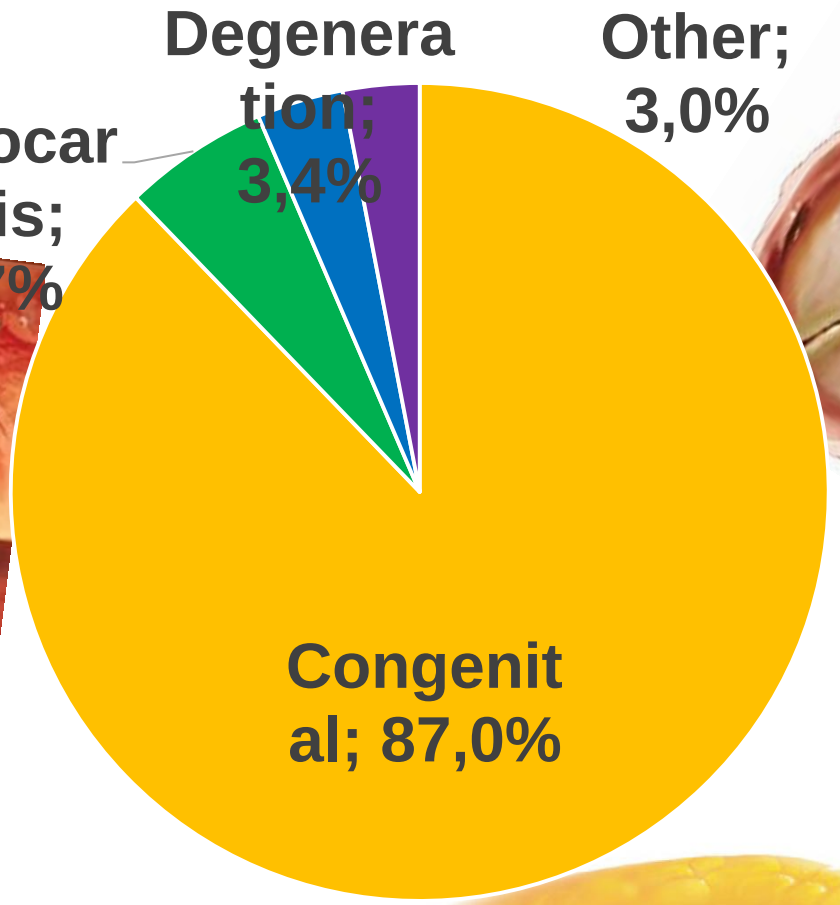


Young and Middle-Aged Adults with Aortic Valve Disease

- High level of physical activity
- Active at work
- Family (women of child-bearing age)

- Long expected postoperative survival (>20 years!!!) exposure to valve-related complications





Type of the valve	N (%)
UAV	112 (37%)
BAV	149 (50%)
TAV	25 (8%)
miscellaneous	16 (5%)

What do the guidelines tell us?

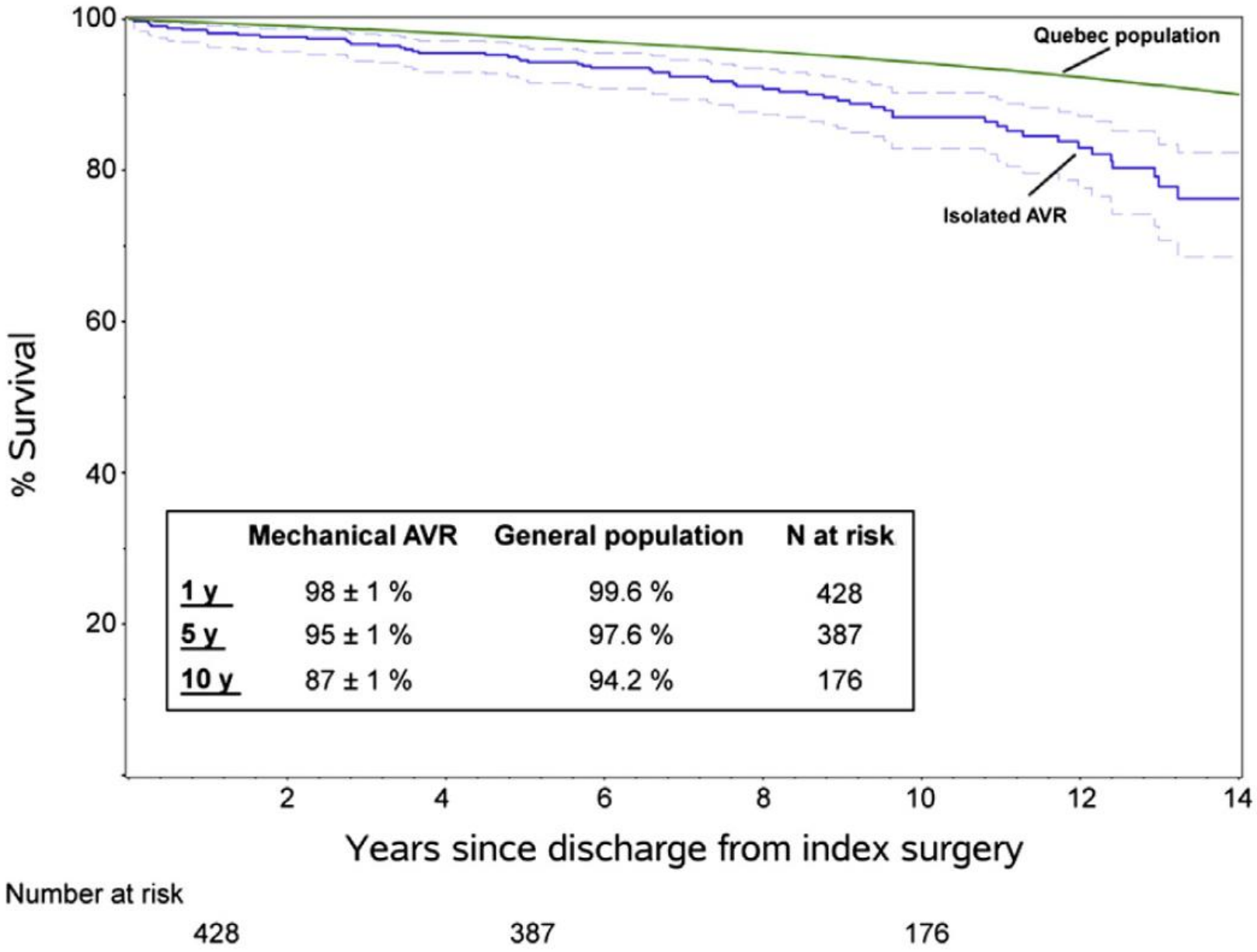
ESC European Society of Cardiology
European Heart Journal (2021) **00**, 1–72
doi:10.1093/eurheartj/ehab395

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

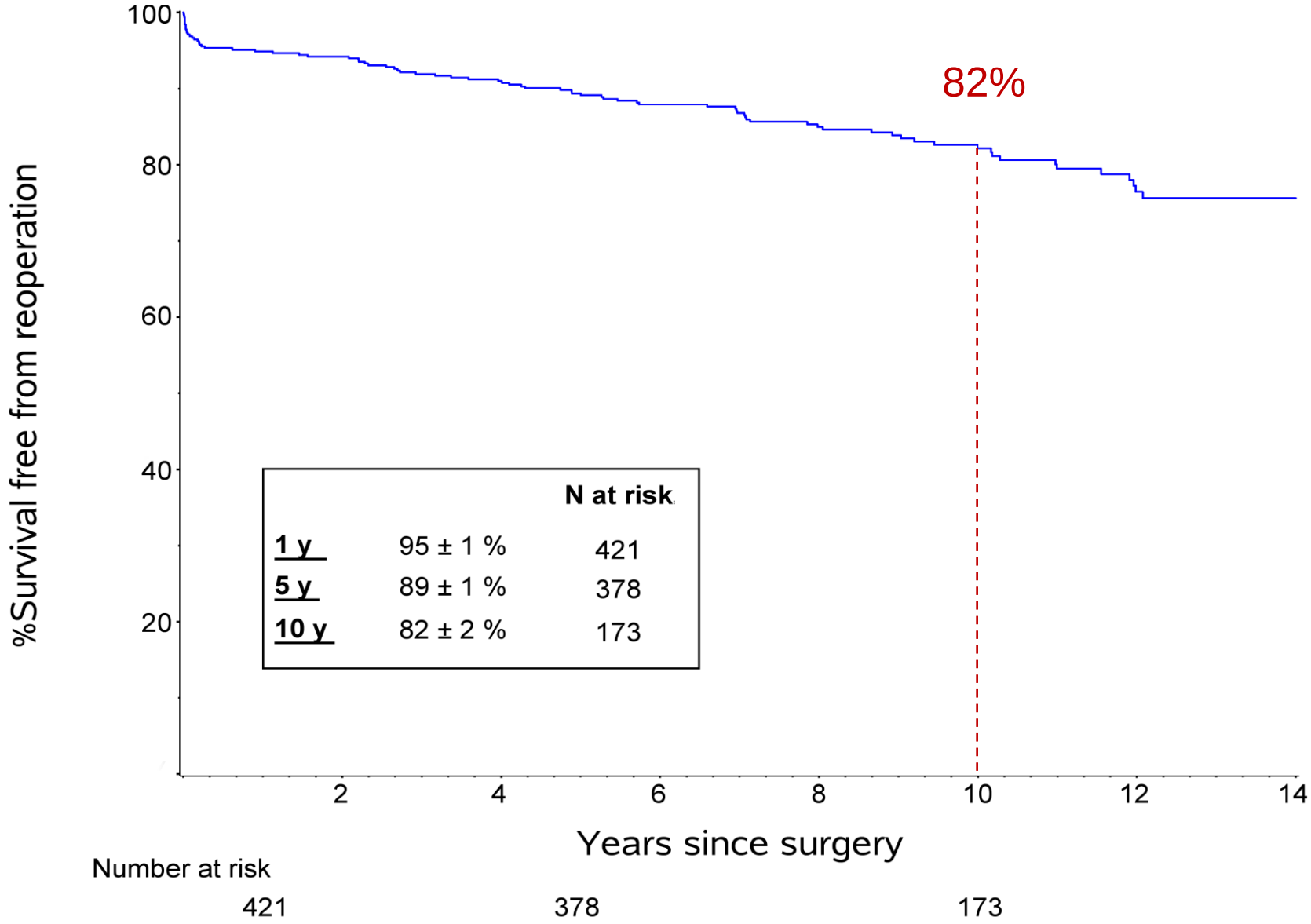
Developed by the Task Force for the management of valvular heart disease of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS)

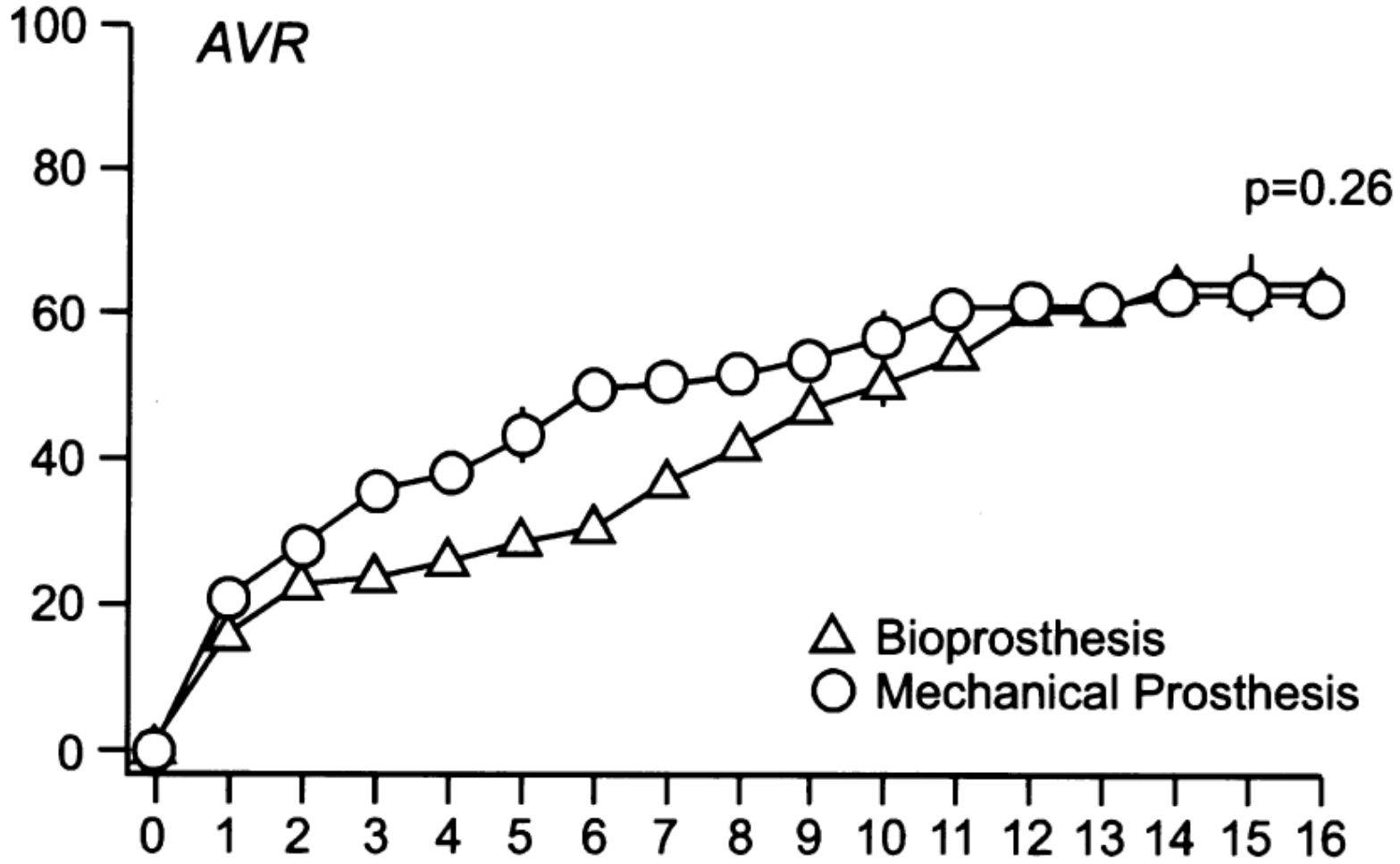
Authors/Task Force Members: Alec Vahanian * (ESC Chairperson) (France), Friedhelm Beyersdorf*[1] (EACTS Chairperson) (Germany), Fabien Praz (ESC Task Force Coordinator) (Switzerland), Milan Milojevic[1] (EACTS Task Force Coordinator) (Serbia), Stephan Baldus (Germany), Johann Bauersachs (Germany), Davide Capodanno (Italy), Lenard Conradi[1] (Germany), Michele De Bonis[1] (Italy), Ruggero De Paulis[1] (Italy), Victoria Delgado (Netherlands), Nick Freemantle[1] (United Kingdom), Martine Gilard (France), Kristina H. Haugaa (Norway), Anders Jeppsson[1] (Sweden), Peter Jüni (Canada), Luc Pierard (Belgium), Bernard D. Prendergast (United Kingdom), J. Rafael Sádaba[1] (Spain), Christophe Tribouilloy (France), Wojtek Wojakowski (Poland), ESC/EACTS Scientific Document Group

A mechanical prosthesis should be considered in patients aged <60 years for prostheses in the aortic position and aged <65 years for prostheses in the mitral position.[462, 464 e]	IIa	B

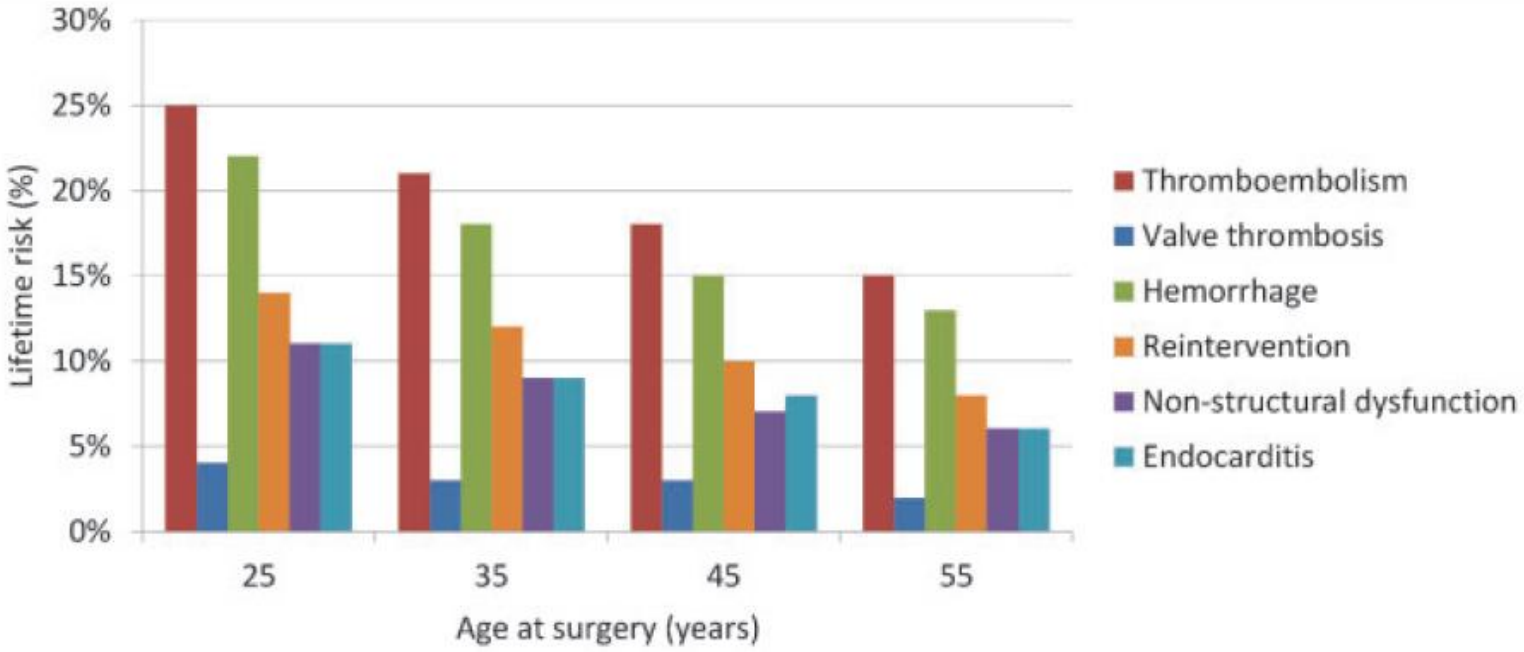


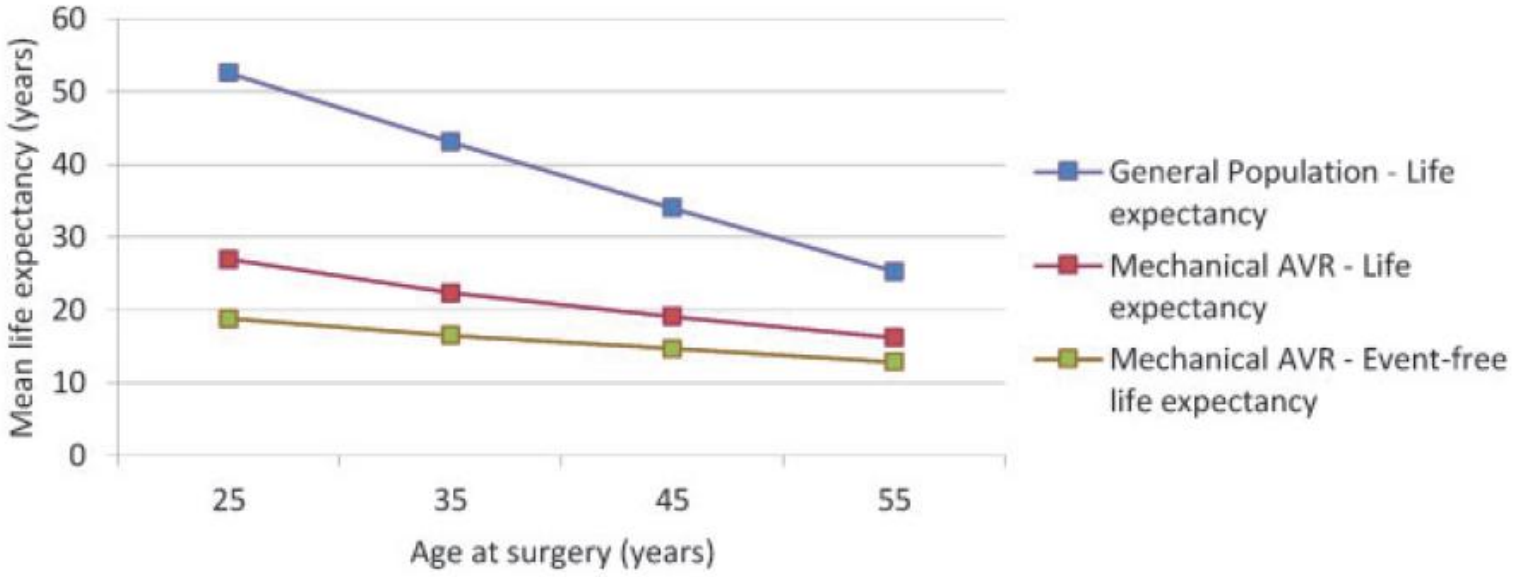
Bouhout I et al. Long-term outcomes after elective isolated mechanical aortic valve replacement in young adults. 2017.


100
80
60
40
20
%Survival free from reoperation
82%
N at risk
1 y 95 ± 1 % 421
5 y 89 ± 1 % 378
10 y 82 ± 2 % 173
2
4
6
8
10
12
14
Years since surgery
Number at risk
421
378
173

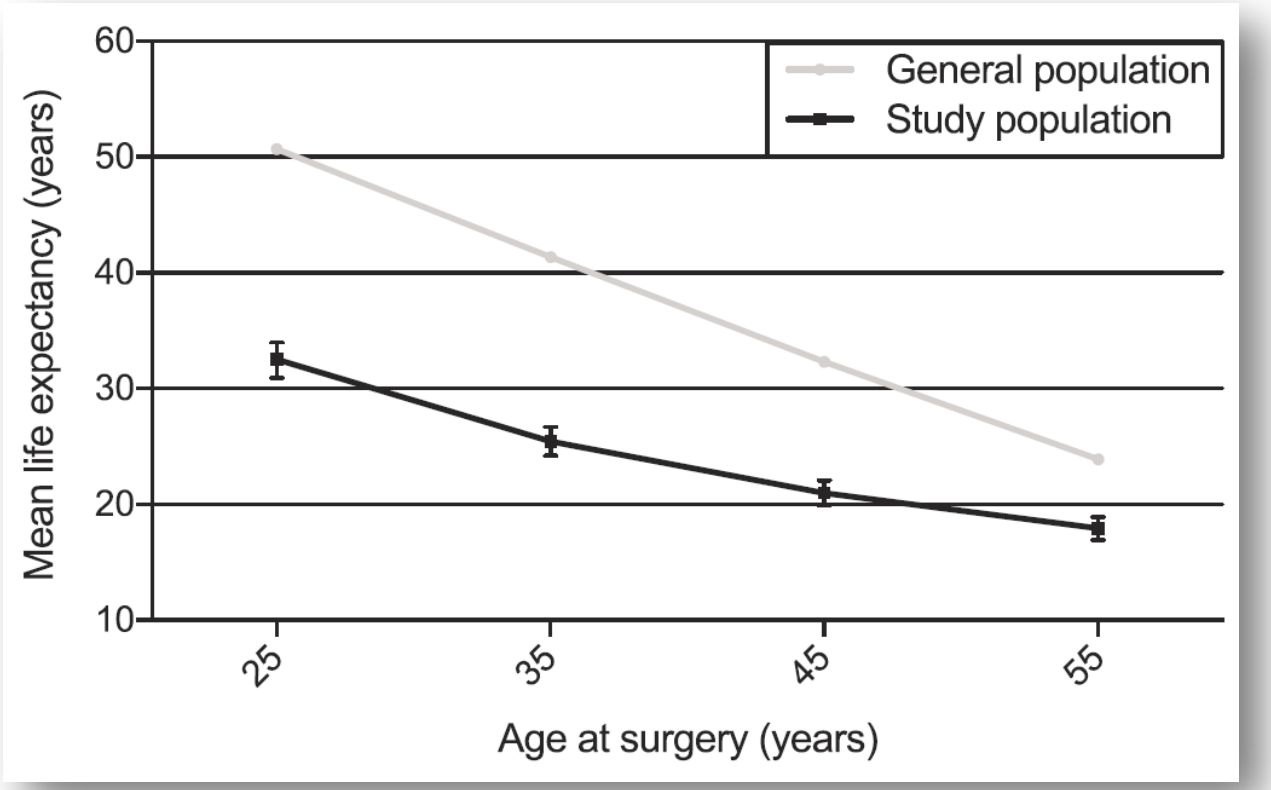


Hammermeister et al. Outcomes 15 years after valve replacement with a mechanical versus a bioprosthetic valve: final report of the Veterans Affairs randomized trial. J Am Coll Cardiol. 2000 Oct;36(4):1152-8.



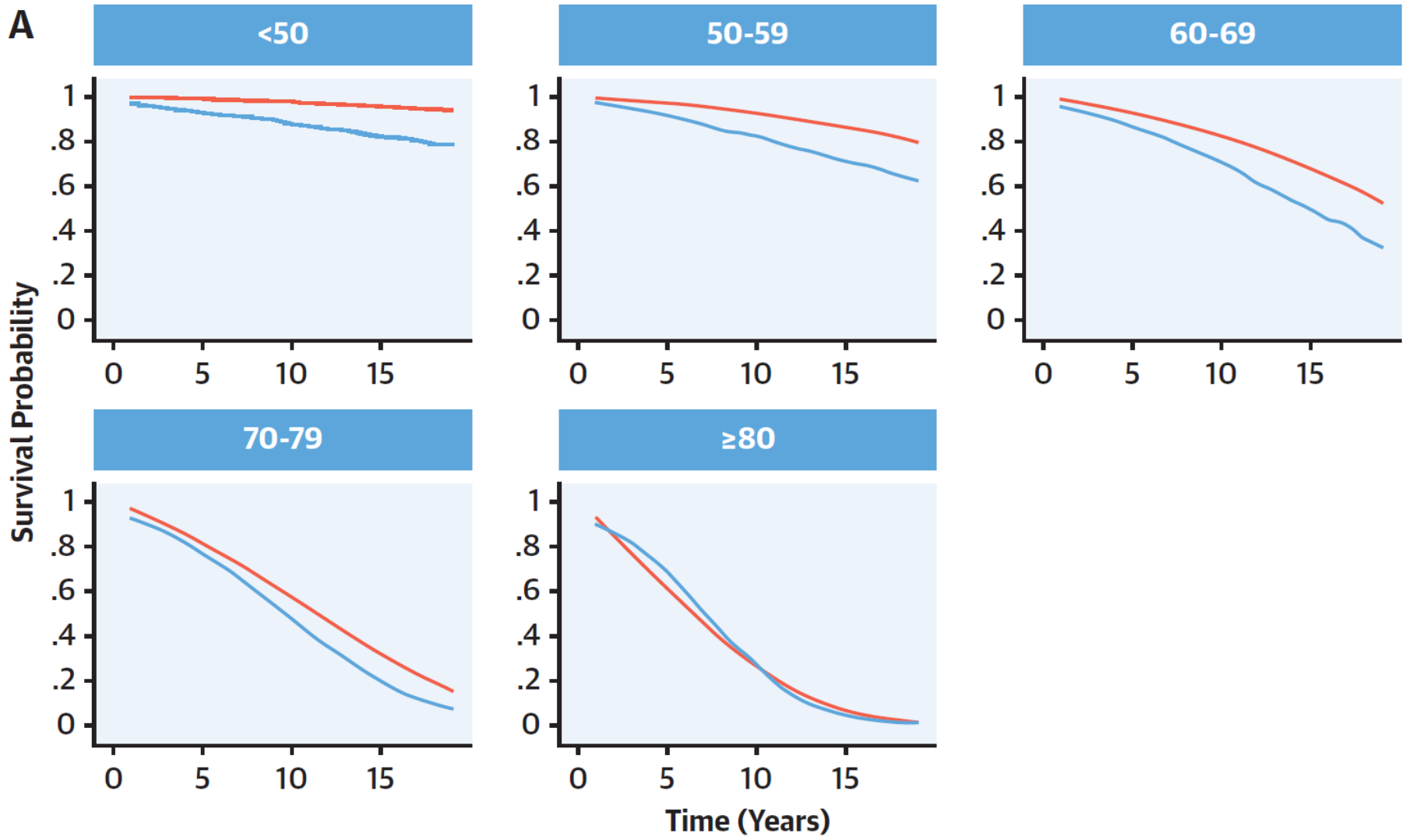


Korteland NM, Etnel JRG, Arabkhani B, Mokles MM, Mohamad A, Roos-Hesselink JWR, Bogers JJC, Takkenberg JM. Mechanical aortic valve replacement in non-elderly adults: meta-analysis and microsimulation. Eur Heart J (2017) 38, 3370-3377.



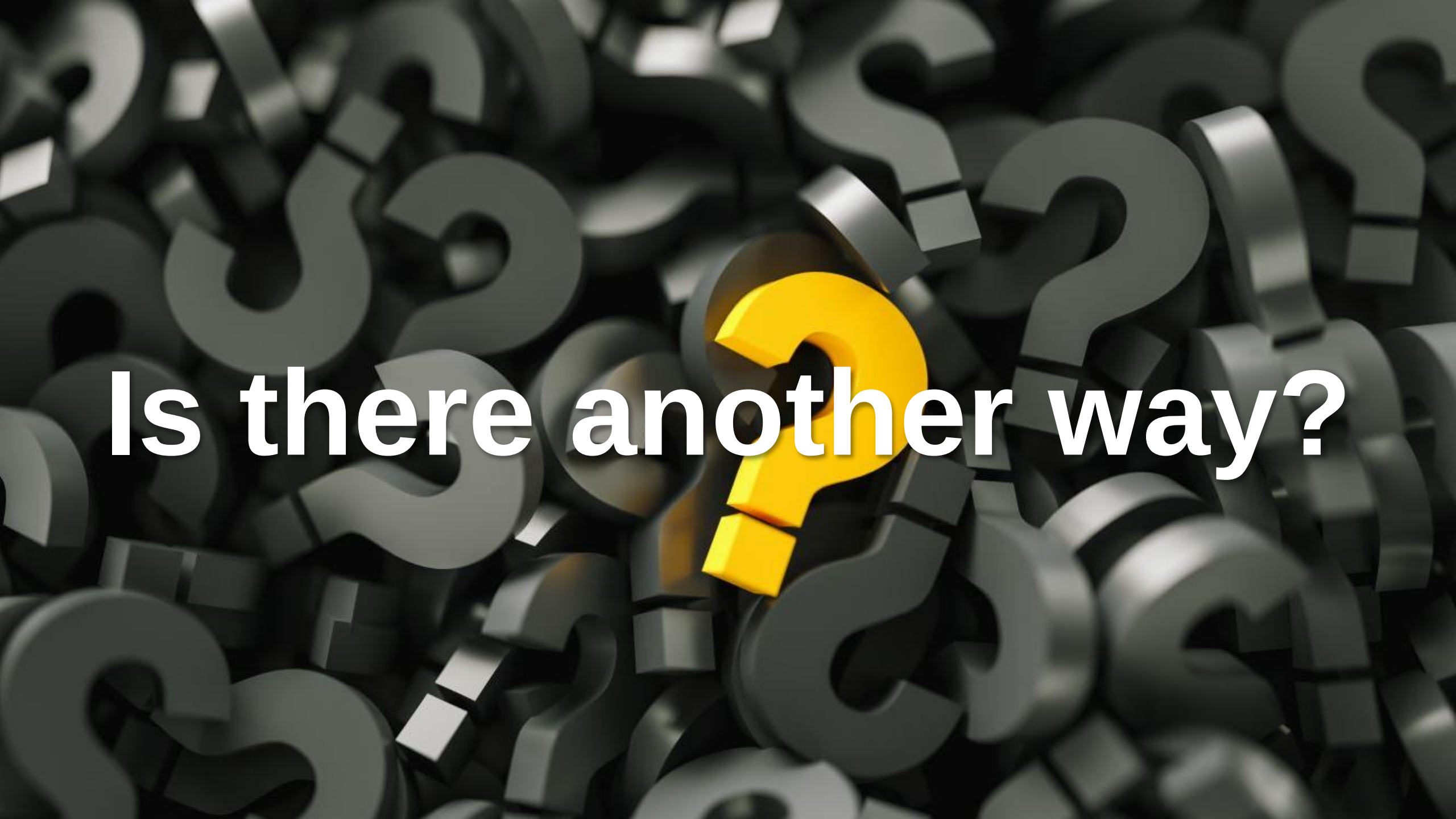
Etnel JRG, Huygens SA, Grashuis P, Pekbay B, Papageorgiou G, Hesselink JWR, Bogers JJC, Takkenberg JM. Bioprosthetic Aortic Valve Replacement in Nonelderly Adults: A systematic Review, Meta-Analysis, Microsimulation. Cir Cardiovasc Qual Outcomes: 12 (2):e005481.

FIGURE 2 Survival After Aortic Valve Replacement

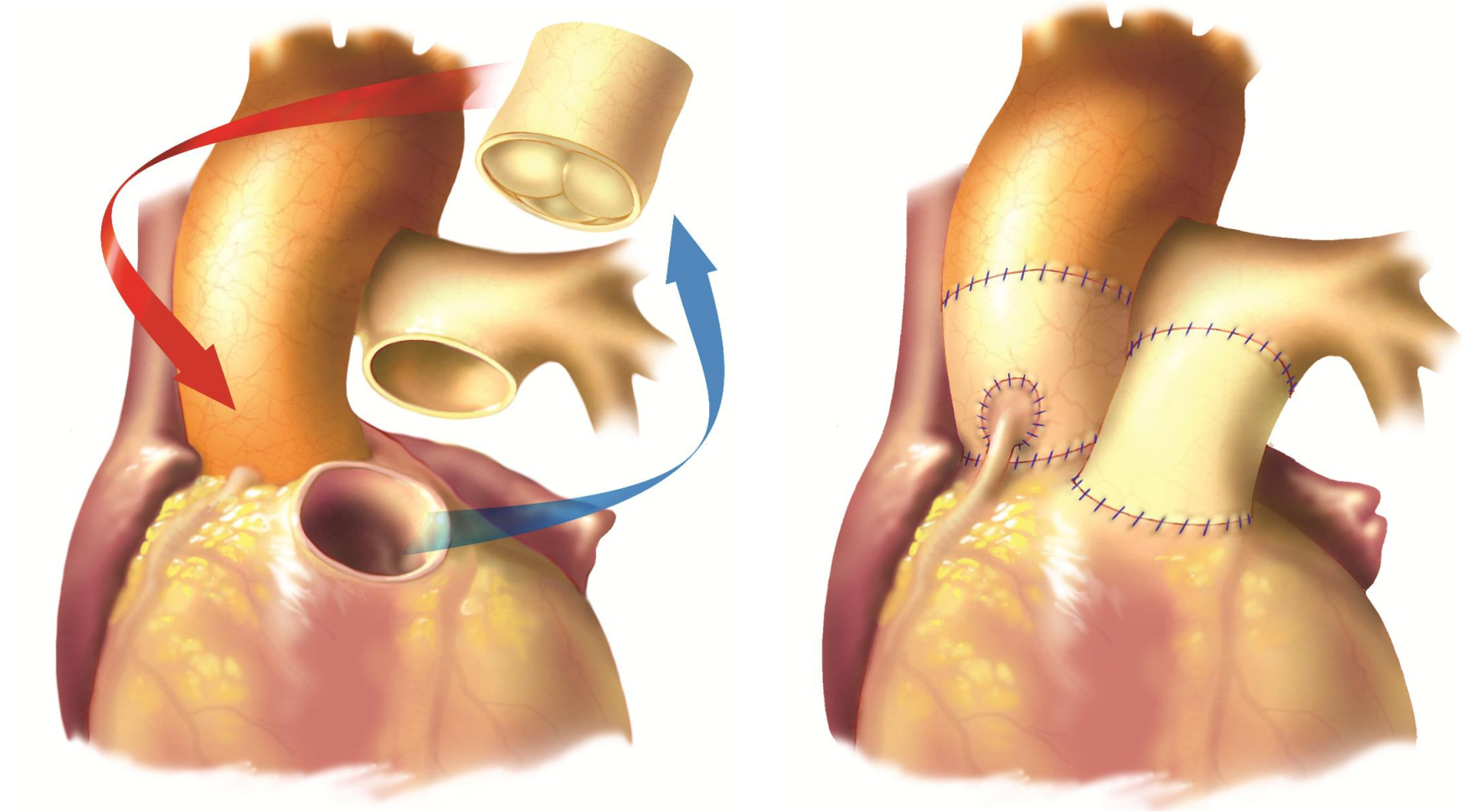


Glaser N, et al. Loss in Life Expectancy after Surgical Aortic Valve Replacement (SWEDEHART Study). J Am Coll Cardiol 2019;74:26-33

PALLIATION


Is there another way?

Ross Procedure



„The next best thing to the nature…“

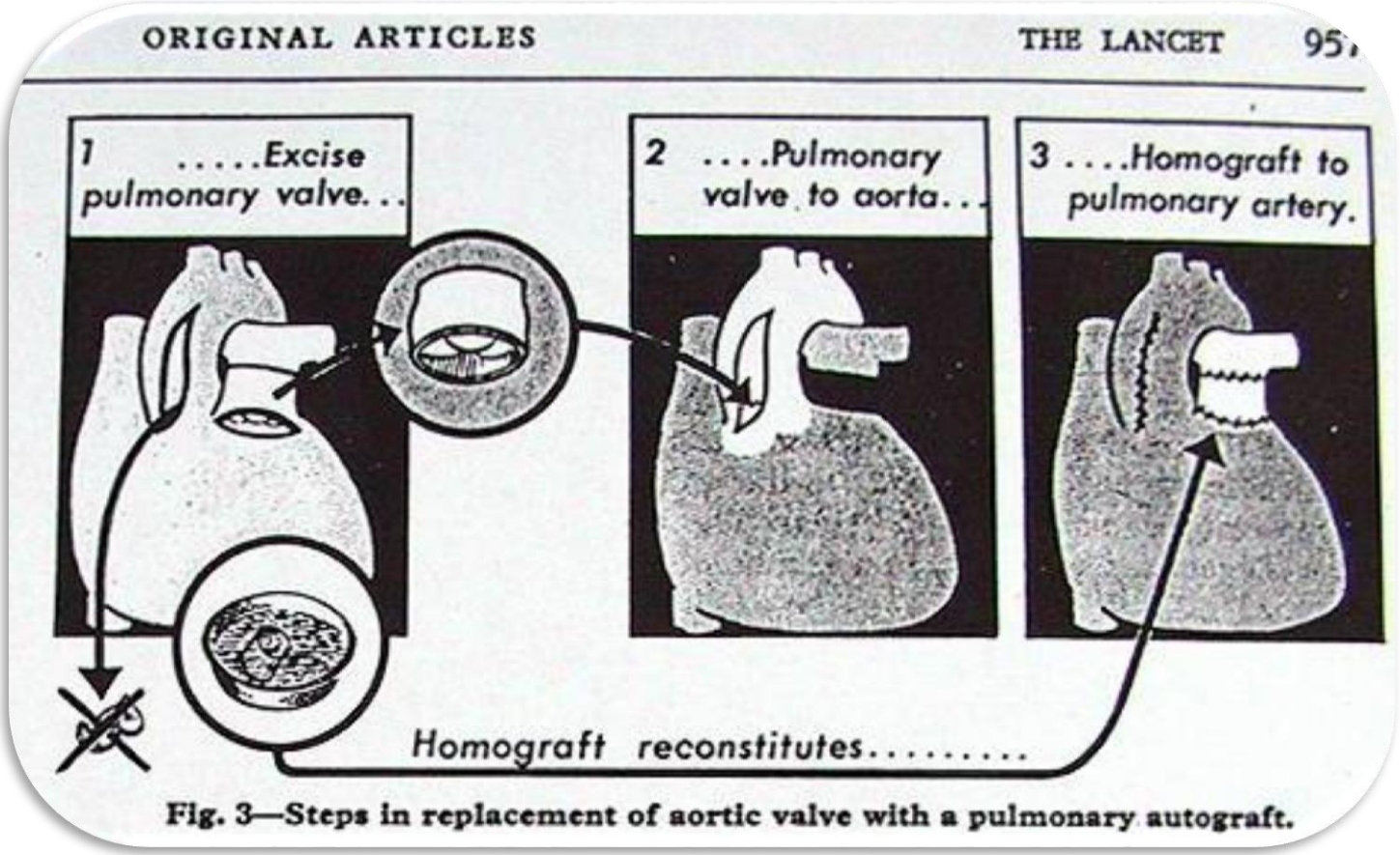
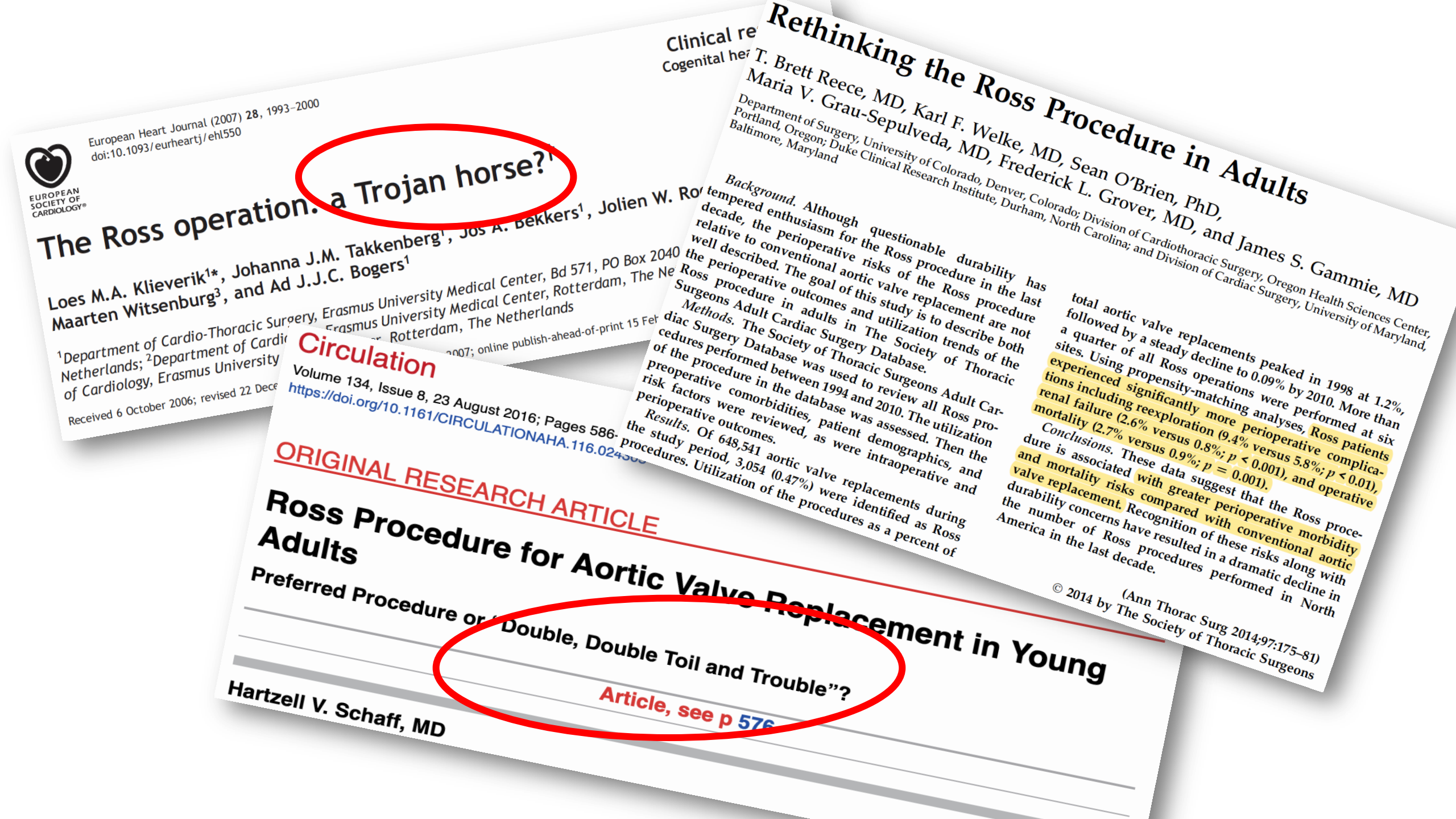


Fig. 3—Steps in replacement of aortic valve with a pulmonary autograft.



European Heart Journal (2007) 28, 1993–2000
doi:10.1093/eurheartj/ehl550

EUROPEAN SOCIETY OF CARDIOLOGY®

The Ross operation: a Trojan horse?

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Volume 134, Issue 8, 23 August 2016; Pages 586-
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ORIGINAL RESEARCH ARTICLE

Ross Procedure for Aortic Valve Replacement in Young Adults

Preferred Procedure or Double, Double Toil and Trouble"?

Article, see p 576

Hartzell V. Schaff, MD

Rethinking the Ross Procedure in Adults

T. Brett Reece, MD, Karl F. Welke, MD, Sean O'Brien, PhD,
Maria V. Grau-Sepulveda, MD, Frederick L. Grover, MD, and James S. Gammie, MD

Department of Surgery, University of Colorado, Denver, Colorado; Division of Cardiothoracic Surgery, Oregon Health Sciences Center, Portland, Oregon; Duke Clinical Research Institute, Durham, North Carolina; and Division of Cardiac Surgery, University of Maryland, Baltimore, Maryland

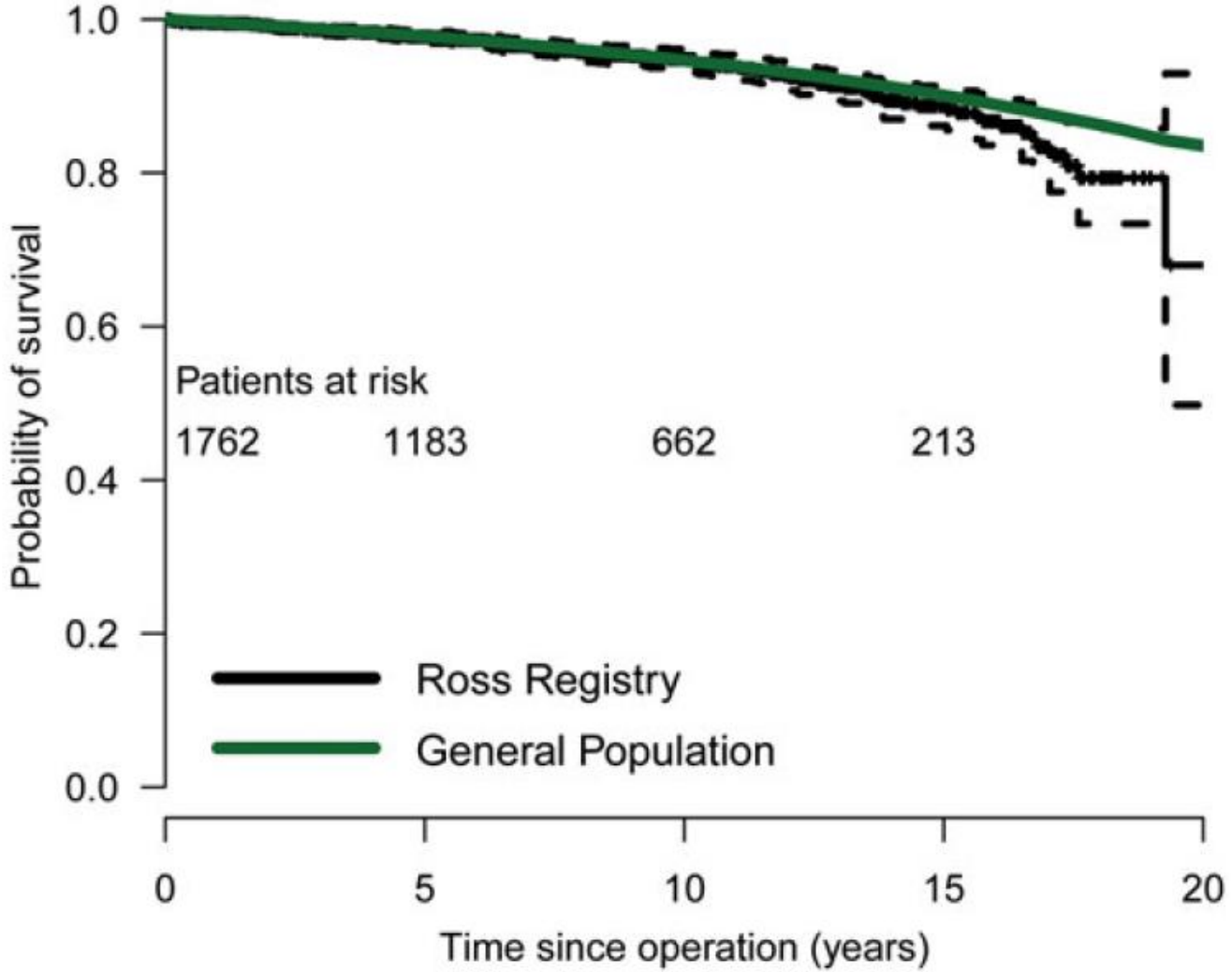
Background. Although questionable durability has tempered enthusiasm for the Ross procedure in the last decade, the perioperative risks of the Ross procedure relative to conventional aortic valve replacement are not well described. The goal of this study is to describe both the perioperative outcomes and utilization trends of the Ross procedure in adults in The Society of Thoracic Surgeons Adult Cardiac Surgery Database.

Methods. The Society of Thoracic Surgeons Adult Cardiac Surgery Database was used to review all Ross procedures performed between 1994 and 2010. The utilization of the procedure in the database was assessed. Then the preoperative comorbidities, patient demographics, and risk factors were reviewed, as were intraoperative and perioperative outcomes.

Results. Of 648,541 aortic valve replacements during the study period, 3,054 (0.47%) were identified as Ross procedures. Utilization of the procedures as a percent of total aortic valve replacements peaked in 1998 at 1.2%, followed by a steady decline to 0.09% by 2010. More than a quarter of all Ross operations were performed at six sites. Using propensity-matching analyses, Ross patients experienced significantly more perioperative complications including reexploration (9.4% versus 5.8%; $p < 0.01$), renal failure (2.6% versus 0.8%; $p < 0.001$), and operative mortality (2.7% versus 0.9%; $p = 0.001$).

Conclusions. These data suggest that the Ross procedure is associated with greater perioperative morbidity and mortality risks compared with conventional aortic valve replacement. Recognition of these risks along with durability concerns have resulted in a dramatic decline in the number of Ross procedures performed in North America in the last decade.

(Ann Thorac Surg 2014;97:175–81)



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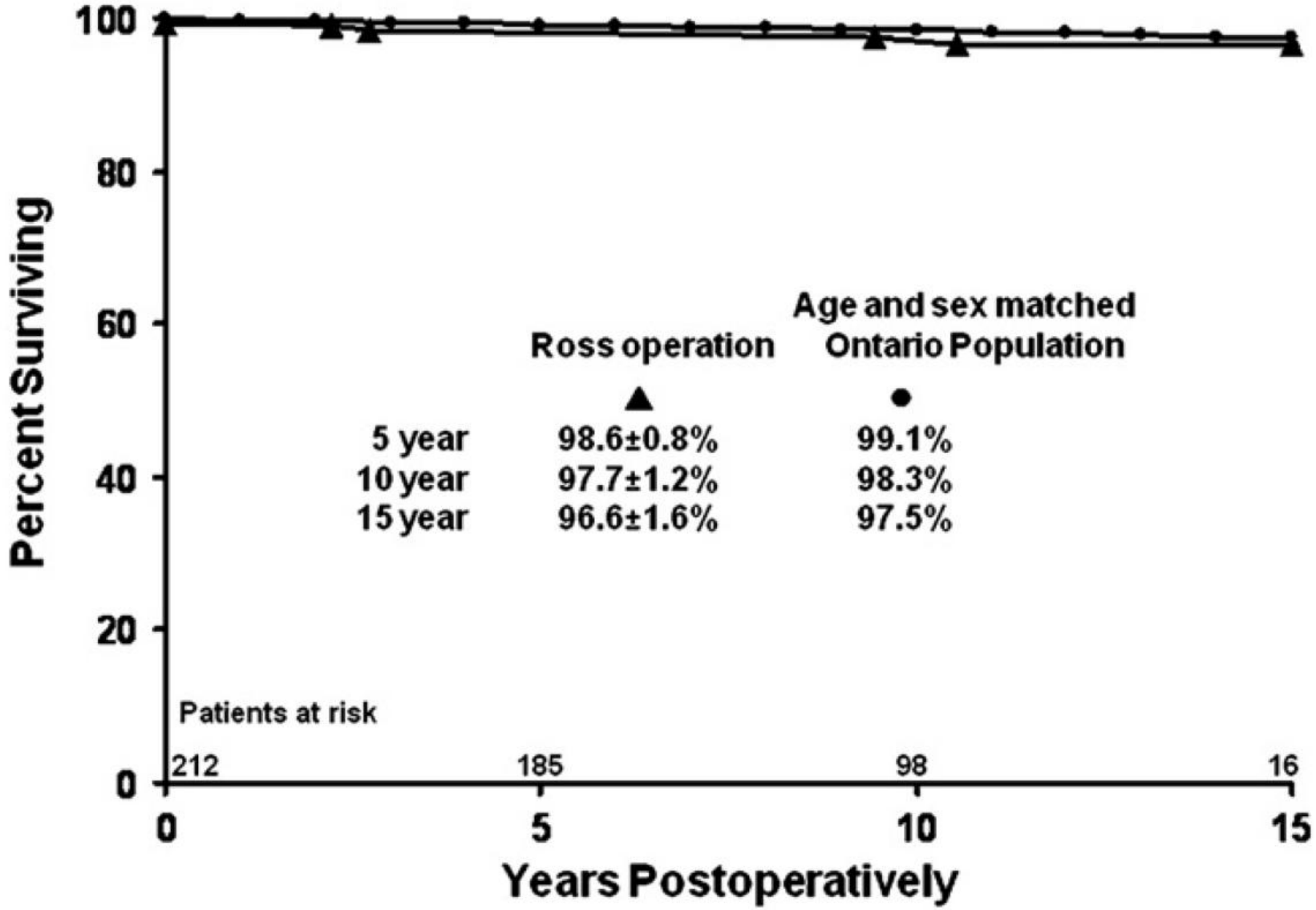
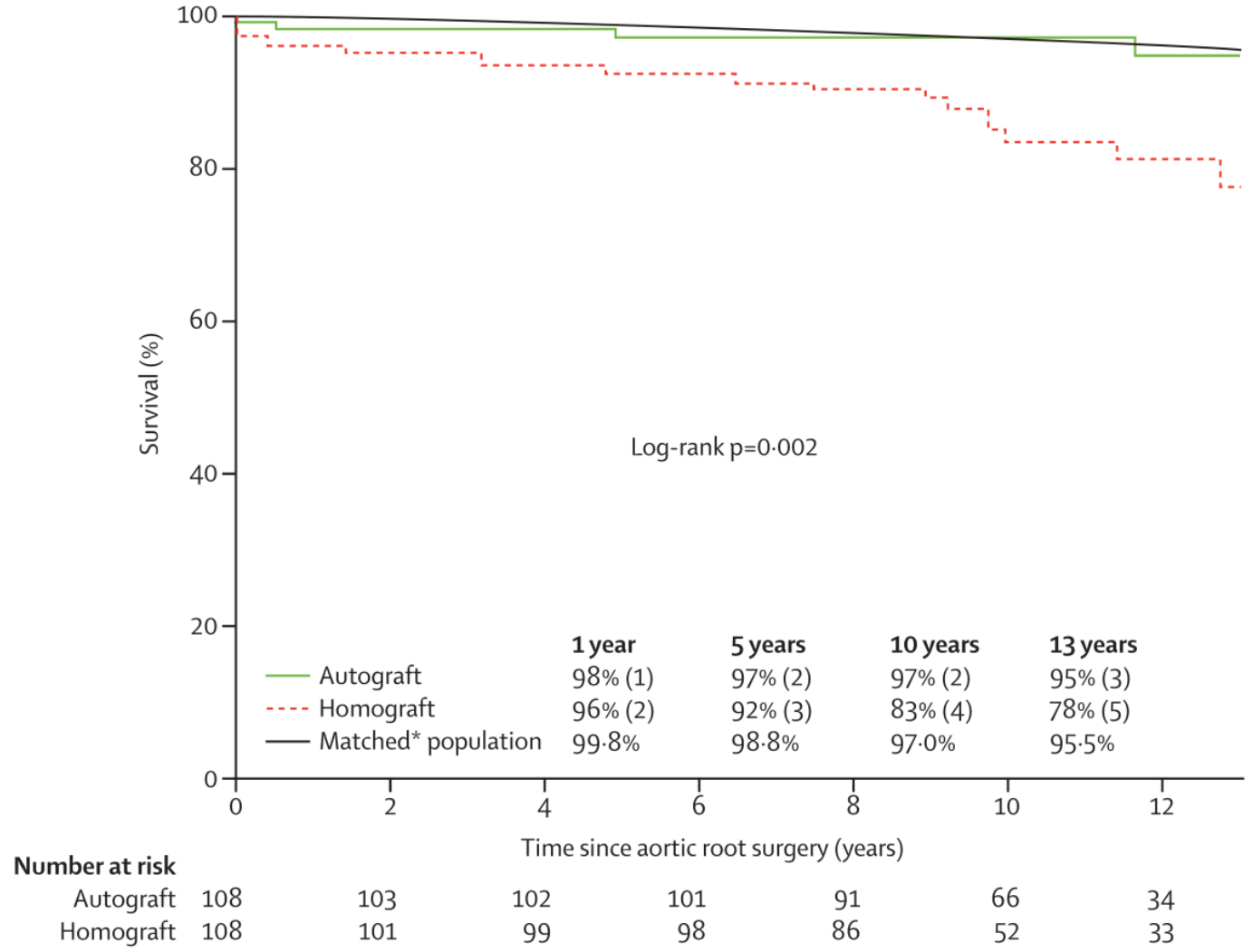


David TE, Woo A, Armstrong S, Maganti M. When is the Ross operation a good option to treat aortic valve disease? J Thorac Cardiovasc Surg. 2010 Jan;139(1):68-73



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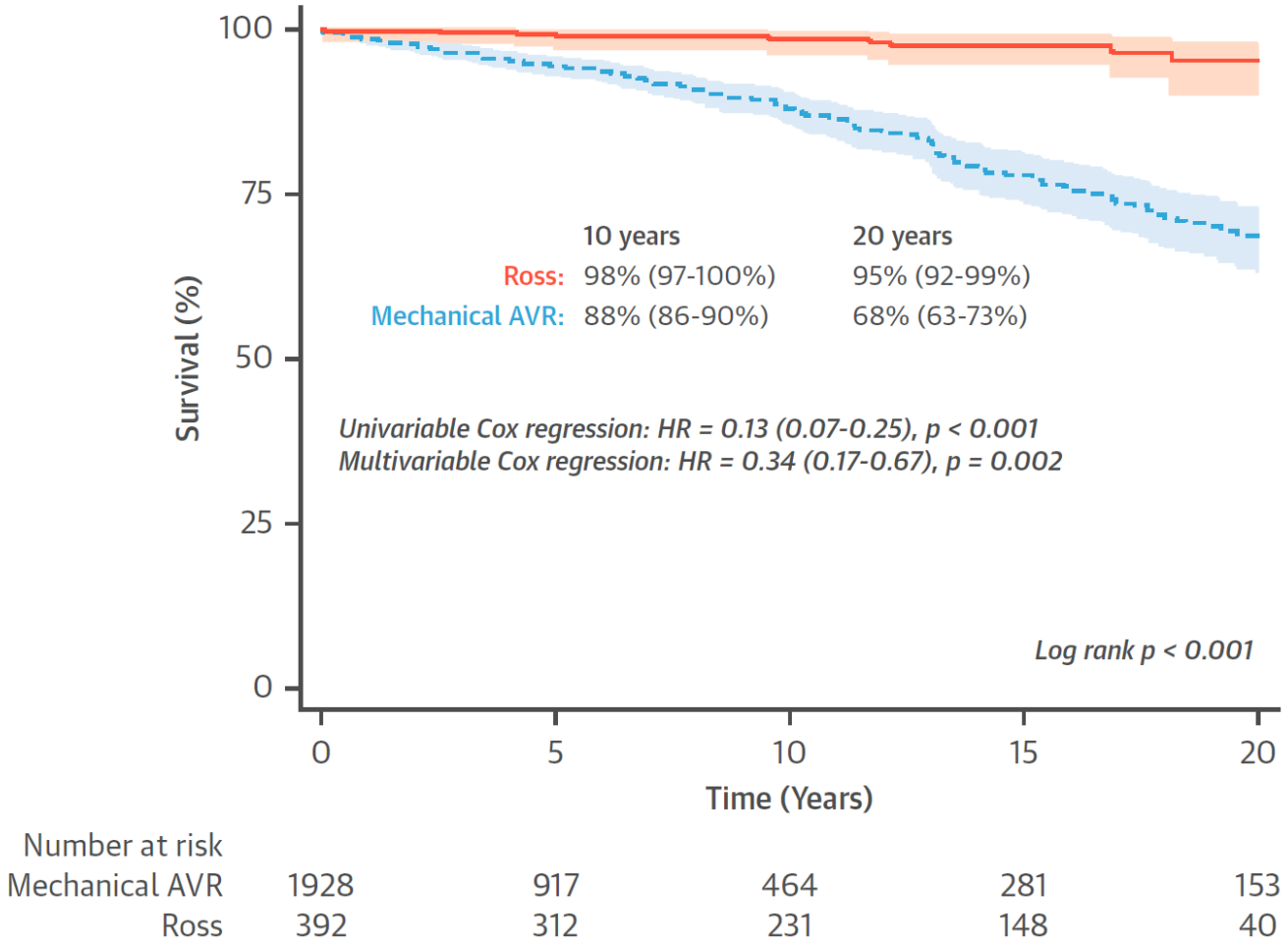


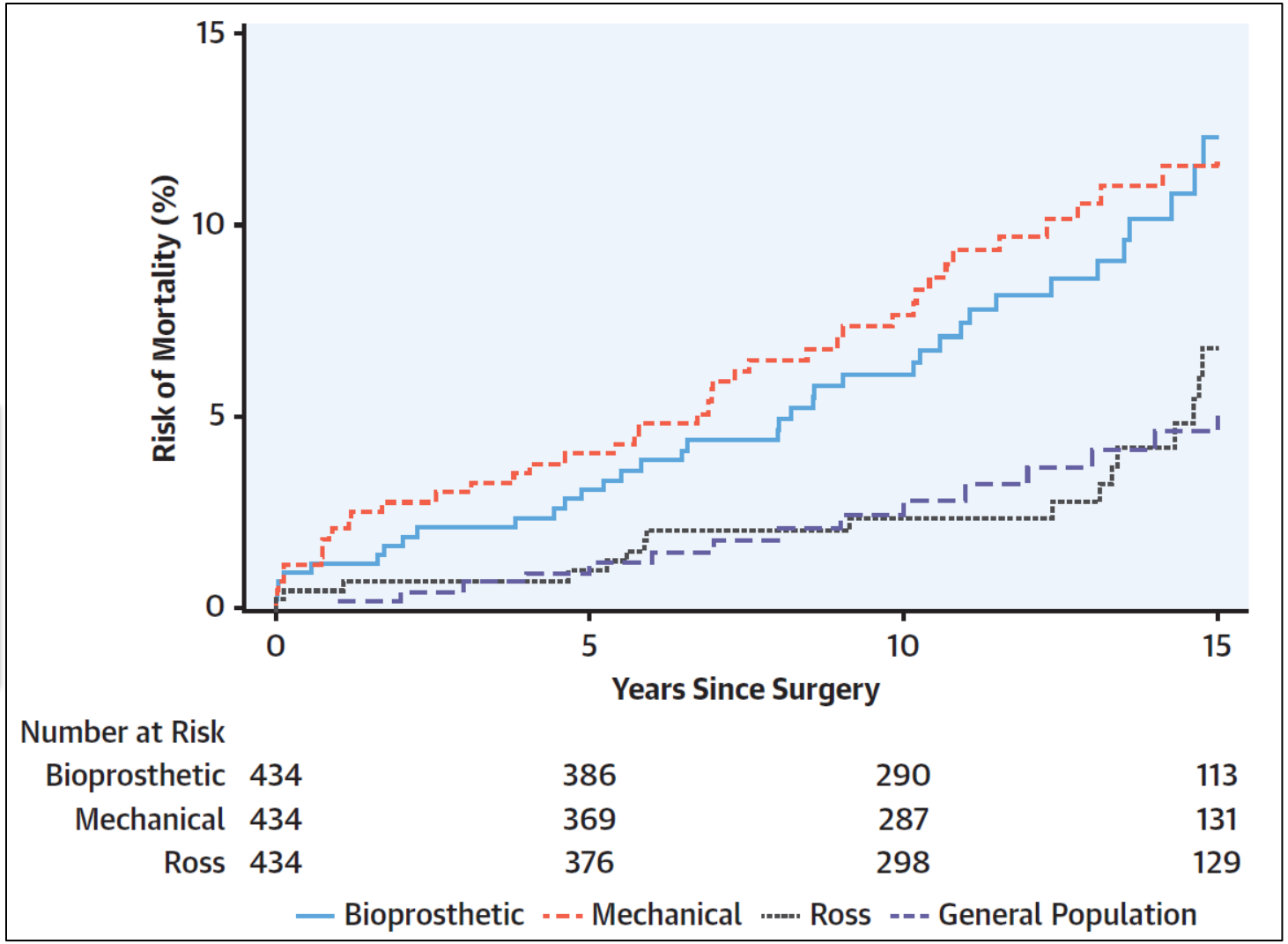
Skillington P et al. Improved Survival After the Ross Procedure Compared With Mechanical Aortic Valve Replacement. J Am Coll Cardiol 2018.

California & NY State

1997-2014

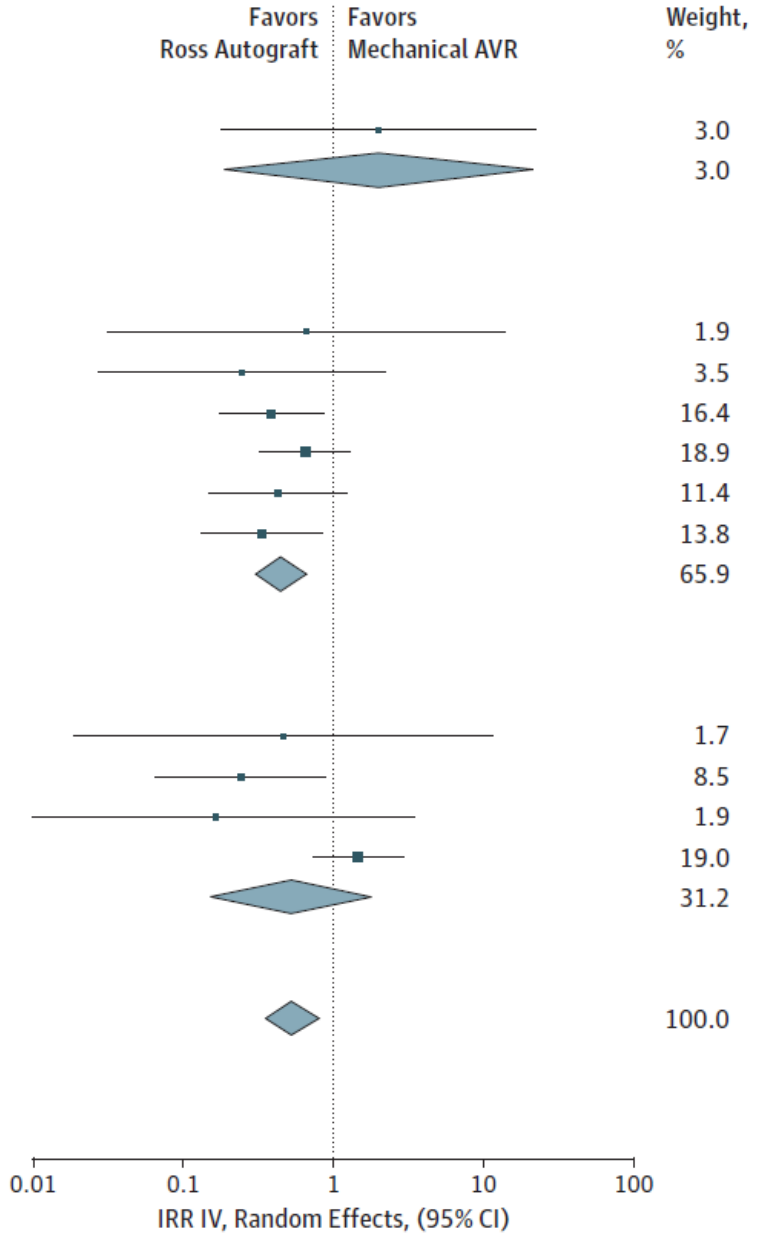
1302 patients

Median F/U 12.5 years



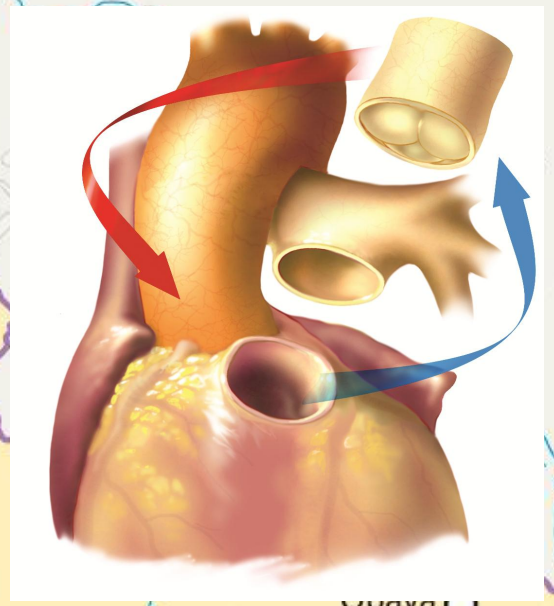
El-Hamamsy I et al. Propensity-Matched Comparison of the Ross Procedure and Prosthetic Aortic Valve Replacement in Adults. J Am Coll Cardiol 2022.

Study or Subgroup	Mean Follow-up, y	log (IRR)	SE	Ross Total	AVR Total	IRR IV, Random (95% CI)	Weight, %
Randomized trial							
Doss et al,[26] 2005	1.0	0.6931	1.2247	20	20	2.00 (0.18-22.05)	3.0
Subtotal (95% CI)				20	20	2.00 (0.18-22.05)	3.0
Heterogeneity: not applicable							
Test for overall effect: $z = 0.57$ ($P = .57$)							
Matched/adjusted observational							
Jaggers et al,[27] 1998	1.7	-0.4185	1.5492	22	27	0.66 (0.03-13.71)	1.9
Concha et al,[30] 2005	2.5	-1.4023	1.1180	63	62	0.25 (0.03-2.20)	3.5
Andreas et al,[32] 2014	8.9	-0.9555	0.4019	159	173	0.38 (0.17-0.85)	16.4
Mazine et al,[33] 2016	14.0	-0.4415	0.3498	208	208	0.64 (0.32-1.28)	18.9
Sharabiani et al,[34] 2016	5.3	-0.8544	0.5380	224	468	0.43 (0.15-1.22)	11.4
Buratto et al,[36] 2018	10.0	-1.0986	0.4644	275	275	0.33 (0.13-0.83)	13.8
Subtotal (95% CI)				951	1213	0.45 (0.30-0.67)	65.9
Heterogeneity: $\tau^2 = 0.00$; $\chi^2 = 1.97$, $df = 5$ ($P = .85$); $I^2 = 0\%$							
Test for overall effect: $z = 3.88$ ($P < .001$)							
Unmatched/unadjusted observational							
Akhyari et al,[39] 2009	3.7	-0.7742	1.6330	18	20	0.46 (0.02-11.32)	1.7
Klieverik et al,[37] 2006	7.0	-1.4250	0.6567	81	204	0.24 (0.07-0.87)	8.5
Zsolt et al,[38] 2008	5.4	-1.8140	1.5492	17	17	0.16 (0.01-3.40)	1.9
Mokhles et al,[31] 2011	6.0	0.3706	0.3469	925	408	1.45 (0.73-2.86)	19.0
Subtotal (95% CI)				1041	649	0.53 (0.15-1.91)	31.2
Heterogeneity: $\tau^2 = 0.88$; $\chi^2 = 7.30$, $df = 3$ ($P = .06$); $I^2 = 59\%$							
Test for overall effect: $z = 0.97$ ($P = .33$)							
Total (95% CI)				2012	1882	0.54 (0.35-0.82)	100.0
Heterogeneity: $\tau^2 = 0.13$; $\chi^2 = 13.95$, $df = 10$ ($P = .18$); $I^2 = 28\%$							
Test for overall effect: $z = 2.85$ ($P = .004$)							
Test for subgroup differences: $\chi^2 = 1.47$; $df = 2$ ($P = .48$); $I^2 = 0\%$							



Mazine A et al. Ross Procedure vs Mechanical Aortic Valve Replacement in Adults: A Systematic Review and Meta-analysis. 2018.

OK, these are all foreign data … but how does it look like in the Czech Republic???



CZECH REPUBLIC

GERMANY

AUSTRIA

SLOVAKIA

PRAGUE

Děčín

Ústí nad Labem

Liberec

Trutnov

Mladá Boleslav

Hradec Králové

Kladno

Kolín

Pardubice

Plzeň

Klatovy

Strakonice

Tábor

Jihlava

Ostrava

Český Těšín

Olomouc

Zlín

České Budějovice

Znojmo

Břeclav

Nisse

Elbe

Vltava

Svratka

Morava

Dyje

Danube

March

0 25 50 75 km

0 25 50 75 mi

AIM OF OUR STUDY

To compare real-world multicentric data of Ross procedure and mAVR

Propensity-Score Matching

Recent Era

Uniform Ross Cohort

- **Primary outcomes:** long-term postoperative survival and freedom from reoperation
- **Secondary outcomes:** short-term postoperative complications and comparison of cohort survival with age- and sex- matched general population

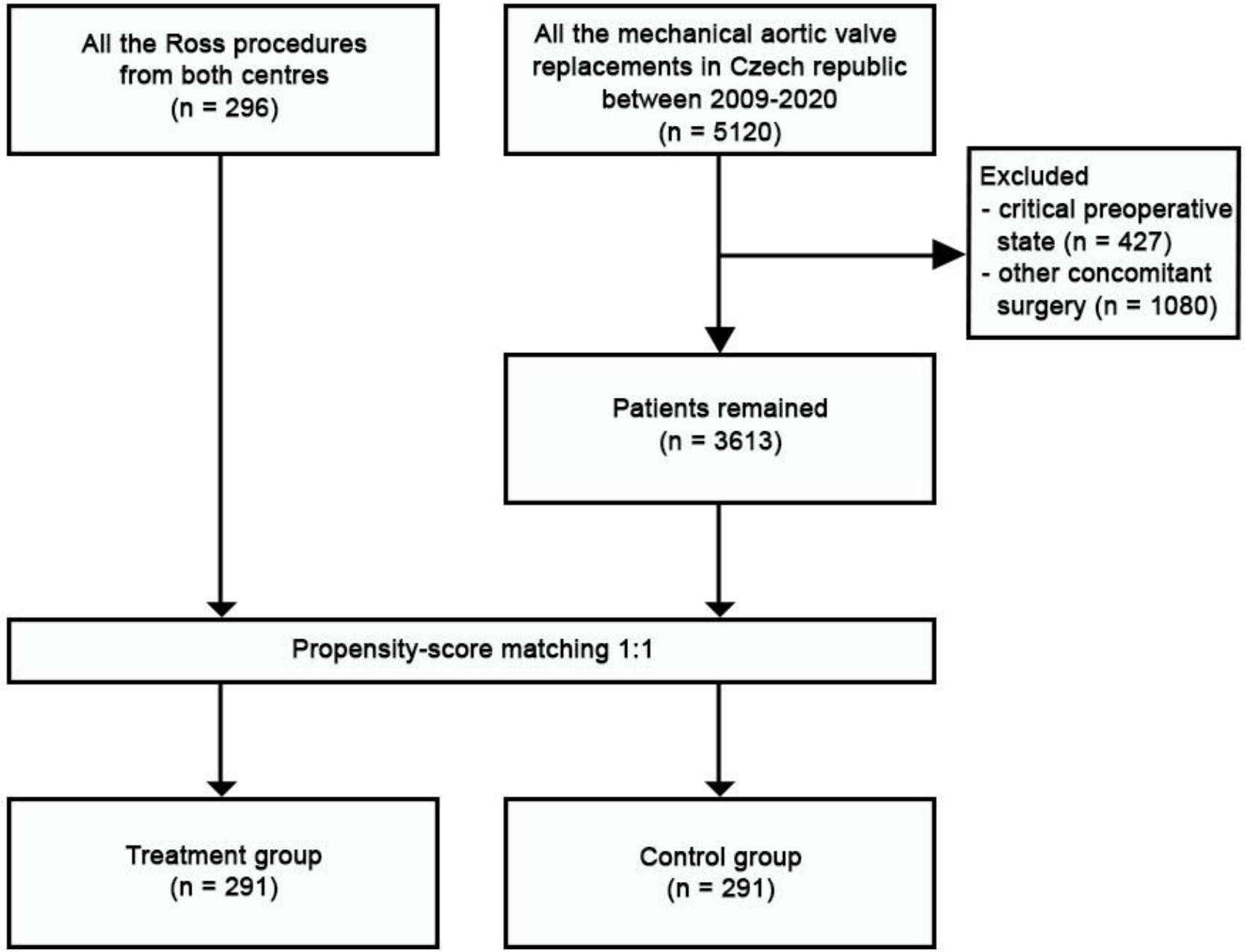
Patients & Methods

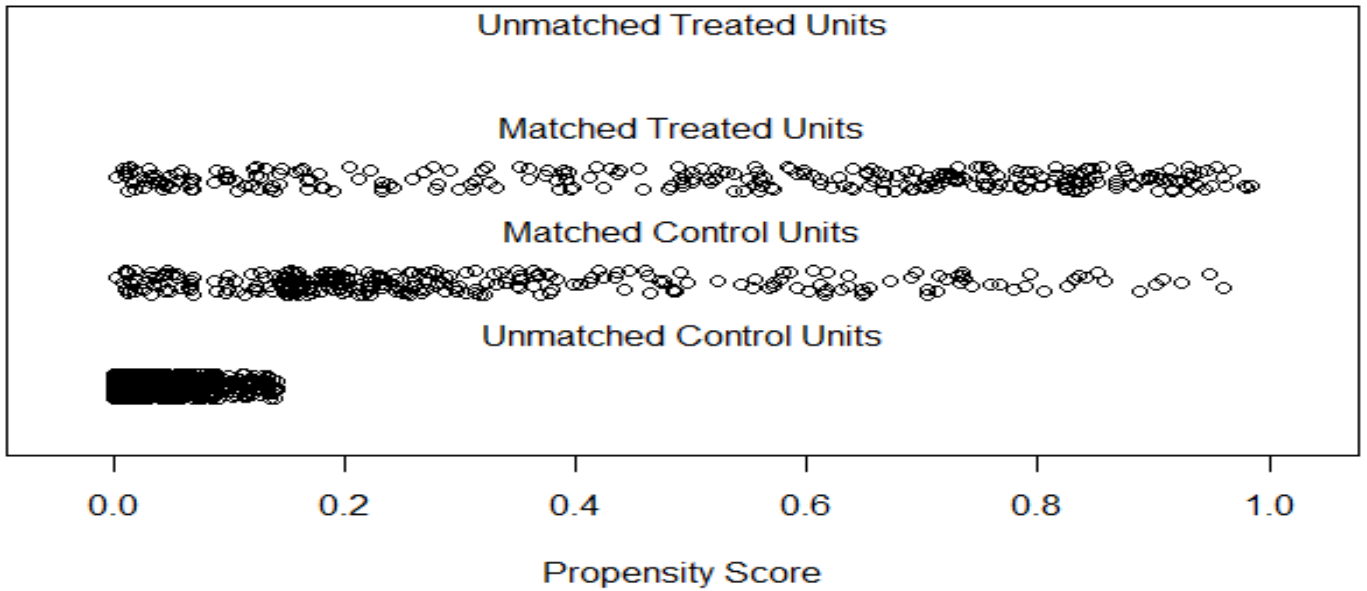
Study period: 1st of January 2009 – 31st of October 2020

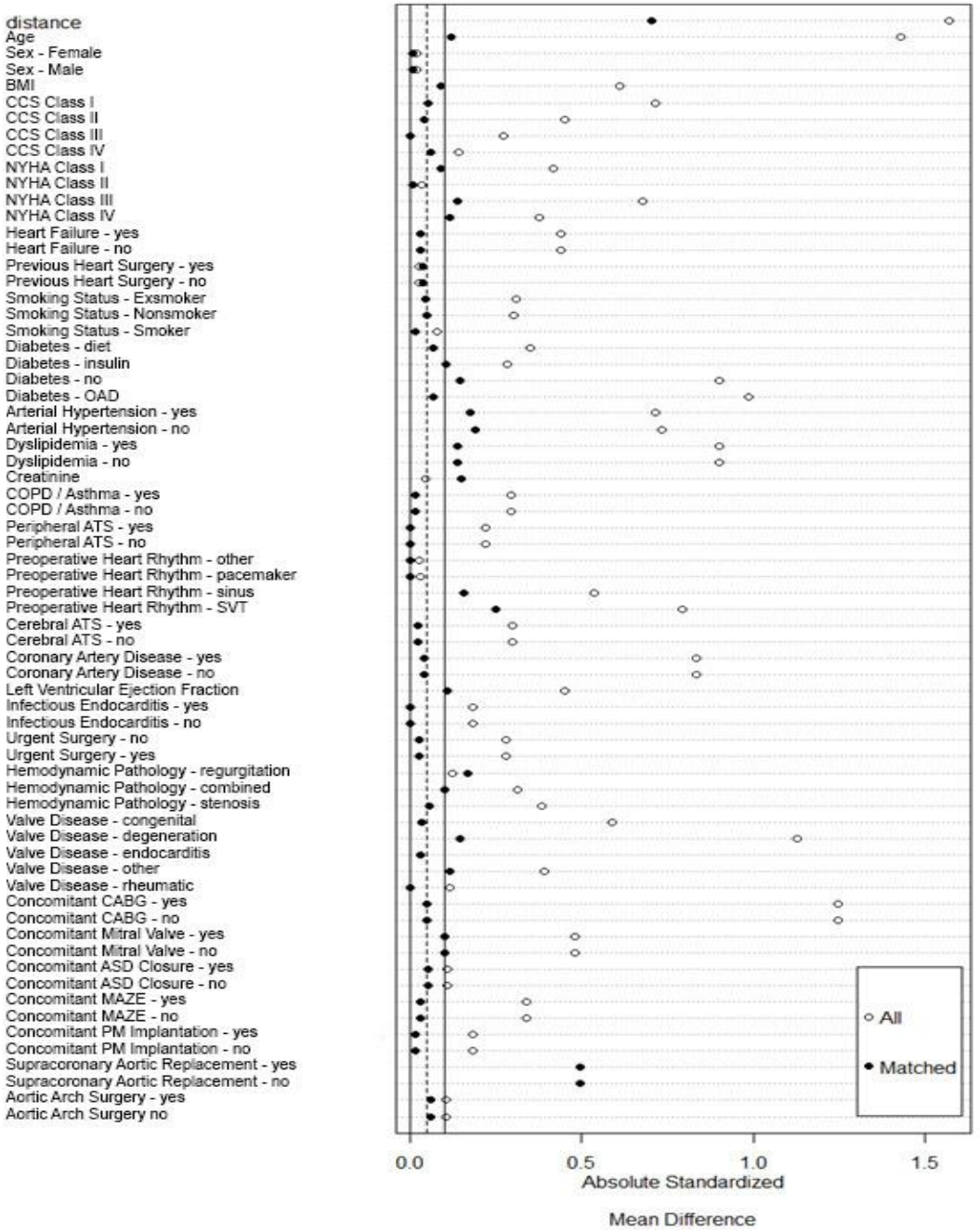
Ross group: Patients from 2 dedicated Ross centers

mAVR group: All patients undergoing mAVRs in the Czech Republic

Data source: The National Registry of Cardiac Surgery of the Czech Republic


All the Ross procedures from both centres (n = 296)
All the mechanical aortic valve replacements in Czech republic between 2009-2020 (n = 5120)
Excluded
- critical preoperative state (n = 427)
- other concomitant surgery (n = 1080)
Patients remained (n = 3613)
Propensity-score matching 1:1
Treatment group (n = 291)
Control group (n = 291)


Unmatched Treated Units
Matched Treated Units
Matched Control Units
Unmatched Control Units
0.0
0.2
0.4
0.6
0.8
1.0
Propensity Score


distance
Age
Sex - Female
Sex - Male
BMI
CCS Class I
CCS Class II
CCS Class III
CCS Class IV
NYHA Class I
NYHA Class II
NYHA Class III
NYHA Class IV
Heart Failure - yes
Heart Failure - no
Previous Heart Surgery - yes
Previous Heart Surgery - no
Smoking Status - Exsmoker
Smoking Status - Nonsmoker
Smoking Status - Smoker
Diabetes - diet
Diabetes - insulin
Diabetes - no
Diabetes - OAD
Arterial Hypertension - yes
Arterial Hypertension - no
Dyslipidemia - yes
Dyslipidemia - no
Creatinine
COPD / Asthma - yes
COPD / Asthma - no
Peripheral ATS - yes
Peripheral ATS - no
Preoperative Heart Rhythm - other
Preoperative Heart Rhythm - pacemaker
Preoperative Heart Rhythm - sinus
Preoperative Heart Rhythm - SVT
Cerebral ATS - yes
Cerebral ATS - no
Coronary Artery Disease - yes
Coronary Artery Disease - no
Left Ventricular Ejection Fraction
Infectious Endocarditis - yes
Infectious Endocarditis - no
Urgent Surgery - no
Urgent Surgery - yes
Hemodynamic Pathology - regurgitation
Hemodynamic Pathology - combined
Hemodynamic Pathology - stenosis
Valve Disease - congenital
Valve Disease - degeneration
Valve Disease - endocarditis
Valve Disease - other
Valve Disease - rheumatic
Concomitant CABG - yes
Concomitant CABG - no
Concomitant Mitral Valve - yes
Concomitant Mitral Valve - no
Concomitant ASD Closure - yes
Concomitant ASD Closure - no
Concomitant MAZE - yes
Concomitant MAZE - no
Concomitant PM Implantation - yes
Concomitant PM Implantation - no
Supracoronary Aortic Replacement - yes
Supracoronary Aortic Replacement - no
Aortic Arch Surgery - yes
Aortic Arch Surgery no
All
Matched
0.0
0.5
1.0
1.5
Absolute Standardized
Mean Difference

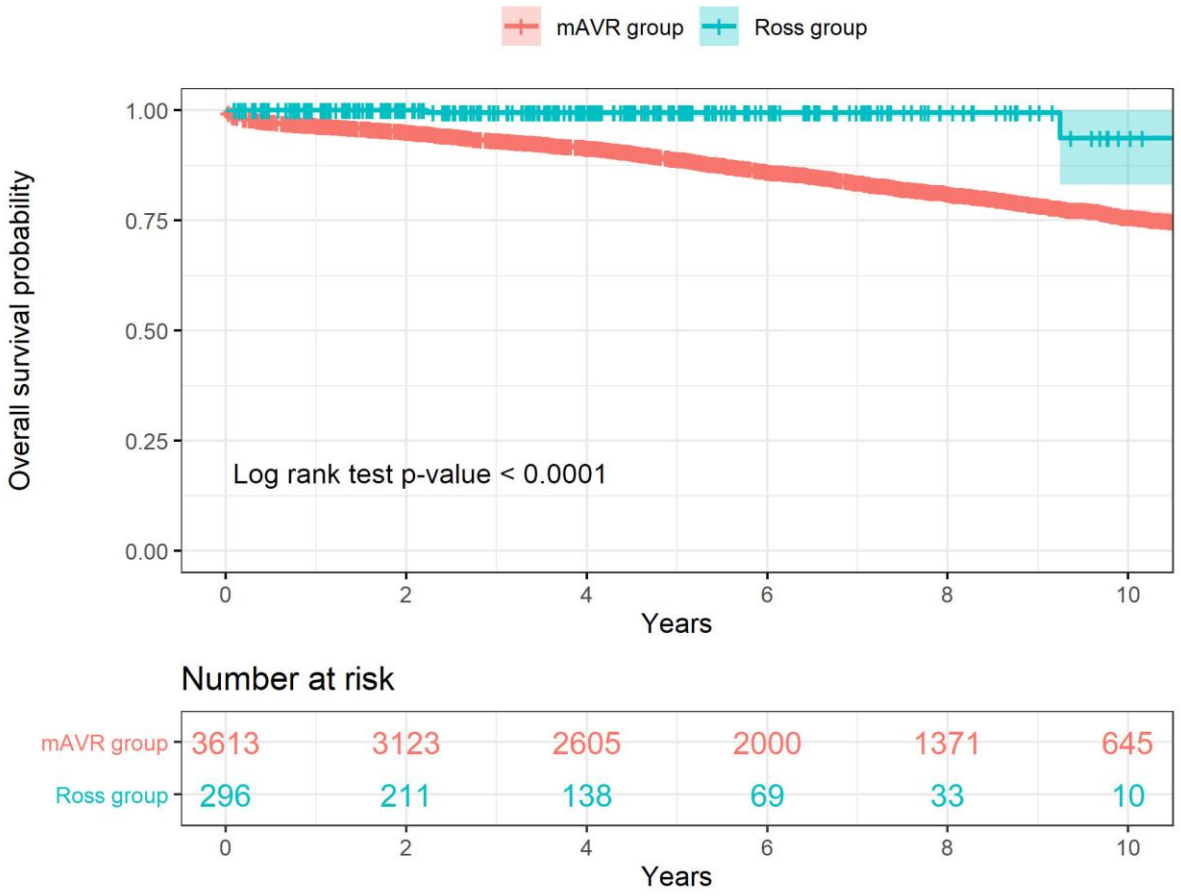
Perioperative outcomes

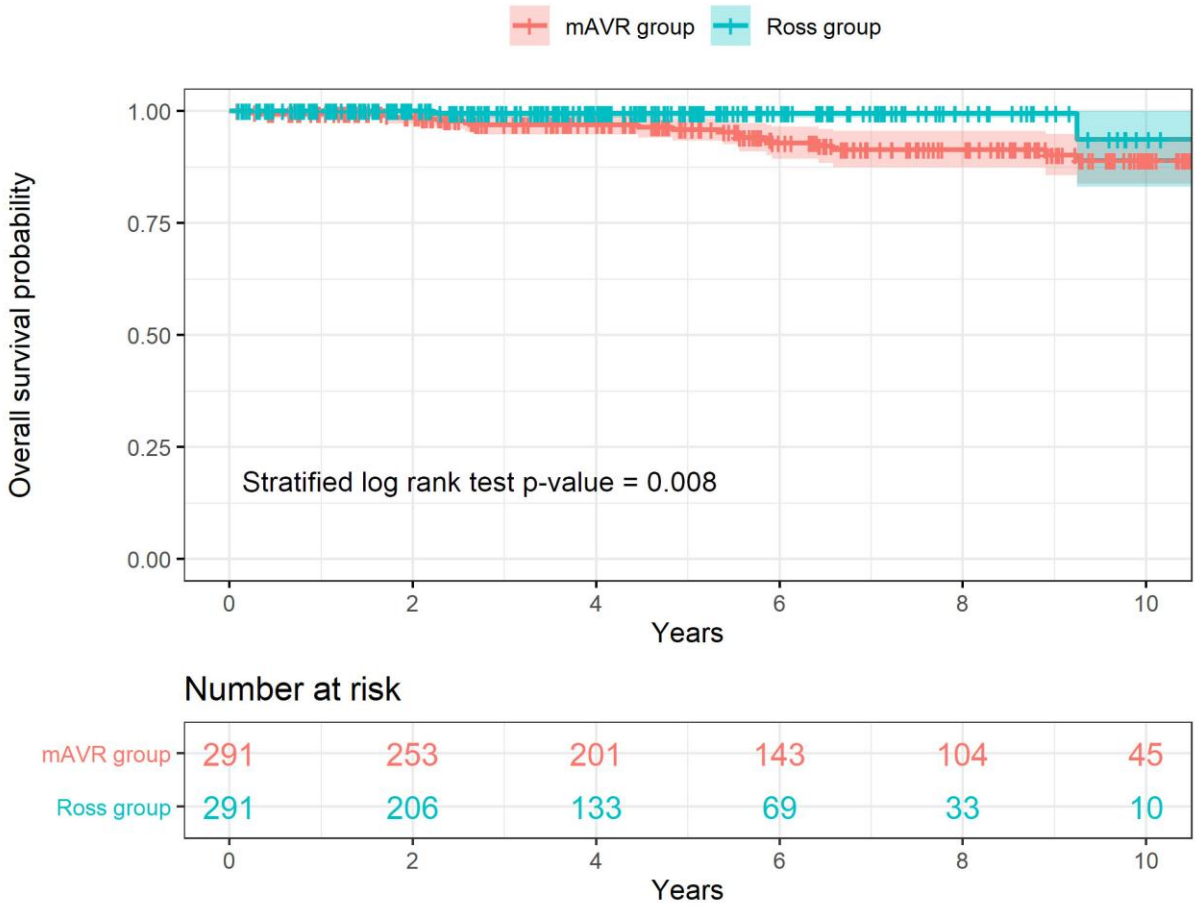
No perioperative mortality in either group.

Longer time of CPB (193 vs 95 mins, $p < 0.001$), aortic crossclamp (156 vs 73 mins, $p < 0.001$) and postoperative artificial ventilation (5.5 vs 5.0 hours $p = 0.013$) in the Ross group.

No difference in incidence of any postoperative complication.

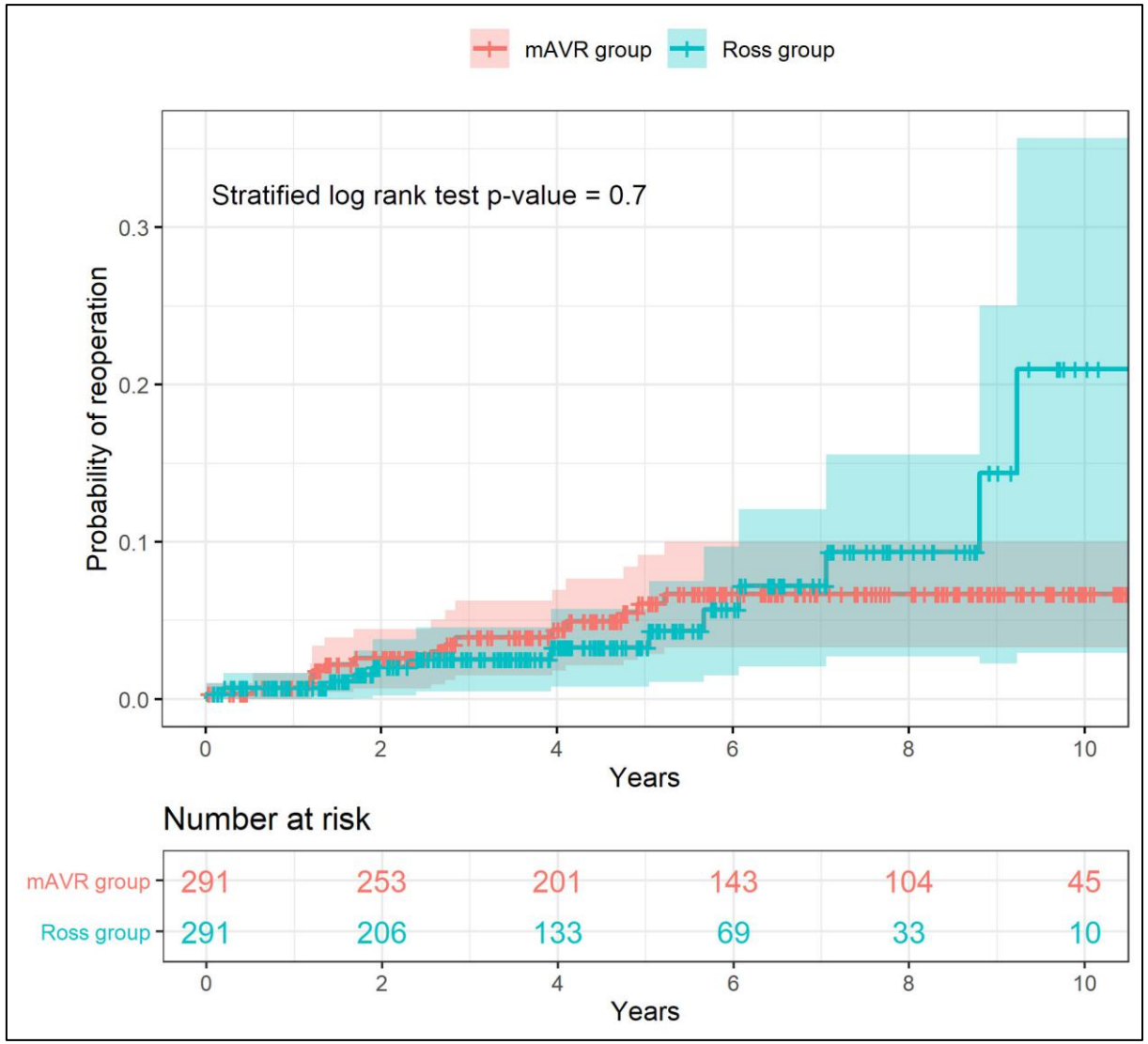
Mid-Term Postoperative Mortality





Average Followup of 4.1 versus 6.1 years.

Risk of Reoperation



Comparison with General Age- and Sex-Matched Population

The Ross Group			
Year	Relative Survival (%)	Lower Limit of CI (%)	Upper Limit of CI (%)
1	100.24	100.24	100.24
3	100.25	99.26	101.24
5	100.85	99.85	101.85
10	97.12	86.78	108.70
The Mechanical Aortic Valve Replacement Group			
Year	Relative Survival (%)	Lower Limit of CI (%)	Upper Limit of CI (%)
1	99.67	98.72	100.63
3	98.06	95.95	100.22
5	97.90	95.33	100.54
10	93.46	88.10	99.15

Study Limitations

Retrospective character

National Registry as a data source

Short Follow-Up

Data of 2 versus 13 centers

MACCE not analyzed

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Long-Term Outcomes of Ross Procedure versus Mechanical Aortic Valve Replacement: Meta-Analysis of Reconstructed Time-To-Event Data

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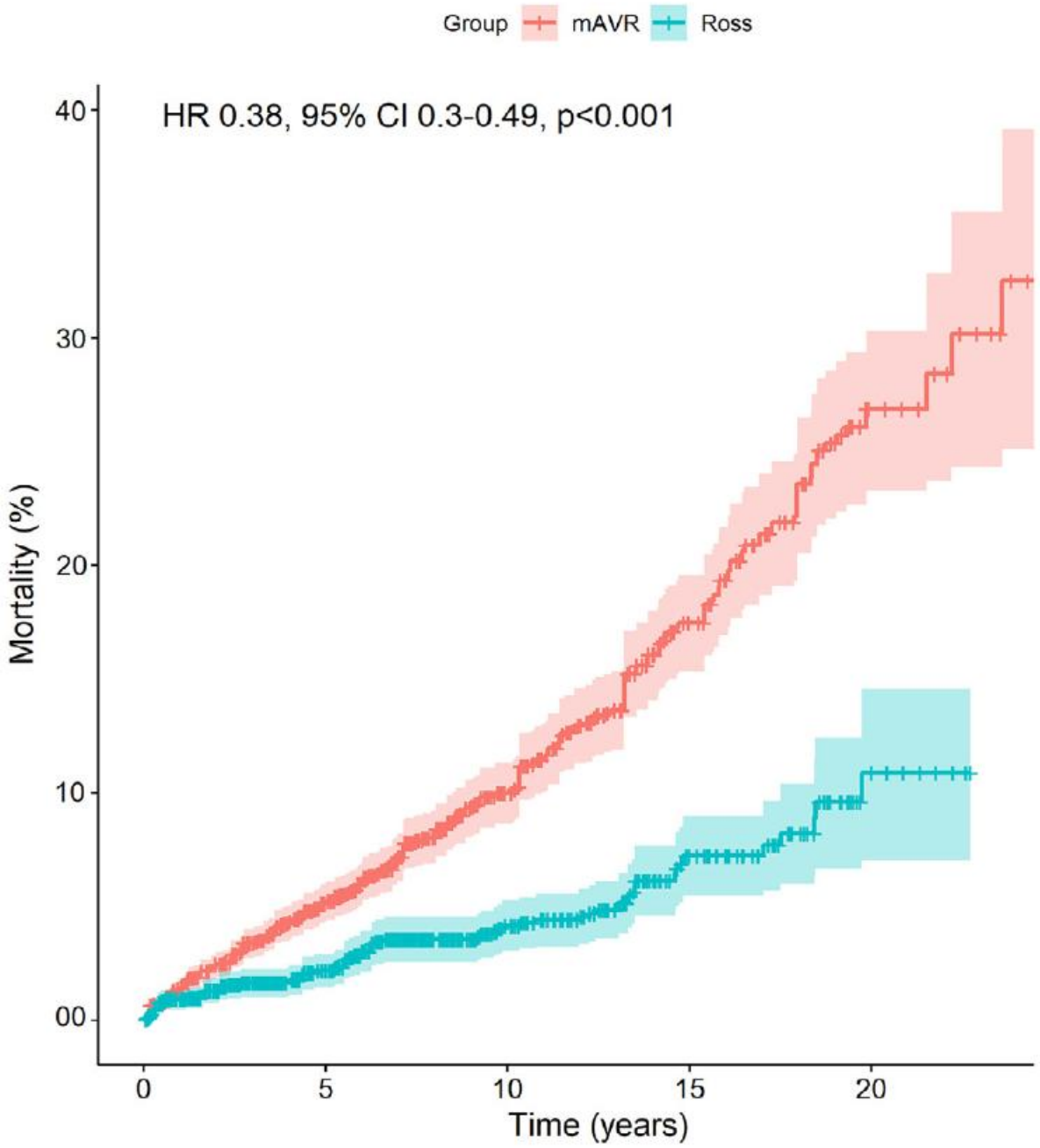
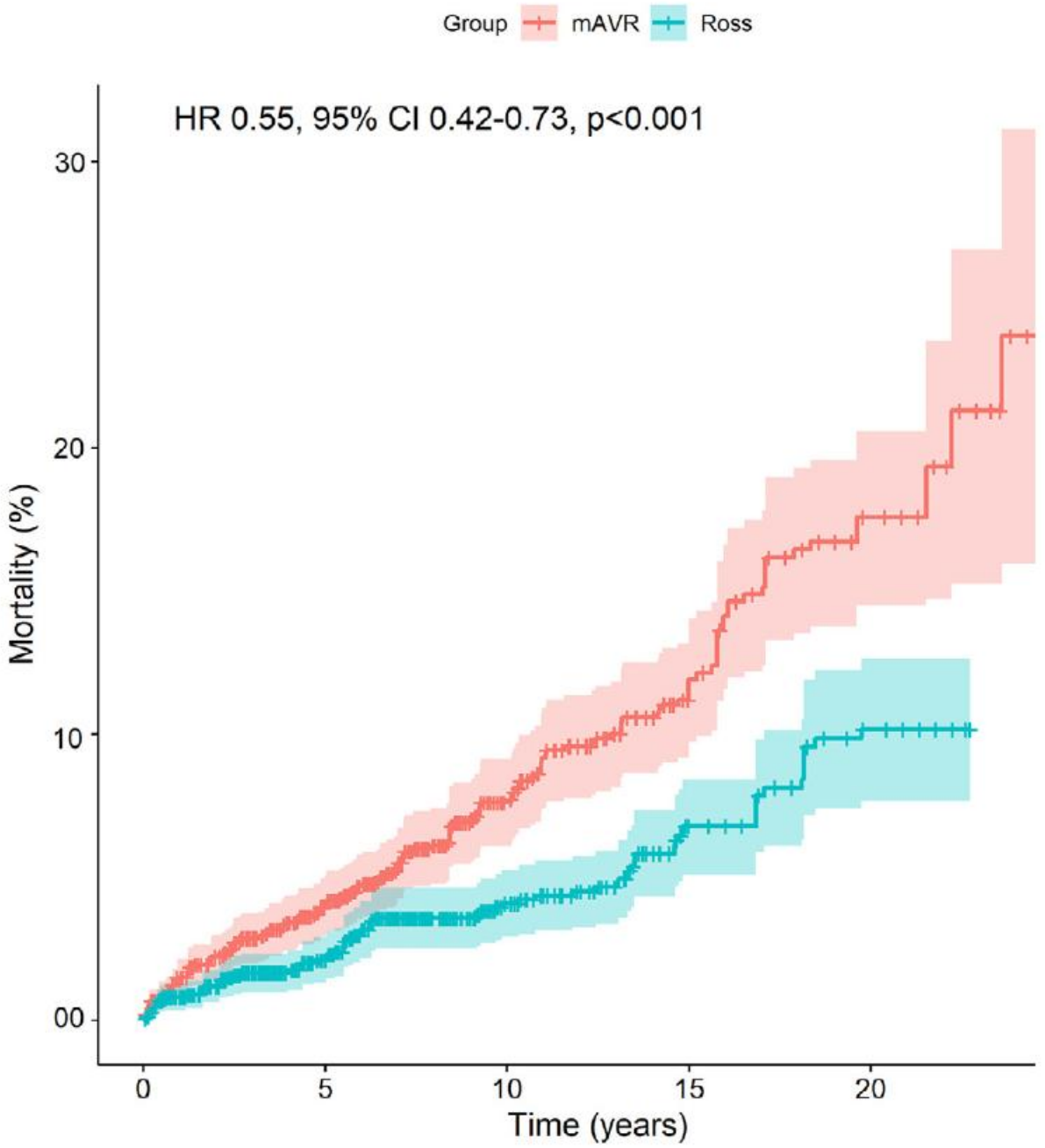
Study	Patients(N) Ross/mAVR	Age years (Mean)Ross/mAVR	Women (%) Ross/mAVR	(mean/median) Ross/mAVR	Exclusion criteria	Design	confounding variables
El-Hamamsy 2022	434/434	35.9±9.2/36.2±9.4	25.0/27.0	12.5 IQR: 9.3-15.7 (overall cohort)	Out-of-state residency; age <18y or >50y; concomitant mitral and/or tricuspid valve surgery or CABG; IE; any history of carcinoid disease, or Marfan syndrome	NR, NP, M	PSM
Gofus 2022	291/291	41.0 (IQR 34-48)/ 42.0 (IQR 32-52)	24.4/24.1	6.1 (32d-11.4y)/ 4.1 (31d-11.7y)	Concomitant operations; acute aortic syndrome; critical preoperative state (artificial ventilation, catecholamines, cardiopulmonary resuscitation or in cardiogenic shock)	NR, NP, M	PSM
Buratto 2018	392/1928	39.0±11.0/52.0±13.0	31.0/28.0	10±7 (overall cohort)	Urgent surgery; other concomitant cardiovascular procedures; or a diagnosis of aortic dissection or IE	NR, NP, M	PSM*
Mazine 2016	208/208	37.3±9.5/37.1±10.9	36.1/37.5	13.6±5.8/14.8±7.2	Acute aortic dissection or active IE or requiring emergency surgery	NR, P, NM	PSM
Andreas 2014	159/173	35±8/41±7	20.0/25.0	9.9±6.0/7.9±5.4	Concomitant CABG, replacement of another heart valve, aortic dissection or aortic arch replacement**	NR, NP, NM	No
Mokhles 2011	253/253	47.3±8.5/48.0±110	23.7/26.9	5.1/6.3	Urgent operation (within 24 hours after admission); aortic dissection or aortic aneurysm; concomitant MVR***	NR, P, M	PSM


Group mAVR Ross
HR 0.38, 95% CI 0.3-0.49, p<0.001
Mortality (%)
40
30
20
10
00
0
5
10
15
20
Time (years)


Group mAVR Ross
HR 0.55, 95% CI 0.42-0.73, p<0.001
Mortality (%)
30
20
10
00
0
5
10
15
20
Time (years)

CONCLUSION

Ross procedure is an excellent treatment option for young and middle-aged adults with severe aortic valve disease.

In dedicated centers, it offers favorable short-term and superior mid-term outcomes in comparison with mechanical aortic valve replacement.

It is currently the only treatment option able to restore survival of younger patients with aortic valve disease to the level of general population.

THANK YOU FOR YOUR ATTENTION!!!