Supplementary Online Content

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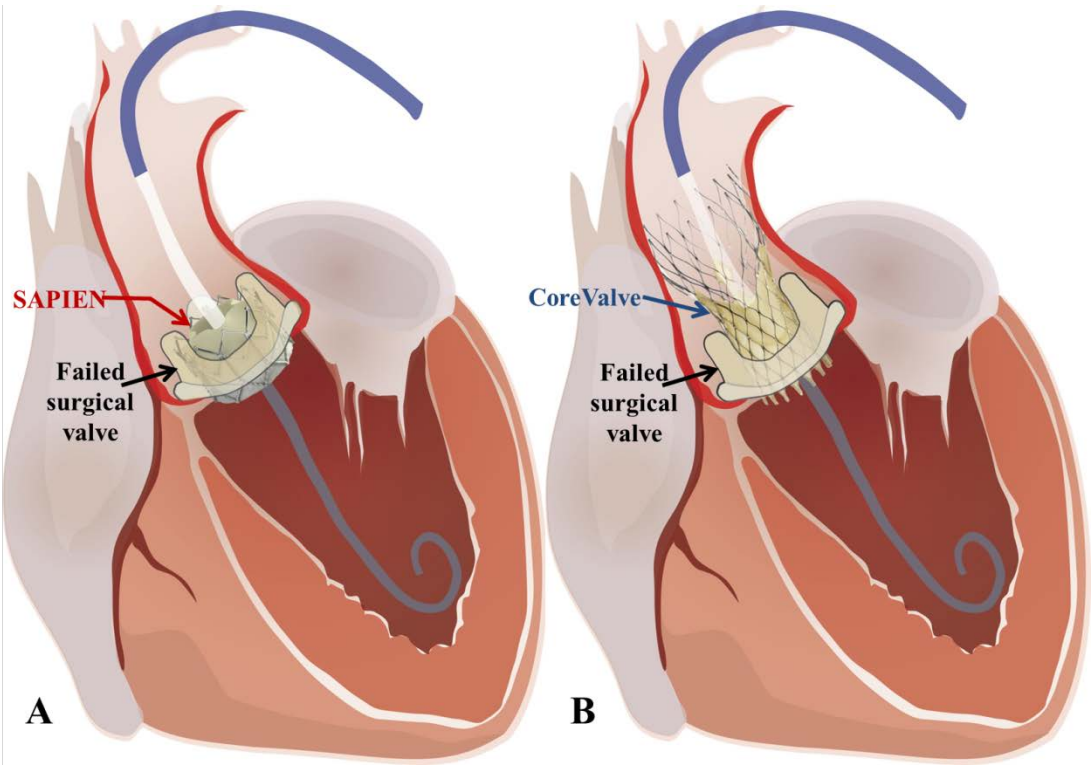
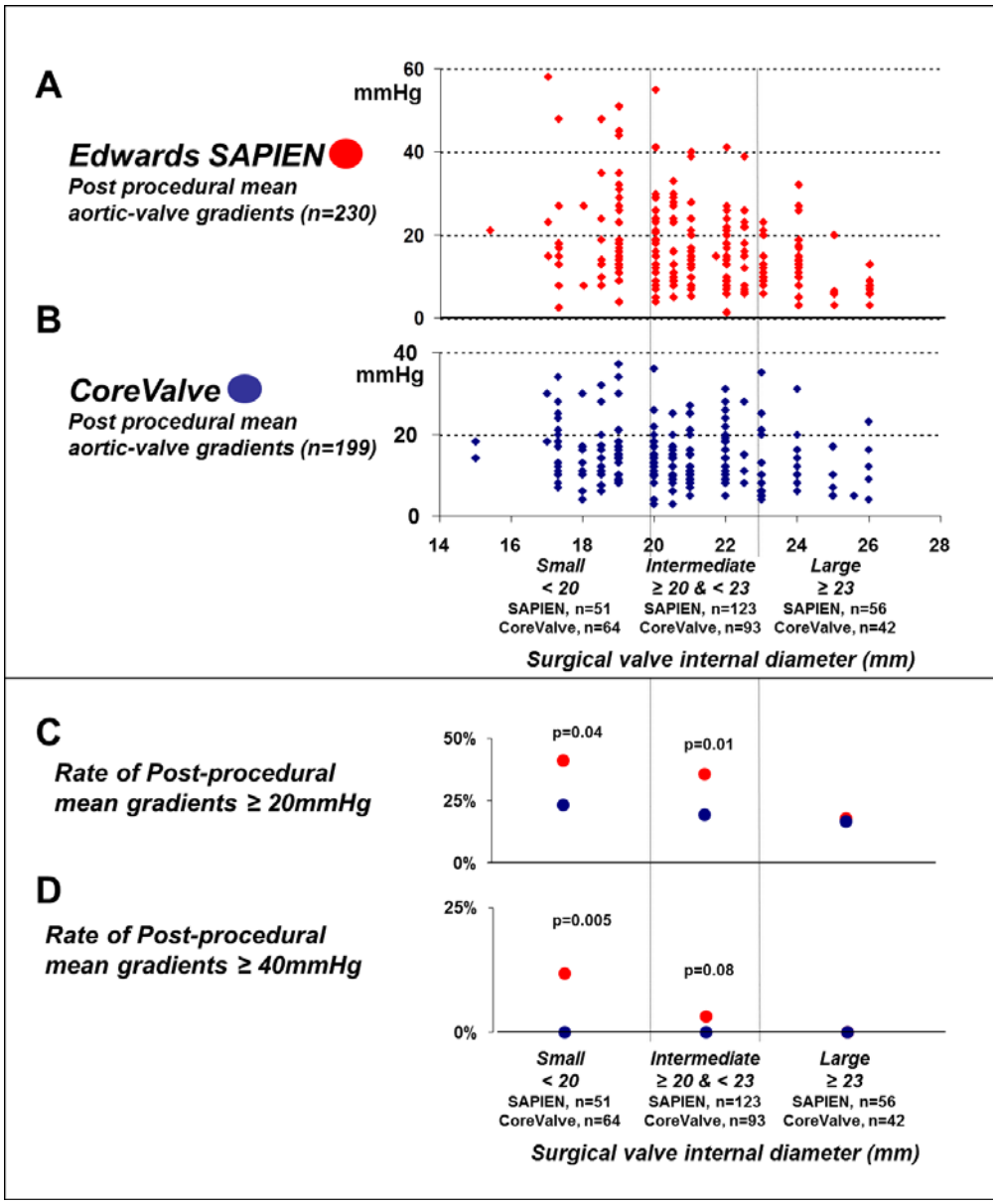
This supplementary material is provided by the authors to give readers additional information about their work.

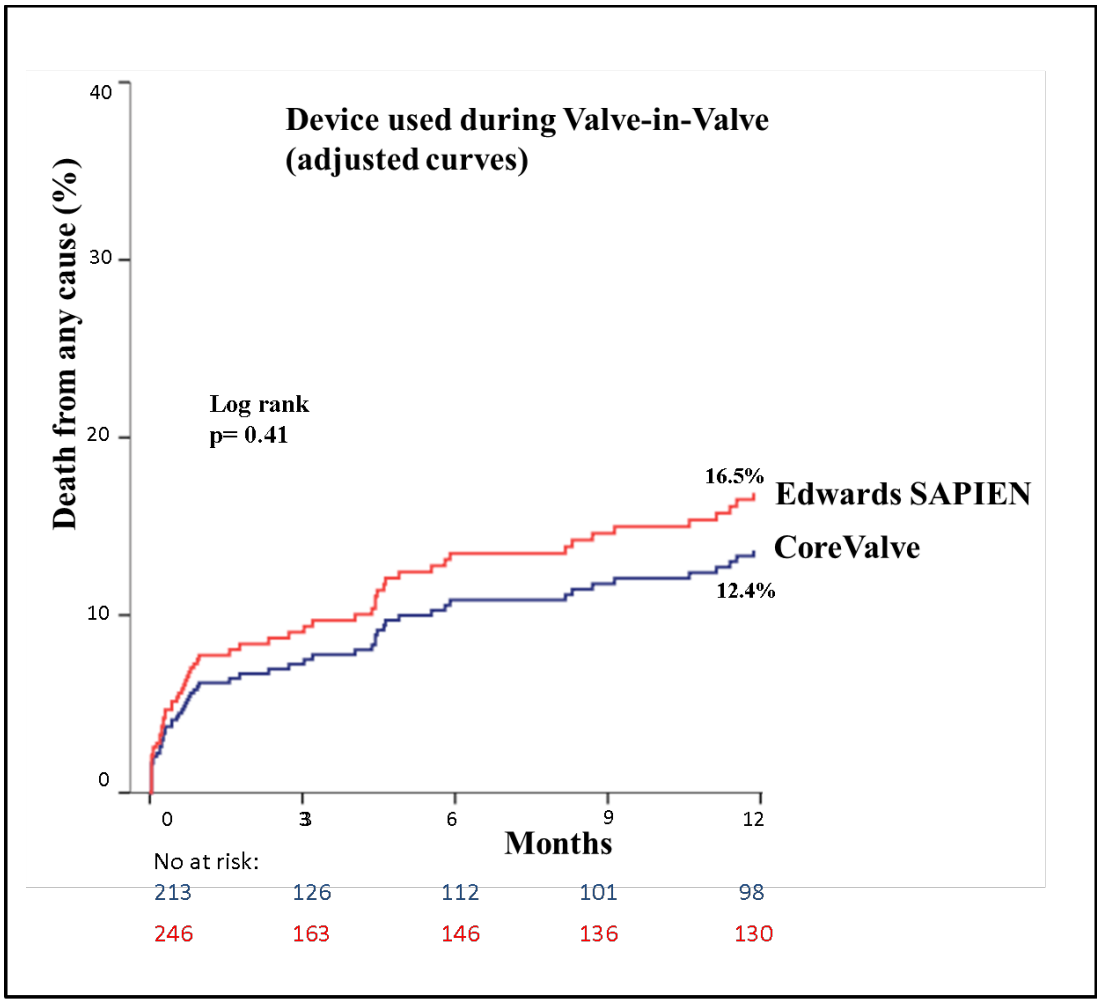


eFigure 1. Illustrations of Transcatheter Aortic Valve-in-valve Implantation in Failed Surgical Bioprostheses (Black Arrow) Using Balloon-Expandable Edwards SAPIEN Indicated by a Red Arrow (A) and a Self-Expandable CoreValve Device Indicated by a Blue Arrow (B)

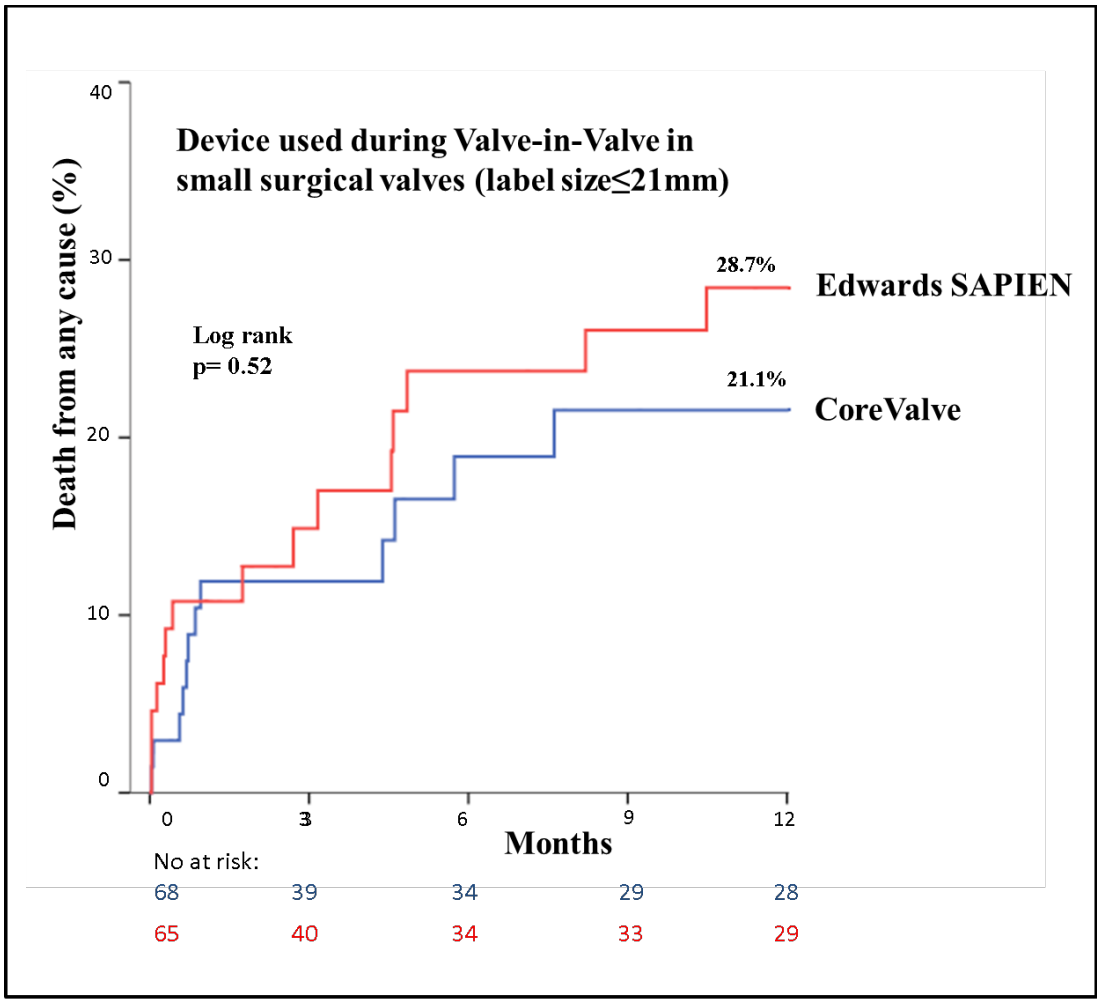


eFigure 2. Analysis of Post-procedural Gradients After Valve-in-Valve (VinV) Procedures According to Surgical Bioprosthesis Size: Small (Internal Diameter <20 mm), Intermediate (≥20 and <23) and Large (≥23 mm)

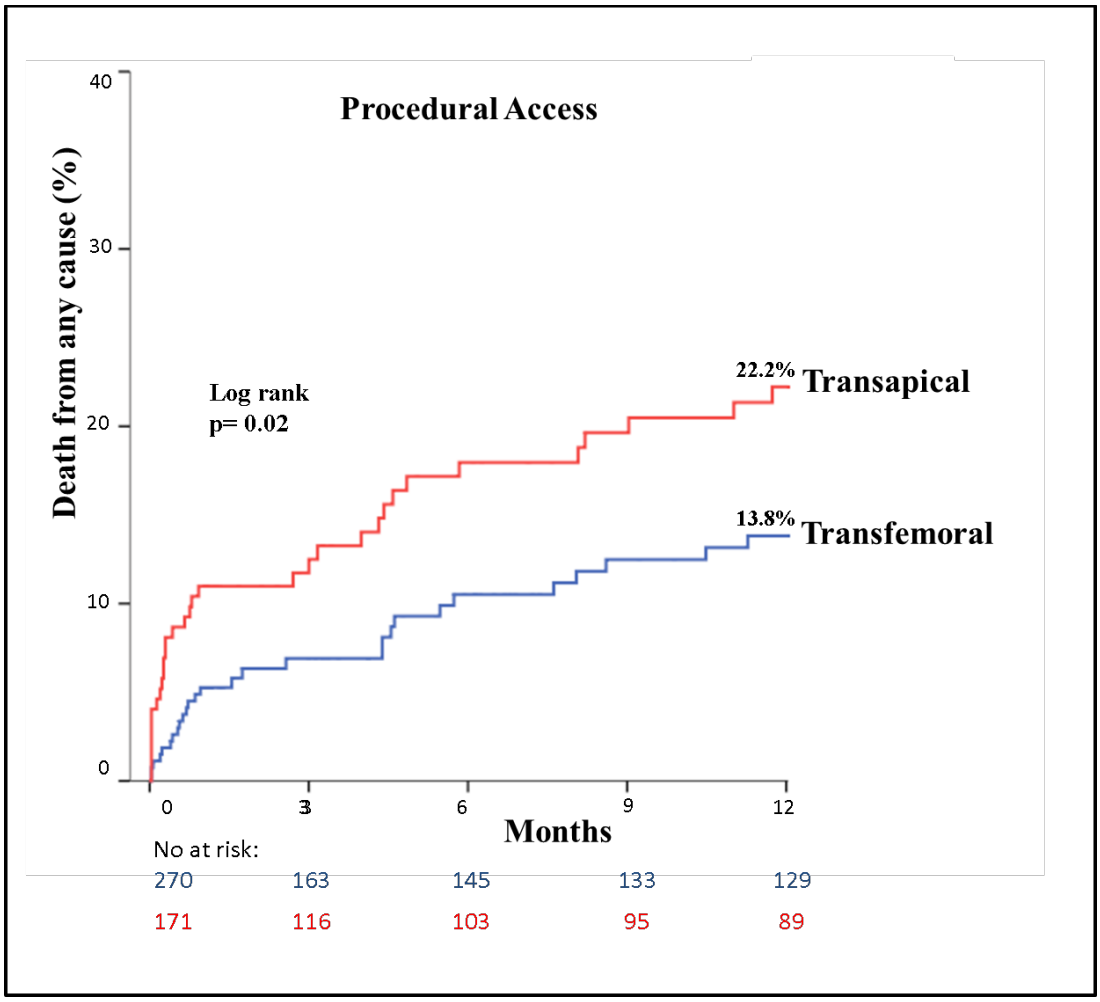
A. Balloon-expandable Edwards SAPIEN VinV procedures (red). **B.** Self-expandable CoreValve VinV procedures (blue). **C.** Incidence of high post-procedural gradient (mean ≥ 20mmHg). In the CoreValve group (blue), there was no significant change in the incidence of elevated gradients in relation to bioprosthesis size (p=0.77). Differently, in the Edwards SAPIEN group, there was a negative trend between the bioprosthesis size and high post-procedural gradients rates (procedures performed in small bioprostheses had higher incidence of elevated gradients, p=0.02). Elevated gradients were more common after Edwards SAPIEN than CoreValve VinV procedures in cases performed in small and intermediate sized bioprostheses (p=0.04 and p= 0.01, respectively). **D.** Incidence of very-high post procedural gradients (mean ≥ 40mmHg). There were no cases of CoreValve VinV procedures resulting very high post procedural gradients. Whereas that occurred in 11.8% of Edwards SAPIEN VinV procedures performed inside small bioprostheses.



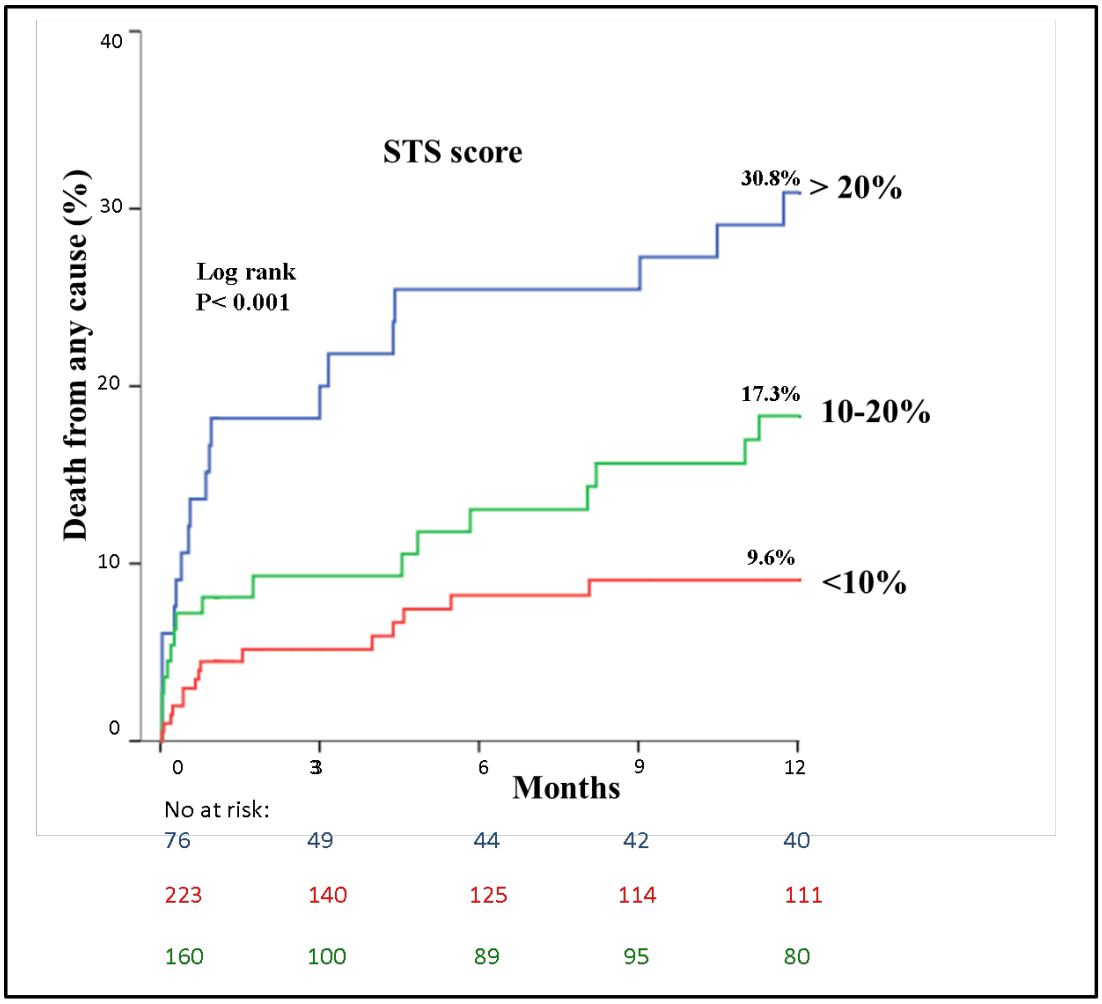
eFigure 3. Adjusted Time to Event Curves in Patients Undergoing Valve-in-Valve Procedures According to Device Used During the Procedure: Balloon-Expandable Edwards SAPIEN vs. Self-expandable CoreValve



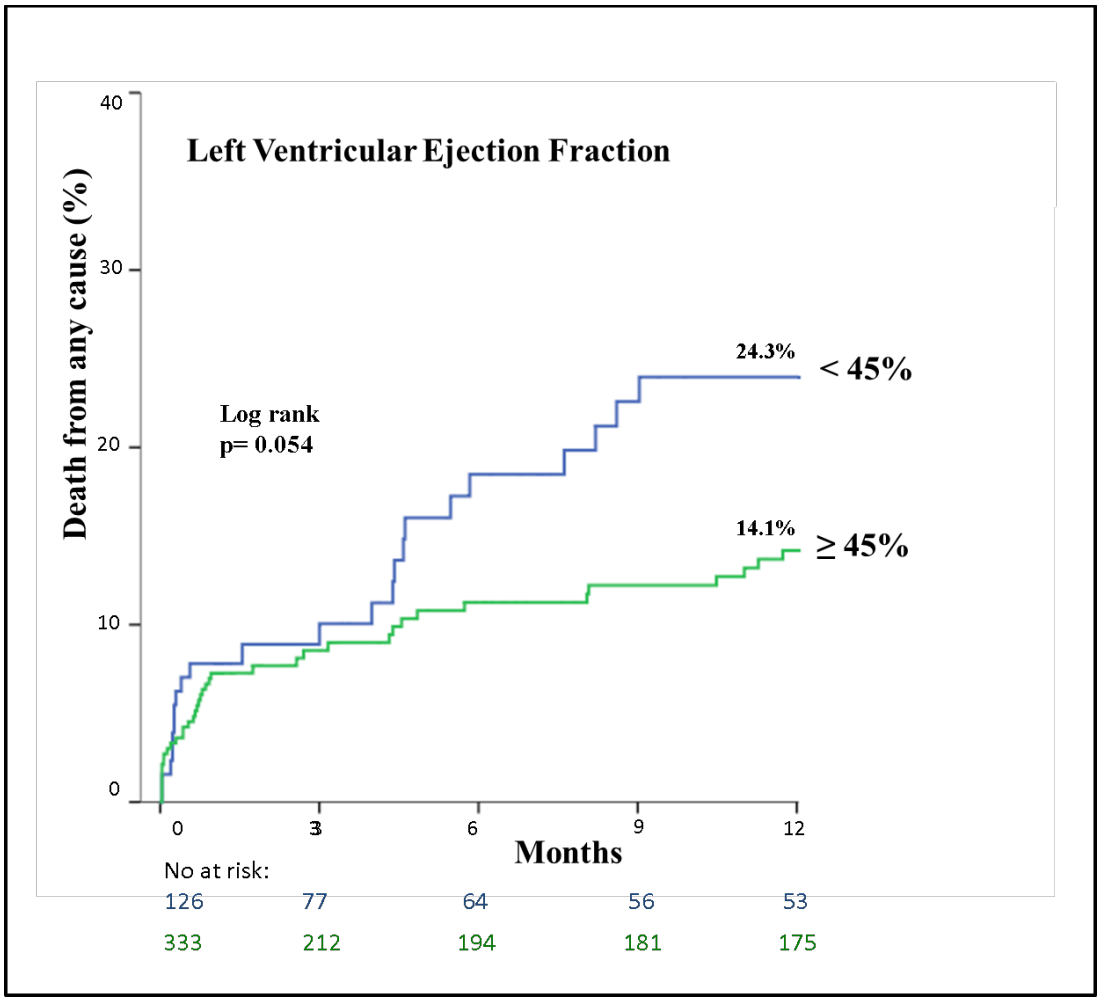
eFigure 4. Time to Event Curves in Patients Undergoing Valve-in-Valve Procedures Inside Small Surgical Valves (Label ≤ 21mm) According to the Device Used During the Procedure: Balloon-Expandable Edwards SAPIEN vs. Self-Expandable CoreValve



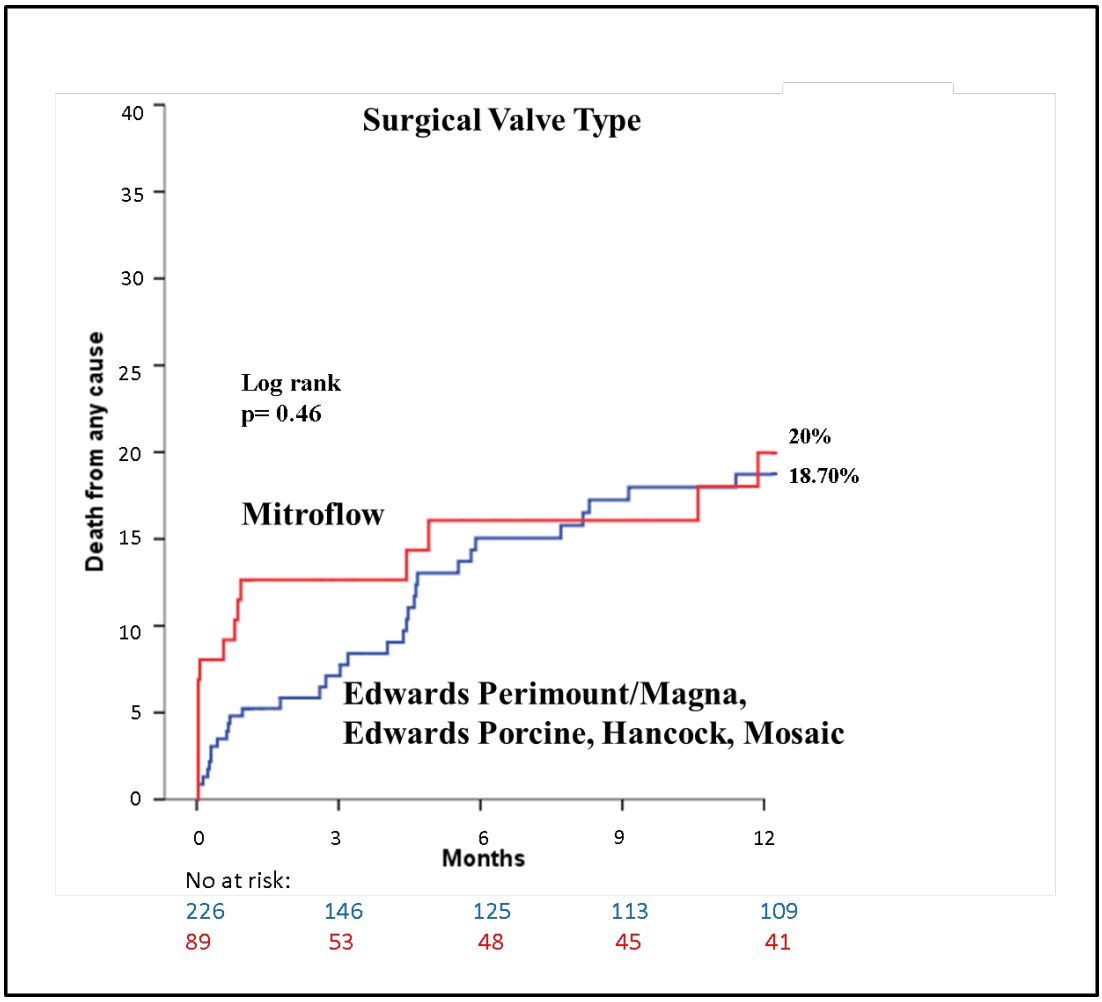
eFigure 5. Time to Event Curve in Patients Undergoing Valve-in-Valve Procedures According to Procedural Access: Transfemoral Artery vs. Transapical



eFigure 6. Time to Event Curve in Patients Undergoing Valve-in-Valve Procedures According to STS (Society of Thoracic Surgeons) Score



eFigure 7. Time to Event Curve in Patients Undergoing Valve-in-Valve Procedures According to Baseline Left-Ventricular Ejection Fraction: ≥45% vs. <45%



eFigure 8. Time to Event Curves in Patients Undergoing Valve-in-Valve Procedures According to the Type of Stented Surgical Valve

eTable 1. Valve-in-Valve International Data (VIVID) Registry: Participating Sites and Key Personnel

Medical Center	Enrolling Physicians	# of cases
German Heart Center, Munich, Germany	Sabine Bleiziffer, MD, Rudiger Lange, MD, PhD, Domenico Mazzitelli, MD	33
Deutsches Herzzentrum Berlin, Berlin, Germany	Miralem Pasic, MD, PhD, Axel Unbehaun, MD, Stephan Dreysse, MD, Semih Buz, MD, Thorsten Drews, MD, Marian Kukucka, MD, Alexander Mladenow, MD, Christoph Klein, MD, Roland Hetzer R, MD, PhD	32
San Raffaele Scientific Institute, Milan, Italy	Antonio Colombo, MD, Azeem Latib, MD, Matteo Montorfano MD, Alaide Chieffo MD, Francesco Maisano MD	23
Asklepios Clinics St. Georg, Hamburg, Germany	Ulrich Schaefer, MD, Christian Frerker, MD, Felix Kreidel, MD, Dimitry Schewel, MD, Karl-Heinz Kuck, MD	23
Quebec Heart and Lung Institute, Quebec, Canada	Josep Rodés-Cabau, MD, Luis Nombela-Franco, MD, Eric Dumont, MD, Daniel Doyle, MD, Robert DeLarochellière, MD	21
Sussex Cardiac Centre, Brighton, UK	David Hildick-Smith, MD, Uday H Trivedi, FRCS	20
Royal Brompton Hospital, UK	Neil E Moat, FRCS, Simon Davies, MD	20
St Paul's, Vancouver, Canada	John Webb, MD, Danny Dvir, MD, David Wood, MD, Anson Cheung, MD, Jian Ye, MD	18
University Heart Center Hamburg, Hamburg, Germany	Hendrik Treede, MD, Moritz Seiffert, MD	16
Hospital Bichat, Paris, France	Alec Vahanian, MD, Dominique Himbert, MD	15
Kerckhoff Heart Center, Bad Nauheim, Germany	Thomas Walther, MD, Won-Keun Kim, MD, Helge Möllmann, MD, Jörg Kempfert, MD	13
Universitaetsklinikum Regensburg, Germany	Christian Hengstenberg, MD, Michael Hilker, MD, Oliver Husser, MD	13
Clinical Institute S. Ambrogio, Milan, Italy	Francesco Bedogni, MD, Luca Testa, MD, PhD, Nedy Brambilla, MD, Maria Luisa Laudisa, MD	12
Odense University Hospital, Denmark	Henrik Nissen MD, PhD	11
University of Heidelberg, Germany	Raffi Bekeredjian, MD	9
Rabin Medical Center, Israel	Ran Kornowski, MD, Abid Assali, MD, Hana Vaknin-Assa, MD	9
Department of Cardiothoracic and Vascular Sciences, University of Padova, Italy	Massimo Napodano, MD, Gino Gerosa, MD, Augusto D'Onofrio, MD, Giuseppe Tarantini, MD, PhD.	8
Bern University Hospital, Bern, Switzerland	Stephan Windecker, MD, Peter Wenaweser, MD, Christoph Huber, MD, Thierry Carrel, MD	8
University Hospital of Lausanne, Lausanne, Switzerland	Enrico Ferrari, MD, Ludwig von Segesser, MD	8
Leids Universitair Medisch Centrum, Leiden, The Netherlands	Arend de Weger, MD, Frank van der Kley, MD, Meindert Palmen, MD, PhD, Jeroen J. Bax, MD, PhD	8
Hemodynamic and Invasive Cardiology Unit, IRCCS Istituto Clinico Humanitas, Milan, Italy	Patrizia Presbitero, MD, Marco Giovanni Mennuni, MD	8
Columbia University Medical Center/New York Presbyterian Hospital and the Cardiovascular Research Foundation, New York, New York, USA	Susheel Kodali, MD, Mat hew R. Williams, MD, Jean-Michel Paradis, MD, Rebecca T. Hahn, MD, Martin B. Leon, MD	7
University Heart Center Dresden, Dresden, Germany	Manuel Wilbring, MD, Utz Kappert, MD, Klaus Matschke, MD	7

St George's Hospital, London, UK	Stephen Brecker, MD, David Roy, MD, Marjan Jahangiri, FRCS	7
Hopital Jacques Cartier, Massy, France	Thierry Lefevre, MD, Kentaro Hayashida, MD, PhD	7
G. Pasquinucci Hospital, Massa, Italy	Alfredo Giuseppe Cerillo, MD, Sergio Berti, MD, Mattia Glauber, MD, Cataldo Palmieri, MD	6
Ospedale Niguarda Ca' Granda, Milan, Italy	Federico De Marco, MD, Silvio Klugmann, MD, Giuseppe Bruschi, MD, Jacopo Oreglia, MD	6
Clinique Pasteur, Toulouse, France	Didier Tchetche, MD, Olivier Vahdat, MD, Bruno Farah, MD, Jean Fajadet, MD	5
Hospital de Santa Cruz, Lisboa, Portugal	Rui Campante Teles, MD, Jose Neves, MD	5
Spedali Civili Brescia, Italy	Ettori Federica, MD, Claudia Fiorina, MD	5
Hospital Universitario Virgen de la Victoria. Málaga, Spain	José María Hernández-García, MD, PhD, Antonio J. Muñoz-García, MD, PhD, Juan H Alonso-Briales, MD Manuel F Jiménez-Navarro MD, PhD	5
Bergmannsheil Ruhr-University, Bochum, Germany	Michael Gotzmann, MD, Waldemar Bojara, MD	5
Rangueil University Hospital, Toulouse, France	Nicolas Dumonteil, MD, Bertrand Marcheix, MD, PhD	5
Segeberger Kliniken GmbH, Bad Segeberg, Germany	Mohamed Abdel-Wahab, MD, Gert Richardt, MD	5
West German Heart Center Essen, Essen, Germany	Philipp Kahlert, MD, Matthias Thielmann, MD, Daniel Wendt, MD, Thomas Konorza, MD	4
Azienda Ospedaliero Universitaria di Bologna Policlinico Sant'Orsola Malpighi, Bologna, Italy	Antonio Marzocchi, MD, Francesco Saia, MD, PhD	4
Cardio-Angiological Center Bethanien, Frankfurt, Germany	Holger Eggebrecht, MD	4
Bristol Heart Institute, UK	Andreas Baumbach, MD, Ali Khavandi, MD, Mark Turner, MD	4
Sheba Medical Center, Ramat Gan, Israel	Victor Guetta, MD, Amit Segev, MD, Israel M Barbash, MD	4
Sahlgrenska University Hospital, Gothenburg, Sweden	Dan Ioanes, MD	4
Centro Hospitalar de Vila Nova de Gaia, Vila Nova de Gaia, Portugal	Vasco Gama Ribeiro, MD	3
University Hospital Duesseldorf, Germany	Marc W. Merx, MD, Malte Kelm, MD	3
Azienda Policlinico Vittorio Emanuele, Catania, Italy	Corrado Tamburino, MD, PhD, Marco Barbanti, MD, Gian Paolo Ussia, MD	3
Tel-Aviv Medical Center, Tel-Aviv, Israel	Arik Finkelshtein, MD	3
Hamilton hospital WDHB, New Zealand	Sanjeevan Pasupati, MBChB, FRACP, Gerald Devlin, MBChB, FRACP, Rajesh Nair MBBS, MRCP	3
Azienda Ospedaliero-Universitaria Pisana, Pisa, Italy	Anna Sonia Petronio, MD	3
Medizinische Klinik und Poliklinik II, Universitaetsklinikum Bonn, Bonn, Germany	Jan-Malte Sinning, MD, Nikos Werner, MD, PhD, Georg Nickenig, MD, PhD, Eberhard Grube, MD, PhD	3

Villa Azzurra Hospita, Rapallo, Italy	Paolo Pantaleo, MD	2
Charles Nicolle Hospital, University of Rouen, France	Helene.Eltchaninoff, MD, Alain Cribier, MD, Christoph Tron, MD	2
Silesian Center for Heart Diseases in Zabrze, Poland	Piotr Chodor, MD, Krzysztof Wilczek, MD	2
AKH Linz, Austria	Michael Grund, MD	1
Alfred Hospital Melbourne, Australia	Antony Walton, MBBS, Stephen Duffy. MBBS	1
Blackpool, UK	David H Roberts, MD	1
Cardiocentre Royal Vineyards, Prague, Czech republic	Viktor Kocka, MD	1
University Hospital of Geneva, Switzerland	Stephane Noble, MD, Marco Roffi, MD,	1

eTable 2. Failed Bioprostheses Included in the Valve-in-Valve International Data (VIVID) Registry

Stented (n= 366)			**Stentless (n= 93)**		
	n	**%**		**n**	**%**
Perimount / Perimount-Magna / Porcine / others (Edwards Lifesciences, Irvine, CA)	129	35.2	Homograft	29	31.2
Mitroflow (Sorin Group Inc, Vancouver, Canada)	89	24.3	Freestyle (Medtronic)	16	17.2
Hancock II (Medtronic, Minneapolis, MN)	54	14.8	Biocor (St. Jude)	11	11.8
Mosaic (Medtronic)	43	11.7	Toronto SPV (St. Jude)	10	10.8
Epic (St. Jude Medical, St. Paul, MN)	20	5.5	Cryolife O'Brien (Cryolife International, Atlanta, GA)	7	7.5
Pericarbon (Sorin)	6	1.6	Freedom (Sorin)	5	5.4
Biocor (St. Jude)	5	1.4	Prima (Edwards)	4	4.3
Intact (Medtronic)	4	1.1	Bravo (Bravo Cardiovascular Inc**)**	3	3.2
Others	16	4.4	Others	8	8.6

Label-size	**n**	**%**
19-mm	11	2.4
21-mm	121	26.4
23-mm	165	35.9
25-mm	96	20.9
27-mm	35	7.6
29-mm	4	0.9
Others	16	3.5
Unknown	11	2.4

eTable 3. Procedural Characteristics

		Mechanism of surgical valve failure				Device used		
	All (n=459)	**Stenosis (n=181)**	**Combined (n=139)**	**Regurgitation (n=139)**	**p Value**	**Self-expandable[b] (n=213)**	**Balloon-expandable[c] (n=246)**	**p Value**
Device size					0.001			<0.001
20-mm	1 (0.2%)	0	1 (0.7%)	0		0	1 (0.4%)	
23-mm	183 (39.9%)	86 (47.5%)	57 (41%)	40 (28.8%)		5 (2.3%)	178 (72.4%)	
26-mm	236 (51.4%)	91 (50.3%)	76 (54.7%)	69 (49.6%)		171 (80.3%)	65 (26.4%)	
29-mm	36 (7.8%)	4 (2.2%)	5 (3.6%)	27 (19.4%)		34 (16%)	2 (0.8%)	
31-mm	3 (0.7%)	0	1 (0.7%)	2 (1.4%)		3 (1.4%)	0	
Access					0.08			<0.001
Transfemoral	270 (58.8%)	100 (55.2%)	79 (56.8%)	91 (65.5%)		197 (92.5%)	73 (29.7%)	
Transapical	171 (37.3%)	75 (41.4%)	55 (39.6%)	41 (29.5%)		0	171 (69.5%)	
Transaxillary	13 (2.8%)	4 (2.2%)	2 (1.4%)	7 (5%)		13 (6.1%)	0	
Transaortic	5 (1.1%)	2 (1.1%)	3 (2.2%)	0		3 (1.4%)	2 (0.8%)	
General anesthesia	321 (69.9%)	123 (68%)	103 (74.1%)	95 (68.3%)	0.44	116 (54.5%)	205 (83.3%)	<0.001
Transesophageal Echocardiography	293 (63.8%)	111 (61.3%)	96 (69.1%)	86 (61.9%)	0.31	96 (45.1%)	197 (80%)	<0.001
Pre-implantation valvuloplasty	137 (29.8%)	64 (35.4%)	53 (38.1%)	20 (14.4%)	<0.001	41 (19.2%)	96 (39%)	<0.0001
Attempted device retrieval[a]	22 (10.3%)	7 (9.3%)	8 (13.3%)	7 (9%)	0.73	22 (10.3%)	NA	NA
Post-implantation valvuloplasty	48 (10.5%)	23 (12.7%)	10 (7.2%)	15 (10.8%)	0.28	40 (18.8%)	8 (3.3%)	<0.001
Second device implantation	26 (5.7%)	8 (4.4%)	10 (7.2%)	8 (5.8%)	0.57	16 (7.5%)	10 (4.1%)	0.052
Ostial coronary obstruction	9 (2%)	7 (3.9%)	1 (0.7%)	1 (0.7%)	0.02	4 (1.9%)	5 (1.6%)	0.91
Need for an emergent surgery	15 (3.3%)	8 (4.4%)	4 (2.9%)	3 (2.2%)	0.50	6 (2.8%)	9 (3.7%)	0.61

NA, not applicable.

[a] Operator effort to retrieve the CoreValve device after starting the implantation process inside the aortic valve. Percentage is out of CoreValve procedures performed in the subgroup analyzed.

[b] Edwards-SAPIEN (Edwards Lifesciences, Irvine, CA).

[c] CoreValve (Medtronic, Minneapolis, MN).