Comparing the Safety and Effectiveness of Five Leading New-Generation Devices for Transcatheter Aortic Valve Implantation: Twelve-Month Results From the RISPEVA Study

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Abstract

Objectives. The management of severe aortic stenosis has been revolutionized by the introduction of transcatheter aortic valve implantation (TAVI), especially in patients at intermediate, high, or prohibitive surgical risk. There is uncertainty, however, regarding the comparative effectiveness and safety of contemporary TAVI devices. **Methods**. We queried detailed data from the ongoing national Italian TAVI registry and compared baseline features, procedural details, and 12-month outcomes of Acurate Neo (Boston Scientific), Evolut Pro/R (Medtronic), Lotus (Boston Scientific), Portico (Abbott Vascular), and Sapien/Sapien S3 Ultra (Edward Lifesciences) transcatheter aortic valves. Several endpoints were collected and appraised, including the composite of death, stroke, myocardial infarction (MI), major bleeding, major vascular complication, surgical aortic valve replacement and transcatheter aortic valve reimplantation, which were deemed major adverse events (MAEs). **Results**. A total of 1976 patients were included, with 234 treated with Acurate, 703 with Evolut, 151 with Lotus, 347 with Portico, and 541 with Sapien. Twelve-month events were not significantly different among the 5 devices, including death (P=.29) and MAE (P=.21), with the notable exception of major vascular complications, which were more common with Acurate and Sapien (P<.001) and permanent pacemaker implantation, which was more frequent with Lotus and Evolut (P<.001). Differences in MAE were more pronounced in women and subjects with prior cardiac surgery, with the lowest event rates in the Evolut group. Propensity-score adjusted analysis suggested that Acurate, Evolut, Portico, and Sapien were all associated with similarly favorable results, whereas adverse events were more evident with Lotus (P<.05). **Conclusion.** Leading current-generation TAVI devices offer similarly favorable results at mid-term follow-up.

J INVASIVE CARDIOL 2021 March 19 (Ahead of Issue).

Key words: aortic stenosis, new-generation device, transcatheter aortic valve implantation, transcatheter aortic valve replacement

The management of severe aortic stenosis has been revolutionized by Alain Cribier's invention of transcatheter aortic valve implantation (TAVI).[1,2] While the first iteration of TAVI was bulky and not refined, subsequent devices have dramatically improved procedural safety and early efficacy, with ensuing favorable impact on long-term effectiveness.[2,3] Accordingly, indications to TAVI have progressively expanded from patients at prohibitive risk to subjects at high and even intermediate surgical risk.[4,5]

Heart team members, and interventional cardiologists in particular, now face a plethora of competing devices, mainly self-expanding (eg, Allegra [NVT], Acurate [Boston Scientific], Evolut [Medtronic], Lotus [Boston Scientific], and Portico [Abbott Vascular]), but also balloon-expandable ones (Sapien [Edwards Lifesciences] and Myval [Meril]).[3,6,7] Accordingly, comparative trials are urgently needed for informed decision making. Notwithstanding recent reports from dedicated randomized trials such as CHOICE, SOLVE-TAVI, SCOPE I, and Portico IDE,[8-11] observational studies offer the possibility to track real-world use of TAVI devices, describe their results at face value, and tentatively compare them after appropriate statistical modeling.

Indeed, we have recently reported on the short-term comparative effectiveness of 5 leading TAVI devices, utilizing the national Registro Italiano GISE sull'Impianto di Valvola Aortica Percutanea (RISPEVA) registry and highlighting key differences in baseline features, procedural aspects, and results, as well as 1-month outcomes.[12,13] We hereby report on the mid-term follow-up of the same patient cohort, in order to confirm or disprove early results in light of the substantial event accrual typical of TAVI patients.

Methods

Details of the ongoing Italian RISPEVA registry, a nationwide observational study collecting data on patients undergoing TAVI, have been reported elsewhere in detail.[12-15] Briefly, RISPEVA is an observational study using a dedicated electronic case report form, enforcing common definitions and processes, and including thousands of patients every year. Its design has been registered at clinicaltrials.gov (NCT02713932), all participating centers obtained institutional review board approval, and all patients provided written informed consent.

As previously reported, and as typical of real-world observational studies, all clinical procedures, from patient screening and selection to procedural features including device choice and ancillary medical management, were at the discretion of the local physicians. While RISPEVA collects details on any TAVI device, for the purpose of this work, which mirrors the prior study focusing on short-term outcomes with 5 leading TAVI devices, we included only cases in which TAVI was performed with Acurate Neo, Evolut Pro or R (combined in the Evolut group), Lotus (first generation), Portico, and Sapien or Sapien S3 Ultra (combined in the Sapien group). Notably, 22 patients (6.3% of all those receiving Portico) underwent TAVI with the first-generation Portico device, whose pivotal trial has been recently reported by Makkar et al.[16] Postprocedural and discharge management were also at the physician's discretion, but ambulatory follow-up was recommended 1-3 months after discharge, and then every 3-6 months thereafter.

Outcome definitions, ranging from procedural or device success to death, myocardial infarction (MI), stroke, major vascular complications, and major bleeding, were all based on the current Valve Academic Research Consortium statement.[17] In addition, we defined a composite endpoint of major adverse events (MAEs) comprising death, MI, stroke, major vascular complications, major bleeding, and surgical aortic valve replacement or transcatheter aortic valve reimplantation.

Statistical analysis. Descriptive analysis was based on count (%) for categorical variables and mean ± standard deviation for continuous variables. Unadjusted analysis was based on chi-squared test for categorical variables and on analysis of variance for continuous variables. In addition, survival curves were created using the Kaplan-Meier method, comparing them with the log-rank test, primarily, and then with the Cox, Fleming-Harrington, Peto-Peto-Prentice, Tarone-Ware, and Wilcoxon tests for sensitivity purposes. Thereafter, we performed missing data imputation and then computed propensity scores for each head-to-head between-device comparison, eventually using such scores as weighted in a Cox proportional hazard model. In particular, propensity scores were obtained using as covariates the following variables: center, age, gender, body mass index, prohibitive risk, Logistic EuroSCORE, EuroSCORE II, STS score, New York Heart Association (NYHA) class III or IV, renal function, prior cardiac surgery, prior valvuloplasty, prior stroke or transient ischemic attack, coronary artery disease, porcelain aorta, severe tortuosity, left ventricular ejection fraction, peak aortic valve gradient, mean aortic valve gradient, aortic valve area, aortic regurgitation, local anesthesia, femoral access, percutaneous approach, embolic protection device, right ventricular pacing, pacing rate, predilation, device size, multiple TAVI devices, postdilation, and balloon diameter. Computations were performed with Stata 13 (StataCorp), and statistical significance was set at the 2-tailed .05 level, without multiplicity penalization.

Results

As previously stated,[13] a total of 1976 patients were included, with 234 (11.8%) receiving Acurate, 703 (35.6%) receiving Evolut, 151 (7.6%) receiving Lotus, 347 (17.6%) receiving Portico, and 541 (27.4%) receiving Sapien, with a follow-up of 12.0 ± 12.7 months. As reported in detail elsewhere, the groups were significantly different for several baseline features, including age, gender, body mass index, indication for TAVI, risk score, and NYHA class (all $P<.05$) (Table 1). Similarly, significant differences in procedural features were evident, ranging from anesthesia to access, approach, sheath size, device size, and postdilation (all $P<.05$) (Table 2).

Clinical and echocardiographic outcomes accrued up to 12 months of follow-up showed similar rates of death, stroke, MI, major bleeding, surgical aortic valve replacement or repeat TAVI, and MAE (all $P>.05$) (Table 3; Figures 1 and 2). However, major

TABLE 1. Baseline features at unadjusted analysis.

Feature	Acurate (n = 234)	Evolut (n = 703)	Lotus (n = 151)	Portico (n = 347)	Sapien (n = 541)	P-Value
Age (years)	83.5 ± 6.0	82.1 ± 6.7	82.0 ± 6.5	82.5 ± 6.5	83.1 ± 6.5	.02
Female gender	156 (66.7%)	391 (55.6%)	83 (55.0%)	223 (64.3%)	288 (53.2%)	<.001
Body mass index (kg/m²)	26.1 ± 4.5	26.1 ± 4.4	25.4 ± 3.9	26.8 ± 4.6	26.1 ± 4.6	.04
Degenerated bioprosthesis	4 (1.7%)	17 (2.4%)	3 (2.0%)	40 (11.5%)	14 (2.6%)	<.001
Prohibitive risk	5 (2.1%)	45 (6.4%)	5 (3.3%)	6 (1.7%)	50 (9.2%)	<.001
Logistic EuroScore	12.9 ± 11.0	16.7 ± 11.6	16.3 ± 14.5	16.2 ± 11.6	16.7 ± 12.1	<.001
EuroScore II	4.1 ± 4.2	5.0 ± 4.9	5.0 ± 6.1	4.2 ± 3.9	5.5 ± 4.8	<.001
STS score	5.0 ± 3.8	5.6 ± 4.1	5.1 ± 4.2	6.3 ± 4.2	5.4 ± 4.2	.05
New York Heart Association class III or IV	162 (69.2%)	445 (63.3%)	111 (73.5%)	258 (74.4%)	341 (63.0%)	<.01
Prior cardiac surgery	21 (9.0%)	38 (5.4%)	13 (8.6%)	22 (6.3%)	40 (7.4%)	.28
Prior aortic valvuloplasty	12 (5.1%)	33 (4.7%)	13 (8.6%)	14 (4.0%)	52 (9.6%)	<.01
Pacemaker dependency	25 (10.7%)	50 (7.1%)	13 (8.6%)	31 (8.9%)	39 (7.2%)	.41
Prior stroke or transient ischemic attack	21 (9.0%)	38 (5.4%)	13 (8.6%)	22 (6.3%)	40 (7.4%)	.28
Estimated glomerular filtration rate (mL/min)	65.1 ± 23.0	62.2 ± 23.8	66.5 ± 47.7	61.1 ± 24.8	62.6 ± 23.6	.22
Left ventricular ejection fraction (%)	53 ± 11	52 ± 10	53 ± 12	54 ± 10	53 ± 10	.42
Peak aortic gradient (mm Hg)	75.4 ± 21.3	76.4 ± 22.9	77.7 ± 23.4	71.4 ± 23.6	77.7 ± 20.9	.01
Mean aortic gradient (mm Hg)	47.8 ± 13.8	47.3 ± 14.9	48.0 ± 14.8	48.0 ± 16.8	48.2 ± 13.8	.90
Aortic valve area (cm²)	0.67 ± 0.23	0.67 ± 0.26	0.66 ± 0.24	0.69 ± 0.24	0.63 ± 0.18	.04
Moderate or severe aortic regurgitation	13 (5.6%)	43 (6.1%)	6 (4.0%)	16 (4.6%)	12 (2.2%)	.02
Porcelain aorta	8 (3.4%)	58 (8.3%)	9 (6.0%)	4 (1.2%)	49 (9.1%)	<.001
Coronary artery disease	62 (26.5%)	198 (28.2%)	34 (22.5%)	44 (12.7%)	140 (25.9%)	<.001
Severe iliac tortuosity	2 (0.9%)	44 (6.3%)	2 (1.3%)	4 (1.2%)	24 (4.4%)	<.001

Data presented as mean ± standard deviation or number (%).

vascular complications appeared less common with Portico, while the rate of pacemaker implantation was lower with Acurate (both *P*<.05) (Figure 3). Other endpoints also appeared different across devices, including NYHA class, left ventricular ejection fraction, aortic gradients, aortic regurgitation, mitral regurgitation, and systolic pulmonary artery pressure (all *P*<.05).

After propensity-score adjustment, all differences became non-significant, with the notable exception of major bleeding (which appeared less common with Evolut vs Lotus; *P*=.03), major vascular complication (which appeared less common with Evolut vs Lotus; *P*=.04), surgical aortic valve replacement or repeat TAVI (which appeared less common with Acurate vs Lotus [*P*=.049] and Sapien vs Lotus [P=.03]), and pacemaker implantation (which appeared less common with Evolut vs Lotus [*P*<.01] and Sapien vs Lotus [*P*<.01]) (Supplemental Table S1).

Exploratory analysis suggested that the risk of MAE was substantially similar across the 5 devices in most subgroups (Supplemental Table S2), including advanced age, obesity, intermediate or low surgical risk, and NYHA class III or IV (all *P*>.05). However, Evolut appeared associated with the lowest rate of MAE in women (*P*=.04) and in patients with prior cardiac surgery (*P*=.04). Moreover, the impact of institutional volume

TABLE 2. Procedural features at unadjusted analysis.

Feature	Acurate (n = 234)	Evolut (n = 703)	Lotus (n = 151)	Portico (n = 347)	Sapien (n = 541)	*P*-Value
Local anesthesia	202 (86.3%)	594 (84.5%)	134 (88.7%)	313 (90.2%)	420 (77.6%)	<.001
Femoral access	216 (92.3%)	612 (87.1%)	141 (93.4%)	303 (87.3%)	510 (94.3%)	<.001
Percutaneous approach	208 (88.9%)	616 (87.6%)	130 (86.1%)	305 (87.9%)	464 (85.8%)	.73
Sheathless procedure	5 (2.1%)	160 (22.8%)	4 (2.7%)	6 (1.7%)	26 (4.8%)	<.001
Sheath size (Fr)	18.4 ± 2.1	15.1 ± 1.7	18.4 ± 1.8	18.4 ± 0.7	14.5 ± 1.7	<.001
Embolic protection device	2 (0.9%)	1 (0.1%)	1 (0.7%)	2 (0.6%)	22 (4.1%)	<.001
Right ventricular pacing	118 (50.4%)	422 (60.0%)	60 (39.7%)	192 (55.3%)	452 (83.6%)	<.001
Predilation	152 (65.0%)	431 (61.3%)	58 (38.4%)	230 (66.3%)	449 (83.0%)	<.001
Balloon diameter (mm)	21.8 ± 2.9	20.4 ± 2.0	20.3 ± 1.9	20.7 ± 1.6	21.6 ± 2.0	<.001
Valve-in-valve	4 (1.7%)	22 (3.1%)	1 (0.7%)	7 (2.0%)	4 (0.7%)	.03
Device size (Fr)	25.0 ± 2.1	28.1 ± 3.1	24.9 ± 2.0	26.4 ± 2.2	25.0 ± 2.4	<.001
Pacing during implant	71 (30.3%)	152 (21.6%)	16 (10.6%)	18 (5.2%)	501 (92.6%)	<.001
Pacing rate (bpm)	181 ± 25	158 ± 36	145 ± 59	163 ± 24	182 ± 12	<.001
Postdilation	111 (47.4%)	202 (28.7%)	2 (1.3%)	165 (47.6%)	27 (5.0%)	<.001
Balloon diameter (mm)	23.2 ± 1.9	24.1 ± 2.6	20 ± 0	23.9 ± 2.0	22.4 ± 2.1	<.001
Balloon length (mm)	42.1 ± 4.7	40.8 ± 2.4	40.0 ± 0	41.1 ± 2.9	40.9 ± 7.4	.42
Fluoroscopy time (seconds)	22.7 ± 13.5	26.3 ± 16.3	30.0 ± 11.0	26.4 ± 14.1	21.5 ± 14.8	<.001
Procedural time (minutes)	120.5 ± 50.8	113.0 ± 51.5	104.5 ± 39.6	87.4 ± 43.1	113.1 ± 46.6	<.001
Device success	232 (99.2%)	693 (98.6%)	148 (98.0%)	343 (98.9%)	533 (98.5%)	.90
Procedural success	232 (99.2%)	693 (98.6%)	148 (99.4%)	345 (99.4%)	533 (98.5%)	.63
Periprocedural death	1 (0.4%)	2 (0.3%)	3 (2.0%)	1 (0.3%)	6 (1.1%)	.08

Data presented as mean ± standard deviation or number (%).

on overall and device-specific outcomes was appraised for hypothesis-generating purposes (Supplemental Tables S3 and S4, respectively). No consistent association between volume and clinical outcomes was apparent, with some events (eg, death and major vascular complications) actually occurring less commonly in low-volume institutions. Finally, sensitivity analysis excluding patients receiving first-generation Portico devices confirmed the main results in terms of direction and magnitude of effects. Notably, new-generation Portico appeared associated with a lower risk of stroke in comparison with old-generation Portico (Supplemental Table S5).

Discussion

This comprehensive comparative-effectiveness study, focusing on 5 leading new-generation TAVI devices used for the management of severe aortic stenosis, has the following implications: (1) after a successful TAVI procedure with current devices, event rates remain low despite the inherent baseline risk; (2) most adverse outcomes occur with a similar frequency with Acurate, Evolut, Lotus, Portico, and Sapien devices; (3) Lotus appears associated with a higher rate of adverse events in comparison to other devices; and (4) Evolut may possibly be superior in terms of comparative effectiveness in women and in patients with prior cardiac surgery.

In less than 2 decades, TAVI changed from an experimental procedure that could be offered only for palliation in inoperable patients to a leading cardiovascular treatment capable of competing successfully with a time-tested intervention such as surgical aortic valve replacement.[2,3] Yet, as is typical of many interventional cardiology procedures, multiple TAVI devices are now available, leading to uncertainties in decision

TABLE 3. Twelve-month clinical and echocardiographic outcomes at unadjusted analysis.

Feature	Acurate (n = 234)	Evolut (n = 703)	Lotus (n = 151)	Portico (n = 347)	Sapien (n = 541)	*P*-Value
Death	27 (11.5%)	78 (11.1%)	18 (11.9%)	53 (15.3%)	58 (10.7%)	.29
Stroke	3 (1.3%)	18 (2.6%)	4 (2.7%)	3 (0.9%)	11 (2.0%)	.35
Myocardial infarction	0 (0.0%)	3 (0.4%)	0 (0.0%)	3 (0.9%)	4 (0.7%)	.48
Major bleeding	10 (4.3%)	20 (2.8%)	7 (4.6%)	9 (2.6%)	27 (5.0%)	.22
Major vascular complications	34 (14.5%)	62 (8.8%)	9 (6.0%)	18 (5.2%)	73 (13.5%)	<.001
Surgical aortic valve replacement or transcatheter aortic valve reimplantation	0 (0.0%)	5 (0.7%)	3 (2.0%)	5 (1.4%)	2 (0.4%)	.09
Permanent pacemaker implantation	18 (7.7%)	124 (17.6%)	40 (26.5%)	44 (12.7%)	76 (14.1%)	<.001
Major adverse events[a]	63 (26.9%)	149 (21.2%)	33 (21.9%)	77 (22.2%)	140 (25.9%)	.21
New York Heart Association class						<.01
I	74 (43.8%)	208 (41.6%)	40 (33.3%)	104 (36.4%)	199 (49.6%)	
II	87 (51.5%)	260 (52.0%)	72 (60.0%)	172 (60.1%)	188 (46.9%)	
III	6 (3.6%)	31 (6.2%)	8 (6.7%)	10 (3.5%)	14 (3.5%)	
IV	2 (1.2%)	1 (0.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Left ventricular ejection fraction (%)	48.8 ± 17.7	46.8 ± 17.4	44.1 ± 17.7	53.0 ± 12.3	47.9 ± 14.9	<.001
Peak aortic gradient (mm Hg)	14.6 ± 5.5	14.8 ± 7.3	25.0 ± 11.1	16.0 ± 7.5	22.7 ± 9.1	<.001
Mean aortic gradient (mm Hg)	8.5 ± 4.0	8.0 ± 4.8	12.9 ± 6.2	9.0 ± 4.5	12.5 ± 5.7	<.001
Aortic valve area (cm^2)	1.27 ± 0.45	1.22 ± 0.39	1.16 ± 0.47	1.14 ± 0.52	1.19 ± 0.39	.62
Aortic regurgitation						<.001
None	17 (18.1%)	106 (28.3%)	45 (55.6%)	52 (23.3%)	121 (41.9%)	
Trace or mild	62 (66.0%)	213 (56.8%)	31 (38.3%)	135 (60.5%)	137 (47.4%)	
Moderate	14 (14.9%)	54 (14.4%)	4 (4.9%)	36 (16.1%)	30 (10.1%)	
Severe	1 (1.1%)	2 (0.5%)	1 (1.2%)	0 (0.0%)	1 (0.4%)	
Aortic regurgitation type						
Periprosthetic	83 (100%)	126 (99.2%)	39 (92.9%)	208 (99.5%)	212 (97.3%)	
Intraprosthetic	0 (0.0%)	1 (0.8%)	3 (7.1%)	1 (0.5%)	6 (2.8%)	
Mitral regurgitation						<.001
None	6 (4.7%)	16 (3.6%)	3 (2.8%)	6 (2.2%)	15 (4.1%)	
Mild	79 (61.7%)	270 (60.3%)	57 (53.3%)	166 (61.5%)	195 (53.4%)	
Mild-to-moderate	36 (28.1%)	53 (11.8%)	41 (38.3%)	85 (31.5%)	132 (36.2%)	
Moderate-to-severe	4 (3.1%)	99 (22.1%)	6 (5.6%)	10 (3.7%)	17 (4.7%)	
Severe	3 (2.3%)	10 (2.2%)	0 (0.0%)	3 (1.1%)	6 (1.6%)	
Systolic pulmonary artery pressure (mm Hg)	35.4 ± 10.7	37.3 ± 10.8	37.7 ± 10.9	36.1 ± 10.3	34.9 ± 10.2	.03

Data presented as mean ± standard deviation or number (%).
[a]Defined as a composite of death, stroke, myocardial infarction, major vascular complication, major bleeding, surgical aortic valve replacement, or transcatheter aortic valve reimplantation.

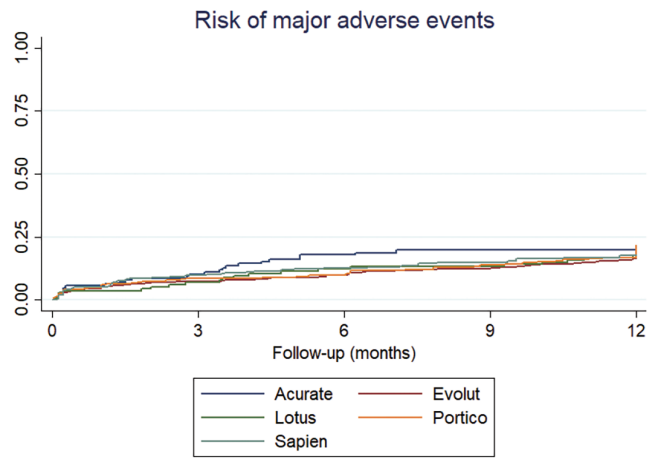

FIGURE 1. Kaplan-Meier failure curve for the risk of major adverse events (composite of death, stroke, myocardial infarction, major vascular complication, major bleeding, surgical aortic valve replacement, or transcatheter aortic valve reimplantation) after transcatheter aortic valve implantation using 5 leading new-generation devices. *P*=.60 at log-rank test.

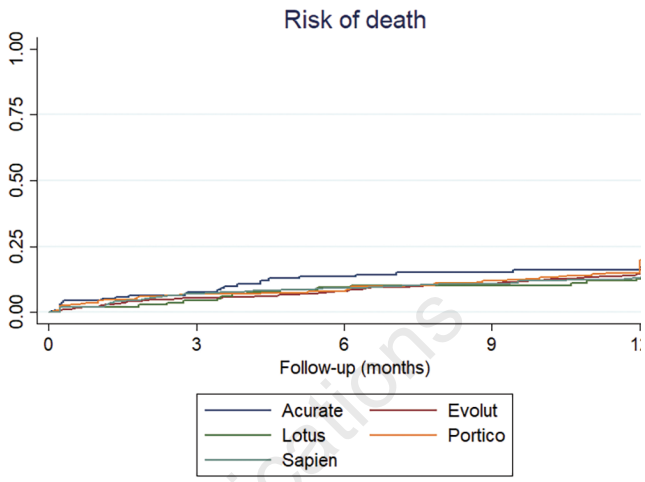

FIGURE 2. Kaplan-Meier failure curve for the risk of death after transcatheter aortic valve implantation using 5 leading new-generation devices. *P*=.28 at log-rank test.

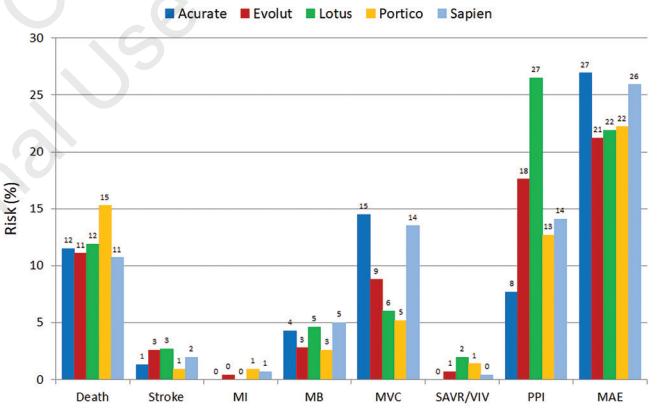

FIGURE 3. Unadjusted analysis for the risk of adverse events after transcatheter aortic valve implantation using 5 leading new-generation devices. MAE = major adverse events; MB = major bleeding; MI = myocardial infarction; MVC = major vascular complication; PPI = permanent pacemaker implantation; SAVR = surgical aortic valve replacement; VIV = valve-in-valve transcatheter aortic valve reimplantation. *P*<.05 for MB and PPI.

making. On top of price and device-specific experience, which can easily be factorized, each TAVI device can be appraised using multiple dimensions, including design, outer size, flexibility, range of valve sizes, deployment technique, landing, and presence of skirt, among many others. Moreover, clinical evidence on outcome rates with each device should be borne in mind for competent and well-considered device decisions.[18]

Randomized trials represent the gold-standard tool to quantify outcome rates and compare competing treatments, and indeed it is important to carefully consider the results of recent and past trials on TAVI, including CHOICE, Portico IDE, SCOPE I, and SOLVE-TAVI, which all support the use of Acurate, Evolut, Portico, and Sapien devices.[19,20] Systematic reviews, pairwise meta-analyses, network meta-analyses, and umbrella reviews may also, albeit in a weaker model, provide information on comparative effectiveness, pooling direct and indirect estimates of effect.[21,22] In addition, non-randomized studies appear informative, as they represent accurate snapshots of real-world device use, and also indirect comparative data, if using appropriate adjustment means.[23,24] Indeed, our present analysis, which details the 12-month results after TAVI with 5 leading new-generation devices, supports findings of prior comparative randomized trials, expanding their results on the many comparisons that can be generated. In particular, we found that Acurate, Evolut, Portico, and Sapien were all associated with favorable clinical results in terms of safety and efficacy. Conversely, unadjusted and adjusted analyses suggested that Lotus was inferior to the other devices analyzed. Finally, we examined specific subgroups to determine whether they benefited from a specific device, and found that Evolut was associated with particularly favorable results in women and patients with prior cardiac surgery.

Obviously, further studies are warranted, including longer-term follow-up of the RISPEVA dataset. Moreover, as soon as sufficient data on other devices have been collected, we aim to compare the outcomes of TAVI with Allegra and Myval in comparison with other leading TAVI devices.[25-27] Eventually, the ideal clinical research tool to compare different TAVI devices would be a platform randomized trial, ie, a large-scale, pragmatic, randomized

trial performed within the context of a large all-comer registry, such as RISPEVA.[23,24] In any case, technical developments are commonplace even within each device life cycle, as clearly shown by iterative improvements in all devices hereby studied, including Portico. Accordingly, early and long-term results from trials employing older versions of any device should be appraised attentively in light of such device refinements.[28,29]

Study limitations. This work has several limitations, which have been previously specified in detail[12-14] and of course include the non-randomized design. In addition, the reader should be cognizant of the lack of external event adjudication, the need for missing data imputation for selected variables, and the risk of type I error inflation due to multiple testing. Accordingly, our findings should mainly be viewed as descriptive and hypothesis generating.

Conclusion

Most leading current-generation TAVI devices offer favorable results at mid-term follow-up, despite some differences in design and size, with similar clinical outcomes irrespective of the chosen device. Whether refinements to Lotus device have improved its comparative safety and efficacy remains to be proven in dedicated clinical studies.

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Funding: The RISPEVA study was supported by unrestricted grants from Edwards Lifesciences and Medtronic.

Disclosure: The authors have completed and returned the ICMJE Form for Disclosure of Potential Conflicts of Interest. Dr Petronio reports grants and consulting income from Abbott, Boston Scientific, GADA, and Medtronic. Dr Biondi-Zoccai reports consultant income from Cardionovum, Innovheart, Meditrial, and Replycare. The remaining authors report no conflicts of interest regarding the content herein.

Manuscript accepted July 28, 2020.

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SUPPLEMENTAL TABLE S1. Propensity-score adjusted comparisons.[a]

Outcome	Acurate vs Evolut	Acurate vs Lotus	Acurate vs Portico	Acurate vs Sapien	Evolut vs Lotus	Evolut vs Portico	Evolut vs Sapien	Lotus vs Portico	Lotus vs Sapien	Portico vs Sapien
Death	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05
Stroke	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05
Myocardial infarction	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05
Major bleeding	*P*>.05	*P*>.05	*P*>.05	*P*>.05	-1.63 95% CI, -3.11 to -0.15 *P*=.03	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05
Major vascular complications	*P*>.05	*P*>.05	*P*>.05	*P*>.05	-2.51 95% CI, -4.96 to -0.05 *P*=.04	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05
Surgical aortic valve replacement or transcatheter aortic valve reimplantation	*P*>.05	-2.05 95% CI, -4.09 to -0.01 *P*=.049	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05	2.39 95% CI, 0.26-4.52 *P*=.03	*P*>.05
Permanent pacemaker implantation	*P*>.05	*P*>.05	*P*>.05	*P*>.05	-0.75 95% CI, -1.31 to -0.19 *P*<.01	*P*>.05	*P*>.05	*P*>.05	0.91 95% CI, 0.39-1.42 *P*<.01	*P*>.05
Major adverse events[a]	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05	*P*>.05

Data presented as log hazard ratio (HR) with 95% confidence interval (CI) of first vs second device, and corresponding *P*-values.
[a]Defined as a composite of death, stroke, myocardial infarction, major vascular complication, major bleeding, surgical aortic valve replacement, or transcatheter aortic valve reimplantation.

SUPPLEMENTAL TABLE S2. Unadjusted risk of 12-month major adverse events[a] in selected subgroups.

Feature	Acurate	Evolut	Lotus	Portico	Sapien	*P*-Value
Age >80 years	49/182 (26.9%)	110/499 (22.0%)	25/103 (24.3%)	55/245 (22.5%)	111/407 (27.3%)	.35
Women	46/156 (29.5%)	77/391 (16.7%)	22/83 (26.5%)	50/223 (22.4%)	82/288 (28.5%)	.04
Body mass index >30 kg/m^2	9/51 (17.7%)	46/222 (20.7%)	5/27 (18.5%)	30/145 (20.7%)	22/109 (20.2%)	.99
Intermediate or low risk[b]	24/111 (21.6%)	65/291 (22.3%)	19/97 (19.6%)	27/110 (24.6%)	85/347 (24.5%)	.84
New York Heart Association class III or IV	45/162 (27.8%)	101/445 (22.7%)	24/111 (21.6%)	65/258 (25.2%)	88/341 (25.8%)	.63
Prior cardiac surgery	8/27 (29.6%)	14/103 (13.6%)	5/19 (26.3%)	19/62 (30.7%)	23/76 (30.3%)	.04
Pacemaker dependency	9/25 (36.0%)	16/50 (32.0%)	1/13 (7.7%)	7/31 (22.6%)	12/39 (30.8%)	.36
Prior stroke or transient ischemic attack						
Estimated glomerular filtration rate <60 mL/min	19/67 (28.4%)	40/203 (19.7%)	11/45 (24.4%)	28/130 (21.5%)	51/163 (31.3%)	.10
Left ventricular ejection fraction <35%	9/25 (36.0%)	31/107 (29.0%)	7/37 (18.9%)	8/27 (29.6%)	22/76 (29.0%)	.66
Moderate or severe aortic regurgitation	2/13 (15.4%)	7/43 (16.3%)	2/6 (33.3%)	6/16 (37.5%)	3/12 (25.0%)	.42
Porcelain aorta	1/8 (12.5%)	16/58 (27.6%)	2/9 (22.2%)	0/4 (0%)	13/49 (26.5%)	.68
Coronary artery disease	17/62 (27.4%)	47/198 (23.7%)	9/34 (26.5%)	14/44 (31.8%)	30/140 (21.4%)	.66

Data presented as number/total (percentage).
[a]Defined as a composite of death, stroke, myocardial infarction, major vascular complication, major bleeding, surgical aortic valve replacement, or transcatheter aortic valve reimplantation.
[b]Society of Thoracic Surgery score <8.0%.

SUPPLEMENTAL TABLE S3. Selected 12-month outcomes focusing on institutional volume (<50, 50-200, >200 patients).

Feature	Low-Volume Institution	Mid-Volume Institution	High-Volume Institution	*P*-Value
Patients	183	312	1481	—
Death	18 (9.8%)	23 (7.4%)	193 (13.0%)	.01
Stroke	2 (1.1%)	4 (1.3%)	33 (2.2%)	.37
Myocardial infarction	0 (0.0%)	2 (0.6%)	8 (0.5%)	.58
Major bleeding	2 (1.1%)	8 (2.6%)	63 (4.3%)	.05
Major vascular complications	12 (6.6%)	48 (15.4%)	136 (9.2%)	<.01
Surgical aortic valve replacement or transcatheter aortic valve reimplantation	2 (1.1%)	4 (1.3%)	9 (0.6%)	.40
Permanent pacemaker implantation	23 (12.6%)	50 (16.0%)	229 (15.5%)	.55
Major adverse events[a]	31 (16.9%)	76 (24.4%)	355 (24.0%)	.10

Data presented as number (percentage).
[a]Defined as a composite of death, stroke, myocardial infarction, major vascular complication, major bleeding, surgical aortic valve replacement, or transcatheter aortic valve reimplantation.

SUPPLEMENTAL TABLE S4. Selected 12-month outcomes focusing on institutional volume (<50, 50-200, >200 patients) and device type.

Volume	Feature	Acurate	Evolut	Lotus	Portico	Sapien	*P*-Value
Low	Patients	n = 2	n = 52	n = 28	n = 48	n = 53	—
	Death	0 (0.0%)	7 (13.5%)	1 (3.6%)	8 (16.7%)	2 (3.8%)	.14
	Stroke	0 (0.0%)	1 (1.9%)	0 (0.0%)	0 (0.0%)	1 (1.9%)	.83
	Myocardial infarction	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	—
	Major bleeding	1 (50.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.9%)	<.001
	Major vascular complications	0 (0.0%)	4 (7.7%)	2 (7.1%)	1 (2.1%)	5 (9.4%)	.64
	Surgical aortic valve replacement or transcatheter aortic valve reimplantation	0 (0.0%)	1 (1.9%)	0 (0.0%)	1 (2.1%)	0 (0.0%)	.79
	Permanent pacemaker implantation	0 (0.0%)	12 (23.1%)	4 (14.3%)	3 (6.3%)	4 (7.6%)	.07
	Major adverse events[a]	1 (50.0%)	10 (19.2%)	3 (10.7%)	9 (18.8%)	8 (15.1%)	.60
Mid	Patients	n = 65	n = 217	n = 4	n = 0	n = 26	—
	Death	8 (12.3%)	13 (6.0%)	1 (25.0%)	—	1 (3.9%)	.16
	Stroke	1 (1.5%)	3 (1.4%)	0 (0.0%)	—	0 (0.0%)	.93
	Myocardial infarction	0 (0.0%)	1 (0.5%)	0 (0.0%)	—	1 (3.9%)	.19
	Major bleeding	3 (4.6%)	4 (1.8%)	0 (0.0%)	—	1 (3.9%)	.61
	Major vascular complications	17 (26.2%)	26 (12.0%)	0 (0.0%)	—	5 (19.2%)	.03
	Surgical aortic valve replacement or transcatheter aortic valve reimplantation	0 (0.0%)	4 (1.8%)	0 (0.0%)	—	0 (0.0%)	.62
	Permanent pacemaker implantation	3 (4.6%)	41 (18.9%)	0 (0.0%)	—	6 (23.1%)	.02
	Major adverse events[a]	25 (38.5%)	43 (19.8%)	1 (25.0%)	—	7 (26.9%)	.02
High	Patients	n = 167	n = 434	n = 119	n = 299	n = 462	—
	Death	19 (11.4%)	58 (13.4%)	16 (13.5%)	45 (15.1%)	55 (11.9%)	.72
	Stroke	2 (1.2%)	14 (3.2%)	4 (3.4%)	3 (1.0%)	10 (2.2%)	.23
	Myocardial infarction	0 (0.0%)	2 (0.5%)	0 (0.0%)	3 (1.0%)	3 (0.7%)	.57
	Major bleeding	6 (3.6%)	16 (3.7%)	7 (5.9%)	9 (3.0%)	25 (5.4%)	.41
	Major vascular complications	17 (10.2%)	32 (7.4%)	7 (5.9%)	17 (5.7%)	63 (13.6%)	<.001
	Surgical aortic valve replacement or transcatheter aortic valve reimplantation	0 (0.0%)	0 (0.0%)	3 (2.5%)	4 (1.3%)	2 (0.4%)	<.01
	Permanent pacemaker implantation	15 (9.0%)	71 (16.4%)	36 (30.3%)	41 (13.7%)	66 (14.3%)	<.001
	Major adverse events[a]	37 (22.2%)	96 (22.1%)	29 (24.4%)	68 (22.7%)	125 (27.1%)	.44

Data presented as number (percentage).
[a]Defined as a composite of death, stroke, myocardial infarction, major vascular complication, major bleeding, surgical aortic valve replacement, or transcatheter aortic valve reimplantation.

SUPPLEMENTAL TABLE S5. Twelve-month clinical and echocardiographic outcomes at unadjusted analysis comparing first-generation vs second-generation Portico devices.

Feature	First-Generation	Second-Generation	Total	*P*-Value
Patients	n = 22	n = 325	n = 347	-
Death	2 (9.1%)	32 (9.9%)	53 (15.3%)	.91
Stroke	2 (9.1%)	1 (0.3%)	3 (0.9%)	<.001
Myocardial infarction	0 (0.0%)	3 (0.9%)	3 (0.9%)	.65
Major bleeding	0 (0.0%)	9 (2.8%)	9 (2.6%)	.43
Major vascular complications	1 (4.6%)	17 (5.2%)	18 (5.2%)	.89
Surgical aortic valve replacement or transcatheter aortic valve reimplantation	1 (4.6%)	4 (1.2%)	5 (1.4%)	.21
Permanent pacemaker implantation	2 (9.1%)	42 (12.9%)	44 (12.7%)	.60
Major adverse events[a]	5 (22.7%)	72 (22.2%)	77 (22.2%)	.95

Data presented as number (percentage).
[a]Defined as a composite of death, stroke, myocardial infarction, major vascular complication, major bleeding, surgical aortic valve replacement, or transcatheter aortic valve reimplantation.