7-Year experience of transcatheter aortic valve implants (TAVI) in a Western Cape private healthcare setting

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INTRODUCTION

The first transcatheter aortic valve implantation (TAVI) was performed in 2002[1] and was followed by rapid expansion of the technology and utility of this procedure. The first implants were done in South Africa in 2009.[2] The local use of TAVI has been hampered by low patient numbers. In an attempt to optimise our experience, we established a public–private partnership between 2 busy private hospitals in the Mediclinic group (Panorama and Vergelegen) and the Division of Cardiology at Stellenbosch University and Tygerberg Hospital. We collected data for all patients prospectively and reported on our initial short-term experience of 79 patients in 2012.[2] In November 2014, the national South African Heart Registry on TAVI (SHARE-TAVI registry) was initiated and has as its goal to include all TAVI cases performed in the country. Our data were collected in parallel to the SHARE-TAVI registry, and this report is on our first 244 patients, most of whom were not part of the SHARE-TAVI registry. A major obstacle to the wider utility of TAVI is the high cost of the device and funder reluctance to provide funding. A paucity of local data adds to this reluctance. The aim of the study was to describe our procedural and follow-up data.

ABSTRACT

Introduction: We describe the largest South African transcatheter aortic valve implantation (TAVI) outcome report of a single team in the Western Cape, over a 7-year period from 2009 - 2016.
Methods: All patients who received TAVI at Mediclinic Vergelegen and Mediclinic Panorama were prospectively entered into a database. A total of 244 implants (61 CoreValve and 183 Edwards valves) were performed.
Results: Patients were high risk with a mean STS score of 7.89 (standard deviation (SD) 5.7) and mean logistic EuroSCORE of 26.5 (SD 12.5). There was a trend toward lower risk over time. Procedures were initially performed mainly via a transapical approach, but this changed to mostly transfemoral with the introduction of smaller delivery systems. Procedural success rate was 91.8% for CoreValve and 88.5% for Edwards cases. Mean length of hospital stay following TAVI was 9 days initially, but this declined to 4 days for the latter part of our experience. One year mortality was 19% and one year stroke rate was 10%.
Conclusion: Despite the limitations of a study of this nature, our group could document outcomes similar to international studies, with improvements over time and illustrating successful cooperation between different hospitals to expand exposure and experience in a resource-constrained environment.
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METHODS

The first Valve Academic Research Consortium (VARC) consensus manuscript was published in 2011, with an update in 2012.[3] This standardised the definitions of many factors pertaining to TAVI, and was used here where relevant.

The heart team

All cases were done in the 2 private hospitals. Collaboration was, however, set up between the 2 hospitals to ensure exposure to more cases. Each hospital nominated a cardiologist, a cardiothoracic surgeon and an anesthesiologist, and we endeavoured to have team members from both hospitals present at all heart team discussions and implants. The team at Mediclinic Panorama nominated a cardiologist from an academic hospital (H.W.) to expand exposure to the state sector and improve the academic output of the team.

Patient population

The study received ethical approval from the University of Stellenbosch's ethics committee (N16/01/005). All patients who received a TAVI at the 2 participating hospitals (Mediclinic Panorama and Mediclinic Vergelegen) were entered into a database. This database was managed by the lead author and was separate to the SHARE-TAVI registry.

Patient risk evaluation

At the start of the study, the logistic EuroSCORE and Society of Thoracic Surgeons Score (STS – score) predicted risk of mortality score and were documented for all patients. Although the EuroSCORE was later updated to the EuroSCORE II, we continued to document the logistic EuroSCORE for continuity.

Imaging

All patients received detailed preprocedural transthoracic echocardiograms (TTE). Parameters documented included left ventricular ejection fraction (LVEF) (measured either with Simpson's or the Teicholtz method), mean gradient over aortic valve, and aortic valve area (AVA) (measured by the continuity equation and planimetry). Paravalvular aortic regurgitation (AR) was evaluated by a combination of aortography (Sellers method[4]), transoesophageal echo (TOE) (according to VARC-2 definitions[3]), and end-diastolic pressure gradient over the valve.

Procedures

The procedures were performed over an extended period and evolved with growing experience. All procedures were performed in a cathlab under general anaesthesia, with TOE guidance. Access was gained via various routes: femoral arteries, transapical puncture with surgical preclosure of the apex, transaortic with a mini-sternotomy, or axillary artery cutdown. The programme was initiated with the Edwards SAPIEN™ system (Edwards Lifesciences™, Irvine, California) and later the Edwards SAPIEN XT and CoreValve (Medtronic, IL). This study did not include any cases of Edwards SAPIEN3 or Medtronic Evolut R valves. Procedural success was defined as per VARC-2 : Absence of procedural mortality and correct positioning of a single prosthetic heart valve into the proper anatomical location and intended performance of the prosthetic heart valve (no prosthesis–patient mismatch and mean aortic valve gradient 20mmHg or peak velocity 3m/s, and no moderate or severe prosthetic valve regurgitation).[3]

Outcomes

Outcomes documented at 1 year included:

■ 1-year survival (mortality data were subdivided into procedural mortality [up to 72 hours post procedure], mortality before discharge from hospital, and mortality in first year after TAVI);

■ clinically detectable cerebrovascular accidents (CVA) at 1 year;

■ New York Heart Association (NYHA) dyspnoea grading at 1 year.

RESULTS

Patient population

A total of 244 patients were entered between October 2009 and September 2016. Until July 2011, all implants were Edwards valves. Thereafter we used both the Medtronic CoreValve and Edwards valves. A total of 61 CoreValves and 183 Edwards valves were implanted.

Patient risk profile

The patient cohort had a male preponderance, with 55.7% males. Most of the patients were octogenarians, with an average age of 80 (range 50 - 94). Our cohort had a mean STS-score predicted mortality of 7.89% (SD 5.7) and a mean logistic EuroSCORE of 26.5% (SD12.5). A decrease in the STS score was observed in the latter phases of the study period. The same decrease in Log EuroSCORE was not observed (Figure 1). Mean age did not change over time. Factors not well accounted for by the STS score, such as porcelain aorta and frailty, were often present in our patients. Table 1 illustrates the proportions of patients who had significant associated comorbidities.
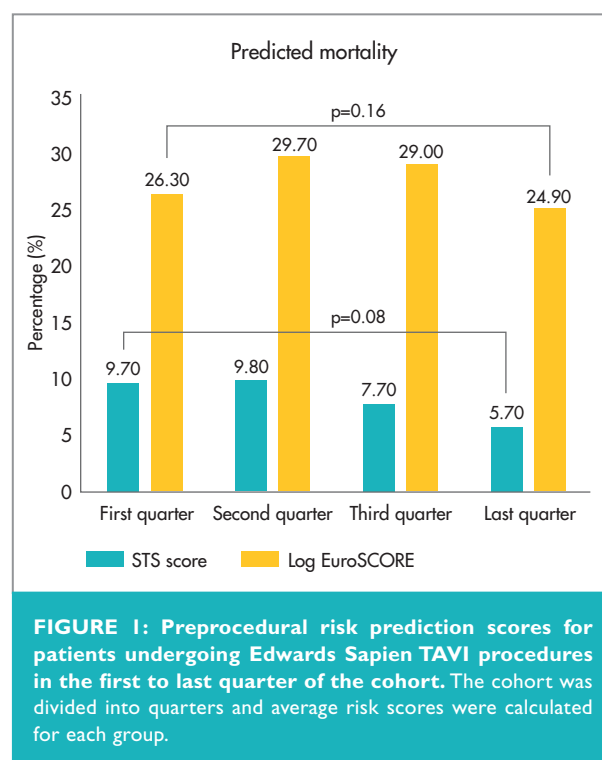

FIGURE 1: Preprocedural risk prediction scores for patients undergoing Edwards Sapien TAVI procedures in the first to last quarter of the cohort. The cohort was divided into quarters and average risk scores were calculated for each group.

TABLE I: Preprocedural comorbidities.

Previous coronary artery bypass graft surgery	38.9% (95/244)
Previous surgical aortic valve replacement	2.04% (5/244)
Preprocedural pacemakers	16.8% (41/244)
Documented frailty	4.09% (10/244)
Preprocedural major organ system dysfunction#	49.5% (121/244)
Underlying/previously diagnosed malignancy (active/current)	9.83% (24/244)
Class 3 obesity (BMI >35kg/m^2)	10.24% (25/244)
Porcelain aorta	9% (22/244)
Previous stroke/peripheral vascular disease	13.93% (34/244)
Preprocedural atrial fibrillation	15.16% (37/244)
Creatinine (umol/liter) Median (SD)	114(75)
Ejection fraction (%) Median (SD)	53(13)

#Defined as LVEF <45% and/or eGFR <60ml/min/1.73m^2 and/or documented respiratory failure in preprocedural notes.

Preprocedural imaging findings

Most patients had preserved left ventricular systolic function with a mean LVEF of 54% (range: 15 - 78%; SD=13%). Very few patients with extremely low LVEF were included, as we viewed an LVEF below 20% without proof of contractile reserve as a contra-indication to TAVI, in line with exclusion criteria of earlier trials. Mean transaortic gradient was 46mmHg (SD 15.6mmHg) and mean aortic valve area 0.7cm^2 (SD 0.16cm^2). Coronary artery disease was common, but revascularisation was only considered in symptomatic patients or life threatening cases. A detailed evaluation of this will be the focus of a separate study. Preprocedural valve sizing was done with a combination of TOE and computerised tomography (CT) scanning. As the reliability of the CT scans improved, this became our preferred mode. Peripheral access vessels were evaluated with either an aortogram at the time of coronary angiography or a CT scan. The major benefit of CT is evaluation and location of calcifications, and after a number of unforeseen vascular problems in patients who did not receive CT evaluation, we adopted CT as the method of choice.

Procedural data

An average of 2.7 procedures was performed per dedicated theatre day. Apart from a single trans-axillary CoreValve implant, 3 different approaches to vascular access were used, depending on the extent of the ileofemoral and aortic root calcification determined from pre-procedural assessment. The transfemoral approach was generally favoured if amenable, followed by the transapical approach and the transaortic

approach (75%, 14%, and 11% respectively). Initially, the only device available was the Edwards Sapien valve, which required a 22-24French sheath for femoral access. This made femoral access impossible in most of the initial cases, and, therefore, a large number were done via transapical access – see Figure 2. Patients underwent general anaesthesia to facilitate continuous TOE guidance in all cases. Mean procedure time was 83min (SD 30.8) and mean screening time 16min (SD 8.9). Procedural success was achieved in 91.8% of CoreValve cases and 88.5%
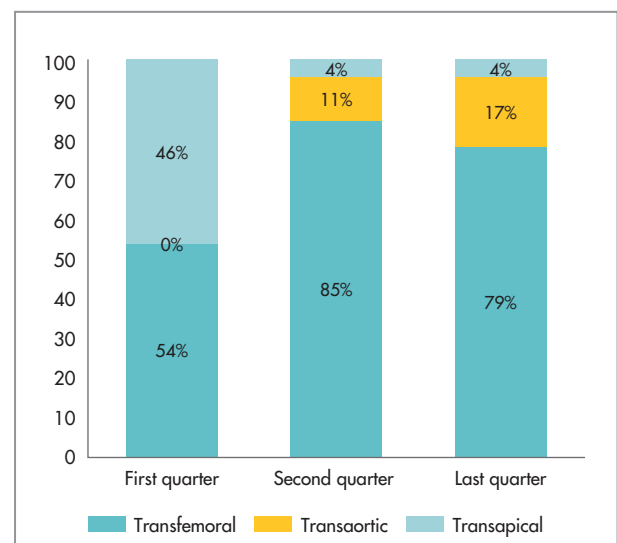

FIGURE 2: TAVI vascular access approach for the 183 Edwards valves only. Each third consisted of 61 cases.
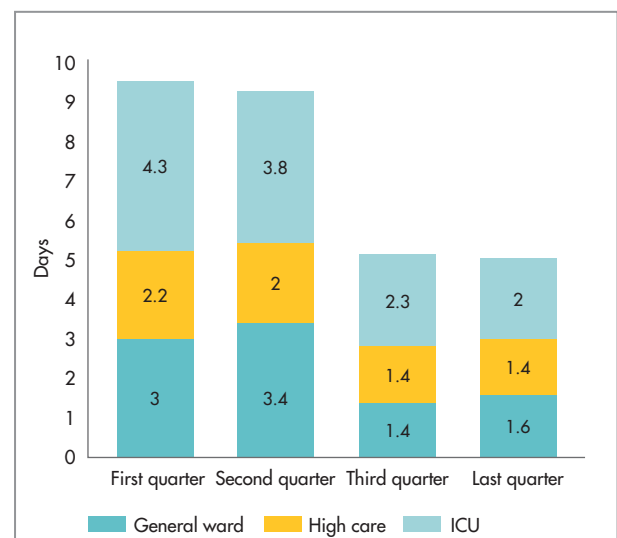

FIGURE 3: Mean Length of hospital stay over reporting period. The cohort was divided into quarters, and mean duration of hospital stay was calculated for each of the groups.

of Edwards cases (mean for entire cohort 89.3%). This lower than expected number was mostly driven by moderate post-procedural AR accounting for approximately 9% of the 10.7% of patients, where procedural success was not attained. Mean length of hospital stay following TAVI was: Intensive care unit (ICU) – 2.19 days (SD 2.58), high care – 2.2 days (SD 2.14), and general ward – 3.36 days (SD 2.66). Hospital stay tended to become shorter with experience – see Figure 3.

Major outcomes

1-year survival

Mortality data were available for 219 of the 244 patients at 1 year following TAVI. Most of the missing patients were referred from far away and we could not obtain follow-up data despite significant efforts. 81% of patients were alive at 1 year (19% all cause 1-year mortality). Of the 46 patients that died in the first year, the breakdown was as follows: 9 (19.5% of total mortality) procedural, 6 (13% of total mortality) prior to discharge from hospital, and the remaining 31 deaths (67.3%) during the 1-year follow up. (See Figure 4).

Causes of the 9 procedural deaths were:

1. Myocardial infarction (left main stem obstruction).

2. Aortic tear.

3. Aortic tear.

4. Ventricular tachycardia, failed resuscitation.

5. Ruptured abdominal aortic aneurysm.

6. Unexplained (day 2 postprocedural).

7. Left ventricular perforation.

8. Severe AR post deployment.

9. Right ventricular perforation by pacemaker wire.

The causes of death in the 6 patients who died in hospital between 72 hours and discharge were:

1. Multi-organ failure.

2. CVA.

3. Unexplained.

4. Unexplained.

5. Unexplained.

6. CVA.

One-year mortality tended to improve with experience: for Edwards valves, the first 50 cases had 17% 1-year mortality vs. 8% for the last 50 (p = 0.35). For CoreValve cases, it improved from 34% - 13% from the first 30 to the last 30 cases (p=0.07) (see Figure 5).

Cerebrovascular accidents (CVA)

The 1-year incidence of clinically detected CVAs was 10%. Eight (33%) occurred in the first 72 hours following the procedure, and the remaining 16 (66%) occurred during the
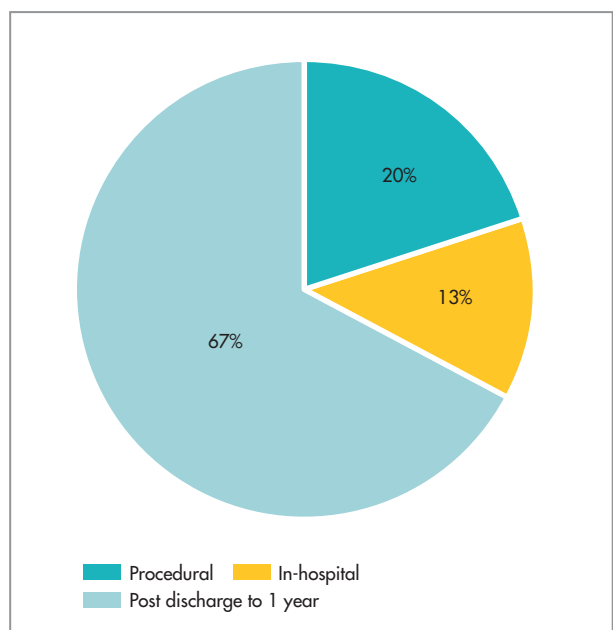

FIGURE 4: Timing of mortality in the first year following the procedure (n=46).
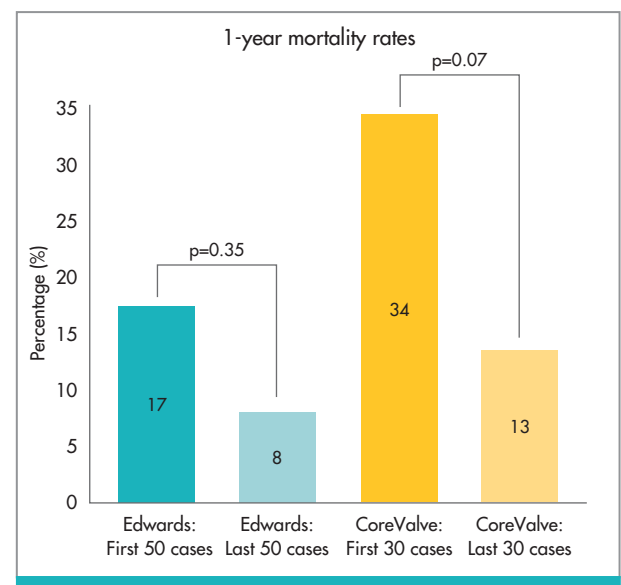

FIGURE 5: Mortality rates for the first parts and last parts of each of the valve types – demonstrating a significant improvement in 1-year survival with technological advances and the growing experience of the heart team.
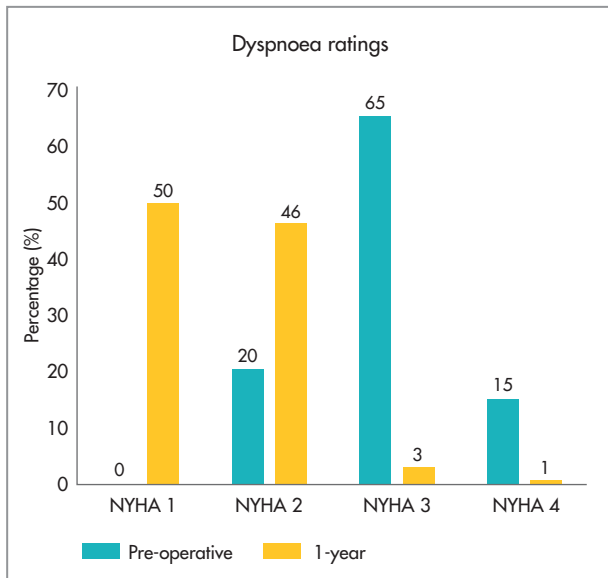
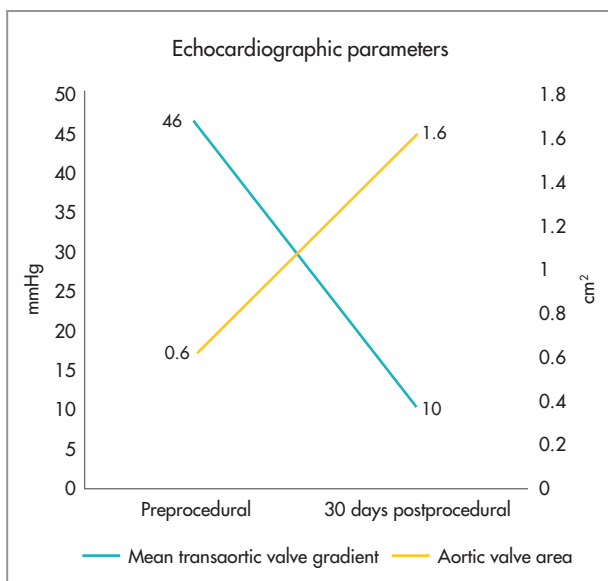**FIGURE 6: Preprocedural and 1-year NYHA dyspnoea grading.**

FIGURE 7: Echocardiographic aortic valve parameters pre- and post-intervention.

first year follow-up. Of those occurring in the inpatient period, 2 events were fatal. It is important to note that, preprocedural, the cohort had a 14% incidence of prior documented CVA or severe peripheral vascular disease – indicating the overall vascular risk of this advanced age group.

New York Heart Association (NYHA) dyspnoea grading

The pre-and postprocedural NYHA dyspnoea ratings are illustrated in Figure 6.

TABLE II: VARC-2 defined procedural complications.	
Complication	**Incidence**
Life threatening bleeding	11/244 (4.51%)
Major bleeding	2/244 (0.82%)
Minor bleeding	1/244 (0.41%)
Major vascular injury	14/244 (5.74%)
Minor vascular injury	17/244 (6.97%)
Permanent pacemaker placement	12/244 (4.92%)
Stroke/TIA	6/244 (2.46%)
TAVI - in - TAVI	5/244 (2%)

Secondary outcomes

Echocardiographic parameters pre-and postprocedural are compared in Figure 7. There was a significant decrease in mean gradient over the valve (46mmHg - 10mmHg), accompanied by a rise in valve area (AVA) from 0.7cm^2 - 1.6cm^2.

Complications

Complications are documented in Table II and are all according to VARC-2 criteria. The results exclude 5 cases of elective TAVI in surgical bioprosthesis implants. The 5 TAVI- in -TAVI cases listed in Table II are cases where the first TAVI implant was incorrect and required a second valve to be implanted. Since vascular complications are major contributors to morbidity and mortality in TAVI, we evaluated the difference in this complication according to the device used (see Table III). Our initial experience was exclusively with very large bore (22-24French) Edwards SAPIEN femoral and transapical devices. Minor vascular complications came down from 17% to 10% with the introduction of the (18-20French) e-Sheath of the SAPIEN XT valves. Major vascular complications were frequent with the transapical approach (which was often used in our early experience), and less so with the switch to the transaortic approach, although absolute numbers are low.

DISCUSSION

The TAVI landscape in South Africa differs vastly from Europe and the US where most data are generated. In Europe, the average number of TAVI centres is almost one per million of population and the average number of implants per centre is 41/yr.[5] We have only 11 centres performing TAVI and the local guidelines state that a team should aim to perform more than 10/yr.[6] In 2015 and 2016 only 5 of the teams reached this target (data presented at SA Heart® Congress 2016 based on SHARE TAVI registry). This can probably be explained partially by our smaller elderly population, but another large

TABLE III: Access site complications stratified according to delivery system.

	Life-threatening bleeding	Major bleeding	Minor bleeding	Major vascular injury	Minor vascular injury
Transfemoral Edwards Sapien (n=50)	3 (6%)	1 (2%)	1 (2%)	4 (8%)	6 (12%)
Transfemoral Edwards Sapien XT (n=84)	3 (3.57%)	0 (0%)	0 (0%)	5 (5.95%)	7 (8.33%)
Transaortic Edwards Sapien (n=18)	2 (11.11%)	0 (0%)	0 (0%)	2 (11.11%)	0 (0%)
Transapical Edwards Sapien (n=31)	3 (9.68%)	1 (3.23%)	0 (0%)	3 (9.68%)	0 (0%)
Medtronic CoreValve (n=61)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	4 (6.56%)
	11 (4.51%)	2 (0.82%)	1 (0.41%)	14 (5.74%)	17 (6.97%)

contributor is resistance to funding the procedure. Funders claim that inadequate data exist pertaining to the outcomes of local patients. Our study documents local experience over an extended period, which embraced the evolution of the techniques and technology.

In line with trends elsewhere, our patient population was elderly and risk scores used changed over time. The mean STS scores ranged from high risk (>6%) initially to intermediate risk (5.5%) for the last quartile of our study population. This is in line with the cautious evolution of entry criteria for randomised studies. In the randomised Placement of Aortic Transcatheter Valves (PARTNER) trial, the average STS score was 11.6%[7] and in PARTNER 2 it was 5.8%.[8] It is not clear why the mean log EuroSCORE did not evolve in the same way, but the simplicity of this scoring system possibly omitted certain significant risk factors. This, together with the mean age remaining at more than 80 years, however confirms the cautious approach to patient selection used by the team.

Extensive echocardiographic parameters were documented both pre- and postprocedurally, but these were performed by many operators in different hospitals and were not verified by a core laboratory. We therefore elected to only report on the hard parameters like valve area and gradient. Paravalvular aortic regurgitation is the most obvious omission, as this is linked to poor outcomes – but is also extremely difficult to reliably quantify.

Procedures were performed under general anaesthesia to enable TOE guidance, in contrast to many first world centres opting to use conscious sedation and to forego TOE for TTE. The obvious benefits of TOE include immediate diagnosis of complications, additional information on valve sizing, and evaluation of procedural success. Our team only adopted a routine sedation policy once we felt comfortable with our ability to function without the benefits of TOE. This experience is not reported here, but we did observe significant improvements in postprocedural recovery times.

Previously reported 1-year all-cause mortality rates in landmark trials/registries were 24% (PARTNER A),[7] 24% (SOURCE),[9] 14% (CoreValve US Pivotal),[10] 12% (PARTNER 2A)[8] and 21.5% in the Brazilian Registry.[11] Our 1-year mortality data improved significantly over time with an 8% and 13% 1-year mortality rate for the last cohorts of both Edwards and CoreValve patients respectively. This emphasises the learning curve for TAVI – as well as improvements in equipment. Experience was also reflected in hospital stay, but not in vascular and bleeding complications. Procedural success was relatively low, but this can largely be explained by our strict adherence to the paravalvular AR criterion of moderate or more as being indicative of failure.

The relatively high stroke rate needs clarification. Newer studies looking at strokes after TAVI require a formal neurological evaluation (using a reproducible scoring system) pre- and post-procedure. Our documentation of this outcome was probably not on the same standard, and many of the patients were referred back to other centres. The exact nature of some of these events was therefore not verified. Over time, the team tended to be more aggressive with anti-thrombotic treatment and the omission of balloon predilatation used in the latest Medtronic Evolut R valves may lead to better results in future.

Vascular complications are low compared to other studies.[12,13] An analysis of the trend in this complication over our study period is however difficult to show, because of changes in multiple variables: We initially performed open surgical exposure of the femoral artery, but with time chose to use percutaneous

closure devices such as ProStar (Abbott, IL), and later Proglide (Abbott, IL). Using ultrasound guidance to locate the femoral artery has been used more recently, and seems likely to reduce complications further. A further explanation for the relatively low initial major vascular complications for the femoral approach is that almost half of the cases were performed via non-femoral access, and only patients with very good femoral anatomy were considered for this approach.

CONCLUSION

Despite the limitations of a study of this nature, our group could document outcomes similar to international studies – with improvements over time and illustrating successful co-operation between different hospitals to expand exposure and experience in a resource-constrained environment.

LIMITATIONS

The research is subjected to the limitations of a retrospective reporting of data. Comparison between the 2 different valve types should not be made as the 2 programmes were started at different times in our experience curve. A more detailed analysis of echocardiographic parameters would have been valuable, but the collection of this data was not uniform enough.

Conflict of interest: none declared.

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