Postoperative permanent pacemaker implantation in patients undergoing trans-catheter aortic valve implantation: what is the incidence and are there any predicting factors?

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Summary

A best evidence topic was written according to a structured protocol. The issue was to determine the incidence and predictors of postoperative permanent pacemaker (PPM) implantation in patients undergoing transcatheter aortic valve implantation (TAVI) for symptomatic calcific aortic stenosis and to compare this to the known risks of this complication following surgical aortic valve replacement (AVR). Using the reported search method 3071 articles were identified, of which 94 were relevant to the procedure of TAVI and 14 were deemed to represent the best evidence. All 14 studies, including both multi-centre registries and single-centre retrospective case series containing ≥30 patients, reported incidence of postoperative PPM implantation. Five of these studies also assessed predictors of the need for postoperative PPM implantation. The author, journal, date and country of publication, study type, level of evidence, patient group, outcomes and results were tabulated for these studies. We conclude that the current best available evidence suggests that the mean incidence of PPM implantation following TAVI is 14.2% (range 0–34%, median 9.7%), although this appears higher with the CoreValve prosthesis (five studies, mean 20.8%, range 9.3–30.0%) than with the Edwards–Sapien prosthesis (six studies, mean 5.4%, range 0–10.1%). The mean incidences of PPM implantation overall and when using the CoreValve prosthesis are higher than the mean incidence of 7.0% (range 3–11.8%, median 7.2%) following conventional AVR and may be explained by distinct differences between the patient groups involved and the procedure performed. Indications for PPM implantation appear to occur early in the postoperative period following TAVI and there is little evidence of recovery following atrioventricular block (AVB). New onset persistent left bundle branch block is common following TAVI but the significance and follow-up required is unclear. Independent predictors of PPM requirement following TAVI include use of the CoreValve prosthesis and evidence of conduction system dysfunction, either pre-existing right bundle branch block or AVB at the time of TAVI. All patients should be made aware of the high risk of PPM implantation with TAVI.

Keywords: Trans-catheter aortic valve implantation; Permanent pacemaker implantation; Postoperative complications; Atrioventricular block; Evidence-based medicine; Calcific aortic stenosis

1. Introduction

A best evidence topic was written according to a structured protocol. This protocol is fully described in ICVTS [1].

2. Clinical scenario

Trans-catheter aortic valve implantation (TAVI) is a relatively new technique with growing clinical use. On a ward round, you notice that three patients who underwent TAVI the previous week for severe symptomatic calcific aortic stenosis (AS) have third degree atrioventricular block (AVB) on postoperative day (POD) 7. You are aware of the risk of this complication with conventional aortic valve replacement (AVR) but do not know the incidence or predictors of this complication in patients undergoing TAVI and decide to investigate.

3. Three-part question

In [patients undergoing TAVI] what are the [incidence and predictors] of [postoperative permanent pacemaker implantation]?

4. Search strategy

All searches were limited to English language articles published after 2002 as TAVI was first performed in humans in 2002 [2]. MEDLINE was searched using the Ovid interface from 2002 to May 2010.

[surgical procedures, minimally-invasive/OR heart valve prosthesis implantation/OR aortic valve/OR aortic valve surgery.mp/OR heart catheterization/OR transcatheter
aortic valve implantation.mp/or percutaneous aortic valve implantation.mp/or trans-catheter aortic valve implantation.mp/or TAVI.mp] AND [pacemaker, artificial/or cardiac pacing, artificial/or heart block/or permanent pacemaker.mp/or permanent pacemaker implantation.mp].

EMBASE was searched using the Ovid interface from the year 2002 to 2010. [minimally-invasive surgery/or heart valve replacement/or heart valve surgery/or heart valve prosthesis/or aorta valve/or intervention cardiovascular procedure/or catheterization/or aortic valve implantation.mp/or transcatheter aortic valve implantation.mp/or percutaneous aortic valve implantation.mp/or trans-catheter aortic valve implantation.mp/or TAVI.mp] AND [pacemaker/or artificial heart pacemaker/or heart block/or permanent pacemaker.mp/or permanent pacemaker implantation.mp].

Additionally, the CINAHL [Cumulative Index to Nursing and Allied Health Literature] database and the Cochrane Database for Systematic Reviews and Central Register of Controlled Trials were searched. All citations and abstracts were reviewed and the reference lists of articles found through these strategies were reviewed.

5. Search outcome

Due to the diverse terms used to describe TAVI, a broad search strategy was used and 3071 papers were found. On review 94 articles were relevant to TAVI and 14 were deemed to represent the best evidence. All 14 studies were multi-centre registries or single-centre retrospective case series containing ≥30 patients and reported incidence of postoperative permanent pacemaker (PPM) implantation. Five of these studies also assessed predictors of the need for PPM implantation. The author, journal, date and country of publication, study type, level of evidence, patient group, outcomes and results were tabulated (Table 1) [3–16].

6. Discussion

All 14 studies were retrospective series or registries, inclusive of 2047 patients from Europe and North America. There is no randomised controlled data in this area.

6.1. Incidence

The mean short-term incidence of PPM implantation in patients undergoing TAVI assessed at hospital discharge (three studies), POD 14 (one study) or POD 30 (ten studies) is 14.2% (range 0–34%, median 9.7%). In comparison, the mean incidence of PPM implantation following AVR is 7.0% (range 3.0–11.8%, median 7.2%) [17–23]. The requirement for PPM implantation appears higher with the CoreValve prosthesis (five studies, mean 20.8%, range 9.3–30.0%) than with the Edwards–Sapien prosthesis (six studies, mean 5.4%, range 0–10.1%). Statistically significant in two studies that used both types of prosthesis (P = 0.018 and 0.008), this trend was observed in all three such studies [13, 14, 16].

All eight studies that provided data on timing of PPM implantation describe the majority of indications arising in <5 days, with three studies seeing a majority within 24 hours [7, 14, 15]. Two studies investigated the need for ventricular pacing at one month and reported a mean proportion of ventricular pacing of 96.6 ± 4.2% in all patients [12], and 79.0 ± 20.3% in the patients who were paced for >10% of the time (6/9 patients) [6]. Recovery of AVB therefore seems unlikely and early indications for PPM implantation should be utilised.

A significant increase in left bundle branch block (LBBB) postoperatively is reported in all seven studies that provide information regarding conduction disturbances. Of the studies providing data to 30 days, three describe persistent LBBB [5, 6, 12], while one reports no significant difference in incidence of LBBB between baseline and 30 days [9]. Persistent LBBB after AVR has been identified as a predictor of syncope, AVB and sudden cardiac death [24]. Only one study reported follow-up of patients with new LBBB following TAVI to six months and identified no further PPM requirement [3]. The importance of new onset persistent LBBB following TAVI is therefore unclear.

6.2. Predictors

Only two studies performed multivariate regression analysis to identify predictors of the need for PPM following TAVI [14, 16]. Independent factors identified as significant (P<0.05) were use of the CoreValve prosthesis and pre-existing right bundle branch block (RBBB) [14], and AVB at prosthesis implantation [16]. Additionally, Bleiziffer et al. identified use of the CoreValve prosthesis and borderline annulus size for prosthesis (a native annulus at the lower end of the recommended size range for a specific prosthesis) as having a considerable effect on the need for PPM implantation following TAVI. Although both factors were non-significant (P = 0.09 and 0.063, respectively), the confidence interval for the odds ratios for these factors included values as high as 17.6 and 5.9, respectively [16].

The mechanism of conduction tissue injury during TAVI is speculated to be mechanical injury due to the prosthesis and the exclusion of the native calcified valve. Jilaihawi et al. hypothesise that factors such as the longer stent frame, self-expanding nature, or ovoid shape of the CoreValve prosthesis, in contrast to the Edwards–Sapien prosthesis, may induce greater compression of structures surrounding the aortic annulus [6].

7. Clinical bottom line

We conclude that the current best available evidence suggests that the mean incidence of PPM implantation following TAVI is 14.2% (range 0–34%, median 9.7%), although this appears higher with the CoreValve prosthesis (five studies, mean 20.8%, range 9.3–30.0%) than with the Edwards–Sapien prosthesis (six studies, mean 5.4%, range 0–10.1%). The mean incidences of PPM implantation overall and when using the CoreValve prosthesis are higher than the mean incidence of 7.0% (range 3–11.8%, median 7.2%) following conventional AVR and may be explained by distinct differences between the patient groups involved and the procedure performed. Indications for PPM implantation appear to occur early in the postoperative period following TAVI and there is little evidence of recovery following AVB. New onset persistent LBBB is common following TAVI but the significance and follow-up required is unclear.
<table>
<thead>
<tr>
<th>Author, date, journal and country</th>
<th>Patient group</th>
<th>Outcome(s)</th>
<th>Results</th>
<th>Comment</th>
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</thead>
<tbody>
<tr>
<td>Sinhal et al., (2008), JACC Cardiovasc Interv, Canada, [3]</td>
<td>n=123 (male 55%)</td>
<td>(A) Incidence of PPM implantation for AVB at 30 days postTAVI</td>
<td>(A) 6.6% (7/106), all for third degree AVB</td>
<td>17 patients excluded from analysis due to pre-existing PPM</td>
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<tr>
<td>Case series (single centre: Vancouver)</td>
<td>Median age 84.8 years</td>
<td>(B) Predictors of PPM implantation (univariate analysis)</td>
<td>(B) Univariate regression analysis: female sex (P=0.045); 42/99 in no AVB group and 6/7 in AVB group</td>
<td>Additional 1.9% patients (2/106) underwent PPM implantation for ‘pre-existing episodic bradycardia’</td>
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<tr>
<td>Data collection dates not reported (level 2b)</td>
<td>(no postoperative AVB) and 83.5 years (postoperative AVB)</td>
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<td></td>
<td>PPM implanted after 45±23 h of dependency on temporary pacing</td>
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<td></td>
<td>Median logistic EuroSCORE 30.1% (range 19.5–42.8%) for whole group</td>
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<td>New LBBB developed in an additional 6.6% of patients; this was transient in 3/7 but persistent until hospital discharge in 4/7 patients. At six months, one patient had died of CHF (four months after trans-apical TAVI) but six patients were well; none had required PPM</td>
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<td></td>
<td>Consecutive TAVI patients (severe AS; not classified; conventional surgery precluded by consensus committee)</td>
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<td></td>
<td>No multivariate regression analysis performed</td>
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<td></td>
<td>All Edwards–Sapien 70% trans-femoral</td>
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<td>Piazza et al., (2008), EuroIntervention, The Netherlands, [4]</td>
<td>n=729 (male 46%)</td>
<td>Incidence of PPM implantation at 30 days postTAVI</td>
<td>9.3% (60/646) but no details of pacing indications</td>
<td>83 patients excluded due to absence of clinical specialist for data collection (all excluded cases performed in more experienced centres)</td>
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<td>Case series (multi-centre European registry from 51 centres, conducted as part of postmarketing surveillance one year post CE mark approval)</td>
<td>Mean age 81.0 years</td>
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<td>PPM implantation most common complication within first 30 days; no details of timing of PPM implantation</td>
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<tr>
<td>Data collection April 2007–2008 (level 2b)</td>
<td>Mean logistic EuroSCORE 23.1 ± 13.8%</td>
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<td>Indications for PPM implantation are not given; adherence to ACC/AHA and ESC guidelines is mentioned although PPM implantation following TAVI is also described in the context of ‘asymptomatic bradycardia’ and ‘LBBB’</td>
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<tr>
<td></td>
<td>Consecutive TAVI patients (severe AS; AVA &lt;0.6 cm²/m²; conventional surgery precluded by consensus committee)</td>
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<td>Timing of PPM implantation not reported</td>
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<td></td>
<td>Age ≥75 years OR logistic EuroSCORE ≥15% OR age ≥65 years with ≥1 predetermined risk factor</td>
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<td>The incidence of new onset LBBB is not reported; there was however a significant association between</td>
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<tr>
<td>Piazza et al., (2008), JACC Cardiovasc Interiv, The Netherlands, [5]</td>
<td>Incidence of PPM implantation for AVB at 30 days postTAVI</td>
<td>17.9% (7/39), all for unspecified AVB</td>
<td>new onset LBBB and implantation depth in LVOT ($P=0.005$)</td>
<td>No regression analysis for predictors of PPM implantation</td>
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<tr>
<td>Case series (single centre: Rotterdam)</td>
<td>$n=40$ (male 50%)</td>
<td>Mean age $82 \pm 7$ years</td>
<td>One patient excluded from analysis due to pre-existing PPM</td>
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<td>Data collection period</td>
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<td>No details of mean/median logistic EuroSCORE</td>
<td>12 further patients had not completed 30 days follow-up at the time of analysis</td>
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<td>November 2005–March 2008 (level 2b)</td>
<td>Consecutive TAVI patients (severe AS; AWA &lt;0.6 cm$^2$/m$^2$; conventional surgery precluded by consensus committee)</td>
<td>All CoreValve 100% trans-femoral</td>
<td>Four patients developed PPM indication within 3±2 days of TAVI; three further patients at 42±23-day (‘30-day’ follow-up ECG). Median time to PPM six days (range 4–47 days)</td>
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<tr>
<td>Jilaihawi et al., (2009), Am Heart J, UK, [6]</td>
<td>$n=34$ (male 47%)</td>
<td>Mean age $84.4 \pm 5.4$ years</td>
<td>Both patients with pre-existing RBBB required temporary pacing immediately postTAVI and subsequent PPM for third degree AVB</td>
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<tr>
<td>Case series (single centre: Leicester, patients recruited as part of CoreValve safety and feasibility study with ongoing registry)</td>
<td>(A) Incidence of PPM implantation for AVB at 30 days postTAVI</td>
<td>(A) 30% (10/30); two patients for prolonged third degree AVB, one patient prolonged 2:1 AVB, six patients intermittent third degree AVB, one patient intermittent 2:1 AVB</td>
<td>Significant increase in frequency of LBBB post procedure (15% vs. 55%, $P=0.001$); this decreased to 48% (13/27) at 30 days but remained significant ($P=0.02$); no further follow-up available but depth of prosthesis implantation in LVOT was associated with new onset LBBB ($P=0.005$)</td>
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<td>(B) Incidence of PPM implantation for AVB</td>
<td>(B) 36.7% (11/30); one further patient for</td>
<td>No regression analysis for predictors of PPM implantation</td>
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<td>Four patients excluded from PPM analysis due to periprocedural death ($n=1$) and pre-existing PPM ($n=3$)</td>
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<td>Additional 3.3% patients (1/30) underwent PPM implantation for SND</td>
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<td>73% patients (8/11) developed PPM</td>
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<td>Data collection January 2007–March 2008 (level 2b)</td>
<td>(severe AS; not classified; conventional surgery precluded by consensus committee)</td>
<td>One year postTAVI (C) Predictors of PPM implantation (univariate analysis)</td>
<td>prolonged third degree AVB (C) Univariate regression analysis: LAD (P&lt;0.004); LBBB with LAD (P = 0.002); septal hypertrophy with IVSD &gt;17 mm (P = 0.045); thickness of NCC on TOE &gt;8 mm (P = 0.002); use of rate-limiting medications (P = 0.004)</td>
<td>indication within six days; remainder may be related to non-device, non-procedures events (PPM at 23 days, 30 days, 360 days) One-month follow-up after PPM available for nine patients: 33.3% (3/9) required ventricular pacing &lt;10% of time; remaining six patients required ventricular pacing for mean time 79 ± 20.3% Significant increase in frequency of LBBB post procedure (23% vs. 62%, P = 0.001); this decreased to 46% (11/24) at median 35 days but remained significant; no further follow-up available No multivariate regression analysis performed Five patients excluded from PPM analysis due to pre-existing PPM 100% patients (5/5) developed PPM indication within 24 h of TAVI; one further patient had ‘transient third degree AVB’ but was not paced; no follow-up available Additional 48% patients (12/25) developed new conduction disturbance; RBBB (1/25), LBBB (6/25) and LBBB with first degree AVB (5/25); overall incidence of LBBB rising from 4% preprocedure to 44% postTAVI; no further follow-up available No regression analysis for predictors of PPM implantation No documentation of pre-existing PPM Timing of PPM implantation not reported</td>
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<td>Calvi et al., (2009), Pacing Clin Electrophysiol, Italy, [7]</td>
<td>n = 30 (male 43%)</td>
<td>Incidence of PPM implantation for AVB at hospital discharge following TAVI</td>
<td>20% (5/25), all for third degree AVB</td>
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<tr>
<td>Case series (single centre: Catania)</td>
<td>Mean age 82.1 ± 8.5 years</td>
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<td>Data collection June 2007–2008 (level 2b)</td>
<td>No details of mean/median logistic EuroSCORE</td>
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<td>Consecutive TAVI patients (severe AS; AAW &lt;1 cm²; conventional surgery precluded by consensus committee)</td>
<td>All CoreValve 100% trans-femoral</td>
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<td>Webb et al., (2009), Circulation, Canada, [8]</td>
<td>n = 168 (male 52%)</td>
<td>Incidence of PPM implantation at 30 days postTAVI</td>
<td>5.4% (9/168) but no details of pacing indications</td>
<td>No documentation of pre-existing PPM Timing of PPM implantation not reported</td>
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<tr>
<td>Case series (single centre: Vancouver)</td>
<td>Median age 84 years (interquartile range 79–87 years)</td>
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<tr>
<td><strong>Data collection</strong></td>
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<tr>
<td>January 2005–April 2008 (level 2b)</td>
<td>Median logistic EuroSCORE 28.6% (interquartile range 17.9–41.0%)</td>
<td>Incidence of PPM implantation for AVB at 30 days post-TAVI</td>
<td>0% (0/29)</td>
<td>Four patients excluded from PPM analysis due to pre-existing PPM</td>
</tr>
<tr>
<td>Part funded by Edwards lifesciences</td>
<td>Consecutive TAVI patients (severe AS; median AWA 0.6 cm²; conventional surgery precluded by consensus committee)</td>
<td>Incidence of PPM implantation for AVB at 30 days post-TAVI</td>
<td>5.6% (4/71), all for unspecified AVB</td>
<td>No documentation of pre-existing PPM</td>
</tr>
<tr>
<td>Gutierrez et al., (2009), Am Heart J, Canada, [9]</td>
<td>All Edwards–Sapien 67% trans-femoral</td>
<td>Incidence of PPM implantation for AVB at 30 days post-TAVI</td>
<td>4% (17/339) but no details of pacing indication</td>
<td>No documentation of pre-existing PPM</td>
</tr>
<tr>
<td>Case series (single centre: Quebec)</td>
<td>n = 33 (male 39%)</td>
<td>Incidence of PPM implantation for AVB at 30 days post-TAVI</td>
<td>0% (0/29)</td>
<td>Four patients excluded from PPM analysis due to pre-existing PPM</td>
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<tr>
<td>April 2007–October 2008 (level 2b)</td>
<td>Mean age 81 ± 9 years</td>
<td>Incidence of PPM implantation for AVB at 30 days post-TAVI</td>
<td>5.6% (4/71), all for unspecified AVB</td>
<td>No documentation of pre-existing PPM</td>
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<tr>
<td>Ye et al., (2010), J Thorac Cardiovasc Surg, Canada, [10]</td>
<td>n = 71 (male 38%)</td>
<td>Incidence of PPM implantation for AVB at 30 days post-TAVI</td>
<td>5.6% (4/71), all for unspecified AVB</td>
<td>No documentation of pre-existing PPM</td>
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<tr>
<td>Case series (single centre: Vancouver)</td>
<td>Mean age 80 ± 9.0 years</td>
<td>Incidence of PPM implantation for AVB at 30 days post-TAVI</td>
<td>5.6% (4/71), all for unspecified AVB</td>
<td>No documentation of pre-existing PPM</td>
</tr>
<tr>
<td>October 2005–February 2009 (level 2b)</td>
<td>Mean logistic EuroSCORE 34.5 ± 20.4%</td>
<td>Incidence of PPM implantation for AVB at 30 days post-TAVI</td>
<td>5.6% (4/71), all for unspecified AVB</td>
<td>No documentation of pre-existing PPM</td>
</tr>
<tr>
<td>Rodes-Cabau et al., (2010), J Am Coll Cardiol, Canada, [11]</td>
<td>n = 339 (male 45%)</td>
<td>Incidence of PPM implantation for AVB at 30 days post-TAVI</td>
<td>4.9% (17/339) but no details of pacing indication</td>
<td>No documentation of pre-existing PPM</td>
</tr>
<tr>
<td>Case series (multi-centre Canadian registry)</td>
<td>Mean age 81 ± 8 years</td>
<td>Incidence of PPM implantation for AVB at 30 days post-TAVI</td>
<td>4.9% (17/339) but no details of pacing indication</td>
<td>No documentation of pre-existing PPM</td>
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<tr>
<th>Author, date, journal and country</th>
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<tbody>
<tr>
<td>Data collection January 2005–June 2009 (level 2b)</td>
<td>STS-PROM score 9.8 ± 6.4%</td>
<td>Consecutive TAVI patients excluding 52 included in the PARTNER trial (severe AS; mean AWA 0.63 cm²; conventional surgery precluded by consensus committee)</td>
<td>(A) Incidence of PPM implantation for AVB at 30 days postTAVI</td>
<td>8.3% (23/339) incidence at 30 days of ‘life-threatening arrhythmia’, two deaths reported due to ventricular arrhythmia and two deaths sudden and unexplained; no further details or follow-up reported</td>
<td>No regression analysis for predictors of PPM implantation</td>
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<td>All Edwards–Sapien 46% trans-femoral</td>
<td>(A) 26.9% (7/26), all for unspecified high degree AVB</td>
<td>Eight patients were excluded from analysis due to pre-existing PPM (n = 3) or periprocedural death prior to consideration of PPM (n = 5)</td>
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<tr>
<td>Baan et al., (2010), Am Heart J, The Netherlands, [12]</td>
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<td>n = 34 (male 53%) Mean age 80 ± 8 years</td>
<td>(B) Predictors of PPM implantation (univariate analysis)</td>
<td>100% patients (7/7) developed PPM indication within three days of TAVI (3/7 immediately postTAVI)</td>
<td>At one month following PPM implantation ventricular pacing was 96.6 ± 4.2% in the seven patients</td>
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<td></td>
<td>Case series (single centre: Amsterdam)</td>
<td>Mean logistic EuroSCORE 14.3 ± 10.1%</td>
<td></td>
<td>Significant increase in frequency of LBBB post procedure (6% vs. 71%, P &lt; 0.0001); this was unchanged at 30 days (70%, P = 0.2); no further follow-up reported</td>
<td>No multivariate regression analysis performed</td>
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<td></td>
<td>Data collection dates not reported (level 2b)</td>
<td>Consecutive TAVI patients (severe AS; mean AWA 0.73 cm²; conventional surgery precluded by consensus committee)</td>
<td>(B) Univariate regression analysis: smaller LVOT diameter (P = 0.01), mitral annular calcification (P = 0.008), smaller indexed EOA (P = 0.04) and more leftward frontal QRS axis (P = 0.02)</td>
<td>No documentation of pre-existing PPM</td>
<td>Timing of PPM implantation not reported</td>
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<tr>
<td>Guinot et al., (2010), J Cardiothorac Vasc Anesth, France, [13]</td>
<td></td>
<td>n = 90 (male 56%) Mean age 81 ± 8 years</td>
<td>Incidence of PPM implantation for AVB at hospital discharge following TAVI</td>
<td>5.6% (5/90), all for unspecified AVB</td>
<td>Incidence of PPM implantation for AVB by prostheses: CoreValve 6.5% (4/62) and Edwards–Sapien 3.6% (1/28), P = 0.50</td>
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<td></td>
<td>Case series (single centre: Paris)</td>
<td>Median logistic EuroSCORE 24% (interquartile range 16–32%)</td>
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<td>Nine further patients (10%) had evidence of unspecified AVB during hospital admission that did not require PPM implantation; seven</td>
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<td>Data collection October 2006–February 2009 (level 2b)</td>
<td>Consecutive TAVI patients (severe AS; mean AWA 0.37 cm²; conventional surgery precluded by consensus committee, generally logistic EuroSCORE ≥ 20%) Edwards–Sapien (n = 28) 100% trans-apical</td>
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Table 1. (Continued)

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<td>Erkapic et al., (2010), Europace, Germany, [14]</td>
<td>CoreValve (n=62) 100% trans-femoral</td>
<td>(A) Incidence of PPM implantation for AVB at hospital discharge (mean 13 ± 6 days) following TAVI; eight patients prolonged third degree AVB, three patient interrupted third degree AVB</td>
<td>No further follow-up reported</td>
<td>Further patients had evidence of ‘other heart block’; no further follow-up reported</td>
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<td>Case series (single centre: Bad Nauheim)</td>
<td>n=56 (male 46%) Mean age 80 ± 6 years Mean logistic EuroSCORE 20 ± 15% Consecutive TAVI patients (severe AS; AVA mean 0.7 cm²; conventional surgery precluded by consensus committee) Edwards–Sapien (n=14) 100% trans-apical CoreValve (n=36) 100% trans-femoral</td>
<td>(A) Incidence of PPM implantation for AVB at hospital discharge (mean 13 ± 6 days) following TAVI; eight patients prolonged third degree AVB, three patient interrupted third degree AVB</td>
<td>(B) Multivariate regression analysis: pre-existing RBBB (P=0.019); use of CoreValve prosthesis (P=0.044)</td>
<td>Seven patients (8%) had atrial fibrillation postTAVI One sudden unexplained death reported and one death due to intractable ventricular arrhythmia; no further details reported</td>
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<tr>
<td>Walther et al., (2010), Eur Heart J, Germany, [15]</td>
<td>n=100 (male 33%) Mean age 82.7 ± 5.0 years Mean logistic EuroSCORE 29.4 ± 13%</td>
<td>Incidence of PPM implantation for AVB at 30 days postTAVI 10.1% (9/89), all for high-grade AVB</td>
<td>11 patients were excluded from PPM analysis due to pre-existing PPM</td>
<td>56% patients (5/9) developed PPM</td>
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<td>Bleiziffer et al., (2010), JACC Cardiovasc Interv, Germany, [16]</td>
<td>Case series (single centre: Munich)</td>
<td>Data collection June 2007–January 2009 (level 2b)</td>
<td>Consecutive TAVI patients (severe AS; unspecified; conventional surgery precluded by age ≥75 years AND additive EuroSCORE ≥9) All Edwards–Sapien 100% trans-apical</td>
<td>(A) Incidence of PPM implantation for AVB at day 14 (prespecified endpoint) postTAVI</td>
<td>(A) 22% (35/159), all for high-grade AVB</td>
<td>indication within 24 h; 100% patients (9/9) developed PPM induction within five days</td>
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<td>Data collection February 2006–January 2008 (level 2b)</td>
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<td>n=200 (male 43%) Mean age 80.8 ± 6.2 years Mean logistic EuroSCORE 21.6 ± 13.0%</td>
<td>(B) Predictors of PPM implantation for AVB (univariate analysis)</td>
<td>(B) Univariate regression analysis: six factors identified with P values &lt;0.1 – intraoperative AVB (P&lt;0.001), use of CoreValve prosthesis (P = 0.008), valvuloplasty balloon size (P = 0.019), borderline annulus size for valve size (P = 0.069), annulus-to-balloon size difference (P = 0.045), and RBBB (P = 0.078). All were entered into a multivariate model</td>
<td>Incidence of arrhythmia or conduction abnormality was not further reported</td>
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<td>n=200 (male 43%) Mean age 80.8 ± 6.2 years Mean logistic EuroSCORE 21.6 ± 13.0%</td>
<td>(C) Predictors of PPM implantation for AVB (multivariate analysis)</td>
<td>(C) Multivariate regression analysis: AVB during TAVI procedure (OR 4.819, 95% CI 2.0–11.9, P = 0.001) only significant factor Use of CoreValve prosthesis (OR 3.781, 95% CI 0.8–17.6, P = 0.09) and borderline annulus size for valve size (OR 2.378, 95% CI 1.0–5.9,</td>
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<td>n=200 (male 43%) Mean age 80.8 ± 6.2 years Mean logistic EuroSCORE 21.6 ± 13.0%</td>
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<td>No regression analysis for predictors of PPM implantation</td>
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<td>n=200 (male 43%) Mean age 80.8 ± 6.2 years Mean logistic EuroSCORE 21.6 ± 13.0%</td>
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<td>Additional 5.7% patients (9/159) underwent PPM implantation for SND (1/159) and ‘bradyarrhythmia’ (8/159)</td>
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<td>n=200 (male 43%) Mean age 80.8 ± 6.2 years Mean logistic EuroSCORE 21.6 ± 13.0%</td>
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<td>Mean time to PPM implantation 4.2 ± 3.5 days (range 0–11 days)</td>
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<td>n=200 (male 43%) Mean age 80.8 ± 6.2 years Mean logistic EuroSCORE 21.6 ± 13.0%</td>
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<td>Incidence of new postoperative conduction disturbance not reported; preoperative RBBB rare in this series: 6/159 patients (4%)</td>
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<td>n=200 (male 43%) Mean age 80.8 ± 6.2 years Mean logistic EuroSCORE 21.6 ± 13.0%</td>
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<td>Incidence of PPM implantation for AVB by prosthesis: CoreValve 27% (33/124) and Edwards–Sapien 6% (2/35), P = 0.008</td>
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<td>n=200 (male 43%) Mean age 80.8 ± 6.2 years Mean logistic EuroSCORE 21.6 ± 13.0%</td>
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<td>Incidence of PPM implantation for AVB by intraoperative AVB: AVB 49% (18/37) and no AVB 14% (17/122), P = 0.001</td>
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PPM, permanent pacemaker; AVB, atrioventricular block; TAVI, trans-catheter aortic valve implantation; RBBB, right bundle branch block; AS, aortic stenosis; LBVB, left bundle branch block; OR, odds ratio; LVOT, left ventricular outflow tract; LAD, left axis deviation; IVSd, interventricular septum dimension in diastole; NCC, non-coronary cusp of the aortic valve; TOE, trans-oesophageal echocardiogram; LAHB, left anterior hemi-block; STS-PROM, society of thoracicsurgeons-predicted risk of mortality; EOA, effective orifice area; CI, confidence interval; CHF, congestive heart failure; AWA, aortic valve area; ACC/AHA, American College of Cardiology/American Heart Association; ESC, European Society of Cardiology; ECG, electrocardiograph; SND, sinus node dysfunction.

Independent predictors of PPM requirement following TAVI include use of the CoreValve prosthesis and evidence of conduction system dysfunction, either pre-existing RBBB or AVB at the time of TAVI. All patients should be made aware of the high risk of PPM implantation with TAVI.

References


