Abstract

Background In a three-month report from the CGA-TAVI registry, we found the Multidimensional Prognostic Index (MPI) and Short Physical Performance Battery (SPPB) to be of value for predicting short-term outcomes in elderly patients undergoing transcatheter aortic valve implantation (TAVI). In the present analysis, we examined the association of these tools with outcomes up to one year post-TAVI.

Methods CGA-TAVI is an international, observational registry of geriatric patients undergoing TAVI. Patients were assessed using the MPI and SPPB. Efficacy of baseline values and any postoperative change for predicting outcome were established using logistic regression. Kaplan-Meier analysis was carried out for each comprehensive geriatric assessment tool, with survival stratified by risk category.

Results One year after TAVI, 14.1% of patients deceased, while 17.4% met the combined endpoint of death and/or non-fatal stroke, and 37.7% the combined endpoint of death and/or hospitalisation and/or non-fatal stroke. A high-risk MPI score was associated with an increased risk of all-cause mortality (aOR = 36.13, 95% CI: 2.77–470.78, \( P = 0.006 \)) and death and/or non-fatal stroke (aOR = 10.10, 95% CI: 1.48–68.75, \( P = 0.018 \)). No significant associations were found between a high-risk SPPB score and mortality or two main combined endpoints. In contrast to a worsening SPPB, an aggravating MPI score at three months post-TAVI was associated with an increased risk of death and/or non-fatal stroke at one year (aOR = 95.16, 95% CI: 3.41–2657.01).

Conclusions The MPI showed value for predicting the likelihood of death and a combination of death and/or non-fatal stroke by one year after TAVI in elderly patients.

Keywords: Comprehensive geriatric assessment; Multidimensional prognostic index; Short physical performance battery; Silver code; Transcatheter aortic valve implantation

1 Introduction

It has been suggested that performing a comprehensive geriatric assessment (CGA) which includes variables related to frailty, mental and physical status, social support, and overall health prior to transcatheter aortic valve implantation (TAVI) may provide valuable information to aid candidate selection among elderly patients. \(^1\) \(^2\) Recent evidence from a single-centre observational study suggests that the Multidimensional Prognostic Index (MPI), which was originally developed to assess mortality after hospitalisation of elderly patients,\(^3\) can accurately predict outcomes for up to twelve months post-procedure in geriatric patients undergoing TAVI.\(^4\) Similarly, in a previous analysis of the present registry (CGA-TAVI), we found a higher MPI to be predictive of death/stroke by three months post-TAVI.\(^5\) In that previ-
ous analysis, we also assessed the Silver Code (SC) and Short Physical Performance Battery (SPPB) tools, and found the latter to also have some predictive value for short-term outcomes in elderly patients post-TAVI.

In the present manuscript, we analysed the CGA-TAVI registry data with the aim of assessing the value of the two principal CGA tools (MPI and SPPB) from the previous analysis for predicting outcomes in the year following TAVI.

2 Methods

The design and rationale of the prospective, international, multicentre, observational CGA-TAVI registry has been previously described. Consequently, only a brief overview is included herein. Elderly patients with severe aortic steno-

sis (AS) were enrolled at one of three hospitals or medical centres in Italy, the Netherlands and Canada between August 2013 and December 2015. The study was approved by the responsible ethics committee at each participating site. All subjects gave their written informed consent to participate.

2.1 Inclusion/exclusion criteria

Patients meeting the following criteria were eligible for inclusion: severe, symptomatic, and calcific AS; age ≥ 80 years; scheduled to undergo transapical- or transfemoral- TAVI; adequate time to perform CGA prior to the procedure (i.e., not an emergency); and ability to participate in follow-up examinations.

2.2 Baseline assessment

At baseline, details of patient demographics, comorbid-

ities, prior cardiovascular interventions, cardiac characteris-
tics, and surgical risk were documented. A geriatrician also carried out the CGA, with each patient evaluated using three assessment tools: the MPI (a mean of eight different components), the SPPB (consisting of repeated chair stands, balance testing, and walking 2.44 meters), and the SC (an algorithm based on administrative data). For the MPI and SC, a lower score indicates a better prognosis; while the inverse is true for the SPPB. Data for the SC are not included in the current analysis, because it did not show any predictive ability in the prior analysis of short-term outcomes in the study population.

2.3 Follow-up

Patients were followed-up at thirty days and three months (data previously published), and again at one year by either telephone or outpatient clinic visit. Recorded outcomes at one year were death, non-fatal stroke, hospitalisation for valve-related symptoms or worsening congestive heart failure, major vascular complications, repeat procedure for valve dysfunction, valve thrombosis, and thromboemolic events (all as defined by the Valve Academic Research Consortium-2 criteria), and selected combinations thereof. These data were used to identify any associations between baseline MPI and SPPB scores (or postoperative change in scores) and clinical outcomes at one year. The main endpoints of interest for the current analysis were all-cause mortality and a composite endpoint of death and/or non-fatal stroke.

2.4 Statistical analysis

Data are presented using descriptive statistics, with absolute values and percentages given for categorical variables and means ± SD for continuous variables. For the purposes of assessing survival, Kaplan-Meier analysis was carried out, with patients stratified into good and poor prognosis groups based on their scores in each of the GCA tools (MPI: mean of 0.0–0.33 and 0.34–1.0, respectively; and SPPB: 7–12 and 0–6 points, respectively). The value of each CGA tool and each of their components for predicting primary and secondary outcomes at one year was assessed using logistic regression. Regression results are presented as odds ratio (OR) with 95% confidence intervals (CI) and P-values. Data were analysed using IBM SPSS statistics version 24 (IBM corporation, Amonk, New York, USA). In all cases, signifi-
cance was determined by a P-value < 0.05.

3 Results

3.1 Baseline patient characteristics

The baseline characteristics of the 71 patients included in the analysis have been described before. In short, the mean ± SD age of the study population was 85.4 ± 2.9 years, patients had a body mass index of 24.7 ± 3.7 kg/m², the most common comorbidities were hypertension (83.1%) and coronary artery disease (53.5%), and more than 80% of pa-
tients were in New York Heart Association (NYHA) class III or IV. AS-related symptoms included class III angina (10%), dizziness on exertion (7.0%) and syncope (7.0%); the mean aortic valve gradient was 50.5 ± 14.1 mmHg and mean left ventricular ejection fraction was 50.9 ± 12.0%. In terms of surgical risk, mean ± SD values for the log EuroSCORE I and Society of Thoracic Surgeons score were 22.5 ± 13.2 and 5.8 ± 3.9, respectively.

3.2 Outcomes at one year

Outcomes at one year (mortality, non-fatal complications
and combined endpoints) are summarised in Table 1 and were available for 70 patients (98.6%). By one year after TAVI, 10 of 70 (14.1%) patients had died, while 12 of 69 (17.4%) had met the combined endpoint of death and/or non-fatal stroke, and 26 of 69 (37.7%) had met the combined endpoint of death and/or re-hospitalisation and/or non-fatal stroke.

### 3.3 Association of MPI and SPPB with one-year outcomes

Outcomes within one year after TAVI for patients stratified by MPI/SPPB score, and association between MPI/SPPB score and outcomes (logistic regression analysis).

#### Table 1. Outcomes within one year after TAVI by MPI/SPPB score, and association between MPI/SPPB score and outcomes (logistic regression analysis).

| MPI score | Total | High risk (0.34 to 1.00) | Low risk (0 to 0.33) | Univariable | Multivariable |
|-----------|-------|--------------------------|----------------------|-------------|--------------|
|           | OR (95% CI) | P-value | OR (95% CI) | P-value |
| All-cause mortality | 7/28 (25.0%) | 3/42 (7.1%) | 4.33 (1.01–18.53) | 0.048 | 36.13 (2.77–470.78) | 0.006 |
| Combined endpoint | 12/41 (29.3%) | 5/41 (12.2%) | 2.40 (0.68–8.53) | 0.18 | 10.10 (1.48–68.75) | 0.018 |
| Death and/or re-hospitalisation | 13/28 (46.4%) | 13/41 (31.7%) | 1.87 (0.69–5.03) | 0.22 | 2.65 (0.79–8.92) | 0.11 |
| Death and/or non-fatal stroke | 7/28 (25.0%) | 13/41 (31.7%) | 1.87 (0.69–5.03) | 0.22 | 2.65 (0.79–8.92) | 0.11 |
| Death, re-hospitalisation and/or stroke | 13/28 (46.4%) | 13/41 (31.7%) | 1.87 (0.69–5.03) | 0.22 | 2.65 (0.79–8.92) | 0.11 |
| Death, re-hospitalisation, stroke, AKI, MVC, repeat procedure, MI, PPI | 15/28 (53.6%) | 18/41 (43.9%) | 1.47 (0.56–3.87) | 0.43 | 1.49 (0.50–4.49) | 0.47 |

#### Table 1. Outcomes within one year after TAVI by MPI/SPPB score, and association between MPI/SPPB score and outcomes (logistic regression analysis).

| SPPB-score | Total | High risk (0 to 6) | Low risk (7 to 12) | Univariable | Multivariable |
|------------|-------|-------------------|-------------------|-------------|--------------|
|           | OR (95% CI) | P-value | OR (95% CI) | P-value |
| All-cause mortality | 9/39 (23.1%) | 1/31 (3.2%) | 9.00 (1.07–75.51) | 0.043 | 7.09 (0.70–71.89) | 0.097 |
| Combined endpoint | 9/39 (23.1%) | 1/31 (3.2%) | 9.00 (1.07–75.51) | 0.043 | 7.09 (0.70–71.89) | 0.097 |
| Death and/or re-hospitalisation | 16/38 (42.1%) | 9/31 (29.0%) | 1.78 (0.65–4.87) | 0.26 | 1.37 (0.41–4.53) | 0.61 |
| Death and/or non-fatal stroke | 10/38 (26.3%) | 2/31 (6.5%) | 5.18 (1.04–25.77) | 0.045 | 8.79 (0.93–83.34) | 0.058 |
| Death, re-hospitalisation and/or stroke | 17/38 (44.7%) | 9/31 (29.0%) | 1.98 (0.72–5.41) | 0.18 | 1.62 (0.50–5.19) | 0.42 |
| Death, re-hospitalisation, stroke, AKI, MVC, repeat procedure, MI, PPI | 23/38 (60.5%) | 10/31 (32.3%) | 3.22 (1.19–8.71) | 0.021 | 3.19 (1.03–9.89) | 0.045 |

Data are presented as n/N (%) unless otherwise indicated. *Adjusted for age, gender, NYHA class and surgical risk (EuroScore). n/N refers the ratio of number of patients with outcome to number of patients at risk. AKI: acute kidney injury; MI: myocardial infarction; MPI: multidimensional prognostic index; MVC: major vascular complication; OR: odds ratio; PPI: permanent pacemaker implantation; SPPB: short physical performance battery; TAVI: transcatheter aortic valve implantation.
fied into high- and low-risk groups according to MPI score are summarised in Table 1, together with the results of logistic regression analysis evaluating the relationship between baseline MPI score and outcomes. After adjustment for other baseline characteristics (including age, gender, NYHA class, and EuroScore surgical risk score), a high-risk MPI score was associated with an increased risk of all-cause mortality (adjusted OR = 36.13, 95% CI: 2.77–470.78, \( P = 0.006 \)) and the combined endpoint of death and/or non-fatal stroke (aOR = 10.10, 95% CI: 1.48–68.75, \( P = 0.018 \)). Kaplan-Meier analysis curves stratified by MPI risk group are shown for survival (Figure 1A), freedom from death and/or

**Figure 1.** Kaplan-Meier survival analysis stratified by MPI group (A), SPPB group (B) and score & Kaplan-Meier analysis for the freedom from death and stroke stratified by MPI group (C), SPPB group (D) and score & Kaplan-Meier analysis for the freedom from death, re-hospitalization and stroke stratified by MPI group (E), SPPB group (F) and score. MPI: multidimensional prognostic index; SPPB: short physical performance battery.
non-fatal stroke (Figure 1C) and freedom from death/hospitalisation/stroke (Figure 1E).

Outcomes within one year after TAVI for patients stratified by SPPB risk, and the results of the analysis of the relationship between baseline SPPB score and outcomes, are summarised in Table 1. After adjustment for other baseline characteristics, no significant associations were found between a high-risk SPPB score and mortality, or the combined endpoints of death and/or non-fatal stroke, or death/hospitalisation/stroke. However, a high-risk SPPB score was independently associated with an increased risk of a composite endpoint comprising all fatal and non-fatal endpoints evaluated (i.e., death/hospitalisation/non-fatal stroke/acute kidney injury/major vascular complication/repeated procedure/myocardial infarction/permanent pacemaker implantation, aOR = 3.19, 95% CI: 1.03–9.89, \( P = 0.045 \)). Kaplan-Meier analysis curves stratified by SPPB risk group are shown for survival (Figure 1B), freedom from death and/or non-fatal stroke (Figure 1D) and freedom from death/re-hospitalization/stroke (Figure 1F).

### 3.4 Association of MPI and SPPB components with one-year outcomes

Associations between components of the MPI and SPPB and key combined outcomes at one year are summarised in Table 2 (association with death and/or re-hospitalization and/or stroke and association with death and/or stroke). After adjusting for baseline characteristics, the only MPI components associated with the combined endpoint of death and/or stroke at one year were worse Activities of Daily Living (ADL) score (aOR = 13.21, 95% CI: 1.54–113.72, \( P = 0.019 \)) and worse Exton-Smith Scale (ESS) score (aOR = 9.30, 95% CI: 1.63–53.19, \( P = 0.012 \)). The only MPI components associated with an increased risk of the combined endpoint of death and/or re-hospitalization and/or stroke at one year were worse Mini Nutritional Assessment (MNA) score (aOR = 3.42, 95% CI: 1.04–11.18, \( P = 0.042 \)) and worse ESS score (aOR = 13.72, 95% CI: 1.64–115.06, \( P = 0.016 \)). No SPPB components were significantly associated with either of these outcomes in the adjusted analysis.

### 3.5 Association of 3-month changes in MPI or SPPB with one-year outcomes

The relationship between a worsening MPI or SPPB score within three months after TAVI and outcomes at one year is summarised in Table 3. A worsening (increasing) MPI score at three months post-TAVI was associated with an increased risk of the combined endpoint of death and/or non-fatal stroke at one year in the adjusted analysis (aOR = 95.16, 95% CI: 3.41–2657.01). No significant independent relationships were found between worsening SPPB and one-year outcomes.

### 4 Discussion

This analysis of the CGA-TAVI registry data found that the MPI, but not the SPPB, showed value for predicting the likelihood of death and a combination of death and/or non-fatal stroke by one year after TAVI in elderly patients.

The rate of all-cause mortality at one year after TAVI (14.1%) in the CGA-TAVI registry was consistent with rates reported in large studies of elderly patients (mean age > 80 years) with a similar level of surgical risk (12.5%–17.1%). The incidence of non-fatal stroke at one year (2.9%) was also within the range reported for other studies (2.2%–4.3%). The current analysis reported rates of valve-related and non-valve-related re-hospitalisation of 8.7% and 20.3%, respectively. Although not directly comparable because of the different definitions used, other studies have reported rates of 3.2%–8.1% for rehospitalisation related to the valve or heart failure and 17.1% for any rehospitalisation.

The incorporation of CGA measures into the clinical assessment of AS candidates for TAVI may improve the assessment of procedural risk and/or risk of adverse outcome at follow-up in this generally elderly population. Studies have shown the potential of various multi-component tools for predicting morbidity and mortality outcomes after elective cardiac surgical procedures and specifically after TAVI.

The MPI is derived from a standard CGA that includes clinical, functional, cognitive, nutritional, and social parameters. Studies have shown that higher MPI scores are associated with higher rates of mortality and other adverse outcomes in older hospitalised patients including those with heart failure or transient ischemic attack. Limited information on its role specifically in TAVI patients is available. A prospective, single-centre, observational study involving 116 patients (mean age 86 years, mean EuroSCORE 19.2%) found that the MPI was able to predict the risk of mortality at six and twelve months after TAVI. In addition, a previous analysis of data from our CGA-TAVI registry found that the MPI had value for predicting the likelihood of a composite of death and/or hospitalisation and a composite of death and/or non-fatal stroke within the first three months after TAVI. The current analysis assessed the value of the MPI for predicting outcomes up to one year after TAVI and found that, after adjusting for baseline characteristics, MPI score was predictive for all-cause mortality and the combination of death and/or non-fatal stroke.
stroke at this timepoint, but not for the composite of death and/or hospitalisation. Thus, based on CGA-TAVI registry data, the MPI was predictive of death and/or non-fatal stroke at both three months and one year after TAVI. However, its predictive value for death and/or hospitalisation in the short term was not maintained through to one year. The previous analysis did not evaluate the relationship specifically with all-cause mortality at three months.

Data are presented as n/N (%) unless otherwise indicated. *Adjusted for age, gender, NYHA class and surgical risk (EuroScore). n/N refers the ratio of number of patients with outcome to number of patients at risk. ADL: activities of daily living; CIRS: cumulative illness rating scale; ESS: exton-smith scale; IADL: instrumental activities of daily living; MNA: mini nutritional assessment; MPI: multidimensional prognostic index; OR: odds ratio; SPMSQ: short portable mental status questionnaire; SPPB: short physical performance battery.

Table 2. Association of MPI and SPPB components with combined outcome of mortality and/or re-hospitalization and/or stroke and association of MPI and SPPB components with combined outcome of mortality and/or stroke at one year after TAVI.

| Mortality, any re-hospitalization, or stroke | Univariable Events in high vs low risk | Multivariable* Events in high vs low risk |
|-------------------------------------------|---------------------------------------|----------------------------------------|
| **High risk** (MPI = 0.34 to 1 or components = 0.5 to 1) | **Low risk** (MPI = 0 to 0.33 or components = 0) | **High risk** (MPI = 0.34 to 1 or components = 0.5 to 1) | **Low risk** (MPI = 0 to 0.33 or components = 0) | **OR (95% CI)** | **P-value** | **OR (95% CI)** | **P-value** |
| MPI | 13/28 (46.4%) | 13/41 (31.7%) | 1.87 (0.69–5.03) | 0.22 | 2.65 (0.79–8.92) | 0.11 |
| Co-habitation status | 11/29 (37.9%) | 15/40 (37.5%) | 1.02 (0.38–2.73) | 0.97 | 1.45 (0.43–4.90) | 0.55 |
| Current medication use | 25/68 (36.8%) | 1/1 (100%) | - | - | - | - |
| ADL score | 5/7 (71.4%) | 21/62 (34.6%) | 4.88 (0.87–27.32) | 0.07 | 4.26 (0.67–27.18) | 0.13 |
| IADL score | 8/17 (47.1%) | 18/52 (34.6%) | 1.68 (0.55–5.10) | 0.36 | 1.377 (0.38–5.03) | 0.63 |
| SPMSQ score | 25/67 (37.3%) | 1/2 (50.0%) | 0.60 (0.04–9.94) | 0.72 | 0.65 (0.03–14.32) | 0.65 |
| MNA score | 7/9 (77.8%) | 19/60 (31.7%) | 7.55 (1.43–39.84) | 0.017 | 13.72 (1.64–115.06) | 0.016 |

| SPPB | 17/38 (44.7%) | 9/31 (29.0%) | 1.98 (0.72–5.41) | 0.18 | 1.62 (0.50–5.19) | 0.42 |
| Repeated Chair Stands | 21/58 (36.2%) | 5/11 (45.5%) | 0.68 (0.19–2.50) | 0.56 | 0.45 (0.09–2.16) | 0.32 |
| Balance Testing | 15/31 (48.4%) | 11/38 (28.9%) | 2.30 (0.85–6.22) | 0.10 | 1.97 (0.67–5.81) | 0.22 |
| Eight-foot walk | 21/45 (46.7%) | 5/24 (20.8%) | 3.33 (1.06–10.46) | 0.04 | 3.40 (0.93–12.46) | 0.064 |

| Mortality and stroke | Univariable Events in high vs low risk | Multivariable* Events in high vs low risk |
|-------------------------------------------|---------------------------------------|----------------------------------------|
| **High risk** (MPI = 0.34 to 1 or components = 0.5 to 1) | **Low risk** (MPI = 0 to 0.33 or components = 0) | **OR (95% CI)** | **P-value** | **OR (95% CI)** | **P-value** |
| MPI | 7/28 (25.0%) | 5/41 (12.2%) | 2.40 (0.68–8.53) | 0.18 | 10.10 (1.48–68.75) | 0.018 |
| Co-habitation status | 5/29 (17.2%) | 7/40 (17.5%) | 0.98 (0.28–3.47) | 0.98 | 1.88 (0.40–8.76) | 0.42 |
| Current medication use | 12/68 (17.6%) | 0/1 (0%) | - | - | - | - |
| ADL score | 3/7 (42.9%) | 9/62 (14.5%) | 4.42 (0.84–23.12) | 0.08 | 13.21 (1.54–113.72) | 0.019 |
| IADL score | 3/17 (17.6%) | 9/52 (17.3%) | 1.02 (0.24–4.32) | 0.97 | 1.10 (0.22–5.63) | 0.91 |
| SPMSQ score | 0/1 (0%) | 12/68 (17.6%) | - | - | - | - |
| CIRS CI | 12/67 (17.9%) | 0/2 (0%) | - | - | - | - |
| MNA score | 7/35 (20.0%) | 5/34 (14.7%) | 1.45 (0.41–5.11) | 0.56 | 2.40 (0.51–11.37) | 0.27 |
| ESS | 5/9 (55.6%) | 7/60 (11.7%) | 9.46 (2.04–43.84) | 0.004 | 9.30 (1.63–53.19) | 0.012 |

| SPPB | 10/38 (26.3%) | 2/31 (6.5%) | 5.18 (1.04–25.77) | 0.045 | 8.79 (0.93–83.34) | 0.058 |
| Repeated Chair Stands | 10/58 (17.2%) | 2/11 (18.2%) | 0.94 (0.18–5.01) | 0.94 | 0.91 (0.12–7.14) | 0.93 |
| Balance Testing | 9/31 (29.0%) | 3/38 (7.9%) | 4.77 (1.16–19.57) | 0.03 | 4.44 (0.95–20.73) | 0.058 |
| Eight-foot walk | 11/45 (24.4%) | 1/24 (4.2%) | 7.44 (0.90–61.65) | 0.06 | - | - |
The SPPB involves physical performance tests that assess lower extremity function.\(^7\) Lower scores on the SPPB have been shown to be predictive of an increased risk of death and/or rehospitalisation in older adults with acute illness,\(^{26}\) death in older patients hospitalised with heart failure,\(^{27}\) and poor functional survival after cardiac surgery.\(^{28}\)  Few data on its predictive role in the setting of TAVI are available. A retrospective single-centre study (155 patients with severe AS, mean age 84 years) found that SPPB score was independently associated with the likelihood of unplanned readmission following TAVI, and that the addition of the SPPB to predictive clinical models increased discriminatory performance for predicting unplanned readmission and all-cause death.\(^{29}\)  A previous analysis of the CGA-TAVI registry found that the SPPB had value for predicting the likelihood of a composite of death and/or hospitalisation and a composite of death and/or non-fatal stroke within the first three months after TAVI.\(^5\) In contrast, the current analysis did not find that SPPB score was an independent predictor of these outcomes at one year, although it did find it was predictive of a composite endpoint comprising all fatal and non-fatal complications. A high-risk SPPB score was associated with an increased likelihood of all-cause mortality and the composite of death and/or non-fatal stroke in univariate analysis, but significance was lost after adjustment for baseline characteristics in multivariate analysis, although the result for death and/or non-fatal stroke approached significance \((P = 0.058)\).  The MPI is a multidimensional tool comprising eight different assessments. As part of the current study, we

| Table 3. Outcomes at one year with respect to worsening of MPI or SPPB within three months after TAVI. |
|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| | Total | Score components available | Increasing MPI \(n = 17\) | Decreasing SPPB \(n = 5\) |
| | | | Univariable OR (95% CI) | Multivariable OR (95% CI) | Univariable OR (95% CI) | Multivariable OR (95% CI) |
| All-cause mortality | 10/70 (14.1%) | 4/56 (7.1%) | 4/17 (23.5%) | - | - | 0/5 (0%) | - | - |
| Combined endpoint | | | | | | | | | |
| Death and/or hospitalisation | 25/69 (36.2%) | 17/55 (30.9%) | 6/17 (35.3%) | 1.14 (0.40–4.52) | 1.10 (0.27–4.56) | 1/5 (20.0%) | 0.53 (0.06–5.14) | 0.46 (0.04–5.66) |
| Death and/or non-fatal stroke | 12/69 (17.4%) | 6/55 (10.9%) | 5/17 (29.4%) | 15.42 (1.64–145.34) | 95.16 (3.41–2657.01) | 1/5 (20.0%) | 2.25 (0.21–24.27) | 3.38 (0.25–44.91) |
| Death, hospitalisation and/or stroke | 26/69 (37.7%) | 18/55 (32.7%) | 7/17 (41.2%) | 1.72 (0.52–5.67) | 1.69 (0.41–6.95) | 2/5 (40.0%) | 1.42 (0.22–9.33) | 1.72 (0.22–13.68) |
| Death, hospitalisation, stroke, AKI, MVC, repeat procedure, MI, PPI | 33/69 (47.8%) | 23/55 (41.8%) | 9/17 (52.9%) | 1.93 (0.61–6.14) | 2.02 (0.54–7.62) | 2/5 (40.0%) | 0.92 (0.14–6.01) | 0.96 (0.13–7.07) |
| Non-fatal complications | | | | | | | | | |
| Non-valve related re-hospitalisation | 14/69 (20.3%) | 12/55 (21.8%) | 4/17 (23.5%) | 1.15 (0.30–4.52) | 0.86 (0.16–4.54) | 0/5 (0%) | - | - |
| Valve-related hospitalisation | 6/69 (8.7%) | 4/55 (7.3%) | 1/17 (5.9%) | 0.73 (0.07–7.56) | 1.32 (0.12–14.86) | 1/5 (20.0%) | 3.92 (0.33–46.90) | 2.52 (0.20–32.32) |
| Non-fatal stroke | 2/69 (2.9%) | 2/55 (3.6%) | 1/17 (5.9%) | 2.31 (0.14–39.31) | 19.61 (0.47–812.40) | 1/5 (20.0%) | 12.25 (0.64–234.81) | 51.99 (0.88–3060.37) |
| Acute kidney injury (stage 2 or 3) | 4/69 (5.8%) | 2/55 (3.6%) | 0/17 (0%) | - | - | 1/5 (20.0%) | 12.25 (0.64–234.81) | 10.57 (0.30–378.98) |
| Major vascular complication | 2/69 (2.9%) | 0/55 (0%) | 0/17 (0%) | - | - | 0/5 (0%) | - | - |
| Repeat procedure for valve dysfunction | 1/69 (1.4%) | 1/55 (1.8%) | 0/17 (0%) | - | - | 1/5 (20.0%) | - | - |
| Myocardial infarction | 2/69 (2.9%) | 1/55 (1.8%) | 0/17 (0%) | - | - | 0/5 (0%) | - | - |
| PPI | 11/69 (15.9%) | 7/55 (12.7%) | 2/17 (11.8%) | 0.88 (0.15–5.06) | 0.44 (0.05–3.70) | 0/5 (0%) | - | - |

Data are presented as \(n\)/N (%) unless other indicated. *Adjusted for age, gender, NYHA class and surgical risk (EuroScore). N refers the ratio of number of patients with outcome to number of patients at risk. AKI: acute kidney injury; MI: myocardial infarction; MPI: multidimensional prognostic index; MVC: major vascular complication; OR: odds ratio; PPI: permanent pacemaker implantation; SPPB: short physical performance battery; TAVI: transcatheter aortic valve implantation.
sought to identify whether there were clear associations between any individual components of the MPI and two composite outcomes at one year after TAVI. The only MPI components independently associated with the combined endpoint of death and/or stroke at one year were worse ADL score and worse ESS score, and the only components associated with the composite of death and/or re-hospitalization and/or stroke at one year were worse MNA score and worse ESS score. Few other studies have specifically reported on individual MPI components in TAVI patients. One study found that a low ADL score was independently predictive of long-term all-cause mortality after TAVI in elderly patients, while two others found univariate associations between ADL score or MNA score and morbidity and mortality after TAVI.

The SPPB comprises balance testing, repeated chair stands, and time to walk eight feet. In patients undergoing TAVI, slow gait speed has been shown to be associated with an increased risk of short- and mid-term mortality and with unplanned readmission. Another study reported that a “timed get up and go” test had good predictive ability for mortality and major morbidity during the first year after TAVI. The current study did not find any significant independent associations between individual components of the SPPB and composite endpoints comprising death and/or stroke or death and/or hospitalisation and/or stroke at one year, although the eight-foot walk was associated with both endpoints in univariate analysis.

The previous analysis of CGA-TAVI data found there was no significant changes in mean MPI score between baseline and three months, whereas mean SPPB score improved significantly. In the current study, a worsening (increasing) MPI score at three months post-TAVI was associated with an increased risk of the composite endpoint of death and/or non-fatal stroke at one year in the adjusted analysis. No significant relationships between worsening SPPB and one-year outcome were found. Little information has been published about the relevance of changes in MPI score over time and no other studies evaluating changes in MPI score over time in TAVI patients were identified. One study involving elderly patients admitted to hospital with an acute illness or a relapse of chronic disease reported that changes in MPI score might be helpful for monitoring the evolution of a patient’s clinical condition during a hospital stay.

4.1 Limitations

This registry analysis provides useful data from a real-world perspective. Despite advanced age and high-risk status for aortic valve replacement, patients with low-risk results on either MPI or SPPB enjoyed excellent short-term and one-year outcomes. This can be particularly helpful with respect to very elderly patients, as this population is often excluded from clinical trials.

However, the observational nature of the study means there is a greater risk of missing data. In addition, the number of patients enrolled was modest, limiting the statistical power of the analysis and the generalisability of the data. Additional studies involving a larger number of participants would be helpful to confirm and expand on the results. The findings of this study are applicable to elderly patients at higher levels of surgical risk; additional evaluation of CGA and its components in other groups of elderly patients may be helpful, given the current shift towards performing TAVI in lower risk patients than in the past.

4.2 Conclusions

Baseline MPI score was an independent predictor of all-cause mortality and a composite of death and/or non-fatal stroke at one year after TAVI in elderly patients. A worsening MPI score at three months post-TAVI was also associated with an increased risk of death and/or non-fatal stroke at one year. SPPB score was not found to be an independent predictor of one-year post-TAVI outcomes. These findings need to be confirmed in a larger sample of TAVI patients.

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*Source:* van Mourik, et al. CGA and outcomes in TAVI
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