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Quality indicators for transcatheter aortic valve implantation in Ontario, Canada: a population-based study

Suleman Aktaa ,[1] Olivia Haldenby,[2] Feng Qiu,[2] Dennis T Ko,[3] Stephen Fremes ,[4,5] Maneesh Sud,[2,6] Sandra B Lauck,[1] Mamas A Mamas ,[7] Daniel J Blackman,[8,9] John G Webb,[10] Harindra C Wijeysundera[2,6]

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For numbered affiliations see end of article.

Correspondence to
Dr Harindra C Wijeysundera; harindra.wijeysundera@sunnybrook.ca

ABSTRACT

Objectives We examined the utility of quality indicators (QIs) for transcatheter aortic valve implantation (TAVI) in the assessment of TAVI care quality and variation in practice.

Design We performed a retrospective population-level cohort study in Ontario, Canada, where all residents receive publicly funded universal medical care. We examined the association between QI attainment and outcomes using multivariable hierarchical logistic models. We used median ORs to understand if variation in clinical outcomes between hospitals was attributable to variation in QI attainment.

Setting We used all-comer registry data from the provincial CorHealth registry in Ontario, with linkage to administrative datasets using unique patient encoded identifiers.

Participants TAVI recipients between 2018 and 2023 in Ontario, Canada.

Intervention We derived a unique set of QIs from internationally agreed ones.

Primary and secondary outcome measures The primary endpoint was a composite of all-cause mortality or rehospitalisation at 1 year from the date of TAVI.

Results Data from 9748 TAVI procedures were included between 2018 and 2023. We identified five feasible QIs, the majority of which had high compliance and minimal variation; the lone exception was the performance of transfemoral TAVI without general anaesthesia (median 0.87; IQR 0.78–0.93). Adherence to QIs was associated with a reduction in the composite endpoint. The strongest association was observed with multidisciplinary heart team involvement (defined as the presence of an interventional cardiologist and a cardiac surgeon) in the TAVI procedure (OR 0.67, 95% CI 0.50 to 0.90, p=0.007), the performance of transfemoral TAVI without general anaesthesia (OR 0.80, 95% CI 0.71 to 0.91, p<0.0004) and the utilisation of the transfemoral access (OR 0.84, 95% CI 0.69 to 1.04, p=0.10). However, variation in clinical outcomes following TAVI between hospitals was not attributable to variation in QI attainment. Falsification analysis suggests substantial residual confounding.

Conclusions We developed a feasible set of QIs for TAVI and validated these QIs using routinely collected data from a large all-comer registry in Ontario. We have identified overall high quality of care for TAVI, but with some variation in practice, which in part is attributable to differences in patient factors. Our work suggests that QIs can inform quality improvement efforts by prompting future work into discretionary versus non-discretionary variation.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This observational study used real-world all-comer registry data from Ontario, Canada.
⇒ Consecutive patients undergoing transcatheter aortic valve implantation (TAVI) for severe aortic stenosis were included.
⇒ We examined the utility of internationally developed quality indicators (QIs) in the assessment of TAVI care quality and variation in practice.
⇒ While association was identified between clinical outcomes and TAVI QIs, a substantial portion of this association was driven by unmeasured, and likely non-discretionary, patient factors.

INTRODUCTION

Over the last two decades, transcatheter aortic valve implantation (TAVI) has underpinned a paradigm shift in the standard of care for aortic stenosis, leading to an exponential growth in demand. As TAVI has grown, there have been concerns regarding suboptimal implementation of TAVI guidelines and potentially variation in the quality of TAVI care.[1–3]

Major cardiac societies including the American College of Cardiology (ACC), the American Heart Association (AHA) and the European Society of Cardiology (ESC) developed quality indicators (QIs) to quantify the quality of care for patients undergoing TAVI and measure both modifiable and non-modifiable variation.[4 5] A recent report from the Swedish TAVI registry highlighted the role of such QIs in quantifying TAVI care and benchmarking performance.[6] However, there is a paucity of studies evaluating TAVI QIs outside of Europe. As such, there is uncertainty as to the generalisability of TAVI QIs across jurisdictions.

Accordingly, to address this gap in knowledge, we sought to investigate the feasibility of measuring QIs using routinely collected administration, and if so, whether any variation exists in TAVI care and outcomes among residents of Ontario, Canada. Such an assessment will identify potential variation in TAVI care delivery but also guide future quality improvement initiatives and resource allocation policies.

METHODS

Study design

We performed a retrospective population-level cohort study in Ontario; Canada's largest province with a population of 16.1 million. All residents of Ontario receive publicly funded universal medical care through the Ontario Ministry of Health via the Ontario Health Insurance Plan (OHIP) with no copayments or coinsurance. TAVI is performed at 11 centres in the province. This study was conducted using administrative datasets linked using unique patient encoded identifiers and analysed at ICES (previously the Institute for Clinical and Evaluative Sciences). We adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) criteria.[7]

Data sources

The CorHealth Ontario clinical registry provided demographic, procedural and comorbidity data on all invasive cardiology procedures in Ontario; as a mandatory requirement for provincial funding, all procedural data on TAVI procedures must be entered into this registry. The accuracy of this database has been previously validated by chart review.[8] Data on in-hospital mortality, out-of-hospital mortality, rurality and income quintile were obtained from the Registered Persons Database. The Canadian Institute for Health Information Discharge Abstract Database (CIHI) provided additional data on complications, acute hospitalisations, supplementary baseline comorbidity and procedural data. The CIHI Same Day Surgery provided data on same-day procedures. Validated ICES databases were used to define dementia, diabetes, heart failure, hypertension and obstructive pulmonary disease. Data on physician billing and laboratory tests were obtained from the OHIP database. Medication information for individuals aged 65 or older who are beneficiaries of the Ontario Drug Benefit (ODB) was obtained from the ODB database; however, this does not include over the counter prescriptions such as aspirin. The hospital frailty index was calculated using an ICES macro using administrative comorbidity codes.[9]

Study population

We included all patients who underwent TAVI for aortic stenosis between 1 April 2018 and 31 March 2023 from the CorHealth registry.

We excluded patients <18 years of age and those with invalid unique identifiers, invalid birth date (eg, missing or after index date), invalid death date (eg, before index date) or invalid sex (from the RPDB). For patients with multiple TAVI procedures during the study period, the first procedure was used to determine the index TAVI.

Quality indicators

We developed a unique set of QIs for the assessment of TAVI care quality. This set was constructed by mapping the 2023 ESC QIs for the care and outcomes of adults undergoing TAVI and the 2024 ACC/AHA clinical performance and quality measures for adults with valvular and structural heart disease against the available data variables from our linked registries (online supplemental table S1).[4 5] The QIs that could not be measured were excluded and only the feasible ones were used in this analysis. Some QIs were slightly modified. Online supplemental table S1 shows the modifications to some of the QIs and the definitions of the measurement specifications for all QIs, including numerators and denominators and exclusion criteria.

In total, we identified five feasible QIs, four from the 2023 ESC QIs for the care and outcomes of adults undergoing TAVI and one from the 2024 ACC/AHA clinical performance and quality measures for adults with valvular and structural heart disease (Table S1).[4 5] These QIs are (1) the presence of an interventional cardiologist and a cardiac surgeon during TAVI (herein referred to as procedural heart team involvement), (2) the performance of gated cardiac CT scan before TAVI, (3) the utilisation of transfemoral access for TAVI, (4) the avoidance of general anaesthesia (GA) for transfemoral TAVI and (5) the performance of a transthoracic echocardiogram following TAVI; to avoid immortal time bias, only patients discharged from hospital alive were included for this QI. These QIs were then used to develop an opportunity-based composite QI (CQI), in which each patient scored between 1 and 5 based on their attainment of each of the five individual QIs when eligible (online supplemental table S1). Different denominators for each of the component QIs within the composite were used to ensure that patients are only considered for the opportunities they were eligible for.

The QIs that were deemed unfeasible from both the ESC and the ACC/AHA suits are shown in online supplemental table S2. The predominant cause for non-feasibility was the unavailability of the relevant data variables within the CorHealth registry to measure these QIs. For instance, data variables about the preoperative risk scores such as the EuroSCORE II and health status are not captured (online supplemental table S2). Other causes of non-feasibility include unknown denominators (eg, overall patients with severe aortic stenosis and overall patients with failed surgical aortic valves), and the challenges in obtaining pharmacotherapy for TAVI recipients, specifically over the counter aspirin. For the QIs that evaluated anti-thrombotic therapy following TAVI, we performed a preliminary analysis to assess the extent of

their feasibility but did not include them in the outcome analysis.

Endpoints

The primary endpoint was a composite of all-cause mortality or rehospitalisation at 1 year from the date of the index TAVI procedure. Secondary endpoints include the length of hospital stay, as well as 30-day complications (defined as death from any cause, stroke or transient ischaemic attack or major bleeding based on the Valve academic research consortium-3 (VARC-3) definitions).[10]

Statistical analysis

Attainment to the feasible QIs was presented in percentages on the provincial-level and hospital-level, with medians and IQR across the 11 hospitals in Ontario.

For outcome analysis of the primary outcomes, we used a hierarchical logistic regression model with a hospital-level random effect, to account for clustering by TAVI hospital. We estimated separate models for each QI as the primary independent variable. Each model was adjusted for baseline patient characteristics, including age, Charlson comorbidity index, frailty score, rural residence, diabetes, hypertension, congestive cardiac failure, chronic obstructive pulmonary disease, dementia, liver disease, cancer, renal disease, ischaemic heart disease, arrhythmia, peripheral vascular disease, cerebrovascular disease, interstitial lung disease and prior coronary revascularisation or valve surgery.

We then developed separate models for 1-year mortality and 1-year rehospitalisation. For the 1-year mortality, Cox proportional hazards models with robust variance estimator were used, while for the evaluation of 1-year rehospitalisation, we used cause-specific hazard models to account for the competing risk of death.

Falsification outcome analysis was performed using cause-specific hazard models for 1-year readmission for pneumonia or gastrointestinal bleed based on international classification of disease (ICD) 10 code in the CIHI-DAD, with a separate model for each QI as an independent variable. Each of these models was subsequently adjusted for baseline clinical characteristics.

To understand if the variation in the composite outcome of 1-year death or rehospitalisation was attributable to variation in the attainment of the QI, we used median OR (MOR) method. We first estimated a null model, followed by a model adjusted for baseline patient characteristics. Finally, we performed additional models that incorporate each QI individually (coded as attained/not-attained), to allow the recalculation of the MOR for each QI and evaluated the extent to which each indicator explains between-hospital variation.

A two-sided $p<0.05$ was considered statistically significant. All statistical analyses were performed using SAS V.9.4 (SAS).

RESULTS

Between 1 April 2018 and 31 March 2023, 9797 TAVI procedures were performed across 11 hospitals in Ontario. Of those, 9748 were included in our study (online supplemental figure S1). The median age was 82 years and 43% of patients were female. The baseline characteristics for the enrolled patients are presented in table 1. Over 75% of the patients had low frailty scores with a relatively low burden of multimorbidity according to the Charlson Index (table 1).

Attainment analysis

The overall attainment to the TAVI QIs was high with provincial rates ranging from 81% for the non-GA transfemoral TAVI to 98% for the multidisciplinary heart team involvement (figure 1). Minimal variation was observed in the attainment to the TAVI QIs across Ontario hospitals (figure 2, online supplemental figure S2). The largest variation was observed in the performance of transfemoral TAVI without GA, with hospitals ranging from 32% to 93% (online supplemental figure S2). There was also marked variation in the attainment to the CQI, with hospitals ranging from 20% to 90% in achieving all the five component QIs in the composite for eligible patients (figure 2, online supplemental figure S2).

Outcome analysis

Crude outcomes

The overall mortality and rehospitalisation at 1 year following TAVI was 10.2% and 37.2%, respectively. The composite of bleeding or stroke complications at 30 days was 5.1%, with the mean length of hospital stay of 5.4 days.

The unadjusted relationship of outcomes with QIs is shown in online supplemental table S3. In general, attainment to QIs was associated with a reduction in adverse outcomes in the unadjusted analyses.

Adjusted outcomes

The association between the TAVI QIs and the primary endpoint of adjusted mortality rates or rehospitalisation at 1 year following TAVI is presented in figure 3. The strongest association was observed in multidisciplinary heart team involvement OR 0.67 (95% CI 0.50 to 0.90), the performance of transfemoral TAVI without GA OR 0.80 (95% CI 0.71 to 0.91) and the utilisation of the transfemoral access OR 0.84 (95% CI 0.69 to 1.04) (figure 3).

Association of QIs and components of primary endpoint

Mortality

The attainment for each of the TAVI QIs was associated with a reduction in adjusted all-cause mortality rates at 1 year after the procedure. The strongest association was observed in the utilisation of the transfemoral access site HR 0.56 (95% CI 0.46 to 0.68), the performance of transfemoral TAVI without GA HR 0.66 (95% CI 0.57 to 0.78) and multidisciplinary heart team involvement during TAVI (HR 0.67 (95% CI 0.46 to 0.96)) (online supplemental figure S3).

Compared with achieving all the 5 individual QIs within the composite, achieving 3 or fewer QIs was associated with a 2-fold increase in risk in all-cause mortality at 1 year (HR 2.05, 95% CI 1.51 to 2.78),

Table 1 Baseline characteristics

Variable	Variable value	Missing
Total	N=9748	
Age at index TAVI, Median (IQR)	82 (76–86)	0.0%
Female, n (%)	4170 (42.8)	0.0%
Nearest census based neighbourhood income (quintile), n (%)		20 (0.2%)
	2054 (21.1)	
	2127 (21.8)	
	1905 (19.5)	
	1740 (17.8)	
	1902 (19.5)	
Rural, n (%)		16 (0.2%)
	No, 8502 (87.2)	
	Yes, 1230 (12.6)	
Charlson score, median (IQR)	1 (0–3)	0.0%
Frailty using Lancet macro, median (IQR)	1 (0–5)	0.0%
Frailty category, n (%)		0.0%
	Intermediate to high (≥5), 2381 (24.4%)	
	Low (<5), 7367 (75.6)	
Diabetes, n (%)	4282 (43.9)	
Hypertension, n (%)	9001 (92.3)	
Heart failure, n (%)	5956 (61.1)	
Ischaemic heart disease, n (%)	6426 (65.9)	
Cardiac arrhythmia/atrial arrhythmia, n (%)	2389 (24.5)	
Peripheral vascular disease, n (%)	365 (3.7)	
Cerebrovascular disease, n (%)	508 (5.2)	
Chronic obstructive pulmonary disease, n (%)	3103 (31.8)	
Cognitive impairment/Dementia, n (%)	618 (6.3)	
Liver disease, n (%)	222 (2.3)	
Cancer, n (%)	992 (10.2)	
Renal disease, n (%)	746 (7.7)	
Interstitial lung disease, n (%)	139 (1.4)	
Dialysis, n (%)	319 (3.3)	
Previous PCI, n (%)	2749 (28.2%)	
Previous CABG, n (%)	1124 (11.5)	
Previous valve surgery, n (%)	863 (8.9)	
Fiscal year, n (%)	2018, 1389 (14.2)	
	2019, 1787 (18.3)	
	2020, 1872 (19.2)	
	2021, 2110 (21.6)	
	2022, 2590 (26.6)	

CABG, coronary artery bypass graft surgery; TAVI, transcatheter aortic valve implantation.

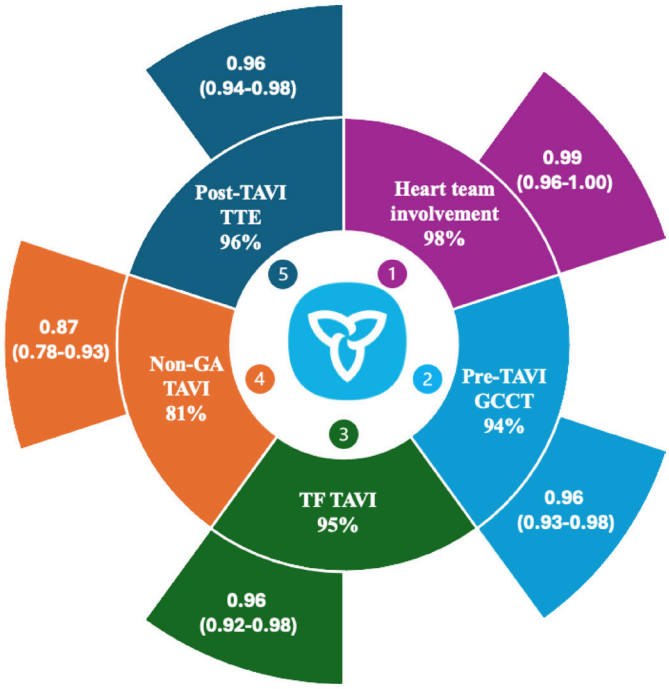

Figure 1 The TAVI QIs with their overall provincial attainment rate (percentages within inner circle) and median (IQR) for attainment across Ontario hospitals (outer circle). GA, general anaesthesia; GCCT, gated cardiac CT; TAVI, transcatheter aortic valve implantation; TF, transfemoral; TTE, transthoracic echocardiogram.

while achieving 4 out of 5 QIs was associated with a 1.4-fold increase (HR 1.39, 95% CI 1.13 to 1.71) (online supplemental figure S3).

Hospital readmission

Significant reduction in rehospitalisation at 1 year after TAVI was observed with the attainment of multidisciplinary heart team involvement HR 0.78 (95% CI 0.64 to 0.93), the performance of transthoracic echocardiogram after TAVI HR 0.86 (95% CI 0.76 to 0.99) and having non-GA transfemoral TAVI HR 0.90 (95% CI 0.85 to 0.97) (online supplemental figure S4).

Falsification analysis

The falsification analyses evaluating pneumonia or gastrointestinal bleeding at 1 year post-TAVI were suggestive of residual confounding. Specifically, the performance of gated cardiac CT before TAVI (HR 0.57, 95% CI 0.39 to 0.84, p=0.004) and non-GA transfemoral TAVI (HR 0.65, 95% CI 0.51 to 0.83, p=0.0004) had significant associations as did the CQI (attainment of 1–3/5 compared with 5/5 QIs (HR 2.73, 95% CI 1.32 to 5.63, p=0.007) and with the attainment of 4/5 compared with 5/5 QIs (HR 1.42, 95% CI 1.12 to 1.79, p=0.004)).

Variation

The null model showed moderate between-group variation, with MOR of 1.098. After adjusting for patient baseline characteristics, the MOR decreased to 1.054, suggesting that much of the between-group variation was

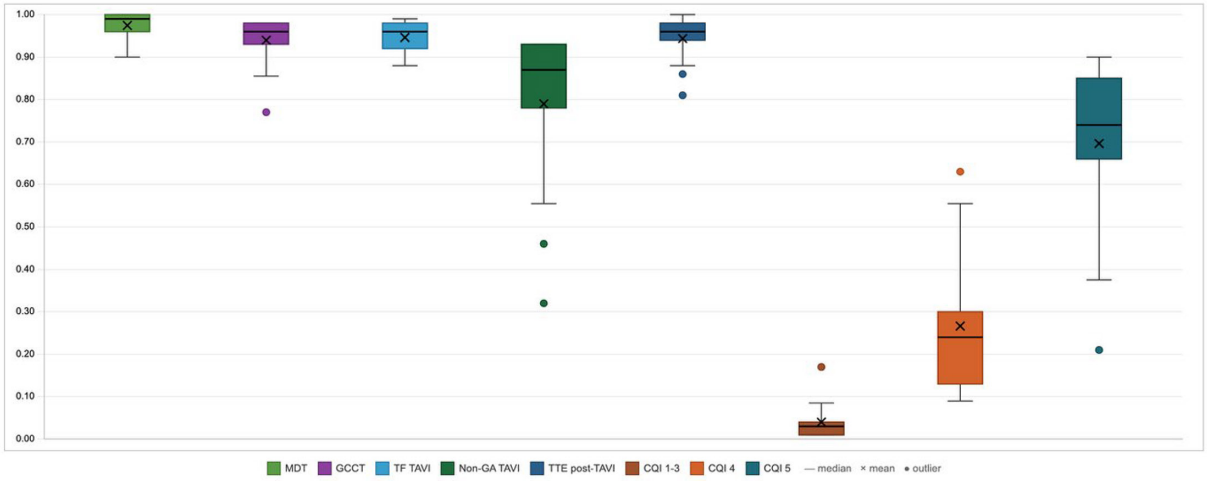

Figure 2 Variation in the attainment to the TAVI QIs across hospitals in Ontario. CQI, composite QI; GA, general anaesthesia; GCCT, gated cardiac CT; MDT, multidisciplinary team; QI, quality indicator; TAVI, transcatheter aortic valve implantation; TF, transfemoral; TTE, transthoracic echocardiogram.

explained by case-mix differences. Adding individual QIs resulted in minimal change in the MOR ranging from 1.02 (CQI) to 1.06 (transfemoral TAVI).

DISCUSSION

Study findings

Our study is a real-world analysis of a combined set of QIs from the ESC and the ACC/AHA. We identified five QIs that were feasible from the all-comer CorHealth registry and used these QIs to construct an opportunity-based CQI and evaluate TAVI care quality across the 11 TAVI centres in Ontario, Canada. In total, data from 9748 TAVI procedures were included, with high attainment rates and a strong association between QI attainment and favourable clinical outcomes up to 12 months after TAVI. However, there was considerable confounding, suggesting that a substantial portion of this association was driven by unmeasured, and likely non-discretionary, patient factors. As such, our work suggests that measurement of QIs is feasible, but interpretation of variation should focus on investigating potentially discretionary factors to inform quality improvement efforts.

CLINICAL RELEVANCE

Our study highlights the importance and the feasibility of using routinely collected registry data for the evaluation

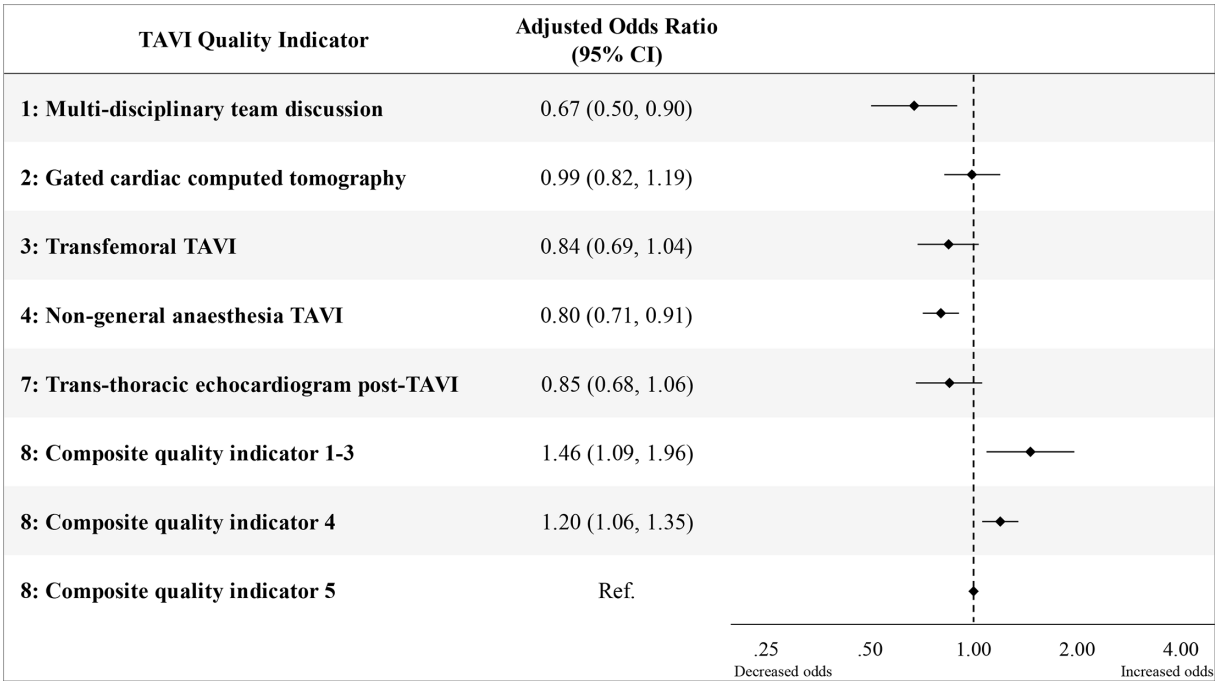

Figure 3 Adjusted ORs for 1-year mortality or hospital readmission according to attainment of TAVI QIs. QI, quality indicator; TAVI, transcatheter aortic valve implantation.

of care quality in TAVI recipients. The growing rates of TAVI among younger and lower surgical-risk patients need to be accompanied by careful considerations of the standards by which TAVI processes of care and outcomes are measured. While professional cardiac societies have established QIs for TAVI,[4 5] the level of implementation of these standards in practice and—more importantly—their association with clinical outcomes have been scarcely studied.

A single publication evaluating the ESC QIs for TAVI was recently published from the Swedish Transcatheter Cardiac Intervention Registry (SWENTRY).[6] In this study, the authors found high attainment of the TAVI QIs in Sweden, with little variation between hospitals. They reported that 80% of the feasible QIs were associated with an improvement in all-cause mortality 1 year after TAVI. Compared with our analysis, there were more feasible QIs in the SWENTRY study with relatively less variation between the enrolled centres. However, our study uniquely developed and validated an opportunity-based CQI and included QIs not only from the ESC but also from the ACC/AHA performance measures. Of note, no falsification analysis was performed in the Swedish study.

Individual QIs

Despite the relatively small number of feasible QIs in the CorHealth TAVI registry and the limitations of administrative data in the Canadian context, we found that these QIs are associated with improved survival after TAVI. Besides, the quantification of the QIs which are strongly associated with favourable outcomes (eg, transfemoral access, procedural heart team involvement and echocardiogram) was relatively seamless and reproducible, highlighting an opportunity to implement such measures for longitudinal quality improvement initiatives over time and across geographies.

Composite QI

The development of a CQI in our study provided a feasible and valid measure of TAVI care quality that encompasses key aspects of TAVI care. Such a measure can be theoretically used by healthcare regulators to assess performance across different settings and highlight temporal and geographical variation in care.

Confounding and future work

In our falsification analyses, we identified considerable residual confounding, which suggests that some of the variation seen was due to patient factors that we did not correct for, and that these, in turn, partially accounted for the differences in outcomes. As such, the use of QIs must be nuanced. It is not appropriate to simply use administrative data derived QIs to rank hospitals or for quality management via pay for performance incentives. Instead, if variation is seen, a deeper dive is needed to understand if the variation and any subsequent outcome differences are due to non-discretionary patient factors or due to discretionary differences in practice. The latter should be the focus of quality improvement efforts.

Strength and limitations

Our study has several strengths. We included patient data from the all-comer CorHealth registry. In total, we analysed data from 9748 TAVI procedures across 11 hospitals in Ontario and linked various data sources. We combined QIs from both the ESC and the AHA/ACC and developed a CQI for TAVI. However, our study must be interpreted in the context of several limitations. The observational nature of our study limits the ability to infer causation between the attainment for the TAVI QIs and clinical outcomes; indeed, the falsification analyses explicitly recommend that such inferences be avoided. We modified the definitions for some QIs; such as the Heart Team discussion one as shown in online supplemental table S1. Some of the QIs exhibited high attainment rate, with little between-hospital variation (eg, gated cardiac CT before TAVI), limiting their utility in highlighting variation and gaps in care delivery. Additionally, attainment analysis was not adjusted for case mix, limiting the ability to assess true variation in TAVI care quality using the QIs. Some QIs were not feasible despite the data linkage between various sources. For instance, we performed an exploratory analysis to assess the attainment of antithrombotic therapy following TAVI given their role in subsequent outcomes.[11] However, the real-world quantification of such QIs is challenging. Information on outpatient prescription records and pharmacotherapy during follow-up was lacking. Besides, the availability of aspirin as an over-the-counter medication limited the ability to measure adherence to this therapy post-TAVI. Even in the recently published study from SWEDEHEART, these QIs were only evaluated for the entirety of the study duration. These are difficult aspects of care to capture in clinical registries but are worthy of investigation given the role of pharmacotherapy in determining outcomes after TAVI.[11]

CONCLUSIONS

In this study, we developed a unique and feasible set of QIs for TAVI and validated these QIs against clinical endpoints using routinely collected registry data from a large all-comer registry in Ontario, Canada. We have identified high quality of care for TAVI but with some variation in practice. Importantly, this variation and differences in outcomes are in part accounted for by unmeasured, likely non-discretionary patient factors. As such, our work suggests that QI measurement should prompt further investigation to identify discretionary causes for the variation, which can then inform subsequent quality improvement efforts.

Author affiliations
[1]Cardiology, St Paul's Hospital, Vancouver, British Columbia, Canada
[2]Institute for Clinical Evaluative Sciences, Toronto, Ontario, Canada

[3]Medicine, Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada
[4]Schulich Heart Program, Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada
[5]Division of Cardiac Surgery, Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada
[6]Department of Medicine, University of Toronto, Toronto, Ontario, Canada
[7]Institute for Science & Technology in Medicine, Keele University, Keele, UK
[8]Leeds General Infirmary, Leeds, UK
[9]Leeds Institute of Cardiovascular & Metabolic Medicine, University of Leeds, Leeds, UK
[10]Centre for Cardiovascular Innovation, St Paul's Hospital, Vancouver, British Columbia, Canada

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Contributors The corresponding author affirms that he has listed everyone who contributed significantly to the work. The authors had access to all the study data, take responsibility for the accuracy of the analysis, and had authority over manuscript preparation and the decision to submit the manuscript for publication. The corresponding author confirms that all authors read and approve the manuscript. The corresponding author is the guarantor for this paper. AI was used to generate Figure S2 in the supplement.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval The use of ICES data in this observational study is authorised under Section 45 of Ontario's Personal Health Information Protection Act and does not require review by a Research Ethics Board.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement No data are available. All data relevant to the study are included in the article or uploaded as supplementary information. No data are available.

ORCID iDs
Suleman Aktaa https://orcid.org/0009-0004-7900-2742
Stephen Fremes https://orcid.org/0000-0003-1723-3049
Mamas A Mamas https://orcid.org/0000-0001-9241-8890

REFERENCES

1 Wijeysundera HC, Gaudino M, Qiu F, *et al*. Regional Differences in Outcomes for Patients Undergoing Transcatheter Aortic Valve Replacement in New York State and Ontario. *Can J Cardiol* 2023;39:570–7.
2 Aktaa S, Ali N, Ludman PF, *et al*. Geographical Inequality in Access to Aortic Valve Intervention in England: A Report from the UK Transcatheter Aortic Valve Implantation Registry and National Adult Cardiac Surgery Audit. *Interv Cardiol* 2024;19:e15.
3 Arnold SV, Manandhar P, Vemulapalli S, *et al*. Trends in Transcatheter Aortic Valve Replacement Outcomes: Insights From the STS/ACC TVT Registry. *JAMA Cardiol* 2024;9:1115–23.
4 Ali N, Aktaa S, Younsi T, *et al*. European Society of Cardiology quality indicators for the care and outcomes of adults undergoing transcatheter aortic valve implantation. *Eur Heart J Qual Care Clin Outcomes* 2024;10:723–36.
5 Jneid H, Chikwe J, Arnold SV, *et al*. 2024 ACC/AHA Clinical Performance and Quality Measures for Adults With Valvular and Structural Heart Disease: A Report of the American Heart Association/American College of Cardiology Joint Committee on Performance Measures. *Circ Cardiovasc Qual Outcomes* 2024;17:e000129.
6 Nilsson K, James S, Backes J, *et al*. Association between quality of care indicators and clinical outcomes in patients undergoing transcatheter aortic valve implantation: insights from SWEDEHEART. *Eur Heart J Qual Care Clin Outcomes* 2026;12:366–78.
7 Elm E von, Altman DG, Egger M, *et al*. Strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. *BMJ* 2007;335:806–8.
8 Wijeysundera HC, Qiu F, Koh M, *et al*. Comparison of Outcomes of Balloon-Expandable Versus Self-Expandable Transcatheter Heart Valves for Severe Aortic Stenosis. *Am J Cardiol* 2017;119:1094–9.
9 Gilbert T, Neuburger J, Kraindler J, *et al*. Development and validation of a Hospital Frailty Risk Score focusing on older people in acute care settings using electronic hospital records: an observational study. *Lancet* 2018;391:1775–82.
10 Généreux P, Piazza N, Alu MC, *et al*. Valve Academic Research Consortium 3: Updated Endpoint Definitions for Aortic Valve Clinical Research. *J Am Coll Cardiol* 2021;77:2717–46.
11 Aktaa S, Wijeysundera HC. Bleeding Complications After Transcatheter Aortic Valve Implantation… Can We Do Any Better? *Can J Cardiol* 2026;42:655–7.