JACC: CARDIOVASCULAR INTERVENTIONS VOL. 11, NO. 6, 2018

PUBLISHED BY ELSEVIER

EDITORIAL COMMENT

Transcatheter Aortic Valve Replacement Risk Prediction for Benchmarking

Work Under Construction*

Stuart J. Head, MD, PhD,[a] Nicolas M. Van Mieghem, MD, PhD[b]

Risk prediction in cardiovascular procedures is important for myriad reasons. Physicians need risk prediction to aid clinical decision making, inform their patients and obtain informed consent, recruit patients in clinical trials, and evaluate outcomes that are benchmarked against other hospitals or health care systems. A clinical risk prediction model should assess the propensity for adverse events in an individual patient and should ideally be a bedside tool that includes only the most relevant variables, which are practical and measurable. However, accuracy is the most important feature of a model that is used for benchmarking purposes, and this may require a larger number of variables if these would improve the accuracy of the model; at this point, practicality may be subordinate to accuracy.

In the case of risk prediction for aortic valve procedures, the emergence of transcatheter aortic valve replacement (TAVR) made risk prediction in clinical practice more challenging. TAVR is undisputedly less invasive than surgical aortic valve replacement and disruptive to the extent that new paradigms apply in terms of indications, expectations, and complications. The population targeted for TAVR may be older, with more comorbidities, and frail. Patients may be at high risk for surgical aortic valve replacement but at low risk for TAVR and vice versa. Established surgical risk models, including the Society of Thoracic Surgeons Predicted Risk of Mortality, European System for Cardiac Operative Risk Evaluation, and European System for Cardiac Operative Risk Evaluation II, were not calibrated for patients undergoing TAVR (1). Frailty and procedural aspects may complement archetypical risk factors, such as age, sex, renal failure, and chronic obstructive pulmonary disease, to improve risk prediction (2). Furthermore, models developed specifically for TAVR did show better performance than models derived from cardiac surgery populations (3-6) and: 1) contributed to our overall understanding of the TAVR procedural risk; 2) it has improved decision making; 3) provided more reliable patient information; and 4) allowed accurate patient inclusion in contemporary trials (7,8). However, the use of risk prediction for benchmarking TAVR outcomes has been somewhat neglected.

The importance of benchmarking is underscored by faster adoption of novel (disruptive) technologies into clinical practice, enhanced scrutiny, and involvement of competent authorities. It is intriguing that within 10 years of the pioneering TAVR procedure by Alain Cribier and only 1 year after U.S. Food and Drug Administration approval of TAVR, more than 200 centers in the United States were already performing TAVR (9,10). However, technology that is still in a development phase is less well established and defined, with the risk of dispersion of treatment indications, procedural techniques, handling of complications, and post-procedural management across centers. To evaluate whether clinical dispersion would jeopardize patient outcomes, benchmarking is necessary to evaluate the quality of each of these centers. To compare

*Editorials published in *JACC: Cardiovascular Interventions* reflect the views of the authors and do not necessarily represent the views of *JACC: Cardiovascular Interventions* or the American College of Cardiology.

From the [a]Department of Cardiothoracic Surgery, Erasmus University Medical Center, Rotterdam, the Netherlands; and the [b]Department of Cardiology, Erasmus University Medical Center, Rotterdam, the Netherlands. Dr. Van Mieghem has received research grants from Boston Scientific, Medtronic, Edwards Lifesciences, and Abbott Vascular. Dr. Head has reported that he has no relationships relevant to the contents of this paper to disclose.

ISSN 1936-8798/$36.00 https://doi.org/10.1016/j.jcin.2018.01.265

centers, outcomes should be adjusted for the procedural risk of the treated patient population. If risk prediction in benchmarking is performed with risk models that lack accuracy, the adjustment may not overcome the positive bias toward centers that include only low-risk patients. Sophisticated, comprehensive risk prediction models are therefore crucial for appropriate adjustment.

SEE PAGE 581

In this issue of *JACC: Cardiovascular Interventions*, Arnold et al. (11) propose a novel risk prediction model with the goal of risk adjustment of TAVR outcomes that could be used for benchmarking purposes. The novel model was used to predict 30-day mortality, which might be more reliable for benchmarking purposes than in-hospital mortality because of different discharge protocols among hospitals or than 1-year mortality because the impact of the procedure is confounded by events during follow-up caused by comorbidities of patients (4). Another strength of the analysis was that the data were derived from the TVT (Transcatheter Valve Therapy) Registry in the United States, which includes clinical variables and assessments of frailty and functional status by means of the Kansas City Cardiomyopathy Questionnaire.

Of the 450 sites in the United States that performed TAVR through 2013 to 2016, the investigators included 188 sites with near-complete data on the Kansas City Cardiomyopathy Questionnaire, frailty, and 30-day mortality. Among the 21,661 real-world patients, mortality at 30 days was 4.7% (n = 1,025). In a development cohort that consisted of 70% of the patients, a multivariable model identified a number of clinical characteristics, moderate or severe tricuspid insufficiency, pre-operative functional status, inability to walk, pre-operative platelet count, and nonfemoral access as independent predictors of mortality. The model showed moderate to good performance, with a C statistic of 0.71 and good calibration with dependable observed versus expected mortality ratios throughout the spectrum of risk (range: 1.1% to 13.8%). In the validation cohort, which consisted of 30% of the patients, the C statistic remained 0.70, although calibration was slightly poorer.

The investigators have presented another crucial step toward improved risk prediction for TAVR. However, important limitations should be recognized. The fact that the majority of centers participating in the TVT Registry were excluded from the analysis is notable and a potential important bias. Furthermore, this proposed prediction model was based largely on clinical variables, yet important anatomic variables such as the height of the coronary arteries (especially for procedures in degenerated bioprosthetic valves), the angle of the ascending aorta and aortic root tract calcification, percentage of oversizing, and others were not addressed (12,13). Future studies will be required to determine whether the inclusion of additional anatomic variables in a more refined and comprehensive model could improve overall risk model performance, like the anatomic SYNTAX (Synergy Between Percutaneous Coronary Intervention With Taxus and Cardiac Surgery) score and combined clinical and anatomic SYNTAX II score in coronary artery disease (14).

One of the most important findings of the study was that adjusted TAVR outcomes were comparable among the participating centers. The rapid TAVR uptake and dispersion apparently did not jeopardize quality or safety. Reassuring as this may be, the present study included only 188 of the 450 centers participating in the TVT Registry. Conceivably, underperforming centers that would require additional guidance and surveillance might have been excluded from this analysis because of incomplete data completion. External validation studies will be important to evaluate whether results within the TVT Registry can be extrapolated to other geographies with different practices and health care systems and allow benchmarking between countries. Therefore, Arnold et al. (11) should be commended for this important contribution to the development of a TAVR risk prediction model used for benchmarking, which remains a work under construction.

ADDRESS FOR CORRESPONDENCE: Dr. Stuart J. Head, Erasmus University Medical Center, Department of Cardiothoracic Surgery, 3000 Rotterdam, the Netherlands. E-mail: s.head@erasmusmc.nl.

REFERENCES

1. Piazza N, Wenaweser P, van Gameren M, et al. Relationship between the logistic EuroSCORE and the Society of Thoracic Surgeons Predicted Risk of Mortality score in patients implanted with the CoreValve ReValving system—a Bern-Rotterdam study. Am Heart J 2010;159:323–9.

2. Kappetein AP, Head SJ, Genereux P, et al. Updated standardized endpoint definitions for transcatheter aortic valve implantation: the Valve Academic Research Consortium-2 consensus document. J Am Coll Cardiol 2012;60:1438–54.

3. Capodanno D, Barbanti M, Tamburino C, et al. A simple risk tool (the OBSERVANT score) for prediction of 30-day mortality after transcatheter aortic valve replacement. Am J Cardiol 2014;113:1851–8.

4. Edwards FH, Cohen DJ, O'Brien SM, et al. Development and validation of a risk prediction

model for in-hospital mortality after transcatheter aortic valve replacement. JAMA Cardiol 2016;1:46–52.

5. Hermiller JB Jr., Yakubov SJ, Reardon MJ, et al. Predicting early and late mortality after transcatheter aortic valve replacement. J Am Coll Cardiol 2016;68:343–52.

6. Debonnaire P, Fusini L, Wolterbeek R, et al. Value of the "TAVI2-SCORe" versus surgical risk scores for prediction of one year mortality in 511 patients who underwent transcatheter aortic valve implantation. Am J Cardiol 2015;115:234–42.

7. Falk V, Baumgartner H, Bax JJ, et al. 2017 ESC/EACTS guidelines for the management of valvular heart disease. Eur J Cardiothorac Surg 2017;52:616–64.

8. Reardon MJ, Van Mieghem NM, Popma JJ, et al. Surgical or transcatheter aortic-valve replacement in intermediate-risk patients. N Engl J Med 2017;376:1321–31.

9. Cribier A, Eltchaninoff H, Bash A, et al. Percutaneous transcatheter implantation of an aortic valve prosthesis for calcific aortic stenosis: first human case description. Circulation 2002;106:3006–8.

10. Mack MJ, Brennan JM, Brindis R, et al. Outcomes following transcatheter aortic valve replacement in the United States. JAMA 2013;310:2069–77.

11. Arnold SV, O'Brien SM, Vemulapalli S, et al. Inclusion of functional status measures in the risk adjustment of 30-day mortality after transcatheter aortic valve replacement: a report from the Society of Thoracic Surgeons/American College of Cardiology TVT Registry. J Am Coll Cardiol Intv 2018;11:581–9.

12. Barbanti M, Yang TH, Rodes Cabau J, et al. Anatomical and procedural features associated with aortic root rupture during balloon-expandable transcatheter aortic valve replacement. Circulation 2013;128:244–53.

13. Ribeiro HB, Rodes-Cabau J, Blanke P, et al. Incidence, predictors, and clinical outcomes of coronary obstruction following transcatheter aortic valve replacement for degenerative bioprosthetic surgical valves: insights from the VIVID registry. Eur Heart J 2018;39:687–95.

14. Farooq V, van Klaveren D, Steyerberg EW, et al. Anatomical and clinical characteristics to guide decision making between coronary artery bypass surgery and percutaneous coronary intervention for individual patients: development and validation of SYNTAX score II. Lancet 2013;381:639–50.

KEY WORDS benchmarking, risk score, TAVR