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EDITORIAL COMMENT

Redo Aortic Valve Interventions

A Good Start Is Half the Job to Subsequent Permutations*

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Twenty years since the introduction of transcatheter aortic valve replacement (TAVR), current guidelines recommend the procedure as first-line therapy for older patients with tricuspid severe aortic stenosis, whereas they favor surgical aortic valve replacement (SAVR) in younger patients and those at low surgical risk.[1,2] A primary focus of severe aortic stenosis management has been the choice between TAVR and SAVR as the first intervention. This is related to the fact that survival after aortic intervention (both SAVR and TAVR) of older as well as high-surgical risk patients is shorter than the durability of bioprostheses in the vast majority of cases.[3] Indeed, the 10-year survival rate thus far reported among patients treated with TAVR is as low as 14% to 35%, depending on patient age.[4,5]

Considering the longer life expectancy of today's TAVR patients and the expansion of TAVR-in-SAVR procedures, the treatment focus should now shift from the first to the second aortic intervention (ie, to the treatment of bioprosthetic failure), regardless of whether the first intervention is SAVR or TAVR. This transition and further paradigm shift are not an easy task for heart teams, considering the absence of robust data and guideline recommendations, as well as the clear implication that the first intervention and prosthesis type might have in facilitating vs complicating aortic reintervention.[6,7] In this issue of *JACC: Cardiovascular Interventions*, 2 papers deal with this complex topic from different approaches.

Using the Society of Thoracic Surgeons (STS) database, Hawkins et al[8] sought to retrospectively define the comparative risk of SAVR after prior TAVR or SAVR. Considering surgical aortic reinterventions between 2011 and 2021, 3 groups were compared: TAVR-SAVR (n = 1,126), SAVR-TAVR-SAVR (n = 674), and SAVR-SAVR (n = 29,306). The investigators found a significant increase in the yearly rate of TAVR explantation, consistent with the expansion of TAVR indications, while they observed a stable, yet significantly higher, rate of redo SAVR procedures. Unfortunately, the rate of TAVR-in-SAVR is not reported, thereby precluding any comparison. Patients reoperated after TAVR were older, with more comorbidities, concomitant valvulopathies, and multivessel coronary artery disease. At adjusted regression analysis (limited to one-half of patients with available STS Predicted Risk of Mortality scores), the TAVR explantation groups had higher operative mortality compared with redo SAVR. This result was confirmed in a matched analysis of 433 pairs of subjects, with TAVR explantation producing higher operative mortality and longer intensive care unit stays. One notable observation of the study by Hawkins et al[8] is that more than one-half the patients required concomitant cardiac procedures (mostly intervention on the mitral valve and coronary artery bypass grafting) at the time of aortic valve reintervention, despite preprocedural work-up at the time of relatively recent TAVR. The latter finding calls for a better heart team prediction of the need for further cardiac interventions in patients with aortic stenosis undergoing transcatheter treatment.

Tang et al[9] analyzed the outcomes of 181 TAVR explantation patients within the international EXPLANTORREDO-TAVR registry, but this time the comparator was redo TAVR, not redo SAVR. The reintervention rate after TAVR was <1%, again with an increasing trend during the more recent study period. The time from index TAVR to reintervention

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was 3 times longer for redo TAVR than TAVR explantation. Consistently, structural valve degeneration (SVD) was more common as an indication for reintervention in the redo-TAVR group, while the rate of patient-prosthesis mismatch was higher in patients undergoing TAVR explantation, with no difference in more than mild paravalvular leak and valve thrombosis. Consistent with the findings of Hawkins et al,[8] the TAVR explantation group showed 4-fold higher 30-day mortality and twice the 1-year mortality of the redo TAVR group, a result that was driven mainly by the early hazard of TAVR explantation. Interestingly, although one would expect a higher prevalence of degenerated tall-frame supra-annular transcatheter heart valves (THV) in the TAVR explantation cohort and a higher prevalence of short-frame intra-annular THVs among patients undergoing redo TAVR (given the increased risk for sinus sequestration and impairment in coronary flow with supra-annular valves), the distribution of the 2 types of THVs was similar in the 2 treatment groups. This finding might be explained by the knowledge that redo TAVR with low implantation of a short-frame balloon-expandable valve in a tall-frame supra-annular THV results in lower risk for coronary obstruction without significant hemodynamic impairment despite leaflet overhang, particularly if the mode of failure of the first THV was regurgitation.[10-12] Unfortunately, information about the prevalent mechanism of SVD (ie, stenosis vs regurgitation) is not reported in either paper.

Both studies have limitations that must be acknowledged, such as their retrospective nature and long study periods, which may have introduced time selection and learning-curve biases. Importantly, the nonrandomized decision to perform SAVR vs TAVR reintervention represents a potential selection bias. Moreover, the large STS database lacks granularity, and the missing information on the age of explanted prostheses precludes any inference on the interplay between the time since the first aortic intervention and clinical outcome. Furthermore, the limited information related to the type of TAVR explanted limits the evaluation on the most appropriate sequence of redo interventions. Nevertheless, the investigators are to be commended, as both studies are timely and important, showing that aortic reintervention is increasing and is a high-risk procedure, and even isolated TAVR explantation cases are associated with a significant risk for early mortality.

These observations add to previous studies showing that among the possible aortic intervention permutations, TAVR explantation is associated with the worst outcomes (**Figure 1**, left[8,9,13-24]). In the EXPLANT-TAVR international registry, 30-day and 1-year mortality rates were as high as 13.1% and 28.5%, respectively.[16] Another study showed that compared with patients not requiring reintervention, patients undergoing TAVR explantation had 4-fold higher mortality.[15] Notably, ascending aortic replacement was noted more frequently among patients undergoing explantation of tall-frame supra-annular valves, although its association with increased perioperative mortality has yet to be demonstrated.[17] Moreover, all TAVR explantation studies included relatively young patients (mean age was consistently <75 years).

Given that TAVR surgical explantation remains a poorly standardized surgical intervention and the absence of prospective robust evidence on the comparison between TAVR explantation and redo TAVR in cases of SVD only (excluding patients with endocarditis, valve thrombosis, patient-prosthesis mismatch, and significant paravalvular leak), the biggest unanswered question is "What is the optimal first valve for aortic intervention in subjects with life expectancy exceeding bioprosthesis durability?" The best SAVR candidates are probably patients with life expectancy beyond THV durability and expected unsuitable anatomy for redo TAVR (ie, those with the highest risk for coronary obstruction and sinus sequestration secondary to low coronary takeoff and small aortic root dimensions). Yet also in this setting, surgeons must avoid the use of bioprostheses with externally mounted leaflets and sutureless and stentless valves, which are less TAVR-in-SAVR friendly because of the increased risk for coronary ostial impairment.[24-27] Likewise, when TAVR is the first intervention, different types of THV do not seem equal with regard to redo TAVR feasibility on the basis of coronary access[7,28] and even TAVR explantation in terms of need for concomitant aortic replacement.[15,17]

The role of the heart team needs further evolution. First, we should develop more accurate prediction models for life expectancy, in order to identify subjects who will live longer than their bioprosthetic valves. Second, we need to anticipate at the time of the first aortic intervention the lifetime sequence of possible permutations of reinterventions, on the basis of specific patient characteristics. This ideally means that when transcatheter approach is the first intervention, future permutations in case of SVD have better options than TAVR explantation (**Figure 1**, right).

Furthermore, it is paramount to discern not only the choice of surgical vs transcatheter intervention

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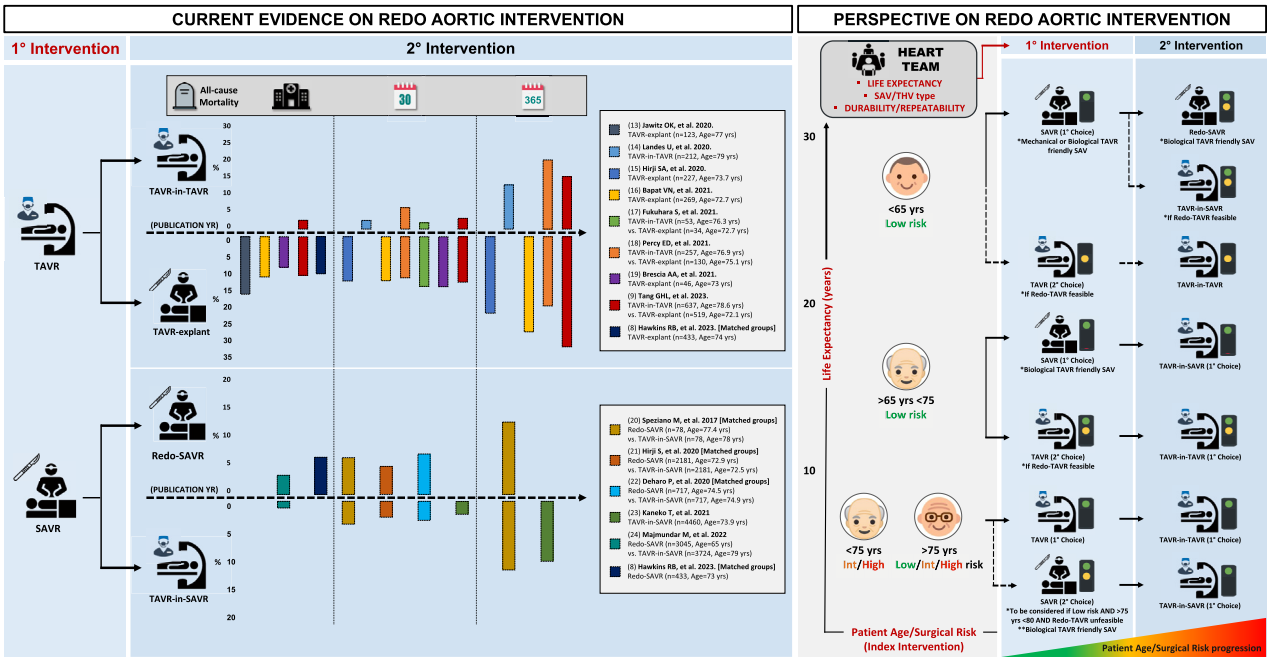
FIGURE 1 Redo Aortic Valve Permutations



(Left) Reported rates of all-cause mortality (operative or in-hospital, 30 days, 1 year) in the largest registries evaluating aortic valve redo interventions (redo transcatheter aortic valve replacement [TAVR], TAVR explantation, redo SAVR, and TAVR-in-SAVR). **(Right)** Lifetime perspective on redo aortic intervention permutations for structural aortic bioprosthesis degeneration. SAV = surgical aortic valve; THV = transcatheter heart valve.

but also the selection of the most appropriate bioprosthesis type. Considering that the need for aortic reintervention for SVD will be encountered at an older age, which is a generally accepted preference for TAVR over SAVR, it is important to fill the missing piece of information about the mid- and long-term performance of redo TAVR compared with TAVR-in-SAVR. If these 2 reinterventions have comparable outcomes, TAVR repeatability might be as important as THV durability. Thus, further research should consider the concept of repeatability of transcatheter intervention.

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REFERENCES

1. Otto CM, Nishimura RA, Bonow RO, et al. 2020 ACC/AHA guideline for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. *J Am Coll Cardiol*. 2021;77(4):e25–e197.

2. Vahanian A, Beyersdorf F, Praz F, et al. 2021 ESC/EACTS guidelines for the management of valvular heart disease. *Eur Heart J*. 2022;43(7):561–632.

3. Martinsson A, Nielsen S, Milojevic M, et al. Life expectancy after surgical aortic valve replacement. *J Am Coll Cardiol*. 2021;78(22):2147–2157.

4. Vanhaverbeke M, Sondergaard L, De Backer O. Life expectancy of patients with a transcatheter aortic valve and the implications for long-term valve durability data collection. *EuroIntervention*. 2023;18:996–998.

5. Scotti A, Nai Fovino L, Coisne A, et al. 10-Year impact of transcatheter aortic valve replacement leaflet design (intra- versus supra-annular) in mortality and hemodynamic performance. *Front Cardiovasc Med*. 2022;9:924958. https://doi.org/10.3389/fcvm.2022.924958

6. Tarantini G, Nai Fovino L. Lifetime strategy of patients with aortic stenosis. *J Am Coll Cardiol Intv*. 2021;14(15):1727–1730.

7. Nai Fovino L, Scotti A, Massussi M, et al. Coronary angiography after transcatheter aortic valve replacement (TAVR) to evaluate the risk of coronary access impairment after TAVR-in-TAVR. *J Am Heart Assoc*. 2020;9:e016446. https://doi.org/10.1161/JAHA.120.016446

8. Hawkins RB, Deeb GM, Sukul D, et al. Redo surgical aortic valve replacement after prior transcatheter versus surgical aortic valve replacement. *J Am Coll Cardiol Intv*. 2023;16:942–953.

9. Tang GHL, Zaid S, Kleiman NS, et al. Explant vs redo-TAVR after transcatheter valve failure: mid-term outcomes from the EXPLANTORREDO-TAVR international registry. *J Am Coll Cardiol Intv*. 2023;16:927–941.

10. Akodad M, Meier D, Sellers S, et al. A bench study of balloon-expandable valves for the treatment of self-expanding valve failure. *EuroIntervention*. Published online January 9, 2023. https://doi.org/10.4244/EIJ-D-22-00769

11. Tarantini G, Sathananthan J, Fabris T, et al. Transcatheter aortic valve replacement in failed transcatheter bioprosthetic valves. *J Am Coll Cardiol Intv*. 2022;15(18):1777–1793. https://doi.org/10.1016/j.jcin.2022.07.035

12. Tarantini G, Delgado V, de Backer O, et al. Redo-transcatheter aortic valve implantation using the SAPIEN 3/Ultra transcatheter heart valves-expert consensus on procedural planning and techniques. *Am J Cardiol*. 2023;192:228–244. https://doi.org/10.1016/j.amjcard.2023.01.010

13. Jawitz OK, Gulack BC, Grau-Sepulveda MV, et al. Reoperation after transcatheter aortic valve replacement: an analysis of the Society of Thoracic Surgeons database. *J Am Coll Cardiol Intv*. 2020;13(13):1515–1525. https://doi.org/10.1016/j.jcin.2020.04.029

14. Landes U, Webb JG, De Backer O, et al. Repeat transcatheter aortic valve replacement for transcatheter prosthesis dysfunction. *J Am Coll Cardiol*. 2020;75(16):1882–1893. https://doi.org/10.1016/j.jacc.2020.02.051

15. Hirji SA, Percy ED, McGurk S, et al. Incidence, characteristics, predictors, and outcomes of surgical explantation after transcatheter aortic valve replacement. *J Am Coll Cardiol*. 2020;76(16):1848–1859. https://doi.org/10.1016/j.jacc.2020.08.048

16. Bapat VN, Zaid S, Fukuhara S, et al. Surgical explantation after TAVR failure: mid-term outcomes from the EXPLANT-TAVR international registry. *J Am Coll Cardiol Intv*. 2021;14(18):1978–1991. https://doi.org/10.1016/j.jcin.2021.07.015

17. Fukuhara S, Tanaka D, Brescia AA, et al. Aortic valve reintervention in patients with failing transcatheter aortic bioprostheses: a statewide experience. *J Thorac Cardiovasc Surg*. https://doi.org/10.1016/j.jtcvs.2021.08.057

18. Percy ED, Harloff MT, Hirji S, et al. Nationally representative repeat transcatheter aortic valve replacement outcomes: report from the Centers for Medicare and Medicaid Services. *J Am Coll Cardiol Intv*. 2021;14(15):1717–1726. https://doi.org/10.1016/j.jcin.2021.06.011

19. Brescia AA, Deeb GM, Sang SLW, et al. Surgical explantation of transcatheter aortic valve bioprostheses: a statewide experience. *Circ Cardiovasc Interv*. 2021;14(4):e009927. https://doi.org/10.1161/CIRCINTERVENTIONS.120.009927

20. Spaziano M, Mylotte D, Thériault-Lauzier P, et al. Transcatheter aortic valve implantation versus redo surgery for failing surgical aortic bioprostheses: a multicentre propensity score analysis. *EuroIntervention*. 2017;13(10):1149–1156. https://doi.org/10.4244/EIJ-D-16-00303

21. Hirji SA, Percy ED, Zogg CK, et al. Comparison of in-hospital outcomes and readmissions for valve-in-valve transcatheter aortic valve replacement vs. reoperative surgical aortic valve replacement: a contemporary assessment of real-world outcomes. *Eur Heart J*. 2020;41(29):2747–2755. https://doi.org/10.1093/eurheartj/ehaa252

22. Deharo P, Bisson A, Herbert J, et al. Transcatheter valve-in-valve aortic valve replacement as an alternative to surgical re-replacement. *J Am Coll Cardiol*. 2020;76(5):489–499. https://doi.org/10.1016/j.jacc.2020.06.010

23. Kaneko T, Makkar RR, Krishnaswami A, et al. Valve-in-surgical-valve with SAPIEN 3 for transcatheter aortic valve replacement based on Society of Thoracic Surgeons Predicted Risk of Mortality. *Circ Cardiovasc Interv*. 2021;14(5):e010288. https://doi.org/10.1161/CIRCINTERVENTIONS.120.010288

24. Majmundar M, Doshi R, Kumar A, et al. Valve-in-valve transcatheter aortic valve implantation versus repeat surgical aortic valve replacement in patients with a failed aortic bioprosthesis. *EuroIntervention*. 2022;17(15):1227–1237. https://doi.org/10.4244/EIJ-D-21-00472

25. Nai Fovino L, Scotti A, Massussi M, et al. Incidence and feasibility of coronary access after transcatheter aortic valve replacement. *Catheter Cardiovasc Interv*. 2020;96(5):E535–E541. https://doi.org/10.1002/ccd.28720

26. Bernardi FLM, Dvir D, Rodes-Cabau J, Ribeiro HB. Valve-in-valve challenges: how to avoid coronary obstruction. *Front Cardiovasc Med*. 2019;6:120. https://doi.org/10.3389/fcvm.2019.00120

27. Sá MPBO, Van den Eynde J, Simonato M, et al. Valve-in-valve transcatheter aortic valve replacement versus redo surgical aortic valve replacement: an updated meta-analysis. *J Am Coll Cardiol Intv*. 2021;14(2):211–220. https://doi.org/10.1016/j.jcin.2020.10.020

28. Tarantini G, Fabris T, Nai Fovino L. TAVR-in-TAVR and coronary access: importance of preprocedural planning. *EuroIntervention*. 2020;16(2):e129–e132. https://doi.org/10.4244/EIJ-D-19-01094

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