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Why "Optimization" in Contemporary TAVI

Marco Barbanti, Giuliano Costa, Alfredo Marchese, Giuseppe Tarantini

The clinical imperative: from acute success to lifetime management

Transcatheter Aortic Valve Implantation (TAVI) was conceived as a rescue procedure for patients who had no other option. Two decades and several landmark trials later — from the early inoperable cohorts to PARTNER 3 and Evolut Low Risk — the same technology is now offered to patients in their sixties who can expect to live with their prosthesis for twenty years or more. This is the paradox that defines contemporary practice: a therapy built to keep the sickest patients alive must now be planned so the healthiest can live well for decades. As TAVI moved from inoperable and high-risk candidates to intermediate- and low-risk groups, it stopped being an alternative for the frail and became the default treatment for a broader, younger and more active population. That shift forces the Heart Team to redefine what constitutes a successful procedure.

When life expectancy is measured in decades rather than years, an immediate fall in the transvalvular gradient is no longer a sufficient measure of success. The relevant endpoints become the durability of the bioprosthesis, unobstructed coronary access and freedom from permanent conduction disturbance — and, crucially in a young

patient, a preserved strategy for the next valve intervention, which will in all likelihood be needed.

Understood this way, optimization is not a matter of marginal technical refinements. It is the discipline of ensuring every step of the procedure serves the patient’s whole life, not only the hours spent in the catheterization laboratory. This is the premise of the present textbook, which connects the evidence from recent trials with the everyday decisions that determine long-term outcome.

Setting the stage: screening, referral, and the network effect

Good results begin long before the patient reaches the catheterization laboratory; they depend on clinical timing and on how well the system around the operator is organized. Choosing the right patient at the right moment calls for structured outpatient pathways and explicit criteria for managing the waiting list — a task that becomes particularly delicate in low-flow, low-gradient aortic stenosis, in asymptomatic patients and in those who need an urgent non-cardiac operation. Whether to intervene, and with which strategy, should also be decided together with an informed patient: expected quality of life and patient preference now belong to sound selection rather than sitting outside it.

Optimization also extends beyond the walls of a single high-volume center. Efficiency and safety are better served by integrated Heart Valve Networks than by isolated TAVI sites. The logic here is organizational and economic as much as clinical: concentrating expertise while widening access is also what keeps the service sustainable for the health system that funds it.

In practice this means rethinking referral from “spoke” hospitals to “hub” centers and standardizing the workflow, so that a multidisciplinary evaluation — on-site or remote — is equally reliable wherever the patient enters the system. It also means agreeing in advance on the structural and clinical safeguards such a model demands, including how to manage patients in centers without on-site cardiac surgery.

None of this organisation runs by itself: it needs someone to run it. The TAVI coordinator is the connective tissue of the Heart Team, the single point of contact who follows the patient from referral through work-up, procedure and follow-up, and who ensures that collectively taken decisions are carried out. By owning scheduling, checklist completion and day-to-day communication between spoke and hub, this

figure turns a well-designed pathway from a diagram into a working reality, and much of the optimization described in this book quietly depends on it.

Pre-procedural precision: checklist, conscious sedation, and CT planning

Consistent results depend on preparation that is deliberate and standardized. At the institutional level, benchmarking outcomes and sustained quality-improvement work are what move a center forward. In practical terms this includes a pre-procedural checklist that weighs frailty, bleeding risk and life expectancy, and protocols — such as the routine use of local anaesthesia with conscious sedation — that lower the physiological burden of the procedure and speed recovery.

Computed tomography planning is where most of the technical decisions are really made. It has moved well beyond annular sizing to become an exercise in anticipation. A careful CT analysis allows the Heart Team to:

- assess the aortic root and the individual distribution of calcium, which guides the choice of device;
- predict conduction disturbance from the anatomy of the membranous septum and the local calcification pattern;
- define the fluoroscopic projections in advance, reducing trial-and-error at the table;
- plan the anatomy for the long term, anticipating a future redo procedure and safeguarding lifelong coronary access.

Planning is becoming safer in its own right, too: low-contrast and contrast-free CT protocols now make it feasible to work up patients with severe renal impairment who were once difficult to study. Automated, machine-learning-based measurement is beginning to enter this workflow; it does not replace expert reading, but it promises to make sizing and reproducibility less operator-dependent.

The lean Cath-Lab: minimalist workflows and tailored implantation

Once the patient is on the table, the aim is a lean, minimalist transfemoral procedure supported by an efficient laboratory. Well-designed setups and disciplined staffing

shorten the "time-to-valve," and with it both procedure duration and the risks that scale with it. Small technical choices matter here: replacing the routine right ventricular pacing catheter with direct wire pacing, for example, has reduced invasiveness and complications at the same time.

Routine ultrasound-guided puncture, paired with a closure strategy chosen for the individual vessel, has cut the large-bore access complications once accepted as the price of the procedure. A secondary radial access provides a safe bailout when a peripheral problem does arise. A genuinely minimalist approach also protects the people in the room, keeping radiation and contrast as low as is reasonable for patient and operator alike.

Within this workflow, deployment itself must be tailored to the individual anatomy. Commissural and coronary alignment has become an explicit goal rather than a fortunate accident, because it protects both coronary flow and the ability to re-access the coronaries later. Implantation depth is a comparable balancing act: high enough to spare the conduction system and limit pacemaker dependence, deep enough for stability and for the valve-in-valve that may follow. Seen this way, the first implant is already the opening move of a lifetime strategy, not a self-contained event.

In-Lab assessment, troubleshooting, and complex anatomies

A result is never assumed; it is verified, in real time, before the patient leaves the room. That means a multimodal assessment at the table — prompt haemodynamic checks of the transvalvular gradient, aortic regurgitation and left ventricular function, read together with multiplane fluoroscopy, angiography and, where feasible, intraprocedural echocardiography.

When a paravalvular leak is found it is corrected on the basis of its mechanism rather than by reflex: calibrated post-dilation, controlled repositioning, or a second valve when these are the right answer. Coronary patency is confirmed, conduction is watched closely, and a final checklist records the physiological and mechanical parameters that matter before the case is called complete.

This degree of control matters most in the anatomies that punish shortcuts. The bicuspid valve is the clearest example: increasingly common as treatment reaches younger patients, and still one of the settings where sizing, alignment and depth all become harder at once. These subsets are addressed in detail later in the book.

Post-procedural recovery and long-term durability

Optimization does not end when the delivery system is withdrawn. A clean, accurate procedure sets up a fast recovery, and contemporary post-TAVI care is built around one: focused rhythm monitoring to avoid unnecessary permanent pacemakers, sensible fluid and renal management, and early mobilization, all supporting early — and safe — discharge. Antithrombotic management belongs in the same discussion. The evidence now favours restraint, with single antiplatelet therapy for most patients without another indication for anticoagulation, while subclinical leaflet thrombosis on follow-up imaging remains an open question rather than a settled one.

Over the longer term the question becomes valve performance and durability. As these prostheses age inside progressively younger recipients, structured surveillance and a shared definition of structural valve deterioration are what allow the next decision to be taken in time rather than in crisis. Regular imaging follow-up is the instrument for this, tracking the valve across the years it is meant to last.

To keep all of this grounded, the final section of the book turns to a series of detailed clinical scenarios, showing how these principles hold up against difficult, specific, real-world cases.

Taken together, *Optimization of Transcatheter Aortic Valve Implantation Therapy* is intended as a practical framework rather than a survey. By moving the goal from surviving the procedure to optimizing every step around it, the Heart Team can deliver a treatment that is safe, durable and physiologically sound — and, above all, one planned for the whole of a patient's life rather than a single afternoon.

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Patient screening, referral and "right patient – right time"

Gianmarco Annibali, Sergio Berti, Giuseppe Musumeci

The expansion of indications for Transcatheter Aortic Valve Implantation (TAVI) to include low-risk and younger patients—commonly under 75 years of age and increasingly within the 65-70 age bracket—has initiated a paradigm shift in the approach to aortic valve disease management. The therapeutic outlook has transitioned from a short-term focus, covering a period of five to ten years, to a comprehensive management strategy that extends over a 20-year horizon.[1, 2]

The current evidence on the mid- to long-term durability of TAVI is highly compelling. Longitudinal data from landmark randomized controlled trials, including the NOTION trial[3] and the PARTNER 3 trial,[4] demonstrate that TAVI platforms exhibit structural valve deterioration rates that are at least comparable to those of surgical bioprostheses. It is noteworthy that transcatheter heart valves (THVs), especially self-expanding valves, frequently exhibit superior effective orifice areas and lower mean transvalvular gradients than surgical bioprostheses.[5] In younger patients, the projected life expectancy often exceeds the proven durability of any existing bioprosthesis. Consequently, the index intervention and the selected THV architecture are critical to determining the lifetime management of patients. This strategic selection must be grounded in three fundamental pillars:[6]

- it is imperative to preserve future coronary access. The selection of an appropriate THV and implant height is pivotal to enabling subsequent percutaneous coronary interventions.
- The feasibility of future TAV-in-TAV procedures depends on meticulous pre-procedural planning. Such planning is imperative to ensure that the aortic root can accommodate future 'valve-in-valve' procedures without compromising the coronary ostia or the sinus of Valsalva.
- If surgical explantation becomes necessary, it is imperative that a comprehensive understanding of the technical complexities involved is in place.

The selection of patients is no longer based on subjective surgical risk scores or age. A rigorous, multidimensional evaluation by the contemporary Heart Team is now required. This framework integrates objective, validated metrics of physical, cognitive and nutritional frailty, enabling clinicians to distinguish between patients who will benefit in terms of survival and those for whom the procedure may be futile.[7]

The indications for treatment have been broadened to include asymptomatic patients with severe aortic stenosis. Historically, aortic valve replacement was not performed until classic symptoms such as angina, dyspnoea or syncope were present. However, contemporary literature suggests that a 'watchful waiting' approach may lead to irreversible myocardial damage and a poorer long-term prognosis.[8] Determining the optimal timing for intervention has become a primary clinical objective, achieved through multiparametric analysis of early decompensation markers, including laboratory biomarkers (*e.g.* NT-proBNP) and advanced echocardiographic parameters such as global longitudinal strain.

In the context of prognostic evaluation, frailty is a crucial component of the comprehensive assessment of patients considered suitable for TAVI.[9] Frailty is defined as a geriatric syndrome characterized by a cumulative decline in physiological reserves and heightened susceptibility to external stressors. Severe frailty has been shown to significantly increase the risk of periprocedural complications, prolonged hospitalization and functional decline. These factors can counteract the clinical benefits of valve replacement.[10]

In contemporary medical practice, the 'eyeball test' — a subjective visual appraisal by the physician — is no longer sufficient to identify frail patients. This informal assessment frequently conflates chronological age or superficial physical appearance with true biological vulnerability. This inaccuracy can lead to two outcomes. Firstly, it may result in the unjustified denial of life-saving therapy to a robust elderly individual.

Secondly, it may result in the inappropriate treatment of a highly vulnerable patient whose frailty is clinically masked.[11]

Consequently, the current international guidelines (ESC/EACTS and ACC/AHA[2, 12]) strongly recommend the routine use of validated, objective frailty screening tools. The following instruments are particularly significant:

- the Clinical Frailty Scale (CFS) is a tool used to assess patients' physical and mental health. It provides a practical, global assessment of fitness and frailty based on clinical judgement and functional status;
- the Essential Frailty Toolset (EFT) is a comprehensive set of instruments designed to assess and address the needs of individuals experiencing frailty. The scale comprises four items, each assigned a score. The first item is lower-extremity weakness, measured by the time taken to complete five chair rises. The second item is cognitive impairment, assessed using the Mini-Mental State Examination. The third item is anaemia, measured by haemoglobin levels. The fourth and final item is malnutrition, measured by serum albumin levels. In large multicentre registries, an elevated EFT score has emerged as a potent independent predictor of one-year mortality and functional decline following TAVI.[13]

Futility constitutes a significant concept in the management of patients with severe aortic stenosis. According to international guidelines, TAVI) is considered clinically futile when the patient's life expectancy is less than one year, despite a successful procedure, or when there is no realistic expectation of an improvement in quality of life or functional capacity. The phenomenon of futility is typically driven by two irreversible pathological categories.

1. Conditions such as advanced malignancies, end-stage liver disease, oxygen-dependent chronic obstructive pulmonary disease and advanced dementia frequently limit the potential benefits of TAVI, resulting in a terminal prognosis irrespective of aortic valve status.
2. Patients presenting with terminal biventricular failure, fixed severe pulmonary hypertension, or advanced restrictive cardiomyopathies (*e.g.* severe cardiac amyloidosis) may have passed the therapeutic 'point of no return'.[14]

The distinction between severe frailty resulting from untreated aortic stenosis, which can be reversed post-intervention, and irreversible systemic decline remains