

ORIGINAL ARTICLE

Perioperative management after transcatheter aortic valve replacement and postoperative delirium assessment: a nationwide Italian survey

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ABSTRACT

BACKGROUND: Patients undergoing Transcatheter Aortic Valve Replacement (TAVR) are at risk for delirium. In Italy, the perioperative management of TAVR lacks standardization: this survey aims to investigate TAVR management across the country, focusing on delirium.

METHODS: A multiple-choice survey was conducted anonymously among 40 high-volume cardiac surgery centers in Italy: questions addressed logistics, surgical procedures, anesthetic management and delirium assessment.

RESULTS: The response rate was 68%. Low-volume centers were excluded, resulting in a final sample of 22 hospitals, including 7 of the top 10 highest-volume TAVR centers in Italy. Only 36% of the participating centers routinely assessed delirium onset after TAVR, and just 18% utilized a validated delirium diagnostic scale. Only one-third of the hospitals systematically assessed patient frailty in the preoperative period. Fast-track protocols for TAVR patients were implemented in 68% of the centers. The transfemoral approach was consistently the first choice, with conscious sedation being the preferred anesthetic strategy (82%). Invasive blood pressure monitoring with a dedicated line was routinely performed in 91% of centers, while urinary catheters were used in half of the hospitals, including 47% of those with fast-track protocols. Postoperatively, 55% of patients were admitted to a Subacute or Coronary Care Unit, while 41% were managed in the Cardiology ward. In most cases, the hospital length of stay was three days or more.

CONCLUSIONS: This survey reveals substantial heterogeneity in perioperative management, delirium prevention and assessment after TAVR in Italy. This heterogeneity may contribute to differences in hospital stay and clinical outcomes.

(Cite this article as: Russo FM, Fiorentini C, Sangalli F, Scolletta S, Martinez-Lopez de Arroyabe B, Conti MC, *et al.* Perioperative management after transcatheter aortic valve replacement and postoperative delirium assessment: a nationwide Italian survey. *Minerva Anestesiol* 2025;91:000–000. DOI: 10.23736/S0375-9393.25.19434-0)

KEY WORDS: Delirium; Transcatheter aortic valve replacement; Frailty; Cardiac surgical procedures.

Delirium, also known as acute confusion state, is a condition defined by a disturbance in attention and awareness that develops acutely and tends to fluctuate.¹ The pathophysiological mechanisms of delirium still remain poorly understood; the most reliable explanation involves neurotransmitter imbalance and neuroinflammation.² Delirium manifests in various clinical scenarios with notable prominence following surgery.³ Patients undergoing cardiac surgery frequently show multiple risk factors for delirium onset, including advanced age, surgical complexity and duration, comorbidities such as cognitive impairment, heavy use of opioid sedatives and benzodiazepines, history of stroke, atrial fibrillation, and peripheral vascular disease.^{4, 5}

Consequently, delirium in cardiac surgery patients represents a significant medical concern, which can seriously jeopardize both short and long-term outcomes.^{6, 7} Aside from short and long-term mortality, delirium is also known for significantly reducing quality of life.⁸ Transcatheter Aortic Valve Replacement (TAVR) has rapidly been emerging in recent years, offering a less invasive alternative compared to traditional aortic valve replacement surgery with positive post-procedural outcomes, such as lower mortality and improvements in quality of life.^{9, 10} However, patients undergoing TAVR procedure are often frail and older compared to other cardiac surgery patients and therefore at higher risk for delirium.³ Therefore, despite the reduced invasiveness, TAVR leads to a significant post-

procedural delirium risk. Besides surgery, which indeed causes the release of psychoactive inflammatory markers, anesthesia exposes the brain to several cognitively active drugs, ultimately altering the biochemical balance in the sleep/arousal pathway.¹¹ Peri-operative management of TAVR is still largely based on local practice. Developing shared protocols and pursuing standardization may help reduce the incidence of delirium. The aim of this study is to provide detailed insights regarding delirium assessment and perioperative management in patients undergoing TAVR among the Italian cardiac surgery centers.

Materials and methods

This multicenter, nationwide online survey was conducted anonymously among cardiac surgery facilities in Italy between August and October 2023. Italian institutions were selected from the publicly available list of Italian centers performing TAVR, with the aim of targeting high-volume centers. A specific effort was made to contact the 10 highest-volume TAVR centers in Italy according to the Gruppo Italiano di Studi Emodinamici (GISE) registry. Invitations to participate were sent via e-mail and social networks on August 1st, with two reminders in September and October for those who had not completed the survey. The final reminder was sent on October 31st. The survey included 24 multiple-choice questions (Supplementary Digital Material 1: Supplementary Table I) designed by a multidisciplinary panel of cardiac anesthesiologists and interventional

cardiologists, grounded on published literature and common clinical practice. Although content validity was ensured by expert consensus, the questionnaire was not pilot tested or formally validated.

The first question identified high-volume centers for TAVR procedures. Centers performing fewer than 100 TAVR/year were excluded to ensure greater consistency and comparability across centers. While our study was not designed to evaluate the relationship between TAVR volume and postoperative delirium incidence, prior literature suggests that higher procedural volumes are generally associated with improved outcomes and more standardized care pathways.^{12, 13}

Questions 2–6 addressed logistics (e.g., length of stay, post-operative care settings), while questions 7–9 focused on surgical procedures. Anesthetic management was explored in questions 10–18, and the remaining questions covered preoperative frailty assessment, delirium onset, and evaluation. Only high-volume centers (>100 TAVR/year) were included in the study.

Categorical variables are reported as numbers and percentages (%).

Results

Characteristics of the investigated centers

The survey was distributed to 40 Italian centers, of which 27 (68%) completed the questionnaire. Among these, 21 were university hospitals. More than half (56%) of the participating hospitals were located in northern Italy, while 8 (30%) were in central Italy and 4 (14%) in the south.

According to publicly available data, non-responding centers did not differ substantially from responders with respect to procedural volume, or academic status.

Among responding centers, 5/27 (18%) did not meet the inclusion criteria (>100 TAVR annually) and were excluded. Due to the limited number of low-volume centers, no formal statistical comparison was feasible with included institutions. Of the remaining 22 centers, seven were ranked among the top 10 highest-volume TAVR centers in Italy, according to GISE registry.¹⁴

All responses were provided by professionals directly involved in the perioperative management of TAVR patients, primarily cardiac anesthesiologists. We received multiple responses from every single center; those data were reviewed for consistency and merged to produce a single representation of the center's practice.

Minor differences concerning drug choice for premedication, anesthesia and postoperative pain management were integrated to retain all information. In only three cases we received discordant responses (concerning length of stay and postoperative admission setting) from professionals working in the same center; in those cases the majority answer was considered representative for that center.

Perioperative management and length of stay (Questions 2–6)

A fast-track protocol for TAVR patients was available in 15 out of 22 centers (68%) (Figure 1).

Following the procedure, according to this survey, patients were admitted to a Sub-Acute or Coronary Care Unit in 12/22 (55%) of hospitals, while in 9/22 (41%) were managed in the cardiology ward. Only one center reported routine admission to the Intensive Care Unit (ICU). In the Italian context, Coronary Care Units are specialized cardiology wards dedicated to the monitoring and treatment of patients with acute cardiac conditions, typically managed by cardiologists. Depending on institutional resources, they may occasionally admit intubated patients, although this is uncommon. Sub-acute units, in contrast, are step-down wards for lower-intensity monitoring, usually reserved for clinically stable patients. They may be managed by other specialists and they do not admit intubated patients.

The hospital length of stay was three days or more in most cases (three days: 13/22, 59%; more than three days: 7/22, 32%). Only two centers discharged patients after just two days.

Surgical management (Questions 7–9)

The transfemoral approach was consistently the first choice. The average TAVR duration was 1–2 hours in 15/22 (68%) of cases, with only one hospital reporting an average duration exceeding 2 hours. A cerebral embolic protection device

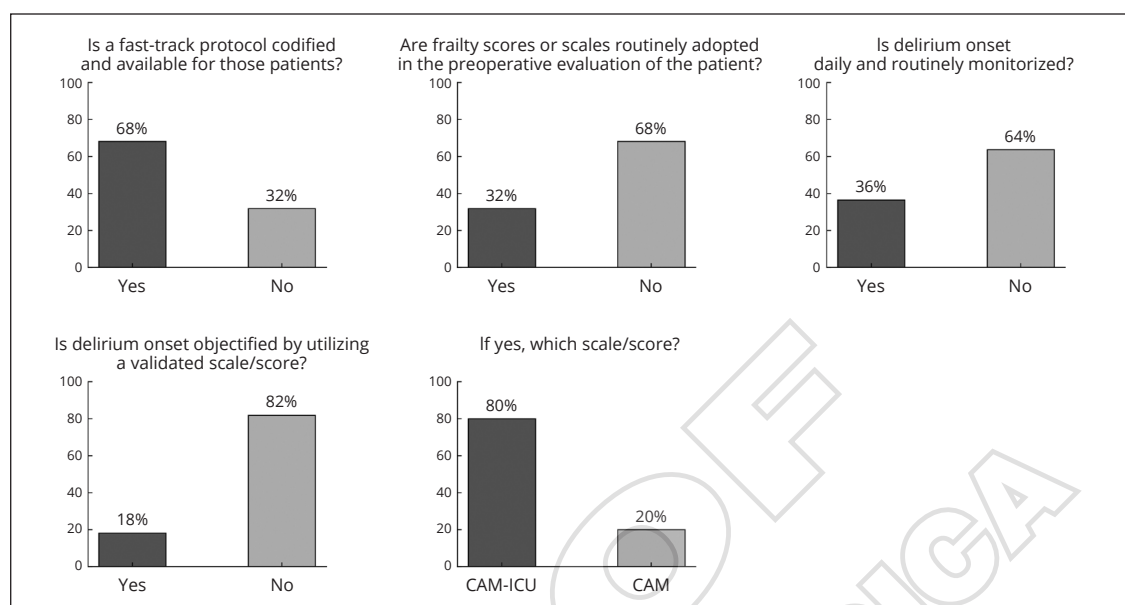


Figure 1.—Centers using a fast-track protocols and using validated scores to assess a frailty and delirium onset. CAM: confusion assessment method; CAM-ICU: Confusion Assessment Method-Intensive Care Unit.

was routinely implanted in high-risk patients at 7/22 centers (32%).

Anesthetic management (Questions 10–18)

The majority of centers performed the procedure under conscious sedation (CS), and the sole use of local anesthesia at the surgical site was used in only four centers, with or without premedication (*e.g.*, benzodiazepines or opioids for anxiety or pain reduction). General anesthesia (GA) was rarely required. When CS was administered, sedation was commonly achieved using Propofol, Remifentanyl and Dexmedetomidine, employed at comparable frequencies. If GA was needed, Propofol was the anesthetic of choice in 13/22 (60%) of cases. A central venous catheter was not routinely placed, while 20/22 (91%) of centers monitored blood pressure invasively via an arterial catheter. A urinary catheter was placed in 11/22 (50%) of cases, including 7/15 (47%) of those with a fast-track protocol.

Delirium onset and diagnosis, preoperative frailty assessment (Questions 19–24)

For preoperative evaluation, 7/22 (32%) of centers assessed frailty (Figure 1), primarily using the validated Frailty Score.¹⁵ Only 8/22 (36%)

centers routinely assessed delirium onset following TAVR, and just 4/22 (18%) used a validated delirium diagnostic scale (Figure 1). Postoperative pain management rarely involved opioids (9%), with paracetamol and nonsteroidal anti-inflammatory drugs (NSAIDs) preferred.

Discussion

This study investigated perioperative clinical practices for delirium prevention and assessment in TAVR patients across Italy. Postoperative delirium is common in patients undergoing cardiovascular procedures, including TAVR, with incidence rates historically reported to range from 26% to 52%.¹⁶ However, delirium specifically following TAVR remains understudied, and its true prevalence in the current era of minimalist approaches may be lower than previously estimated, as suggested by recent data, possibly reflecting both improved perioperative care and the fact that TAVR may be now offered to patients with lower perioperative risk compared to the past.¹⁷ Delirium in cardiac surgery patients is a complex and potentially serious condition requiring a proactive and multidisciplinary approach.¹⁶ Effective delirium

management is based on three key pillars: prevention, assessment and management.¹⁸

Delirium prevention

The etiology of delirium is multifactorial, resulting from a complex interplay between a patient's baseline vulnerability (e.g., advanced age, frailty, cognitive impairment) and exposure to precipitating factors, such as prolonged procedures or the use of opioids and benzodiazepines for sedation.¹⁹ Effective prevention therefore hinges on early identification of at-risk patients, minimizing procedural invasiveness, and ensuring optimal perioperative comfort. Despite the recognized importance of comprehensive frailty assessment in stratifying delirium risk, validated multidimensional tools were infrequently used across surveyed centers, with only a minority applying them systematically (Figure 1). This may be due to the time-consuming nature of these assessments and the current lack of consensus on which tools best predict delirium or long-term outcomes. Anesthetic management further contributes to risk, as exposure to cognitively active agents can disrupt neurochemical pathways involved in arousal and cognition.²⁰ In our survey, benzodiazepines were primarily used as preoperative premedication and administered hours before potential delirium onset; nevertheless, their possible role in increasing postoperative delirium risk cannot be ruled out and warrants cautious use, especially in high-risk patients. Clinically, these considerations underscore that delirium cannot be effectively prevented by targeting a single factor. Instead, a multicomponent approach, addressing various modifiable risk elements, is the most promising strategy.

Intraoperative anesthetic considerations

Modern TAVR protocols emphasize a minimalist approach, from hospital admission to discharge, to reduce invasiveness and improve outcomes.²¹ In line with European practice, the majority of surveyed centers favored CS and local anesthesia over GA, reserving GA for select cases.²² The SOLVE-TAVI randomized trial found no significant differences between CS and GA in terms of mortality, myocardial infarction, stroke, or delirium incidence, with a low conversion rate

from CS to GA (5.9%), confirming the safety of CS.²³ While GA allows for transesophageal echocardiography and easier complication management, it is associated with higher complication rates and no clear benefits in LOS or neurological outcomes.²¹ In Italy TAVR procedures are often performed primarily by interventional cardiologists, who may also manage sedation and analgesia in selected low-risk patients without direct anesthesiologist support. In this survey, Dexmedetomidine emerged as the preferred agent for CS, likely reflecting the familiarity of Italian cardiologist with its use.²⁴ Dexmedetomidine has been associated with a lower incidence of delirium compared to Propofol and other narcotics, with minimal risk of bradycardia at low doses.²⁵ Routine use of central venous and urinary catheters should be minimized. Avoiding urinary catheterization has been linked to fewer in-hospital complications, including lower urinary tract infections.²⁶ The "no catheters except for one peripheral venous line" policy, as described by Chopra *et al.*, could further simplify the TAVR process.²⁷ Although none of the surveyed centers routinely placed central lines, urinary catheters were still used in 7 of 15 hospitals implementing a fast-track protocol. Furthermore, loco-regional anesthesia is gaining increasing interest in patients undergoing cardiac surgery and may present a promising opportunity to enhance anesthesia management in TAVR procedures. Few studies have focused on this topic so far and evaluated ilio-inguinal and femoral block.^{28, 29} However, the optimal loco-regional anesthesia technique has yet to be fully explored.

Procedural considerations

Surgical factors also impact delirium risk. Minimally invasive approaches and shorter procedures have been associated with lower delirium rates.³⁰ In this survey, most TAVR procedures lasted 1-2 hours, with the transfemoral approach being the preferred strategy. This aligns with European practice due to the approach's reduced invasiveness, allowing for percutaneous access under local anesthesia or CS, minimizing procedural time, sedative use, and perioperative pain.^{28, 31} The development of transfemoral TAVR has made aortic valve replacement more

accessible to elderly patients previously deemed inoperable due to excessive surgical risk.³² Our survey did not evaluate the impact of cerebral embolic protection devices on delirium. Their use varied among centers, reflecting ongoing uncertainty about their benefits *versus* the increased invasiveness and procedural time. Further research is needed to clarify their role in delirium prevention.

Delirium assessment

One of the most striking findings of our survey is the lack of a standardized method for delirium assessment across the majority of participating centers. Despite the high clinical relevance of postoperative delirium, its onset was routinely assessed in only 8/22 (36%) of cases, and validated diagnostic scales were rarely used (Figure 1). Over the years, various tools have been developed to screen, diagnose, and assess delirium severity.³³ The most accurate and widely used diagnostic tool is the Confusion Assessment Method (CAM), including its ICU-adapted version (CAM-ICU).^{34, 35} While CAM-ICU is strongly recommended by guidelines, its use remains limited in the surveyed centers. Possible explanations include lack of education and awareness among practitioners, perceived time constraints in busy clinical environments, and understaffing.^{18, 36, 37} Given the impact of postoperative delirium on outcomes, increasing awareness and promoting systematic use of validated assessment tools should be a priority for future quality improvement initiatives.

Delirium management and length of stay

Following TAVR, most patients were admitted to cardiology wards (41%) or sub-intensive care units (55%), with ICU admission being rare. This may have influenced LOS and postoperative pain management, as opioids are often avoided in non-ICU settings due to overdose concerns and limited provider experience with opioid-related side effects.^{38, 39} Consequently, paracetamol and non-steroidal anti-inflammatory drugs (NSAIDs) were the preferred analgesics, as reflected in our survey. Since inadequate pain control might be a key contributor to delirium, a balanced analgesic approach, including opioids only when neces-

sary, should be considered.¹⁸ Despite the proven benefits of fast-track TAVR protocols in reducing complications and improving recovery, they were implemented in only 15/22 (68%) of surveyed hospitals (Figure 1).^{3, 19} Early discharge within 48 hours is recommended to minimize risks, yet this survey reported a LOS >3 days in 7/22 (32%) of cases.⁴⁰ Prolonged hospital stays may be influenced by clinical optimization before the procedure, as well as logistical factors such as routine ICU or sub-acute care unit admissions, which occurred in 13/22 (59%) of surveyed centers.

Possible perioperative strategy for delirium prevention in TAVR

In line with recent European literature, the authors emphasize the potential benefits of a unified and standardized protocol for managing TAVR patients in Italy. To help minimize the risk of perioperative delirium in TAVR patients, a fast-track protocol could consider three key aspects:

- hospitalization duration: scheduling admission the same day or the day before the procedure may reduce risks, with an emphasis on minimizing ICU stays and promoting early postoperative mobilization;
- procedure invasiveness: the transfemoral approach should be prioritized, favoring percutaneous over surgical access. The routine use of urinary catheters and central venous lines should be limited, based on individual patient assessment;
- anesthetic management: conscious sedation should be preferred over general anesthesia, with a preference for short-acting agents to minimize sedation-related cognitive effects.

Limitations of the study

This survey has several limitations. First, the inclusion of only high-volume centers ensured greater consistency and comparability across respondents, but restricts the generalizability to lower-volume institutions, where perioperative management and resource availability may differ significantly. Second, the absence of clinical outcome data (such as actual delirium incidence or length of stay in patients who developed de-

lirium) precludes any associations between perioperative practices and clinical outcomes. The results should therefore be interpreted as descriptive and hypothesis-generating rather than conclusive. Third, this study shares common survey-related limitations, including potential response bias, as participants may have portrayed their practices in a favorable light or provided answers aligned with perceived expectations.

Conclusions

This nationwide survey reveals substantial heterogeneity in perioperative management after TAVR in Italy. Establishing minimal common standards, such as structured fast-track protocols and routine delirium screening with validated tools like the CAM-ICU, could be key to harmonizing practices and improving patient outcomes.

What is known

- Delirium is a preventable post-TAVR complication.
- There are currently no guidelines on perioperative management of TAVR patients.

What is new

- There is significant heterogeneity among TAVR patients management in Italy.
- Routine assessment of delirium with standardized scales in Italy is rare.

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Conflicts of interest

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Authors' contributions

Filippo M. Russo, Paolo Meani, and Valentina Ajello have given substantial contributions to the conception or the design of the manuscript, author Chiara Fiorentini and author Filippo Russo to acquisition, analysis and interpretation of the data. All authors have participated to drafting the manuscript, author Paolo Meani and Valentina Ajello revised it critically. All authors read and approved the final version of the manuscript.

Congresses

This paper was presented as poster at the ITACTA Congress, Bologna, Italy, February 29 – March 1 2024.

Acknowledgements

The authors acknowledge Giovanna Pedrazzini (Department of Anesthesia, Critical Care and Emergency, Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, Milan, Italy), Mattia Gomarasca (Department of Anesthesia and Intensive Care, ASST Ovest Milanese, Legnano, Italy), Martina Monti (Department of Anesthesia and Intensive Care, ASST Papa Giovanni XXIII, Bergamo, Italy), Ottavia M. Cozzi (Cardio Center, IRCCS Humanitas Research Hospital, Rozzano, Italy), Andrea Crosignani (Department of Cardiothoracic and Vascular Anesthesia, Grande Ospedale Metropolitano Niguarda, Milan, Italy) as participating investigators.

History

Article first published online: _____. - Manuscript accepted: October 21, 2025. - Manuscript revised: October 7, 2025. - Manuscript received: July 19, 2025.

Supplementary data

For supplementary materials, please see the HTML version of this article at www.minervamedica.it

Comment in: Rajkumar K, Crimi E. Delirium after transcatheter aortic valve replacement: an underrecognized target for perioperative standardization. *Minerva Anestesiologica* 2025;91:000–000. DOI: _____