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OPTIMIZING TAVR EFFICIENCY AND OUTCOMES WITH NURSE-LED SEDATION

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CV BUSINESS WHITE PAPER

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INTRODUCTION

Transcatheter aortic valve replacement (TAVR) has revolutionized the treatment of aortic stenosis. Advancements in valve design, delivery systems and procedural technique have extended this minimally invasive alternative to cardiac surgery to patients of all risk categories. As TAVR volumes continue to rise, cardiovascular programs are seeking innovative ways to optimize resource utilization, improve efficiency and maintain safe, high-quality patient care. One approach gaining traction is the implementation of nurse-led sedation (NLS) for TAVR procedures in appropriately selected patients.

This CV business white paper provides a comprehensive framework for discussing this emerging approach to TAVR sedation and its impact on patients, providers and health systems. We address the main aspects of implementing NLS for TAVR procedures, including the demonstrated safety, driving factors, benefits and important considerations for program success. Insights were gathered from two successful programs that have effectively implemented NLS—the University of Maryland Medical Center (UMMC) and the University of Texas (UT) Health San Antonio/ University Health—through data collection and interviews with lead physicians, program coordinators, and cath lab managers.

Key findings highlighted in this publication include:

- Driving factors behind the adoption of NLS.
- Potential benefits for patients, staff and healthcare systems.
- Financial impact of NLS for TAVR.
- Key considerations for program success.
- Strategies for overcoming implementation challenges.

By empowering nurses to work at the top of their license, NLS programs have the potential to streamline TAVR procedures, reduce resource utilization, and maintain excellent patient outcomes.[1,2] Notably, successful implementation requires careful planning, robust training and a commitment to patient safety. This CV business white paper aims to provide valuable insights and practical guidance to cardiovascular administrators and clinicians that support informed decision-making and successful development of an NLS program.



Clinical Safety of NLS

When considering innovative care delivery approaches, the concern for patient safety remains top of mind. Several publications have addressed the safety of NLS in TAVR and showed no significant differences in major adverse complications such as vascular complications, bleeding and stroke, as well as similar echocardiographic success.[3,4] This knowledge provided both programs with the confidence that given appropriate planning and patient selection, they could implement NLS and drive high-quality patient outcomes. Indeed, the programs report that alongside a low incidence of conversion to general anesthesia, procedural outcomes are no different from those with anesthesia-led sedation.

BENEFITS OF NURSE-LED SEDATION FOR TAVR

Improved Resource Utilization

NLS for TAVR procedures offers significant advantages in resource utilization. Reducing reliance on anesthesiology teams for TAVR makes them available for other cardiovascular procedures, such as atrial fibrillation ablation, left atrial appendage closure (LAAC) and cardiovascular surgery. Constraints arising from anesthesia's availability can be a driving force for implementing NLS. The use of NLS can help to ease scheduling limitations related to anesthesia coverage, improving patient access to TAVR and procedural capacity. Delays or cancellations due to emergent surgeries requiring anesthesia may also be reduced while freeing up valuable anesthesia providers for procedures where anesthesia care is non-negotiable. Further, the use of NLS leverages the expertise of registered nurses (RNs) already present in the cath lab setting to work at the top of their license in providing procedural care.



"PATIENTS ARE DEFINITELY UP AND MOVING AROUND FASTER
than they are with general anesthesia."

Susan Huppmann, DNP, CRNP, CCRN
TAVR Program Manager, UMMC

CASE VIGNETTE

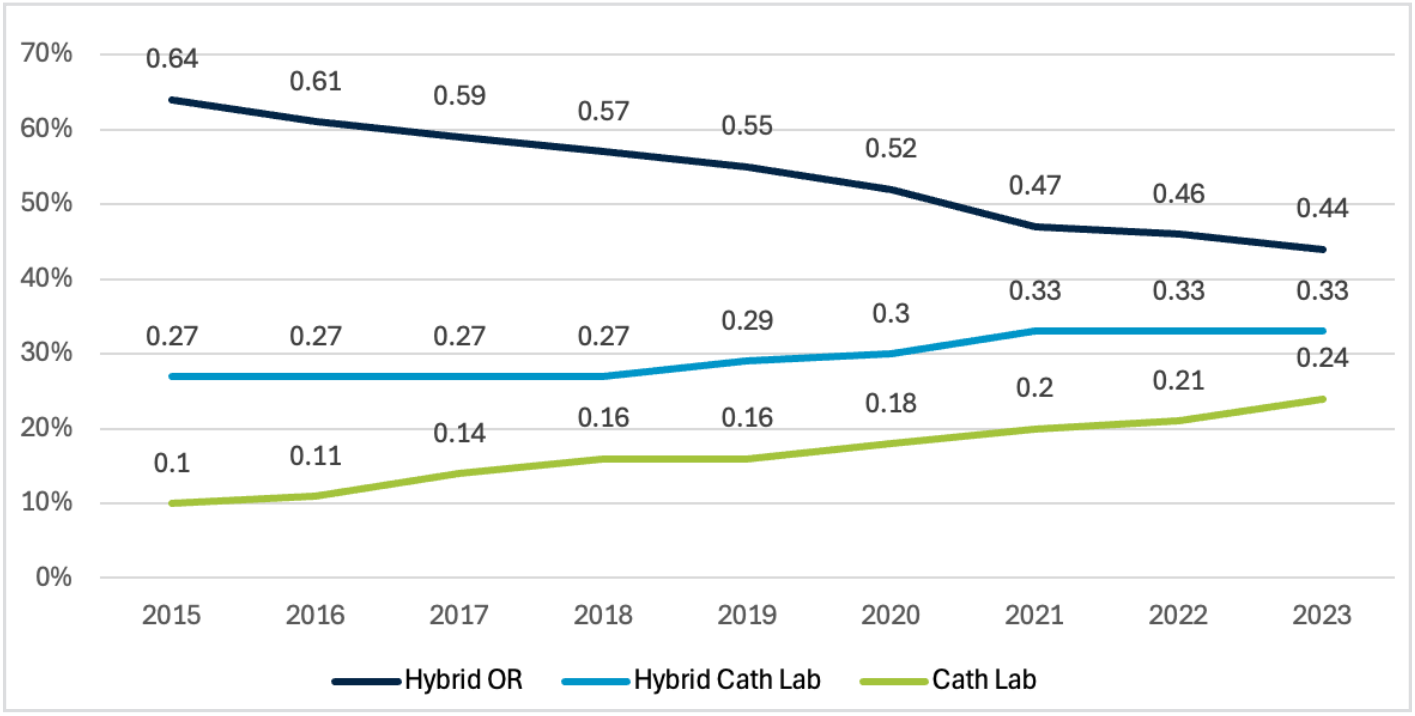
The University of Maryland Medical Center (UMMC) faced a significant challenge in their structural heart (SH) program. Despite growing demand for TAVR procedures, they were constrained by limited availability of anesthesiologists. They experienced delays in patient care, scheduling difficulties and occasional procedure cancellations when anesthesiologists were urgently needed elsewhere.

Implementing an NLS program for TAVR procedures allowed cath lab RNs to administer and monitor conscious sedation, freeing up anesthesiologists for more complex cases. The results were transformative. UMMC was able to:

- Improve TAVR procedure scheduling flexibility and reduce wait times for patients.
- Reduce procedural delays and cancellations related to anesthesia's need to support other urgent/emergent procedures.
- Increase TAVR procedural capacity by adding an additional TAVR procedure day to their weekly schedule.
- Accommodate allocation of anesthesia resources to other complex SH procedures.

Current data from the National Cardiovascular Registry (NCDR®) Society of Thoracic Surgeons (STS)/American College of Cardiology (ACC) Transcatheter Valve Therapy (TVT) Registry™ indicates that TAVR procedures are increasingly moving outside of the operating room (OR). As of 2023, 57% of TAVR procedures were performed in either a cath lab or hybrid cath lab **(Figure 1)**.[5] The use of NLS fits this trend of moving procedures away from the OR. Not only are NLS procedures performed outside the OR, but procedural efficiency is also improved. Patient preparation time is more streamlined, and lab turnaround is improved by eliminating a full anesthesiology assessment, patient intubation and extubation. These findings echo published data describing significant reductions in procedural duration when NLS is employed.[3]

Figure 1: TAVR Procedure Location, Calendar Years 2015-2023, STS/ACC TVT Registry Database



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CASE VIGNETTE

The use of NLS at University Health has led to operational efficiencies in procedural workflows and patient throughput **(Figure 2)**. The streamlined workflow of NLS has decreased patient pre-procedure prep time and shortened the time patients spend in the procedure lab after the TAVR procedure is complete. They observed an average reduction in:

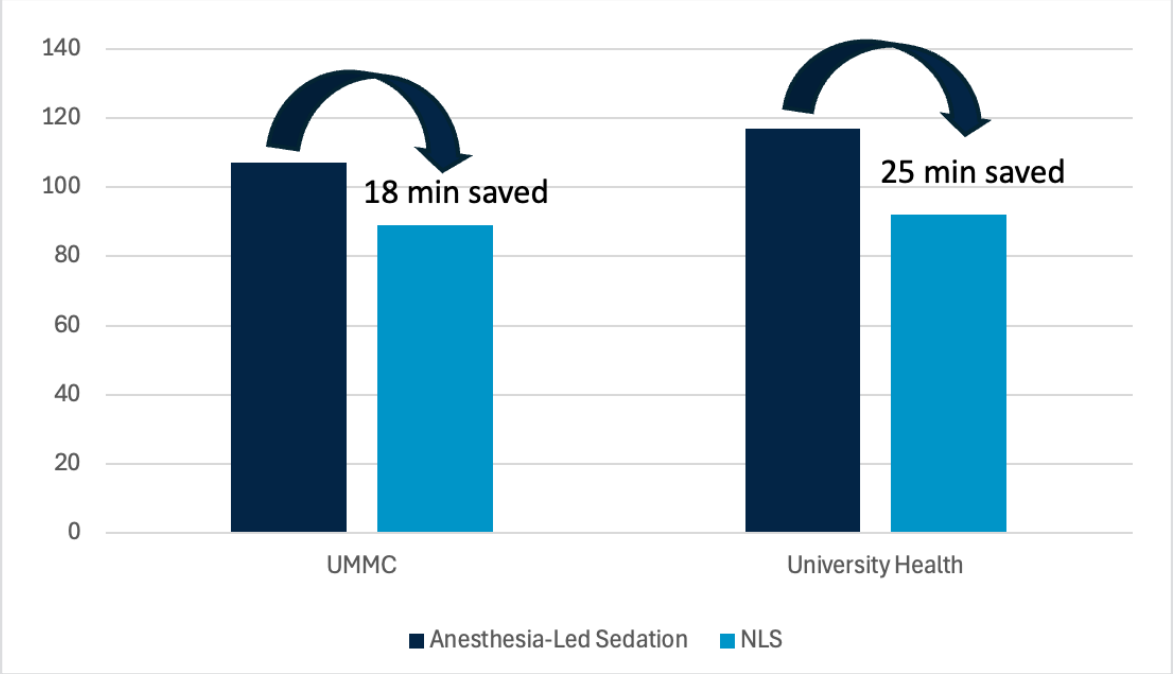
- TAVR procedure time by seven minutes.
- Turnaround time by seven minutes.

The most striking efficiency was realized by using two procedure teams and labs, allowing the second patient to be prepped while the first case finished. The improved transition between procedures helped to maximize resource utilization and increase the number of procedures completed in a day.

Further, the total post-operative length of stay was reduced by six hours, allowing for an earlier patient discharge the following day.

Both programs anecdotally reported they find that patients recover faster and are more alert on arrival to the recovery area than with anesthesia-led sedation **(Figure 2)**. Physicians appreciated having greater control over the amount of sedation their patients receive and felt as though sedation-related post procedure hypotension was less common, which when present, may raise concerns for possible bleeding.

Figure 2: Total Lab Time Savings With NLS vs. Anesthesia-Led Sedation



Cost Effectiveness

One very attractive contribution of NLS in TAVR is the potential for lower overall procedure costs. Cost savings are primarily attributable to the avoidance of anesthesia and post-anesthesia care unit (PACU) use.[6] **One program reported procedural savings of over $8,000 per procedure.** Patients return to the procedural lab recovery area for initial monitoring with transfer to a cardiovascular nursing unit for continued monitoring, similar to the process for other invasive cardiac procedures. With the more rapid recovery process, patients are ambulating sooner, supporting the opportunity for earlier hospital discharge.

Drivers for the Use of NLS

- Demand for scheduling SH procedures with anesthesia.
- Increasing TAVR volumes and resource constraints.
- Need for improved procedural efficiency.
- Cost considerations.

Key Considerations for Implementing an NLS Program

Patient Selection

Thoughtfully established criteria for identifying patients appropriate for NLS is key to ensuring patient safety and minimizing the conversion to anesthesia-led care. Both programs used guidance from the American Society of Anesthesiologists (ASA) criteria for moderate sedation to form the baseline for identifying patients appropriate for NLS.[7] Criteria included consideration of body size and habitus, cardiac function, Mallampati score, ASA classification ≤ ASA III and anticipated use of femoral access. Another best practice was review of patients with a heart team approach as clinical criteria must include patient-specific status at the time of presentation.[2] Patients who meet criteria proceed with NLS, while others are referred to anesthesia for further evaluation. Patients are in turn re-reviewed by the procedural physician and nurses on the day of the procedure. This selective approach ensures that patient safety remains paramount and appropriate anesthesia care is provided based on individual needs. While NLS offers clear advantages, it may not be suitable for all patients or procedures. Anesthesiologist involvement remains essential, particularly for cases outside the NLS protocol, to verify that all patients receive appropriate sedation and anesthesia care tailored to their specific needs.

Eligibility for NLS trends toward lower-risk patients, though both programs noted that as their experience with NLS grew, their comfort with safely performing the procedure without anesthesia-led care in urgent cases or patients with lower ejection fractions (EFs) also grew. **(Table 1).**

Sample Patient Selection Criteria

- Body mass index (BMI) <40
- EF >30%
- No history of obstructive sleep apnea (OSA)
- ASA III classification or lower
- Not claustrophobic
- Amenable to femoral access

Table 1: Comparison of Patients Receiving NLS vs. Anesthesia Care

Program	UMMC – Baltimore, MD		University Health – San Antonio, TX	
Sedation Type	**NLS**	**Anesthesia-Led Sedation**	**NLS**	**Anesthesia-Led Sedation**
Age (Mean in Years)	76	77	77	78
BMI (Mean)	26.7	29.9	28.9	31.2
STS Score (Mean)	3.7	5.3	1.6	4.1
Five-Meter Walk (Mean in Seconds)	7	6	6.7	6.9
Mallampati Score (Mean)	2.2	2.3	1.3	2.2
Pre-Operative LVEF % (Mean)	54	53	66	61

BMI = body mass index; LVEF = left ventricular ejection fraction; STS = Society of Thoracic Surgeons

Multidisciplinary Team Approach

A deliberate, collaborative multidisciplinary planning process is key to program success. In each facility, the first step was to cultivate buy-in and develop patient selection criteria that aligned with those from the available literature. A physician and administrative dyad created a multidisciplinary work group to develop clinical and operational workflows, which were key in designing the NLS program. Including anesthesia leadership in these discussions was particularly important to maintain programmatic quality, safety and overall success. Programs found it took three to four months of planning before conducting their first NLS case.

Recommended Roles to Include in NLS Program Development

- TAVR team
  - IV cardiology
  - CT surgeon
  - TAVR coordinator
  - SH advanced practice provider (APP)
- Anesthesia
- Cath lab manager
- Clinical nurse specialist or educator
- Pharmacy
- Cardiovascular unit manager
- Staff RNs

Policies and Procedures

Programs also identified the importance of developing policies and procedures to guide the care of patients receiving NLS and fall under the scope of practice for RNs. Once developed, content was reviewed and approved by the TAVR team, anesthesiologists, cath lab leadership, TAVR procedural staff and pharmacy. Content of the policies and procedures was incorporated into standard order sets to maximize adherence and minimize variation in care delivery.

Sedation orders were built on existing cath lab sedation protocols for PCI, creating a familiar starting point for cath lab RNs experienced in caring for high-risk, complex patients. One facility supplied NLS medications in a "kit" in the cath lab to make routine, necessary pro re nata (PRN) medications readily available throughout the procedure. They collaborated with information technology and pharmacy to populate the procedure log and medication administration record to streamline documentation.

Download samples of a TAVR Protocol and TAVR Timeout Checklist from UMMC.



"THERE'S NO QUESTION THAT NLS IS GOING TO BE THE STANDARD FOR MOST TAVR IN THE FUTURE. *As the technology continues to improve with lower profile devices and improved safety, every program should consider it.* **IT IS VERY SIMPLE AND EASY TO APPLY."**

Ahmed Almomani, MD, FACC, FSCAI,
Assistant Professor of Medicine, Interventional Structural Cardiologist, UT Health San Antonio

Staff Education

Cath lab nurses were provided supplementary education to establish competency in moderate sedation for TAVR patients by hospital and industry team members. Special emphasis was placed on maintaining patient sedation and comfort during valve deployment and vascular access closure. The entire team participates in emergency simulation drills to practice declining patient scenarios and build familiarity with low-frequency, high-risk situations. When beginning NLS, both programs conducted the first several NLS cases with anesthesia present in the control room. This helped to boost the confidence of all team members as they assumed sedation management of TAVR patients. Annual education and skill validation is used to verify ongoing capabilities of nurses providing TAVR sedation.

Specific efforts are taken to guarantee patient safety throughout the TAVR procedure. Procedure physicians and nurses review patients to confirm that NLS is still the appropriate approach to sedation before bringing them back to the procedure room. The RN administering sedation is dedicated to monitoring the patient and is not assigned additional responsibility during the case. To adhere to regulatory requirements, patients are assessed every five minutes for vital signs, level of consciousness, oxygen saturation and pain score. In the case of an emergency or need to convert to anesthesia-led sedation, staff have access to call anesthesiology, perfusionists, pharmacy, respiratory therapists and other emergency staff for support. The procedural area has standard hemodynamic support equipment, airway support and code carts readily available.

Post-Procedure Care

Since patients have not received general anesthesia, they do not need a traditional PACU bed for recovery. Instead, they may spend a short time in the cath lab recovery area before being transfered to a cardiovascular inpatient telemetry unit. A thorough in-person nurse handoff further supports patient safety in this next level of care. Patients are off bedrest and ambulating between four to six hours post procedure and followed by the cardiology inpatient rounding service. If patients are clinically stable and their electrocardiograms are also stable, they are discharged 24 to 36 hours after the procedure.

Performance Monitoring

As with any new program, performance monitoring and feedback is important for ongoing success. Using the NCDR STS/ACC TVT Registry and operational data elements can inform TAVR teams about success and opportunities for improvement. Both programs have not seen a significant difference in patient outcomes and anecdotally report a high degree of patient satisfaction with the use of NLS. Similarly, procedural physicians report satisfaction with the ability to complete more TAVR cases in a timelier fashion while freeing up anesthesiology for cases where anesthesia care is required. In addition to clinical outcomes and satisfaction, there is an opportunity to measure and monitor operational performance to assess the value NLS brings to the organization on multiple levels. In summary, the programs have enhanced access to valve care for their patients while maintaining or increasing lab utilization and improving financial performance.

Measuring Organizational Value of NLS

Areas of focus for measuring and monitoring the value of a TAVR NLS program may include:

- Total TAVR Lab Time: Wheels in to wheels out (in minutes)
- Total TAVR Procedure Time: Access start to access closure (in minutes)
- Turnaround Time: Wheels out to wheels in for sequential TAVR cases (in minutes)
- Total Time Cath Lab Prep/Recovery to Transfer to Next Level of Care (in hours)
- Post-Procedure Length of Stay (in hours)
- Total Length of Stay (in hours)
- Number of Case Cancellations Related to Anesthesia Coverage
- TAVR Procedure Wait Time: Case request to case performed
- Total TAVR Cases Performed per Month
- Total SH Cases Performed per Month
- Cost of NLS TAVR vs. Anesthesia-Led TAVR Procedures
- Physician and Staff Satisfaction With NLS
- TAVR Patient Satisfaction

Potential Challenges and Limitations

As with any new process, it is important to anticipate potential challenges. Cardiothoracic surgeons from participating programs voiced initial concerns related to losing the predictability of anesthesia-led sedation. Interventional cardiologists were less concerned, given their routine use of NLS in cath lab procedures, including critically unstable patients. However, the interventional cardiologists did find the absence of anesthesia in the case did heighten their awareness of patients' sedation level and hemodynamic status. The use of a multidisciplinary workgroup was beneficial in addressing concerns. Anesthesiologists were engaged early in the development of the NLS program and contributed to the development of patient selection criteria. They also are invited to participate in heart team discussions and contribute to decisions regarding the appropriateness of NLS in specific patient situations. The anesthesia departments recognized NLS helped to avoid delays elsewhere and freed them up for more urgent, complex procedures.

At both facilities, nurses were experienced in providing sedation for unstable patients undergoing complex interventional procedures. They were advised that NLS for TAVR fell within their scope of practice. Upon receiving the education and skills to apply their existing knowledge to the TAVR patient population, the nursing staff readily embraced the responsibility of managing sedation for TAVR procedures. Further, cath lab staff were reassured by the fact that most TAVR patients arrive from home for elective procedures in stable condition, which further increased their confidence in implementing NLS for these cases.

Figure 3: Change Management Steps for NLS



Checklist for NLS Program Development

- ✓ Form a multidisciplinary work group to achieve buy-in and consensus. Be sure to engage with anesthesiology early in the planning process.
- ✓ Develop policies and procedures clarifying patient selection criteria and nursing responsibilities. Include key facility leaders and staff in their review and approval.
- ✓ Collaborate with IT to incorporate policy and procedure content into standard order sets and procedural documentation.
- ✓ Create standard workflows for patient review and selection for NLS.
- ✓ Work with cath lab and anesthesia scheduling teams to ensure the sedation type is clearly indicated on the cath lab procedure schedule.
- ✓ Use change management strategies to support and sustain process changes.
- ✓ Provide education to cath lab staff on the specific knowledge and skills needed for TAVR procedural sedation.
- ✓ Plan simulation opportunities to familiarize staff with emergency management of patients.
- ✓ Collect and review operational, financial and patient outcomes on a regular basis. Share performance with all team members and facility cardiovascular leaders.

CONCLUSION

Nurse-led sedation for TAVR procedures represents a promising approach to optimize resource utilization and improve procedural efficiency without compromising patient safety or outcomes. Experienced cath lab nurses already possess many of the skills required to manage complex patients. With targeted supplemental education and guidance, these nurses can effectively administer and monitor sedation in appropriately selected patients, leveraging existing expertise while promoting top of license work. Further, using NLS in TAVR procedures creates cost savings for organizations. With constraints often encountered with the availability of anesthesia services, centers can also increase their procedural capacity and throughput. This is particularly valuable as the number and types of SH procedures continue to experience significant growth.

Importantly, NLS has been shown to contribute to shorter procedural times and reduced length of stay for selected TAVR patients. This streamlined approach benefits both patients and healthcare systems by improving efficiency without sacrificing quality of care. As TAVR continues to evolve toward more minimalist techniques, NLS is well-positioned to play an expanding role. With thoughtful implementation, robust protocols, proper patient selection and mechanisms for anesthesia backup when needed, NLS represents a valuable tool to optimize TAVR delivery in the future.



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