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Reducing length of stay for patients undergoing transcatheter aortic valve replacement using a prescreening approach

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ABSTRACT

Background: As transcatheter aortic valve replacement (TAVR) becomes a preferred treatment option for patients with aortic valve stenosis, and demand for TAVR increases, it is imperative that length of stay (LOS) is reduced while maintaining safety and effectiveness.

Local Problem: As TAVR procedures have become less invasive and more streamlined, current protocols have not been updated to reflect today's postprocedure requirements.

Methods: The next-day discharge (NDD) protocol was established using available literature. A convenience sample was evaluated for NDD protocol inclusion during aortic multidisciplinary team conference using predetermined inclusion and exclusion criteria. Length of stay for NDD protocol participants was compared with LOS from a retrospective convenience sample of patients undergoing TAVR in the time frame mirroring NDD protocol initiation of the year prior.

Interventions: Patients meeting inclusion criteria were enrolled in the NDD protocol with a goal of discharge to home on postprocedural day 1 by 2:00 p.m. The NDD protocol included preprocedure expectation setting, prescheduled same-day postprocedure imaging, and discharge priority on postprocedure day 1.

Results: There is a significant difference in LOS between the NDD eligible retrospective and prospective groups. The prospective group has a significantly lower LOS than the retrospective group (M = 1.6 vs 2.1, respectively; p = .0454).

Conclusions: An NDD protocol can help reduce LOS after TAVR in appropriately selected patients. Further protocol revision will be required to optimize LOS outcomes.

Keywords: NDD; next-day discharge; process improvement; quality improvement; length of stay; LOS; TAVR; transcatheter aortic valve replacement.

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Background and local problem

Transcatheter aortic valve replacement (TAVR) is an attractive option for patients with severe aortic stenosis and is now the treatment of choice for many patients (Carroll et al., 2020). As TAVR becomes more common, ensuring efficiency in postprocedural length of stay (LOS) is imperative (Mack et al., 2019) to ensure availability of resources. Transcatheter aortic valve replacement procedures, historically, followed postoperative surgical valve protocols with an average 6-day LOS (Wood et al., 2019). As TAVR became less invasive and more streamlined, the necessary postprocedure hospitalization period has decreased. However, many hospitals have not reimagined the postprocedural protocols to fit within today's changing environment.

As hospitals prepare to perform more TAVR procedures to meet the growing demand, strategies will need to be implemented to effectively manage an expanding capacity. Currently, there is a gap in the literature for up-to-date postprocedure care protocols of TAVR patients, which allows for significant variations in the LOS (Spies & Whisenant, 2014). Previous studies have suggested that next-day discharge (NDD) is both feasible and safe (Alkahalil et al., 2018; Kamioka et al., 2018; Kontronias et al., 2018; Lauck et al., 2016; Sud et al., 2017) and provide a stable framework in which to base new protocols. Although work on decreasing postprocedure LOS has begun, there remains much room for improvement through standardization of postprocedural care. This quality

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improvement initiative was aimed at standardizing a postprocedure pathway to reduce and remove barriers to NDD by ensuring timeliness of postprocedural care. Interventions to accomplish this will include preidentification of patients appropriate for NDD, prescheduling of postprocedure imaging, and preeducation to prepare patients for NDD.

Purpose of project

It was postulated that replication of minimalist TAVR clinical pathways, along with the addition of a prescreening tool to predict the patient population within the TAVR subset that would benefit from an NDD protocol, would allow for decreased LOS. The purpose of this project was to determine whether implementation of the NDD protocol, modeled after previously successful clinical pathways, is an effective tool in reducing LOS in a large intercity hospital.

Literature review

Current literature supports the safety and feasibility of NDD protocol development (Alkahalil et al., 2018; Kamioka et al., 2018; Lauck et al., 2016; Marcantuono et al., 2014). However, there are currently no published evidence-based guidelines for an NDD protocol for patients undergoing TAVR. The impact of NDD after transfemoral TAVR was studied by Lauck et al. (2019), who suggested that some of the chief drivers of cost maintenance included management of in-hospital complications, device price, and length of hospital stay. Although complications and device price are improving, they are not predictable and amenable to intervention. However, postprocedure LOS is an aspect of care that provides opportunity for cost reduction.

Lauck et al. (2019) found that patient profiles were different for NDD candidates versus non-NDD candidates. Discharge disposition to home rather than a rehabilitation facility was a characteristic of a patient most appropriate for NDD because they experienced a lower rate of hospital readmission in a 30-day period and had comparable rates of 30-day mortality as those with a longer LOS (Lauck et al., 2019). Lauck et al. (2019) concluded that a comprehensive pathway streamlining preprocedure, peri-procedure, and postprocedure care may help to reduce costs while also optimizing outcomes. A standardized "minimalist" clinical pathway demonstrated success in NDD while at the same time demonstrating no increased risk of 30-day mortality or morbidity (Lauck et al., 2019) and resulting in superior one-year outcomes as compared with non-NDD patients (Kamioka et al., 2018). Replication of the outcomes reported from previously successful clinical pathway discharge programs for post-TAVR patients will require a multidisciplinary team effort to achieve the desired outcomes of safe, effective, and efficient care (Wood et al, 2019).

Methods

Before protocol implementation, approval from the institutional review board (IRB) was requested and granted. This quality improvement project was considered exempt by the IRB. Participants appropriate for inclusion in the NDD protocol were identified using a convenience sample and determined using the TAVR NDD Eligibility Form (Appendix A, Supplemental Digital Content 1, http://links.lww.com/JAANP/A153). This screening tool was developed for use within the NDD protocol because there was no currently available screening tool appropriate for this protocol (see example of protocol workflow in Appendix B, Supplemental Digital Content 2, http://links.lww.com/JAANP/A154). Patient's LOS was measured through review of the electronic medical record (EMR). Length of stay for NDD protocol participants was compared with LOS from a retrospective convenience sample of patients undergoing TAVR from February 1, 2020 through July 30, 2020. The prospective sample was a convenience sample evaluated for protocol inclusion during Aortic Multidisciplinary Team Conference (MDT).

Intervention

The NDD protocol was developed for use in an 877-bed intercity hospital. Protocol inclusion screening began on February 1, 2021 and concluded on July 30, 2021. Screening took place during aortic MDT using the TAVR NDD Eligibility Form. Eligibility was documented in the MDT meeting minutes in the patient's EMR to serve as an indicator of enrollment. Specific inclusion and exclusion criteria were used as detailed in **Table 1**.

Patients eligible for participation in the NDD protocol were scheduled as either a first or second daily TAVR procedure based on physician and schedule availability. A patient list of planned TAVR procedures requiring same-day postprocedural transthoracic echocardiogram (TTE) was sent by email to the noninvasive department manager and scheduler to ensure timely scheduling of post-TAVR TTE.

The morning after successful TAVR procedure, patients were evaluated by the nurse practitioner, Structural Heart Disease (SHD) Fellow, and/or Interventional Cardiologist Attending Physician to determine discharge readiness. Considerations that necessitated withdrawal from the NDD protocol included, but were not limited to, new conduction disturbance on ECG, hemodynamic instability, vascular access complication, patients' subjective report, and/or deranged laboratory values. If no contraindications to discharge were noted, echocardiogram was reviewed by either the SHD fellow or the attending cardiologist, and patients were cleared for discharge if no abnormalities were noted. Patients were discharged per standard hospital protocol by the Hospitalist Service. Discharge goal was 2:00 p.m. on postprocedure day 1.

Table 1. Inclusion and exclusion criteria for NDD protocol

Inclusion criteria	Exclusion criteria

• 18 years or older
• Transfemoral or transcaval access
• For patients without a preexisting permanent pacemaker
  ○ Scheduled to receive balloon expandable valve
• Outpatient status before procedure
• No preexisting conduction disease without presence of permanent pacemaker (right bundle branch block, second-degree heart block; Lilly et al., 2020)
• Frailty score of 1 or less
  ○ Frailty indicators include
  ■ BADL = />6
  ■ 5-m walk <6 s
  ■ Albumin = 3.5 or higher
	• <18 years old
	• Require alternative access
	  ○ Trans-axillary
	  ○ Trans-aortic
	  ○ Trans-carotid
	  ○ Trans-apical
	• Scheduled for self-expanding valve in absence of permanent pacemaker (Lilly et al., 2020)
	• Inpatient status immediately before TAVR
	• Pre-existing conduction disturbance
	  ○ R BBB
	  ○ Second-degree heart block
	• Frailty score 2 or greater
	  ○ Frailty indicators include
	  ■ BADL = />6
	  ■ 5-m walk <6 s
	  ■ Albumin = 3.5 or higher

Results

All analyses were done using SAS 9.4 and statistical significance was set at $p < .05$.

There was a total of 122 retrospective patients. Fifty-one patients (42%) qualified for the NDD protocol and 71 patients (58%) did not qualify. There were a total of 126 patients evaluated for prospective protocol inclusion. Fifty-five patients (44%) qualified for inclusion and 71 patients (56%) did not qualify for inclusion. Average total LOS was calculated in days. Difference between total LOS was done using Wilcoxon rank sum test due to nonnormality.

Mean total LOS for the entire retrospective sample was 3.4 days, whereas the mean LOS for all prospective patients was 2.4 days. There is a significant difference in LOS between the retrospective and prospective groups ($p = .0016$). The prospective group had a significantly lower LOS than the retrospective group (**Table 2**).

Mean LOS for the retrospective group who were not eligible for NDD inclusion was 4.2 days. Mean LOS for the retrospective group, who would have been eligible for the NDD protocol, was 2.1 days. There is a significant difference in LOS between the NDD-eligible retrospective and noneligible retrospective groups ($p < .0001$). The noneligible group has a significantly longer LOS than the eligible group (**Table 3**).

Mean LOS for prospective patients who did qualify for NDD protocol was 1.6 days. Mean LOS for retrospective group who would have qualified for NDD protocol was 2.1 days. There was a significant difference in LOS between the NDD-eligible retrospective and prospective groups ($p = .0454$). The prospective group has a significantly lower LOS than the retrospective group (**Table 4**).

Of the 55 prospective patients qualifying for NDD, 19 (36%) were successfully discharged on postprocedure day 1 by 2:00 p.m. Of the remaining 36 NDD protocol

Table 2. Summary of retrospective versus prospective (ALL) group

Group	N	Variable	Mean	SD	Median	Minimum	Maximum
Retro	122	Total LOS (days)	3.4	3.7	2.1	0.4	20.3
		Total LOS (h)	80.7	88.4	50.5	10.5	487.3
Pros	126	Total LOS (days)	2.4	3.0	1.4	0.8	20.5
		Total LOS (h)	58.5	70.8	33.0	19.6	491.1

Note: There is a significant difference in LOS between the retrospective and prospective groups. The prospective group has a significantly lower LOS than the retrospective group (p = .0016).
LOS = length of stay.

Table 3. Summary of noneligible versus eligible retrospective patients

NDD Eligible	N	Variable	Mean	SD	Median	Minimum	Maximum
No	71	Total LOS (days)	4.2	4.3	2.3	0.4	20.3
		Total LOS (h)	102.1	103.4	56.1	10.5	487.3
Yes	51	Total LOS (days)	2.1	2.0	1.4	1.0	14.5
		Total LOS (h)	51.1	49.1	33.9	24.0	347.0

Note: There is a significant difference in the LOS between the retrospective NDD eligible and retrospective noneligible groups. The noneligible group has a significantly longer LOS than the eligible group, p < *.0001.*
LOS = length of stay; NDD = next day discharge.

patients who were not discharged home by the target time of 2:00 p.m., the most common reasons included new conduction disturbances (4 patients, 7%), postprocedure groin complication (3 patients, 5.5%), delay of discharge order from discharging physician (12 patients, 21.8%), delay in clearance for discharge from SHD team (4 patients, 7%), patient delay (4 patients, 7%), postprocedure complications that were not access related (2 patients, 3.6%), postprocedure TTE not completed day of procedure (2 patients, 3.6%), and other reasons (3 patients, 5.5%; **Table 5**). Of the 71 patients who were determined not to be NDD eligible, 4 (5.6%) were discharged home by 2:00 p.m. on postprocedure day 1.

The TAVR eligibility form had an 89% reliability in determining patients appropriate for NDD. Of the 55 patients qualifying for NDD, 6 patients (11%) had events resulting in withdrawal from the NDD protocol. These events included new conduction disturbance requiring further evaluation with an electrophysiology study (*N* = 1), femoral access site complications (hematoma, pseudo aneurysm, etc.; *N* = 3), allergic reaction to protamine during procedure requiring ICU care (*N* = 1), flash pulmonary edema requiring ICU care (*N* = 1), and inpatient TAVR procedure after acute illness requiring hospitalization (*N* = 1).

Discussion

Implementation of the NDD protocol was able to show a statistically significant reduction in LOS for patients who were determined eligible for inclusion. Reductions in LOS were demonstrated in all groups.

The entire retrospective sample compared with the entire prospective sample demonstrated a mean LOS reduction of 1.0 day (p = .0016). The retrospective sample happened to fall during the beginning of the COVID-19 pandemic, which may have had an impact on LOS for that particular group. Additionally, patients were electively postponing TAVR procedures at this time if disease severity allowed. This may have directly affected LOS during the retrospective time frame because it is feasible to consider that only the sickest patients were being treated at that specific time.

Length of stay differences were noted between the retrospective eligible and the retrospective noneligible groups. The LOS difference was a mean of 1.9 days (p < .0001). This difference helps to define the expected LOS difference between patients who would qualify for NDD compared with those who would not.

The retrospective eligible group versus the prospective eligible group demonstrated a mean LOS reduction of 0.5 days (p = .0454). This reduction demonstrates that

Table 4. Summary retrospective eligible versus prospective eligible

Group	N	Variable	Mean	Std Dev	Median	Minimum	Maximum
Retro	51	Total LOS (d)	2.1	2.0	1.4	1.0	14.5
		Total LOS (h)	51.1	49.1	33.9	24.0	347.7
Pros	55	Total LOS (d)	1.6	1.0	1.3	1.0	6.4
		Total LOS (h)	39.2	25.0	30.9	22.9	154.4

Note: There is a significant difference in LOS between retrospective NDD eligible and prospective NDD eligible group. The prospective group has a significantly lower LOS than the retrospective group, p < *.0454.*
LOS = length of stay; NDD = next-day discharge.

Table 5. Reasons prospective eligible patients were not discharged by 2:00 p.m

	n	%
New conduction disturbances	4	7
Groin complication	3	5.5
Delay in discharge order	12	21.8
Delay in cardiac clearance	4	7
Patient delay/no ride	4	7
Non access related postprocedure complication	2	3.6
Postprocedure TTE delay	2	3.6
Other	3	5.5

preidentification of appropriate patients, prescheduling of postprocedure imaging, and early patient expectation setting can significantly decrease LOS. Although the reduction in LOS cannot be entirely attributed to implementation of the NDD protocol, specific portions of the protocol, including preidentification of appropriate patients and prescheduling of postprocedure imaging, seem to be effective modalities in beginning to reduce unnecessary delays to discharge.

The prescreening eligibility form was evaluated to determine the accuracy with which it is able to predict a patient's actual readiness for NDD. There was a small subset of patients who did not initially qualify for inclusion in the NDD protocol who were able to be discharged by the target time of postoperative day 1. This suggests that it may be reasonable to reconsider some of the inclusion criteria to determine which items may be expanded to allow for greater inclusion. Some of these items include reducing frailty measure inclusion to include patients with a frailty score of 2 and including patients with lower risk, preexisting conduction disturbances, such as first-degree atrioventricular nodal block and pre-existing right bundle branch blocks. With an 89% success rate, the screening tool could continue to be effectively used to help predict which patients would appropriate for NDD.

Of the factors found to be significant in delaying discharge, patient hesitancy, lack of transportation home on postprocedure day 1, conduction disturbances requiring further telemetry monitoring or electrophysiology study, groin complications, and lack of timely discharge from the discharging physician were the most common. The most anticipated delay of discharge was delay in postprocedure imaging; however, this was not found to be as significant as previously thought and, in fact, the largest identified delay was timely rounding and entry of discharge orders from the discharging providers.

There is room for continued improvement in patient education and expectation setting that could potentially have a significant impact on reducing unnecessary delays to discharge. For example, the NDD protocol included patient education surrounding the plan for NDD by 2:00 p.m. This would allow for patients and their families to ensure transportation would be available. Many patients still reported that they were unaware of the anticipated NDD and, therefore, did not have a ride secured. Patients also reported not being comfortable with NDD because they expected to spend two to three days in the hospital.

Another area of the protocol that fell short of the goal was timely discharge by the discharging providers. The delay in provider discharge was one of the most challenging areas encountered during the implementation of the protocol. Further work to ensure timely and expedited discharge in conjunction with the Hospitalist team is imperative to successfully reduce LOS.

Length of stay data were shared with the nursing staff and physician staff collectively to help demonstrate the importance of continuing to work on cost reduction strategies through eliminating unnecessary barriers to discharge. More work will need to be done to effectively determine whether a revised version of the NDD protocol will continue to provide reductions in LOS.

Limitations

Several steps of the protocol, as originally written, were routinely omitted after implementation, which hindered the success of the NDD protocol. Additional limitations included absence of clinical staff buy in and support, deficiency in timely rounding by attending physician staff, and omission of inclusion eligibility discussion during MDT conference. Lack of eligibility discussion hindered the protocol because necessary documentation relating to eligibility and inclusion was not well disseminated among the team. Additional limitations included the inability to consistently obtain required postprocedure imaging on the same day as the procedure and consistent preprocedure patient preparation for NDD. Many times, expectations of an extended hospital stay created a barrier to NDD because reliable rides home were frequently unavailable. Finally, there continues to be a delay in discharge from the primary Hospitalist group after patients received cardiac clearance.

Summary

Successful implementation of an NDD protocol will allow for a more streamlined postprocedure discharge process for patients undergoing TAVR procedures. In addition to reducing LOS, additional benefits of an NDD protocol may include increased ability to accommodate a larger population, decrease in iatrogenic complications as a result of extended hospitalizations, improvement in financial benefits from shorter LOSs, decreased costs associated with complications, and reduction of lost revenue from bed unavailability (Lauck et al., 2019).

Although we were able to observe a significant decrease in the LOS between patients undergoing TAVR between February and June of 2020 and February and June of 2021, we cannot effectively say that it was solely the result of the NDD protocol initiative. However, we have established a strong platform to continue working from in an effect to continue to drive the initiative forward. The original NDD protocol contained many layers of intervention aimed at reducing barriers to timely discharge. Although successful, there remains room for continued improvement. Many of the interventions need to be further reimagined to continue to drive down LOS.

Authors' contributions: *C. N. Cusin developed this quality improvement project, developed the NDD protocol and screening tool, collected data, and composed the manuscript. P. A. Clark edited and revised the manuscript. C. W. Lauderbach edited and revised the manuscript. J. Wyman assisted with conceptualization and edited the manuscript.*

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