# Promoting **Early Mobility** in Patients After Transcatheter Aortic Valve Replacement: An Evidence-Based Protocol

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BACKGROUND Aortic stenosis is prevalent among older adults and is commonly treated with transcatheter aortic valve replacement. Both high- and low-risk patients benefit from early mobility and discharge after this procedure; however, hospital protocols to improve patient mobility and shorten hospital stays have not been systematically implemented.

OBJECTIVE To develop and evaluate a post–transcatheter aortic valve replacement protocol to standardize care and efficiently advance patients from the operating room to discharge.

METHODS A prospective pre-post design was used to evaluate the effect of the new standardized protocol on length of stay, timing of mobility, time spent in intensive care, and quality of life in patients undergoing transcatheter aortic valve replacement between April 2019 and March 2020.

INTERVENTIONS Interventions included team-based education and integration of an evidence-based order set into the electronic health record. Education was provided to both patients and staff.

RESULTS At 6 months after implementation of the intervention, statistically significant improvements were observed in mean overall (5.26 vs 2.45 days; $P = .001$) and postprocedure (3.05 vs 2.16 days; $P = .004$) length of stay. No significant difference was found in performance on the 5-meter walk test. Quality of life improved in both groups from baseline to 30-day follow-up ($P = .01$).

CONCLUSION Implementation of the post–transcatheter aortic valve replacement protocol was associated with significant improvement in overall and postprocedure length of stay and improved quality of life. Additional work is needed to examine strategies to ensure safe next-day discharge. (*Critical Care Nurse*. 2021; 41[5]:e9-e16)

**Aortic stenosis is a common disease among older adults, affecting approximately 2.7 million people aged 75 years and older in North America.**[1] The population of older adults is expected to increase by 8.3%, or an estimated 0.8 million people, by 2025 and 11.8%, or an estimated 1.4 million people, by 2050.[1,2] The American College of Cardiology recommends that patients who have been diagnosed with severe aortic stenosis by means of transthoracic echocardiography and who experience symptoms undergo an aortic valve replacement.[2] According to Russo et al,[3] once symptoms

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occur in patients with severe aortic stenosis, prognosis is very poor, with a mortality rate of up to 60% within 2 years without treatment.

Patients with low to moderate surgical risk were traditionally offered either standard surgical aortic valve replacement (AVR) with a midline sternotomy or minimally invasive AVR with a mini-sternotomy or right thoracotomy.[4] However, in early 2019, 2 key trials were reported that assessed outcomes in patients who were deemed low-risk surgical candidates and underwent transcatheter AVR (TAVR): the PARTNER 3 trial[5] and the Evolut Surgical Replacement and Transcatheter Aortic Valve Implantation in Low Risk Patients trial.[6] These studies indicated that TAVR was superior to surgical AVR in low-risk patients with regard to incidence of stroke, acute kidney injury, and atrial fibrillation; length of hospitalization and incidence of rehospitalization; and mortality.[5,6] As a result, in August 2019, the US Food and Drug Administration expanded indications for TAVR to include patients deemed at low risk for death or major complications from open-heart surgery. Therefore, a younger and healthier population is now eligible for minimally invasive options to treat aortic stenosis. As the older adult population grows and the expansion of indications is reflected in practice, use of the TAVR procedure is expected to increase.

Implementing a postprocedure protocol with emphasis on early mobilization has been shown to promote more rapid recovery after TAVR, reducing LOS, resource use, and cost.

As a result of growing evidence of the safety and clinical benefits of TAVR, hospitals will be expected to accommodate increased demand, requiring them to have efficient protocols in place to safely and efficiently care for the rising volume of patients. Implementing a specialized postprocedure protocol with emphasis on early mobilization has been shown to promote more rapid recovery after TAVR, reducing length of stay (LOS), resource use, and cost.[7-9] Early mobilization and fast-track protocols have been shown to be feasible and safe and to have positive effects on the functional capacity of patients who are deconditioned at baseline.[8-12] Although standardized post-TAVR orders to advance the patient efficiently from the operating room to discharge have also been shown to be safe and effective, such protocols have not been widely implemented. Use of specific postprocedure protocols may also provide substantial benefits by reducing nursing workload. Hübner et al[13] evaluated the success of a recovery program after surgery based on nursing workload. Nursing workload was evaluated as anticipated work burden quantified by points based on the nursing care plan. Tasks included professional activities such as medical tasks, physical actions, communication, and administrative duties. The results indicated that nursing staff saved an average of 45 minutes per patient each day compared with the conventional postsurgical protocol.[13]

The purpose of this study was to develop a post-TAVR protocol to standardize care and advance the patient efficiently from the operating room to discharge and to evaluate the effect of such a protocol on LOS, quality of life, and early mobility. This study was approved by the Maimonides Medical Center institutional review board and met criteria for exemption as a quality improvement study.

## Methods

### Design

This study used a pre-post design, with data gathered at points before and after the intervention according to a plan-do-study-act (PDSA) quality improvement approach. We sought to educate and obtain feedback from nurses, nurse practitioners, physical therapists, and support


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staff before and every 2 months after implementation of the intervention. The educational sessions occurred over a 6-month PDSA period from October 2019 through March 2020. The order set was implemented in October 2019 and has been used for patients meeting the inclusion criteria after the TAVR procedure.

## Setting and Patient Selection

All post-TAVR patients at Maimonides Medical Center who met inclusion criteria from October 2019 through March 2020 were eligible to participate in the study, including patients deemed TAVR candidates and those undergoing mitral or aortic valve-in-valve procedures. Patients who could not be successfully extubated in the operating room, experienced a major vascular complication or a major stroke after the procedure, or died were excluded. Patients undergoing a mitral clip procedure were also excluded. Patients who underwent TAVR from April through September 2019 made up the preintervention group. Data for this group were obtained by means of retrospective record reviews and accessing the transcatheter valve therapy registry. Patients who underwent TAVR after the implementation of the TAVR-specific order set from October 2019 through March 2020 and met inclusion criteria made up the postintervention group.

## Aims

The primary aim of this study was to implement a protocol to standardize patient care following a TAVR procedure and, 6 months after implementation of the protocol, to evaluate post-TAVR LOS, time spent in the intensive care unit (ICU), and timeliness of initial postprocedure physical therapy evaluation. Secondary aims were to evaluate mobility and quality of life at 30 days after the procedure.

## Measures

Procedural LOS was defined as the time the patient spent in the hospital after the procedure, measured in days. Overall LOS was defined as the patient's entire hospitalization stay in days. We measured the time the patient spent in the ICU in hours, starting when the patient was admitted from the operating room and ending when the patient's status was downgraded to telemetry. Functional status was evaluated with the 5-meter walk test, and quality of life was measured using the 12-item Kansas City Cardiomyopathy Questionnaire (KCCQ-12).[14] We evaluated timeliness of mobility according to the first physical therapy visit after the procedure. We evaluated the patient's mobility at baseline (before the procedure) and at 30 days after the procedure using the 5-meter walk test. We used the KCCQ-12 to quantify heart failure symptoms at baseline and 30 days after the procedure for both the preintervention and postintervention groups. Lower KCCQ-12 scores indicate more severe heart failure symptoms and disease impact on the patient's quality of life. The patient's time in the ICU, procedural LOS, and timeliness of physical therapy were among the data used to determine the success of the intervention.

## Intervention

We developed a post-TAVR protocol designed to allow nurses, nurse practitioners, physical therapists, and support staff to efficiently deliver care to patients after TAVR. During implementation of the protocol, we provided education to staff on the rationale and target times for early mobility and discharge and the benefits of standardized protocols in achieving these outcomes. We also educated staff about indications for use of the protocol and its integration into the electronic health record (EHR). We evaluated the effectiveness of staff education by assessing the extent to which the protocol was adopted into practice, including effective use of the EHR order set, timeliness of the initial physical therapy consultation, time spent recovering in the ICU, and overall hospital LOS.

Patients were taught what to expect after the procedure and were encouraged to set feasible, realistic goals for postdischarge planning.

Patients received education during the initial office visit on physical therapy and discharge planning after the procedure. Patients were taught what to expect after the procedure and were encouraged to set feasible, realistic goals for postdischarge planning. The measures of success of the education intervention for patients included a feasible patient-reported physical therapy goal, a patient-reported outcome measure of quality of life, and mobility at 30 days after the procedure.

The protocol included a TAVR-specific order set derived from the Vancouver Transcatheter Aortic Valve Replacement Clinical Pathway to provide milestones in the patient's progress.[8] The multidisciplinary team made

up of physicians, nurse practitioners, nurses, and nursing information scientists worked to develop the order set and integrate it into the EHR system. Orders included admission orders, postprocedure laboratory tests, echocardiography, chest radiography, and progressive dietary orders. Also included was an ambulation order set to begin physical therapy early in the recovery process. Vital signs, access site, and neurological status were to be assessed every 15 minutes for the first 4 hours, then every 30 minutes for 2 hours, and then every hour. Progressive dietary orders, bladder scan orders (for patients without a Foley catheter and able to void), and orders for postprocedure antibiotics and other medications were available for the registered nurse and cardiothoracic ICU nurse practitioner to activate.

The protocol seamlessly moved the patient through the acute postprocedure phase, reduced the time they spent immobile, and facilitated their progress out of the ICU and to the step-down unit.

Before protocol implementation, the cardiothoracic ICU and step-down unit staff received an educational presentation describing the need for the specialized order set and the goals for post-TAVR patients. At the conclusion of the TAVR procedure, the operating room physician assistant entered the post-TAVR order set. Once the patient entered the cardiothoracic ICU, the registered nurse activated the appropriate orders for the patient. The cardiothoracic ICU staff cared for the patient and collaborated with the TAVR team to determine the most appropriate time to remove invasive catheters. The physical therapist received initial orders to assess and treat the patient by means of the post-TAVR order set. After the invasive catheters were removed by the cardiothoracic ICU staff, hemostasis was achieved, and vital signs were stable, the patient was evaluated and mobilized. The protocol seamlessly moved the patient through the acute postprocedure phase, reduced the time they spent immobile, and facilitated their progress out of the cardiothoracic ICU and to the telemetry step-down unit. The order set included postprocedure day 1 orders such as morning laboratory tests, postprocedure echocardiography, electrocardiography, and chest radiography.

### Evaluation Plan

Descriptive statistics were obtained for patients' demographic variables including sex, ethnicity, pertinent medical history, insurance providers, preprocedure Society of Thoracic Surgeons risk score, preprocedure and postprocedure 5-meter walk test results, and pre- and postprocedure KCCQ-12 scores. A *t* test and a Mann-Whitney test were used to compare the pre- and postintervention groups. The mobility (5-meter walk test) and quality of life (KCCQ-12) measures were administered before the TAVR procedure and 30 days after the procedure for both groups. An independent *t* test was used to compare the pre- and postintervention groups' time in the ICU (in hours), overall LOS, and procedural LOS.

## Results

From April through September 2019, a total of 38 patients underwent the TAVR procedure; these patients formed the preintervention group. From October 2019 through March 2020, 46 patients underwent the TAVR procedure. Of these 46 patients, 38 were deemed good candidates for the specialized order set and early mobility protocol and formed the postintervention group. The study included patients undergoing mitral valve-in-valve (2 patients in the preintervention group; none in the postintervention group) and aortic valve-in-valve (1 patient in the preintervention group; 2 patients in the postintervention group) procedures.

In the preintervention group, 17 patients (45%) were male and 21 patients (55%) were female; in the postintervention group, 22 patients (58%) were male and 16 patients (42%) were female. Most of the patients in both groups identified as White (30 [79%] in each group). The postintervention group had a significantly higher number of patients identifying as Hispanic (8 vs 1; $P = .03$). Most patients in both groups had Medicare insurance (36 [95%] in each group; see Table).

Preprocedure medical history, including comorbidities and aortic stenosis severity, was similar in the 2 groups. Medical history data included hypertension, diabetes mellitus, end-stage renal disease (on dialysis), cerebrovascular accident, transient ischemic attack, preprocedure pacemaker insertion, and preprocedure coronary artery bypass graft. Patients' mean aortic valve area, mean aortic valve gradient, and Society of Thoracic Surgeons score showed no significant difference in the severity of aortic stenosis between the pre- and postintervention groups (see Table).

In the preintervention group, the mean (SD) overall LOS was 5.26 (4.82) days and the mean (SD) procedural

LOS was 3.05 (1.74) days. In the postintervention group, the mean (SD) overall LOS was 2.45 (1.72) days and the mean (SD) procedural LOS was 2.16 (0.59) days. The data were compared using an independent *t* test, but they did not meet the assumption of homogeneity of variance. Therefore, equal variances were not assumed, and the degrees of freedom were adjusted. The decreases in LOS and procedural LOS from before to after the intervention were statistically significant: $t_{46.2} = 3.39$, $P = .001$ for LOS, and $t_{45.5} = 3.001$, $P = .004$ for PLOS. The time the patient spent in the ICU also decreased from before to after the intervention from a mean (SD) of 33.9 (25.52) hours to 23.6 (12.64) hours, but the difference was not significant: $t_{54.1} = 1.51$, $P = .25$.

Patients in the postintervention group were evaluated by a physical therapist by postprocedure day 1 (mean [SD], 1 [0.402] day). No significant differences were found in average 5-meter walk test times between baseline and 30-day follow-up in either group (Figure 1). However, patients in both groups had a significant improvement in their quality of life based on KCCQ-12 scores from baseline to 30-day follow-up ($P = .01$; Figure 2).

## Discussion

The results of this study suggest that implementation of a post-TAVR protocol involving integration of a standardized evidence-based order set into the EMR reduces the time patients spend in intensive care after the procedure, the procedural LOS, and the overall LOS. The order set includes specific orders tailored to the post-TAVR patient to facilitate progression from the ICU to discharge. After protocol implementation, patients spent fewer hours in the ICU recovering from anesthesia and achieving hemodynamic stability. The benefits to patients, families, and the health care system that are demonstrated by these results support the findings of other studies reported in the literature. Although similar studies have been performed in other patient populations, the specific advantages of a standardized postprocedure order set for TAVR patients including physical therapy and evaluation of mobility and quality of life at 30 days have not been widely reported.

The LOS and procedural LOS were both improved with the use of the standardized post-TAVR protocol. Increased baseline LOS in the preintervention group was attributed to a larger volume of existing inpatients who were evaluated for treatment with TAVR. In comparison, the postintervention group had more patients admitted electively for TAVR. Although the decrease in the time patients spent in the ICU was not statistically significant, clinically

**Table** Demographic characteristics of patients by group

| Characteristic | No. (%) of patients[a] Preintervention group (n = 38) | Postintervention group (n = 38) |
|---|---|---|
| Sex | | |
| Male | 17 (45) | 22 (58) |
| Female | 21 (55) | 16 (42) |
| Race/ethnicity[b] | | |
| Black | 8 (21) | 6 (16) |
| White, non-Hispanic | 30 (79) | 30 (79) |
| Hispanic[c] | 1 (3) | 8 (21) |
| Payer status | | |
| Medicaid | 9 (24) | 13 (34) |
| Medicare | 36 (95) | 36 (95) |
| Private insurance | 12 (32) | 10 (26) |
| Hypertension | | |
| Yes | 36 (95) | 36 (95) |
| No | 2 (5) | 2 (5) |
| Diabetes | | |
| Yes | 16 (42) | 15 (39) |
| No | 22 (58) | 23 (61) |
| ESRD (on dialysis) | | |
| Yes | 4 (11) | 4 (11) |
| No | 34 (89) | 34 (89) |
| Cerebrovascular accident | | |
| Yes | 2 (5) | 3 (8) |
| No | 36 (95) | 35 (92) |
| Transient ischemic attack | | |
| Yes | 3 (8) | 0 (0) |
| No | 35 (92) | 38 (100) |
| Preprocedure pacemaker insertion | | |
| Yes | 3 (8) | 0 (0) |
| No | 35 (92) | 38 (100) |
| Preprocedure coronary bypass graft | | |
| Yes | 5 (13) | 8 (21) |
| No | 33 (87) | 30 (79) |
| STS score, mean (SD) | 5.62 (4.19) | 4.43 (3.76) |
| Aortic valve area, mean (SD), $cm^2$ | 0.75 (0.14) | 0.76 (0.15) |
| Aortic valve mean gradient, mean (SD), mm Hg | 43.8 2 (15.7) | 42.7 (17.5) |

Abbreviations: ESRD, end-stage renal disease; STS, Society of Thoracic Surgeons.

[a] Unless otherwise indicated.
[b] Some patients identified as multiple ethnicities, which contributed to more than the total number of patients in the group.
[c] $P = .03$; statistically significant difference.

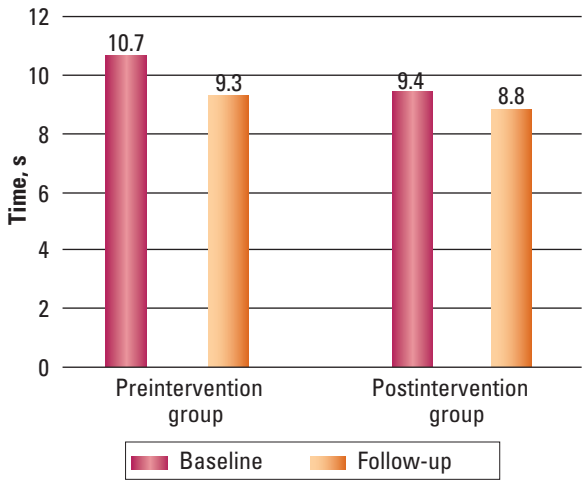


**Figure 1** Mean time to complete 5-meter walk test at baseline and 30-day follow-up in pre- and postintervention groups.

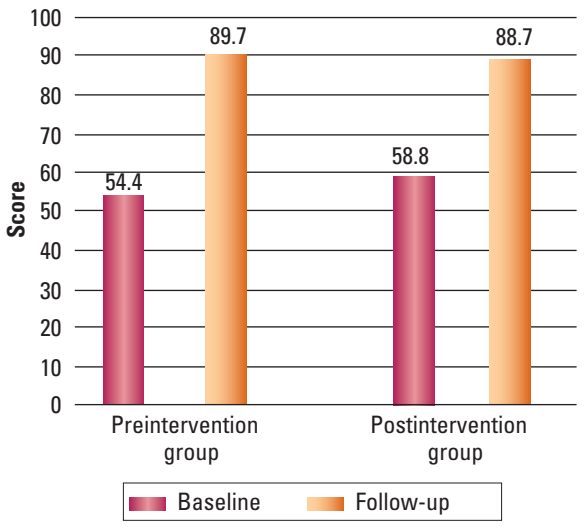


**Figure 2** Mean score on 12-item Kansas City Cardiomyopathy Questionnaire at baseline and 30-day follow-up in pre- and postintervention groups.

patients experienced rapid hemodynamic recovery and early ambulation. These results are similar to those of other studies reported in the literature that evaluated pathways and fast-track protocols to decrease LOS after TAVR.[8,9] Like the Vancouver 3M Clinical Pathway, our order set simplified the care and quantity of orders placed by the surgical physician assistant and cardiothoracic ICU nurse practitioner. Before implementation of the post-TAVR protocol, the cardiothoracic ICU registered nurse and nurse practitioner identified and discontinued many orders that were not relevant to patient care. Patients who were hemodynamically stable and awaking appropriately after anesthesia were assessed for invasive catheter removal. Femoral sheaths and arterial catheters were removed by the cardiothoracic ICU staff, and patients remained in bed until adequate hemostasis was achieved. In our experience, patients were helped out of bed after catheter removal for comfort and to avoid physical deconditioning. Likewise, studies have suggested that ambulation 3 hours after sheath removal does not significantly increase the risk of major vascular complications and increases the patient's comfort.[15] Other order changes that significantly altered discharge delays included the postprocedure echocardiogram, chest radiograph, and blood work. Shortening this workflow to next-day echocardiograms and chest radiographs allowed providers to assess the newly implanted valve and overall heart function and evaluate the patient for discharge.

To decrease immobility, the post-TAVR protocol included an evaluation by the physical therapist and progressive ambulation orders for the registered nurse to activate. Our results support those of other studies showing that early mobilization and evaluation by a physical therapist can safely reduce in-hospital deconditioning and increase the likelihood of discharging patients to their homes rather than an acute care facility.[10] Early assessment by the physical therapist allowed the patient to safely ambulate the day after the procedure. In addition, although patients are typically frail and deconditioned before TAVR because of exertional decompensation, efforts to reduce decompensation during hospitalization were successful. Although there was no significant change from before to after the procedure in patients' 5-meter walk test time, the data suggest that patients did not experience further decompensation during hospitalization.

Promoting a change in the culture of the ICU was of utmost importance. Our results were similar to those of studies investigating early discharge in patients with an uncomplicated procedure and hospitalization.[8,9,16] The staff and providers' perception of postprocedure care for TAVR patients was assessed before and after implementation of the protocol and order set, with open discussion throughout the 6-month PDSA cycles allowing the

staff to evaluate the protocol and offer suggestions for improvement. In general, staff members were open to and interested in advancing patients from the operating room to the step-down unit with limited time in the ICU. The cardiothoracic ICU nurses cared for TAVR patients immediately following the procedure and allowed physical therapists to encourage patients to ambulate and sit in a chair when they were clinically stable. The willingness of the staff to reduce ICU time for post-TAVR patients was critical. Education was also provided on the new low-risk indication and impending larger TAVR patient population. Education regarding patients who are less debilitated, have fewer comorbidities, and are deemed low risk allowed the staff to take a more aggressive approach to postprocedure recovery.

Educating the patient and helping to establish patient expectations for discharge during the initial office visit was pivotal in the ability to discharge the patient home rather than to an acute care rehabilitation facility. Our findings support previous recommendations to notify team members 1 day before discharge to allow for effective discharge planning, including review of discharge medications, follow-up appointments, and outpatient physical therapy and home care referrals.[9] However, some patients and their families believed that the best discharge plan was to an acute care rehabilitation facility because of long-standing deconditioning. The time the patient spent in bed while hospitalized was limited, minimizing further decompensation. In cases of uncomplicated procedures, outpatient physical therapy can assist in postprocedure recovery and speed reconditioning.

Patient-centered care is at the forefront of our team philosophy. Our institution provides care to a large and diverse patient population, including many members of the Orthodox Jewish community. In our efforts to provide culturally competent care, the postprocedure stay was often prolonged owing to the patient's Friday Shabbat religious obligations. The TAVR procedures are mainly performed on Wednesdays, and thus Friday discharges have presented a challenge. The patient's religious and cultural needs are prioritized; therefore, patients were kept in the hospital until Sunday to ensure a safe discharge and allow the patient to satisfy their religious commitment.

## Limitations

This study has several limitations, the most important of which is low patient volume. At the beginning of 2019, our TAVR program experienced a drastic decrease in overall patient volume due to lack of awareness about the procedure. To combat the decrease, our team offered providers educational sessions. This initiative greatly increased our referral base and case numbers during the end of 2019 and the beginning of 2020.

A second limitation has been the COVID-19 pandemic. As limits were placed on nonessential outpatient visits, many postintervention patient visits scheduled during the 30-day postprocedure window had to be canceled. In lieu of in-person visits, patients were interviewed by telephone to assess their clinical progress and to complete their KCCQ-12.

## Conclusion

Severe symptomatic aortic stenosis is a progressive disease that, when left untreated, has a mortality rate of more than 60% within 2 years. Positive results from trials involving low-risk patients mean that the volume of patients undergoing TAVR will increase, requiring institutions to prepare to accommodate the influx. The objective of this study was to implement an evidence-based protocol to facilitate seamless progression of TAVR patients from admission to discharge. Evaluation 6 months after protocol implementation revealed significant decreases in patients' LOS and procedural LOS. As the TAVR procedure evolves, with reduced operative time and less anesthesia, additional work will be needed to evaluate strategies for safe next-day discharge. CCN

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Financial Disclosures
None reported.

## See also

To learn more about early mobility, read "Nurses' Perceptions of Barriers to Out-of-Bed Activities Among Patients Receiving Mechanical Ventilation" by Cooper et al in the *American Journal of Critical Care*, 2021;30(4):266-274. Available at **www.ajcconline.org**.

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