

Standardized Total Knee Arthroplasty Pathway Improves Outcomes in Minority Patients

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Demand for total knee arthroplasty (TKA) is expected to reach 3.48 million procedures annually in the United States by 2030.¹ With increased demand comes increased emphasis on improving both TKA outcomes and perioperative efficiency. Using a standardized care pathway for TKA is one method that has been implemented to achieve these goals.²⁻¹² Results of published studies on the utilization of standardized TKA pathways have demonstrated improved early outcomes including reduced length of stay (LOS), reduced cost, decreased blood loss and transfusions, and reduced opioid use, with no increased incidence of complications.^{2-6,8,9,11-14} However, these studies have either consisted primarily of White patients or not specified their samples' ethnic makeup.^{2-6,8,9,11-14} There are limited studies on implementing standardized TKA pathways in minority populations. Inferior TKA outcomes have been documented in minority populations compared with those reported in nonminority populations.¹⁵⁻¹⁸

The purpose of this study was to evaluate the effects of a multidisciplinary standardized TKA pathway on TKA outcomes at an urban teaching hospital that primarily serves minority patients. We hypothesize that pathway standardization in this population will reduce the LOS, shorten the use of patient-controlled analgesia (PCA), and increase the rate of discharge to home without an increase in complications following unilateral primary TKAs.

METHODS

This was an institutional review board–approved, retrospective cohort study. Two groups of consecutive patients underwent primary unilateral TKAs, before and after the institution of the standardized pathway. The pathway was designed with the collaboration of fellowship-trained arthroplasty surgeons, anesthesiologists, nurses (both in the operating room and on the wards), and social services professionals. The protocols were based upon evidence-based data and techniques already available in the literature. The pathway was implemented in September 2015.

The hospital is an urban, county-financed tertiary teaching hospital that primarily serves minority and indigent patients. The

ABSTRACT

OBJECTIVES: Inferior total knee arthroplasty (TKA) outcomes are reported in minority populations. Standardized TKA pathways improve outcomes but have not been studied extensively in minority populations. This study evaluated the impact of TKA pathway standardization at an urban teaching hospital that predominantly treats minority patients.

STUDY DESIGN: Retrospective cohort study.

METHODS: This study compared primary TKA outcomes before and after implementation of a standardized multidisciplinary pathway that emphasized preoperative education and discharge planning, preemptive multimodal pain control, and early rehabilitation. Patients were grouped as “nonpathway” (n = 144) or “pathway” (n = 182) based on whether they underwent TKA before or after pathway implementation. Outcomes included length of stay (LOS), patient-controlled analgesia (PCA) use, blood transfusion, postoperative hemoglobin, complications, and discharge disposition. Analysis involved negative binomial and multiple logistic regression models, *t* tests, and Fisher's exact tests.

RESULTS: Mean (SD) age was 61.6 (8.7) years, and 36.5% were men. Ethnicity of the patients included Hispanic (44.5%), African American (27.9%), Asian (14.1%), and White (12.9%). Pathway and nonpathway patients were similar demographically and racially. Pathway patients had shorter LOS (*P* = .04), less PCA use (*P* < .001), more frequent discharge home (*P* = .03), fewer transfusions (*P* = .002), and higher postoperative hemoglobin (*P* < .001). Overall incidence of complications was similar (*P* = .61). Nonpathway patients developed more cardiopulmonary complications (*P* = .02), whereas pathway patients had more wound dehiscence (*P* = .01).

CONCLUSIONS: Compared with nonpathway patients, standardized TKA pathway patients had shorter LOS, decreased PCA use, increased discharge to home, fewer blood transfusions, and higher postoperative hemoglobin, with no difference in total incidence of complication.

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“nonpathway” cohort included 144 consecutive patients who underwent TKAs from April 2014 to August 2015 by 2 fellowship-trained arthroplasty surgeons. The “pathway” cohort included 182 consecutive patients who underwent TKAs from September 2015 to August 2016 by 1 fellowship-trained arthroplasty surgeon. All surgeons utilized similar surgical techniques and implant selection. All the patients analyzed in the study had at least 90 days of follow-up.

Pathway

For the nonpathway patients, there was no preoperative discharge planning or standardized perioperative pain control regimen. All patients received femoral nerve blocks and general anesthesia. A tourniquet was utilized, and tranexamic acid (TXA) was not administered during surgery. Postoperatively, the patients received hydromorphone or morphine PCA and oral hydrocodone as needed. The PCA was discontinued when the pain was adequately controlled with oral medications. Venous thromboembolic prophylaxis included sequential compression devices and either low-molecular-weight heparin or aspirin during the inpatient stay. All patients received aspirin 325 mg twice daily for 4 weeks after discharge.

The pathway patients attended a preoperative “joints camp” to meet with the nurses, social workers, and advanced practitioners (physician assistant and nurse practitioner) to review the informed consent, discuss the procedure, establish the expectations, emphasize early mobilization, discuss discharge planning, approve and acquire durable medical equipment, and coordinate postdischarge physical therapy and follow-up visits. In addition, a perioperative multimodal pain control regimen was instituted. Pathway patients received adductor canal blocks instead of femoral nerve blocks to allow for preservation of quadriceps activation and early mobilization postoperatively. The protocol included preemptive pain control using oxycodone and gabapentin in the preoperative holding area. Either general or spinal anesthesia was utilized, with preference for spinal anesthesia when possible. Tourniquet and intravenous TXA were used for all the procedures. The postoperative pain regimen consisted of scheduled oxycodone given for 5 doses, with hydrocodone given as needed. Hydromorphone or morphine PCA was also available if required. Physical therapy evaluation and mobilization began the day of the surgery. Indwelling urinary catheter was no longer utilized unless clinically indicated. Thromboembolic prophylaxis was similar to that of the nonpathway group. There was no change in implant selection or surgical techniques after pathway implementation.

Data Collection and Analysis

Demographic and clinical variables collected for analysis included age, sex, body mass index (BMI), ethnicity, LOS in days, PCA use in days, preoperative hemoglobin (most recent value prior to surgery),

TAKEAWAY POINTS

Inferior total knee arthroplasty (TKA) outcomes are reported in minority populations. This study, performed at an urban teaching hospital that predominantly treats minority patients, found that a standardized care pathway for TKA was associated with improved outcomes and no difference in overall complication rates compared with nonpathway TKA patients.

- ▶ The standardized multidisciplinary care pathway emphasized preoperative education and discharge planning, preemptive multimodal pain control, and early rehabilitation.
- ▶ Pathway patients had decreased length of stay, decreased patient-controlled analgesia use, and more frequent discharge to home.
- ▶ Although overall complications were similar, pathway patients had fewer cardiopulmonary complications but increased wound dehiscence.

postoperative hemoglobin (first value after surgery), incidence of blood transfusion, discharge disposition (home vs skilled nursing facility vs rehabilitation facility), and complications.

Demographic characteristics were reported for all patients together, as well as pathway and nonpathway patients separately. Continuous variables were described with mean and SD compared using 2-independent sample *t* tests with the Satterthwaite method for unequal variances. Categorical variables were described using proportions and compared with Fisher’s exact tests.

Next, a negative binomial regression model for our primary outcomes compared LOS and PCA use between pathway and nonpathway patients. A nonlinear regression model was used to evaluate LOS and PCA use between cohorts and reported as geometric means (GMs). In addition, disposition was analyzed in a binary fashion as discharged to home vs discharged to facility other than home (skilled nursing or rehabilitation facility). To estimate the probability of discharge home with adjusted odds ratios (ORs), a multiple logistic regression model was created and included penalized maximum likelihood estimation along with Firth’s bias correction. Age, sex, BMI, ethnicity, need for blood transfusion, and incidence of complications were adjusted for as covariates in both the negative binomial and multiple logistic regression models.

Statistical analyses were carried out using SAS software version 9.4 (SAS Institute Inc). Level of significance was set at $\alpha = .05$ (2-tailed), and the false discovery rate (FDR) procedure was implemented to control false positives over the multiple tests.

RESULTS

In total, 326 patients were included (144 nonpathway and 182 pathway patients). The mean (SD) age was 61.6 (8.7) years (range, 42–84 years). Men made up 36.5% of patients. The mean (SD) BMI was 31.6 (4.8) kg/m² (range, 18.6–44.6 kg/m²). Ethnicity of the patients included Hispanic (44.5%), African American (27.9%), Asian (14.1%), White (12.9%), and other (0.6%). Pathway and nonpathway patients were not different in age ($P = .06$), gender ($P = .56$), BMI ($P = .12$), or ethnic composition (Hispanic [$P = .78$], African American [$P = .37$], White [$P = .50$], Asian [$P = .83$]). See **Table 1** for a summary of demographic characteristics. General anesthesia was utilized for

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TABLE 1. Comparison of Patient Characteristics

	Nonpathway (n = 144)	Pathway (n = 182)	P
Age in years, mean (SD)	62.6 (8.9)	60.8 (8.6)	.06
Male gender, n (%)	55 (38.2%)	64 (35.0%)	.56
BMI in kg/m ² , mean (SD)	32.1 (5.1)	31.2 (4.5)	.12
Hispanic, n (%)	62 (43.1%)	83 (45.4%)	.78
African American, n (%)	47 (32.6%)	44 (24.0%)	.37
Asian, n (%)	22 (15.3%)	24 (13.1%)	.83
White, n (%)	12 (8.3%)	30 (16.4%)	.50
Preoperative Hb in g/dL, mean (SD)	13.4 (1.4)	13.1 (1.4)	.10

BMI, body mass index; Hb, hemoglobin.

TABLE 2. Comparison of Outcomes^a

	Nonpathway (n = 144)	Pathway (n = 182)	P
Length of stay in days, GM (95% CI)	3.10 (2.76-3.49)	2.66 (2.47-2.83)	.04
PCA use in days, GM (95% CI)	1.87 (1.74-2.00)	0.04 (0.01-0.14)	<.001
Blood transfusion, n (%)	14 (9.7%)	3 (1.6%)	.002
Postoperative Hb in g/dL, mean (SD)	10.5 (1.5)	11.7 (2.5)	<.001
Discharge disposition, n (%)			.03
Home	125 (86.8%)	173 (95.1%)	
Skilled nursing facility	10 (6.9%)	6 (3.3%)	
Inpatient rehabilitation	9 (6.3%)	3 (1.6%)	

GM, geometric mean; Hb, hemoglobin; PCA, patient-controlled analgesia.

^aBold indicates statistical significance ($P < .05$).

TABLE 3. Complications^a

	Nonpathway (n = 144)	Pathway (n = 182)	P
Any complication, n (%)	20 (13.9%)	21 (11.5%)	.61
Periprosthetic joint infection	3 (2.1%)	4 (2.2%)	.94
Wound dehiscence	0 (0.0%)	8 (4.4%)	.01
Joint stiffness or instability	4 (2.8%)	7 (3.9%)	.60
Foot drop	0 (0.0%)	1 (0.6%)	.37
Deep vein thrombosis	2 (1.4%)	1 (0.6%)	.43
Pulmonary embolism	3 (2.1%)	0 (0.0%)	.05
Pneumonia, COPD exacerbation	4 (2.8%)	0 (0.0%)	.02
Stroke, arrhythmia	4 (2.8%)	0 (0.0%)	.02

COPD, chronic obstructive pulmonary disease.

^aBold indicates statistical significance ($P < .05$).

all 144 nonpathway patients but only 101 of 182 pathway patients, with the rest receiving spinal anesthesia (100% vs 55.5%; $P < .001$).

The LOS and the PCA use were compared between the 2 groups using the negative binomial regression model. The LOS was shorter for the pathway group (GM, 2.65 days; 95% CI, 2.47-2.83; range, 1-9;

$P = .04$; FDR, 0.04) than for the nonpathway group (GM, 3.10 days; 95% CI, 2.76-3.49; range, 1-21). Additionally, the pathway patients required less PCA use (GM, 0.04 days; 95% CI, 0.01-0.14; range, 0-4; $P < .001$; FDR, <0.001) than the nonpathway patients (GM, 1.87 days; 95% CI, 1.74-2.00; range, 0-7).

Regarding disposition, 95.1% of pathway patients and 86.8% of nonpathway patients were discharged to home. The multiple logistic regression model demonstrated that the pathway patients were significantly more likely to be discharged to home than the nonpathway patients (OR, 2.39; 95% CI, 1.05-5.76; $P = .03$; FDR, 0.03).

Despite there being no difference in the mean preoperative hemoglobin between the 2 groups (13.1 g/dL for pathway patients vs 13.4 g/dL for nonpathway patients; $P = .10$), as shown in Table 1, pathway patients required fewer transfusions (1.6% vs 9.7%; $P = .002$) and had higher mean postoperative hemoglobin values (11.7 vs 10.5 g/dL; $P < .001$). Outcomes comparisons are summarized in Table 2.

The incidence of total complications was not different between the groups (11.5% for pathway patients vs 13.9% for nonpathway patients; $P = .61$; FDR, 0.75). The nonpathway patients had more cardiopulmonary complications (5.6% vs 0%; $P = .02$; FDR, 0.06) whereas the pathway patients had more incidences of wound dehiscence (4.4% vs 0%; $P = .01$; FDR, 0.06). Incidence of pulmonary embolism was greater in the nonpathway patients but did not reach significance (2.1% vs 0%; $P = .051$; FDR, 0.10). Complications are detailed in Table 3.

DISCUSSION

Our data were similar to those in previous reports on the efficacy of standardized clinical pathways in improving TKA outcomes.^{2-6,8,9,11-14} This study, however, is unique in that the study patient population consisted primarily of minority ethnicities with lower socioeconomic status in an urban teaching center.

Limited studies exist on the utilization of standardized pathways in minority populations undergoing TKAs. Available published studies have reported a substantial disparity between minority and nonminority patient populations in terms of TKA access and outcomes. Minority patients undergo fewer TKAs than nonminority patients, despite having similar arthritis disease prevalence.^{19,20} They also more frequently undergo TKA in low-volume centers,^{15,17,21} which have been associated with poorer outcomes.²²⁻²⁴

There are differences in TKA outcomes between minority and nonminority patients. Preoperatively, minority patients have lower Oxford Knee Scores, have higher pain levels, and tend to anticipate higher levels of postoperative pain.^{25,26} Postoperatively, minority patients have longer LOS and are more likely to be discharged to a subacute care facility than to home.^{14,27-29} African American and Hispanic patients in particular are at higher risk of complications and readmissions.¹⁵⁻¹⁷ Furthermore, minority patients achieve lower postoperative knee functional scores.^{26,30-32} Minority patients also have been identified as having a disproportionate rate of TKA revisions.³³ Finally, being in an ethnic minority has been identified

as an independent risk factor for in-hospital mortality following TKA.^{17,34} These disparities highlight the importance of improving outcomes for minority patient populations through standardized care pathways for TKA.

The TKA pathway patients in this study had a significant decrease in LOS and increase in discharge to home. This is valuable because shorter stays and discharge to home have been associated with improved clinical outcomes, increased patient satisfaction, and reduced costs.^{2,27,35,36}

At our institution, reducing LOS by 1 day saves the hospital approximately \$665. This value includes room expenses, routine laboratory testing, physical therapy, and medications. Our data showed that the TKA pathway standardization was associated with a 0.45-day reduction in LOS. At a rate of 300 TKAs per year, for example, the shorter LOS alone would reduce the costs to our institution by \$89,709.

Discharge to a subacute care facility has also been associated with increased odds of readmission and the development of respiratory, septic, thromboembolic, and urinary complications.³⁷ Furthermore, discharge to a subacute care facility is a cost driver in total joint arthroplasty. This further underscores the financial benefit of standardized care pathways that are associated with the reduction of discharges to the subacute care facility and an increase of discharges to home.^{13,36}

Studies have also demonstrated that minority patients tend to report higher pain levels preoperatively and anticipate higher postoperative pain levels.^{25,26} Our TKA pathway pain protocol effectively reduced PCA use. The improved pain management invariably contributed to earlier and more effective mobilization of the patients. Other studies have reported that patients using PCA are twice as likely to miss therapy sessions.³⁸ Decreased PCA use allowing for earlier mobilization could have had other benefits, including risk reduction of venous thromboembolism, pneumonia, delirium, urinary retention, and urinary tract infection.³⁹⁻⁴¹

Pathway patients had higher postoperative hemoglobin levels and decreased need for blood transfusion, despite similar preoperative hemoglobin levels. In our pathway, this finding is likely related to the use of TXA intraoperatively, as this was the only difference in blood loss management between the 2 groups. This has been previously reported.⁹

Wound dehiscence was the only complication that occurred significantly more often in the pathway group than in the nonpathway group. Both groups had similar closure technique with regard to the suture material and size used. There was also no change in the surgical dressing protocol between the groups. Six of the 8 patients with wound dehiscence in the pathway group underwent skin closure with subcutaneous Monocryl as opposed to staples. The increase in wound dehiscence in the pathway group may have been due to increased incisional stresses as a result of the earlier and more aggressive rehabilitation and more effective pain management. The surgical site or the periprosthetic joint infection rate, however, was not different between the 2 groups.

Limitations

Limitations of this study include its retrospective design and lack of randomization. Randomization may not have been appropriate, however, given that standardized pathways for TKA are generally accepted as safe and effective in the general population. Furthermore, as a limitation, we did not conduct chart review of patients who were not a part of the pathway after implementation. In addition, the surgical techniques between the pathway and nonpathway surgeons, although similar, were not standardized with regard to tourniquet time and closure techniques. Functional data were not well documented and therefore could not be analyzed. Although we can infer that the pathway patients made functional gains more quickly than the nonpathway patients given the shorter LOS and more frequent discharge to home, we do not have precise data on how quickly our patients met specific range of motion and activity milestones. We also did not account for how factors related to each patient's living situation might have affected discharge disposition. Another limitation is that we did not control for specific medical or clinical characteristics outside of basic demographic information. However, we do not suspect significant differences between pathway and nonpathway patients in terms of clinical characteristics, as these were relatively large samples of patients from the same institution undergoing the same procedure for the same disease process. Finally, a relatively short follow-up (minimum of 90 days) was required for inclusion, which may not capture complications that develop in the longer term.

CONCLUSIONS

This study demonstrated that the institution of a standardized TKA pathway resulted in shorter LOS, decreased PCA use, increased discharge to home, fewer blood transfusions, and higher postoperative hemoglobin with no difference in the total incidence of complications. Our data validated that the utilization of the standardized pathway was effective and safe in improving outcomes in the minority patient populations at an urban teaching hospital and could potentially reduce the costs of TKA. Further studies are needed to corroborate our conclusions and evaluate whether standardized pathways could reduce the disparity in the outcomes between minority and nonminority patient populations. ■

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