Arthroplasty Today 3 (2017) 45–49

Contents lists available at ScienceDirect

Arthroplasty Today

journal homepage: http://www.arthroplastytoday.org/

Original research

Improving value in primary total joint arthroplasty care pathways: changes in inpatient physical therapy staffing

Christopher E. Pelt, MD [a,*], Mike B. Anderson, MSc [a], Robert Pendleton, MD [b], Matthew Foulks, PT [c], Christopher L. Peters, MD [a], Jeremy M. Gililland, MD [a]

[a] Department of Orthopaedic Surgery, The University of Utah, Salt Lake City, UT, USA
[b] Department of Internal Medicine, The University of Utah, Salt Lake City, UT, USA
[c] Department of Physical Therapy, The University of Utah, Salt Lake City, UT, USA

ARTICLE INFO

Article history:
Received 9 December 2015
Received in revised form
11 February 2016
Accepted 16 February 2016
Available online 8 April 2016

Keywords:
Value-driven outcomes
Total joint arthroplasty
Physical therapy
Early ambulation and value

ABSTRACT

Background: An early physical therapy (PT) care pathway was implemented to provide same-day ambulation after total joint arthroplasty by changing PT staffing hours.
Methods: After receiving an exemption from our institutional review board, we performed a secondary data analysis on a cohort of patients that underwent primary TJA of the hip or knee 6 months before and 12 months after implementation of the change. Data on same-day ambulation rates, length of stay (LOS), and in-hospital costs were reviewed.
Results: Early evaluation and mobilization of patients by PT improved on postoperative day (POD) 0 from 64% to 85% after the change ($P \leq .001$). The median LOS before the change was 3.27 days compared to 3.23 days after the change ($P = .014$). Patients with higher American Society of Anesthesiologists scores were less likely to ambulate on POD 0 ($P = .038$) and had longer hospital stays ($P < .001$). Early mobilization in the entire cohort was associated with a greater cost savings ($P < .001$).
Conclusions: A relatively simple change to staffing hours, using resources currently available to us, and little additional financial or institutional investment resulted in a significant improvement in the number of patients ambulating on POD 0, with a modest reduction in both LOS and inpatient costs.
© 2016 The Authors. Published by Elsevier Inc. on behalf of The American Association of Hip and Knee Surgeons. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Introduction

As health care and reimbursement reform progresses, the value equation (value = quality + service/costs) is becoming increasingly prominent. Total joint arthroplasty (TJA), well known to be one of the most quality-of-life–restoring and cost-effective procedures in medicine, is under increasing pressure to provide improved value given the ever-increasing utilization of this intervention [1,2]. One method for improving value has been increasing the early mobility of patients undergoing TJA. Early mobility has many potential advantages to the postoperative recovery process of patients undergoing TJA. Prior studies have indicated that early mobilization can decrease complications such as venous thromboembolic events, decrease length of stay (LOS), decrease hospital-acquired conditions, decrease hospital costs, and improve functional outcomes [3-15]. As a result, efforts to improve early mobilization may indirectly improve value by improving quality and decreasing costs. Thus, further refinement of the postoperative care pathway may be needed and has previously been recommended [16].

Multimodal approaches to the improvement of perioperative care of joint replacement patients have become increasingly popular. These so-called “rapid recovery” care pathways typically use several strategies including, but not limited to, preoperative patient education and expectation management, preoperative multimodal pain medication, enhanced anesthesia practices, minimally invasive surgical techniques, antiemetic therapies, postoperative multimodal pain medication control with narcotic minimization, early mobilization, accelerated discharge and disposition, and case

One or more of the authors of this paper have disclosed potential or pertinent conflicts of interest, which may include receipt of payment, either direct or indirect, institutional support, or association with an entity in the biomedical field which may be perceived to have potential conflict of interest with this work. For full disclosure statements refer to http://dx.doi.org/10.1016/j.artd.2016.02.003.

* Corresponding author. 590 Wakara Way, Salt Lake City, UT, 84106, USA. Tel.: +1 801 587 5448.
E-mail address: chris.pelt@hsc.utah.edu

http://dx.doi.org/10.1016/j.artd.2016.02.003
2352-3441/© 2016 The Authors. Published by Elsevier Inc. on behalf of The American Association of Hip and Knee Surgeons. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

management [5,17]. Widespread adoption of the many necessary pieces of these protocols may be challenging given potential institutional and administrative barriers as well as financial, personnel, or other similar resource limitations. Attempts to identify opportunities for improvement using existing resources may aid in efforts to overcome these barriers.

Based on the findings of these prior studies and pathways, as well as an increased focus on value at our institution along with a newly available cost-and-quality–tracking tool known as Value Driven Outcomes (VDO), we assembled a multidisciplinary team of surgeons, nurses, therapists, case managers, and value engineers with a goal of identifying opportunities for improvement in our joint replacement care pathways using currently available resources. We hypothesized that changing the inpatient physical therapists' scheduled work hours to include a swing shift to be able to evaluate all patients on the day of surgery (postoperative day 0, POD 0), with the goal of ambulation on POD 0, would lead to improvements in quality and decreases in cost. To test this hypothesis, we sought to answer the following research questions:

1. Did the change in physical therapy (PT) staffing result in increased early ambulation on POD 0?
2. Was LOS shorter after the PT staffing change?
3. Was there a cost benefit associated with early ambulation?

Material and methods

In the fall of 2012, a multidisciplinary team was assembled at our institution to identify potential areas for improvement as part of a joint replacement care pathway improvement project. During this process, we identified early ambulation as a target for improvement. After receiving an exemption from our institutional review board, we performed secondary data analysis on a cohort of patients that underwent TJA of the hip or knee. Data from the 6 months prior (n = 259) to implementation of the change in April 2013 were reviewed and compared to data for the 12 months after (n = 489) the change using an institutional cost and quality dashboard tool, known as VDO. Of the 748 primary joint replacements, 461 underwent primary total knee arthroplasty (TKA) and 287 had undergone primary total hip arthroplasty (THA). This time frame was chosen to minimize the potential impact of other care pathway improvement initiatives that were ongoing both before and after that 18-month window, during which time the primary focus and only major change to the care pathway was the early ambulation initiative.

Under the guidance of the department manager and lead inpatient orthopaedic physical therapist (MF), inpatient PT staffing hours were adjusted. Previous staffing of 3-6 full-time physical therapists and physical therapy assistants (PTAs) with a work schedule of 8 AM-5 PM was modified to a new schedule to provide 3-4 full-time physical therapists and PTAs during the regular daytime shift and adding a swing shift from 11 AM to 8 PM with 1-2 physical therapists and PTAs. The goal of the intervention was to increase the rate of evaluating and attempting to assist all postoperative primary TJA patients with ambulation on the day of surgery.

The primary outcome comprised of the number of patients who were evaluated and ambulated on the day of surgery (POD 0), as documented by PT in the electronic medical record. The difference in overall cost before and after the implementation of the swing shifts with the PT staff was compared. The VDO tool provided cost data for each patient in terms of percentage cost savings as compared to the mean overall historical cost from the prior year, and therefore, our cost data are presented as such.

Patient characteristics are reported as mean (range) for age and body mass index (BMI) and compared using an independent-samples *t* test. American Society of Anesthesiologists physical status classification (ASA scores) are presented as median (interquartile range [IQR]) and analyzed using the Wilcoxon rank sum test. A chi-square analysis was used to compare the proportion of males and females between the groups.

Our primary outcome, early ambulation on POD 0, was analyzed using multivariable logistic regression. The main predictor was before or after implementation of the PT staffing change, and potential covariates included age, sex, BMI, ASA score (classified as 1, 2, ≥3), anesthesia type (general or spinal), and procedure (THA vs TKA). Given the inherent skewness of LOS, it was analyzed using these same predictors in several regression models: linear regression, linear regression with a log transformation of LOS, gamma regression, and Cox proportional hazards regression [18]. The results were consistent across all models with and without the outliers, and thus, we present results from the multivariable linear regression model for ease of interpretation. Cost savings also had a skewed distribution, but negative values precluded the LOS models. Thus, cost savings results are presented from a multivariable linear regression, where the statistical significance of results was verified using bootstrapping. In the cost saving model, the primary predictor was early ambulation and covariates included those previously described. The presence of collinearity in the regression models was assessed with the variance inflation factor diagnostic [19]. When the variance inflation factor was >10, the variables included in the model were chosen by clinical significance. To further assess the cost savings related to the intervention, a simple linear regression analysis was performed to identify the difference in cost savings between groups with 95% confidence intervals. The outcome was generated as 14% of the overall cost savings, which was directly attributable to facility utilization as explained in the following. Analyses were conducted in Stata version 13.1 (College Station, TX), and statistical significance was assessed at the 0.05 level.

Results

There was no difference in age, BMI, ASA score, or sex between patients who underwent TJA before and after the PT staffing change (Table 1, all $P > .500$). Patients who underwent TKA were older ($P < .001$) with a mean age of 63 years (range, 20-92), whereas patients who underwent THA had a mean age of 59 years (range, 12-95). The BMI was greater in the TKA patients ($P < .001$) with a mean BMI of 32.8 kg/m^2 (range, 15.4-61.6) compared to a mean BMI of 30.5 kg/m^2 (range, 15.3-59.7).

Early evaluation and mobilization of patients by the PT staff improved significantly on POD 0 from 64% in the 6 months prior to 85% after the change in PT staffing (Table 2, $P < .001$). Of those patients who were unable to ambulate on POD 0 after the change,

Table 1
Comparison of patient characteristics before and after the change in the PT schedule.

Characteristic	Before change, n = 259	After change, n = 489	*P* value
Age, y, mean (range)	61 (14-95)	62 (12-88)	.761
BMI, kg/m^2; mean (range)	31.7 (15.4-57.1)	32.0 (15.3-61.6)	.604
ASA score, median (IQR)	2 (2-3)	2 (2-3)	.760
Sex, n (%)			
Female	156 (60)	293 (60)	.934
Male	103 (40)	196 (40)	
Procedure			
TKA	161 (62)	300 (61)	.828
THA	98 (38)	189 (39)	

Table 2
Factors associated with early ambulation on POD 0.

Early ambulation	OR	95% CI	*P* value
Group	3.01	2.10-4.32	<.001
Sex	1.13	0.78-1.64	.511
ASA score	0.70	0.50-0.98	.038
Procedure	0.66	0.45-0.98	.039
Anesthesia	1.04	0.71-1.54	.837

OR, odds ratio.
Group is coded so that 1 represents patients seen after the PT staffing change, sex is coded so that males = 1, and procedure is coded so that primary total hip arthroplasty is 1 and primary total knee arthroplasty is 0. In addition, anesthesia was coded as 1 for spinal and 0 for general.

the primary reason was due to late arrival to the floor (21 of 75, 28%, Table 3). Interestingly, patients who underwent THA were less likely to ambulate on POD 0 ($P = .025$) as were patients with a higher ASA score ($P = .038$, Table 2). Notably, regarding the lower likelihood of THA patients to mobilize on POD 0, 78% (n = 63) of the THA patients received a general anesthesia compared to 45% of TKA patients ($P < .001$).

The median LOS before the change was 3.27 days (IQR, 3.11-4.07) compared to a median 3.23 days (IQR: 2.78-3.38) after the change (Fig. 1, $P = .014$). ASA scores were associated with longer lengths of stay, whereas being male was associated with a decreased LOS (Table 4). Finally, the procedure (hip or knee replacement) did not appear to affect the LOS ($P = .957$). Patients who underwent primary THA had a median LOS of 3.23 days (IQR, 2.53-3.41) compared to primary TKA with a median 3.25 days (IQR, 3.07-3.41).

Early ambulation was associated with a greater cost savings (Fig. 2) in all patients, before and after the implementation of the change (Table 5, $P < .001$). Patients who ambulated early had a median cost savings of 28% (IQR, 21%-37%) from the average historical costs compared to a median 22% (IQR, 14%-30%) in those that ambulated later. A higher ASA score was associated with less cost savings ($P < .001$), whereas patients that underwent the procedure with spinal anesthesia had greater cost savings ($P = .001$, Table 5).

During the entire study period, it is important to note that the overall direct hospital costs showed a median cost savings of 21.67% (IQR, 14.30%-25.97%) from the average historical costs before the change and a median cost savings of 33.13% (IQR, 23.91%-38.65%) after the change, demonstrating improved median cost savings of 11.5% in patients who underwent TJA after the PT staffing change (observed β: 13.31, bootstrap standard error: 1.75, $P < .001$). The general trend during the entire study period was for continued cost savings measures in multiple other domains (pharmacy, imaging, implant pricing, laboratory, and so forth), despite our time selection criteria of the 18 months with minimal other changes to the joint replacement care pathway. After further reviewing the cost savings that occurred after the change, we evaluated for these potentially confounding variables. The majority of savings was due to contract

Table 3
The reasons patients were unable to ambulate on POD 0 after the change in PT staffing.

Reason	n (%)
Late arrival from the floor	21 (28)
Unknown (lack of documentation)	16 (21)
Nausea	9 (12)
Fatigue	9 (12)
Residual spinal effect	7 (9)
Pain	6 (8)
Other	4 (5)
Respiratory issues	2 (3)
Cardiac issues	1 (1)

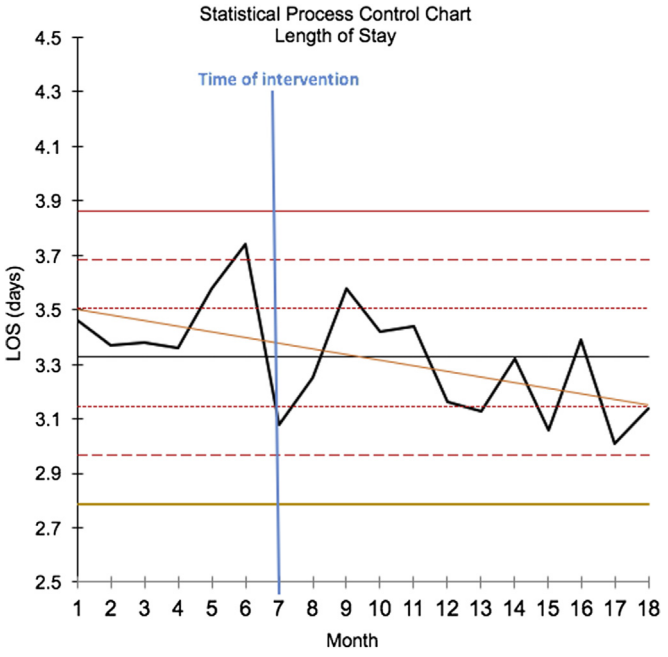

Figure 1. This process control chart demonstrates the trend toward decreased LOS from before and after the PT staffing change.

renegotiations on TJA implant pricing which was responsible for 80% of the total cost savings (Fig. 3). Another 6% of the cost savings were related to adjustments in ancillary services including imaging, laboratory, and pharmacy. The remaining 14% of the savings were due to decreased facility utilization, including shorter LOS, during this time period. In the regression model, we identified an increased cost savings of 1.9% (95% CI, 1.5%-2.4%, $P < .001$) in the postimplementation group that is likely attributable to the PT staffing change.

Discussion

Given the increasing pressures to deliver higher quality care at lower costs, hospitals and care providers will be tasked with looking at their practices for areas of improvements. It is possible that simple or small changes may make meaningful impacts in the value equation. The change to physical therapists' work hours in the hospital setting represents one simple change made at our institution in hopes of improving quality and decreasing cost. We were able to improve early PT evaluation and ambulation, allowing for 85% of TJA patients to ambulate on POD 0. Improved rates of early

Table 4
Factors associated with length of stay.

LOS	β	SE β	*t*	*P* value
Group	−0.20	0.08	−2.46	.014
Age	0.006	0.003	1.95	.051
Sex	−0.23	0.08	−2.98	.003
BMI	−0.004	0.005	−0.66	.511
ASA score	0.40	0.08	5.35	<.001
Procedure	−0.005	0.08	−0.05	.957
Anesthesia	−0.105	0.08	−1.29	.198

$F(6, 688) = 8.25$, $P < .001$, $R^2 = 0.080$.
Group is coded so that 1 represents patients seen after the PT staffing change, sex is coded so that males = 1, and procedure is coded so that primary total hip arthroplasty is 1 and primary total knee arthroplasty is 0. In addition, anesthesia was coded as 1 for spinal and 0 for general.

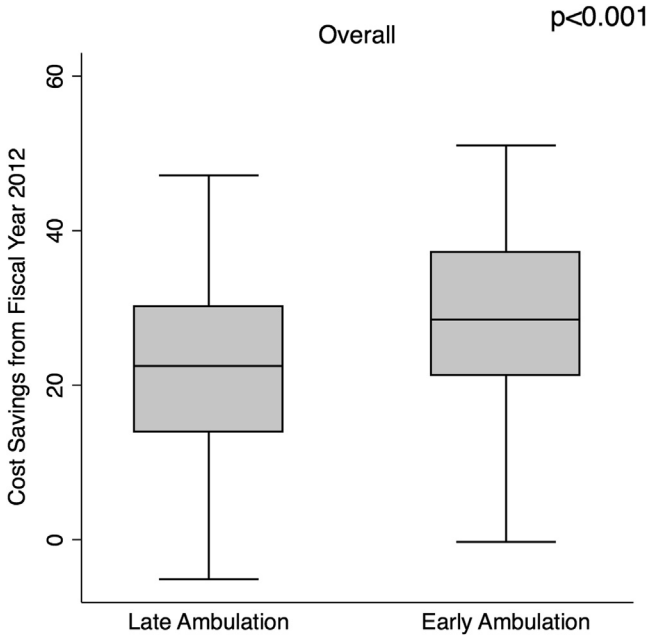

Figure 2. A box plot demonstrating cost savings between the early and late ambulators in all patients. The y-axis represents the percentage of cost savings from the historical average.

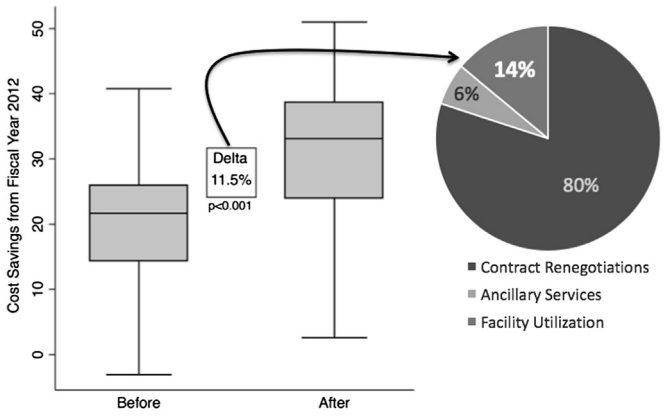

Figure 3. This combined chart demonstrates the distribution of cost savings (pie chart) from the difference in cost savings (box plot) before and after implementation of the swing shifts, where 14% of the 11.5% improvement being related to LOS (facility utilization), resulting in a cost savings of 1.9% attributable to the intervention.

ambulation were associated with lower LOSs and improved overall cost savings. Notably, we found that patients with more comorbidities (higher ASA scores) failed to demonstrate significant improvement in the likelihood to ambulate on POD 0 and similarly were likely to stay longer and have lower cost savings.

In 1998, Munin et al. [3] demonstrated a decreased cost with early ambulation, defining early ambulation being on POD 3. Advances in the postoperative pathways for TJA and the demands to improve the value equation since that time have resulted in much shorter lengths of stay, with rapid recovery and early ambulation contributing to the improvements of the value equation by decreasing overall costs, despite maintaining similar outcomes in readmission rates and hospital-acquired conditions or patient safety indicator fallouts [5,14,15]. The change in the hours of PT staffing at our institution showed a significant improvement in same-day ambulation for patients undergoing TJA. When accounting for facility utilization and LOS, a 1.9% cost reduction was attributable to our intervention. This, while at first glance is seemingly a small improvement, may represent meaningful overall cumulative savings when looking at the larger scale of joint replacements collectively at individual institutions, or an even broader scale.

Interestingly, we found that patients who underwent THA were less likely to ambulate on POD 0. However, upon further review, we found that the majority of these patients (78%) had undergone the procedure with general anesthesia. Gonano et al. [20] report improved pain management and less use of analgesics in patients that underwent orthopaedic intervention with spinal anesthesia compared to general anesthesia. Furthermore, Macfarlane et al. [21,22] report that regional anesthesia and/or analgesia decreased pain and minimized opioid-related adverse events in both hip and knee replacement patients compared to general anesthesia. They also showed that regional anesthesia facilitated rehabilitation after primary TKA [21]. Given the significant difference in anesthesia techniques between the THA and TKA patients, and the adverse effects associated with general anesthesia, it is likely that this had an effect on the lower early ambulation rates in the THA patients. Efforts toward increasing the utilization of regional anesthesia is a current care pathway initiative at our institution.

We also, perhaps not surprisingly, found that patients with ASA scores >2 were less likely to ambulate on the day of surgery and had longer LOS and increased costs. This may be due to several potential causes. First, patients with more significant comorbidities may simply be less likely to mobilize because of their overall physical health and medical conditions. Furthermore, there could be an association between higher medical comorbidities and more complex surgeries, which, at our institution, are often scheduled later in the operating day. It stands to reason that, even with a therapist staying later in the day, patients with a later surgery time may have less overall recovery time, and, along with their comorbid conditions, may be less likely to mobilize on POD 0.

The improvement in LOS was similarly an interesting finding in our study. The improvement in LOS was statistically significant in our analysis; however, we would argue that an improvement in the average of 3.27-3.23 days may not represent a clinically significant improvement. Although we anticipated seeing a reduction in LOS, we had expected the decrease to be more clinically meaningful. Other studies have shown that multiple factors may affect LOS, including patient expectations and care pathways [23-25]. Although our group took a significant effort into modifying the simple to make changes, such as PT staffing hours, we have lacked needed resources and institutional support to similarly improve the other components. During the present study period, LOS was a function of the historical "standard of care" at our institution. Patients were told they would be hospitalized for 2-3 days, there was no effort made to discharge patients earlier, and the patients, as a result, stayed 2-3 days. Criteria for discharge during the study period included mobility suitable to meet the needs of home, rehab, or skilled nursing facility

Table 5
Early ambulation and cost savings.

Cost savings	Observed β	Bootstrap SE β	*Z*	*P* value
Early ambulation	11.77	2.76	4.26	<.001
Age	0.04	0.07	0.59	.557
Sex	−0.62	1.60	−0.39	.699
BMI	−0.012	0.13	−0.10	.923
ASA score	−5.73	1.54	−3.71	<.001
Procedure	−1.25	1.92	−0.65	.515
Anesthesia	5.52	1.60	3.45	.001

Group is coded so that 1 represents patients ambulating on the day of surgery, sex is coded so that males = 1, and procedure is coded so that primary total hip arthroplasty is 1 and primary total knee arthroplasty is 0. In addition, anesthesia was coded as 1 for spinal and 0 for general.

requirements, pain adequately controlled, and the patient tolerating eating, drinking, voiding, and having all other medical conditions stable and suitable for discharge. Current care pathway improvement initiatives include a new preoperative patient education and expectation setting program, the addition of case managers into the preoperative clinics to prepare patients for their eventual discharges earlier in the process, and initiatives toward resetting patient and in-hospital provider expectations for abbreviated hospital stays.

Limitations of this present study include the secondary analysis with the use of institutional databases as the data source. First, a historical LOS likely creates a significant ceiling effect on the primary outcome of interest, and this may have contributed to the inability to see greater improvements. Second, our initial cost and quality metrics were likely influenced by multiple factors, including those not related just to the change in PT staffing and not demonstrated in the database. Purchasing contract negotiations and general trends toward improvement in quality metrics at our institution and nationally are also likely ongoing simultaneously. We took efforts to account for these concomitantly occurring factors. Using the VDO tool, we were able to create a cost savings report demonstrating reduction in overall costs. At first glance, we found significant reductions in costs associated with the care of our patients during the same interval as our PT staffing intervention was implemented. However, this potentially exciting finding served as a learning point for our study group and should similarly serve as a point of caution for other centers using similar institutional costing tools such as our VDO tool. There may be significant limitations in the ability to interpret data when using generic costing tools. Without our efforts to fully account for all potential changes, most notably to implant pricing contracts around the same time, we initially made the mistake of generalizing the perceived improvements to our simple intervention. Although we attempted to control for confounding factors in our analysis, there still may be other contributing factors such as complex cases being performed later in the day or other patient, family, or surgical factors that could influence whether patients were likely to ambulate on the day of surgery and similarly affect the other outcomes such as cost and quality metrics.

Conclusions

A relatively simple change to staffing hours, using resources currently available to us, and little additional financial or institutional investment resulted in a significant improvement in the number of patients ambulating on POD 0, with a modest reduction in both LOS and inpatient costs. Patient comorbidities (ASA scores) are more likely to influence the LOS and decrease any potential cost savings as opposed to staffing issues.

References

[1] Dall TM, Gallo P, Koenig L, Gu Q, Ruiz D. Modeling the indirect economic implications of musculoskeletal disorders and treatment. Cost Eff Resour Alloc 2013;11(1):5.
[2] Kurtz S, Ong K, Lau E, Mowat F, Halpern M. Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. J Bone Joint Surg Am 2007;89(4):780.
[3] Munin MC, Rudy TE, Glynn NW, Crossett LS, Rubash HE. Early inpatient rehabilitation after elective hip and knee arthroplasty. JAMA 1998;279(11):847.
[4] Dowsey MM, Kilgour ML, Santamaria NM, Choong PF. Clinical pathways in hip and knee arthroplasty: a prospective randomised controlled study. Med J Aust 1999;170(2):59.
[5] Berend KR, Lombardi Jr AV, Mallory TH. Rapid recovery protocol for perioperative care of total hip and total knee arthroplasty patients. Surg Technol Int 2004;13:239.
[6] Oldmeadow LB, McBurney H, Robertson VJ, Kimmel L, Elliott B. Targeted postoperative care improves discharge outcome after hip or knee arthroplasty. Arch Phys Med Rehabil 2004;85(9):1424.
[7] Petersen MK, Madsen C, Andersen NT, Soballe K. Efficacy of multimodal optimization of mobilization and nutrition in patients undergoing hip replacement: a randomized clinical trial. Acta Anaesthesiologica Scandinavica 2006;50(6):712.
[8] Pearse EO, Caldwell BF, Lockwood RJ, Hollard J. Early mobilisation after conventional knee replacement may reduce the risk of postoperative venous thromboembolism. J Bone Joint Surg Br 2007;89(3):316.
[9] Khan F, Ng L, Gonzalez S, Hale T, Turner-Stokes L. Multidisciplinary rehabilitation programmes following joint replacement at the hip and knee in chronic arthropathy. Cochrane Database Syst Rev 2008;(2):CD004957.
[10] Chandrasekaran S, Ariaretnam SK, Tsung J, Dickison D. Early mobilization after total knee replacement reduces the incidence of deep venous thrombosis. ANZ J Surg 2009;79(7-8):526.
[11] Renkawitz T, Rieder T, Handel M, et al. Comparison of two accelerated clinical pathways—after total knee replacement how fast can we really go? Clin Rehabil 2010;24(3):230.
[12] Labraca NS, Castro-Sanchez AM, Mataran-Penarrocha GA, et al. Benefits of starting rehabilitation within 24 hours of primary total knee arthroplasty: randomized clinical trial. Clin Rehabil 2011;25(6):557.
[13] Chen AF, Stewart MK, Heyl AE, Klatt BA. Effect of immediate postoperative physical therapy on length of stay for total joint arthroplasty patients. J Arthroplasty 2012;27(6):851.
[14] Tayrose G, Newman D, Slover J, et al. Rapid mobilization decreases length-of-stay in joint replacement patients. Bull Hosp Jt Dis 2013;71(3):222.
[15] Larsen K, Hansen TB, Thomsen PB, Christiansen T, Soballe K. Cost-effectiveness of accelerated perioperative care and rehabilitation after total hip and knee arthroplasty. J Bone Joint Surg Am 2009;91(4):761.
[16] Kehlet H, Soballe K. Fast-track hip and knee replacement—what are the issues? Acta Orthopaedica 2010;81(3):271.
[17] Berger RA, Sanders SA, Thill ES, Sporer SM, Della Valle C. Newer anesthesia and rehabilitation protocols enable outpatient hip replacement in selected patients. Clin Orthop Relat Res 2009;467(6):1424.
[18] Austin P, Rothwell D, Tu J. A comparison of statistical modeling strategies for analyzing length of stay after CABG surgery. Health Serv Outcomes Res Methodol 2002;3(2):107.
[19] Hamilton L. Statistics with Stata, updated for version 9. Belmont, CA: Thomson Brooks/Cole Publishing; 2006.
[20] Gonano C, Leitgeb U, Sitzwohl C, et al. Spinal versus general anesthesia for orthopedic surgery: anesthesia drug and supply costs. Anesth Analg 2006;102(2):524.
[21] Macfarlane AJ, Prasad GA, Chan VW, Brull R. Does regional anesthesia improve outcome after total knee arthroplasty? Clin Orthop Relat Res 2009;467(9):2379.
[22] Macfarlane AJ, Prasad GA, Chan VW, Brull R. Does regional anaesthesia improve outcome after total hip arthroplasty? A systematic review. Br J Anaesth 2009;103(3):335.
[23] Halawi MJ, Vovos TJ, Green CL, et al. Preoperative pain level and patient expectation predict hospital length of stay after total hip arthroplasty. J Arthroplasty 2014;30(4):555.
[24] Ayalon O, Liu S, Flics S, et al. A multimodal clinical pathway can reduce length of stay after total knee arthroplasty. HSS J 2011;7(1):9.
[25] den Hertog A, Gliesche K, Timm J, Muhlbauer B, Zebrowski S. Pathway-controlled fast-track rehabilitation after total knee arthroplasty: a randomized prospective clinical study evaluating the recovery pattern, drug consumption, and length of stay. Arch Orthop Trauma Surg 2012;132(8):1153.