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Original research

Use of new interactive patient-provider software improves patient satisfaction and outcomes—a retrospective single-center study

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ABSTRACT

Background: While a number of studies have explored patient- and provider-related factors contributing to quality of care, few studies have explored the role of technology in improving quality and optimizing patient-provider communication. This study explores the use of an interactive patient-provider software platform (IPSP) at a single institution. Specifically, we compared: (1) patient satisfaction scores, (2) complication rates, and (3) readmission rates before and after the use of an IPSP on patients undergoing total hip arthroplasty and total knee arthroplasty.
Material and Methods: A retrospective review was performed on all total hip arthroplasty and total knee arthroplasty patients who completed a Press Ganey survey at a single institution between the years 2014 and 2017. Primary outcomes included Press Ganey patient satisfaction scores and 90-day complication and readmission rates. Mann-Whitney U testing and chi-squared analyses were conducted to assess continuous and categorical variables, respectively.
Results: Analysis revealed an improvement in median Clinician and Group Consumer Assessment of Healthcare Providers and Systems (89 vs 97) and Hospital for Consumer Assessment of Healthcare Providers and Systems scores (9 vs 10; $P < .001$) between pre-IPSP and post-IPSP. There was a decrease in 90-day complication rates (17.3 vs 11.2%; $P = .035$) but no decrease in readmission rates (0.30 vs 0.18%, $P = .322$) between the 2 time points.
Conclusions: The use of an IPSP proved instrumental in improving patient satisfaction and lowering 90-day complication rates at a single institution. The implementation of an IPSP may prove beneficial to arthroplasty surgeons and health-care institutions alike seeking to optimize the quality of care. Larger multicenter studies are necessary to validate the results of the present study.

Introduction

The Center for Medicare and Medicaid Services (CMS) has made clear its efforts to improve health care quality. Part of these efforts has centered on readjusting reimbursement, which has now undergone a paradigm shift from a fee-for-service to a fee-for value model [1]. This value, defined as the quality of care provided per cost of service [2], is the impetus behind newer reimbursement structures such as the Bundle Payment for Care Improvement initiatives, Comprehensive Care for Joint Replacement Model, and Global Budget Revenue model [3,4]. For arthroplasty surgeons, these changes provide a significant opportunity to optimize patient care and reduce costs [5].

While these new value-based reimbursement models harbor varying components, they are similar in that they all incorporate quality adjustors meant to increase the quality of care per dollar cost. This quality is calculated as the summation of both patient experience of care and patient outcome during a predetermined risk-bearing period [6,7]. Currently, 2 metrics, the Hospital for Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey and Clinician and Group Consumer Assessment of

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Table 1
Comparison of patient demographics for the pre-IPSP and post-IPSP periods.

Variable	Pre-IPSP	Post-IPSP	*P*-value	95% CI for mean difference
Age, y (standard deviation)	63.24 (6.63)	64.00 (6.70)	.162	−1.86 to 0.33 y
BMI, kg/m^2 (standard deviation)	32.82 (7.83)	33.61 (7.49)	.215	−2.05 to 0.46 kg/m^2
Female	68.30%	65.90%	.119	N/A
TKA %	56.80%	57.40%	.831	
THA %	43.20%	42.60%		
CCI				
0	50.30%	51.30%	.673	
1	22.90%	20.20%		
2	20.60%	19.20%		
≥3	6.10%	9.20%		

BMI, body mass index; CCI, Charlson comorbidity index; N/A, not applicable.

Healthcare Providers and Systems (CG CAHPS), have been approved by the CMS as a measurement of patient experience of care [8-11]. Alternatively, outcomes are measured as rates of potential avoidable utilization (ie, readmissions) [12-14] and reportable complications that occur during the risk-bearing period. Providers are responsible for all incurred costs due to patient readmission and surgical-related complications during the risk-bearing period [15]. Thus, an inability to reduce readmission and complication rates while improving patient satisfaction can lead to reduced earnings and higher than nominal financial cost for arthroplasty providers serving under a value-based model [16-18].

Multiple studies have reported on improved patient satisfaction and outcomes when patient-provider communication is optimized during the risk-bearing period [19-24]. This may provide opportunities for arthroplasty surgeons looking to improve their value of care. As such, utilizing technology that creates a platform for patients to directly communicate with their surgeon may prove to be beneficial [25,26]. While the effectiveness of this approach has been demonstrated in both business and marketing sectors [27-29], there is a paucity of studies that directly assess the effects of implementing such technology in the lower extremity joint arthroplasty practice setting. Thus, the purpose of this study was to explore the use of an interactive patient-provider software platform (IPSP) at a single institution. Specifically, we compared: (1) patient satisfaction scores, (2) complication rates, and (3) rates of readmission before and after the use of an interactive patient-provider platform at a single large-volume arthroplasty surgery institution.

Material and Methods

Patient selection

Institutional review board approval was obtained for the retrospective review of all primary total knee arthroplasty (TKA) and primary total hip arthroplasty (THA) patients (performed by 2 separate surgeons) who completed a Press Ganey (PG) CG CAHPS survey and a PG HCAHPS survey between January 1, 2014 and December 31, 2017. The use of an IPSP was established in January 2016. During that time period, the only administrative change implemented was IPSP use. To limit time as a confounder, we assessed identical time period lengths before and after the use of an IPSP. Pre-IPSP was designated as the time period between January 1, 2014 and December 31, 2015. Post-IPSP (in which at least the first patient was enrolled) was designated as the time period between January 1, 2016 and December 31, 2017. Patients who were under the age of 18 years, discharged to hospice, received psychiatric or rehabilitative services, and prisoners and patients with international addresses were excluded [30]. This yielded a total of 574 (278 in pre-IPSP; 296 in post-IPSP) patients who completed both the HCAHPS and CG CAHPS survey. For comparison purposes, there were a total number of 1030 (630 TKAs, 400 THAs) and 1111 (648 TKAs, and 463 THAs) total joint arthroplasty procedures performed during the pre-IPSP and post-IPSP periods, respectively.

Interactive patient-provider software platform

The use of an IPSP involved the active enrollment of patients who were scheduled for lower extremity arthroplasty (TKA or THA) at a single institution. Between January 1, 2016 and December 31, 2017, 100% of patients were enrolled in an IPSP with an approximate 70% engagement. Patient-IPSP engagement started once the patient activated a link that was emailed from their respective surgeons. All patients were given an account that could be accessed through the Internet or by downloading the IPSP app (IOS only). A series of questions that tethered to proprietary alert algorithms were given to patients during the postoperative period. Such questions screened for deep venous thrombosis, pulmonary embolism, cellulitis/superficial surgical site infection, fever, or acute joint infection. Responses that may be concerning were automatically flagged and given to the provider (surgeon and midlevel). Health-care providers (all midlevels and surgeons) were also alerted to questions posed by patients and are given the opportunity to respond directly to the patient through the application portal. Patient communications were based on the plan of care prepared by the surgeons and multidisciplinary team. Starting from 21 days before surgery, patients received messages daily to help them prepare for surgery. Postoperatively, patients received scheduled

Table 2
Comparison of pre- and post-IPSP patient satisfaction scores, readmission and complication rates.

Variable	Pre-IPSP	Post-IPSP	*P*-value	95% CI for difference
Mean overall CGAHPS score (standard deviation)	89.21 (5.59)	97.40 (5.08)	<.001	−9.07 to −7.31
Median overall HCAHPS score (interquartile range)	9.00 (0.75)	10.00 (1.00)	<.001	N/A[a]
Readmission rates	0.30%	0.18%	.322	N/A[a]
Complication rates	17.30%	11.20%	.035	N/A[a]

[a] Not applicable for statistical analysis.

Table 3
PG (HCAHPS) domain responses.

Domain	Pre-IPSP (%)	Post-IPSP (%)	*P*-value
Communication with nurses	90	93	.367
Responsiveness of staff	82	81	.967
Communication with doctors	71	89	<.001
Hospital environment	82	83	.483
Pain management	83	84	.221
Communication about medications	92	91	.527

This table reports on the percentage of patients who gave a score of “4” (domain score range from 1 to 4).

messages aimed at screening for common surgical complications (ie, pulmonary embolism, deep vein thrombosis, and so forth). This extended until 17 days after surgery. Aside from daily reminder messages, patients, surgeons, nurses, and other members of the care team engaged in communication pertaining to care and patient concerns.

End point variables

Patient satisfaction was measured using HCAHPS and CG CAHPS survey scores. The HCAHPS survey is a validated survey used by the CMS to determine patient perception of care. At our institution, this survey is administered via PG to all patients with an approximate response rate of 27% after hospital discharge. Patients with a primary diagnosis of a psychiatric episode were not given the survey to fill. Alternatively, CG CAHPS surveys were given to all patients at clinics. At our institution, we have been able to attain a response rate of 33% to all CG CAHPS surveys. For this study, we used data from patients who completed a CG CAHPS survey during a pre-surgery clinic visit and HCAHPS (PG) survey after surgery.

Complications were counted as all procedure-specific adverse events from the date of surgery through 90-days postoperatively [31]. In addition, patient readmissions were counted as all-cause readmissions related to the indexed surgical procedure within 90 days.

Statistical analysis

An independent sample t-test/Mann-Whitney U test and chi-squared analysis/Fisher exact test were conducted to assess continuous and categorical variables. A 2-tailed *P*-value threshold of .05 was set as the threshold for statistical significance. All statistical analyses were performed using SPSS version 25 (IBM Corp., Armonk, NY).

Results

Patient demographics

Demographical analyses demonstrated no significant difference between the 2 time measurement points with respect to age ($P = .162$), body mass index ($P = .215$), gender ($P = .119$), TKA/THA ratio ($P = .831$), and Charlson comorbidity index ($P = .673$) (Table 1).

Patient satisfaction

T-test and Mann-Whitney U testing revealed an improvement in mean CG CAHPS scores (89 vs 97; $P < .001$) and median HCAHPS scores (9 vs 10; $P < .001$) when comparing pre-IPSP and post-IPSP time points (Table 2). HCAHPS subcategorical analysis demonstrated a statistically significant increase in the percentage of patients giving a rating of “4” (range 1 to 4) in the “communication with doctors” domain between the 2 time periods (71 vs 89%; $P < .001$) (Table 3).

Table 4
Differences in rates of complications between the 2 time periods.

Complication[a]	Pre-IPSP	Post-IPSP	*P*-value
Abduction contracture	1	1	.999
Hematoma/seroma	7	6	.783
Peripheral nerve palsy	4	1	.202
Knee arthrofibrosis[b]	3	2	.677
Heterotopic ossification	4	4	.612
Infection	1	1	.999
Trochanteric bursitis	9	8	.884
Wound dehiscence	0	2	.999
Periprosthetic fracture	1	1	.999
Hip dislocation	1	2	.999
Severe pain requiring Emergency room/unscheduled clinic visit	12	3	.026
Cellulitis	5	2	.398

[a] Count data.
[b] Range of motion of 90° or less.

Complication rates

Chi-square analysis demonstrated a significant decrease in the rates of short-term reportable (90-day) complications (17.3 vs 11.2%; $P = .035$) (Table 3). Further stratification for complications revealed a statistically significant decrease in severe pain requiring unscheduled/emergency room visit between the 2 years (1.7% to 0%; $P = .026$) (Table 4). There were no differences in time till complication between the 2 periods (Table 5).

Readmission rates

Between January 1, 2014 and December 31, 2015 (pre-IPSP), there were a total of 10 readmissions from all patient eligible discharges (0.30%) vs a total of 6 readmissions between January 1, 2016 and December 31, 2017 period (post-IPSP; 0.18%). Analysis of rates reported no significant difference in readmission rates between the 2 time points ($P = .322$) (Table 2).

Discussion

The CMS has developed a series of reimbursement models targeted at optimizing value of care [32,33]. These models employ quality adjustors meant to modify reimbursement based on value. As such, there is an increasing interest in adjustable provider and patient factors to improve patient satisfaction, while decreasing the number of readmissions and complications that occur during the risk-bearing period. This study assessed the effect of implementing an IPSP on patient experience of care metric scores, 90-day complication rates, and 90-day readmission rates at a single high-volume institution. Our findings demonstrated that the use of this tool was instrumental in improving patient satisfaction scores and reducing 90-day complication rates at a single institution.

The improvements in patient perception of care scores with the use of IPSP may reflect a connection between patient-provider communication and patient satisfaction. In a retrospective study (level of evidence III) entailing 3123 inpatient stays at a general medicine service, Clever et al. [34] reported a positive correlation between “attending total communication score” and patient satisfaction ($B = 0.58$; $P < .001$). Similarly, in a retrospective study on 692 THA patients, Delanois et al. [19] (level of evidence III) reported a positive association between patient communication with care providers (1. nurses: $\beta = 0.373$, $P < .001$; 2. physicians $\beta = 0.236$, $P = .002$) and overall hospital rating in women patients.

Table 5
Mean time till complication (in days).

Complication (standard deviation)[a]	Pre-IPSP (d)	Post-IPSP (d)	*P*-value	95% CI for mean difference
Abduction contracture	26.00 (N/A)	31.00 (N/A)	N/A[a]	N/A
Hematoma/seroma	11.29 (8.04)	12.83 (7.83)	.732	−11.27 to 8.18
Peripheral nerve palsy	87.25 (2.50)	85.00 (N/A)	N/A	N/A
Knee arthrofibrosis	82.67 (4.16)	85.00 (2.83)	.511	−12.43 to 7.76
Infection	14.00 (N/A)	14 .00 (N/A)	N/A	N/A
Trochanteric bursitis	11.33 (4.53)	11.13 (4.32)	.924	N/A
Wound dehiscence	N/A	12.00 (N/A)	N/A	N/A
Periprosthetic fracture	82.00 (N/A)	33.00 (N/A)	N/A	N/A
Hip dislocation	68.00 (N/A)	61.50 (9.19)	N/A	N/A
Severe pain requiring emergency room/unscheduled clinic visit	43.00 (12.25)	41.33 (20.01)	.901	−42.99 to 46.32
Cellulitis	11.40 (2.79)	13.00 (1.41)	.373	−6.01 to 2.81

N/A, not applicable.
[a] N/A due to low count.

Furthermore, frequent reminders and automated questions tailored towards the patient's surgical intervention allowed for providers to optimize both patient compliance and address patients with concerning postoperative symptomatology. As such, unplanned readmissions were reduced between the pre- and post-IPSP groups; albeit this decrease was not statistically significant. Still, the link between provider-patient communication and the likelihood of readmission has been previously reported. In a retrospective study (level of evidence III) on 1000 patients, Auerbach et al. [35] reported that lack of discussions about care goals among patients with serious illnesses were among the most strongly associated factors for 30-day readmission (adjusted odds ratio [OR], 3.84; 95% confidence interval [CI], 1.39-10.64). In another retrospective study (level of evidence III) that reported on 24,868 patients, Kemp et al. [36] demonstrated a higher likelihood of readmission among patients who felt that they were not involved in their care decisions (OR = 1.79; 95% CI, 1.59-2.01), as well as patients who did not receive written information at discharge (OR = 1.96; 95% CI, 1.83-2.11).

The reduction in complication rates seen in our study may be due to increased patient compliance to postoperative protocols, which was augmented by increased provider-patient interaction [37,38]. This association between patient communication and preventable adverse events has been described by Barlett et al. [39] (level of evidence III). In their study involving a total of 2355 patients who were discharged from an acute care setting, the authors reported that patients with communication problems were more likely to have a preventable adverse event (OR 3.00; 95% CI, 1.43-6.27). Similarly, in a retrospective study (level of evidence III) on 109,974 patients, Gallardo et al. [40] revealed a 34% decrease in odds of acquiring a health care–associated infection in patients with a HCAHPS measure of “communication about medicines” 10 percentage points higher than the mean.

There were several limitations that existed in this study. This study is retrospective in nature and thus falls short in comparison to prospective randomized clinical control trials. In addition, this study was limited to patients who completed the HCAHPS and the CG CAHPS survey. Therefore, this may have led to selection bias, as we were unable to assess patient satisfaction in patients who did not complete a survey. However, a minimum sample of 30 surveys are purported to be necessary for statistical validity and to be an adequate representation of patient satisfaction [41]. Furthermore, the discrepancy between the patient engagement period for IPSP (21 days preoperatively to 17 days postoperatively) and our 90-day postoperative window for our study end points indicates that the use of IPSP may not fully explain the reduction in rates of readmission. In addition, due to the retrospective nature of our study, we were unable to assess whether the use of IPSP resulted in interventions or preventions of complications. This analysis would require a prospective study to follow the process in real time and collect data on interventions used during study duration. Also, there may have been some disparity between survey completion and experiencing a complication or readmission. Furthermore, the difference we noted in both CG CAHPS and HCAHPS scores may have varying effects based on provider demographical region. However, with increasing competition to improve care metrics, small differences may lead to larger effects on reimbursement as time progresses [19,42-45]. Despite these limitations, this study is the first of its kind and demonstrates the benefit of utilizing an IPSP in the quest to improve value of care.

Conclusions

The present study demonstrates improved value of care delivery with the use of IPSP at a single high-volume arthroplasty center. As the shift away from fee-for-service models continue, arthroplasty surgeons may further align themselves with the CMS's goals by identifying factors in which to improve their value of care. An emerging use of technological platforms to optimize provider-consumer satisfaction has long warranted an investigation of its use in medicine. Through optimizing patient-provider communication and stimulating patient active engagement in their care, arthroplasty surgeons may maximize both patient satisfaction while reducing readmission and complication rates. Large multicentered prospective trials are needed to address some of the limitations present in this study. Specifically, future prospective studies should evaluate the direct effects of IPSP on patient satisfaction, clinical outcomes, and complications in patients undergoing TKA or THA.

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