Arthroplasty Today xxx (2017) 1–4

Contents lists available at ScienceDirect

Arthroplasty Today

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

Original research

Can an arthroplasty risk score predict bundled care events after total joint arthroplasty?

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ARTICLE INFO

Article history:
Received 20 February 2017
Received in revised form
5 June 2017
Accepted 15 July 2017
Available online xxx

Keywords:
Bundled payments
Risk stratification
Arthroplasty

ABSTRACT

Background: The validated Arthroplasty Risk Score (ARS) predicts the need for postoperative triage to an intensive care setting. We hypothesized that the ARS may also predict hospital length of stay (LOS), discharge disposition, and episode-of-care cost (EOCC).
Methods: We retrospectively reviewed a series of 704 patients undergoing primary total hip and knee arthroplasty over 17 months. Patient characteristics, 90-day EOCC, LOS, and readmission rates were compared before and after ARS implementation.
Results: ARS implementation was associated with fewer patients going to a skilled nursing or rehabilitation facility after discharge (63% vs 74%, $P = .002$). There was no difference in LOS, EOCC, readmission rates, or complications. While the adoption of the ARS did not change the mean EOCC, ARS >3 was predictive of high EOCC outlier (odds ratio 2.65, 95% confidence interval 1.40-5.01, $P = .003$). Increased ARS correlated with increased EOCC ($P = .003$).
Conclusions: Implementation of the ARS was associated with increased disposition to home. It was predictive of high EOCC and should be considered in risk adjustment variables in alternative payment models.

Introduction

The number of total joint arthroplasties (TJAs) performed continues to rise, and due to the progress in modern medicine, older patients with more medical comorbidities are now among those undergoing TJA [1,2]. Despite TJA being widely regarded as a safe, successful surgery with excellent patient outcomes, complications can occur [3-6]. Additionally, surgeons and hospitals are increasingly focused on optimizing perioperative care following TJA given the rise in value-based payment strategies, which include episode-of-care and bundled payment models. Alternative payment models aim to provide quality care in a cost-efficient manner by homing in on hospital length of stay (LOS), discharge disposition, and readmission rates. However, current reimbursement schemes do not account for variability in patient and technical factors. Initial hospital stay costs may be significantly increased based on patient comorbidities and if a revision surgery is performed [7,8]. Moreover, postdischarge costs and readmissions still make up the majority of the total episode-of-care costs (EOCC) [9].

At our institution, Kamath et al developed the Arthroplasty Risk Score (ARS), a model based on preoperative risk factors, which was implemented as a quality improvement initiative but then showed that mortality and unplanned intensive care unit (ICU) admissions could be reduced by stratifying patients undergoing elective THA [10-12]. Further work and iterations of the quality improvement intervention identified medical comorbidities associated with increased likelihood for requiring critical care, and the group noted that intraoperative factors may be more important than preoperative factors in this estimation [10-12]. The ARS was shown to accurately predict the need for postoperative triage to an intensive care setting. Given that the preoperative and intraoperative factors

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.2017.07.005.

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http://dx.doi.org/10.1016/j.artd.2017.07.005
2352-3441/

utilized in the ARS also relate to elements of care within bundled care systems, our group questioned if the ARS would have utility in anticipating health resource utilization. In the current healthcare economic milieu, it is increasingly important to stratify patients to bundled care and nonbundled care payment systems in order to be cost effective while still providing optimal patient care. Our hypothesis is that the ARS could be applied to predict hospital LOS, discharge disposition, and total EOCC.

The primary purpose is to study whether the adoption of ARS at our institution for risk stratification resulted in decreased LOS, change in discharge disposition, and decline in readmission rate. A secondary objective of the study included whether the ARS model resulted in decreased EOCC. We also sought to identify potential independent risk factors for high EOCC.

Material and methods

We retrospectively reviewed a consecutive series of 704 patients undergoing primary total hip and knee arthroplasty procedures within a single high-volume academic institution from October 2013 to March 2015. This study was approved and conducted per guidelines set by our institutional review board. No outside funding was received for this study. Patients undergoing arthroplasty procedures for fracture or malignancy, as well as those patients under the age of 18 years, were excluded from the study. From October 2013 to September 2014, patients were triaged to the orthopedic floor or to the ICU postoperatively based on our previously published risk stratification protocol [10]. Patients with 2 or more of the following risk factors were sent to the ICU postoperatively: age >75 years, body mass index (BMI) >35 kg/m^2, revision arthroplasty, creatinine clearance <60 mL/min, and history of coronary artery disease. After September 2014 until March 2015, patients were triaged to the ICU postoperatively if they had 3 or more points on the ARS scale, which included history of cardiac disease, chronic obstructive pulmonary disease, renal disease, BMI >35 kg/m^2, intraoperative vasopressors, and estimated blood loss >1 L [10-12].

Before surgery, all patients underwent preoperative evaluation and medical optimization by a single group of internists and were co-managed by the same group throughout the duration of their inpatient stay. This group confirmed all medical comorbidity diagnoses used in this study. Patient demographics and risk factors were identified and entered into our institution's arthroplasty database. These comorbidities and variables included a history of cardiac, chronic obstructive pulmonary, and renal disease; BMI and intraoperative vasopressor use; and estimated blood loss >1 L. Comorbidities required to calculate the Charlson Comorbidity Index (CCI), as defined by the original paper, were also recorded [13].

We also recorded LOS, readmission rate, discharge disposition, and postoperative complications within 90 days of surgery. Complications were defined and graded per a published definition [14]. Grade I complications not requiring intervention were excluded from the study. EOCC data were collected by our third party bundled convener and standardized to CMS costs from the date of surgery until 90 days postoperatively.

Statistical analysis

An *a priori* power analysis was first performed to determine the appropriate sample size. Our primary outcome measure was to determine whether adoption of the ARS model resulted in decreased EOCC. Based on prior published data [15] on mean CMS costs, to detect a $3000 difference in EOCC, we would need to enroll a total of 352 patients to achieve a power of 0.80 assuming at type I error rate of 0.05. Statistical analysis was first performed comparing those patients who were risk stratified per the ARS and those who were not. Binary and categorical variables between the 2 groups were analyzed using a chi-square test. When expected variables were <5, we employed the Fisher's exact test. Continuous variables such as age and BMI were analyzed with the Student's *t*-test. The level of statistical significance was set at $P < .05$. Patient demographics, medical comorbidities, 90-day EOCC data, LOS, and readmission rates were compared between groups before and after implementation of the ARS tool in September 2014. To control for confounding variables, multivariate logistic regression analysis was then performed on all 704 patients to identify the independent effect of the ARS on patients in the upper quartile of EOCC at our institution ($31,804).

Results

We found no differences in the patient characteristics of the pre-ARS ($n = 410$) versus post-ARS ($n = 294$) groups in terms of age, BMI, household income, or ethnicity (Table 1). There were 260 men and 444 women with a mean age of 69 years (range 26-95). The mean BMI was 30.94 kg/m^2 (range 14.47-70.600). Mean EOCC was $28,342.80 ($11,381.23-$191,045.80) in the pre-ARS cohort and $28,995.26 in the post-ARS cohort (range $14,222.15-$140,449.30) (Table 1). Mean LOS was 3.61 days (range 1-19) in the pre-ARS group and 3.86 days (range 1-2) in the post-ARS group. The mean ARS score in the pre-ARS group was 1.49 (range 0-6) and 1.42 in the post-ARS group (range 0-6) (Table 1).

After institution of the ARS, the number of ICU admissions decreased from 70 patients to 36 patients over the study period (17% vs 12%, $P = .077$) (Table 2). Of these ICU patients, the proportion of patients discharged to rehab decreased from 100% to 83% ($P = .001$). Among the subset of ICU patients, there was no difference between the pre-ARS and post-ARS groups with respect to mean age (71.2 vs 74.5 years, $P = .105$), mean BMI (31.5 vs 30.7, $P = .640$), mean CCI (3.0 vs 2.7, $P = .611$), or the proportion of female

Table 1
Summary of the characteristics of pre-ARS and post-ARS implementation groups.

Characteristic	Post-ARS	Pre-ARS	*P* value
Mean age (y)	69.27	69.35	.921
Gender (%)			
Female	58.16	66.10	.031
Male	41.84	33.90	.031
Mean BMI (kg/m^2)	30.78	31.22	.450
Mean length of stay (d)	3.86	3.61	.133
Mean household income in ZIP code of residence (USD)	62,557.36	63,001.45	.837
Bottom quartile of median household income (%)	22.10	21.46	.837
Mean episode of care costs (USD)	28,995.26	28,342.80	.590
Mean index inpatient admission costs (USD)	12,387.86	12,321.12	.839
Mean postdischarge rehabilitation costs (USD)	1929.04	17,093.15	.633
Mean home-health costs (USD)	2667.72	2850.28	.131
Mean postdischarge outpatient care (USD)	841.34	834.93	.947
Ethnicity (%)			
White	69.73	67.32	.497
Non-White	30.27	32.68	.497
Mean CCI	2.25	2.02	.329
CCI 3 or greater (%)	27.89	26.10	.596
Mean ARS	1.42	1.49	.498
ARS >3 (%)	5.78	6.83	.575
In-hospital complication (%)	26.87	27.07	.952
Discharge disposition (%)			
Home	37.10	26.30	.002
Skilled nursing or rehabilitation facility	62.90	73.70	.002
Surgery (%)			
Knee arthroplasty	50.00	53.41	.371
Hip arthroplasty	50.00	46.59	.371