

Characterizing Patient Preferences Surrounding Total Knee Arthroplasty

John M. Reuter, MS, Carolyn A. Hutyra, BS, Cary S. Politzer, BS, Christopher C. Calixte, BS, Daniel J. Scott, MD, MBA, David E. Attarian, MD, and Richard C. Mather III, MD, MBA

Investigation performed at the Duke University Health System, Durham, North Carolina, and EmergeOrtho, Durham, North Carolina

Background: Episode-based bundled payments for total knee arthroplasty emphasize cost-effective patient-centered care. Understanding patients' perceptions of components of the total knee arthroplasty care episode is critical to achieving this care. This study investigated patient preferences for components of the total knee arthroplasty care episode.

Methods: Best-worst scaling was used to analyze patient preferences for components of the total knee arthroplasty care episode. Participants were selected from patients presenting to 2 orthopaedic clinics with chronic knee pain. They were presented with descriptions of 17 attributes before completing a best-worst scaling exercise. Attribute importance was determined using hierarchical Bayesian estimation. Latent class analysis was used to evaluate varying preference profiles.

Results: One hundred and seventy-four patients completed the survey, and 117 patients (67%) were female. The mean age was 62.71 years. Participants placed the highest value on surgeon factors, including level of experience, satisfaction rating, and complication rates. Latent class analysis provided a 4-segment model of the population.

Conclusions: This study demonstrated differences in patient preferences for the components of a total knee arthroplasty care episode and characterized distinct preference profiles among patient subsets. Stakeholders can use this information to focus efforts and policy on high-value components and to potentially create customized bundles guided by preference profiles.

Clinical Relevance: This study is clinically relevant because the patient preferences identified here may help providers to design customized bundles for total knee arthroplasty care.

Bundled payments are among several alternative payment models proposed in response to the increasing rates and economic burden of total knee arthroplasty¹⁻⁷. Bundled payments incentivize value^{5,8-12}, defined as outcomes that patients deem important divided by cost^{12,13}.

Process standardization is cited as driving value in health care¹⁴, and reports of standardized joint replacement clinical pathways have noted improved outcomes at lower or maintained costs¹⁵⁻¹⁷. However, empirical economic theory finds that customization, particularly along defined patient profiles and preferences, may further increase value¹⁸⁻²¹, and patient-centeredness is acknowledged as a central tenet of health-care

reform^{22,23}. Understanding patient preferences for components of the total knee arthroplasty care episode may be an important step toward creating value-based experiences. Standardized pathways may be tailored on the basis of preferences, and multiple pathways could be developed after exhausting value gains from standardization.

Patient preferences can be measured using stated-preference methodology built on the utility theory²⁴. Best-worst scaling is one such method, grounded in the premise that the value a person places on one object compared with another is proportional to how often the person chooses it over the other²⁵. Originally deployed to measure consumer preferences as a shift from rating

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scales toward a choice-based methodology with valid theoretical foundations^{25,26}, best-worst scaling use in health care has recently increased substantially^{27,28}.

Best-worst scaling presents respondents with a series of attribute subsets from a master set²⁷. Respondents identify their most and least preferred items in each subset²⁷. From these selections, a person's attribute preference ranking is constructed²⁷.

The present study utilized best-worst scaling to assess patient preferences for aspects of total knee arthroplasty treatment. Prior studies evaluating preferences for perioperative total knee arthroplasty care²⁹⁻³² used ranking and rating scales, which can be cognitively demanding to participants and are subject to known limitations^{26,27,33}. Best-worst scaling accounts for many of these limitations, may be less cognitively demanding, and better simulates resource constraints by forcing participants to choose rather than deem all options important^{25-27,33}.

For this current study, a best-worst scaling exercise elicited patient preferences with regard to components of the total knee arthroplasty care episode, and latent class analysis identified preference-based subgroups of patients. Some of these components could be customized within total knee arthroplasty bundles, and analysis of respondent subgroups may offer insight into the creation of patient-specific care bundles.

Materials and Methods

This prospective study was reviewed and was approved by the Duke University institutional review board.

Patient Population

Patients who were 50 to 80 years of age and had chronic knee pain and/or arthritis were recruited. Patients were included even if they had already undergone total knee arthroplasty or were not presently considering it. All patients were seeking care for knee pain at the time of participation. Patients with prior total knee arthroplasty may have been seeking care for the replaced or non-replaced knee. No other exclusion criteria were used. Recruitment took place between August 2016 and March 2017 in joint reconstruction practices at Duke University Health System and EmergeOrtho. Multiple sites were included to improve external validity for generalizability of preferences. Sample size was determined on the basis of prior best-worst scaling studies^{28,34}. No personal health information was collected. Each participant completed the survey once either before or after seeing their physician.

Survey Design

The survey included 4 sections: demographic information collection, attribute education (information about and description of attributes), best-worst scaling exercise, and reflection questions. Demographic questions collected information such as age, sex, and knee pain history. The survey introduction is shown in Figure 1.

Best-Worst Scaling Design

An object case best-worst scaling exercise was used to determine the relative importance of the attributes³⁵. Participants

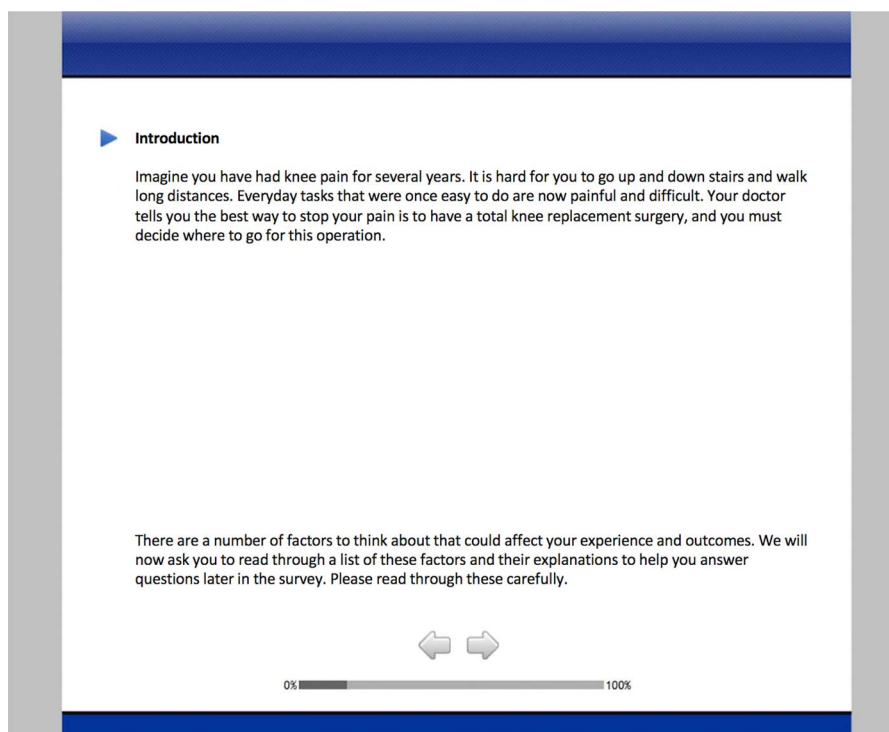


Fig. 1
Best-worst scaling survey introduction.

This is the Most Important factor in picking a hospital for surgery	This is the Least Important factor in picking a hospital for surgery
	Driving distance to hospital
X	Hospital satisfaction rating
	Instruments used to place knee implant
	Rehab options after surgery
	Hospital food quality X

Fig. 2
Example of a best-worst scaling choice task.

were randomly assigned to complete 1 of 300 potential questionnaire versions. All versions included the same content, but questions were ordered differently and contained different combinations of attributes. Each version contained 20 unique choice tasks with 5 attributes per task (Fig. 2). The instrument was programmed with Sawtooth Software version 8.2.0 (Sawtooth Software).

Attribute Identification

Stakeholder input and literature review were used to construct the initial attribute list. A panel of orthopaedic surgeons, health

economists, and health services researchers contributed to refine the initial list. The survey was then tested using Amazon’s Mechanical Turk, a web-based participant pool well studied and used in social sciences and recently utilized in orthopaedics³⁶⁻⁴⁰. Preference results and qualitative comments were used to further refine the attribute list. The survey was then similarly tested and was refined for another round using Amazon’s Mechanical Turk.

Next, the survey was administered to 5 members of the research group who were unfamiliar with the instrument. Structured interviews were conducted to assess clarity of information,

TABLE I List of Attributes and Corresponding Levels	
Attribute	Levels
Surgeon factors	
Surgeon level of experience	High volume, fellowship-trained surgeon; high volume, non-fellowship trained surgeon; moderate to low volume, non-fellowship trained surgeon
Surgeon satisfaction rating	5 stars, 3 to 4 stars, <3 stars
Surgeon complication rate	Low: 0% to 1.6%; medium: 1.6% to 3.0%; and high: >3.0%
Hospital factors	
Hospital satisfaction rating	4 to 5 stars, 3 stars, 1 star
Parking options	Valet parking, regular parking
Food quality	Standard meal; gourmet, healthy meal; or personalized meal
Driving distance to hospital	15 minutes, 1 hour, 3 hours
Implant factors	
Types of knee implant	Upgraded bearing surface, regular implant
Instruments used to place knee implants	Patient-specific instruments, standard instruments
Warranty for knee replacement surgery	Lifetime warranty, 1-year warranty, no warranty
Preoperative and postoperative period	
Rehabilitation options after surgery	Home health physical therapy, outpatient physical therapy, online or simulation physical therapy
Preoperative and postoperative appointment options	Appointments with a surgeon, appointments with a physician assistant and nurse, and appointments with a personal case manager after surgery only
Length of stay in hospital after surgery	Outpatient surgery or inpatient surgery
Wait time from clinic visit until surgery	<1 month, 2 to 3 months, or 3 to 6 months
Cost	
Out-of-pocket costs	\$200, \$1,000, or \$5,000
Referral	
Primary care physician’s referral	Referral or no referral
Family and friends’ experience with the institution	Positive experience or negative experience

TABLE II Whole-Sample Demographic Characteristics

Demographic Characteristic	Value
Age* (yr)	62.71 ± 7.50
Sex†	
Male	33 (57)
Female	67 (117)
Race†	
White	74 (128)
Hispanic or Latino	1 (2)
Black or African American	24 (42)
Native American or American Indian	0 (0)
Asian/Pacific Islander	1 (2)
Other	0 (0)
Marital status†	
Single	14 (25)
Married	67 (116)
Divorced	9 (16)
Widowed	7 (12)
Other	1 (2)
Did not answer	2 (3)
Education level†	
Did not complete high school	4 (7)
High school/GED (general equivalency development)	15 (26)
Some college	32 (55)
Bachelor's degree	29 (50)
Master's degree	14 (25)
Advanced graduate work or PhD	6 (11)
Not sure	0 (0)
Income level†	
<\$20,000	7 (12)
\$20,000 to \$39,999	12 (21)
\$40,000 to \$59,999	11 (19)
\$60,000 to \$79,999	15 (26)
\$80,000 to \$99,999	13 (22)
≥\$100,000	28 (49)
Not sure, prefer not to answer	13 (22)
Did not answer	2 (3)
Previous diagnosis of arthritis†	
Yes	82 (143)
No	18 (31)
Previous total knee replacement†	
Yes	34 (60)
No	66 (114)
How difficult was this survey to complete? †	
Not difficult at all	64 (114)
Somewhat difficult	22 (38)
Moderately difficult	13 (22)
Very difficult	0 (0)
Extremely difficult	0 (0)
Your opinion on the length of this survey†	
Too long	43 (75)
Too short	1 (1)
Just right	56 (98)
Time to complete survey* (min)	33.73 ± 0.47

*The values are given as the mean and the standard deviation. †The values are given as the percentage of respondents, with the number of respondents in parentheses.

response times, and perception of the list of attributes. The survey instrument and attribute list were refined again on the basis of these interviews.

The survey was then administered to 4 patients who fit the study's inclusion criteria. Formal, structured, qualitative interviews were conducted with the patients. Findings from these interviews were used to further refine the survey instrument and attribute list. Data from these participants were not included in the analysis.

The final list included 17 attributes describing various aspects of a total knee arthroplasty care episode (Table I). Defined attribute levels were not evaluated in the best-worst scaling design but were included in the patient education section to ensure information clarity. For example, to explain the attribute "wait time from clinic visit until surgery," participants were told that they could theoretically wait less than 1 month, 2 to 3 months, or 3 to 6 months from scheduling the surgical procedure until their surgical procedure date. "Less than 1 month," "2 to 3 months," and "3 to 6 months" would be the levels for the attribute "wait time from clinic visit until surgery." Levels were used in this survey to explain the attribute, but only attributes were presented to patients during the best-worst scaling exercise.

Statistical Analysis

Incomplete questionnaires were not analyzed. Descriptive statistics summarized demographic information. Hierarchical Bayesian estimations analyzed attribute importances, which were re-scaled to permit relative comparisons (i.e., an attribute with an importance of 12 is said to be twice as important as one with an importance of 6).

A latent class analysis was conducted to evaluate heterogeneity within the sample. Latent class analysis identifies groups of participants with similar preferences and produces a probability estimate. This estimate is the mean membership probability for each participant, quantifying his or her probability of belonging to each segment in the latent class analysis model⁴¹.

Models containing 2 through 10 segments were examined. The Consistent Akaike Information Criterion (CAIC) was primarily used to determine the most appropriate number of segments⁴². The CAIC plateaued from 4 (13,619.41) to 7 segments (13,619.68), indicating a reasonable fit for models with 4 to 7 segments. A 4-segment model was chosen because of the low CAIC and more fluid patient classification for clinicians. Chi-square tests and post hoc tests^{43,44} were used to assess demographic differences between segments. All analyses were performed using Sawtooth Software version 8.2.0 and SPSS version 24 (IBM).

Results

Demographic Characteristics

Two hundred and sixteen patients participated; 174 (81%) completed the questionnaire and were included in the final analysis. The mean respondent age (and standard deviation) was 62.71 ± 7.50 years. The majority of participants were white

Whole Sample Importances (Standard Deviation)



Fig. 3
Whole-sample importances. The importance value is written with the standard deviation in parentheses.

(74%), female (67% [$n = 117$]), married (67%), and not currently employed (49%), and had completed at least some college education (81%).

Our study also gathered information relevant to the total knee arthroplasty attributes. Twenty-six percent of participants reported familiarity with Hospital Consumer Assessment of Healthcare Providers and Symptoms (HCAHPS) ratings. Eighty-four percent of respondents reported previously using a family member or friend's recommendation to choose a physician. Fifty-six percent of patients selected outpatient physical therapy, rather than telerehabilitation or home-health physical therapy, as their preferred rehabilitation option. A demographic summary is presented in Table II.

Relative Importance of Attributes

Whole-sample attribute importances are presented in Figure 3. "Surgeon's experience level" (15.90), "surgeon's satisfaction rating" (14.32), and "surgeon's complication rate" (13.05) were the most important attributes. A comparison of mean importance ratings between those who had already undergone a total knee arthroplasty ($n = 60$) and those who had not ($n = 114$) showed similar profiles.

Latent Class Segmentation

Demographic analysis showed significant differences in race ($p = 0.003$), education level ($p = 0.001$), previous diagnosis of arthritis ($p = 0.014$), history of total knee arthroplasty ($p < 0.001$), ability to pay \$1,000 out-of-pocket ($p = 0.021$), and previous use of family or friends' referral for health-care providers ($p = 0.021$) between segments. Segment demographic characteristics are presented in Table III with by-segment attribute importances in Table IV. "Surgeon's experience level," "surgeon's satisfaction rating," and "surgeon's complication rate" were the 3 most important attributes in all segments except segment 3.

Segment 1

This segment contained 77 patients, 44% of the whole sample. The mean membership probability was 96.92%. Segment 1 preferences and demographic statistics best reflected the whole-sample results (Fig. 4).

Segment 2

Significantly more patients in segment 2 than in any other segment reported having completed advanced graduate education ($p = 0.03$). This segment contained 34 participants, 20% of the sample.

TABLE III Latent Class Segment Demographic Characteristics

Demographic Characteristics	Segment 1	Segment 2	Segment 3	Segment 4
Age* (yr)	62.04 ± 7.66	64.04 ± 7.05	60.68 ± 7.26	63.39 ± 7.11
Sex†				
Male	27.27 (21)	41.18 (14)	31.82 (7)	36.59 (15)
Female	72.73 (56)	58.82 (20)	68.18 (15)	63.41 (26)
Race†				
White	68.83 (53)	73.53 (25)	45.45 (10)‡	97.56 (40)‡
Hispanic or Latino	1.30 (1)	2.94 (1)	0.00 (0)	0.00 (0)
Black or African American	28.57 (22)	23.53 (8)	50.00 (11)‡	2.44 (1)‡
Native American or American Indian	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Asian/Pacific Islander	1.30 (1)	0.00 (0)	4.55 (1)	0.00 (0)
Other	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Marital status†				
Single	15.58 (12)	20.59 (7)	4.55 (1)	12.20 (5)
Married	63.64 (49)	64.71 (22)	77.27 (17)	68.29 (28)
Divorced	9.09 (7)	5.88 (2)	9.09 (2)	12.20 (5)
Widowed	7.79 (6)	8.82 (3)	4.55 (1)	4.88 (2)
Other	1.30 (1)	0.00 (0)	4.55 (1)	2.44 (1)
No answer	2.60 (2)	0.00 (0)	0.00 (0)	0.00 (0)
Education status†				
Did not complete high school	2.60 (2)	2.94 (1)	13.64 (3)‡	2.44 (1)
High school or GED (general equivalency development)	20.78 (16)‡	5.88 (2)	27.27 (6)	4.88 (2)‡
Some college	40.26 (31)‡	29.41 (10)	27.27 (6)	19.51 (8)
Bachelor's degree	27.27 (21)	26.47 (9)	13.64 (3)	41.46 (17)‡
Master's degree	7.79 (6)‡	20.59 (7)	18.18 (4)	19.51 (8)
Advanced graduate work or PhD	1.30 (1)‡	14.71 (5)‡	0.00 (0)	12.20 (5)
Not sure	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Income level†				
<\$20,000	9.09 (7)	5.88 (2)	9.09 (2)	2.44 (1)
\$20,000 to \$39,999	14.29 (11)	11.76 (4)	18.18 (4)	4.88 (2)
\$40,000 to \$59,999	15.58 (12)	5.88 (2)	13.64 (3)	4.88 (2)
\$60,000 to \$79,999	9.09 (7)	26.47 (9)	18.18 (4)	14.63 (6)
\$80,000 to \$99,999	14.29 (11)	8.82 (3)	9.09 (2)	14.63 (6)
≥\$100,000	22.08 (17)	29.41 (10)	13.64 (3)	46.34 (19)
Not sure, prefer not to answer	15.58 (12)	11.76 (4)	18.18 (4)	9.76 (4)
No answer	0.00 (0)	0.00 (0)	0.00 (0)	2.44 (1)
Previous diagnosis of arthritis†				
Yes	72.73 (56)‡	88.24 (30)	100.00 (22)‡	85.37 (35)
No	27.27 (21)‡	11.76 (4)	0.00 (0)‡	14.63 (6)
Previous total knee replacement†				
Yes	23.38 (18)‡	67.65 (23)‡	50.00 (11)	29.51 (8)‡
No	76.62 (59)‡	32.35 (11)‡	50.00 (11)	80.49 (33)‡
How difficult to pay \$1,000 out-of-pocket†				
Not difficult at all	33.77 (26)	35.29 (12)	31.82 (7)	56.10 (23)‡
Somewhat difficult	33.77 (26)	47.06 (16)	31.82 (7)	36.59 (15)
Very difficult	15.58 (12)	17.65 (6)	9.09 (2)	4.88 (2)
Extremely difficult, could not pay	14.29 (11)	0.00 (0)‡	22.73 (5)‡	2.44 (1)
No answer	2.60 (2)	0.00 (0)	4.55 (1)	0.00 (0)

continued

TABLE III (continued)

Demographic Characteristics	Segment 1	Segment 2	Segment 3	Segment 4
Use of family and friend referral†				
Yes	80.52 (62)	94.12 (32)	68.18 (15)†	90.24 (37)
No	19.48 (15)	5.88 (2)	31.82 (7)	7.32 (3)
No answer	0.00 (0)	0.00 (0)	0.00 (0)	2.44 (1)
Mean membership probability	96.92%	97.75%	99.07%	97.49%

*The values are given as the mean and the standard deviation. †The values are given as the percentage of patients in the segment, with the number of patients in parentheses. ‡Significant difference between segments.

The mean membership probability was 97.75%. Following the surgeon factors, “primary care physician’s referral” (13.40) and “family and friends’ experiences with the surgeon or institution” (10.02) were the most important attributes.

Segment 3

Significantly more patients in segment 3 than in any other segment identified as black or African American ($p < 0.001$) and reported “did not complete high school” as their highest level of education ($p = 0.01$). This segment contained 22 patients, 13% of the sample. The mean membership probability was 99.07%.

“Surgeon’s experience level” was the most valuable attribute, but with an importance of only 11.83. “Surgeon’s

satisfaction rating” was the second most valuable (10.97), followed by “rehabilitation options after surgery” (9.69) and “preoperative and postoperative appointment options” (8.29). “Surgeon’s complication rate” (6.50) appeared fifth.

Segment 4

Significantly more participants in segment 4 than in any other group identified as white ($p < 0.001$) and reported being able to pay \$1,000 out-of-pocket without difficulty ($p = 0.01$). This segment contained 41 participants, 24% of the sample. The mean membership probability was 97.49%. “Type of knee implant” (10.89) was the next most important attribute after the surgeon factors.

TABLE IV Latent Class Segment Attribute Rankings

Attribute Rankings	Importance			
	Segment 1	Segment 2	Segment 3	Segment 4
Surgeon’s experience level	17.14	17.75	11.83	17.51
Surgeon’s satisfaction rating	13.80	14.72	10.97	15.99
Surgeon’s complication rate	13.14	14.05	6.50	15.71
Type of knee implant	8.74	2.37	6.43	10.89
Out-of-pocket cost	8.17	3.99	5.24	1.49
Hospital’s satisfaction rating	7.65	4.92	8.23	9.41
Rehabilitation options after surgery	7.60	4.69	9.69	2.46
Warranty for knee replacement surgery	7.27	5.57	4.57	4.95
Instruments used to place knee implant	5.42	1.36	4.33	4.88
Primary care physician’s referral	2.80	13.40	3.44	1.65
Length of stay in hospital after surgery	2.75	2.01	6.07	2.09
Preoperative and postoperative appointment options	2.43	2.95	8.29	1.18
Family and friends’ experiences with the surgeon or institution	1.18	10.02	3.73	10.29
Wait time from clinic visit until surgery	1.16	1.31	3.93	1.05
Driving distance to hospital	0.53	0.55	3.38	0.23
Hospital parking options	0.15	0.19	2.16	0.14
Hospital food quality	0.07	0.16	1.24	0.10

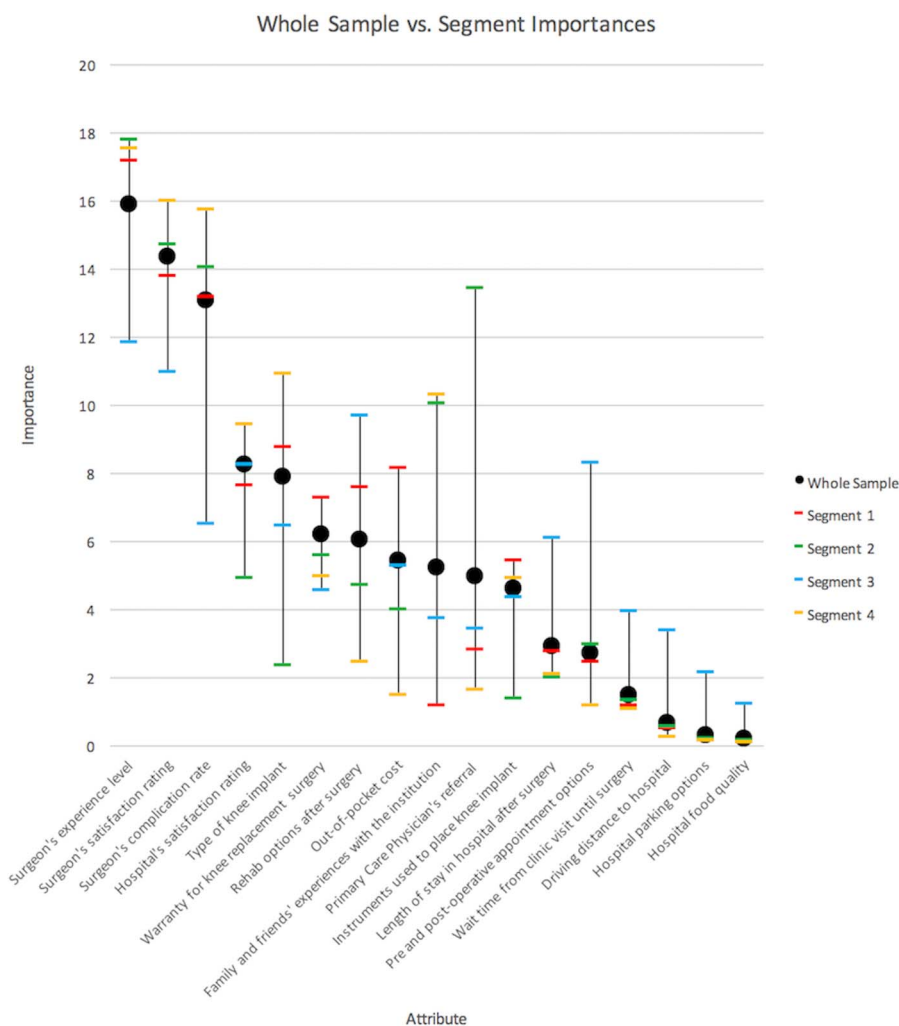


Fig. 4
Attribute importance values for the whole-sample and segment populations.

Discussion

Standardization of total knee arthroplasty care with episode-based reimbursement underscores a need to avoid unnecessary services and customize high-impact facets of treatment^{11,45,46}, and determining treatment aspects that patients value may be a pivotal step in this process. Previous studies examining total knee arthroplasty patient preferences have used rating and ranking methods, techniques with known biases and limitations^{26,27,33}. This current study used best-worst scaling, a preference measurement tool designed to move away from rating scales and toward a choice-based methodology with valid theoretical foundations^{25,26}.

Our whole-sample results generally agreed with the existing literature. Prior work demonstrated that surgeon characteristics, including surgeons' experience and perceived skill, are the most important factors to patients²⁹⁻³², which was reflected in our analysis. Earlier studies have described waiting time for the surgical procedure, distance to the hospital, reputation of the hospital, others' experiences, and hospital quality as being valuable to patients²⁹⁻³².

In our whole-sample analysis, such factors were valued well below surgeon factors.

Of note, "warranty for knee replacement surgery" was valued similarly to "hospital's satisfaction rating," the most valuable non-surgeon attribute, and well above non-surgeon factors such as driving distance and waiting time for the surgical procedure. If we assume converging equivalence in surgeon performance, a warranty was among the most significant factors to our participants. Warranties can be considered a natural extension of episode bundles, essentially expanding the episode while narrowing risk relative to traditional bundles. Warranties can be offered by various stakeholders, including device manufacturers, provider organizations, and payers.

These findings can guide the formation of episode-based bundled payment plans. Our patients distinctly expressed the desire to see a high-performing surgeon. This suggests that optimizing surgeon performance is the primary value driver from the patient perspective. Organizations should first focus on recruiting high-volume fellowship-trained surgeons and

working with their current surgeons to reduce complications. Organizations may then explore warranty packages for patients. Although not yet widely available, warranties have been used with cardiac procedures and have been evaluated for colon surgery^{47,48}. One study identified a potential 6% nationwide reduction in expenditures from a warranty⁴⁷, which, when combined with our patients' interest, offers an opportunity to create value.

Organizations can build on the core components of surgeon performance and a warranty and can produce greater value with customized offerings. The importance of understanding differences between patients when utilizing bundled payment plans has been noted⁴⁶. Our latent class analysis results confirmed our hypothesis of heterogeneity and begin to shape potential customized bundles. In particular, our latent class analysis suggested 2 segments for which customized bundles could create additional value: segment 3 with a "high-touch" bundle and segment 4 with a "high-tech" bundle.

In segment 3, "rehabilitation options after surgery" and "preoperative and postoperative appointment options" attained higher values than in any other attribute or in the whole sample. This segment had the highest percentage of African-American participants and reported a lower education level. We offer 2 explanations for these preferences in light of these demographic characteristics. First, prior studies have shown that less educated patients seek continuous care, preferring to work with the same providers throughout a clinical episode, and that African-American patients harbor greater mistrust for health systems than their white counterparts^{29,49-51}. It is possible then that these patients valuing choice in postoperative rehabilitation and preoperative and postoperative appointments indicates a desire to work continuously with their surgeon and therapists from the health system in which the surgical procedure was performed. This would satisfy a desire for continuous care and would allow these patients to develop trusting relationships with their providers and health systems. Second, minority patients have traditionally lacked access to care compared with white patients⁵²⁻⁵⁴. This segment's preference profile may be a response to this. These patients valuing choice in postoperative rehabilitation and preoperative and postoperative appointments may be an expression of their desire for improved access to care.

With regard to a customized bundle, this segment valued choice and communication during the postoperative period, a time highlighted by multiple authors as the largest source of variability in total knee replacement cost and an ideal venue in which to drive value^{5,9,11,46}. To realize this opportunity when working with populations similar to this segment, providers could offer a high-touch bundle. Such a model would include, in addition to being seen by a high-performing surgeon, consistent contact from the surgeon and care team, the ability to see the surgeon at postoperative appointments, and, if possible, therapy appointments within the health system in which the surgical procedure was performed. This could satisfy a desire

for continuous care, could build the patient-provider relationship, and could ensure access to care for patient populations previously shown to lack it, promoting a patient-centered experience.

Segment 4 placed more importance on the type of implant than any other segment or the whole sample, and this was their most valued attribute following the surgeon factors. A significantly greater number of patients in this segment than in any other segment reported having no difficulty paying \$1,000 out-of-pocket ($p = 0.01$). This preference and demographic profile may describe a segment with the means and willingness to acquire the best perceived technology possible. This is consistent with previous reports suggesting that >80% of patients would be willing to pay out-of-pocket for more sophisticated technology compared with a standard implant⁵⁵. This population may then be interested in a high-tech bundle that includes, in addition to being seen by a high-performing surgeon, a non-standard implant.

Segments 1 and 2 are less easily characterized. Segment 2 placed more value on referrals than other segments or the whole sample. One way to deliver value to a population interested in referrals would be through outreach strategies to establish referral networks between joint replacement specialists and primary care physicians. However, the most notable characteristic of this segment was a higher education level. Further analysis is needed to better identify patients to whom a referral-centered bundle might appeal.

This study had 3 primary limitations. First, in a best-worst scaling exercise, patients can only rate the attributes presented to them. Certain attributes identified in other research as important to patients facing knee replacement, largely related to patients' relationship with and subjective opinion of their surgeon, were not included in this study^{29,32}. These factors are not customizable aspects of a care episode and are beyond this current study's scope. Second, we did not exclude patients who already had undergone a total knee arthroplasty, so our sample did not perfectly represent patients considering total knee arthroplasty. However, the preference profiles between these groups did not vary notably, indicating that having experienced a total knee arthroplasty care episode did not dramatically change patients' preferences. Third, although latent class analysis produced distinct groups, we were limited in our ability to define them. For example, although the segment 2 preferences were distinct, we were unable to characterize the patients in that segment with the demographic and descriptive data that we collected. These preference differences may have stemmed from previous health-care experiences or factors not captured in our survey. Further analysis, including qualitative interviews, may be needed for further characterization.

In conclusion, this study used an established preference elicitation method to measure patient preferences for aspects of a total knee arthroplasty care episode. Latent class analysis characterized groups of patients according to their preferences. Providers may use this information when designing total knee

arthroplasty bundles to deliver patient-centered care. Further research may explore preference differences that we were unable to characterize. ■

John M. Reuter, MS¹
 Carolyn A. Hutyra, BS²
 Cary S. Politzer, BS²
 Christopher C. Calixte, BS²
 Daniel J. Scott, MD, MBA²
 David E. Attarian, MD²
 Richard C. Mather III, MD, MBA²

¹University of Rochester School of Medicine and Dentistry, Rochester, New York

²Department of Orthopaedic Surgery, Duke University School of Medicine, Durham, North Carolina

E-mail address for J.M. Reuter: JohnM_Reuter@URMC.Rochester.edu

ORCID iD for J.M. Reuter: [0000-0002-3279-6395](https://orcid.org/0000-0002-3279-6395)
 ORCID iD for C.A. Hutyra: [0000-0002-3541-1104](https://orcid.org/0000-0002-3541-1104)
 ORCID iD for C.S. Politzer: [0000-0001-6193-3806](https://orcid.org/0000-0001-6193-3806)
 ORCID iD for C.C. Calixte: [0000-0002-6995-2160](https://orcid.org/0000-0002-6995-2160)
 ORCID iD for D.J. Scott: [0000-0002-6996-9472](https://orcid.org/0000-0002-6996-9472)
 ORCID iD for D.E. Attarian: [0000-0002-7171-3935](https://orcid.org/0000-0002-7171-3935)
 ORCID iD for R.C. Mather III: [0000-0002-1525-7568](https://orcid.org/0000-0002-1525-7568)

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