


# Decision Aid Implementation and Patients' Preferences for Hip and Knee Osteoarthritis Treatment: Insights from the High Value Healthcare Collaborative

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**Background:** Shared decision making (SDM) research has emphasized the role of decision aids (DAs) for helping patients make treatment decisions reflective of their preferences, yet there have been few collaborative multi-institutional efforts to integrate DAs in orthopedic consultations and primary care encounters.

**Objective:** In the context of routine DA implementation for SDM, we investigate which patient-level characteristics are associated with patient preferences for surgery versus medical management before and after exposure to DAs. We explored whether DA implementation in primary care encounters was associated with greater shifts in patients' treatment preferences after exposure to DAs compared to DA implementation in orthopedic consultations.

**Design:** Retrospective cohort study.

**Setting:** 10 High Value Healthcare Collaborative (HVHC) health systems.

**Study participants:** A total of 495 hip and 1343 adult knee osteoarthritis patients who were exposed to DAs within HVHC systems between July 2012 to June 2015.

**Results:** Nearly 20% of knee patients and 17% of hip patients remained uncertain about their treatment preferences after viewing DAs. Older patients and patients with high pain levels had an increased preference for surgery. Older patients receiving DAs from three HVHC systems that transitioned DA implementation from orthopedics into primary care had lower odds of preferring surgery after DA exposure compared to older patients in seven HVHC systems that only implemented DAs for orthopedic consultations.

**Conclusion:** Patients' treatment preferences were largely stable over time, highlighting that DAs for SDM largely do not necessarily shift preferences. DAs and SDM processes should be targeted at older adults and patients reporting high pain levels. Initiating treatment conversations in primary versus specialty care settings may also have important implications for engagement of patients in SDM via DAs.

**Keywords:** shared decision making, patient engagement, patient preferences, quality of care, health systems, collaborative learning

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## Introduction

There is a growing interest in engaging patients to be more active participants in their own care through shared decision making (SDM), a collaborative approach to clinical decisions in which both physicians and patients contribute to conversations about the best treatment choice given patients' preferences and values.<sup>1</sup> Many studies indicate

that when patients are engaged in SDM, they not only become more knowledgeable about their conditions but they also experience less conflict about their treatment choices.<sup>2,3</sup> Moreover, patients who adopt active roles in their care experience improved clinical outcomes and are more likely to adhere to treatment plans.<sup>4</sup>

The use of patient decision aids (DAs) to facilitate SDM has been of growing empirical interest through policy initiatives that seek to advance the role of patients in medical decision-making. Although DAs – which often take the form of pamphlets, videos, or web-based programs – do not guarantee that SDM occurs, dozens of randomized trials have demonstrated that they are critical tools for facilitating SDM.<sup>5</sup> DAs are effective resources for improving patients' knowledge of their conditions and engaging them as decision makers alongside clinicians in treatment choices.<sup>3</sup> A 2017 Cochrane systematic review found a lower proportion of individuals reporting passive roles in decision-making among patients exposed to DAs compared with those not receiving DAs.<sup>6</sup> DAs are particularly valuable for conditions such as total hip and knee replacements where “there is a lack of clear evidence showing superiority of one treatment, and treatment choices vary in ways that may matter to patients”.<sup>7</sup>

DAs have been most widely tested among patients with knee and/or hip osteoarthritis because these conditions are highly preference sensitive, among the most commonly performed orthopedic procedures in the US, and increasingly costly procedures for commercially and publicly insured patients.<sup>8</sup> Initiating discussions about these tradeoffs critically shape patient awareness and expectations,<sup>9</sup> and DAs are especially well suited to initiate conversations about the possible benefits and risks associated with the complicated choice between arthroplasty and medical management.<sup>10</sup> Studies across clinical settings from orthopedic surgery<sup>11</sup> to mental health<sup>12</sup> underscore the role of DAs in facilitating decisional certainty, or confidence for a given patient to choose the most appropriate treatment choice.<sup>13</sup> Patients are less likely to experience regret or dissatisfaction when they feel supported and confident in their chosen treatment paths.<sup>14</sup> These factors underlie the importance of incorporating DAs into treatment trajectories for these patients.

Despite a growing body of research emphasizing the role of DAs in fostering alignment of patient preferences with treatment decisions,<sup>15,16</sup> there have been few large-scale efforts to integrate them into routine clinical practice. As a result, there is a dearth of evidence about treatment

preferences across patient subgroups in the context of routine implementation of DAs to support SDM, especially across diverse health systems.<sup>17</sup> Emerging research suggests that certain populations of patients might benefit from DAs to support shared decisions about treatment choices. DAs to support SDM may be especially helpful among older and comorbid patients for whom treatment tradeoffs in light of personal preferences may be especially complex,<sup>18–20</sup> and for whom improved treatment adherence and decision satisfaction is especially important in helping achieve better health outcomes for these vulnerable populations.<sup>21</sup> Additionally, the care context for shared decision making may also have important implications for conversations about treatment preferences. Previous work indicates that, on average, surgeons express the least support for SDM compared with other specialists.<sup>22</sup> Given the longitudinal nature of patients' relationships with primary care physicians,<sup>23</sup> conversations about treatment benefits and risks may be more helpful to treatment decisions when they occur upstream to a surgical consultation.

## Aim

This cohort study utilizes patient data collected from the High Value Healthcare Collaborative (HVHC) – a learning collaborative of health systems – that implemented DAs to support SDM for hip and knee osteoarthritis patients. We investigate which patient-level characteristics are associated with preference for surgery following exposure to DAs intended to support SDM in routine care settings. Within the first month of the project, three of the HVHC systems moved DA implementation from orthopedic consultations to primary care physician encounters because of concerns about implementation fidelity and wanted to focus on patients who are earlier in the treatment decision-making process.<sup>24</sup> Given variable implementation across the HVHC systems, we explore whether upstream implementation of SDM in primary care in three systems is associated with differing patient treatment preferences after exposure to DAs compared to the seven systems that implemented DAs within orthopedic practices.

## Hypotheses

SDM research highlights the importance of patient characteristics in influencing conversations about treatment preferences. Patient age, ethnicity, educational attainment as well as the patient's overall health status are hypothesized to shape treatment decisions when exposed to DAs as part of the SDM process.<sup>25</sup> Research concerning treatment choices for elective surgeries has highlighted a decline in preference for such surgeries with increasing patient age.<sup>26,27</sup> Patient concerns

about serious complications of surgeries, long recovery periods and the need to rely upon others to help with post-operative care are commonly cited explanations for older patients to choose more conservative treatment modalities.<sup>28</sup>

Hypothesis 1: Uncertain older adult patients (aged 65 years and older) will be less likely to report a post-DA preference for surgery compared with middle-aged (51–64 year old) hip and knee patients.

The relationship between high pain levels and shifts in treatment preferences remains an under-examined area. Patients reporting worse scores on one assessment of osteoarthritis severity and pain were more likely to have chosen surgery over medical management,<sup>29</sup> and knee osteoarthritis patients were more likely to choose surgical interventions when they reported more severe pain and greater functional limitations compared with patients reporting fewer impediments to activity and less pain.<sup>30</sup>

Hypothesis 2: Uncertain hip and knee patients who report worse pain scores will be more likely to report a preference for surgery post-DA intervention.

The intersection of comorbidity burden and decision-making for preference-sensitive conditions has been a topic of increasing investigation.<sup>31,32</sup> Longitudinal studies of hip and knee patients who underwent joint arthroplasties have noted a trend toward greater comorbidity burden among this group.<sup>33,34</sup> Current estimates suggest that almost one half of older adults live with three or more chronic conditions.<sup>18</sup> Multimorbidity adds complexity to conversations about trade-offs associated with treatment choices for preference-sensitive conditions like osteoarthritis, elevating the importance of tools such as DAs in helping to facilitate information exchange in light of patient values. In light of these complexities, we hypothesize that:

Hypothesis 3: Uncertain hip and knee patients with more comorbidities will be less likely to report a preference for surgery post-DA intervention.

We report methods and results in accordance with the Strengthening of Reporting in Observational Studies in Epidemiology (STROBE) guidelines for cohort studies.<sup>35</sup>

## Methods

### Study Setting and Participants

This retrospective cohort study leverages data collected from 10 High Value Healthcare Collaborative (HVHC)

systems between July 2012 to June 2015, when HVHC was awarded a Centers for Medicare and Medicaid Innovation (CMMI) grant to implement DAs to support SDM for patients considering surgery for hip or knee osteoarthritis.<sup>36</sup> This intervention was implemented in orthopedic specialty practices and was in most cases “triggered” by patients calling to make an appointment to discuss treatment options for hip or knee osteoarthritis. Patients viewed condition-specific DAs produced by Health Dialog that addressed the risks and benefits of surgery or medical management for hip or knee osteoarthritis and featured real patients as they discussed their experiences and satisfaction with their treatment choices. Health Dialog DAs have been widely utilized and acknowledged as providing balanced information on the benefits and tradeoffs of treatment trajectories for conditions including hip and knee osteoarthritis.<sup>37,38</sup> These DAs could be viewed online, on DVD, or on a tablet in the physician’s office prior to or following patients’ appointments. Health coaches, who were often trained nurses, were able to address questions that arose for patients viewing the DAs in-office.

Treatment preferences were assessed before and after DA exposure. Patients completed pre-DA surveys that assessed demographic information, pain scores, expectations for health outcomes and treatment preferences (surgical vs non-surgical vs unsure) before viewing DAs, while post-DA surveys assessed treatment preferences after DA viewing. These surveys were completed online if the patient viewed the DA at home or on tablets if DAs were viewed in the physician’s office. The Unified Data Extract – which includes system-reported clinical records – captured information such as ICD-9 codes used to construct Charlson comorbidity scores. Among 6544 hip and knee patients with both health records in HVHC’s Unified Data Extract and pre- and post-DA patient survey records, 1343 knee patients and 495 hip patients had complete pre- and post-DA surveys, resulting in an analytic sample of 1838 patients.

The overarching goals of the project were to improve the health status (as measured by pain and functioning) of patients considering hip and knee interventions, to increase the number of patients engaged in SDM, and to reduce rates of hip and knee surgeries not reflective of patient preferences.

### Data Sources

The HVHC Unified Data Extract enables analysis of inpatient and outpatient encounter-level data as well as ICD-9

diagnosis codes for hip and knee osteoarthritis patients.<sup>39</sup> The patient survey data include patient responses to questions assessing preferred treatment choices (before and after DA viewing) as well as patient-reported Hip Disability and Osteoarthritis Outcome Score (HOOS) and Knee Disability and Osteoarthritis Outcome Score (KOOS) pain scores.

We utilized likelihood-based imputation to derive values for patients with missing pain scores. For these analyses, the patient cohort is restricted to those with diagnoses of knee osteoarthritis (ICD-9 CM diagnostic codes 715.09, 715.16, 715.26, 715.36 or 715.96) or hip osteoarthritis (ICD-9 CM diagnostic codes 715.09, 715.15, 715.25, 715.35 or 715.95). All analyses were conducted in parallel for the hip and knee cohorts. The Dartmouth Institutional Review Board (IRB) approved a waiver of consent for this study as it would not adversely affect the rights and welfare of the subjects because: (1) data is stored in limited data sets (de-identified except for dates of service and ZIP codes) with direct patient identifiers stored in a separate location; and (2) data analysis covered under this study is for retrospective analysis only and the research could not practicably be carried out without the waiver of consent since the database houses only retrospective data across multiple health systems and obtaining consent would not be feasible for a population of this size. The HVHC Program Management Office can attest to the study upholding all principles relating to patient confidentiality, informed consent and IRB review in accordance with the Declaration of Helsinki.

## Measures

### Outcome

#### Treatment Preferences Post-DA Exposure

Patient treatment preferences are captured in the following question, asked before and after DA viewing: “At this time [before or after viewing the DA], what treatment are you leaning toward doing for your [hip/knee] pain?” The three response categories are: [hip/knee] surgery, non-surgical treatment, or not sure. We assessed preference for surgery by patients’ post-DA response.

### Independent Variables

We account for pre-DA exposure treatment preferences by including variables representing 1) uncertainty before exposure to the DAs, 2) whether patients report differences in treatment preferences before and after the DA (from uncertainty toward a preference, or from one preference to another), and 3) changes in decision making stage. To

assess decision making stage, patients were asked before and after DA viewing: “How far along are you with this decision?” Patients reported one of four categories: [1] “Not yet thought about all the options,” [2] “Considering the different options,” [3] “Close to choosing an option,” or [4] “Already chose an option.” We constructed an ordinal outcome, where shifts in decision stage are characterized as a decrease (moving down in the numbered response, i.e. from [3] to [2]), a stable response (the same numbered response reported before and after DA viewing), or an increase (moving up in numbered response).

The patient surveys assessed patient age and the Hip Disability and Osteoarthritis Outcome Score (HOOS) and Knee Disability and Osteoarthritis Outcome Score (KOOS). The HOOS and KOOS pain subscales, which consist of 10 and 9 items, respectively, were normalized on a 0–100 scale, where 0 indicates no pain and 100 indicates extreme hip or knee pain. The HOOS and KOOS surveys have been well validated and demonstrated to be reliable in assessing both short- and long-term pain relating to osteoarthritis.<sup>40</sup>

The Charlson Comorbidity Index (CCI) was calculated using encounter data to characterize the comorbidity burden of the hip and knee osteoarthritis patients included in our sample. The CCI is a continuous measure that weights the sum of 17 comorbid conditions.<sup>41</sup>

We control for patient sex, race/ethnicity, marital status, and education level in adjusted analyses. Prior literature exploring the association between patient characteristics and treatment decisions after SDM suggests that patient preferences for surgical interventions are influenced by patient sex, with females slightly more likely to express a tendency toward conservative (non-surgical) treatment options when compared with males.<sup>42,43</sup> A patient’s social support system – in particular having a spouse – also plays a notable role in patient decision-making. Spouses contribute another voice to the dialogue concerning treatment benefits and disadvantages at the same time that they often assume some responsibility for the patient’s ongoing care.<sup>44</sup> We control for patient race in light of research showing that non-white patients are less likely to choose surgery compared with white patients, possibly because of differing perceptions of risk-to-benefit ratios.<sup>11</sup> Patients with higher educational attainment may be more likely to actively engage in SDM than less well-educated patients.<sup>45</sup> To the extent that education serves as a marker of socio-economic (as well as insurance) status, these patients may also experience fewer financial impediments should they decide to pursue surgery.



## Statistical Analyses

Patient characteristics were compared by post-DA preference using chi-square analysis for dichotomous variables and analysis of variance (ANOVA) for continuous outcomes, with robust standard errors to account for patient clustering within systems. Due to small cell sizes for hip patients, some independent variable categories are collapsed differently than for knee patients (i.e. age categories for hip patients are Under 64 and 65+, while age categories for knee patients are Under 50, 50–64, and 65+).

We assessed the relationship between DA exposure and treatment preference for surgery across patient subgroups using multivariable logistic regression models that adjusted for patient-level control variables and health system fixed effects to account for patient clustering within systems. Likelihood-based multiple imputation incorporating all control variables was employed to address missing data from HOOS and KOOS pain scores across health systems.<sup>46</sup> Results were averaged across 5 imputed data sets.

To explore whether upstream implementation in primary care across three systems is associated with shifts in the relationship between patient-level variables and post-DA treatment preferences compared with the full sample of patients across all HVHC systems, we restricted the analyses to the three systems.

## Results

Descriptive statistics for the knee and hip patients across all HVHC systems are reported in Table 1. The mean age among knee patients was 59.3 years (SD = 9.6); among hip patients, it was 58.5 years (SD = 10.1). Across condition and preference categories, patients under the age of 65 comprised a larger segment of the study population compared with older patient (over 70% of the hip and knee patient populations, respectively). The majority of patients were female (64.5% among knee patients and 56.2% among hip patients) and Caucasian (82% of both knee and hip patients). The mean Charlson Comorbidity Index (CCI) across hip and knee patients was less than 2 (1.40 among hip patients and 1.38 among knee patients).

Whereas less than half (48%) of the entire sample of knee patients expressed a post-DA preference for surgery, 63% of hip patients preferred surgery after exposure to DAs. Among hip patients, 4.4% went from an uncertain preference to a preference for surgery, while half that number (2.2%) of hip patients switched from an uncertain preference to a preference for non-surgical intervention.

Similarly, among the knee cohort, 4.1% of patients went from an uncertain preference to a preference for surgery. A slightly higher number of knee patients (5.3%) compared with hip patients switched from an uncertain preference to a preference for non-surgical intervention. Notably, the majority of knee (84.5%) and hip patients (88.5%) maintained stable preferences both pre- and post-DA exposure.

In adjusted analyses of post-DA treatment preferences (reported in Table 2), knee patients aged 65 and older had lower odds of choosing surgery after DA exposure compared with patients aged 50–64 (OR = 0.79,  $p = 0.4$ ). Hip patients aged 65 and older, however, had slightly higher odds of choosing surgery after DA exposure compared with younger patients (OR = 1.03,  $p = 0.9$ ). Thus, we only find partial support for our first hypothesis, as neither of these results attained statistical significance at the  $p < 0.05$  level. Hip and knee patients with worse pain scores had somewhat greater odds of choosing surgery post-DA relative to patients reporting less pain, supporting our second hypothesis (OR = 1.05,  $p < 0.01$  and OR = 1.04,  $p < 0.01$ , respectively). We find lower odds for knee patients with high Charlson comorbidity scores reporting a preference for surgery post-DA (OR = 0.93,  $p < 0.01$ ), but no such relationship for hip patients, thus not supporting our third hypothesis.

Results examining hip and knee patient treatment preferences among the three upstream implementing HVHC systems are reported in Table 3 ( $n = 75$  and  $n = 246$ , respectively). One notable difference with primary analysis findings concerns knee patients aged 65 and older who had 42% lower odds of preferring surgery post-DA compared with patients 64 years of age and younger (compared with 21% reduced odds of choosing surgery in the full sample of knee patients). The association between pain and comorbidity with treatment preferences is similar to findings in the main analysis, but with larger odds ratios.

## Discussion

In a collaborative multi-system implementation of DAs, we found that patient characteristics were associated with patient preferences for surgery for hip and knee osteoarthritis. Hip and knee patients reporting high levels of pain were most likely to have preferences for surgery post-DAs. Notably, a greater proportion of knee patients than hip patients reported increased certainty for their treatment preference after completing DAs (13% vs 20%). These findings are consistent with what has been reported in

**Table I** Descriptive Statistics for DA Exposed Knee and Hip Patients Across All HVHC Systems

	Knee (N = 1343)		Hip (N = 495)	
	N	% of Column Total	N	% of Column Total
<b>Age (Mean, SD)</b>	59.3 (9.6)		58.5 (10.1)	
<b>Gender</b>				
Female	869	64.7	278	56.1
Male	474	35.3	217	43.8
<b>Race (vs White)</b>				
Non-White/Other	358	26.7	85	17.1
White	985	73.3	410	82.8
<b>Marital Status</b>				
Unmarried	591	44	200	40.4
Married	752	56	295	59.6
<b>Pre-DA Uncertain</b>	384	28.6	117	23.6
<b>Switched Preference Post-DA (from pre-DA choice)</b>				
Uncertain to Surgical	55	4.1	22	4.4
Uncertain to Non-Surgical	71	5.3	11	2.2
Other†	82	6.1	24	4.8
Stable Preferences††	1135	84.5	438	88.5
<b>Decision Making Stage Post-DA</b>				
Increase	262	19.5	63	12.7
Stable	971	72.3	396	80
Decrease	85	6.3	29	5.9
<b>Charlson Comorbidity Index (Mean, SD)</b>	1.38 (2.00)		1.40 (2.79)	
<b>Pain Score (HOOS or KOOS)</b>	52.7 (18.5)		54.8 (19.8)	
<b>Education Level</b>				
Less than/Graduated High School/GED	389	29	110	22.2
Some College/Graduated from College	699	52	277	56
Postgraduate Education	255	19	108	21.8

**Notes:** † Other includes patients switching from a surgical or non-surgical preference to uncertain, patients switching from a surgical preference to non-surgical preference post-DA exposure, and patients switching from a non-surgical preference to surgical preference post-DA exposure. †† Includes patients who were continuously uncertain (pre- and post-DA).

other pragmatic clinical settings examining the impact of DAs upon treatment certainty.<sup>47</sup>

Nearly 20% of knee patients and 17% of hip patients in our study remained uncertain about their treatment preferences after viewing DAs (results not shown), which is higher than levels reported in RCTs.<sup>14</sup> One explanation for this divergent finding concerns the selection of patients who received DAs across HVHC systems. Given the non-randomized nature of HVHC's implementation of DAs, older hip patients who were exposed to DAs may have been chosen based upon their appropriateness as candidates for surgery instead of medical management. Such a limitation has been noted elsewhere in the SDM literature.<sup>38</sup> Nonetheless, these results underscore

that routine implementation of SDM may not shift patient preferences to the same extent as has been reported in RCTs or non-pragmatic trials.<sup>28</sup> Whereas RCTs have protocols that are generally adhered to and monitored, pragmatic implementation occurs in organizational contexts where differences in culture, the presence or lack of champions, and competing demands are expected to influence the uptake (and success) of engaging patients in shared decision making.

The introduction of DAs upstream in primary care may allow for conversations of treatment tradeoffs that differ from those that take place downstream in specialty care settings. Previous work suggests that not only are patients' general health histories better known to primary care

**Table 2** Association Between Patient Characteristics and Post-DA Surgical Choice, All HVHC Systems

	Patients Choosing Surgery Post-DA			
	Knee (n = 648)		Hip (n = 311)	
	Adjusted Model	CI	Adjusted Model	CI
<b>Age</b>	Age (Reference: 51–64)		Age (Reference: 64 and under)	
Under 50	0.89	0.60–1.32	N/A	N/A
65+	0.79	0.58–1.07	1.03	0.61–1.73
<b>Gender</b>				
Female	0.57**	0.43–0.75	1.12	0.70–1.80
Male	Ref	Ref	Ref	Ref
<b>Race (vs White)</b>				
Hispanic	1.27	0.77–2.08	0.87	0.20–3.71
Non-White/Other	1.15	0.81–1.63	0.79	0.43–1.48
White	Ref	Ref	Ref	Ref
<b>Marital Status</b>				
Unmarried	1.00	0.76–1.31	0.52**	0.32–0.85
Married	Ref	Ref	Ref	Ref
<b>Pre-DA Uncertainty</b>	0.09**	0.06–1.14	0.06**	0.03–0.11
<b>Switched Preference Post-DA (from pre-DA choice)</b>	0.91	0.82–1.36	0.80	0.39–1.67
<b>Decision Making Stage Post-DA</b>				
Stable	3.72**	2.06–6.69	1.07	0.29–2.69
Increase	0.89	0.28–4.57	0.89	0.41–2.80
Decrease	Ref	Ref	Ref	Ref
<b>Charlson Comorbidity Index</b>	0.93**	0.88–0.99	1.01	0.92–1.12
<b>Pain Score (HOOS or KOOS)</b>	1.04**	1.03–1.05	1.05**	1.03–1.06
<b>Education Level</b>				
Some College/Graduated from College	1.15	0.76–1.73	1.33	0.74–2.39
Postgraduate Education	1.10	0.79–1.52		
Less than/Graduated High School/GED	Ref	Ref	Ref	Ref

Note: \*\*p<0.01.

physicians (PCPs), but PCPs are often better able to help patients make treatment choices that are aligned with personal values.<sup>48,49</sup> Our sensitivity analysis reveals that among upstream implementing systems, there is a strong association between high pain scores and choice of surgery post-DA among hip patients (OR = 1.19,  $p < 0.01$ , respectively). To the extent that there is greater familiarity with patients' longitudinal experiences of pain in primary care settings, conversations about a given patient's appropriateness for surgery may be carried out with better knowledge of their general health status and other risk factors. Importantly, our patient population tended to be under 65 (with a mean age of 58 among hip patients and 59 among knee patients), which may also be a contributing factor to

patients choosing surgery over more conservative treatment. Although few of our findings reached statistical significance, we found associations of large magnitude between patient characteristics and post-DA treatment preferences for upstream-implementing systems.

Our findings should be considered in light of some limitations. First, our data were collected from an implementation study, thus precluding the possibility of constructing a "pure" unexposed control or comparison group. Secondly, there was heterogeneity of the SDM intervention across practice sites; some patients were prompted to view a Health Dialog DVD DA or an online DA while other practices invited patients to view the DA on an iPad. In some instances, patients viewed DAs after rather than

**Table 3** Association Between Patient Characteristics and Post-DA Surgical Choice, Upstream Implementing HVHC Systems Only

	Adjusted Model	Confidence Interval (CI)	Adjusted Model	CI
	Knee Patients (n = 246)		Hip Patients (n = 75)	
<b>Age</b>	Age (Reference: 51–64)		Age (Reference: 64 and Under)	
Under 50	0.77	0.27–2.19	N/A	N/A
65+	0.58	0.30–1.12	0.98	0.19–5.05
<b>Gender</b>				
Female	0.66	0.32–1.37	0.86	0.11–6.70
Male	Ref		Ref	
<b>Race</b>				
Hispanic	0.93	0.15–5.63		N/A
Other/Non-white	0.94	0.23–3.84	1.85	0.15–23.45
White	Ref		Ref	
<b>Marital Status</b>				
Not Married	1.37	0.69–2.71	1.81	0.22–15.12
Married	Ref		Ref	
<b>Pre-DA Uncertainty</b>	0.17**	0.07–0.43	<0.001*	<0.001–0.05
<b>Switched Preference Post-DA (from pre-DA choice)</b>	1.32	0.45–3.83	1.91	0.06–65.58
<b>Decision Making Stage</b>				
Stable	2.82	0.58–13.66	3.57	0.14–92.45
Increase	1.93	0.38–9.87	3.44	0.07–166.20
Decrease	Ref		Ref	
<b>Charlson Comorbidity Index</b>	1.04	0.91–1.20	1.23	0.74–2.03
<b>Pain Score</b>	1.04**	1.02–1.06	1.19**	1.07–1.31
<b>Education</b>				
Some College/College Graduate	1.47	0.71–3.04	6.34	0.89–45.20
Postgraduate Education	1.36	0.52–3.57	N/A	N/A
Graduated High School	Ref		Ref	

Notes: \*p<0.05, \*\*p<0.01.

before their appointment with a specialist. These differences alongside the extent to which SDM took place within these encounters may have impacted our findings in ways that we were unable to measure given a lack of documentation at individual practice or physician/health care team levels. We are not able to determine which specific patients within upstream-implementing systems received DA in primary versus specialty practices. However, since this shift tended to occur earlier in the implementation, most patients completed DAs for primary care encounters in these three systems. Finally, although our data are drawn from geographically diverse health systems, HVHC systems are not representative of all health systems, and members pay fees that support centralized data collection and reporting. Our

findings may not be generalizable to systems with fewer resources and capacity for SDM and may face more challenges of implementing DAs.

## Conclusion

In a multi-system project intended to routinely implement the use of DAs to support SDM, we found that greater pain was associated with greater odds of surgical preference across both upstream and downstream-implementing systems. Older hip and knee patients within systems that moved the DAs upstream into primary care had lower odds of choosing surgery compared with older patients in the overall sample of systems. Understanding nuances of shifts in preferences across primary versus specialty care



settings are needed to better support patients in the complexity of decision-making for preference-sensitive conditions. Pragmatic studies that compare the routine integration of DAs into primary versus specialty care could further clarify which groups of patients are most likely to find DAs helpful in treatment decision-making processes, and whether important differences exist across other patient-centered outcomes such as decision certainty and regret. Identifying mechanisms by which DAs can be complemented by such activities as health coaching, shared medical appointments and care management<sup>50,51</sup> to reduce decisional uncertainty could advance the optimal alignment of treatment preferences and decisions for all patients.

## Disclosure

The authors report no conflicts of interest in this work.

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