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The Impact Of Decision Aids On Adults Considering Hip Or Knee Surgery

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Abstract

Trials of decision aids developed for use in shared decision making find that patients engaged in that process tend to choose more conservative treatment for preference-sensitive conditions. Shared decision making is a collaborative process in which clinicians and patients discuss trade-offs and benefits of specific treatment options in light of patient values and preferences. Decision aids are paper, video, or web-based tools intended to help patients match personal preferences with available treatment options. We analyzed data for 2012–15 about patients within the ten High Value Healthcare Collaborative member systems who were exposed to condition-specific decision aids in the context of consultations for hip and knee osteoarthritis, with the intention that the aids be used to support shared decision making. Compared to matched patients not exposed to the decision aids, those exposed had two-and-a-half times the odds of undergoing hip replacement surgery and nearly twice the odds of undergoing knee replacement surgery within six months of

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the consultation. These findings suggest that health care systems adopting decision aids developed for use in shared decision making, and used in conjunction with hip and knee osteoarthritis consultations, should not expect reduced surgical utilization.

Hip and knee osteoarthritis are among the most prevalent and quickly growing chronic conditions in the United States, with estimates that these and other forms of musculoskeletal arthritis affect nearly 30 million Americans.[1] Projections from the Centers for Disease Control and Prevention indicate that the number of adults ages sixty-five and older living with osteoarthritis is expected to double from 21.4 million in 2005 to 41.1 million by 2030.[2] In 2014, Medicare spent approximately $50,000 per arthroplasty hospitalization, with total costs nearing $7 billion.[3]

There is growing evidence about the role of shared decision making (SDM)—a collaborative process in which clinicians and patients discuss trade-offs and benefits of specific treatment options in light of patient values and preferences[4]—to help patients make informed decisions about elective procedures such as arthroplasty.[5–7] Decision aids developed to support SDM are paper, video, or web-based tools intended to help patients match personal preferences with available treatment options. However, evidence indicates that exposure to decision aids is associated with a general tendency away from surgery and toward medical management across a range of preference-sensitive conditions, including hip and knee osteoarthritis.[8,9] A pragmatic trial of patients at Group Health Cooperative demonstrated that exposure to decision aids was associated with 26 percent fewer hip replacement surgeries and 38 percent fewer knee replacements, relative to surgeries in a cohort of matched patients who received usual care.[10] In contrast, a randomized controlled trial that randomly assigned hip and knee osteoarthritis patients to SDM and usual care arms found no significant difference in choice of surgery across these groups.[11] A systematic review of fifteen SDM trials[12] found that using decision aids as part of SDM increased the propensity of patients to select less invasive treatment options, although only five studies had significant findings.[10,13–16]

In light of trials that tend to find that patients are more likely to choose conservative treatments when engaged in SDM,[10] we examined the extent to which the use of decision aids intended to support the SDM process for hip and knee consultations was associated with decreased propensity to undergo surgery (arthroplasty) over six months compared to a comparison group whose members received care in the same health systems and resembled patients in the intervention group in all major respects except exposure to decision aids in conjunction with their consultations. Moreover, we explored the issue in the context of systemwide, routine implementation of decision aids, as opposed to a limited trial.

Study Data And Methods

Data

Founded in 2009, the High Value Healthcare Collaborative (HVHC) consists of ten health care systems with a shared goal of studying and disseminating promising interventions in the collaborative to improve the quality of care for their patient populations while reducing

overall health care costs. A three-year grant from the Center for Medicare and Medicaid Innovation supported HVHC's efforts to, among other projects, implement decision aids to support SDM for patients considering hip and knee arthroplasty within orthopedic practices.[17] The goals of routine exposure to those DAs included improving pain and functioning of patients considering hip or knee arthroplasty and reducing rates of hip and knee surgeries not reflective of patient preferences. HVHC's intervention made use of a web-based questionnaire, a decision aid, and a follow-up questionnaire.

System-reported clinical and administrative data from the High Value Healthcare Collaborative's Unified Data Extract included information about intervention- and comparison-group patients who underwent arthroplasty within the grant period (July 1, 2012–June 30, 2015). Encounter-level data from eligible adult patients (those ages 18–86) within collaborative system sites in the same period were integrated with information from the Unified Data Extract and analyzed. We included patients with diagnoses of hip osteoarthritis (*International Classification of Diseases*, Ninth Revision, Clinical Modification [ICD-9-CM], diagnostic codes 715.09, 715.15, 715.25, 715.35, or 715.95) or knee osteoarthritis (ICD-9-CM diagnostic codes 715.09, 715.16, 715.26, 715.36, or 715.96) osteoarthritis were included. We excluded patients if they had missing data for age, sex, or comorbidity status ($n = 27$). The intervention group consisted of patients exposed to decision aids and for whom both pre- and post-visit surveys that assessed patient preferences were completed before June 30, 2015 ($n = 1,643$). Patients were selected for the matched comparison group if they had an ICD-9 code for hip or knee osteoarthritis and an orthopedic consultation within the grant period, but no documentation of previous decision aid exposure ($n = 4,108$).

Intervention-group patients viewed condition-specific decision aids online, on a DVD, or on a tablet in the physician's office either before or following orthopedic consultations. Health Dialog decision aids—regardless of modality (for example, DVD or online)—were used across all provider sites. These decision aids provide balanced information about treatment options for conditions including hip and knee osteoarthritis and meet standards set by the International Patient Decision Aid Standards Collaboration.[18] Before and after viewing the decision aids, patients completed surveys that assessed their treatment preferences and decision certainty, as well as asking questions about topics ranging from education and employment history to self-assessed pain (as measured by the pain subscale of the Knee Injury and Osteoarthritis Outcome Score and Hip Injury and Osteoarthritis Outcome Score). Health coaches, most of whom were nurses, answered questions regarding the decision aid and survey questions for patients who completed the decision aid while in the medical office. During the orthopedic appointment, surgeons could review survey responses, clarify questions, and address patient concerns that might not have been addressed by the decision aid.

Study Design

Leveraging the routine provision of decision aids for patients with hip and knee osteoarthritis within HVHC, we compared arthroplasty rates among patients of practices that used decision aids (the intervention group) to patients of practices within the same systems

that did not implement decision aids (the comparison group). The main independent variable was exposure to decision aids in conjunction with hip or knee osteoarthritis consultations. The decision aids were intended to be used routinely as part of the SDM process for hip and knee osteoarthritis in participating High Value Healthcare Collaborative practices, and exposure was documented at the patient-level in collaborative administrative data. The primary outcome was whether or not intervention patients had hip or knee arthroplasty within six months of completing the decision aid. ICD-9-CM procedure codes 81.54 and 81.51 (for knee and hip arthroplasty, respectively) were used to identify patients who had arthroplasty within six months of their orthopedic consultations. Intervention and matched comparison group patients' utilization data were compared to assess surgical utilization within six months of decision aid exposure in the period July 2012–June 2015.

For multivariable regression analyses, we controlled for patient characteristics that could be associated with patients' decision aid use and treatment choices, including age, sex, race, marital status, and health insurance type. Multiple studies have found that adults ages sixty-five and older are less likely to pursue surgical intervention for preference-sensitive conditions such as hip or knee osteoarthritis.[19,20] Clinicians may be less likely to engage older patients than younger patients in discussions about the benefits and trade-offs of surgery.[21] Female patients are less likely than males to choose surgery across a range of preference-sensitive conditions, including joint arthroplasty.[22,23] Nonwhite patients are also less likely to have surgery than white patients are[24]—a finding that has been attributed to minority patients' perceptions of greater risk-to-benefit ratios for surgery.[25] Other research suggests that physicians are less likely to offer surgery to patients who are members of racial/ethnic minority groups, compared to white patients.[26] In addition, patients living with a spouse or partner may feel better supported in the decision to pursue surgery and subsequently in the recovery period, compared with unmarried patients.[27] A patient's health insurance payer type may affect perceptions of access to and cost sharing for surgical interventions.[28] The propensity for patients to undergo hip and knee arthroplasty has been found to be lower among Medicaid beneficiaries than among privately insured and Medicare patients.[29]

Statistical Analyses

To understand differences in surgical utilization between patients who were exposed to the decision aid intervention for hip or knee osteoarthritis and patients who were not exposed, we stratified patient data by health system and exposure date (decision aid exposure date for the intervention group and specialty consultation appointment date for the comparison group), followed by propensity score matching. Stratifying patients before propensity score analyses is a method that has been demonstrated to further reduce bias in nonrandomized study settings.[30] Comparison-group patients were matched to intervention-group patients via propensity score matching that used post-decision aid survey completion dates within a corresponding six-month timeframe. Optimal variable propensity score matching, which matches multiple comparison cases to treatment observations,[31] was used. Patient age; sex; and diagnoses of diabetes, depression, or congestive heart failure (key medical comorbidities that can affect osteoarthritis care) were included[32,33] to reduce potential selection effects when assessing the relationship between decision aid exposure and surgical utilization.

Optimal variable propensity score matching also selects comparison cases that most closely match intervention cases across selected covariates, thus optimizing balance across the groups in a manner that is not achieved when using propensity score weighting.[34]

Multivariable logistic regression models estimated the relationship between decision aid exposure and surgical utilization after optimal propensity score matching, separately for hip and knee patients. The regression models controlled for patient age, sex, comorbidity, race, marital status, and health insurance payer type. The models also included health system fixed effects to account for patient clustering within systems.

Sensitivity Analysis

As an alternative to optimal propensity score matching, we conducted a sensitivity analysis that used propensity score weighting, because that weighting retains the entire sample of observations (both intervention and comparison)[35]—which may result in more generalizable findings. For propensity score weighting, we incorporated the same variables as we did with optimal matching (patient age, sex, and comorbidity status) before conducting logistic regression analyses.

Limitations

The study findings should be considered in light of important limitations. First, decision aid implementation and SDM processes were heterogeneous across the High Value Healthcare Collaborative member systems and were dynamic over time, as practices learned through experience. For example, some patients were prompted to view a Health Dialog DVD or online decision aid before their appointments, while other practices invited patients to view the decision aid on an iPad in the orthopedist’s office. Because these differences across practices and over time were not documented in detail, we were unable to account for them in our analyses.

Second, we were unable to confirm whether SDM processes occurred in the consultations for intervention- or comparison-group patients. Audio or video recordings of interactions could elucidate whether SDM processes occurred, but it is not feasible to use these methods in a large-scale implementation of decision aids.

Third, High Value Healthcare Collaborative systems pay membership fees to support data collection and reporting. Thus, the generalizability of our findings to health systems with fewer resources or less experience could be limited. Nevertheless, no studies have examined the impact of decision aids developed for use in SDM on surgical utilization across multiple health systems, which underscores the novelty of our research.

Finally, although we included depression, diabetes, and congestive heart failure as key comorbidities, we were unable to include a more comprehensive set of comorbidities or the length of time since initial diagnoses of hip or knee osteoarthritis, because diagnosis data were limited for comparison group patients.

Study Results

Exhibit 1 summarizes the numbers and percentages of all adult patients with hip and knee osteoarthritis (including those who were exposed to decision aids in conjunction with consultations) within the health care systems that were members of the High Value Healthcare Collaborative during the period July 1, 2012-June 30, 2015.

Among hip patients, the unadjusted six-month postconsultation arthroplasty rate for the comparison group was 29.1 percent, versus 53.9 percent for the intervention group (data not shown). Among knee patients, the rates were 24.4 percent for the comparison group and 32.4 percent for the intervention group. The differences in rates across intervention and comparison groups for both the hip and knee cohorts were significant ($p < 0.001$).

Descriptive statistics before optimal propensity score matching revealed several differences across the decision aid intervention and comparison groups. For example, knee patients who were Hispanic accounted for a larger share of the comparison group than the intervention group (10.3 percent versus 4.3 percent). So did knee patients who were Medicaid beneficiaries (11.1 percent versus 2.9 percent). Among hip patients, commercially insured patients accounted for a larger proportion of the intervention group than the comparison group (45 percent versus 27 percent) (online appendix exhibit A1).[36]

We compared the unadjusted mean differences between intervention- and comparison-group patients shown in appendix exhibit A1[36] with the adjusted mean differences shown in exhibit 2. We found that optimal propensity score matching resulted in a 52.5 percent reduction in the standardized mean difference for patient age across knee patients in the intervention and comparison groups and a 5.2 percent reduction in the standardized mean difference across sexes for the intervention and comparison knee groups. Among hip patients, optimal matching resulted in a 37.5 percent reduction in the standardized mean difference by patient age between the intervention and comparison groups. For the knee cohort, although optimal propensity score matching diminished differences between intervention and comparison groups, differences remained significant across age, comorbidity status, race, and payer type. Similarly, for hip patients, differences between intervention and comparison groups diminished with optimal propensity score matching but remained significant across age, marital status, and payer type variables.

In optimal propensity score matched logistic regression models, knee intervention patients had 1.77 greater odds of undergoing arthroplasty six months after a consultation, relative to comparison knee patients (exhibit 3). Hip patients exposed to decision aids had 2.59 greater odds, relative to comparison group patients.

Several patient characteristics were associated with undergoing arthroplasty. Knee patients with diabetes had lower odds of having arthroplasty, compared to patients without diabetes (odds ratio: 0.84), but knee patients with depression had higher odds, compared to patients without depression (OR: 1.54). Black/African American and Hispanic/Latino knee patients had lower odds of arthroplasty (ORs: 0.48 and 0.60, respectively), compared to non-Latino white patients.

Similarly, Black/African American and Hispanic/Latino (ORs: 0.40 and 0.26 respectively) hip patients had lower odds of arthroplasty compared with non-Hispanic/Latino white patients. Older age was also a significant predictor of lower surgical utilization in the hip cohort.

The overall findings were robust to the alternative specification of propensity score weighting. These results are shown in appendix exhibit B1.[36] Results of multivariable regression using propensity score weighting, which included a larger comparison group, were consistent with results using optimal variable propensity score matching, but optimal matching yielded odds ratios of smaller magnitude and less significance.

Discussion

Adult patients with hip or knee osteoarthritis at the ten High Value Healthcare Collaborative systems in 2012–15 who were exposed to condition-specific decision aids in conjunction with orthopedic consultations were no less likely to undergo arthroplasty within six months than matched patients whose consultations did not include such exposure. These findings are notable in light of existing evidence from smaller-scale intervention studies that using decision aids as part of SDM processes results, on average, in more conservative treatment for preference-sensitive conditions.[10] One explanation for why the High Value Healthcare Collaborative findings differed from those of previous studies is that decision aids were implemented as part of routine care delivery across diverse health systems rather than as a short-term project in a single health system. Compared to randomized controlled trials of surgical utilization after exposure to decision aids developed for use in SDM, SDM interventions under real-world conditions could be affected by organizational culture, time constraints, availability of resources, and the presence or lack of feedback loops,[37] resulting in low implementation fidelity that could diminish decision aids' impact on SDM processes.[38,39] Moreover, many patients were primarily exposed to decision aids before consultations in orthopedic practices that receive fee-for-service reimbursement for arthroplasty and other services. As a result, these patients might not have discussed surgical and nonsurgical treatment options to the same extent that patients in a primary care setting might have done. In light of the longitudinal nature of many patients' relationships with their primary care physicians, conversations that occur "upstream" about treatment options and expectations could consider a broader and more nuanced health history. Upstream implementation of decision aids as part of the SDM processes in primary care settings might affect arthroplasty rates differently and should be examined in future research.

Notably, we found that patients with clinical depression had a greater propensity to undergo arthroplasty for hip or knee osteoarthritis, compared with patients without depression. In addition to decreased quality of life, people with depression also have a high likelihood of physical morbidity and mortality,[40,41] which might make it more difficult for these patients to pursue nonsurgical treatment options such as physical therapy. Patients with depression are also more likely to experience poor postoperative outcomes: For example, patients with depression who undergo coronary artery bypass surgery have a higher incidence of readmissions and serious cardiac events such as arrhythmias, as well as postoperative delirium.[42] Initiating informed conversations about the trade-offs of surgery and nonsurgery

via decision aids with patients with depression is especially important given the unique risks and benefits among this patient population. Future studies that examine the impact of SDM-focused training for engaging patients with depression could aid in the development of decision support for clinicians who engage in SDM with these patients.

The routine implementation of decision aids in High Value Healthcare Collaborative member practices did not sway hip and knee patients toward more conservative treatment for osteoarthritis. In light of the heterogeneity among systems in the criteria they used for selecting patients who were exposed to DAs as part of consultations for hip or knee osteoarthritis, it is possible that patients who ultimately were exposed to decision aids were chosen because of their candidacy for hip or knee arthroplasty. If that were the case, it would bias our results toward the null hypothesis. Importantly, the intended goal of decision aids is not to reduce rates of surgical interventions, but rather to facilitate conversations that help patients and clinicians collaboratively choose the treatment most closely aligned with the patient's preferences.[4]

Policy Implications

National efforts to encourage the routine use of SDM for preference-sensitive conditions continue to gain momentum through the Centers for Medicare and Medicaid Services' mandated physician participation in SDM interventions for atrial fibrillation, lung cancer screening, and implantable cardioverter-defibrillators.[43] Pragmatic SDM demonstration projects should prioritize producing evidence about how health care systems and physician practices can develop the climate and capacity to implement SDM with high fidelity.[44] There are other important patient-centered outcomes to consider in future research on the impact of decision aids, including pain management and patient satisfaction with treatment choices. Increased efforts to identify best practices of using decision aids to support SDM in primary care settings might support the provision of patient-centered care for preference-sensitive conditions and improved patient outcomes.

Conclusion

The scale of quality improvement initiatives implemented by the High Value Healthcare Collaborative provides valuable opportunities for health care systems to learn from one another about how best to integrate patient-centered engagement strategies into routine clinical practice. The collaborative's implementation of decision aids designed to support SDM as part of consultations for hip or knee osteoarthritis patients expands evidence from single-system trials to a multisite routine implementation of decision aids, with the intention that the decision aids be used to facilitate the SDM process. In contrast with findings from single-site studies, our findings underscore the fact that multisystem implementation of decision aids for hip and knee osteoarthritis is not necessarily associated with patients' choosing more conservative treatment options for these conditions. Health care systems that adopt decision aids developed for use in SDM and used in conjunction with hip and knee osteoarthritis consultations should not expect reduced surgical utilization.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Bios for 2019–00100_Hurley

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Notes

1. National Institutes of Health. Ostoeoarthritis [Internet]. Bethesda (MD):NIH; [last updated 2018 6 30; cited 2019 Sep 25]. Available from: https://report.nih.gov/nihfactsheets/viewfactsheet.aspx?csid=55
2. Centers for Disease Control and Prevention. Public health and aging: projected prevalence of self-reported arthritis or chronic joint symptoms among persons aged >65 years—United States, 2005–2030. MMWR Morb Mortal Wkly Rep. 2003;52(21):489–91. [PubMed: 12809109]
3. Bert JM, Hooper J, Moen S. Outpatient total joint arthroplasty. Curr Rev Musculoskelet Med. 2017;10(4):567–74. [PubMed: 29064004]

4. Elwyn G, Frosch D, Thomson R, Joseph-Williams N, Lloyd A, Kinnersley P, et al. Shared decision making: a model for clinical practice. J Gen Intern Med. 2012;27(10):1361–7. [PubMed: 22618581]
5. Coylewright M, Dick S, Zmolek B, Askelin J, Hawkins E, Branda M, et al. PCI Choice decision aid for stable coronary artery disease: a randomized trial. Circ Cardiovasc Qual Outcomes. 2016;9(6):767–76. [PubMed: 27803090]
6. Elwyn G, Edwards A, Thompson R. Shared decision making in health care: achieving evidence-based patient choice. 3rd ed Oxford: Oxford University Press; 2016.
7. Stacey D, Légaré F, Lewis K, Barry MJ, Bennett CL, Eden KB, et al. Decision aids to help people facing health treatment or screening decisions. Cochrane Database Syst Rev. 2017;4:CD001421.
8. Stacey D, Hawker G, Dervin G, Tugwell P, Boland L, Pomey MP, et al. Decision aid for patients considering total knee arthroplasty with preference report for surgeons: a pilot randomized controlled trial. BMC Musculoskelet Disord. 2014;15(54):54. [PubMed: 24564877]
9. Veroff D, Marr A, Wennberg DE. Enhanced support for shared decision making reduced costs of care for patients with preference-sensitive conditions. Health Aff (Millwood). 2013;32(2):285–93. [PubMed: 23381521]
10. Arterburn D, Wellman R, Westbrook E, Rutter C, Ross T, McCulloch D, et al. Introducing decision aids at Group Health was linked to sharply lower hip and knee surgery rates and costs. Health Aff (Millwood). 2012;31(9):2094–104. [PubMed: 22949460]
11. Bozic KJ, Belkora J, Chan V, Youm J, Zhou T, Dupaix J, et al. Shared decision making in patients with osteoarthritis of the hip and knee: results of a randomized controlled trial. J Bone Joint Surg Am. 2013;95(18):1633–9. [PubMed: 24048550]
12. Reames BN, Shubeck SP, Birkmeyer JD. Strategies for reducing regional variation in the use of surgery: a systematic review. Ann Surg. 2014;259(4):616–27. [PubMed: 24240626]
13. Auvinen A, Hakama M, Ala-Opas M, Vornanen T, Leppilahti M, Salminen P, et al. A randomized trial of choice of treatment in prostate cancer: the effect of intervention on the treatment chosen. BJU Int. 2004;93(1):52–6, discussion 56. [PubMed: 14678367]
14. Kennedy AD, Sculpher MJ, Coulter A, Dwyer N, Rees M, Abrams KR, et al. Effects of decision aids for menorrhagia on treatment choices, health outcomes, and costs: a randomized controlled trial. JAMA. 2002;288(21):2701–8. [PubMed: 12460093]
15. Whelan T, Levine M, Gafni A, Sanders K, Willan A, Mirsky D, et al. Mastectomy or lumpectomy? Helping women make informed choices. J Clin Oncol. 1999;17(6):1727–35. [PubMed: 10561209]
16. Whelan T, Levine M, Willan A, Gafni A, Sanders K, Mirsky D, et al. Effect of a decision aid on knowledge and treatment decision making for breast cancer surgery: a randomized trial. JAMA. 2004;292(4):435–41. [PubMed: 15280341]
17. Weeks WB, Schoellkopf WJ, Sorensen LS, Masica AL, Nesse RE, Weinstein JN. The High Value Healthcare Collaborative: observational analyses of care episodes for hip and knee replacement surgery. J Arthroplasty. 2017;32(3):702–8. [PubMed: 27776908]
18. Elwyn G, Burstin H, Barry MJ, Corry MP, Durand MA, Lessler D, et al. A proposal for the development of national certification standards for patient decision aids in the US. Health Policy. 2018;122(7):703–6. [PubMed: 29728288]
19. Hudak PL, Armstrong K, Braddock C 3rd, Frankel RM, Levinson W. Old er patients' unexpressed concerns about orthopaedic surgery. J Bone Joint Surg Am. 2008;90(7):1427–35. [PubMed: 18594089]
20. Hurria A, Leung D, Trainor K, Borgen P, Norton L, Hudis C. Factors influencing treatment patterns of breast cancer patients age 75 and older. Crit Rev Oncol Hematol. 2003;46(2):121–6. [PubMed: 12711357]
21. Hamel MB, Toth M, Legedza A, Rosen MP. Joint replacement surgery in elderly patients with severe osteoarthritis of the hip or knee: decision making, postoperative recovery, and clinical outcomes. Arch Intern Med. 2008;168(13):1430–40. [PubMed: 18625924]
22. Nilsdotter AK, Lohmander LS, Klässbo M, Roos EM. Hip disability and osteoarthritis outcome score (HOOS)—validity and responsiveness in total hip replacement. BMC Musculoskelet Disord. 2003;4(10):10. [PubMed: 12777182]
23. Roos EM, Lohmander LS. The Knee injury and Osteoarthritis Outcome Score (KOOS): from joint injury to osteoarthritis. Health Qual Life Outcomes. 2003;1(64):64. [PubMed: 14613558]

24. Kwoh CK, Vina ER, Cloonan YK, Hannon MJ, Boudreau RM, Ibrahim S A. Determinants of patient preferences for total knee replacement: African-Americans and whites. Arthritis Res Ther. 2015;17(348):348. [PubMed: 26635132]
25. Lurie JD, Spratt KF, Blood EA, Tosteson TD, Tosteson AN, Weinstein J N. Effects of viewing an evidence-based video decision aid on patients' treatment preferences for spine surgery. Spine (Phila Pa 1976). 2011;36(18):1501–4. [PubMed: 21358485]
26. Katz JN. Persistence of racial and ethnic differences in utilization and adverse outcomes of total joint replacement. J Bone Joint Surg Am. 2016;98(15):1241–2. [PubMed: 27489313]
27. Ibrahim SA, Siminoff LA, Burant CJ, Kwoh CK. Differences in expectations of outcome mediate African American/white patient differences in "willingness" to consider joint replacement. Arthritis Rheum. 2002;46(9):2429–35. [PubMed: 12355491]
28. Wiznia DH, Nwachuku E, Roth A, Kim CY, Save A, Anandasivam NS, et al. The influence of medical insurance on patient access to orthopaedic surgery sports medicine appointments under the Affordable Care Act. Orthop J Sports Med. 2017;5(7):2325967117714140.
29. Warth LC, Callaghan JJ, Wells CW, Liu SS, Klaassen A, Gao Y, et al. Demographic and comorbid disparities based on payer type in a total joint arthroplasty cohort: implications in a changing health care arena. Iowa Orthop J. 2011;31:64–8. [PubMed: 22096422]
30. Austin PC. An introduction to propensity score methods for reducing the effects of confounding in observational studies. Multivariate Behav Res. 2011;46(3):399–424. [PubMed: 21818162]
31. Rosenbaum PR. Design of observational studies. New York, NY: Springer; 2010.
32. Hall AJ, Stubbs B, Mamas MA, Myint PK, Smith TO. Association between osteoarthritis and cardiovascular disease: systematic review and meta-analysis. Eur J Prev Cardiol. 2016;23(9):938–46. [PubMed: 26464295]
33. Nüesch E, Dieppe P, Reichenbach S, Williams S, Iff S, Jüni P. All cause and disease specific mortality in patients with knee or hip osteoarthritis: population based cohort study. BMJ. 2011;342:d1165.
34. Glynn RJ, Schneeweiss S, Stürmer T. Indications for propensity scores and review of their use in pharmacoepidemiology. Basic Clin Pharmacol Toxicol. 2006;98(3):253–9. [PubMed: 16611199]
35. Guo S, Fraser MW. Propensity score analysis: statistical methods and applications. Los Angeles (CA): Sage; 2010.
36. To access the appendix, click on the Details tab of the article online.
37. Rohrbach LA, Grana R, Sussman S, Valente TW. Type II translation: transporting prevention interventions from research to real-world settings. Eval Health Prof. 2006;29(3):302–33. [PubMed: 16868340]
38. Keith RE, Hopp FP, Subramanian U, Wiitala W, Lowery JC. Fidelity of implementation: development and testing of a measure. Implement Sci. 2010;5(5):99. [PubMed: 21192817]
39. Grace SM, Rich J, Chin W, Rodriguez HP. Fidelity of implementation to a care team redesign and improved outcomes of diabetes care. Int J Qual Health Care. 2015;27(1):60–6. [PubMed: 25431469]
40. Ghoneim MM, O'Hara MW. Depression and postoperative complications: an overview. BMC Surg. 2016;16(5):5. [PubMed: 26830195]
41. Guerini F, Morghen S, Lucchi E, Bellelli G, Trabucchi M. Depressive symptoms and one year mortality among elderly patients discharged from a rehabilitation ward after orthopaedic surgery of the lower limbs. Behav Neurol. 2010;23(3):117–21. [PubMed: 21098965]
42. Tully PJ, Baker RA. Depression, anxiety, and cardiac morbidity outcomes after coronary artery bypass surgery: a contemporary and practical review. J Geriatr Cardiol. 2012;9(2):197–208. [PubMed: 22916068]
43. Merchant FM, Dickert NW Jr, Howard DH. Mandatory shared decision making by the Centers for Medicare and Medicaid Services for cardiovascular procedures and other tests. JAMA. 2018;320(7):641–2. [PubMed: 29868828]
44. Fisher ES, Shortell SM, Savitz LA. Implementation science: a potential catalyst for delivery system reform. JAMA. 2016;315(4):339–40. [PubMed: 26813203]

Exhibit 1:

Hip and knee osteoarthritis patient cohort at High Value Healthcare Collaborative (HVHC) member systems, July 1, 2012-June 30, 2015

	HIP PATIENTS		KNEE PATIENTS	
SYSTEM	**NO.**	**% OF COHORT**	**NO.**	**% OF COHORT**
Baylor Health System	8,644	17.3	27,131	17.7
Beth Israel Deaconess Medical Center	929	1.9	2,593	1.7
Denver Health	860	1.7	5,467	3.6
Eastern Maine Healthcare Systems	2,958	5.9	9,357	6.1
Intermountain Healthcare	10,806	21.6	45,962	30.0
MaineHealth	0	0.0[a]	3,661	2.4
Mayo Clinic	15,252	30.5	25,386	16.5
Scott and White Health	5,062	10.1	19,670	12.8
UCLA Health System	2,906	5.8	7,345	4.8
Virginia Mason Medical Center	2,623	5.2	6,883	4.5
All	50,040	100.0	153,455	100.0

SOURCE Authors' analysis of data submitted by members of the High Value Healthcare Collaborative. NOTE UCLA is the University of California Los Angeles.

[a]MaineHealth did not submit any data on hip patients.

Exhibit 2:

Adjusted characteristics of the hip and knee osteoarthritis patient cohort after optimal variable propensity score matching propensity by cohort group [July 1, 2012-June 30, 2015]

	Hip patients		Knee patients	
	Intervention	**Comparison**	**Intervention**	**Comparison**
All	446	1,115	1,197	2,993
Mean age (years)	58.2	60.6****	59.3	60.2**
Female	242	621	768	1,823**
Comorbidities				
Congestive heart failure	8	37*	27	107**
Depression	70	195	232	609
Diabetes	44	134	177	559***
Race/ethnicity				
White	353	876	859	1,973***
Hispanic or Latino	13	58	125	345***
Black or African American	32	79	96	269***
Other Non- Hispanic/Nonwhite	48	102	117	406***
Married or with a life partner	263	582***	670	1,582**
Payer				
Medicare	165	430****	445	1,064****
Medicaid	43	62****	133	281****
Medicare and Medicaid	10	10****	52	77****
Private insurer	200	323****	418	870****

SOURCE Authors' analysis of data submitted by members of the High Value Healthcare Collaborative. NOTES The cohort was divided into intervention (members received decision aids) and comparison (members did not receive decision aids) groups. Sex and comorbidities were variables included in the propensity score matching algorithm. Characteristics were adjusted for propensity score matching.

* $p < 0.10$

** $p < 0.05$

*** $p < 0.01$

**** $p < 0.001$

Exhibit 3:

Impact of exposure to decision aids on use of arthroplasty among hip and knee osteoarthritis patients after optimal variable propensity score matching, [July 1, 2012-June 30, 2015

	Patients using arthroplasty			
	Hip patients (*n* = 1,561)		**Knee patients (*n* = 4,190)**	
	Model 1	**Model 2**	**Model 1**	**Model 2**
Intervention versus comparison group	2 12****	2 59****	1 68****	1 77****
Mean age	1 01***	1.01*	1 03****	1 03****
Female	0.94	0.97	0.92	0.99
Comorbidities				
Congestive heart failure	0.71	0.74	0.78	0.84
Depression	1.17	1.28	1 29***	1 54****
Diabetes	0 52****	0.70*	0 61****	0.84**
Race/ethnicity (ref: white)				
Hispanic or Latino	—[a]	0 26****	—[a]	0.60****
Black or African American	—[a]	0 40****	—[a]	0 48****
Other Non-Hispanic Nonwhite	—[a]	0.59***	—[a]	0.85
Married or with a life partner	—[a]	1.26*	—[a]	1 46****
Payer (ref: private insurer)				
Medicare	—[a]	0.77	—[a]	0.66****
Medicaid	—[a]	0.81	—[a]	0.66**
Medicare and Medicaid	—[a]	0.70	—[a]	0.61*
Other	—[a]	2 45****	—[a]	1.30**

SOURCE Authors' analysis of data submitted by members of the High Value Healthcare Collaborative. NOTES The exhibit shows odds ratios after propensity score matching. Model 1 examined the association between the variables included in the propensity score matching algorithm and use of arthroplasty between intervention and comparison groups (those whose members did and did not receive decision aids, respectively). Model 2 examined the association between the full specification of variables included in the analysis and use of arthroplasty. Significance refers to the difference between the cohort groups.

$p < 0.10$

** $p < 0.05$

*** $p < 0.01$

**** $p < 0.001$