Patient Engagement Approaches in Total Joint Arthroplasty: A Review of Two Decades

Aaron Alokozai, BS¹, David N. Bernstein, MD, MBA, MA², Linsen T. Samuel, MD, MBA³, and Atul F. Kamath, MD³

Abstract
Patient engagement is a comprehensive approach to health care where the physician inspires confidence in the patient to be involved in their own care. Most research studies of patient engagement in total joint arthroplasty (TJA) have come in the past 5 years (2015-2020), with no reviews investigating the different patient engagement methods in TJA. The primary purpose of this review is to examine patient engagement methods in TJA. The search identified 31 studies aimed at patient engagement methods in TJA. Based on our review, the conclusions therein strongly suggest that patient engagement methods in TJA demonstrate benefits throughout care delivery through tools focused on promoting involvement in decision making and accessible care delivery (eg, virtual rehabilitation, remote monitoring). Future work should understand the influence of social determinants on patient involvement in care, and overall cost (or savings) of engagement methods to patients and society.

Keywords
shared decision making, patient engagement, decision aid

Introduction
While the demand for total joint arthroplasty (TJA) has been increasing, there are growing concerns around postoperative variation in outcomes and health care costs.¹-³ Applying surgery to an appropriate clinical setting remains challenging, as there is no consensus on TJA candidacy. For example, one prior study found a third of total knee arthroplasty surgeries were deemed to be inappropriate.⁴

Many in orthopedic surgery, like other fields in medicine, are working towards a transformation where patients are at the center of the health care team. Patient engagement should be a comprehensive approach to health care where the physician inspires confidence in the patient to be involved in his or her own care. Greater involvement of patients in their care (ie, patient activation) promotes met expectations and alignment of care with their preferences and values. This may help guide care teams by shifting patients who will not gain meaningful improvement from surgery to non-operative management. For surgical candidates, patient engagement may improve preoperative risk factor optimization (eg, weight loss or smoking cessation) and postoperative adherence (eg, completing physical therapy).

Most research studies of patient engagement in TJA have come in the last 5 years (2015-2020), with no reviews investigating the different patient engagement methods in TJA.

The primary purpose of this review is to examine patient engagement methods in TJA.

Materials and Methods

Literature Search
A comprehensive search was conducted using PubMed/MEDLINE, Embase, and the Cochrane Library databases. The following MeSH terms and keywords were used to search the titles of published literature: “total hip arthroplasty,” “total knee arthroplasty,” “total joint,” “knee prosthesis,” “hip prosthesis,” “surgery,” “total hip replacement,” “total knee replacement,” “partial/unicompartmental,” “hip resurfacing,” “patient involvement,” “shared decision making” “patient engagement,” “patient experience,” “patient participation” “decision aid,” “technology,” “mobile application,” and

¹ Tulane University School of Medicine, New Orleans, LA, USA  
² Harvard Combined Orthopedic Residency Program, Boston, MA, USA  
³ Cleveland Clinic Foundation, Cleveland, OH, USA

Corresponding Author:  
Atul F. Kamath, Center for Hip Preservation, Orthopedic and Rheumatologic Institute, Cleveland Clinic, 9500 Euclid Avenue, Mailcode A41, Cleveland, OH 44195, USA.  
Email: kamatha@ccf.org

Creative Commons Non Commercial CC BY-NC: This article is distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 License (https://creativecommons.org/licenses/by-nc/4.0/) which permits non-commercial use, reproduction and distribution of the work without further permission provided the original work is attributed as specified on the SAGE and Open Access page (https://us.sagepub.com/en-us/nam/open-access-at-sage).
“media” in combination with the “AND” or “OR” Boolean operators. Additionally, reference lists of relevant studies were scrutinized. Data extraction included study data, study design, type of engagement, and study conclusions.

Inclusion criteria were (i) studies published between 2000 and August 2020, (ii) English language publications and complete articles from peer-reviewed journals, and (iii) orthopedic patients under consideration for total hip and total knee arthroplasty. Exclusion criteria were (i) protocols established for future research (ii) studies involved in solely the development of patient engagement method, rather than their evaluation, and (iii) and case studies.

Data Acquisition
The initial query yielded 2534 articles. The screening was centered around whether the study evaluated a patient engagement method. Two reviewers (AA and DB) working independently and in duplicate screened all titles and abstracts; except for records in which both reviewers agreed to exclude, all other records were retrieved in full text. These reviewers screened full-text articles using the same procedure with acceptable reproducibility for all decisions. Disagreements were resolved by consensus. Applying inclusion and exclusion criteria resulted in 31 manuscripts included for analysis. Engagement methods were categorized as those focused on decision making (decision aids), and engagement methods which utilized technological support (virtual physical therapy/remote education, care pathway management, remote monitoring).

Analysis included collection of publication year, engagement method, care delivery phase (clinic visit [decision making], follow-up [remote monitoring, nonoperative management], or postoperative), study design, relevant results/outcomes of the study, and reported conflict of interest. A review of each study’s reference lists was performed but did not result in any additional articles being considered for our investigation (Figure 1).

Figure 1. Diagram depicting the selection process for article inclusion.
### Table 1. Overview of All Studies Included in Review.

| Study by publication year | Engagement method | Care delivery phase | Study design | Results | Relevant outcomes | Conflict of interest/disclosure |
|---------------------------|-------------------|---------------------|--------------|---------|------------------|-------------------------------|
| Prvu Bettger et al5       | Technological support (virtual physical therapy) | Postoperative | Randomized   | Virtual physical therapy was noninferior in function and had lower costs of care. | Physical function, cost | Yes |
| Hurley et al6            | Decision making (decision aids) | Clinic visit | Cohort       | Older patients and patients with high pain levels had an increased preference for surgery. Further, engagement of patients in SDM via decision aids in primary care versus specialty care may impact patient preferences for surgery. | Treatment preference | No |
| Trenaman et al7          | Decision making (decision aids) | Clinic visit | Randomized   | At 2-years most patients (73.9% decision aid arm and 79.1% control) had surgery. At 7 years, patients exposed to decision aids had a similar likelihood of undergoing surgery and mean per-patient costs compared to those without decision aid. | Treatment preference, cost | No |
| Hoogland8                | Technological support (virtual physical therapy) | Postoperative | Observational | A home-based rehabilitation program (tablet app and mobility monitoring) had good adherence (92%) and positive patient experience. | Treatment adherence, patient experience | Yes |
| Sepucha et al9           | Decision making (decision aids) | Clinic visit | Randomized   | The majority (67.2%) made informed patient-centered decisions. Knowledge scores were higher for the short decision aid group (P < .001). Surgeons reported the majority of the visits were of normal duration or shorter. | Knowledge of condition, visit duration | Yes |
| Cronström et al10        | Technological support (remote education) | Follow-up | Qualitative  | Studied digital program aimed at reducing symptoms of osteoarthritis in patients who opt for nonoperative treatment. Participation in program leads to some patients changing their attitude about TJA and treatment options. | Physical symptoms, treatment preference | Yes |
| Mangla et al11           | Decision making (decision aids) | Clinic Visit | Randomized   | Comparison of decision aids between 2 vendors (DA-A vs DA-B). Despite having different content and formats, the 2 decision aids had similar overall effectiveness. | Knowledge of condition, treatment preference | Yes |
| Wang et al12             | Technological support (virtual physical therapy) | Postoperative | Meta-analysis | Technology-assisted rehabilitation results in statistically significant improvement in pain, but no difference in hospital readmissions or treatment-related adverse events. | Patient-reported pain, hospital readmission, adverse events | Yes |

(continued)
| Study by publication year | Engagement method | Care delivery phase | Study design | Results | Relevant outcomes | Conflict of interest/disclosure |
|--------------------------|-------------------|-------------------|-------------|---------|------------------|------------------------------|
| Higgins et al\(^{13}\)  | Technological support (care pathway management) | Postoperative | Case control | Patients in the patient engagement (PES) cohort had a statistically significant shorter mean length of stay (**P** < .001). PES was also associated with a statistically significant reduction in rates of reoperation (**P** = .031). | Hospital duration, reoperation | Yes |
| Gollish et al\(^{14}\)   | Technological support (remote monitoring) | Follow-up | Cohort | Use of mobile applications improves patient experience and reduces follow-up calls to surgeons' offices. | Patient experience, follow-up calls | No |
| Yahanda et al\(^{15}\)   | Technological support (remote monitoring) | Follow-up | Cohort | The use of telemonitoring text and voice messaging interventions for an 88-week period to engage patients (instead of nurses calling patients) lead to increased savings and return of investment. | Patient experience, cost | No |
| Doiron-Cadrin et al\(^{16}\) | Technological support (virtual physical therapy) | Postoperative | Randomized | Patients participating in tele-prehabilitation reported high satisfaction. No difference in patient-reported outcomes when compared to usual in person care. | Satisfaction, patient reported function | No |
| McDonall et al\(^{17}\) | Technological support (care pathway management) | Postoperative | Randomized | Multimedia intervention lead to significantly lower mean pain intensity scores postoperatively and reduced length of hospital stay (**P** = .04). Use of technology-enhanced patient activation (**P** = .04), leads to higher satisfaction with care (**P** = .01), and a higher likelihood to refer others to health services (**P** = .02). | Patient-reported pain, hospital length, satisfaction, patient experience | No |
| Castle et al\(^{18}\)   | Technological support (remote monitoring) | Follow-up | Methods comparison | Found to be a reliable measure of knee range of motion to remotely monitor patients. | Patient experience, range of motion | No |
| Boland et al\(^{19}\)   | Decision making (decision aids) | Clinic visit | Randomized | Patients who used the decision aid were more likely to make better-quality decisions at an academic site compared to community site. Academic site also had longer consultations and more verbal education. | Decision quality, visit duration | Yes |
| Sepucha et al\(^{20}\)  | Decision making (decision aids) | Clinic visit | Cohort | Decision aid use was associated with higher knowledge scores and shared decision making. Most patients received their preferred treatment (no difference by decision aid use). Surgical rates were lower for those who received decision aids. | Knowledge of condition, treatment preference | Yes |

(continued)
Table 1. (continued)

| Study by publication year | Engagement method | Care delivery phase | Study design | Results | Relevant outcomes | Conflict of interest/disclosure |
|---------------------------|-------------------|---------------------|--------------|---------|-------------------|--------------------------------|
| de Jesus et al\textsuperscript{21} | Decision making (decision aids) | Clinic visit | Prospective | 77.8% of patients reported that the decision aid helped them make decision between unicompartmental knee arthroplasty and total knee arthroplasty. | Treatment preference | Yes |
| Trenaman et al\textsuperscript{22} | Decision making (decision aids) | Clinic visit | Randomized | The use of decision aid leads to fewer surgeries over the 2-year period reducing cost per patient, while providing additional quality-adjusted life year per patient. | Treatment preference, cost, patient experience (quality-adjusted life year) | No |
| Zheng et al\textsuperscript{23} | Technological support (care pathway management) | Qualitative | | Patients liked to be engaged by progress reports and educational advices. Both patients and clinicians found summary reports of symptoms changing over time helpful. | Satisfaction | Yes |
| Jayakumar et al\textsuperscript{24} | Technological support (care pathway management) | Case control | | Patient-focused technology-enabled program lead to lower costs for patients and reduced length of stay without impacting outcomes | Hospital length, cost, patient-reported function | Yes |
| Ibrahim et al\textsuperscript{25} | Decision making (decision aids) | Clinic visit | Randomized | Use of decision aid increased rates of total knee replacement among Black patients. However, rates of recommendation for surgery did not differ significantly. | Treatment preference | No |
| Stacey et al\textsuperscript{26} | Decision making (decision aids) | Clinic visit | Randomized | Compared to controls, patients using decision aid had shorter wait times, fewer surgeries, and higher decision quality. Results were not statistically significant. | Visit duration, treatment preference, decision quality | Yes |
| Barlow et al\textsuperscript{27} | Decision making (decision aids) | Clinic visit | Qualitative | Evaluation of how prediction tools impact patient decision making. Found to have better effect earlier in care cycle. May be subject to optimism bias if patients are predicted to have poor outcomes. | Treatment preference | Yes |
| Shue et al\textsuperscript{28} | Decision making (decision aids) | Clinic visit | Randomized | Comparison of 2 decision aids (booklet-only vs booklet with DVD). While both were effective in improving patient knowledge and willingness to participate in the decision process, the addition of the DVD did not statistically improve patient acceptance or knowledge. | Knowledge of condition, treatment preference | No |
| Washington and Shacklady\textsuperscript{29} | Decision making (decision aids) | Clinic visit | Prospective | Patient felt both clinic discussion and decision aid were easy to understand, but the decision aid improved understanding of osteoarthritis. | Knowledge of condition | No |

(continued)
Results

The search identified 31 studies aimed at patient engagement methods in TJA (Table 1).

Engagement Focused on Decision Making

We found 19 engagement methods focused on decision making (decision aids, \( n = 19 \)). Evaluation of engagement focused on decision making was centered around knowledge of condition, treatment preferences, decision quality, and surgical rate. Tools were primarily utilized preoperatively to inform shared decision making. The application of decision aids was found to improve patient knowledge scores, as well as increase patient confidence in knowing what questions to ask their doctors.\(^9\,20,21,34\) Stacey et al\(^{33}\) found that patients exposed to a decision aid made an informed choice that is consistent with their values (56.4% vs 25.0%; \( P < .001 \)).

Overall, authors of the various studies published on patient-focused engagement tools have mostly reported increased patient knowledge, higher confidence, a greater possibility of making an informed treatment decision that aligns with their goals, values, and preferences (Table 1 expands on the conclusions of each study).

Engagement Focused on Technological Support

We found 12 engagement methods which utilize technological support (virtual physical therapy/remote education \( [n = 5] \), care pathway management \( [n = 4] \), remote monitoring \( [n = 3] \)). Themes of engagement methods focused on technology were
functional prerehabilitation/rehabilitation, remote monitoring of patients, educational media, and patient support through care pathway management. Engagement through technological tools was predominantly used postoperatively or to follow-up. Authors of prior studies have reported it may offer a platform to support patient participation in their recovery after TJA. Virtual rehabilitation in one prior study led to better health outcomes and reduced cost burden after TJA. Further, technology-enabled patient engagement solutions may progress quality assessments such as length of stay and rates of reoperation within 60 days.13 Overall, authors of the various studies have mostly reported lower costs, shorter length of stays, and higher patient satisfaction and experience (Table 1 expands on the relevant results and outcomes of each study).

Discussion
Slover et al36 previously noted that, despite the increased attention paid to patient engagement methods, few studies have been directly focused on its impact on TJA. Our review of the past 20 years found that most of the applications of patient engagement methods in TJA have come in the last 5 years (2015-2020), with authors of the various studies reporting a number of benefits (eg, patient-reported outcomes, patient experience and satisfaction, decision-related outcomes, eg, quality, patient involvement, treatment concordance) to all stakeholders with respect to TJA.

Engagement methods focused on decision making have been effective in promoting patient-centered care in TJA. For example, patients exposed to a decision aid made an informed choice that is consistent with their values.33 This is vital, as treatment decisions tailored to the patient’s preferences (patient-centered) may lead to better health outcomes and improved experience (higher satisfaction and met expectations).20,37 Promising work in artificial intelligence can enhance decision making with generated personalized predictions using prior patient reported outcome measures, patient clinical risk factors, and psychosocial risk factors (depression, patient activation).38-40 Personalized predictions provide an additional metric to engage patients, and guide discussions about surgical appropriateness and postoperative expectations. Importantly, engagement methods focused on decision making can be introduced into the clinical setting without impacting efficiency of the office visits, which benefits all stakeholders.9,30,34

The use of technology (eg, mobile applications or telemonitoring) to enhance patient engagement may play a critical role during various phases of care delivery (follow-up, postoperative). Authors of prior studies have reported it may offer a platform to involve patients remotely and support participation (ie, increased activation) in their recovery after TJA. Virtual rehabilitation may provide a high-value alternative for patients with disability or lack of transportation.5 Further, engagement methods utilizing technology may improve quality measures such as length of stay and rates of reoperation within 60 days.13 In addition, mobile and online tools may be used to connect patients with accurate, accessible health information regarding their postoperative course. This may prevent misinterpretation of symptoms. Authors of several studies report this method of engagement may promote a healthy mindset and positive recovery environment, as well as reduce follow-up calls.14,15,41 Future work should focus on clear clinical guidelines for the indications of a mobile app to engage patients, as well as expansion of mobile feedback mechanism from patients.

Our study was not without limitations. Heterogeneity of the outcome measures and variation in patient engagement methods may limit generalizability. Further, differences in patient characteristics, and geographic settings made it difficult to evaluate and compare papers. However, our findings show that the magnitude of the findings might differ between papers, but the specific associations were mostly aligned between studies.

Conclusions
Based on our review of 31 studies, the conclusions therein strongly suggest that patient engagement methods in TJA demonstrate benefits throughout care delivery. We encourage orthopedic surgeons to continue researching the effect of patient engagement through tools focused on promoting involvement in decision making and accessible care delivery (eg, virtual rehabilitation, remote monitoring). Future work should understand the influence of social determinants on patient involvement in care, and overall cost (or savings) of engagement methods to patients and society.42,43

Ethical Review Committee Statement
Institutional Review Board approval is not required.

Statement of Human and Animal Rights
All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.5

Informed Consent Statement
Informed consent was not obtained as no individual participants were included in the study.

Disclosures
Aaron Alokozai and Dr Linsen Samuel have nothing to disclose. Dr David Bernstein reports grants from AOAS, grants from AOA, outside the submitted work. Dr Atul Kamath reports personal fees and other from Zimmer Biomet, personal fees from DePuy Synthes, personal fees and other from Corin, personal fees from Heraeus Medical, personal fees and other from Pacira Pharmaceuticals, other from Johnson & Johnson, other from Procter & Gamble, personal fees from Innomed, other from Aaos, other from AAHKS, other from BMC Musculoskeletal Disorders, outside the submitted work.
Declaration of Conflicting Interests

The authors declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: AA and LTS have nothing to disclose. DNB discloses the following: Clinical Orthopedics and Related Research: Editorial or governing board; Institute for Strategy and Competitiveness at Harvard Business School: Employee Journal of Orthopedic Experience & Innovation: Editorial or Governing Board. AFK discloses the following: AAOS: Board or Committee Member American Association of Hip and Knee Surgeons: Board or Committee Member; Anterior Hip Foundation: Board or Committee Member; BodyCad: Paid Consultant DePuy, A Johnson & Johnson Company: Paid Consultant; Paid Presenter or Speaker; Innomed: IP Royalties; Johnson & Stock: Stock or Stock Options Ortho Development: Paid Consultant; Procter & Gamble: Stock or Stock Options; Signature Orthopedics: Research Support; United Ortho: Paid Consultant Zimmer: Paid Consultant; Paid Presenter or Speaker; Stock or Stock Options.

Funding

The authors received no financial support for the research, authorship and/or publication of this article.

ORCID iDs

Aaron Alokozai 1 https://orcid.org/0000-0002-9068-9600
Atul F. Kamath 2 https://orcid.org/0000-0002-9214-2756

References

1. Neuprez A, Neuprez AH, Kauj XF, Kurth W, Daniel C, Thirion T, et al. Total joint replacement improves pain, functional quality of life, and health utilities in patients with late-stage knee and hip osteoarthritis for up to 5 years. Clin Rheumatol. 2020; 39:861-71.
2. Mainard D, Guillemin F, Cuny C, Mejat-Adler E, Galois L, Delagoutte J. [Quality of life assessment one year after total hip or knee arthroplasty]. Rev Chir Orthop Reparatrice Appar Mot. 2000;86:464-73. Available from: http://www.ncbi.nlm.nih.gov/pubmed/10970970
3. Bumpass DB, Nunley RM. Assessing the value of a total joint replacement. Curr Rev Musculoskelet Med. 2012;5:274-82.
4. Riddle DL, Jiranek WA, Hayes CW. Use of a validated algorithm to judge the appropriateness of total knee arthroplasty in the United States: a multicenter longitudinal cohort study. Arthritis Rheumatol. 2014. doi: 10.1002/art.38685
5. Prvu Bettger J, Green CL, Holmes DJN, Chokshi A, Mather RC, Hoch BT, et al. Effects of virtual exercise rehabilitation in-home therapy compared with traditional care after total knee arthroplasty: VERITAS, a randomized controlled trial. J Bone Joint Surg Am. 2020. doi: 10.2106/JBJS.19.00695
6. Hurley VB, Wang Y, Rodriguez HP, Shortell SM, Kearing S, Savitz LA. Decision aid implementation and patients’ preferences for hip and knee osteoarthritis treatment: insights from the high value health care collaborative. Patient Prefer Adherence. 2020. doi: 10.2147/PPA.S227207
7. Trenaman L, Stacey D, Bryan S, Payne K, Hawker G, Bansback N. Long-term effect of patient decision aids on use of joint replacement and health care costs. Osteoarthr Cartil. 2020. doi: 10.1016/j.joca.2020.01.019
8. Hoogland J, Wijnen A, Munsterman T, Gerritsma CLE, Dijkstra B, Zijlstra WP, et al. Feasibility and patient experience of a home-based rehabilitation program driven by a tablet app and mobility monitoring for patients after a total hip arthroplasty. JMIR mHealth uHealth. 2019. doi: 10.2196/10342
9. Sepucha K, Bedair H, Yu L, Dorrwacher JM, Dwyer M, Talmo CT, et al. Decision support strategies for hip and knee osteoarthritis: less is more: a randomized comparative effectiveness trial (DECIDE-OA study). J Bone Joint Surg Am. 2019. doi: 10.2106/JBJS.19.00004
10. Cronström A, Dahlberg LE, Nero H, Hammarlund CS. “I was considering surgery because I believed that was how it was treated”: a qualitative study on willingness for joint surgery after completion of a digital management program for osteoarthritis. Osteoarthr Cartil. 2019. doi: 10.1016/j.joca.2019.04.004
11. Mangla M, Bedair H, Dwyer M, Freiberg A, Sepucha K. Pilot study examining feasibility and comparing the effectiveness of decision aids for hip and knee osteoarthritis: a randomized trial. MDM Policy Pract. 2019;4(1):238146831982727.
12. Wang X, Hunter DJ, Vesentini G, Pozzobon D, Ferreira ML. Technology-assisted rehabilitation following total knee or hip replacement for people with osteoarthritis: a systematic review and meta-analysis. BMC Musculoskelet Disord. 2019. doi: 10.1186/s12891-019-2900-x
13. Higgins M, Jayakumar P, Kortlever JTP, Rijk L, Galvain T, Drury G, et al. Improving resource utilisation and outcomes after total knee arthroplasty through technology-enabled patient engagement. Knee. 2019. Available from: http://www.ncbi.nlm.nih.gov/pubmed/31767514
14. Gollish JD, Pereira L, MacLeod AM, Wainwright A, Kennedy D, Robarts S, et al. My hip & knee: improving patient engagement and self-management through mobile technology. Healthc Q 2019;22:63-7.
15. Yahanda AT, Marino NE, Barron J, Concepcion A, St John T, Lu K, et al. Patient engagement and cost savings achieved by automated telemonitoring systems designed to prevent and identify surgical site infections after joint replacement. Telemed e-Health. 2019;25(2):143-51.
16. Doiron-Cadrin P, Kairy D, Venditti PA, Lowry V, Poitras S, Desmeules F. Feasibility and preliminary effects of a tele-prehabilitation program and an in-person prehabilitation program compared to usual care for total hip or knee arthroplasty candidates: a pilot randomized controlled trial. Disabil Rehabil. 2020. doi: 10.1080/09638288.2018.1515992
17. McDonall D, Kairy D, Venditti PA, Lowry V, Poitras S, Desmeules F. Technology-assisted rehabilitation following total knee or hip arthroplasty: less is more: a randomized comparative effectiveness trial (DECIDE-OA study). J Bone Joint Surg Am. 2019. doi: 10.2106/JBJS.19.00004
18. Castle H, Kozak K, Sidhu A, Khan RJK, Haebech S, Bowden V, et al. Smartphone technology: a reliable and valid measure of knee movement in knee replacement. Int J Rehabil Res. 2018. doi: 10.1097/MRR.0000000000000276
19. Boland L, Taljaard M, Dervin G, Trenaman L, Tugwell P, Pomey MP, et al. Effect of patient decision aid was influenced by presurgical evaluation among patients with osteoarthritis of the knee. Can J Surg. 2017;60(6):3316.

20. Sepucha K, Atlas SJ, Chang Y, Dorrwachter J, Freiberger A, Mangla M, et al. Patient decision aids improve decision quality and patient experience and reduce surgical rates in routine orthopaedic care. J Bone Jt Surg - Am Vol. 2017. doi: 10.2106/JBJS.16.01045

21. de Jesus C, Stacey D, Dervin GF. Evaluation of a patient decision aid for unicompartimental or total knee arthroplasty for medial knee osteoarthritis. J Arthroplasty. 2017;32:3340-4.

22. Trenaman L, Stacey D, Bryan S, Taljaard M, Hawker G, Dervin G, et al. Decision aids for patients considering total joint replacement: a cost-effectiveness analysis alongside a randomised controlled trial. Osteoarthr Cartil. 2017. doi: 10.1016/j.joca.2017.05.022

23. Zheng H, Tulu B, Choi W, Franklin P. Using mHealth app to support treatment decision-making for knee arthritis: patient perspective. eGEMs (Generating Evid Methods to Improv Patient Outcomes. 2017. doi: 10.13063/2327-9214.1284

24. Jayakumar P, Di J, Fu J, Craig J, Goughn V, Nadarajah V, et al. A patient-focused technology-enabled program improves outcomes in primary total hip and knee replacement surgery. JBJS Open Access. 2017. doi: 10.2106/jbjs.oa.16.00023

25. Ibrahim SA, Blum M, Lee GC, Moad P, Medvedeva E, Collier A, et al. Effect of a decision aid on access to total knee replacement for black patients with osteoarthritis of the knee a randomized clinical trial. JAMA Surg. 2017;152. doi: 10.1001/jamasurg.2016.4225

26. Stacey D, Taljaard M, Dervin G, Tugwell P, O’Connor AM, Pomey MP, et al. Impact of patient decision aids on appropriate and timely access to hip or knee arthroplasty for osteoarthritis: a randomized controlled trial. Osteoarth Cartil. 2016. doi: 10.1016/j.joca.2015.07.024

27. Barlow T, Scott P, Griffin D, Realpe A. How outcome prediction could affect patient decision making in knee replacements: a qualitative study. BMC Musculoskelet Disord. 2016. doi: 10.1186/s12891-016-1165-x

28. Shue J, Karia RJ, Cardone D, Samuels J, Shah M, Slover JD. A randomized controlled trial of two distinct shared decision-making aids for hip and knee osteoarthritis in an ethnically diverse patient population. Value Health. 2016;19(4):478-93.

29. Washington K, Shacklady C. Patients’ experience of shared decision making using an online patient decision aid for osteoarthritis of the knee—a service evaluation. Musculoskeletal Care. 2015. doi: 10.1002/msc.1086

30. Elwyn G, Pickles T, Edwards A, Kinsey K, Brain K, Newcombe RG, et al. Supporting shared decision making using an option grid for osteoarthritis of the knee in an interface musculoskeletal clinic: a stepped wedge trial. Patient Educ Couns. 2016;99(4):571-7.

31. Youm J, Chan V, Belkora J, Bozic KJ. Impact of socioeconomic factors on informed decision making and treatment choice in patients with hip and knee OA. J Arthroplasty. 2015. doi: 10.1016/j.arth.2014.09.006

32. Volkmann ER, Fitzgerald JD. Reducing gender disparities in post-total knee arthroplasty expectations through a decision aid. BMC Musculoskeletal Disorders. 2015. doi: 10.1186/s12891-015-0473-x

33. 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 Musculoskeletal Disorders. 2014;15(1). doi: 10.1186/1471-2474-15-54

34. Bozic KJ, Bellora 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 Jt Surg - Ser A. 2013;95(18):1633-9.

35. Weng HH, Kaplan RM, Boscarin WJ, MacLean CH, Lee IY, Chen W, et al. Development of a decision aid to address racial disparities in utilization of knee replacement surgery. Arthritis Rheum. 2007;57(4):568-75. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17471558

36. Slover J, Alvarado C, Nelson C. Shared decision making in total joint replacement. JBJS Rev. 2014;2(3):1.

37. Sepucha KR, Atlas SJ, Chang Y, Freiberger A, Malchau H, Mangla M, et al. Informed, patient-centered decisions associated with better health outcomes in orthopedics: prospective cohort study. Med Decis Making 2018;38:1018-26.

38. Jayakumar P, Bozic KJ. Advanced decision-making using patient-reported outcome measures in total joint replacement. J Orthop Res. 2020. Available from: http://www.ncbi.nlm.nih.gov/pubmed/31994752

39. Kunze KN, Karhade AV, Sadauskas AJ, Schwab JH, Levine BR. Development of machine learning algorithms to predict clinically meaningful improvement for the patient-reported health state after total hip arthroplasty. J Arthroplasty. 2020. doi: 10.1016/j.arth.2020.03.019

40. Price A, Smith J, Dakin H, Kang S, Eibich P, Cook J, et al. The arthroplasty candidacy help engine tool to select candidates for hip and knee replacement surgery: development and economic modelling. Health Technol Assess (Rockv). 2019;23(32):vii-216. Available from: http://www.ncbi.nlm.nih.gov/pubmed/31287051

41. Ring D, Johnston SC. Your best life: resiliency and the art of medicine. Clin Orthop Relat Res. 2018;476:937-9.

42. Martinez-Siekavizza SN, Winter SC, Barchi F. Pilot survey of orthopaedic physicians regarding shared decision making in elbow surgery. J Orthop Surg - Ser A. 2013;95(18):1633-9.

43. Légaré F, Ratté S, Stacey D, Kryworuchko J, Gravel K, Graham ID, et al. Interventions for improving the adoption of shared decision making by healthcare professionals. Cochrane Database Syst Rev. 2010 May 12;(5):CD006732. doi: 10.1002/14651858.CD006732.pub2. Update in: Cochrane Database Syst Rev. 2014;9:CD006732. PMID: 20464744.

**Author Biographies**

Aaron Alokozai is a medical student at Tulane University School of Medicine. He was previously awarded the Dell Medical School...
Value-Based Care Delivery Summer Fellowship, where he investigated topics relevant to designing, implementing, and disseminating value-based care delivery models in orthopaedic surgery.

David N. Bernstein is an orthopaedic surgery resident at the Harvard Combined Orthopaedic Residency Program (HCORP) in Boston, MA. He is a former senior researcher in Value-Based Health Care at Professor Michael Porter’s Institute For Strategy And Competitiveness at Harvard Business School.

Linsen T. Samuel is a clinical research fellow in the Department of Orthopaedic Surgery at the Cleveland Clinic Foundation. His research interests include the investigation of reimbursement models in adult reconstruction, as well as analysis of differing approaches to total hip arthroplasty.

Atul F. Kamath is a professor of Orthopaedic Surgery at the Cleveland Clinic Lerner College of Medicine and Case Western Reserve University School of Medicine. He also serves as the Director of the Center for Hip Preservation at the Cleveland Clinic Foundation, where he also serves as the Director for Adult Reconstruction Research in the Department of Orthopaedic Surgery. His focus of research is on young hip preservation modalities and on the anterior approach to total hip arthroplasty.