Association of patient engagement strategies with utilisation and spending for musculoskeletal problems in the USA: a cross-sectional analysis of Medicare patients and physician practices

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ABSTRACT

Objective Musculoskeletal problems like hip and knee osteoarthritis and low-back pain are preference sensitive conditions. Patient engagement strategies (PES), such as shared decision-making and motivational interviewing, can help align patients’ preferences with treatment options and potentially reduce spending. We assess the association of physician practice-level adoption of PES with utilisation and spending.

Design Cross-sectional study in which patients were matched across low, moderate and high levels of PES via coarsened exact matching.

Setting Primary and secondary care in 2190 physician practices.

Participants 39 336 hip, 48 362 knee and 67 940 low-back patients who were Medicare beneficiaries were matched to the 2017–2018 National Survey of Healthcare Organizations and Systems.

Primary and secondary outcome measures Total hip replacement (THR), total knee replacement (TKR), 1–2 level posterior lumbar fusion (LF), total annual spending, components of total annual spending.

Results Total annual spending for patients with musculoskeletal problems did not differ for practices with low versus moderate PES, low versus high PES or moderate versus high PES, but spending was significantly lower in some categories for practices with relatively higher PES adoption. For hospital-owned and health system-owned practices, the ORs of receiving LF were 0.632 (95% CI 0.398 to 1.009) for patients attributed to practices with high PES compared with patients attributed to practices with moderate PES. For independent practices, the odds of receiving THR were 1.403 (95% CI 1.035 to 1.902) for patients attributed to practices with moderate PES compared with patients attributed to practices with low PES.

Conclusions Practice-level adoption of PES for patients with musculoskeletal problems was generally not associated with total spending. PES, however, may steer patients toward evidence-based treatments. Opportunities for overall spending reduction exist as indicated by the variation in the subcomponents of total spending by PES adoption.

INTRODUCTION

Patient engagement strategies (PES)—which include shared decision-making (SDM) and motivational interviewing—help align patients’ preferences with treatment options for preference sensitive conditions and can support the provision of patient-centred care. Studies of SDM—particularly randomised controlled trials—find that patients engaged in SDM are more likely to choose conservative treatment options over surgical intervention. However, there is a dearth of research examining the
association of physician practice-level adoption of PES with utilisation and spending.

Although previously associated with reduced healthcare costs via lower utilisation of surgical or other invasive treatments, PES may increase rather than decrease spending in the short run because patients may opt for recommended screenings and procedures that increase spending. This effect may be exacerbated by the fact that some decision aids used as part of PES may have been developed by or in conjunction with pharmaceutical or device companies and could potentially reflect a conflict of interest. A similar conflict of interest may occur with respect to systems whose hospitals benefit from providing surgical interventions. One study of hospitalised patients facing surgery choices found that the introduction of SDM increased the number of surgical interventions. Similarly, a recent study of patients with hip or knee osteoarthritis within 10 healthcare systems found that hip patients who received decision aids had two and a half times the odds of undergoing surgery and knee patients who received decision aids had nearly twice the odds of surgery compared with propensity score matched comparison groups. These findings highlight that practice-level adoption of PES may be associated with greater spending because upfront financial investments are often needed to support PES whether in the form of materials such as decision aids to enable SDM conversations or process redesigns at the practice level to facilitate capacity—sometimes through additional hiring of clinical support staff. Even if operational costs increase in the short run with SDM implementation, this may not be undesirable if the ultimate goal of strategies such as SDM is to facilitate patient involvement in treatment decision-making such that the rates of invasive treatment options are reflective of patients’ voices in concert with professional judgement.

We estimate the association of physician practice-level adoption of PES for patients with hip osteoarthritis, knee osteoarthritis, or low-back pain on utilisation and spending among Medicare fee-for-service beneficiaries. Total hip replacement (THR) (for treatment of hip osteoarthritis) and total knee replacement (TKR) (for treatment of knee osteoarthritis) are associated with improved long-term clinical outcomes, whereas the evidence supporting the effectiveness of 1–2 level posterior lumbar fusion (LF) (for treatment of low-back pain) is mixed, with one 11-year follow-up study of three randomised controlled trials finding no difference in patient-reported outcomes between LF and exercise therapy.

Prior research has also demonstrated that total spending is higher among hospital-owned or health-system owned practices versus independent physician practices. As more independent practices are vertically integrated under hospital or health-system ownership, there are expanded incentives to increase utilisation of services for Medicare beneficiaries because the programme reimburses outpatient care at a higher rate for hospital-based outpatient care compared with free-standing independent practices. Among health-system owned practices, imaging and medical equipment have been highlighted as two key areas of greater utilisation compared with independent practices. Given health-system-level incentives for maintaining utilisation and spending, PES may not have an effect on reducing utilisation and spending.

To examine this, we estimate the association of practice ownership with spending and utilisation in the context of practice adoption of PES. In light of evidence demonstrating that THR and TKR tend to result in more positive outcomes compared with LF, we hypothesise that patients attributed to physician practices with relatively high adoption of PES will have greater utilisation of THR and TKR and higher annual spending for hip patients and knee patients compared with patients attributed to practices with lower adoption of PES. In contrast, we hypothesise that patients attributed to physician practices with relatively high adoption of PES will have lower utilisation of LF and lower spending for low-back patients compared with patients attributed to practices with relatively lower adoption of PES.

This study is the first national study to link adoption of PES with claims-derived outcome measures (eg, spending, utilisation). Previous studies of SDM indicate cherry-picking of patients receiving SDM, resulting in selection bias, or use regression controls versus propensity score weighting to handle potential biases. From a methodological perspective, we advance SDM research through the use of coarsened exact matching as a robust method for handling potential selection bias.

METHODS

Data

We linked anonymised 2017 patient-level Medicare claims data to the 2017/18 National Survey of Healthcare Organizations and Systems (NHSOS) and IQVIA OneKey Data to estimate the association of physician practice-level adoption of PES with spending and utilisation for older adults with hip, knee, and/or low-back problems. We attributed patients to practices using methods similar to those the Centers for Medicare & Medicaid Services (CMS) uses as part of their Medicare Shared Savings Program (MSSP), which is a well-documented and widely accepted method for assigning patients to healthcare providers. This method is based on where patients receive the plurality of their primary care. All physician and non-physician providers that bill qualifying evaluation and management (E&M) codes are included in the attribution. Mirroring the MSSP regulations for prioritising attribution to a primary care provider (PCP), we attributed beneficiaries to PCPs in practices that provided the plurality of the beneficiary’s qualifying E&M visits. Beneficiaries without qualifying E&M visits to a PCP were then attributed to the specialist providers (non-PCP) with whom they have a plurality of qualifying E&M visits. We attributed patients to practices using the National Provider Identifier (NPI)-OneKey crosswalk. NPIs in...
OneKey are directly affiliated with practices, so these NPI-OneKey pairs were the crosswalk between NPIs and OneKey practices. Patients that could not be attributed to an OneKey practice were instead attributed via a tax identification number or CMS certification number.

International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) diagnostic codes were used to define inclusion and exclusion criteria for older adult patients with hip, knee and/or low-back problems (online supplemental appendix 1). The final sample (n=155 638) included 39 336 hip, 48 362 knee and 67 940 low-back patients.

**Measures**

Outcome variables include both dollar-denominated spending variables and binary indicators of utilisation. Dollar-denominated variables include total allowed payments and relevant component payments for durable medical equipment, imaging, E&M, procedures, testing, facilities, acute care/critical access hospitals, complex post acute-care skilled nursing facilities, skilled nursing/rehabilitation, ordinary home health, complex postacute care home health, hospice and other. Binary outcome variables include utilisation measures of THR, TKR and LF.

We measure PES using a composite measure of nine NSHOS questions assessing adoption and extent of implementation of motivational interviewing and SDM. The main independent variable is a PES composite (range: 0–9) measure. To derive the measure, numerical scores assigned to the answers to nine questions were summed: (1) does your practice have clinicians/staff formally trained in motivational interviewing (0=none, 1=clinicians only, 2=staff only, 3=clinicians and staff); (2) do physicians and/or staff in your practice routinely use motivational interviewing to aid with behaviour change for weight loss/diet (0=no, 1=yes); (3) do physicians and/or staff in your practice routinely use motivational interviewing to aid with behaviour change for increase in physical activity (0=no, 1=yes); (4) do physicians and/or staff in your practice routinely use motivational interviewing to aid with behaviour change for medication adherence (0=no, 1=yes); (5) considering the physicians and staff in your practice, how many are formally trained in SDM (0=none, 1=some, 2=most, 3=all); (6) considering the physicians and staff in your practice, how many routinely engage in SDM (0=none, 1=some, 2=most, 3=all); (7) considering the physicians and staff in your practice, how many routinely use decision aids (0=none, 1=some, 2=most, 3=all); (8) considering the physicians and staff in your practice, how many routinely engage in SDM (0=none, 1=some, 2=most, 3=all); and (9) how many eligible patients receive decision aids before making a decision about osteoarthritis (hip or knee replacement) treatment (0=none, 1=some, 2=most, 3=all)? Scores were divided into low (0%–25%), medium (26%–66%) and high (>67%) categories for sensitivity analysis purposes.

**Statistical methods**

We employed coarsened exact matching. When using coarsened exact matching, continuous variables are converted into meaningful segments. All relevant variables are then matched, such that only the treatment variable varies across the matched groups. A simple comparison of means between the treatment and comparison groups was conducted using a two-variable regression model, which provides an estimate of the average treatment association. This approach limits the extent to which the average treatment association is model dependent and balances all linear and nonlinear relationships as well as all interactions between variables. Moreover, this approach limits the sample to data that are on the common support and is approximately invariant to measurement error.

A key assumption in matching approaches, including coarsened exact matching, is that treatment assignment is ignorable conditional on included covariates or in our case, the set of variables we are matching on. The methodology assumes there are no unmeasured confounders or omitted variables such that treatment assignment is independent of potential outcomes. To the extent there are important variables that are both not available to match on and also correlate with both PES and outcomes; bias may still occur. In this study, we do not have access to clinical information on the severity of a given musculoskeletal condition. This could result in bias if, for example, more clinically severe patients are more likely to have surgery or are more costly to treat and also are more likely to be established patients in high PES practices. Since PES is measured at the practice level, if more clinically severe patients are more likely to be treated in hospital-owned/system-owned practices relative to independent practices, we would expect PES to have larger associations with the probability of surgical intervention and total expenditures at hospital-owned/system-owned practices relative to independent practices, other things equal. There is no clear prediction regarding the components of total expenditures.

Available matching variables were chosen to include the following categories known to be associated with variation in medical decision making: demographics, medical conditions (different patients have different medical care preferences), geographical area and physician practice characteristics (physician preferences affect medical care). We matched on sex, age category (65–69, 70–74, 75–79, 80–84, 85 or greater), race/ethnicity (white, black, Hispanic, other), at or below the federal poverty level, dual eligible, disabled, more than three hierarchical condition categories, congestive heart failure, coronary artery disease, diabetes, cancer, chronic obstructive pulmonary disease, end-stage renal disease, mental illness, population density (suburban, large town, small town, isolated
rural area), census region (west, midwest, northeast, south), organisation (physician-owned, federally qualified health centre, nursing facility, other organisation), number of physicians in organisation (0–7, 8–12, 13–19, 20–99, 100 or more), percentage of physicians engaged in primary care (0%–32%, 33%–99%, 100%), percentage of patient care revenue from Medicaid (0, 1%–29%, 30% or greater), and accountable care organisation affiliation. Matching was performed separately for each class of patients (hip, knee, low back) within two categories of organizations (independent versus hospital- or health-system owned). Cut-points for the percentage of physicians engaged in primary care follows earlier work that uses 33%–99% to designate multispecialty practices and 100% to designate primary care practices, and cut-points for the percentage of patient care revenue from Medicaid also follows earlier work. After matching, patients thus only varied with respect to their practice PES index level. All combinations of the practice-level PES index were compared: low to moderate, moderate to high and high to low. When using coarsened exact matching, continuous variables are converted into meaningful segments. This approach limits the extent to which the average treatment effect is model dependent, and balances all linear and nonlinear relationships as well as all interactions between variables. Moreover, this approach limits the sample to data that are on the common support and is approximately invariant to measurement error.

Using these matched data, we applied logistic regression to determine the ORs for binary outcomes and generalised linear regression with a log link and a gamma distribution of dollar-denominated outcomes to determine marginal associations. The latter was used to examine total spending and components of spending to assess whether specific spending categories are more strongly associated with higher PES. All regressions include robust standard errors and were performed using Stata V.15.

**Patient and public involvement**

No patient involved.

### RESULTS

Descriptive statistics are presented in online supplemental appendix 1 and are presented by hospital-owned and health-system owned practices, and independent practices for each pairwise comparison of PES: high versus low PES, high versus moderate PES, and moderate versus low PES. These statistics only present matched observations and are on the common support.

Two statistically significant differences are found with regard to receiving surgery. Among practices owned by hospitals or health systems, the odds of patients receiving

| Variables | (1) | (2) | (3) |
|-----------|-----|-----|-----|
| Hip Replacement Surgery | OR (95% CI) | OR (95% CI) | OR (95% CI) |
| High versus low PES | 1.063 (0.885 to 1.253) | 1.013 (0.771 to 1.331) | 0.826 (0.451 to 1.513) |
| Observations | 4857 | 6189 | 8975 |
| High versus mod PES | 0.817 (0.617 to 1.082) | 0.997 (0.829 to 1.199) | 0.632 (0.396 to 1.009) |
| Observations | 8032 | 9705 | 13 794 |
| Mod versus low PES | 1.016 (0.806 to 1.281) | 1.09 (0.915 to 1.298) | 0.869 (0.608 to 1.241) |
| Observations | 10 260 | 11 832 | 17 414 |

| Hospital/health-system owned practices | | | |
|----------------------------------------|-----|-----|-----|
| High versus low PES | 0.91 (0.600 to 1.379) | 0.985 (0.759 to 1.278) | 1.366 (0.794 to 2.350) |
| Observations | 3643 | 4541 | 6173 |
| High versus mod PES | 1.174 (0.835 to 1.650) | 1.064 (0.853 to 1.327) | 0.789 (0.501 to 1.243) |
| Observations | 5674 | 7476 | 10 392 |
| Mod versus low PES | 1.403 (1.035 to 1.902) | 0.978 (0.786 to 1.217) | 1.278 (0.842 to 1.940) |
| Observations | 6870 | 8619 | 11 192 |

Bold denotes statistically significant relationship (p ≤ 0.05).

Logistic regression using coarsened exact matching.

PES, patient engagement strategies.
|                          | Total allowed payments | Durable medical equipment payments | Imaging payments | Evaluation and management payments |
|--------------------------|------------------------|------------------------------------|-----------------|-------------------------------------|
|                          | 95% CI                 | 95% CI                             | 95% CI          | 95% CI                             |
| **Total spending and durable medical equipment, imaging and evaluation and management spending components** | | | | |
| **Table 2**             |                       |                                    |                 |                                     |
| **Hip patients—spending (hospital/system-owned practices)** |                       |                                    |                 |                                     |
| High versus low PES     | 0.024 −0.103 to 0.152 | −0.554 −1.126 to 0.018            | −0.042 −0.157 to 0.074 | 0.02 −0.072 to 0.111 |
| Observations            | 4857                   | 4857                               | 4857            | 4857                                |
| High versus moderate PES| 0.027 −0.085 to 0.139  | −0.136 −0.45 to 0.178              | 0.225 0.142 to 0.308 | 0.109 0.027 to 0.191 |
| Observations            | 8032                   | 8032                               | 8032            | 8032                                |
| Moderate versus low PES  | −0.019 −0.103 to 0.065 | −0.335 −0.87 to 0.2                | −0.035 −0.099 to 0.029 | −0.043 −0.104 to 0.018 |
| Observations            | 10 260                 | 10 260                             | 10 260          | 10 260                              |
| **Knee patients—spending (hospital/system-owned practices)** |                       |                                    |                 |                                     |
| High versus low PES     | 0.009 −0.095 to 0.112  | −0.003 −0.269 to 0.264             | 0.017 −0.079 to 0.114 | 0.032 −0.043 to 0.106 |
| Observations            | 6189                   | 6189                               | 6189            | 6189                                |
| High versus moderate PES| 0.043 −0.04 to 0.127   | 0.008 −0.204 to 0.219              | 0.183 0.114 to 0.252 | 0.04 −0.035 to 0.114 |
| Observations            | 9705                   | 9705                               | 9705            | 9705                                |
| Moderate versus low PES  | 0.018 −0.055 to 0.091  | 0.003 −0.191 to 0.196              | 0.023 −0.043 to 0.089 | 0.042 −0.036 to 0.12 |
| Observations            | 11 832                 | 11 832                             | 11 832          | 11 832                              |
| **Low-back patients—spending (hospital/system-owned practices)** |                       |                                    |                 |                                     |
| High versus low PES     | 0.028 −0.07 to 0.126   | 0.094 −0.223 to 0.412              | 0.036 −0.033 to 0.106 | 0.01 −0.057 to 0.078 |
| Observations            | 8975                   | 8975                               | 8975            | 8975                                |
| High versus moderate PES| 0.08 −0.005 to 0.165   | 0.276 0.068 to 0.484               | 0.199 0.142 to 0.256 | 0.07 0.008 to 0.133 |
| Observations            | 13 794                 | 13 794                             | 13 794          | 13 794                              |
| Moderate versus low PES  | −0.01 −0.074 to 0.053  | 0.021 −0.166 to 0.208              | −0.01 −0.058 to 0.038 | −0.008 −0.059 to 0.043 |
| Observations            | 17 414                 | 17 414                             | 17 414          | 17 414                              |
| **Hip patients—spending (independent practices)** |                       |                                    |                 |                                     |
| High versus low PES     | 0.018 −0.153 to 0.189  | 0.028 −0.462 to 0.518              | −0.018 −0.132 to 0.096 | −0.04 −0.136 to 0.056 |
| Observations            | 3643                   | 3643                               | 3643            | 3643                                |
| High versus moderate PES| 0.103 −0.03 to 0.236   | −0.148 −0.477 to 0.181             | 0.035 −0.067 to 0.138 | 0.046 −0.052 to 0.144 |
| Observations            | 5674                   | 5674                               | 5674            | 5674                                |
| Moderate versus low PES  | −0.008 −0.122 to 0.107 | 0.074 −0.206 to 0.354              | 0.072 −0.02 to 0.164 | −0.002 −0.081 to 0.077 |
| Observations            | 6870                   | 6870                               | 6870            | 6870                                |
| **Knee patients—spending (independent practices)** |                       |                                    |                 |                                     |
| High versus low PES     | −0.054 −0.192 to 0.085 | −0.257 −0.624 to 0.11             | 0.03 −0.067 to 0.127 | −0.057 −0.14 to 0.026 |
| Observations            | 4541                   | 4541                               | 4541            | 4541                                |
| High versus moderate PES| 0.003 −0.098 to 0.103  | −0.04 −0.297 to 0.217              | 0.085 0.001 to 0.169 | 0.018 −0.062 to 0.098 |
| Observations            | 7476                   | 7476                               | 7476            | 7476                                |

Continued
LF surgery are 36.8% lower for patients attributed to practices with high PES relative to patients attributed to practices with moderate PES. Among patients attributed to independent practices, the odds of receiving THR are 40.3% higher for patients attributed to practices with moderate PES compared with patients attributed to practices with low PES. No other statistical differences in the odds of receiving versus not receiving surgery were found across the various pairwise comparisons of PES for THR, TKR and LF (table 1). However, there is no statistical difference in total spending across patients with hip problems, knee problems, or low-back problems when we compare low-to-moderate PES, low-to-high PES or moderate-to-high PES (table 2).

In spite of no overall spending differences, we find that the components of spending vary significantly by practice-level adoption of PES for musculoskeletal problems. The major spending categories are as follows: durable medical equipment, imaging, procedures, E&M, testing, facilities and home health (tables 2–4).

Durable medical equipment only varied statistically for low-back patients attributed to hospital-owned and health-system owned practices, where high versus moderate PES levels were associated with 27.6% higher payments. No association was found when varying levels of PES for either hip or knee patients in hospital-owned or health-system owned practices or for any patient category attributed to independent practices. See table 2.

With regard to imaging payments for patients attributed to hospital-owned or health-system owned practices, higher levels of PES were significantly and positively associated with higher payments (18.3%–22.5%) for all three patient types when comparing high versus moderate PES levels. This pattern was only present for knee patients attributed to independent practices (8.5%). See table 2.

For procedure payments among patients attributed to independent practices, this occurs for moderate versus low PES levels (11.5%). See table 3. For procedure payments among patients attributed to system-owned practices, higher levels of PES were significantly associated with higher payments for hip patients (10.9%) and low-back patients (71%) when comparing high versus moderate PES levels. This pattern was only present for knee patients attributed to independent practices (8.5%). See table 2.

With regard to imaging payments for patients attributed to hospital-owned or health-system owned practices, higher levels of PES were significantly and positively associated with lower PES levels when comparing low-back patients (10.9%) and low-back patients (71%) when comparing high versus low PES levels. This pattern was only present for hip patients attributed to independent practices (8.5%). See table 2.

For procedure payments among patients attributed to system-owned practices, higher levels of PES were significantly and positively associated with lower PES levels when comparing low-back patients (10.9%) and low-back patients (71%) when comparing high versus low PES levels. This pattern was only present for hip patients attributed to independent practices (8.5%). See table 2.
Table 3  Procedure, testing, facilities and hospital spending components

| Procedure payments | Testing payments | Facilities payments | Acute care/critical access hospital payments |
|--------------------|------------------|---------------------|---------------------------------------------|
| **95% CI**         | **95% CI**       | **95% CI**          | **95% CI**                                  |
| **Hip patients—spending (hospital/system-owned practices)** | **Knee patients—spending (hospital/system-owned practices)** | **Low-back patients—spending (hospital/system-owned practices)** | **Hip patients—spending (independent practices)** |
| High versus low PES | 0.08 (0.034 to 0.194) | −0.034 (−0.136 to 0.068) | 0.24 (0.067 to 0.413) | 0.189 (−0.056 to 0.434) |
| Observations | 4857 | 4857 | 4857 | 4857 |
| High versus moderate PES | 0.007 (−0.092 to 0.106) | 0.093 (0 to 0.185) | 0.319 (0.167 to 0.471) | −0.041 (−0.243 to 0.161) |
| Observations | 8032 | 8032 | 8032 | 8032 |
| Moderate versus low PES | −0.015 (−0.092 to 0.063) | −0.029 (−0.099 to 0.041) | 0.106 (−0.054 to 0.266) | 0.097 (−0.062 to 0.255) |
| Observations | 10 260 | 10 260 | 10 260 | 10 260 |
| High versus low PES | 0.0158 (−0.091 to 0.123) | −0.012 (−0.095 to 0.071) | 0.348 (0.167 to 0.529) | 0.035 (−0.198 to 0.269) |
| Observations | 6189 | 6189 | 6189 | 6189 |
| High versus moderate PES | 0.047 (−0.035 to 0.129) | 0.083 (0.011 to 0.155) | 0.449 (0.325 to 0.573) | 0.063 (−0.1 to 0.225) |
| Observations | 9705 | 9705 | 9705 | 9705 |
| Moderate versus low PES | 0.0431 (−0.023 to 0.11) | −0.013 (−0.07 to 0.045) | 0.203 (0.084 to 0.322) | 0.019 (−0.123 to 0.161) |
| Observations | 11 832 | 11 832 | 11 832 | 11 832 |
| High versus low PES | 0.022 (−0.069 to 0.112) | 0.05 (−0.029 to 0.128) | 0.309 (0.163 to 0.455) | 0.005 (−0.279 to 0.289) |
| Observations | 8975 | 8975 | 8975 | 8975 |
| High versus moderate PES | 0.106 (0.038 to 0.174) | 0.086 (0.023 to 0.148) | 0.391 (0.294 to 0.488) | −0.062 (−0.313 to 0.189) |
| Observations | 13 794 | 13 794 | 13 794 | 13 794 |
| Moderate versus low PES | −0.054 (−0.125 to 0.017) | −0.046 (−0.098 to 0.006) | 0.086 (−0.003 to 0.175) | −0.055 (−0.225 to 0.114) |
| Observations | 17 414 | 17 414 | 17 414 | 17 414 |
| High versus low PES | 0.007 (−0.123 to 0.137) | 0.181 (0.037 to 0.325) | −0.302 (−0.574 to −0.03) | −0.091 (−0.35 to 0.168) |
| Observations | 3643 | 3643 | 3643 | 3643 |
| High versus moderate PES | 0.048 (−0.064 to 0.161) | 0.168 (0.046 to 0.29) | 0.015 (−0.179 to 0.209) | 0.162 (−0.071 to 0.395) |
| Observations | 5674 | 5674 | 5674 | 5674 |
| Moderate versus low PES | −0.017 (−0.157 to 0.124) | −0.076 (−0.25 to 0.099) | −0.064 (−0.262 to 0.134) | 0.15 (−0.077 to 0.377) |
| Observations | 6870 | 6870 | 6870 | 6870 |
| High versus low PES | 0.045 (−0.051 to 0.142) | 0.086 (−0.028 to 0.2) | −0.208 (−0.422 to 0.006) | −0.068 (−0.294 to 0.157) |
| Observations | 4541 | 4541 | 4541 | 4541 |

Continued
Table 3  Continued

| Procedure payments | Testing payments | Facilities payments | Acute care/critical access hospital payments |
|--------------------|------------------|---------------------|---------------------------------------------|
|                     | 95% CI           | 95% CI             | 95% CI                                     | 95% CI                                      |
| High versus moderate PES | 0.058 −0.024 to 0.14 | **0.132** to **0.043 to 0.221** | 0.138 −0.036 to 0.312 | 0.027 −0.175 to 0.228 |
| Observations       | 7476             | 7476               | 7476                                        | 7476                                        |
| Moderate versus low PES | 0.012 −0.073 to 0.096 | 0.033 −0.041 to 0.107 | −0.037 −0.21 to 0.137 | −0.018 −0.19 to 0.154 |
| Observations       | 8619             | 8619               | 8619                                        | 8619                                        |
| Low-back atients—spending (independent practices) |                 |                     |                                             |                                             |
| High versus low PES | −0.041 −0.133 to 0.052 | 0.03 −0.053 to 0.112 | −0.152 −0.32 to 0.016 | −0.081 −0.357 to 0.196 |
| Observations       | 6173             | 6173               | 6173                                        | 6173                                        |
| High versus moderate PES | −0.02 −0.112 to 0.071 | **0.115** to **0.046 to 0.184** | −0.082 −0.23 to 0.066 | −0.164 −0.397 to 0.069 |
| Observations       | 10 392           | 10 392             | 10 392                                       | 10 392                                       |
| Moderate versus low PES | **0.11** to **0.033 to 0.187** | 0.046 −0.014 to 0.107 | 0.033 −0.102 to 0.169 | −0.043 −0.267 to 0.18 |
| Observations       | 11 192           | 11 192             | 11 192                                       | 11 192                                       |

Bold denotes statistically significant relationship (p≤0.05).
Generalised linear model using coarsened exact matching.
PES, patient engagement strategies.
and significantly associated with higher payments for hip patients (18.1%). See table 3.

For facilities payments, hospital-owned and system-owned practices had significantly higher spending only for knee-patients for all comparisons of PES levels (20.3%–44.9%). There was no variation in spending by PES for independent practices.

Finally, home health agency payments only varied in independent practices for knee patients, where moderate versus low levels of PES were associated with 61.4% lower payments. There were no other measurable PES associations. See table 4.

Sensitivity analysis
In online supplemental appendix 2, we perform the same analysis as above using alternative PES cut-points of low (0%–33%), moderate (34%–66%) and high (>67%), rather than the original PES cut-points of low (0%–25%), moderate (26%–75%) and high (>75%). By definition, the alternative PES levels are, on average, closer together. In other words, the comparisons across levels are examining the association of outcomes with smaller differences in PES. In addition, the matched sample sizes will differ when using the alternative PES levels. Thus, we expect to find differences in magnitude of the measured relationships due to variation in the average differences being measured and variation in statistical significance due to differences in matched sample sizes. Overall, this is what we find: if a relationship is statistically significant using one set of PES cut-points, the analogous relationship using the other set of PES cut-points always has the same sign (the relationship remains positive or negative) although the magnitude of the relationship may be altered, and the relationship may become more or less precise (gain or lose statistical significance). There is one minor exception to this rule. See online supplemental appendix 2.

DIscussion
Practice-level adoption of PES has limited association with surgical interventions for hip, knee and low-back problems in the USA. For beneficiaries attributed to hospital-owned or health-system owned physician practices, the ORs for receiving LF is 36.8% lower for patients of practices with high PES relative to patients of practices with moderate PES. For independent practices, the ORs of patients receiving THR surgery is 40.2% higher for beneficiaries attributed to practices with moderate PES relative to beneficiaries attributed to practices with low PES.
These findings provide partial support for our hypothesis that patients attributed to hospital or health system-owned practices with higher adoption of PES have greater utilisation of LF but lower utilisation of LF compared with patients attributed to practices with relatively lower adoption of PES. We did not, however, find greater utilisation for TKR among patients in hospital-owned or health-system-owned practices with high use of PES. This suggests that any conflicts of interest regarding those who prepare decision aids used as part of PES may not be resulting in much or any association with outcomes. Since the evidence base for LF is weaker than for THR and TKR, it may be that practices with higher use of PES may be steering patients toward evidence-based care differently than in low PES practices. Although we did not find greater utilisation of TKR for patients with knee osteoarthritis among practices with higher PES, a recent randomised controlled trial of SDM and decision aids in the context of management of knee osteoarthritis found that while share decision making implementation positively impacted patients’ experiences and decision quality, it had no impact on rates of TKR.

In light of prior research demonstrating the existence of system-level incentives for maintaining spending, we also hypothesised that the use of PES may not necessarily translate to reduced spending associated with low-back pain, knee problems, or hip problems. Although we found no differences in overall spending similar to other analyses of practice associations, our analyses revealed that certain components of spending did vary by PES level and hospital-owned and health-system-owned versus independent practices. For example, hospital-owned and health-system-owned practices with high PES levels had greater spending on imaging across all three surgical interventions relative to hospital-owned and health-system-owned practices with moderate PES levels. Additionally, payments associated with durable medical equipment were higher for patients attributed to hospital-owned or health system-owned practices with high versus moderate PES levels. Notably, this was only true for patients treated for low-back pain rather than patients with hip or knee osteoarthritis. These findings are consistent with previous evidence that spending for patients treated in hospital-owned or health-system-owned versus independent practices was higher by almost 6 percentage points and significantly higher spending across the categories of medical equipment and imaging alongside unclassified services. Our study examines spending in the context of higher versus lower physician practice-level adoption of PES and notes similarly higher spending for hospital-owned or health-system-owned practices.

Although we find evidence of systematic associations of relative levels of PES with components of spending, there is no measurable association of PES with total annual spending. The ability to detect statistically significant associations in spending components but not in aggregate spending is likely because large differences in small spending components translate into smaller changes in the aggregate measure. This indicates that while PES do not appear to be associated with total spending, it likely affects treatment choices in ways that may be important to patient satisfaction and other patient-reported outcomes, including pain management, mental health, and disability. If true, this would make PES cost-effective even if practices with high PES adoption do not have lower overall spending.

Our results should be considered in light of limitations. First, we are unable to establish causal relationships given the cross-sectional study design. However, we used coarsened exact matching, which is a robust method for handling potential selection bias. Second, the assessment of PES was based on a single informant survey, which may be subject to social desirability response bias. This could result in a compression of the distribution of PES if organisations with a lower PES report a higher PES than is actually the case, whereas organisations with higher PES would report more accurately. The larger any such compression, the more likely the association of PES with outcomes could be understated in our analyses. In addition, to the extent social desirability varies by whether a practice is independently-owned relative to hospital-owned/system-owned, other things equal, there could be different findings on the association of PES with overall costs and the probability of surgical intervention across these two categories of practices. The reported levels of PES, however, indicate that such strategies were used by less than half of practices, indicating that social desirability biases are unlikely to have a large effect on our results.

Third, we are unable to assess the role of patient preferences in treatment decisions to the extent preferences are not accounted for by patient demographics. Quasi-experimental research of PES implementation in routine settings should examine the extent to which patient preferences help explain some of the differential utilisation of surgery by practice-level adoption of PES.

**CONCLUSION**

In conclusion, practice-level adoption of PES may not reduce total spending for older adults with musculoskeletal problems but may steer them toward evidence-based treatments. The existence of variation in the components of total spending for low-back patients, hip patients, and knee patients suggests that process changes could result in reduced total spending if each component of cost is systematically analysed and appropriately modified. Differences in spending components across hospital-owned and health-system owned versus independent practices within each PES comparison suggest that potentially unnecessary activities may be occurring in the testing, imaging, procedure, E&M, and durable medical equipment categories that should be examined in future research.
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REFERENCES

1 Chilton R, Pires-Yfantouda R, Wylie M. A systematic review of motivational interviewing within musculoskeletal health. Psychol Health Med 2012;17:392–407
2 Martin BI, Lurie JD, Farrokhi FR, et al. Early effects of Medicare’s bundled payment for care improvement program for lumbar fusion. Spine 2018;43:705–11
3 Bombard Y, Baker GR, Orlando E, et al. Engaging patients to improve quality of care: a systematic review. Implement Sci 2018;13:98
4 Elwyn G, Frosch D, Thomson R, et al. Shared decision making: a model for clinical practice. J Gen Intern Med 2012;27:1361–7
5 Stacey D, Légare F, Lewis K, et al. Decision AIDS for people facing health treatment or screening decisions. Cochrane Database Syst Rev 2017;4:CD001431
6 Veroff D, Marr A, Wennberg DE. Enhanced support for shared decision making reduced costs of care for patients with preference-sensitive conditions. Health Aff 2013;32:285–93.
7 Arterburn D, Weilman R, Westbrook E, et al. Introducing decision AIDS at group health was linked to slightly lower hip and knee surgery rates and costs. Health Aff 2012;31:2094–104.
8 Rätsep T, Abel A, Linnamägi Ulla. Patient involvement in surgical treatment decisions and satisfaction with the treatment results after lumbar intervertebral discectomy. Eur Spine J 2014;23:873–81
9 Thompson R, Paskins Z, Main BG, et al. Addressing conflicts of interest in health and medicine: current evidence and implications for patient decision aid development. Med Decis Making 2021;41:21100881.
10 Barry MJ, Chan E, Moulton B, et al. Disclosing conflicts of interest in patient decision AIDS. BMC Med Inform Decis Mak 2013;13 Suppl 2:S3.
11 Tak HJ, Ruhnke GW, Meltzer DO. Association of patient preferences for participation in decision making with length of stay and costs among hospitalized patients. JAMA Intern Med 2013;173:1195–205.
12 Hurley VB, Rodriguez HP, Kearing S, et al. The impact of decision AIDS on adults considering hip or knee surgery. Health Aff 2020;39:100–7.
13 Billings J. Promoting the dissemination of decision AIDS: an odyssey in a dysfunctional health care financing system. Health Aff 2004;23:VAR-128–VAR-132.
14 Elwyn G, Edwards A, Thompson R. Shared decision making in health care. 3rd edn. Oxford University Press, 2016.
15 Grayson CW, Decker RC. Total joint arthroplasty for persons with osteoarthritis. Pm R 2012;4:S97–103.
16 Kerr D, Zhao W, Lurie JD. What are long-term predictors of outcomes for lumbar disc herniation? A randomized and observational study. Clin Orthop Relat Res 2015;473:1920–30.
17 Mannion AF, Brox JL, Fairbank JCT. Comparison of spinal fusion and nonoperative treatment in patients with chronic low back pain: long-term follow-up of three randomized controlled trials. Spine J 2013;13:1438–48.
18 Neprash HT, Chernew ME, McWilliams JM, Little evidence exists to support the expectation that providers would consolidate to enter new payment models. Health Aff 2017;36:346–54.
19 Burns LR, Goldsmith JC, Sen A. Horizontal and vertical integration of physicians: a tale of two tails. Adv Health Care Manag 2013;15:39–117.
20 Song Z, Wallace J, Neprash HT, et al. Medicare fee cuts and Cardiologist-Hospital integration. JAMA Intern Med 2015;175:1229–31.
21 Ho V, Metcalfe L, Vu L, et al. Annual spending per patient and quality in hospital-owned versus Physician-Owned organizations: an observational study. J Gen Intern Med 2020;35:649–55.
22 Colla C, Yang W, Mainor AJ, et al. Organizational integration, practice capabilities, and outcomes in clinically complex Medicare beneficiaries. Health Serv Res 2020;55 Suppl 3:1085–97.
23 Fisher ES, Shortell SM, O’Malley AJ, et al. Financial integration’s impact on care delivery and payment reforms: a survey of hospitals and physician practices. Health Aff 2020;39:1302–11.
24 Center for Medicare C for M and MS. Medicare shared savings program: shared savings and losses assignment methodology, specifications. version 3, 2014. Available: https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/sharedsavingsprogram/Downloads/Shared-Savings-Losses-Assignment-Spec.pdf
25 Blackwell M, Iacus S, King G, et al. Cem: Coarsened exact matching in Stat. Sta J 2009;9:524–46.
26 Iacus SM, King G, Porro G. Causal inference without balance checking: Coarsened exact matching. Political Analysis 2012;20:1–24.
27 DE H, Imai K, King G. Matching as nonparametric preprocessing for reducing model dependence in parametric causal inference. Political Analysis 2007;15:199–236.
28 Committee on Geographic Variation in Health Care Spending and Promotion of High-Value Care, Board on Health Care Services, Institute of Medicine. Variation in Health Care Spending: Target Decision Making, Not Geography. National Academies Press (US), 2013. http://www.ncbi.nlm.nih.gov/books/NBK201647/.
29 Finkelstein A, Gentzkow M, Williams H. Sources of geographic variation in health care: evidence from patient migration. Q J Econ 2016;131:1681–726.
30 Cutler D, Skinner JS, Stern AD, et al. Physician beliefs and patient preferences: a new look at regional variation in health care Spending. Am Econ J Econ Policy 2019;11:192–221.
31 Dunn WR, Lyman S, Marx RG. Small area variation in orthopedics. J Knee Surg 2005;18:51–6.
32 Bishop TF, Ramsay PP, Casalino LP, et al. Financial integration’s processes used less often for depression than for other chronic conditions in US primary care practices. Health Aff 2015;34:394–400.
33 Kandel ZX, Rittenhouse DR, Bibo S, et al. The CMS state innovation models initiative and improved health information technology and care management capabilities of physician practices. Med Care Res Rev 2021;78:350–60.
34 Lurie JD, Spratt KF, Good DA, et al. Effects of viewing an evidence-based video decision aid on patients’ treatment preferences for spine surgery. Spine 2011;36:1501–4.
35 Scalia P, Barr PJ, O’Neill C, et al. Does the use of patient decision AIDS lead to cost savings? A systematic review. *BMJ Open* 2020;10:e036834.

36 Jayakumar P, Moore MG, Furlough KA, et al. Comparison of an artificial Intelligence-Enabled patient decision aid vs educational material on decision quality, shared decision-making, patient experience, and functional outcomes in adults with knee osteoarthritis: a randomized clinical trial. *JAMA Netw Open* 2021;4:e2037107.

37 Nichols DE, Haber SG, Romaine MA, et al. Changes in utilization and expenditures for Medicare beneficiaries in patient-centered medical homes: findings from the Multi-Payer advanced primary care demonstration. *Med Care* 2018;56:775–83.

38 Orzol S, Keith R, Hossain M, et al. The impact of a health information Technology-Focused patient-centered medical neighborhood program among Medicare beneficiaries in primary care practices: the effect on patient outcomes and spending. *Med Care* 2018;56:299–307.

39 Iacus SM, King G, Porro G. Causal inference without balance checking: Coarsened exact matching. *Polit Anal* 2012;20:1–24.

40 Robinson JC, Brown TT. Quantifying opportunities for hospital cost control: medical device purchasing and patient discharge planning. *Am J Manag Care* 2014;20:e418–24.