Associations Between Relative Value Units and Patient-Reported Back Pain and Disability

Gerontology & Geriatric Medicine
Volume 3: 1–12
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sagepub.com/journalsPermissions.nav
DOI: 10.1177/2333721416686019
journals.sagepub.com/home/ggm
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Abstract

Objective: To describe associations between health care utilization measures and patient-reported outcomes (PROs). **Method:** Primary data were collected from patients ≥65 years with low back pain visits from 2011 to 2013. Six PROs of pain and functionality were collected 12 and 24 months after the index visits and total and spine-specific relative value units (RVUs) from electronic health records were tabulated over 1 year. We calculated correlation coefficients between RVUs and 12- and 24-month PROs and conducted linear regressions with each 12- and 24-month PRO as the outcome variables and RVUs as predictors of interest. **Results:** We observed very weak correlations between worse PROs at 12 and 24 months and greater 12-month utilization. In regression analyses, we observed slight associations between greater utilization and worse 12- and 24-month PROs. **Discussion:** We found that 12-month health care utilization is not strongly associated with PROs at 12 or 24 months.

Keywords

electronic health records, low back pain, patient-reported outcomes, relative value units (RVUs), Roland–Morris Disability Questionnaire score

Manuscript received: August 2, 2016; **final revision received:** November 23, 2016; **accepted:** November 28, 2016.

Introduction

Low back pain is a major cause of functional limitation and disability, particularly in the elderly (Eggermont et al., 2014). In addition, back pain is the fifth most common reason for provider visits in the United States (R. Chou et al., 2007). One study estimated that the incremental direct costs of care for persons with neck and back pain in 2005 in the United States were US$86 billion, with costs for patients with spine problems estimated to be 73% greater than costs of patients without spine problems (B. I. Martin et al., 2008). Research has shown that most cases of acute low back pain either resolve with no or minimal treatment within 4 to 6 weeks or tend not to improve even with a variety of interventions (Chou & Huffman, 2009; Deyo et al., 2015; Enthoven, Skargren, & Oberg, 2004; Friedly et al., 2014; Itz, Geurts, van Kleef, & Nelemans, 2013; Pengel, Herbert, Maher, & Refshauge, 2003; Von Korff & Saunders, 1996).

An important question for back pain researchers is whether health care utilization measures obtained from sources such as electronic health records (EHRs) or administrative databases are associated with measures of patient health such as pain and functionality that are typically ascertained directly from patients. If a strong relationship existed between administrative and patient-reported measures, researchers could use health care utilization data from large databases as proxies for patient-reported outcomes (PROs) and avoid the time and expense of collecting measures of pain and function directly from patients.

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The purpose of this article was to describe associations between administratively collected measures of health care utilization (such as provider visits, procedures, and hospitalizations) and PROs. We hypothesized that, after adjustment for demographic factors and baseline PROs, health care utilization over 1 year would be strongly correlated with PROs measured at 12 and 24 months. For example, patients who had low levels of pain and reported little back pain–related disability 12 and 24 months after their index visits would have had minimal 12-month health care utilization. However, we hypothesized that patients who had high health care utilization from receipt of many back-related interventions over the 12 months since their index back pain visits would have poor measures of pain and function at 12 and 24 months.

Method

Patient Population

The Back Pain Outcomes Using Longitudinal Data (BOLD) study protocol has been published previously (Jarvik et al., 2012) and several previous publications have reported findings from this study (Deyo et al., 2015; Jarvik et al., 2014; Jarvik et al., 2015; Karvelas et al., 2016; Rundell, Gellhorn, et al., 2015; Rundell, Goode, et al., 2016; Rundell, Sherman, et al., 2016; Rundell, Sherman, Heagerty, Mock, & Jarvik, 2015a, 2015b). Briefly, patients were eligible for the study if they were ≥65 years old and sought care for back pain (with or without radiculopathy or myelopathy) and had had no health care visits for back pain within the past 6 months. Because the aim of the BOLD study was to evaluate real-world treatment effectiveness, we attempted to make the inclusion criteria as broad as possible. However, because we expected treatments and PROs to be quite different from other back pain etiologies, patients whose back pain was due to trauma such as vehicular accidents were excluded, as were patients with a history of malignancy in the previous 5 years (however, we did not exclude patients who were diagnosed with incident tumors that might have caused them to seek care for their index back pain). We enrolled patients between March 2011 and March 2013 from three study sites throughout the United States: Henry Ford Health System (Henry Ford) in Detroit, Michigan; Kaiser Permanente Northern California (Kaiser); and Harvard Vanguard Medical Associates (Harvard) in Boston, Massachusetts. The University of Washington served as the data coordinating center. All study participants provided informed consent and all participating institutions provided institutional review board approval.

Patient Data and Outcome Measures

In the baseline interview, patients provided demographic information such as age, gender, race, years of education, current employment status, smoking status, and marital status. Patients also rated their back and leg pain from 0 to 10 on a Numeric Rating Scale (NRS; Farrar, Young, LaMoreaux, Werth, & Poole, 2001). The NRS scale has been shown to be valid, reliable, and sensitive to detecting changes in pain intensity, and was recommended as the primary outcome in clinical trials of pain by the Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials (IMMPACT) because patients, especially older patients, preferred it (Dworkin et al., 2005). Treatment for back pain was determined by each patient's health care providers; no specific treatments were offered to patients as a result of their participation in this study.

Patients completed measures of pain, back pain–related disability, and health-related quality of life at baseline and 3, 6, 12, and 24 months after baseline. For this article, we focused on PROs measured at 12 and at 24 months after the index visit. These outcomes include the following:

- The Roland–Morris Disability Questionnaire (RDQ) score, consisting of 24 questions assessing back pain–related physical disability (Bergner, Bobbitt, Carter, & Gilson, 1981) shown to have excellent internal consistency (Patrick & Deyo, 1989) and responsiveness to clinical changes over time (Jarvik et al., 2012; Patrick et al., 1995). Scores ranged from 0 to 24, with higher scores indicating worse function. This score was the a priori primary outcome of the BOLD study.
- The Brief Pain Inventory (BPI) Interference scale (Cleeland & Ryan, 1994), which assessed back pain interference with activities such as ability to walk, work normally, and sleep. This score ranged from 0 to 10, with higher scores indicating greater interference with activities.
- The EuroQol Group Index (EQ-5D index; EQ-5D-Index) score is a validated standardized health utility instrument that measures mobility, self-care, usual activities, pain/discomfort, and anxiety/depression (Barton et al., 2008). This score ranged from 0 to 1, with 0 indicating death and 1 indicating perfect health.
- The EuroQol Group Visual Analog Scale (EQ-5D-VAS) is a quality-of-life assessment scored from 0 (*worst imaginable health state*) to 100 (*best imaginable health state*; Barton et al., 2008).
- The Patient Health Questionnaire–4 (PHQ-4) has been shown to have high sensitivity and specificity for identification of depression and anxiety (Kroenke, Spitzer, & Williams, 2003). The scale ranged from 0 to 12, with higher scores indicating greater depression/anxiety.
- The Behavioral Risk Factor Surveillance System (BRFSS) Falls screen assessed both the number of falls as well as injurious falls the respondent had in

the previous 3 weeks (Ganz, Higashi, & Rubenstein, 2005; Hannan et al., 2010; Mackenzie, Byles, & D'Este, 2006; Pluijm et al., 2006).

EHR Data

Because our study sites were integrated health systems, we were able to obtain EHR data from 365 days prior to the date of the index visit until 365 days following the visit, withdrawal, or death, whichever occurred first. We linked PRO data to EHR data, which contained information about hospitalizations and provider visits, including Current Procedural Terminology (CPT) codes (American Medical Association [AMA], 2013) for each procedure or visit.

Using EHR data from the 12 months preceding the index visit, we calculated the Quan comorbidity score, which enhanced the earlier Charlson comorbidity index and updated the comorbidity weights with more recent data (Quan et al., 2011).

Calculation of Overall and Spine-Specific Relative Value Units (RVUs)

To quantify health care utilization, we used RVUs, which are a system used in the United States for assigning the relative amount of work of health care encounters using the CPT code set (Hsiao, Braun, Dunn, et al., 1988; Hsiao, Braun, Yntema, & Becker, 1988). RVUs are based on three components: physician work (52% of total RVU; time and skill required to provide the service), practice expense (44% of total RVU; expenses for space, supplies, and office staff), and malpractice expense (4% of total RVU; Satiani, 2012). The RVU system is used by the United States Centers for Medicare and Medicaid Services, and about three quarters of public and private payers in the United States use components of the RVU system to reimburse physicians (American Academy of Pediatrics, 2015). Because RVUs provide consistent measures of resource consumption in different medical contexts, many studies have used them as surrogates for outcomes such as expenditures (Lind et al., 2012; Miller et al., 2011; Raja et al., 2011), productivity (Cheriff, Kapur, Qiu, & Cole, 2010; Davis, 2001; Khandelwal et al., 2012; Moote, Nelson, Veltkamp, & Campbell, 2012; Parent, McArthur, & Sava, 2013; Silich & Yang, 2012), extent of health care services provided (Henley, Mann, Holt, & Marotta, 2001; Mortele et al., 2011; Moser & Applegate, 2012a, 2012b), and physician time (J. D. Martin et al., 2010).

We mapped each CPT code to its year-specific RVU value (Centers for Medicare and Medicaid Services, 2009, 2010, 2011, 2013, 2014, 2015). To ensure uniformity among the study sites, we did not include geographic modifiers in the RVU calculations. For each individual, we summed all RVUs accumulated from the day of the index visit through 365 days after the index visit and separately summed all RVUs accumulated 365 days prior to the index visit. Similarly, we summed RVUs that were specific to treatment of back pain (hereafter termed, "spine-specific" RVUs) for health care utilization between 0 and 365 days. When possible, we used an algorithm that combined CPT and International Classification of Diseases, Clinical Modification (ICD-9-CM) codes to determine whether RVUs were spine-specific. However, most of the data from Kaiser did not include ICD-9-CM codes. Because some CPT codes are generic (e.g., evaluation and management visits), we only counted procedures at Kaiser as spine-related if they took place on the same day as other spine-related CPT codes (e.g., x-ray of lower spine) or if they occurred on the day of the index visit.

In addition, some data in the EHRs included patient encounters for procedures such as vaccinations, assessment of blood pressure, and surgical aftercare that did not include CPT codes. These were assigned the year-appropriate RVUs associated with CPT code 99211, a 5-min evaluation and management visit that did not involve physician interaction.

Statistical Analysis

Because we expected utilization and PROs to vary by back pain diagnosis category, all analyses were stratified by baseline diagnosis, categorized as axial back pain, back and leg pain, spinal stenosis, and other (see Supplemental Table 1 for ICD-9-CM diagnosis codes for each of these categories). Because the distribution of RVUs was skewed, we performed Wilcoxon non-parametric tests to compare median total and spine-specific RVUs across demographic variables. We also calculated the proportions and chi-square tests of patients who had at least one CPT code indicating that they received physical therapy, epidural steroid injections, and lumbar spine surgery in the 12 months after their index visits. We calculated means of each of the PROs measured at 12 and 24 months from the index visit, as well as the Spearman correlation coefficients of each of the 12- and 24-month PROs against total and spine-specific RVUs accumulated in the 12 months after the index visit. Finally, to determine whether RVUs accumulated in the 12 months after the index visit were associated with PROs at 12 and 24 months, we performed multivariate linear regressions with each PRO, and separately examined total and spine-specific 12-month RVUs as the predictors of interest. Because of the skewed distribution of overall and spine-specific RVUs, we used a log base 2 transformation of RVUs in each regression model and report model coefficients that can be interpreted relative to a twofold increase in RVUs. We adjusted all regression models for site, age, gender, baseline RDQ, baseline NRS, and log-adjusted RVUs in the year prior to the index visit. In addition, we adjusted the models for other baseline or demographic variables when RVUs were found to be significantly different between categories ($p < .05$) in univariate analyses.

Table 1. Total and Spine-Specific RVUs in the 12 Months Following Enrollment by Demographic and Clinical Variables at Baseline at All Study Sites, Stratified by Baseline Diagnosis Category.

	Axial back pain			Back and leg pain			Spinal stenosis			Other		
	n	Total RVU median (*SD*)	SPINE RVU median (*SD*)	*n*	Total RVU median (*SD*)	SPINE RVU median (*SD*)	*n*	Total RVU median (*SD*)	SPINE RVU median (*SD*)	*n*	Total RVU median (*SD*)	SPINE RVU median (*SD*)
Total	2,940	25 (99)	2 (53)	941	32 (190)	3 (120)	241	27 (120)	3 (97)	239	29 (190)	2 (140)
Site												
Henry Ford	686	29 (91)[a]	4 (41)[a]	41	38 (56)[a]	8 (16)[a]	12	21 (59)[a]	5 (9)[a]	6	19 (24)	4 (2)
Kaiser Permanente	1,683	26 (110)[a]	2 (65)[a]	761	34 (210)[a]	3 (130)[a]	129	32 (160)[a]	3 (130)[a]	165	30 (230)	2 (160)
Harvard Vanguard	571	21 (27)[a]	1 (9)[a]	139	24 (32)[a]	1 (13)[a]	100	20 (30)[a]	1 (13)[a]	68	26 (35)	1 (8)
Female	1,914	27 (90)[a]	2 (47)[a]	603	34 (180)[a]	3 (98)	162	29 (120)	3 (89)	161	30 (81)	2 (26)
Male	1,026	23 (110)[a]	2 (64)[a]	338	29 (190)[a]	3 (150)	79	22 (130)	3 (110)	78	26 (310)	2 (240)
Age												
65-69	1,031	21 (94)[a]	2 (54)	327	30 (190)	3 (110)	40	21 (130)	3 (100)	88	27 (62)[a]	2 (32)
70-74	740	26 (90)[a]	2 (46)	261	34 (170)	3 (140)	61	25 (110)	4 (76)	62	26 (350)[a]	3 (260)
75-79	541	29 (90)[a]	2 (52)	178	32 (160)	3 (80)	54	30 (200)	3 (170)	51	34 (51)[a]	2 (5)
80-84	405	30 (120)[a]	3 (59)	119	36 (270)	3 (170)	54	32 (28)	3 (8)	23	41 (150)[a]	3 (25)
85-98	223	31 (130)[a]	3 (66)	56	37 (45)	3 (12)	32	22 (65)	2 (18)	15	22 (63)[a]	2 (4)
Race												
White	791	25 (93)	3 (56)[a]	211	30 (150)	3 (110)	39	25 (170)	2 (160)	36	30 (38)	2 (7)
Non-White	2,122	3 (56)	2 (52)[a]	720	33 (200)	3 (120)	202	27 (110)	3 (80)	198	28 (210)	2 (150)
Education												
High school or less	889	27 (120)[a]	3 (60)[a]	236	32 (210)	4 (110)	66	29 (160)	3 (110)	60	28 (47)	2 (10)
Some college	827	27 (110)[a]	2 (63)[a]	279	36 (180)	3 (120)	57	28 (100)	3 (88)	65	27 (89)	2 (37)
College grad or more	1,216	23 (75)[a]	2 (39)[a]	425	30 (180)	3 (120)	117	24 (100)	2 (94)	114	30 (270)	2 (200)
Employment status												
Working	331	20 (99)[a]	2 (46)[a]	111	28 (130)	3 (110)	23	20 (170)	2 (170)	28	16 (37)[a]	2 (8)
Not working	2,598	26 (96)[a]	2 (54)[a]	824	33 (190)	3 (120)	217	28 (120)	3 (86)	210	30 (200)[a]	2 (150)
Smoking status												
Never smoked	1,652	26 (78)[a]	2 (36)	491	31 (190)	3 (100)	132	25 (130)	2 (98)	118	28 (48)	2 (26)
Quit >1 year ago	1,090	26 (120)[a]	2 (73)	405	34 (190)	3 (140)	97	29 (110)	3 (100)	111	30 (280)	2 (200)
Current smoker	188	19 (97)[a]	2 (49)	45	40 (180)	4 (120)	11	20 (46)	4 (10)	10	22 (16)	2 (3)
Marital status												
Not living with partner	1,177	27 (99)[a]	3 (43)[a]	358	32 (150)	3 (110)	83	29 (170)	2 (130)	75	27 (90)	2 (14)
Married/living with partner	1,756	25 (98)[a]	2 (60)[a]	580	32 (210)	3 (130)	157	26 (92)	3 (71)	163	30 (220)	2 (170)
Comorbidity (Quan)												
0-1	431	22 (89)[a]	2 (50)[a]	164	24 (160)[a]	3 (120)	26	21 (130)	3 (120)	41	28 (85)[a]	3 (46)

(continued)

Table 1. (continued)

	Axial back pain			Back and leg pain			Spinal stenosis			Other		
	n	Total RVU median (*SD*)	SPINE RVU median (*SD*)	*n*	Total RVU median (*SD*)	SPINE RVU median (*SD*)	*n*	Total RVU median (*SD*)	SPINE RVU median (*SD*)	*n*	Total RVU median (*SD*)	SPINE RVU median (*SD*)
2	1,094	21 (87)[a]	2 (59)[a]	347	27 (200)[a]	3 (130)	97	23 (150)	3 (110)	84	23 (39)[a]	2 (10)
3-17	1,415	31 (110)[a]	2 (50)[a]	430	39 (190)[a]	3 (110)	118	31 (98)	3 (77)	114	33 (270)[a]	2 (200)
Site of index visit												
Primary care provider	2,802	25 (96)[a]	2 (51)[a]	922	32 (190)	3 (120)[a]	241	27 (120)	3 (97)	236	28 (190)	2 (140)
Urgent care	35	21 (75)[a]	1 (3)[a]	10	20 (47)	2 (17)[a]	0	—	—	2	53 (58)	1 (2)
Emergency department	103	43 (160)[a]	9 (110)[a]	9	52 (85)	15 (9)[a]	0	—	—	1	150	2
Back pain duration												
<1 month	1,076	24 (100)	2 (66)[a]	315	30 (150)	3 (120)	27	27 (42)	3 (14)	76	27 (65)	2 (37)
1-3 months	541	25 (96)	3 (46)[a]	249	34 (250)	3 (160)	20	42 (120)	4 (6)	35	34 (470)	2 (350)
3-6 months	169	25 (68)	3 (19)[a]	88	36 (200)	4 (150)	19	34 (88)	4 (13)	18	31 (170)	3 (5)
6-12 months	172	25 (98)	3 (76)[a]	64	31 (78)	3 (13)	11	39 (200)	4 (180)	15	32 (42)	3 (7)
1-5 years	414	28 (110)	2 (40)[a]	122	32 (110)	4 (76)	62	22 (110)	2 (110)	27	27 (32)	2 (5)
>5 years	566	27 (90)	2 (40)[a]	103	32 (210)	3 (10)	101	27 (140)	3 (110)	67	27 (59)	2 (7)
RVUs year prior												
0-7	683	15 (85)[a]	2 (65)[a]	243	20 (150)[a]	3 (120)[a]	56	16 (110)[a]	2 (110)[a]	55	17 (370)[a]	2 (280)
>7-14	611	21 (100)[a]	2 (53)[a]	240	28 (180)[a]	3 (90)[a]	52	24 (110)[a]	4 (92)[a]	49	25 (67)[a]	2 (43)
>14-34	839	28 (88)[a]	2 (42)[a]	226	35 (220)[a]	3 (140)[a]	71	27 (38)[a]	3 (8)[a]	79	30 (67)[a]	2 (7)
>34	802	41 (110)[a]	2 (53)[a]	230	49 (190)[a]	4 (130)[a]	61	45 (190)[a]	3 (140)[a]	56	53 (110)[a]	2 (39)
Baseline NRS (back)												
0-2 (little pain)	547	20 (84)[a]	2 (27)[a]	218	23 (170)[a]	2 (51)[a]	54	23 (68)[a]	2 (19)[a]	61	28 (59)	2 (4)[a]
3-6 (moderate pain)	1,364	25 (92)[a]	2 (45)[a]	415	31 (170)[a]	3 (100)[a]	134	20 (99)[a]	2 (88)[a]	111	27 (270)	3 (200)[a]
7-10 (severe pain)	1,029	31 (110)[a]	3 (71)[a]	308	41 (220)[a]	5 (170)[a]	53	45 (190)[a]	6 (150)[a]	67	32 (100)	2 (6)[a]
Baseline RDQ												
0-5 (least disability)	960	19 (66)[a]	2 (10)[a]	274	24 (150)[a]	2 (42)[a]	62	16 (32)[a]	1 (15)[a]	106	26 (51)	2 (31)[a]
6-10	697	25 (120)[a]	2 (63)[a]	236	29 (190)[a]	3 (110)[a]	64	29 (200)[a]	2 (170)[a]	50	29 (59)	3 (8)[a]
11-16	766	29 (100)[a]	3 (63)[a]	274	39 (140)[a]	5 (61)[a]	70	29 (100)[a]	4 (79)[a]	53	30 (120)	2 (5)[a]
17-24 (worst disability)	517	37 (120)[a]	4 (69)[a]	157	52 (280)[a]	8 (240)[a]	45	38 (83)[a]	4 (8)[a]	30	41 (500)	2 (380)[a]
Confidence back pain will be gone in 3 months												
8-10 (confident)	1,179	23 (86)[a]	2 (40)[a]	412	30 (140)	3 (90)	49	29 (190)	2 (150)	83	30 (51)	3 (14)
5-7	726	29 (120)[a]	2 (71)[a]	271	35 (220)	4 (140)	51	29 (87)	4 (17)	58	30 (360)	2 (270)
0-4 (not confident)	1,031	27 (99)[a]	2 (52)[a]	255	33 (210)	3 (140)	141	25 (100)	3 (89)	97	27 (100)	2 (41)

Note. RVU = relative value unit; NRS = Numeric Rating Scale; RDQ = Roland–Morris Disability Questionnaire.
[a]Indicates Wilcoxon $p < .05$

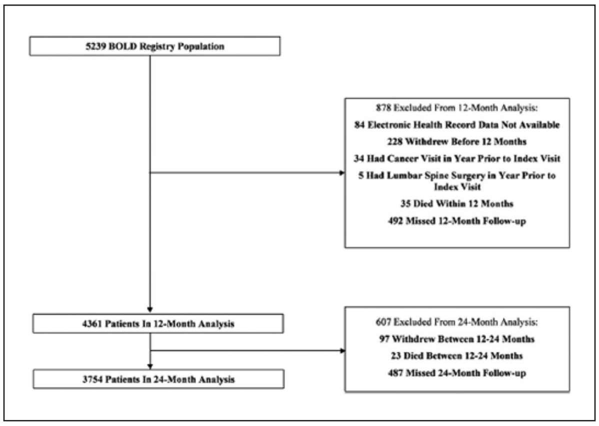

Figure 1. Study population with exclusion criteria.
Note. BOLD = Back Pain Outcomes Using Longitudinal Data.

As a sensitivity analysis that accounted for changes in PROs from 0 to 24 months, we created binary variables that indicated whether patients achieved ≥30% improvement in each PRO and analyzed these variables in adjusted logistic regressions against total and spine-specific RVUs. In a separate sensitivity analysis, we used multiple imputation methods (Yuan, 2011) to impute 12- and 24-month PRO data for participants who were missing follow-up data. We also separately examined results stratified on site instead of index back pain diagnosis. Because results from these were not meaningfully different from our main analyses, only the results of the complete case analysis using the 12- and 24-month PROs as the outcome variables are presented (Romaniuk, Patton, & Carlin, 2014).

All analyses were performed using SAS version 9.3 (Cary, NC).

Results

The cohort for the 12-month analyses was comprised of 4,361 patients and, for the 24-month analyses, 3,754 patients. We excluded 878 (17%) patients from the 12-month analyses and 607 (12%) additional patients from the 24-month analysis because of missing follow-up assessments (and, therefore, missing the main PROs of this analysis), death, withdrawal, unavailable EHR data, or because they had lumbar surgery or visits for cancer in the year prior to their index visits (Figure 1).

Table 1 shows medians and standard deviations of total and spine-specific RVUs accumulated in the year following the index visit, stratified by baseline back pain diagnosis category. We observed significant site-specific differences in the amount of RVUs consumed at 12 months, with the lowest median RVU consumption at Harvard and higher medians at Henry Ford and at Kaiser. In general, RVUs were greater for females, patients who were not working, patients who were former smokers, and patients with higher comorbidity scores. Patients with worse baseline pain and functionality, measured by the NRS and the RDQ scores, had greater utilization of total and spine-specific RVUs in the subsequent 12 months. Patients with more total RVUs in the year prior to the index visit had greater total RVUs in the year following the index visit.

The numbers and percentages of patients who had at least one CPT code indicating receipt of physical therapy, epidural steroid injections, and lumbar spine surgery are shown in Table 2. Patients with axial back pain were most likely to have received physical therapy (18% received at least one session of physical therapy) and, along with patients with uncategorized diagnoses, least likely to have received lumbar spine surgery within 12 months (1% of patients with axial back pain and 0.4% of patients with other diagnoses received surgery). Sixteen percent of patients with back and leg pain and 16% of those with spinal stenosis received epidural steroid injections.

The means of each of the 12- and 24-month PROs as well as the Spearman correlation coefficients between each PRO and total and spine-specific RVUs are shown in Table 3. For each baseline diagnosis category, RDQ, BPI, and PHQ-4 scores were weakly positively correlated with total and spine-specific RVUs, indicating that greater RVUs were associated with greater pain, disability, anxiety, and depression scores. Similarly, total and spine-specific RVUs were weakly negatively correlated with the EQ-5D-VAS and EQ-5D-Index scores, indicating that lower health-related quality of life was associated with more RVUs.

Results of adjusted linear regressions of PROs against total and spine-specific RVUs are shown in Table 4. For patients with axial back pain, we observed that a doubling of the total RVUs was associated with lower 12- and 24-month EQ-5D-Index and EQ-5D-VAS scores. Although these were statistically significant, which indicates that total RVUs were weakly associated with lower health-related quality of life, the associations were small and of doubtful clinical importance (Hagg, Fritzell, Nordwall, & Swedish Lumbar Spine Study Group, 2003; Ostelo et al., 2008). We also observed a statistically significant association between total RVUs and the 24-month PHQ-4 scores among patients with axial back pain (a doubling of the total RVUs was associated with a 0.08 increase—95% CI = [0.02, 0.2]—in the 24-month PHQ-4), again indicating that increased RVUs were associated with slightly greater depression and anxiety, but again this difference was likely clinically insignificant. For axial back pain, after adjustment for baseline PROs and confounders, we did not observe any other statistically or clinically significant associations between total RVUs and RDQ, BPI, or the number of falls. We also did not observe statistically significant associations between spine-related RVUs and any of the PROs.

For patients with initial diagnoses of back and leg pain, a doubling of the total RVUs was associated with a statistically significant .2 (95% CI = [0.005, 0.4]) change in the 12-month RDQ score, a −.006 (95% CI = [−0.01, −0.0003]) change in the 12-month EQ-5D-Index, a −.9

Table 2. Proportion Receiving Physical Therapy, Epidural Steroid Injections, and/or Lumbar Spine Surgical Treatments Within 12 Months of the Index Visit, Stratified by Baseline Back Pain Diagnosis.

Treatment received within 12 months (yes/no)	Axial back pain (*n* = 2,940)	Back and leg pain (*n* = 941)	Spinal stenosis (*n* = 241)	Other (*n* = 239)	Chi-square test *p*
Physical therapy	533 (18%)	58 (6%)	15 (6%)	10 (4%)	<.0001
Epidural steroid injections	171 (6%)	152 (16%)	38 (16%)	7 (3%)	<.0001
Lumbar spine surgery	39 (1%)	29 (3%)	4 (2%)	1 (0.4%)	.001

(95% CI = [−1.6, −0.3]) change in the 12-month EQ-5D-VAS, a −1.0 (95% CI = [−1.7, −0.3]) change in the 24-month EQ-5D-VAS, and a −.02 (95% CI = [−0.04, −0.0004]) change in the number of falls reported in the previous 3 weeks. Again, although these results reached statistical significance, their clinical significance is minimal (Dworkin et al., 2008; Kovacs et al., 2007; Ostelo & de Vet, 2005; Ostelo et al., 2008). We did not observe any statistically significant relationships between spine-specific RVUs and PROs among patients with back and leg pain.

Among patients with baseline diagnoses of spinal stenosis, we found that a doubling of total RVUs was associated with a 0.6 (95% CI = [0.1, 1.1]) increase in the 24-month RDQ and a 0.1 (95% CI = [0.02, 0.1]) increase in the number of falls at 12 months. In addition, a doubling of spine-related RVUs was associated with a 0.1 (95% CI = [0.03, 0.2]) increase in the 12-month BPI, a 0.01 (95% CI = [−0.02, −0.01]) decrease in the 12-month EQ-5D-Index, and a 1.0 (95% CI = [−1.8, −0.01]) decrease in the EQ-5D-VAS. Finally, among patients with other back pain diagnoses, we found that a doubling of total RVUs was associated with a 0.4 (95% CI = [0.03, 0.9]) increase in 12-month RDQ and a 0.2 (95% CI = [0.02, 0.4]) increase in the 12-month BPI. As with the previous results, the clinical significance of these differences is negligible (Dworkin et al., 2008; Kovacs et al., 2007; Ostelo & de Vet, 2005; Ostelo et al., 2008).

Discussion

At all study sites, we observed weak correlations between worse 12- and 24-month pain, functionality, and health-related quality of life and slightly greater total and spine-specific RVUs accumulated in the year following index visits for back pain. When we adjusted for demographic and baseline factors, we observed weak associations between increased RVUs and slightly worsening PROs. Taken together, these results indicate that 12-month health care utilization is not strongly associated with PROs at 12 or 24 months and information about health care utilization cannot serve as a proxy for PROs in populations of older adults with low back pain.

The relationship between low back pain and resource use is complicated because low back pain is a heterogeneous condition, with some patients improving in relatively short time frames with minimal intervention and other patients having intractable symptoms over time despite multiple treatments (Newell, Field, & Pollard, 2014). Our results seem to support this hypothesis, because the patients with more severe pain and disability at the baseline visit tended to have slightly higher total and spine-specific RVUs in the subsequent 12 months, but we did not find evidence that greater resource use was associated with improved PROs at 12 or 24 months. In fact, greater utilization was generally associated with slightly worse PROs. These results imply that patients with worse PROs at baseline experienced more interventions over the subsequent 12 months compared with patients with less pain and disability at baseline but, on average in this population, these treatments did not result in improvements in reports of pain, functionality, or health-related quality of life.

Other research has indicated that interventions intended to alleviate back pain, though expensive, can be minimally effective in terms of improvements in patient-reported pain. For example, guidelines issued by the American Pain Society (R. Chou et al., 2009) indicated that lumbar fusion is associated with only moderate benefits for chronic non-radicular lower back pain compared with standard non-surgical therapy, and with no difference in benefit compared with a program of intensive rehabilitation. In addition, Martin et al. used data from the U.S. Medical Expenditure Panel Survey to evaluate health care expenditures for back and neck pain, as well as whether the health status of adults with back and neck problems improved between 1997 and 2005. They found that despite a 65% inflation-adjusted increase in expenditures, age- and gender-adjusted measures of functionality among adults with spine problems were worse in 2005 compared with 1997 (B. I. Martin et al., 2008).

The major strength of our study was access to a large registry of older adults with low back pain selected from three diverse geographical U.S. locations. In addition, because our patients were drawn from integrated health systems, we had access to a wealth of data on health care utilization from EHRs. However, despite our having obtained data from health systems with excellent information technology systems and staff, the EHR data that we retrieved from the three sites varied systematically, limiting our ability to compare utilization between health systems. For example, the spine diagnosis variable was defined slightly differently because one site (Kaiser) was

Table 3. Mean and Median PROs and Spearman Correlation Coefficients Between Total and Spine-Specific RVUs and 12-Month PROs.

	Axial back pain (*n* = 2,940)				Back and leg pain (*n* = 941)				Spinal stenosis (*n* = 241)				Other (*n* = 239)			
	n	*M* (*SD*)[a]	Correlation total RVU	Correlation spine RVU	*n*	*M* (*SD*)[a]	Correlation total RVU	Correlation spine RVU	*n*	*M* (*SD*)[a]	Correlation total RVU	Correlation spine RVU	*n*	*M* (*SD*)[a]	Correlation total RVU	Correlation spine RVU
12-month RDQ	2,937	8.3 (6.9)	.19	.21	938	8.3 (6.6)	.23	.21	241	10.0 (7.0)	.18	.19	236	8.3 (6.8)	.23	.14
24-month RDQ	2,521	8.1 (7.1)	.16	.18	817	8.4 (6.8)	.16	.16	208	9.4 (7.3)	.23	.17	201	7.4 (6.9)	.21	.15
12-month BPI	2,931	2.6 (2.5)	.18	.18	937	2.8 (2.5)	.22	.20	240	3.3 (2.7)	.19	.27	237	2.7 (2.5)	.23	.13
24-month BPI	2,516	2.5 (2.5)	.16	.16	816	2.7 (2.5)	.16	.15	208	3.0 (2.4)	.16	.12	200	2.5 (2.4)	.20	.16
12-month EQ-5D-Index	2,905	0.8 (0.2)	−.18	−.19	928	0.8 (0.2)	−.23	−.20	240	0.7 (0.2)	−.26	−.27	234	0.8 (0.2)	−.23	−.09
24-month EQ-5D-Index	2,484	0.8 (0.2)	−.17	−.16	808	0.8 (0.2)	−.18	−.17	203	0.8 (0.2)	−.19	−.14	196	0.8 (0.2)	−.16	−.11
12-month EQ-5D-VAS	2,900	73.7 (18.9)	−.20	−.12	924	73.9 (18.7)	−.23	−.15	239	72.0 (18.3)	−.09	−.17	237	73.3 (18.0)	−.19	−.07
24-month EQ-5D-VAS	2,498	73.7 (18.6)	−.15	−.09	813	73.2 (18.2)	−.19	−.12	239	70.9 (20.2)	−.09	−.09	198	71.6 (18.7)	−.11	−.09
12-month PHQ-4	2,903	1.7 (2.6)	.12	.08	924	1.8 (2.5)	.17	.15	240	1.8 (2.7)	.10	.17	237	2.0 (2.8)	.16	.06
24-month PHQ-4	2,485	1.8 (2.8)	.14	.09	810	1.8 (2.6)	.13	.10	203	1.8 (2.8)	.12	.08	200	2.0 (2.9)	.12	.10
12-month BRFSS Falls	2,910	0.1 (0.4)	.05	.04	931	0.1 (0.6)	.05	.03	241	0.2 (0.6)	.18	.09	236	0.2 (0.6)	.11	.01
24-month BRFSS Falls	2,502	0.1 (0.6)	.04	.03	815	0.1 (0.5)	−.03	.02	204	0.1 (0.4)	−.01	−.003	201	0.2 (0.6)	.05	−.003

Note. PRO = patient-reported outcome; RVU = relative value units; RDQ = Roland–Morris Disability Questionnaire (scale 0-24; higher = worse function); BPI = Brief Pain Index (scale 0-10); higher = worse interference with activities; EQ-5D-Index = EuroQol Group Index (scale 0-1; 0 = death, 1 = perfect health); EQ-5D-VAS = EuroQol Group Visual Analog Scale (scale 0-100; 0 = worst imaginable health state, 100 = best imaginable health state); PHQ-4 = Patient Health Questionnaire (scale 0-12; higher = greater depression/anxiety); BRFSS = Behavioral Risk Factor Surveillance System (scale = number of reported falls).

[a]For PROs observed at 12 or 24 months from index visit.

Table 4. Adjusted Linear Regression Estimates and 95% Confidence Intervals of PROs at 12 and 24 Months Against Log Transformed Total and Spine-Specific RVUs.

	Axial back pain		Back and leg pain		Spinal stenosis		Other	
Variable	Total RVU estimate[a] [95% CI][b]	Spine RVU estimate[a] [95% CI][c]	Total RVU estimate[a] [95% CI][d]	Spine RVU estimate[a] [95% CI][e]	Total RVU estimate[a] [95% CI][f]	Spine RVU estimate[a] [95% CI][g]	Total RVU estimate[a] [95% CI][h]	Spine RVU estimate[a] [95% CI][i]
12-month RDQ	0.1 [−0.1, 0.2]	0.05 [−0.03, 0.1]	**0.2 [0.005, 0.4]**	0.1 [−0.04, 0.2]	0.3 [−0.1, 0.7]	0.1 [−0.2, 0.3]	**0.4 [0.03, 0.9]**	0.1 [−0.2, 0.3]
24-month RDQ	0.03 [−0.1, 0.2]	−0.01 [−0.1, 0.1]	−0.04 [−0.3, 0.2]	−0.02 [−0.2, 0.1]	**0.6 [0.1, 1.1]**	0.03 [−0.3, 0.3]	0.3 [−0.2, 0.8]	0.01 [−0.2, 0.3]
12-month BPI	0.03 [−0.01, 0.1]	0.01 [−0.02, 0.04]	0.1 [−0.01, 0.2]	0.03 [−0.02, 0.1]	0.1 [−0.04, 0.3]	**0.1 [0.03, 0.2]**	**0.2 [0.02, 0.4]**	0.02 [−0.1, 0.1]
24-month BPI	0.04 [−0.01, 0.1]	0.01 [−0.03, 0.04]	−0.01 [−0.1, 0.1]	0 [−0.1, 0.05]	0.1 [−0.1, 0.2]	−0.01 [−0.1, 0.1]	0.1 [−0.1, 0.3]	0.04 [−0.1, 0.1]
12-month EQ-5D-Index	**−0.004 [−0.01, −0.001]**	−0.002 [−0.004, 0.001]	**−0.006 [−0.01, −0.0003]**	−0.003 [−0.01, 0.0002]	**−0.02 [−0.03, −0.004]**	**−0.01 [−0.02, −0.01]**	−0.01 [−0.02, 0.001]	0 [−0.01, 0.01]
24-month EQ-5D-Index	**−0.01 [−0.009, −0.001]**	0 [−0.003, 0.002]	−0.001 [−0.01, 0.01]	−0.002 [−0.01, 0.002]	−0.01 [−0.02, 0.01]	0 [−0.01, 0.01]	0 [−0.02, 0.003]	0 [−0.01, 0.01]
12-month EQ-5D-VAS	**−0.7 [−1.1, −0.3]**	0.004 [−0.2, 0.2]	**−0.9 [−1.6, −0.3]**	−0.2 [−0.6, 0.2]	−0.6 [−1.9, 0.7]	**−1.0 [−1.8, −0.1]**	−1.1 [−2.4, 0.3]	0.5 [−0.3, 1.2]
24-month EQ-5D-VAS	**−0.5 [−0.9, −0.04]**	0.1 [−0.2, 0.4]	**−1.0 [−1.7, −0.3]**	−0.3 [−0.7, 0.2]	0 [−1.6, 1.6]	−0.1 [−1.1, 0.8]	−0.1 [−1.7, 1.4]	0.1 [−0.8, 1.0]
12-month PHQ-4	0.03 [−0.03, 0.1]	0 [−0.04, 0.04]	0.1 [−0.02, 0.2]	0.03 [−0.03, 0.1]	−0.1 [−0.3, 0.1]	0.04 [−0.1, 0.2]	0.1 [−0.1, 0.3]	−0.1 [−0.2, 0.1]
24-month PHQ-4	**0.08 [0.02, 0.2]**	−0.02 [−0.1, 0.03]	0.1 [−0.03, 0.2]	0.02 [−0.04, 0.1]	−0.03 [−0.3, 0.2]	0.003 [−0.1, 0.1]	−0.1 [−0.3, 0.2]	−0.1 [−0.2, 0.1]
12-month BRFSS Falls	0.01 [−0.003, 0.02]	0 [−0.01, 0.005]	−0.01 [−0.04, 0.01]	−0.01 [−0.02, 0.01]	**0.1 [0.02, 0.1]**	0.01 [−0.02, 0.04]	0.01 [−0.04, 0.1]	0 [−0.01, 0.1]
24-month BRFSS Falls	0.01 [−0.01, 0.02]	0 [−0.01, 0.01]	**−0.02 [−0.04, −0.0004]**	0 [−0.01, 0.01]	0 [−0.04, 0.04]	−0.003 [−0.03, 0.02]	0.03 [−0.02, 0.1]	0 [−0.03, 0.03]

Note. Boldface results indicate $p < .05$. PRO = patient-reported outcome; RVUs = relative value units; 95% CI = 95% confidence interval; RDQ = Roland–Morris Disability Questionnaire (scale 0-24; higher = worse function); BPI = Brief Pain Index (scale 0-10; higher = worse interference with activities); EQ-5D-Index = EuroQol Group Index (scale 0-1; 0 = death, 1 = perfect health); EQ-5D-VAS = EuroQol Group Visual Analog Scale (scale 0-100; 0 = worst imaginable health state, 100 = best imaginable health state); PHQ-4 = Patient Health Questionnaire (scale 0-12; higher = greater depression/anxiety); BRFSS = Behavioral Risk Factor Surveillance System (scale = number of reported falls); NRS = Numeric Rating Scale (0-10; 0 = no pain, 10 = pain as bad as you can imagine).

[a]Estimates reported relative to a twofold increase in RVUs.

[b]Adjusted for site, age, gender, baseline RDQ, baseline NRS (back), education, employment status, smoking status, marital status, Quan comorbidity score, setting of index visit, log-adjusted RVUs in the year prior to the index visit, and pain expectations in 3 months.

[c]Adjusted for site, age, gender, baseline RDQ, baseline numeric rating score (back), race, education, employment status, marital status, Quan comorbidity score, setting of index visit, back pain duration, log-adjusted RVUs in the year prior to the index visit, and pain expectations in 3 months.

[d]Adjusted for site, age, gender, baseline RDQ, baseline NRS (back), log-adjusted RVUs in the year prior to the index visit, and Quan comorbidity score.

[e]Adjusted for site, age, gender, baseline RDQ, baseline NRS (back), setting of index visit, and log-adjusted RVUs in the year prior to the index visit.

[f]Adjusted for site, age, gender, baseline RDQ, baseline NRS (back), and log-adjusted RVUs in the year prior to the index visit.

[g]Adjusted for site, age, gender, baseline RDQ, baseline NRS (back), and log-adjusted RVUs in the year prior to the index visit.

[h]Adjusted for site, age, gender, baseline RDQ, baseline NRS (back), employment status, Quan comorbidity score, and log-adjusted RVUs in the year prior to the index visit.

[i]Adjusted for site, age, gender, baseline RDQ, and baseline NRS (back).

unable to provide ICD-9 diagnosis codes. However, by adjusting our analyses for site, we were still able to analyze the relationship between PROs and RVUs. Also, because more than 60% of the patients came from one center (Kaiser) and because all the patients received care from integrated health systems, our results may not be generalizable to the entire U.S. population of older adults with back pain. Although we attempted to adjust for back pain severity and health care utilization patterns by adjusting for RVUs in the year prior to the index visit and for baseline measures of pain, function, and comorbidity, some of our results may be attributable to residual confounding. Another limitation is that although we attempted to reduce heterogeneity in this population by performing analyses stratified on baseline diagnosis, a large proportion of the population were diagnosed with non-specific axial back pain, and heterogeneity likely existed even within this group. In addition, some procedures such as laboratory tests and prescription medications do not have RVUs and we were not able to draw conclusions about the relationship between these and PROs. Finally, although we captured most utilization data from the EHR, we did not have access to data resulting from services obtained outside of the participating health systems. However, due to convenience and financial incentives to seek care within the systems, we believe that we captured the majority of the health care utilization by this patient population.

In conclusion, our results indicate that, in this population of back pain patients aged 65 and above, increased health care 12-month utilization as measured by RVUs was only weakly associated with worse pain, functionality, and health-related quality of life 12 and 24 months after an initial back pain encounter. Therefore, the associations between 12-month resource utilization, which can be relatively easily collected through EHRs, and subsequent patient outcomes are not strong enough to justify using them as proxies for PROs at 12 or 24 months.

Acknowledgments

We would like to acknowledge the following individuals: Zoya Bauer at the University of Washington, Andrew L Avins at Kaiser Permanente Northern California, and DeShawn Mahone at Henry Ford Health System.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by the Agency for Healthcare Research and Quality (AHRQ): Grants 1R01HS01922201 and 1R01HS022972-01.

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