HSR Health Services Research

DOI: 10.1111/1475-6773.12098
RESEARCH ARTICLE

Health Care Utilization and Costs Associated with Adherence to Clinical Practice Guidelines for Early Magnetic Resonance Imaging among Workers with Acute Occupational Low Back Pain

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Objective. To estimate health care utilization and costs associated with adherence to clinical practice guidelines for the use of early magnetic resonance imaging (MRI; within the first 6 weeks of injury) for acute occupational low back pain (LBP).

Data Sources. Washington State Disability Risk Identification Study Cohort (D-RISC), consisting of administrative claims and patient interview data from workers' compensation claimants (2002–2004).

Study Design. In this prospective, population-based cohort study, we compared health care utilization and costs among workers whose imaging was adherent to guidelines (no early MRI) to workers whose imaging was not adherent to guidelines (early MRI in the absence of red flags).

Data Collection/Extraction Methods. We identified workers (age >18) with work-related LBP using administrative claims. We obtained demographic, injury, health, and employment information through telephone interviews to adjust for baseline differences between groups. We ascertained health care utilization and costs from administrative claims for 1 year following injury.

Principal Findings. Of 1,770 workers, 336 (19.0 percent) were classified as nonadherent to guidelines. Outpatient and physical/occupational therapy utilization was 52–54 percent higher for workers whose imaging was not adherent to guidelines compared to workers with guideline-adherent imaging; utilization of chiropractic care was significantly lower (18 percent).

Conclusions. Nonadherence to guidelines for early MRI was associated with increased likelihood of lumbosacral injections or surgery and higher costs for outpatient, inpatient, and nonmedical services, and disability compensation.

Key Words. Low back pain, costs, utilization, diagnostic imaging, clinical practice guidelines, workers' compensation

Clinical practice guidelines for acute low back pain (LBP) consistently agree that routine spinal imaging tests within 4–6 weeks of symptom onset are not necessary for patients who do not present with complications, or "red flags" (American College of Occupational and Environmental Medicine 2007; Bradley 2007; Chou et al. 2007; Davis et al. 2008; ABIM Foundation 2012). Red flags include age under 20 or over 70 (or 50, depending on the guideline), history of cancer, intravenous drug use, prolonged use of corticosteroids, osteoporosis, infection, or focal neurologic deficit with progressive or disabling symptoms (Davis et al. 2008). After 4–6 weeks, patients with persistent LBP or signs of radiculopathy or spinal stenosis should be evaluated with magnetic resonance imaging (MRI) or computed tomography (CT) only if they are expected to benefit from invasive treatments, such as surgery or epidural steroid injection (Chou et al. 2007).

Recent research suggests that ~20 percent of LBP cases among workers' compensation claimants receive early (within the first 4–6 weeks of symptoms) MRI, a proportion of whom may be receiving unnecessary care (Webster and Cifuentes 2010; Graves et al. 2012). The propensity to adopt and utilize new technologies for advanced imaging, combined with a general lack of utilization controls, generates concern from the perspective of payers, especially public payers facing increasing budgetary constraints. Use of costly procedures, such as MRI for LBP, may also be associated with increased subsequent treatment and costs, without concomitant improvements in health outcomes (Jarvik et al. 2003; Gilbert et al. 2004b). With the potential for early MRI to lead to additional, more intensive or more invasive treatment for LBP, a patient who had early MRI may utilize more health care resources than an equivalent patient who waited 6 weeks before receiving MRI (Waddell 1996).

In Washington State, back injuries constitute 18 percent of all claims and 23 percent of all workers' compensation costs (Washington State Department of Labor and Industries). In 2008, lumbar MRI costs exceeded $7.4 million for WA injured workers (Washington State Health Care Authority Health Tech-

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nology Assessment Advanced Imaging Management Workgroup). In response to rapidly increasing imaging costs, the WA legislature mandated that State health care agencies consider methods to implement best practice guidelines for the use of advanced imaging in 2009 (Washington State Legislature 2009).

This population-based cohort study evaluates health care utilization and costs associated with non-adherence to clinical practice guidelines for early MRI among WA workers' compensation claimants with acute, non-specific LBP who missed at least 4 days of work.

METHODS

Study Sample and Data Collection

The Washington Workers' Compensation Disability Risk Identification Study Cohort (D-RISC) was a population-based cohort study designed to identify risk factors for chronic disability among workers with acute back injury (Turner et al. 2008). Workers with new occupational LBP claims were identified through weekly reviews of the Washington State Department of Labor and Industries (L&I) State Fund claims database from July 2002 through April 2004. The State Fund insures two-thirds of all nonfederal WA workers; the remaining third are covered by large, self-insured companies, for whom complete data are unavailable. Trained interviewers contacted workers aged 18 years and older who had a claim with the State Fund for a low back sprain or strain. Workers were ineligible if they were unable to complete the telephone interview in English or Spanish, were hospitalized for the injury in the first 30 days, or had fewer than 4 days of missed work due to injury, which is the requirement for receiving work loss compensation in Washington State (Turner et al. 2008). Eligible participants completed a computer-assisted telephone interview. Medical records were reviewed by occupational health nurses to develop a clinical estimation of injury severity for eligible participants (Stover et al. 2006). Administrative and medical data associated with the back injury claim were followed for 1 year after injury for all participants. Medical claims data provided procedure types, dates, providers, and allowed charges for all care associated with the back injury. We extracted total disability compensation for time away from work due to the injury from State Fund administrative data. The University of Washington Institutional Review Board approved the study, and participants provided informed consent and were compensated $10.

Of the 4,354 workers identified, 1,178 could not be contacted, 120 were ineligible due to language limitations, and 909 declined to participate. Of the

2,147 subjects who agreed to participate, 240 were excluded for filing medical claims but lacking work disability compensation, and 22 others were excluded for other reasons. The final D-RISC sample of 1,885 workers was slightly older and included more women, compared to nonparticipants (Turner et al. 2008). For this study, we excluded workers who did not file a claim within 2 months after injury (55) to avoid including chronic injury cases. We also excluded from these analyses workers whose medical chart review indicated absent reflexes (knee or ankle), bladder complaints, or motor abnormalities (including sensory loss or muscle weakness) for whom early MRI might be indicated (60). The final sample for this study consisted of 1,770 workers, for whom early MRI is more discretionary. Clinical practice guidelines for the diagnosis and treatment of LBP do not consider radiculopathy a red flag and recommend that patients with nonspecific LBP and radicular symptoms initially be treated conservatively. Therefore, we included patients with radicular symptoms ($N = 379$) in the study.

Measurement

Adherence to Guidelines. The independent variable of interest was adherence to clinical practice guidelines, which state that for individuals with nonspecific LBP, early MRI is not necessary for patients who do not present with complications, or "red flags" (American College of Occupational and Environmental Medicine 2007; Chou et al. 2007). Early MRI was defined as record of lumbar MRI (CPT-4 codes 72148, 72149, 72158) in the State Fund's medical bill payment database within 42 days from reported injury date. We excluded any workers with complications or "red flags" (see aforementioned exclusion criteria), so all individuals in the final study sample should not have received early MRI. Workers who received early MRI were classified as nonadherent and those who did not were classified as adherent. (A small percentage [1.4 percent] of workers who did not receive an early MRI received early CT imaging; however, given this small proportion, we elected to focus this study only on early MRI).

Health Care Utilization. We used allowed medical bills to determine health care utilization for 1 year following the injury date, regardless of whether or when they were adherent, to capture the utilization for an entire episode of back pain. We included the following services and procedures: lumbar CT, lumbar radiography, lumbosacral injections, lumbar surgery, chiropractor

visits, physical or occupational therapy (PT/OT), and outpatient visits. We used the Current Procedural Terminology (CPT-4) codes and codes specific to L&I ("local codes") (Appendix A). We used provider types and specialties to determine the type of office visit. To avoid overcounting procedures that are typically billed in technical and professional components, we based our counts on a maximum of one distinct procedure per day.

Cost Measures. We categorized costs into four components: outpatient services, inpatient services, nonmedical costs, and disability compensation. We calculated outpatient services, inpatient services, and nonmedical costs using medical billing data and defined as the total reimbursed amount delivered to facilities or health care services up to 1 year following the injury date. Like utilization, we summed costs for 1 year following injury for all workers, regardless of whether an MRI was received within the first 6 weeks, later, or at all. Total outpatient costs included any procedures that took place during an outpatient visit (not during hospitalization) with CPT-4 codes 00000–99999, HCPCS codes G (medical procedures), J (drugs), L (orthotic/prosthetic procedures), and L&I local codes representing health care services (e.g., pain evaluation, attendant services). Inpatient costs included allowed costs for any service, treatment, or procedure that took place during hospitalization. We identified nonmedical costs using L&I local codes and included vocational assistance and rehabilitation, employability assessments, worker transportation, and medical devices needed to return to work. We defined disability compensation as the total wage-replacement benefits associated with the LBP claim and was computed from L&I administrative data. Disability compensation can be regarded as a proximate health outcome, as it is indicative of long-term disability and a commonly used surrogate marker of functional status and returning to work after an injury (Fulton-Kehoe et al. 2007). We adjusted all costs for inflation to 2005 US dollars using the Consumer Price Index for Medical Care (2002: 285.6; 2003: 297.1; 2004: 310.1; 2005: 323.2) (Bureau of Labor Statistics).

Covariates. We selected covariate measures a priori based on health services utilization models and current literature regarding LBP disability (Andersen 1995; Pransky et al. 2002; Turner et al. 2004). Covariates were ascertained from D-RISC structured telephone interviews, medical chart reviews, and claims data.

Claims records included age for all claimants. Participants provided other demographic information (race/ethnicity, education, income, and

marital status) during interviews, which were conducted ~3 weeks (median 18 days) after claim receipt. Self-reported health measures were collected at baseline interviews and included health status aside from injury, pain intensity (any pain in the last week) (Von Korff et al. 1992), and Roland–Morris disability questionnaire score, which assesses disability specific to LBP (Roland and Morris 1983; Turner et al. 2003). Review of medical records by occupational health nurses provided three injury severity categories: (1) Mild sprain/strain; (2) Major sprain/strain without evidence of radiculopathy; and (3) Evidence of radiculopathy (Stover et al. 2006). We measured catastrophizing, a psychosocial health measure of coping response, and categorized it as low, moderate, and high (Sullivan and Bishop 1995). We assessed work fear-avoidance by averaging responses from two items from the Fear-avoidance Beliefs Questionnaire and categorized it as very low, low-moderate, high, and very high (Waddell et al. 1993). We measured mental health status using the SF-36v2 for a 1 week time frame and categorized scores based on U.S. population norms: two or more SD below the general population mean, 1–2 SD below, 1 SD below, and at/above the mean (Ware and Sherbourne 1992; Ware, Kosinski, and Dewey 2000).

Labor and Industries administrative claims data allowed us to determine whether the worker had a previous compensable back claim. At interviews, workers reported overall job satisfaction, physical demands at work, and whether their employer offered accommodations for the injury (e.g., change in physical environment, tasks, or work schedule) (Turner et al. 2008). Employment industry was determined according to the North American Industry Classification System (U.S. Census Bureau 2002).

We determined the first attending provider for the claim from L&I administrative data and categorized the provider as a primary care physician, occupational health physician, chiropractor, surgeon, emergency department, or other (e.g., specialists and physical medicine).

Statistical Analyses

We compared workers whose imaging use was nonadherent to guidelines for early MRI to workers whose care was adherent to guidelines. We used STATA/IC 10.1 for Macintosh (Stata Corp., College Station, TX, USA) for all analyses (StataCorp 2007).

Because we did not randomly allocate early MRI to groups, systematic differences likely exist (Graves et al. 2012) and confounding by indication

may be present. It is possible that unmeasured cofounders could introduce bias. We used propensity scores as covariates to attempt to address these issues. We estimated the probability of nonadherence using demographics, injury, provider, and occupational characteristics for each worker (Appendix B). Interviews provided a substantial number of covariates to estimate propensity scores with good accuracy. We chose covariates for the propensity score model based on models of health services utilization and literature regarding LBP disability and resource use (Andersen 1995; Pransky et al. 2002; Jarvik et al. 2003). We used propensity scores as regression covariates in all multivariable analyses (D'Agostino 1998).

We compared health care utilization and costs for workers whose imaging use was nonadherent to guidelines for early MRI to workers whose care was adherent to guidelines. For procedures and services used infrequently (injections, surgical procedures, and imaging), we reported the proportion of workers with any utilization over the 1 year follow-up and compared groups using chi-squared tests. For common utilization measures, such as office visits, we calculated the mean number of visits in the 1 year follow-up. We compared unadjusted means using *t*-tests.

Multivariable models with propensity-score covariance adjustment also included covariates that could influence health care utilization, including pain and function, demographic, work, provider, injury category, and injury characteristics. For binary outcomes assessing any use of health care services (injection, surgical procedures, and imaging), we estimated relative risks (RR) using modified Poisson regression with robust standard errors. This method is appropriate for estimating RR in prospective studies with binary outcomes and common disease incidence (≥10 percent) (Zou 2004). For counts of health care utilization (chiropractor, PT/OT, and outpatient visits), we estimated incident rate ratios (IRR) using negative binomial regression. We estimated health care costs (outpatient, inpatient, pharmacy, nonmedical, and disability compensation) using a propensity-adjusted generalized linear model (GLM). GLMs perform well in analyzing right-skewed and over-dispersed cost and utilization data (Blough, Madden, and Hornbrook 1999; Diehr et al. 1999; Manning, Basu, and Mullahy 2005). Log link and Gamma family were GLM specifications for cost models; Box-Cox and modified Park Tests supported these selections (Manning and Mullahy 2001; Manning, Basu, and Mullahy 2005). We used bootstrap resampling methods to estimate 95 percent confidence intervals of estimates.

RESULTS

Worker Characteristics

Among 1,770 eligible workers, 336 (19.0 percent) received an early MRI within 6 weeks of injury that was not adherent to guidelines. The mean time between injury and MRI for the early MRI group was 22 days (median 21). Of the remaining 1,434 workers whose care was adherent to guidelines, 254 (17.7 percent) received an MRI after the first 6 weeks of injury symptoms (time to MRI was 115 days; median was 85 days).

Workers whose imaging experience was not adherent to guidelines reported higher Roland scores, pain intensity, catastrophizing, and fear avoidance scores, poorer mental health status, heavier physical demands at work, and lack of accommodations for their injury at work (chi-squared test, $p < .01$; Table 1). A smaller proportion of workers whose imaging was not adherent to guidelines had a chiropractor as their initial medical provider (19.6 percent), compared to other workers (33.1 percent).

Unadjusted Health Care Utilization and Costs by Adherence to Guidelines

Among workers whose imaging was not adherent to guidelines, 30.4 percent received a lumbar radiograph in the year following the injury, compared to 18.1 percent of workers whose imaging was adherent to guidelines ($p < .001$; Table 2). A significantly larger proportion of workers whose imaging was not adherent to guidelines received at least one lumbosacral injection or surgical procedure compared to adherent workers ($p < .001$). Workers with imaging that was not adherent to guidelines had more PT/OT and outpatient visits compared to workers whose imaging was adherent. Unadjusted mean costs were significantly higher among workers whose imaging was nonadherent to guidelines for all measures (Table 2). Outpatient costs averaged $7,583 for workers whose imaging was not adherent to guidelines, compared to $2,807 for workers with imaging adherent to guidelines. Workers whose imaging was not adherent to guidelines received an average of $10,442 in disability compensation in the year following injury, almost four times more than workers with imaging adherent to guidelines ($2,775).

Table 1: Baseline Demographic, Psychosocial, and Injury Characteristics of Study Participants

	Adherence to Clinical Practice Guidelines That Advise Against Early MRI for Patients without "Red Flags"		
	Nonadherent (N = 336)	*Adherent (N = 1434)*	*Sig.*
Age (at injury)			
Under 24 years	24 (7.1)	166 (11.6)	0.015
25–34 years	75 (22.3)	384 (26.8)	
35–44 years	117 (34.8)	419 (29.2)	
45–54 years	89 (26.5)	319 (22.2)	
Over 55 years	31 (9.2)	146 (10.2)	
Sex			
Female	91 (27.1)	477 (33.3)	0.029
Male	245 (72.9)	957 (66.7)	
Race/ethnicity			
Non-Hispanic white	253 (75.3)	976 (68.1)	0.060
Non-Hispanic non-white	33 (9.8)	205 (14.3)	
Hispanic non-white	31 (9.2)	170 (11.9)	
Hispanic white	11 (3.3)	36 (2.5)	
Education			
Less than high school	44 (13.1)	191 (13.3)	0.299
High school diploma/GED	126 (37.5)	476 (33.2)	
Some college	146 (43.5)	636 (44.4)	
College degree	20 (6.0)	130 (9.1)	
Household income ($)			
<30,000	116 (34.5)	591 (41.2)	0.074
30–45,000	88 (26.2)	351 (24.5)	
45–70,000	88 (26.2)	311 (21.7)	
>70,000	36 (10.7)	126 (8.8)	
Marital status			
Married	177 (52.7)	727 (50.7)	0.132
Living with partner	48 (14.3)	203 (14.2)	
Divorced	73 (21.7)	265 (18.5)	
Other	38 (11.3)	236 (16.5)	
Body mass index			
Normal <25	86 (25.6)	444 (31.0)	0.088
Overweight 25–29	133 (39.6)	550 (38.4)	
Obese 30–34	79 (23.5)	283 (19.7)	
Very obese >34	34 (10.1)	119 (8.3)	
Health in year before injury			
Excellent	87 (25.9)	324 (22.6)	0.485
Very good	113 (33.6)	523 (36.5)	
Good	96 (28.6)	435 (30.3)	
Fair/poor	40 (11.9)	149 (10.4)	

continued

Table 1. *Continued*

	Adherence to Clinical Practice Guidelines That Advise Against Early MRI for Patients without "Red Flags"		
	Nonadherent (N = 336)	*Adherent (N = 1434)*	*Sig.*
Health status at time of interview			
Excellent	67 (19.9)	282 (19.7)	0.187
Very good	110 (32.7)	521 (36.3)	
Good	110 (32.7)	454 (31.7)	
Fair/poor	47 (14.0)	176 (12.3)	
Roland-Morris score (0–24)			
Low (0–6)	13 (3.9)	409 (28.5)	<0.001
Moderate (7–12)	43 (12.8)	331 (23.1)	
High (13–18)	112 (33.3)	400 (27.9)	
Very high (19–24)	168 (50.0)	294 (20.5)	
Pain intensity (0–10)			
Low/no pain (0–3)	35 (10.4)	406 (28.3)	<0.001
Mild pain (4–6)	110 (32.7)	563 (39.3)	
Moderate/high pain (7–10)	191 (56.8)	462 (32.2)	
Injury severity			
Mild sprain/strain and/or minor physical exam findings	99 (29.6)	905 (63.5)	<0.001
Major sprain/strain evidenced by substantial immobility	72 (21.6)	305 (21.4)	
Evidence of radiculopathy	163 (48.8)	216 (15.1)	
SF36 Mental health score			
2 SD below population mean	82 (24.4)	174 (12.1)	<0.001
1-2 SD below population mean	95 (28.3)	285 (19.9)	
1 SD below population mean	93 (27.7)	351 (24.5)	
At or above population mean	66 (19.6)	622 (43.4)	
Catastrophizing (0–4)			
Low (<1)	39 (11.6)	373 (26.0)	<0.001
Moderate (1–2.9)	173 (51.5)	781 (54.5)	
High (3–4)	124 (36.9)	280 (19.5)	
Work fear-avoidance (0–6)			
Low (0–2.9)	30 (8.9)	324 (22.6)	<0.001
Moderate (3–4.9)	87 (25.9)	486 (33.9)	
High (5–5.9)	133 (39.6)	398 (27.8)	
Very high (6)	86 (25.6)	226 (15.8)	
Offered job accommodation for disability			
Yes	118 (35.1)	689 (48.0)	<0.001
No	211 (62.8)	729 (50.8)	
1 + previous compensable back claims			
Yes	82 (24.4)	259 (18.1)	0.011
No	254 (75.6)	1,165 (81.2)	

continued

Table 1. *Continued*

	Adherence to Clinical Practice Guidelines That Advise Against Early MRI for Patients without "Red Flags"		
	Nonadherent (N = 336)	*Adherent (N = 1434)*	*Sig.*
Job satisfaction			
Not at all	15 (4.5)	86 (6.0)	0.689
Not too satisfied	29 (8.6)	128 (8.9)	
Somewhat satisfied	144 (42.9)	593 (41.4)	
Very satisfied	148 (44.0)	623 (43.4)	
Industry			
Trade/transportation	79 (23.5)	355 (24.8)	0.109
Natural resources	10 (3.0)	75 (5.2)	
Construction	69 (20.5)	250 (17.4)	
Manufacturing	36 (10.7)	104 (7.3)	
Management	57 (17.0)	229 (16.0)	
Education/health	45 (13.4)	227 (15.8)	
Hospitality	40 (11.9)	194 (13.5)	
Physical demands at work			
Light	53 (15.8)	296 (20.6)	0.014
Medium	101 (30.1)	460 (32.1)	
Heavy	78 (23.2)	348 (24.3)	
Very heavy	100 (29.8)	324 (22.6)	
Type of first medical visit			
Primary care	164 (48.8)	622 (43.4)	<0.001
Occupational medicine	17 (5.1)	39 (2.7)	
Chiropractor	66 (19.6)	474 (33.1)	
Surgeon	11 (3.3)	25 (1.7)	
Emergency room/clinic	71 (21.1)	250 (17.4)	
Other	7 (2.1)	24 (1.7)	

Nonadherent group reflects workers who received an MRI within the first 6 weeks of injury. Adherent group reflects workers who received an MRI after the first 6 weeks of injury ($N = 255$) or did not receive an MRI at all ($N = 1{,}179$).
Frequency counts do not always sum to total because of missing responses or rounding.
Values are N(%) and significance values indicate results from chi-squared tests.

Propensity Scores

We generated propensity scores for each worker to characterize the estimated probability of that worker's imaging being nonadherent to guidelines for early MRI. To evaluate the fit of the propensity scores, we compared disability compensation, which can be considered a proximate health outcome (Fulton-Kehoe et al. 2007), across propensity scores and observed that disability compensation varied in relation to propensity scores. For low propensity scores (0–0.03), the median disability compensation was $210 (inter-quartile range [IQR]: 458), for middle propensity scores (0.03–0.19), the median was $644

Table 2: Unadjusted Health Care Costs and Utilization by Imaging Category

	Adherence to Clinical Practice Guidelines That Advise Against Early MRI for Patients without "Red Flags"		
	Nonadherent (N = 336)	*Adherent (N = 1434)*	*p-value*
Any utilization of services, %			
MRI	100.0	17.8	<.001
CT	5.4	3.1	.048
Radiograph	30.4	18.1	<.001
Injection	40.8	6.9	<.001
Surgery	19.9	2.5	<.001
Number of visits, mean (SD)*			
Chiropractic	14.7 (28.1)	13.9 (24.2)	.641
PT/OT	18.4 (19.9)	6.8 (13.8)	<.001
Outpatient	12.2 (8.0)	4.3 (6.1)	<.001
Costs, mean (SD)*,†			
Outpatient services	$7,583 (5,147)	$2,807 (4,084)	<.001
Inpatient services	1,702 (2,445)	388 (1,077)	<.001
Non-medical‡	2,425 (3,347)	670 (2,062)	<.001
Disability compensation	10,442 (10,916)	2,775 (6,089)	<.001
Total costs	22,151 (17,092)	6,640 (11,019)	<.001

*Mean number of visits and mean costs include all workers, including nonusers and those with zero costs.
†Costs refer to total reimbursed amounts for procedures and visits that occurred within 1 year following injury, inflation adjusted to 2005 equivalents, based on Medical Consumer Price Index.
‡Nonmedical costs include reimbursement for vocational (return-to-work) assistance or rehabilitation, employability assessments, worker transportation, medical devices, and other costs not included in other cost categories.
Nonadherent group reflects workers who received an MRI within the first 6 weeks of injury. Adherent group reflects workers who received an MRI after the first 6 weeks of injury ($N = 255$) or did not receive an MRI at all ($N = 1{,}179$).
Values are counts (percentages) and unadjusted means (SD) as indicated. *p*-values indicate unadjusted comparison using chi-squared or *t*-tests.
CT, computed tomography (lumbar); MRI, magnetic resonance imaging (lumbar); PT/OT, physical therapy or occupational therapy.

(IQR: 1,768), and for the highest propensity scores (0.19–0.98), the median was $5,333 (IQR: 12,386).

Adjusted Health Care Utilization and Costs by Adherence to Guidelines

Table 3 shows results from propensity score-adjusted multivariable regression models that adjust for sociodemographic, health, injury, psychosocial, and employment characteristics, and type of first medical visit (all covariates listed in Table 1). Compared with workers whose imaging was adherent to

Table 3: Adjusted Health Care Costs and Utilization: Results from Propensity Score-Adjusted Regression Analyses

	Nonadherent versus Adherent to Clinical Practice Guidelines That Advise against Early MRI for Patients without "Red Flags"
Any utilization of services	RR (95% CI)
CT	0.40 (0.18, 0.92)
Radiograph	1.04 (0.81, 1.34)
Injection	1.93 (1.43, 2.62)
Surgery	2.16 (1.28, 3.66)
Number of office visits	IRR (95% CI)
Chiropractic	0.82 (0.69, 0.97)
PT/OT	1.54 (1.33, 1.80)
Outpatient	1.52 (1.30, 1.77)
Costs*	CR (95% CI)
Outpatient services	1.52 (1.33, 1.70)
Inpatient services	3.10 (1.72, 4.47)
Non-medical†	1.87 (1.34, 2.39)
Disability compensation	1.63 (1.34, 1.92)
Total costs	1.62 (1.38, 1.86)

*Costs refer to total reimbursed amounts for procedures and visits that occurred within 1 year following injury, inflation adjusted to 2005 equivalents, based on Medical Consumer Price Index.
†Nonmedical costs include reimbursement for vocational (return-to-work) assistance or rehabilitation, employability assessments, worker transportation, medical devices, and other costs not included in other cost categories.
Ratios compare workers whose imaging experience was not adherent to clinical practice guidelines (received early MRI) to workers with imaging adherent to guidelines (workers who received an MRI after the first 6 weeks of injury or did not receive an MRI at all).
CR, cost ratio; CT, computed tomography; IRR, incidence rate ratio; MRI, magnetic resonance imaging; PT/OT, physical therapy or occupational therapy; RR, relative risk.

guidelines, utilization of lumbosacral injections and surgical procedures was nearly twice as high for workers whose imaging was not adherent to guidelines (RR: 1.93 and 2.16, respectively). Workers with imaging that was not adherent to guidelines were less likely to receive a CT (RR: 0.40, 95 percent CI: 0.18–0.92) and had 18 percent fewer chiropractic visits (IRR: 0.82, 95 percent CI: 0.69–0.97) than workers whose care was adherent to guidelines. Nonadherence to guidelines for early MRI was associated with increased health care utilization for PT/OT and outpatient visits.

Adjusting for covariates and propensity scores, costs for workers who were not adherent to guidelines were significantly higher for all cost components (Table 3). Compared to workers with imaging adherent to guidelines, adjusted health care costs were significantly higher for workers whose imaging was not adherent, with the highest cost difference associated with inpatient costs (210 percent higher), followed by non-medical costs (87 percent higher),

disability compensation (63 percent higher), and outpatient costs (52 percent higher).

DISCUSSION

Despite clinical guideline recommendations that advanced imaging, such as MRI, should not take place in the first 6 weeks of LBP symptoms, in our sample of workers with uncomplicated, nonspecific acute LBP, we found that 19.0 percent of workers with LBP received at least one MRI within this time frame. This nonadherence to guidelines was associated with increased likelihood of surgery, injections, PT/OT and outpatient visits, but decreased risk of lumbar CT imaging and chiropractic visits despite adjustment for baseline symptom severity and propensity scores predicting adherence to the guidelines.

Other studies in nonworker populations have shown that use of early imaging may be associated with higher utilization and medical costs (Jarvik et al. 2003; Gilbert et al. 2004a,b). A study that randomized patients to receive early imaging (MRI or CT) or delayed, selective imaging showed a higher likelihood of outpatient visits among those with early imaging. The total number of visits did not differ between the groups (Gilbert et al. 2004b), in contrast to our study that found a significant impact on the amount of subsequent utilization. In another randomized trial, Jarvik and colleagues found that LBP patients randomized to receive early MRI engaged in more consultation visits and had a higher mean cost of health care services, compared to the radiography patients, although this result was not statistically significant (Jarvik et al. 2003). In an analysis of workers' compensation claimants, Webster and Cifuentes found that early MRI was associated with higher mean medical costs compared to not receiving an MRI at all ($21,921 vs. $2,779). Yet their analysis did not focus on adherence to guidelines and therefore did not include workers who received an MRI after the first 6 weeks of care, nor did the study adjust for individual-level factors such as pain intensity or physical functioning (Webster and Cifuentes 2010). Early MRI has also been associated with prolonged disability for occupational LBP in several studies (Mahmud et al. 2000; Webster and Cifuentes 2010). To our knowledge, this is the first study to integrate patient-reported pain and injury information with administrative claims data to evaluate the costs and utilization of nonadherence to clinical practice guidelines for early MRI among workers' compensation patients.

We observed a greater likelihood of back surgery and lumbosacral injections among workers whose imaging experience was not adherent to guidelines, after adjusting for covariates. This finding supports earlier research (Jarvik et al. 2003; Webster and Cifuentes 2010; Ivanova et al. 2011) of others who have suggested that early imaging may be used for planning of subsequent care, such as surgery or injections (Webster and Cifuentes 2010). Despite significantly lower utilization of CT and chiropractic visits, increased use of costly procedures and services among workers with early imaging contributed to substantially higher costs. Our adjusted regression analyses indicate that for workers with acute LBP, nonadherence to guidelines was associated with 48 percent higher costs for outpatient services and 210 percent higher costs for inpatient services, compared to workers whose imaging experience was adherent to guidelines. We speculate that the results of early MRI may lead to a cascade of health care services, thus contributing to higher costs and utilization in the early MRI group. Patients whose care is not adherent to early MRI guidelines may also have characteristics that predispose them to consume more care. However, it is also conceivable that residual confounding exists, despite the use of propensity scores, and that the patient population with nonadherent imaging apparently had more severe injuries or complained of more pain than those whose imaging was adherent to guidelines.

The financial impact of early imaging could be justified by improved health outcomes; however, studies suggest that early imaging does not result in significant, cost-effective improvements in pain, functioning, or health status, compared to individuals who receive usual care (Jarvik et al. 2003; Gilbert et al. 2004b). While these studies focus on early MRI and not on guideline adherence specifically, the comparison groups in this study (adherent vs. non-adherent) were defined by receipt of early MRI in the absence of red flags. Therefore, the results of previous research are informative to this study. The excess costs associated with early imaging are not trivial, and adherence to evidence-based guidelines could result in substantial cost savings for payers, such as workers' compensation programs, presumably without deleterious effects to patients.

The strength of this study included the ability to follow a large, population-based cohort of workers with LBP and collect detailed information about each worker's health care and injury experience. The combination of independent and dependent variables available from administrative claims and interview data represents a substantial strength of this study and enabled

numerous confounders, including pain, functioning, and health status, to be taken into account in analyses.

Workers' compensation claimants are not responsible for deductibles or out-of-pocket expenses, so our estimates approximate the total direct costs. Many indirect costs, such as the transportation costs to/from appointments, are reimbursed and thus accounted for in nonmedical costs. Nonetheless, costs associated with LBP treatments that are not covered by workers' compensation, such as acupuncture and over-the-counter medications, would not be included in these analyses.

This study has several limitations. First, although this study used a large, population-based sample, subjects were restricted to Washington State workers' compensation claimants with nonsevere injuries that resulted in ≥4 days of compensated lost work time. As such, results may not be generalized beyond a working population with compensable, nontraumatic occupational injuries. Nonetheless, nonspecific occupational LBP is a particularly common condition (Levy 2006), enabling the results to be applicable to a relatively large population. Second, given the observational nature of this study, the possibility of residual confounding by unmeasured variables or incomplete control of confounding for pain and function may exist, despite the availability of numerous individual-level, independent variables. Also, as noted above, it is possible that non-adherence (and thus early MRI) could be an indicator of more severe injury, despite our efforts to statistically adjust for this using propensity scores. It is also possible that patients who received injections may have had MRI for planning purposes; however, we did not evaluate this association in our study. Third, the design and scope of this study limited our ability to evaluate providers' rationale for not adhering to guidelines or the appropriateness of imaging. Also, we defined provider as the first attending provider; however, a patient may have several or change providers, and it is not possible to know whether the first attending provider ordered a patient's MRI or was responsible for care later in the course of LBP treatment. Previous research suggests workers may not consistently see the same providers throughout the course of care for occupational LBP treatment (Tacci et al. 1998; Atlas et al. 2004). Fourth, the comparison group for this study is inherently heterogeneous, as it included both individuals with resolved symptoms requiring no additional treatment and those with persistent symptoms that require additional management, including advanced imaging. Misclassification of this group may have occurred (e.g., some individuals may have had symptoms that warranted early MRI that they did not receive) because clinical characteristics and symptoms of this group that are not available to us. Finally,

this study used administrative claims data and we did not have access to imaging test results, so we were unable to evaluate outcomes associated with the injury and cannot make conclusions about the effectiveness of the care received. These are important topics in health care utilization and cost research and should be addressed by future research.

Despite its limitations, this study provides valuable insight regarding the association of nonadherence to clinical practice guidelines for early MRI with health care utilization and reimbursed costs among workers' compensation claimants. Evidence-based guidelines for early MRI serve as valuable tools to address unnecessary resource use, associated costs, and the potential for adverse outcomes. This study shows that contrary to recommendations, early MRI is a common element of routine care for workers' compensation claimants with non-specific, uncomplicated LBP and is associated with significant increases in utilization and costs. This cascade of care could be avoided through promotion and adherence to clinical guidelines for early MRI.

ACKNOWLEDGMENTS

Joint Acknowledgment/Disclosure Statement: The authors acknowledge Jerry Gluck, Rae Wu, and Melinda Fujiwara at the University of Washington Occupational Epidemiology and Health Outcomes Program for their assistance in carrying out this study. We also thank Tom Wickizer and Diane P. Martin for their feedback in the early stages of this research. This research was supported by Centers for Disease Control and Prevention (CDC), National Institute for Occupational Safety and Health (NIOSH) grants 1 R0 OH04069 (PI: Franklin) and 1 T42 OH008433 (PI: Seixas), and Agency for Healthcare Research and Quality (AHRQ) grant R01 HS019222-01 (PI: Jarvik). Dr. Graves receives fellowship support from National Institutes of Health (NIH), National Institute of Child Health and Human Development (T32 HD057822-01A2, PI: Rivara). This work was also supported by the Harborview Injury Prevention & Research Center, University of Washington. The content is solely the responsibility of the authors and does not necessarily represent the official views of the CDC, AHRQ, or NIH.

Disclosures: No benefits in any form have been or will be received from a commercial party related directly or indirectly to the subject of this manuscript. Dr. Jarvik is a cofounder and stockholder of PhysioSonics, and serves as consultant for HealthHelp and GE Healthcare. No disclosures for other authors.

Disclaimers: None.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Appendix SA1: Author Matrix.

Appendix SA2: Identification of utilization measures.

Appendix SA3: Variables included in logistic regression model to develop propensity score weights.