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The Influence of Managed Care on the Use of Magnetic Resonance Imaging (MRI) in the Evaluation of Low Back Pain in the Oregon Workers' Compensation System

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ABSTRACT

Objective: Substantial evidence suggests that current rates of magnetic resonance imaging (MRI) in the diagnostic evaluation of non-specific low back pain (LBP) are excessive. MRIs can provide exquisite anatomical detail of the spine. While MRIs are highly sensitive diagnostic tools, they cannot distinguish well between incidental and clinically relevant findings on imaging. The increased detection of "surgically-amenable" anatomic abnormalities has led to unnecessary surgery and has substantially increased the cost of treating LBP. Managed care has the potential to reduce medical costs and health care services utilization and has gained a larger market share amongst some state's Workers' Compensation systems in response to the rise in medical costs. This study compared the proportion of MRIs among managed care organization (MCO) and non-MCO billed medical events to evaluate the influence of managed care on imaging utilization in the diagnostic evaluation of LBP.

Methods: This cross-sectional study used the Oregon Workers' Compensation medical service billing database (Bulletin 220) provided by the Information Management Division of the Oregon Department of Consumer and Business Services. Claims with International Classification of Diseases (ICD-9-CM) diagnostic codes for simple LBP (724.2, 846.0-9, and 847.2-4) from 1999-2002 were abstracted. Frequency tables and logistic regression were used to examine the association between MCO enrollment and MRI use in an episode of care for injured workers, adjusting for claimant and provider characteristics. The nature of imaging trends over time in each study group was evaluated with the Wald Chi-square trend statistic in the final logistic regression model.

Results: The total number of billed medical events for non-specific LBP during calendar years 1999-2002 was 457,715. The medical events were fairly evenly distributed among MCOs and non-MCOs (47.3% versus 52.7% of all claims). In 1999, the proportion of billed imaging events among MCO-billed medical events was less than non-MCO billed medical events (0.6% versus 0.8%), and the odds of an imaging event among MCO-billed medical events was 0.70 times that among non-MCO billed medical events(OR: 0.70 95% CI: 0.61, 0.81; p-value <.001). In the subsequent years, 2000-2002, however, the proportion of imaging events among non-MCOs' events decreased while that among MCOs' events remained relatively stable, resulting in equal proportions of imaging events at 0.6% in 2001. Thus, the odds of imaging in these years were relatively similar among both study groups(OR: 1.08, 1.01, 1.05, respectively).

Conclusion: The MCO effect on reducing imaging utilization was significant in 1999 but was not present in the 3 subsequent years. Therefore, the MCO effect was inconsistent, and possibly declined during the four year study period.

INTRODUCTION

Substantial evidence suggests that current rates of magnetic resonance imaging (MRI) in the diagnostic evaluation of non-specific low back pain (LBP) are excessive. (Deyo, 1994; Jarvik, 2001; Lurie, 2003) MRIs can provide exquisite anatomical detail of the spine.(Black, 1993) While MRIs are highly sensitive diagnostic tools, they cannot distinguish well between incidental and clinically relevant findings on imaging.(Jarvik 2003, Boden 1990) The increased detection of "surgically-amenable" anatomic abnormalities has led to unnecessary surgery and has substantially increased the cost of treating LBP.(Lurie, 2003; Davis, 1993) Managed care has the potential to reduce medical costs and health care services utilization and has gained a larger market share amongst some state's Workers' Compensation systems in response to the rise in medical costs. (Baldwin, 2002) This study compared the proportion of MRIs among managed care organization (MCO) and non-MCO billed medical events to evaluate the influence of managed care on imaging utilization in the diagnostic evaluation of LBP.

Introduction to Low Back Pain

LBP is a major cause of pain and lost work productivity. Up to one quarter of the U.S. population have low back pain in any given year and two-thirds experience it at some point during their life.(Deyo, 2001; Atlas 2004) Among working adults less than 45 years old, it is the leading ailment causing occupational disability.(Tryanovich, 1999) The total cost of low back problems, including diagnostic and treatment costs, has been estimated to be approximately $26 billion, accounting for about 2.5% of the nation's annual health care expenditures in 2002.(Luo, 2004) Among workers, the annual cost of medical care totals $9 billion and accounts for one fourth of all workers' compensation (WC) costs.(Atlas, 2004) Lost productivity is estimated to be one hundred million work days.(Guo, 1999)

Classification of Low Back Pain and Indications for Imaging.

The overwhelming majority of patients with simple low back pain (LBP) symptoms are diagnosed with mechanical low back pain, in which the term "mechanical" designates an anatomic or functional abnormality, usually musculoligamentous injury or inflammation. These cases of back pain are commonly attributed to a strain or sprain, or a degenerative process, and ninety-percent resolve spontaneously within 6 weeks.(Jarvik, 2002; Deyo 2001; Atlas, 2001) Up to eighty-five percent of cases cannot be given a precise pathoanatomical diagnosis because the pain can originate from any of the structures of the spine, including the ligaments, tendons, intervertebral disks, vertebrae, facet joints, and paraspinal muscles, and these can be difficult to differentiate on a physical exam.(Deyo, 1999; Atlas, 2001)

Mechanical low back pain is also referred to as non-specific low back pain (NSLBP) or simple LBP to contrast it from specific low back pain. In cases of specific LBP, a specific cause of the pain is usually identifiable and attributed to a process such as a neoplasia, inflammatory disease, or infection, rather than a mechanical abnormality of spine structures.(Von Korff, 1994) Specific LBP also encompasses nerve root irritation due to a disc herniation or protrusion which is characterized by pain radiating down the leg in addition to the lumbar pain, and can cause neurological impairment. These diseases can lead to serious physical debilitation or death but specific LBP is a rare diagnosis.(Jarvik, 2002) the pre-test probabilities for cancer and infection, for example, are very low, estimated at less than 0.7% and 0.01%, respectively. Of all LBP cases, specific LBP accounts for less than 5%.(Verillis, 2004; Jarvik 2002)

Treatment differs for non-specific LBP and SLBP. In general, in cases of specific LBP, a specific cause of the LBP is usually identified and can potentially be reversed by surgical and/or medical intervention. These cases require prompt imaging and laboratory testing for diagnosis of the disease process. Screening patients for the risk factors of such underlying diseases, which are identified as "red flags", is usually sufficient to detect important diagnoses in the primary evaluation of LBP.(Troyanovich,1999; Von Korff 1994, Jarvik 2002) The "red flags" include fever, history of cancer, unexplained weight loss, age greater than 50, urinary tract infection, intravenous drug use, saddle anesthesia, sensory loss, or prolonged use of corticosteroids.(Troyanovich, 1999)

In contrast, in cases of non-specific LBP, the musculoligamentous injury is benign, self-limited, and does not need surgical treatment, and therefore does not require advanced diagnostic imaging.(Atlas, 1996; Bessette, 1996) Therefore, national treatment guidelines indicate that patients with non-specific LBP should undergo 6 weeks of conservative treatment, including anti-inflammatory medication and alteration of activities, before undergoing any imaging, during which time, ninety percent of cases will resolve. In the 10 percent of cases that fail conservative treatment and physical therapy, surgery may be warranted, and in these cases, imaging is indicated to assess surgical candidacy. (Bigos, 1994; Atlas, 2003)

Limitations of Imaging and Implications for Surgical Outcomes

Spinal surgery rates have markedly increased in the last couple decades. Davis et al. conducted an analysis of National Hospital Discharge Services, and report that between 1979-81 and 1988-90, the number of hospitalizations for lumbar surgery more than doubled (increasing by

68,000), and the rate two of the most common surgical procedures (lumbar fusion surgery and lumbar exploration/decompression) increased >60%. The rate of hospitalizations with lumbar disc surgery increased 140% among males greater than or equal to 65 years of age.(Davis, 1993)

MRI rates have paralleled the growth in the rates of spinal surgery. In 1997, MRIs were three times more likely to be used for diagnostic purposes compared with 1987.(Fuerstein, 2004) Beginning in the 1980s, advanced imaging (MRI) came to replace plain radiography as the initial diagnostic tool in LBP evaluations which allowed increasingly smaller irregularities to be detected, and subsequently incidental or unrelated findings have triggered further unnecessary diagnostic studies or treatments.(Deyo, 1994)

Concern regarding the relationship between imaging and spinal surgeries was reinforced by the wide, yet unexplained, geographic variation in spinal surgery rates. In 1996–1997, spinal surgery rates in the Medicare population varied seven- to fifteen-fold, depending upon the type of surgery, across geographic areas of the United States. Differences in patient populations and health care supply had explained only about 10% of this variation in various analyses.(Weinstein, 2000; Lurie, 2003) In 2003, Lurie et al. reported that areas with higher rates of MRI had higher rates of spine surgery overall, that advanced spinal imaging accounted for 22% of the variability in overall spine surgery rates. Perhaps most striking, that imaging alone explained more than twice as much of variation in spine surgery rates as combinations of population characteristics and health care supply variables had explained in prior studies.

Other lines of evidence point to a relationship between imaging and spinal surgery. A randomized control trial of imaging versus radiographs in the diagnostic evaluation of LBP found that the studies resulted in nearly identical outcomes for primary care patients with low back pain, but that those who underwent advanced imaging initially had higher costs of care, specifically a mean (averaged over the study group) cost difference of $321 ($2380 vs. $2059) because of the increased number of spine operations that patients are likely to undergo. (Jarvik JG, 2003)

Anatomic accuracy is only valuable if there is a causal association between "abnormal" anatomy and back pain or sciatica. Many studies have documented a high prevalence of disc abnormalities on imaging in asymptomatic subjects. Bulging discs are found in up to 50%, and a herniated disc occurs in 20-30%, with both findings being more common in older subjects.(Jarvik, 2001) Over 20% of asymptomatic subjects over 60 years of age have imaging evidence of spinal stenosis.(Jarvik, 2001; Boden, 1990) Furthermore, among symptomatic individuals, their self-report of pain or weakness has limited correlation with anatomical impairment on imaging studies.(Beatie, 2000)

Thus, it is increasingly understood that, as diagnostic tool in the evaluation of LBP, imaging has a high sensitivity but an inadequate specificity to identify a specific cause because clinically irrelevant findings are common.(Deyo, 1994; Jarvik, 2001) The hazard of overdetection is overtreatment.(Black, 1993; Lurie, 2003; Davis, 1993) High surgical rates are associated with inferior outcomes because of inappropriate selection of surgical candidates and the introduction of potentially harmful effects of surgical complications. (Jarvik, 2003)

Gap between treatment guidelines and physician practices

The substantial geographic and intraspecialty variability in clinicians' thresholds for obtaining advanced spinal imaging, and evidence of overutilization of MRIs, prompted efforts to summarize evidence supporting common treatments for low back pain and to develop recommendations for evidence-based practice. (Carey, 1996; Boden, 1998; Jarvik, 2002) As stated above, the Agency for Health Care Policy and Research (AHCPR), a division of the US Department of Health and Human Services, published guidelines for the management of adult LBP in 1994 that recommended a conservative approach to imaging.(Bigos, 1994) Specifically, diagnostic testing should not be a routine part of the initial evaluation, but used selectively based upon the history, examination, and initial treatment response. For patients whose symptoms are not improving over 2 to 4 weeks, referral for physical treatments is appropriate. Patients with radicular pain and little or no neurological findings should receive conservative treatment, but elective surgery is appropriate for those with evidence of nerve root compression who are unresponsive to conservative therapy after 6 weeks.(Bigos, 1994; Atlas, 2003)(Appendix I) The validity of these guidelines have been demonstrated by several studies (Wadell, 1996; Jarvik, 2002), and the UK Department of Health has published similar guidelines.(Bigos, 1994)

Despite the widespread existence of evidence-based guidelines, the gap between the treatment recommended by the guidelines and practice by physicians persists.(Carey, 1995; Tacci, 1999) In 1994, Cherkin et al published a study titled "What you see is what you get" which demonstrated that a physician's specialty influenced his/her threshold for ordering imaging for patients with non-specific LBP. A spectrum of imaging patterns along specialty lines was noted with physiatrists being the least likely to image and neurosurgeons being by far (twice as much as other specialties) the most likely to image.(Cherkin, 1994) Further evidence for inappropriate (early and extensive) imaging is provided by Atlas's 1996 study which concluded that "the diagnostic evaluation depends heavily on the individual physician and his or her specialty, and not just the patient's symptoms and findings." Finally, Boden et al reported that only 25% of advanced spinal images met criteria for appropriateness, and a retrospective study of a health maintenance organization reported that 66% of advanced imaging was inappropriate (premature or unnecessary) according to AHCPR guidelines. (Boden, 1998; Schroth 1992)

Influence of Diagnostic Challenges in the Primary Care Setting on Imaging

The particular diagnostic challenge in the evaluation of LBP may be a major reason for the difficulty in putting treatment guidelines into practice. In the diagnostic evaluation of LBP, a PCP's major diagnostic task is to distinguish the 5% of patients with serious underlying diseases or neurological impairments requiring referral to a specialist from the 95% of patients with non-specific LBP. Studies show that primary care providers (PCPs) often prescribe early (within 6 weeks of symptom onset) imaging.(Jarvik, 2002) and it may be the anxiety about missing potentially important diagnosis that contributes to early imaging.(Deyo, 1996)(Appendix I)

Early imaging may be common also because the clinical evaluation of LBP rarely reveals a specific cause of disease, and patients who are given a vague diagnosis are more likely to demand imaging.(Deyo, 1996; Consumer Reports, 1995) Studies report that a patient's perceived need for imaging may initiate its use despite its contraindication based on guidelines, and that the greatest variability in ordering imaging tests occurs in those patients with non-specific LBP who request imaging.(Wilson, 2001; Shye, 1998)

While the reassurance value of a diagnostic tool is appealing for physicians and patients alike, a study which reviewed the literature from January 1966 to September 2001 concluded that improvement in measures of reassurance and satisfaction have not facilitated measurable improvements in functional status or health-related quality of life.(Jarvik, 2002) Thus, despite the significant diagnostic challenge LBP presents to practitioners, the value of departing from treatment guidelines for purposes of reassurance is not grounded in the scientific literature.

Managed Care

Work-related low back pain (WRLBP) constitutes a subtype of LBP as its presentation and natural history differ from that of non-occupational LBP. Specifically, it is more likely to have an acute onset, be persistent, impair function, and require more treatment than non-occupational cases.(Atlas, 2004) Consequently, during this time of increasing medical costs of treating LBP, the worker's compensation system been particularly affected. For example, the estimated costs of worker's compensation cash and medical benefits paid to workers rose from $27.3 billion in 1987 to $45.7 billion in 1992, constituting an annual growth rate about 5% higher than that of national health care costs (15% versus 10%). These costs increased while the prevalence of work disability decreased, demonstrating that medical costs were increasing per worker, and were doing so at a faster rate than overall medical inflation.(Baldwin, 2002)

Some states and workers' compensation insurers responded to the increased disability and medical costs by introducing managed care in the late 1980s and early 1990s.(Mitka, 2005) Managed care gained part of the market share of Worker's Compensation Programs in Oregon, Florida, Washington and California, and achieved success in cost containment in each without sacrificing health outcomes.(Cheadle, 1999; Oregon DCBS, 1999; Baldwin, 2002)

During the 1980s in Oregon, WC costs were among the highest in the nation. In 1990, Senate bills were passed which allowed workers' compensation insurers to contract with department-certified managed care organizations to control costs and maintain quality care. (Oregon DCBS, 1999.(Sutton, 2005) DCBS conducted a study of the managed care effect in Oregon in 1995, reporting a 12% reduction in medical costs for MCO enrollees as compared to non-enrolled workers with similar medical outcomes for both groups. MCO enrollees were reported to be slightly less satisfied with their access to care but equally as satisfied with their overall care.(Oregon DCBS, 1999)

In 1996, a study by an independent organization, the Workers' Compensation Research Institution, identified the major reasons why controllable costs fell. Active claims management and more frequent denials accounted for one-third to one-half of the drivers of cost containment. Improved safety and falling claim frequency accounting for the great remainder of contributors to reducing system costs.(Gardner, 1996) Therefore, it is likely that measures employed by MCOs to achieve cost containment, including promotion of appropriate levels of resource utilization, are an important component of future cost reduction efforts though further studies are required to quantify this effect.

Summary

In summary, substantial evidence suggests that current imaging rates for patients with nonspecific LBP are excessive. Despite evidence-based treatment guidelines indicating that diagnostic imaging should be used judiciously, clinicians continue to use imaging inappropriately (early and excessively) for reasons that may be related to increased availability of the technology and the diagnostic dilemma inherent in the clinical evaluation of LBP. It is increasingly understood, however, that incidental MRI-findings may not have clinical relevance but they have contributed to poor selection of surgical candidates, and poor surgical outcomes. As a result, finite resources are being expended inefficiently and patients are increasingly receiving aggressive treatments when more conservative treatment may provide greater benefit and/or be less harmful.

SPECIFIC AIMS

There have been few studies on imaging utilization for work-related LBP, and none to date in Oregon. This study proposes to examine diagnostic imaging utilization by estimating the proportion of MRI services overall, and by MCO-enrollment status, among billed medical events for injured workers with LBP. The degree of variation in MCOs' and non-MCOs' billed imaging events will be used to assess the potential influence of managed care on utilization of MRIs in the Oregon WC population.

1) Estimate the proportion of MRI services among billed medical events for injured workers with LBP who are enrolled and who are not enrolled in a MCO for each year between 1999-202, as well as estimate the relative odds of imaging for these same years, and the unique contribution of managed care enrollment, and other factors related to imaging, to the odds of an imaging event.
2) Determine the association between managed care enrollment and an imaging event while adjusting for the other variables related to imaging.
3) Examine the nature and chronologic trend of MCOs' and non-MCOs' billed imaging events.

METHODS

Study Design

This study used a cross-sectional analysis of the Oregon Workers' Compensation database developed and maintained by the Information Management Division of the Oregon Department of Consumer and Business Services (DCBS). Using this administrative database, we examined the proportion of imaging among MCOs' and non-MCOs' billed services for treatment of LBP, and the influence, if any, of managed care on this medical event. This database, called Bulletin 220 Data after the administrative directive that mandated it, contains the collected medical services billing which Oregon workers' compensation insurers and self-insured employers are required to report on a quarterly basis. This dataset was used because it provided the pertinent data fields required for the present study, including a medical event's coded medical diagnosis, type of service (imaging), and MCO-enrollment status, and allowed for large-scale outcomes research in an inexpensive manner. The study period was limited to the years 1999-2002 because the most recent complete data at the time of study's inception was from the second quarter of 2002, and only a few years of analyses were required to achieve adequate power in this large database. The database was made available to the researcher by her thesis advisor's involvement with the DCBS, as detailed below.

The immense size of the dataset conferred significant power to detect a statistical difference between the study groups; however, it also required strategic design to address several of the limitations inherent in the analysis of an administrative dataset. To begin with, available clinical information is confined to that relevant for billing purposes and lacks the detailed clinical information that is useful for research purposes. The dataset contains ICD-9 diagnostic codes, however, these codes can introduce systematic bias since they are not unique identifiers and may be assigned inconsistently by medical practioners. Furthermore, without access to the claimants' medical charts, the coded medical diagnosis could not be validated by reviewing a claimant's clinical history or physical exam, and furthermore, disease severity could not be assessed. The inability to obtain accurate diagnoses or control for disease severity impeded assuring sufficient similarity of the study groups in all manners excluding the variable of interest, i.e. MCO enrollment, and therefore could potentially have biased study findings.

However, simplification of medical diagnosis into a broader clinical classifications and restriction of the sample to a subtype of LBP were used to achieve comparability of the study groups. As stated above, indications for imaging are dictated generally by the classification of LBP into non-specific and specific-LBP. In the former group, imaging is reserved in the rare cases which has failed conservative therapy and may achieve therapeutic benefit with spinal surgery, while in the latter group, imaging is indicated depending upon the clinical picture of neuroimpingement causing motor/sensory changes as opposed to referred pain or need to identify the source of an underlying serious pathology. Therefore, regardless of the type of non-specific LBP and the severity of the pain, imaging is not indicated in the great majority of cases, and therefore controlling for these variables in this subtype of LBP is relatively unimportant. By restricting the study sample to include only those bills with coded medical diagnoses classifiable as non-specific LBP, and analyzing all non-specific LBP diagnoses as one disease entity rather than individual medical diagnoses, I achieved relatively homogeneity of the disease prognosis and imaging indications among MCO's and non-MCO's billed medical events.

Study Sample

The study sample consisted of accepted disabling claims for workers diagnosed with non-specific LBP who had received medical services between the first quarter of 1999 through the second quarter of 2002. Each claim can have a multitude of billed medical events. In Oregon, "disabling" claims are those claims for injuries in which workers lose more than three days from work or in which they suffer permanent disability or death and "accepted" claims are those in which the insurer acknowledges that the injury was work-related. The claims had been officially closed, i.e. they reached that point at which further treatment would not result in further patient improvement and this was acknowledged formally by the insurer. In 2002, 37 percent of accepted disabling claims were enrolled in MCOs. (Sutton, 2005)

The sample contained only bills with medical diagnoses classifiable as non-specific LBP, which, according to the medical literature, include the following: lumbago (low back pain, low back syndrome, lumbalgia) and sprains and strains of the sacroiliac area or of other and unspecified regions of the back (unspecified, thorax, lumbar, sacrum, coccyx).

Datasets

Datasets included a selected subset from Bulletin 220 Data, coding datasets commonly used in identification of medical diagnoses and procedures, and an additional dataset comprised of rural and non-rural designations of zip codes that was created for linkage with the providers' zip codes in the DCBS dataset.

1. Medical services billing data:

The project used Bulletin 220 Data that is a compilation of electronically submitted medical payment information from Oregon workers' compensation insurers and self-insured employers. All workers' compensation insurers and self-insured employers (insurers) who had at least 100 accepted disabling claims in the previous calendar year are required to report quarterly data on reimbursement for medical services to DCBS.(DCBS, 2004) Required reporting fields include all medical payments for services covered by the Department's workers' compensation fee schedules. Covered services include: anesthesiology, surgery, radiology, pathology and laboratory, medicine, physical medicine and rehabilitation, office services (evaluation and management), hospital services, pharmacy, durable medical equipment, and medical supplies as well as some multidisciplinary and Oregon-specific codes for services unique to the workers' compensation system. Accepted coding of these services include Hospital Revenue Codes, International Classification of Diseases-Clinical Modification (ICD-9-CM) Procedure Codes, Current Procedural Terminology (CPT), HCFA Common Procedure Coding System (HCPCS), National Drug Compendium (NDC), Anesthesiology (RVRBS), and optional data whenever available. All of these disparate coding systems are intermixed in a single service field. Quality control of the dataset is maintained by DCBS field audits and requirements that reported data field must be at least 95% complete.(Appendix: Bulletin 220 Data).

The database was made available through a data sharing agreement between the OHSU Center for Research on Occupational and Environmental Toxicology (CROET) and DCBS. CROET is an Oregon research institution that receives funding from the Oregon WC system to study the causes and epidemiology of occupational injuries, and Bulletin 220 has been made available to CROET to conduct such studies. My thesis advisor, Dr. Gary Rischitelli, arranged for DCBS to provide me with data required for the current study. I requested a query of all claims during the period from 1999-2002 involving non-specific LBP (identified by a subgroup of specified ICD-9 diagnosis codes) along with data from the fields for the service code (managed care identifier), service date, medical provider federal ID number, provider type, provider zip code, CPT code, and claimant identifier and characteristics including date of birth, gender, and level of education.

Record Layout of Requested Data Fields

DESCRIPTION	ALPHA NUMERIC
Medical provider federal ID No.	X
Provider ZIP	X
Service code (MCO number)	X
ICD-9-CM diagnosis code	X
Procedure code	X
Date of birth (YYYYMMDD)4	X
Date of service (YYYYMMDD)4	9.00
Gender	X
Education level	9.00
Patient ID	X

9.00 = Numerical data X = Character or alphanumeric data.

2. ICD-9-CM Diagnosis Codes:

The International Classification of Diseases-Clinical Modification (ICD-9-CM) is a classification system for medical diagnoses and is the official system of assigning codes to diagnoses in the United States. The ICD-9-CM codes are derived from the World Health Organization's International Classification of Diseases and are overseen by two U.S. governmental agencies, the National Center for Health Statistics (NCHS) and the Centers for Medicare and Medicaid Services.(NCHS, 2005) These codes were used to abstract the study sample from the larger Bulletin 220 dataset by identifying all bills with a diagnosis code of non-specific LBP.

II. Designation of ICD-9-CM Diagnosis Codes Identifying NON-SPECIFIC LBP	
Sprains and strains of sacroiliac region (lumbosacral joint/ligament is 846.0)	846.0-846.9
Sprains and strains of other and unspecified regions of the back (thoracic)	847.1

Sprains and strains of other and unspecified regions of the back (lumbar)	847.2
Sprains and strains of other and unspecified regions of the back (sacrum)	847.23
Sprains and strains of other and unspecified regions of the back (coccyx)	847.4
Sprains and strains of other and unspecified regions of the back (unspecified)	847.9
Lumbago (Low back pain, Low back syndrome, Lumbalgia)	724.2

3. Current Procedural Terminology (CPT) Codes, Fourth Edition:

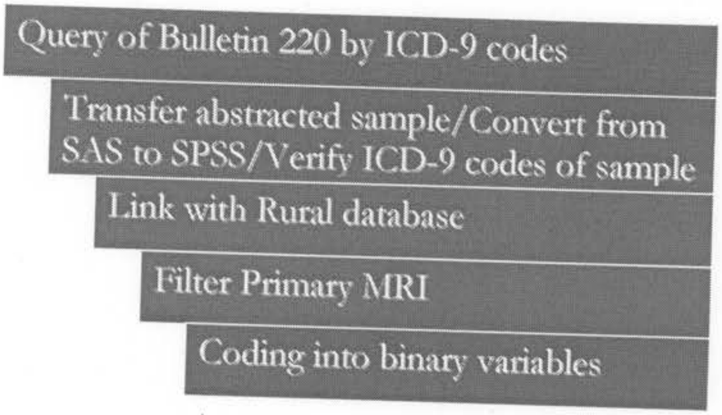
The Current Procedural Terminology codes is a proprietary system of descriptive terms and identifying codes for the reimbursement of medical services and procedures. It was first developed in 1966 by the American Medical Association and has come to be the most widely accepted medical nomenclature used to report medical procedures and services under public (Medicare and Medicaid) and private health insurance programs.(AMA, 2005) The code for a lumbar MRI (72148) was used to identify the imaging service among billed medical events.

4. Rural service designation:

The Oregon Office of Rural Health Affairs has defined a rural hospital as one located geographically "ten or more miles from the centroid of a population center of 30,000 or more". The Office provides a list of all rural hospitals and their zip codes.(Oregon Office of Rural Health Affairs, 2005) A dataset was created which listed all Oregon zip codes and assigned each as rural or non-rural consistent with the Office's rural designation of the hospital(s) within that zip code. This dataset was then linked to the DCBS dataset by a variable common to both datasets, specifically the provider zip code, to designate the locale of service as rural or non-rural. Later in the study, we discovered that the provider zip code corresponded to that of the central billing office rather than that of the actual service provider. When a service is performed at a branch location, these two zip codes will not correspond, making the utility of this variable questionable.

Data Management

Flow sheet



Initial data management

The abstracted sample was transferred by the DCBS research analyst in SAS (Statistical Analysis System) programming. Because of the software and support availability of SPSS (Statistical Package for the Social Sciences) programming at OHSU, the dataset was converted from SAS to SPSS prior to analysis. Frequency analysis of the ICD-9 codes was performed to verify that no ICD-9 codes other than those requested were in the dataset, i.e.: 724.2 (lumbago), 846.0-9 (sprain; lumbosacral, sacroiliac, sacrospinatus, sacrotuberous, sacroiliac not elsewhere classified, and sacroiliac not otherwise specified), and 847.2-4 (sprain of the lumbar region, sacrum, and coccyx).

Data management of study variables (Appendix: Summary of Measurement Variables)

Outcome variable. The outcome was a binary variable indicating whether or not the billed service was a lumbar MRI. Imaging service was identified with the CPT code 72148, "Magnetic resonance (e.g., proton) imaging, spinal canal and contents, without contrast material" to stratify the study population into those with and without lumbar imaging. Since the outcome variable of interest was whether or not imaging had occurred rather than the total number of MRIs performed overall, recurrent imaging within a claim was excluded from the analysis. To do this, an algorithm was developed that generated a proxy for primary MRIs. This proxy was used to filter the data so that only primary MRIs were included in the subsequent analysis.

Variable of Interest This study focused on MCO-enrollment status to investigate the potential MCO effect on imaging. Multiple service codes identifying enrollment in a MCO were pooled to create a dichotomous variable of MCO or non-MCO billed events. Bills coded with a lack of enrollment in a MCO were designated as the reference category.

Control Variables There is little existing data on risk factors for imaging, though the literature is replete on those associated with LBP, including age, gender, level of education, and rural service, and it is reasonable to assume that the two may overlap. Therefore, efforts were made to statistically adjust for these factors and quantify the relationship between imaging and MCO enrollment in an unbiased manner. Epidemiologic studies report low back pain as increasing with age and occurring more frequently in males greater than fifty year old than in those under age fifty.(Von Korff, 2003) Among compensable back injuries, the overall male-to-female ratio across all industries is 1.3 among persons 45-64 and 1.8 among those less than age 45 years. Not unexpectedly, then, women workers are half as likely to have spinal surgery as males. Additionally, the incidence of LBP is higher in persons who have not reached higher levels of education.(Oleinick, 1998) Provision of service in a rural locale was also selected as a likely determinant of imaging since access to care in these settings may be limited relative to that in metropolitan areas for reasons related to the availability of health care providers and/or services.(DHHS, 1998 and 2000) Finally, year of service was included because of the potential interaction of the MCO effect and time. In other words, the association between managed care and imaging may have varied depending upon the year of service, in which case the odds of imaging would need to be reported separately for each year.

Gender, age, education level, and rural service were coded into binary categories (feature present versus feature absent) with age less than fifty, female gender, and non-rural health care provider, designated as reference categories. Year of service was recoded as a four-category variable, with 1999 designated as the reference category. Since only date of service and date of birth were available from the dataset, age was calculated by subtracting the latter from the former. Age was also analyzed as a continuous variable to check if it offered a statistically improved model.

STATISTICAL ANALYSIS

Descriptive Analysis

The study population was stratified by MCO enrollment, and frequencies and percentaging of demographic characteristics of injured workers, including age, gender, level of education, and rural service, were calculated. The education variable was discarded from the analysis because the frequency analysis revealed numerous illogical entries. To assure that the baseline characteristics were equally distributed among those enrolled and not enrolled in a MCO, cross-tabulation of baseline characteristics with MCO enrollment was performed on categorical variables to calculate a Pearson's Chi-Square Statistic and crude odd-ratio. Additionally, the independent samples t-test was performed on the continuous variable, age, to calculate the difference in means between these two groups. If a significant imbalance between groups in a baseline characteristic was found, it was further determined if that characteristic was strongly associated with the outcome, and was therefore confounding the data. If the characteristic was associated with MCO enrollment and imaging, it was selected as an important control variable. Adjusting for the influence of this variable on the outcome would help to tease out the real association between MCO enrollment and imaging. (Roberts, 1999)

Logistic Regression Model Building

Univariate Analysis

Univariate analysis of each variable with MRI as the dependent variable was performed to determine the independent influence of the covariates and MCO enrollment on imaging. All study variables were selected for the multivariable model.

Multivariable analysis

Logistic regression analysis was performed to study the association between imaging and MCO enrollment while controlling for all other study variables. Potential interactions, including that between time and managed care, were introduced into the model to assure the best fit of the model to the data. The logit (log odds) expression of the preliminary multivariate model was the following:

$$\text{Log}(P/1\text{-}P) = \beta 0 + \beta 1(\text{MCO enrollment}) + \beta 2(\text{gender}) + \beta 3(\text{age}) + \beta 4(\text{year of service}) + \beta 5(\text{rural})$$

Where P = Probability of LBP claim containing MRI

Once the multivariable model was fit, measures were taken to assure that fields with large amounts of missing data were not biasing study outcomes. One-third of claims were missing a data entry for provider zip code, and therefore for a rural or urban designation of service. To determine the influence of the missing data on the association between MCO and imaging, the rural variable was entered into the multivariate model and linear regression was performed twice: once with the claims with missing zip codes present and once with the claims with missing zip codes absent. The statistical significance of the MCO variable in the initial model (rural provider variable absent, claims with missing zip codes present) was then compared to that in the 2 models adjusted for the rural provider. If the level of significance of the MCO variable was comparable among the three models, it was considered that the missing data was did not significantly alter study findings regarding the association between imaging and MCO enrollment. Finally, the Nagelkerke Statistic, a pseudo-r-squared measure that determines the variability in the dependent variable that is explained by the linear regression model, was used to assess whether the categorical or the continuous age variable provided a better fit for the model.

Assessing the fit of the model

The Hosmer-Lemeshow goodness-of-fit test was used to check whether the model's estimates fit the data at an acceptable level.(Hosmer, 2002)

Data Trend

To assess for an imaging trend over time within each study group, the dataset was split into injured workers enrolled and not enrolled in a MCO and a linear regression model was built to include year of service. The model was again adjusted for age, gender, and health care provider working in a rural locale. The Wald test for trend was performed to assess if there was a significant trend and the nature (linear, parabolic, quadratic) of the trend over time.

RESULTS

Descriptive Analysis

Descriptive statistical analysis of ICD-9 diagnoses revealed a total of 457,715 billed medical events of non-specific LBP during calendar years 1999-2002. The total number of MCO-billed medical events was 216,327, accounting for 47.3% of all medical events in the treatment of non-specific LBP.(Table 1) MRI services accounted for 0.6% of all MCO-billed medical events in all years except, in 2000, in which the percentage transiently increased to 0.8%. In contrast, the percentage of MRI services among all non-MCO billed medical events decreased from 0.8% in 1999, to 0.7% in 2000, and to 0.6% in the subsequent years.(Figure 1) Seventy percent of claims were comprised of medical events for two medical diagnoses: Sprains/strains of the lumbar region were the most frequently reported diagnosis, accounting for 46% of all non-specific LBP claims, followed by lumbago (low back pain, low back syndrome, lumbalgia) which accounted for 25.3% of all non-specific LBP claims. The remaining diagnoses included sprain/strains of the thoracic, sacroiliac region, sacrum, coccyx, and otherwise and unspecified regions of the back.

Table 1 summarizes the comparison of selected demographic characteristics and year of service involved in MCO and non-MCO billed medical events. Forty-four percent of MCO-bill medical events had an imaging event and 51% MCO-bill medical events had a rural provider zip code. Injured workers 50 years of age or greater, and less than 50 years, were coded in 46% and 48%, respectively, of MCO-billed events. Males and females were the coded gender of 49 and 44 percent, respectively, of MCO-medical events. The percentage of MCO-billed medical events increased over time, accounting for 40% of all medical events in 1999, and increasing to approximately 50% of all medical events in each of the subsequent 3 years. The mean age recorded in the MCO and non-MCO billed events was 40.30 years (standard deviation= 10. 7 and 11.0, respectively).

The Pearson's Chi-Square analysis revealed that the coded variables, including the event of imaging, the age of the claimant as a categorical and as a continuous variable, the gender, the year of service, and a treatment by a rural health care provider, were significantly different among MCO and non-MCO billed medical events (p-value<0.05). MCO-billed events were only slightly less likely to involve an injured worker who was greater than 50 years old than one who was less than 50 years old. Similarly, MCO-billed events were only slightly less likely to or involve a rural provider zip code than a non-rural provider zip code, or involve females than males(OR: 0.95). MCO-billed events were 1.2 times as likely to involve males as females. MCO-billed events for non-specific LBP were more common in each year following the initial year of study: In the years 2000-2002, MCO billed events were 1.59, 1.59 and 1.42, respectively, times as likely to be present than in the year 1999. These odds ratios are reported in Table 1.

Claimant characteristics versus MRI utilization (Study Aim #1)

MCO enrollment and a year of service in 2002 were significantly associated with imaging in the simple logistic regression model. The odds of an imaging event among MCO-billed medical events was 0.863 times as likely as that among non-MCO-billed medical events(95% CI: 0.800, 0.930; p-value <0.001). Bills with a date of service in the year 2002 were 0.610 times as likely to have an imaging event as those with a date of service in 1999(95% CI: 0.481, 0.774; p-value < .001). The odds of an imaging event occurring in 2000 and 2001 was 1.030 and 0.851, respectively, times that of one occurring in 1999 (p-value: 0.772; 0.129). The odds of imaging event having a rural billing zip code was 0.926 times as likely compared to one having a metropolitan health care provider(p-value: 0.150). An imaging event was only slightly more common among medical events for males than females (OR:1.057; p-value: 0.168) and among medical events for claimants 50 years old or greater than for claimants less than 50 years old(OR: 1.017; p-value 0.712). Finally, age as a continuous variable also was significantly associated with imaging (mean difference -.2765; p-value 0.008).

Multivariable Logistic Regression Model (Study Aim #2)

In the initial multivariable model, MCO enrollment status was not significantly related to imaging. A relatively significant change, by eleven and fourteen percent, from the crude odds ratio to the adjusted odds ratio, was detected for year of service in 2000 and 2001 which suggested potential confounding of the data by time and the need for a more complex model. A statistically significant interaction between time and MCO status was found and when the model was rebuilt to incorporate this interaction term, a significant association between MCO enrollment and imaging was detected. In 1999, imaging events were significantly less likely to be reported among the MCO-billed medical events as compared to that of the non-MCOs (OR:0.704; 95% CI: 0.612, 0.810; p-value <.001). The significant effect was not present in the subsequent years: In 2000-2002, the odds of imaging among both groups was relatively similar and the confidence intervals included 1.0. (OR: 1.0856; 95% CI: 0.951) (OR: 1.0145, 95% CI: 0.874) (1.176, 95% CI: 0.900, 1.235)

The level of significance of the MCO variable remained unchanged regardless of whether or not the rural variable was included, and regardless of whether the rural variable, when included, did or did not include the claims with the missing zip codes. The variable was therefore dropped from the final model.

Age, as a binary variable, was not significantly associated with imaging. Using age as a continuous variable did not reduce the variability in the model, as measured by the Nagelkerke Statistic, and therefore age was chosen for the final model. The final model produced a Hosmer-Lemeshow statistic of 4.700 with a corresponding p-value of 0.789. Thus, we cannot reject the null hypothesis of a goodness-of-fit test and conclude that the observed data fit the predicted model well.

Linear Trend Analysis with Polytomous Variables (Specific Aim #3)

According to the Wald statistic for linear trends, a statistically significant linear decrease in imaging events occurred over the four-year period among non-MCO medical events($p<0.001$). Such a trend is visualized by a graph of the annual percent of imaging events which demonstrates a decrease in the percent of imaging events among all non-MCO medical events from 0.8% to 0.6%. In contrast, the percent of MCO-billed imaging events remained relatively stable at 0.6% in all years except 2000, in which the percentage rose to 0.8%.

DISCUSSION

This study expands the literature on health care services utilization and managed care in a Workers' Compensation population. Substantial evidence suggests rates of magnetic resonance imaging (MRI) in the diagnostic evaluation of non-specific low back pain (LBP) are excessive, and may have led to overtreatment surgically. Managed care organizations have employed techniques to promote appropriate utilization across large groups of physicians, and therefore have the potential to contain excessive imaging. This study compared imaging utilization between MCOs and non-MCOs to evaluate the influence of managed care by comparing the proportion of MRIs amongst managed care organization (MCO) and non-MCO billed medical events during 1999-2002 to evaluate the recent influence of managed care on imaging utilization.

To study imaging utilization at the appropriate level of care, the optimal unit of analysis would have been the claimant rather than the individual events of service. With some simplifying assumptions, however, findings at the claim level are transferable to the claimant level. If the relative difference between MCO and non-MCO billed imaging proportions is constant, i.e., the claimant-level imaging proportions are proportionately smaller than the claim-level imaging proportions among both MCO and non-MCO billed medical events, however, it is reasonable to assume that the outcomes of research on claims could be extrapolated to claimants. Since the average number of bills per claim among MCOs and non-MCOs is relatively similar, 26.5 and 21.7, respectively, and therefore, the magnitude of the reduction in the denominator in both study groups would be similar, it is likely that the relative difference between the two would be maintained.

To quantify the results of a translation of claim-level data to claimant-level data, the following calculations were made: Services were distributed fairly equally with an average of 23 bills per claim for both study groups. The denominator at the claimant level was therefore 23 times smaller than that at the claim level, amounting to approximately 20,000 claimants (457,000/23). Since recurrent MRIs were filtered out of the analysis, the hazard of overcounting the number of claimants who had undergone imaging in such an extrapolation was avoided. A claim with an imaging event truly represented a claimant who had undergone at least one imaging procedure. On average, 0.7 percent of claims were imaged, which translates into 3200 imaging events. At the claimant level, 3200 imaging events in a LBP population of 20,000 represents 16% of the population.

While recurrent MRIs were excluded from analysis, recurrent episodes of non-specific LBP were maintained. Inflation of the denominator relative to the numerator results in an underestimate the proportion of imaging among claimants. The literature was reviewed to assess the magnitude of this effect. One study reported that 15% of workers had at least one recurrent episode connected with their initial injury during an average follow-up of 3.5 years.(Gluck, 1998) Applying these findings to my study, the denominator of all claimants with LBP may be inflated by at least 15% in the translation of the data from the claim-level to the claimant-level. Adjusting for this effect, the sample size would increase to 23,000 and the number of MRIs to 161. Again, these results are dependent upon the relative difference in imaging events between MCO and non-MCO billed data is maintained. The difference in percentages in the year 1999, for example, was 33% (0.6% among MCOs and 0.8% among non-MCOs).

Study results showed that the effect of managed care on imaging utilization varied by year. Consistent with our hypothesis, in 1999, a significant difference in imaging events among MCO and non-MCO billed medical events was present. MCO-bills were 0.7 times as likely to be a bill for an imaging service as compared to non-MCO bills. Contrary to expectations, however, the effect was only present in the first year of the four-year study. Analysis of the linear trends of imaging reveals a steady decrease in the percent of non-MCO-billed imaging events and a relatively stable plateau in the percent of MCO-billed imaging events so that the former converged to that of the latter in the last two years of the study. Furthermore, the univariate analyses demonstrated that over time MCO enrollment increased and the number of MRIs decreased and that MCO enrollment was associated with decreased imaging, suggesting a complex interaction between time, MCO enrollment and imaging. Testing for the potentially significant interaction between time and MCO enrollment in the multivariate analysis confirmed the presence of the effect modification by time on MCO enrollment.

The inconsistent MCO effect is open to several interpretations. To speculate, physician behavior may have been fundamentally changed by practicing in a MCO. A Kaiser Permanente study of the years 1997-2002 reported that 63% of physicians felt that managed care plans had increased their use of practice guidelines and disease management protocols in patients care.(Berberabe, 2004) MCOs can promote appropriate utilization through application of a variety of techniques, including dissemination of treatment guidelines, pre-authorization, and continuous review of physician imaging patterns and outcomes, across a large population of physicians.(Cherkin, 1994) With education and reinforcement by the MCOs, practicing with a higher threshold for imaging utilization may have become habitual and applied non-differentially to injured workers enrolled and not enrolled in MCOs. This would assume that the same physician seeing both MCO and non-MCO patients. Behavioral and system change is often gradual, however, and it is difficult to understand why a difference in imaging utilization would exist in one year and disappear in the next. Without evaluation of data prior to 1999, it is not possible to delineate whether the significant difference reflected a larger trend over time or a spurious event. Without post-2002 data, it cannot be assess if such an effect persisted over time as would be expected if the MCO effect did carry over to imaging utilization among non-MCO patients.

It may be that the MCO effect did persist over time but that this effect was masked in the later years of the study as more claimants were enrolled in MCOs. In the years 2000-2002, claimants were consistently one and a half times as likely to be enrolled in a MCO as they were in 1999. A 1999 DCBS study titled, "The Effect of Managed Care in Oregon", reported that claimants are often enrolled in MCOs shortly after incurring an injury and that their study finding were biased by MCO enrollee's greater severity of disease, despite efforts made in the study design to control for this variable.(DCBS, 1999) If the claimants enrolled in MCOs were more likely to be ones who had failed conservative therapy and required imaging, MCOs would be less able to reduce imaging utilization. MCOs do have a higher number of bills per visit among MCOs as compared to non-MCOs, which may lend support to such an explanation if the increased frequency is reflective of a greater disease severity. On the other hand, it may be that the increased number of visits is due to more follow-up visits to monitor the non-specific LBP over time among MCOs than non-MCOs. Follow-up visits are a part of the national treatment guidelines and it may be that MCOs adhere to these guidelines more than non-MCOs.

Without more information, the only conclusion of this study can be that the data demonstrate an inconsistent MCO effect that possibly declined over time and that further research is required to further delineate any trends that may be present.

Gender was not a significant predictor of imaging in the final model. Gender was related to MCO enrollment, with males being 1.2 times as likely as females to be enrolled in a MCO. This suggested that if gender were also related to imaging, it would be a confounder. It was not found to be related to imaging in the univariate analysis, however. Nonetheless, it was included was left in the final model because of the paucity of available study variables and potential confounding. The literature had described males as being more likely to have back injuries and undergo spinal surgery, and therefore it was not unexpected that sixty percent of the study sample was comprised of males. A review of the literature on compensable back injuries described a wide variation in rates by occupation. It furthermore described a 20-to-60-fold difference among male-to-female risk ratios among the various occupations, with the highest ratios occurring in the handler-laborer occupations and the lowest among professionals (men) or executives (women).(Gluck, 1998) Therefore, occupation may have been a more important determinant of imaging than gender. However, claimants' occupations were not included in the dataset and therefore could not be controlled for.

The analysis was also limited by the inability to control for other predictors of imaging, including rural health care provision and provider type, because of the poor quality of the data for research purposes. Provision of care by a rural provider was chosen as an important determinant of imaging for two reasons. First, access to health care services in rural settings may be limited. Secondly, specialists are less common in rural areas and more common in urban areas than non-specialists, and studies showed that the former are more likely to image inappropriately than the latter.(Atlas, 2002) The association between provider specialty and urban/rural locale was described in 1998 in a DHHS report on the nation's problem of geographic misdistribution of specialists between urban and rural areas which has resulted in a "substantial oversupply of specialty physicians in metropolitan areas" and a "large underserved population in rural areas".(DHHS, 1998)

The rural variable was a poor measure of rural service as the dataset only provided the billing zip code of the MRI service, which can differ from the zip code of the MRI service if the imaging group is part of a chain business. If we can assume that branches are more likely to be located in rural settings and that central billing offices are more likely to be located in urban centers, more rural MRIs will be misclassified as urban than urban as rural. In other words, a rural classification is likely to contain rural claims while an urban classification is likely to contain urban claims plus some of the rural claims. Such a misclassification would increase the denominator and reduce the numerator in calculating the odds ratio of a rural imaging event to an urban imaging event, therefore dampening the rural effect, and biasing the odds ratio towards one. This may explain, at least in part, the insignificance of the rural variable in this study. It may also be true that there is widespread availability of imaging services so that access to this service in rural areas is not limited. Regardless, because this variable did not accurately affect the association between MCO enrollment and imaging, it was dropped from the final model.

The other major predictor of imaging that this study failed to control for was the provider type of the physician referring a claimant for imaging. As detailed in the introduction, whether or not a patient receives advanced imaging can depend on the specialty of the referring provider.(Cherkin, 1994) Because information in this dataset was collected for administrative purposes, rather than research purposes, the provider type coding in Bulletin 220 refers to the location of the provider of the MRI service as occurring in a clinic office (MD), outpatient hospital (HO), or imaging facility (RA) rather than the provider type of the referring physician.(Johnson, 2004) Without information on the ordering provider ID, one cannot predict the degree or direction of any bias introduced by interspecialty imaging variation or by differences between the study groups in the predominant provider type.

In general, the generalizeability of research outcomes from analysis of administrative datasets is broader than that of prospective randomized trials in which the study population often represents a small subset of a larger population. Because MCO penetration and Workers' Compensation Systems vary so greatly from state to state, however, it would be wise to exercise caution in applying these study findings to populations other than Oregon workers.

Limitations

The limitations of this study are those inherent in the use of an administrative dataset and the retrospective nature of the study. Such limitations include restriction of the study variables to those available in the dataset. As mentioned above, provider type and the rural/urban status of the referring physician are predictors of imaging that could not be controlled for adequately because the information was collected for administrative purposes rather than research purposes and therefore did not convey the intended meaning of the research variable.

The lack of detailed clinical information in the administrative dataset introduced several limitations to the study analysis. First, medical diagnoses recorded in the dataset could not be verified by an independent review of the medical charts. Second, the clinical appropriateness of imaging could not be evaluated based on the patient's history and physical exam. Consequently, the study question was aimed at detecting variation in imaging patterns between MCOs and non-MCOs rather than which group's practices more closely resemble the national treatment guidelines. Finally, it required that persons with non-specific LBP be chosen according to reported ICD-9 diagnostic codes While study populations are commonly selected in this way, use of ICD-9 codes can introduce imprecision into the case selection process because the codes are not unique (may be overlapping diagnoses), they may be assigned inconsistently by a physician, and there may be intraprovider variation in assignment of diagnoses. These limitations were addressed by collapsing several overlapping diagnoses representing the full spectrum of non-specific LBP into a single diagnostic category.

Strengths

The greatest strength in any analysis of an administrative dataset is its tremendous statistical power to detect small differences in large populations over time. Small changes at the population level can have dramatic personal and significant economic effects and are therefore useful in guiding future health care policies and resource allocation. While imaging events accounted for, on average, only 0.7% of all billed-medical events over a four year period, in a population of 457,000, this percentage represents 3200 imaging events and 16% of claimants with non-specific LBP who were imaged. As explained above, these numbers are underestimated for reasons owing to the study design. Only ten percent of persons with non-specific LBP fail conservative therapy, and, not all will require imaging---indications for imaging in these persons is determined by their clinical manifestations and history.(Atlas, 2003) If the epidemiology of LBP can be applied to the Workers' Compensation population, and assuming that extrapolation of results at the claim level to the claimant-level is possible, the study's finding is consistent with previous studies documenting the overutilization of imaging.

Analysis of administrative data also allows study of "real world" trends across a large population over time in an inexpensive, efficient manner. An understanding of trends in health care resource utilization and clinical outcomes at the population level are required for states or large institutions to make informed decision-making and allocate resources efficiently. Study findings of larger trends can then serve as fodder for the more specific questions that can be more effectively answered by prospective trials employing clinical data. By summarizing utilization patterns over time and identifying variation in imaging by MCO enrollment status, this study makes a small contribution towards building the fund of knowledge around health care services utilization and managed care in the workers' compensation population. In doing so, it has helped to generate new hypotheses for future research and establish priorities for future research.

Future Research and Implications for Public Health Policy and Programs

As mentioned above, research on administrative datasets often cannot conclusively answer specific questions because of the limitations of the data quality and available data variables. Furthermore, they cannot address the clinical appropriateness of physician behavior. The findings of this study and others warrant studying a cohort of subjects over time to prospectively collect information on variations in imaging utilization among physicians treating MCO enrollees and non-MCO enrollees. Collecting information on clinical outcomes and subjective measures, such as patient satisfaction with care, is essential to assure that they are not sacrificed with changes in health care provision and access to care.

Additionally, taking into account the context in which physician behavior is being altered will be able to accurately apply study outcomes to the various managed care settings. Some examples would include survey or observational studies of the techniques associated with successful utilization management, such as reinforcement of appropriate clinical decision-making and provision of incentives for change, and of the characteristics of the managed care setting, such as the degree of participation of insurers and physicians in managed care.

The Washington Managed Care Project and other similar interventions will be a rich source of information to answer questions about the managed care environment and how to achieve enduring change in physician behavior while maintaining quality of care and health care costs.(Cheadle, 1999) The authors of this program attribute the large success of this program in containing imaging utilization and spinal surgeries to the comprehensive nature of the occupational model. The model makes extensive use of integrated case management, ongoing physician feedback, and education of patients and physicians alike surrounding the natural history and treatment of low back pain.(Wickizer, 2002) It does appear likely that engaging physicians and patients in educational processes and providing the appropriate incentives for change can promote appropriate utilization and successful provision of health care in the future will depend upon identifying features of successful interventions by managed care.

TABLES

Table 1. Claimant characteristics and year of service versus MCO status among cases of low back pain in the Oregon Workers' Compensation population (1999-2002).

Characteristic		MCO-billed medical event n (%)	Non-MCO-billed medical event n (%)	OR	95% CI
All claims		216,327 (47.3%)	241,388 (52.7%)	-----	---------
Rural health care provider*	Yes	38,445 (48.1%)	41,401 (51.9%)	0.90	0.89, 0.92
	No	120,119 (50.7%)	116,662 (49.3%)	Ref	
Age	< 50	169,467 (47.5%)	187,092 (52.5%)	Ref	
	50+	44,104 (46.1%)	51,606 (53.9%)	0.95	0.94, 0.96
Gender	Male	143,917 (48.9%)	150,482 (51.1%)	1.20	1.186, 1.215
	Female	72,410 (44.3%)	90,879 (55.7%)	Ref	
Year of Service	1999	41,987 (39.7%)	63,821 (60.3%)	Ref	
	2000	52,546 (51.1%)	50,215 (48.9%)	1.59	1.58, 1.602
	2001	52,377 (51.3%)	49,741 (48.7%)	1.59	1.58, 1.60
	2002	47,831 (51.5%)	44,988 (48.5%)	1.42	1.41, 1.43
		Mean (SD)	**Mean (SD)**	**Difference**	**95% CI**
Age		40.294 (10.682)	40.298 (10.969)	-.00035	-.067, .06

*30.8 percent of claims are missing;

Table 2. Claimant characteristics versus MRI utilization among cases of low back pain in the Oregon Workers' Compensation population (1999-2002)

Characteristic		**MRI** n (%)	**No MRI** N (%)	**OR Unadjusted**	**95% CI** (OR)	**p-value**
All claims		2774 (0.6%)	454941 (99.4%)	-----	-------	----------
MCO enrollment	Yes	1,210 (43.6%)	215,117 (47.3%)	0.863	0.800,0.930	**<.0001**
	No	1,564 (56.4%)	239,824 (52.7%)	Ref		
Rural Billing Zip Code*	Yes	463 (23.8%)	79,383 (25.2%)	0.926	0.834, 1.028	0.15
	No	1,482 (76.2%)	235,299 (74.8%)	Ref		
Age	50+	589 (21.4%)	95,121 (21.2%)	1.017	0.929, 1.115	0.712
	< 50	529 (78.9%)	356,030 (78.6%)	Ref		
Gender	Male	1,819 (65.6%)	292,580 (64.3%)	1.057	0.977, 1.143	0.168
	Female	955 (34.4%)	162,334 (35.7%)	Ref		
Year of Service	1999	743 (30.4%)	105,065 (26.2%)	Ref		
	2000	196 (27.4%)	102,091 (25.5%)	1.030	0.845, 1.255	0.772
	2001	534 (21.8%)	101,957 (25.3%)	0.851	0.691, 1.048	0.129
	2002	498 (20.4%)	92,331 (23%)	0.610	0.481, 0.774	**<.0001**
		Mean (SD)	**Mean (SD)**	**Difference**	**95% CI**	**P-value**
Age	16-75	40.570+/- 10.471	40.295 +/- 10.837	-0.2765	-0.682, 0.131	**.008**

*30.8 percent of claims are missing;

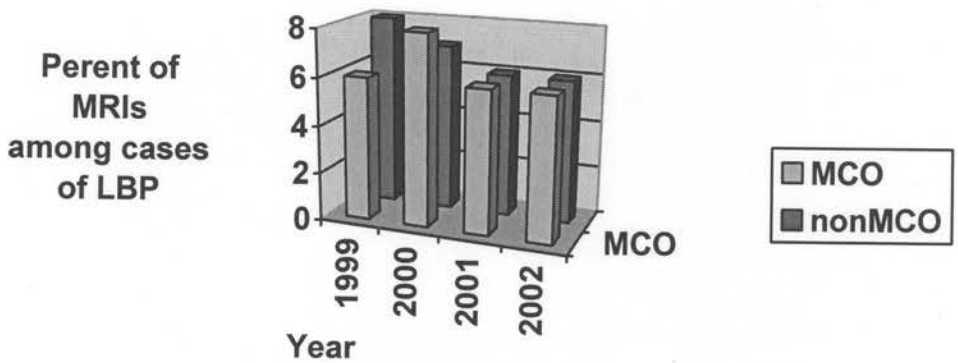
Table 3. Multivariate Logistic Regression Model for LBP

Variable	ˆβ	se(ˆβ)	OR	95% CI (OR)	p*
MCO enrollment	-0.351	0.074	0.704	0.612, 0.810	<.0001
Gender	-.011	0.038	1.011	0.941, 1.081	0.774
Age	0.006	0.044	0.994	0.912, 1.084	0.898
2000	-0.126	0.063	0.882†	0.779, 0.998	0.047
2001	-0.280	0.067	0.755†	0.629, 0.828	<.0001
2002	-0.326	0.070	0.722†	0.553, 0.768	<.0001
2000*MCO	0.433	0.098	1.542	1.272, 1.869	<0.001
2001*MCO	0.365	0.104	1.441	1.175, 1.767	<.0001
2002*MCO	0.404	0.108	1.498	1.213, 1.850	<.0001

Year of Service	OR† †(Year of Service * MCO Interaction)	95% CI (OR)	p*
1999	0.704	0.612, 0.810	*<.0001*
2000	1.0856	0.951, 1.238	
2001	1.0145	0.874, 1.176	
2002	1.0546	0.900, 1.235	

†Odds of being imaged in service year as compared to that in 1999.
††Odds of imaging among MCOs as compared to non-enrollees.

Figure 1. Imaging Prevalence Over Study Period



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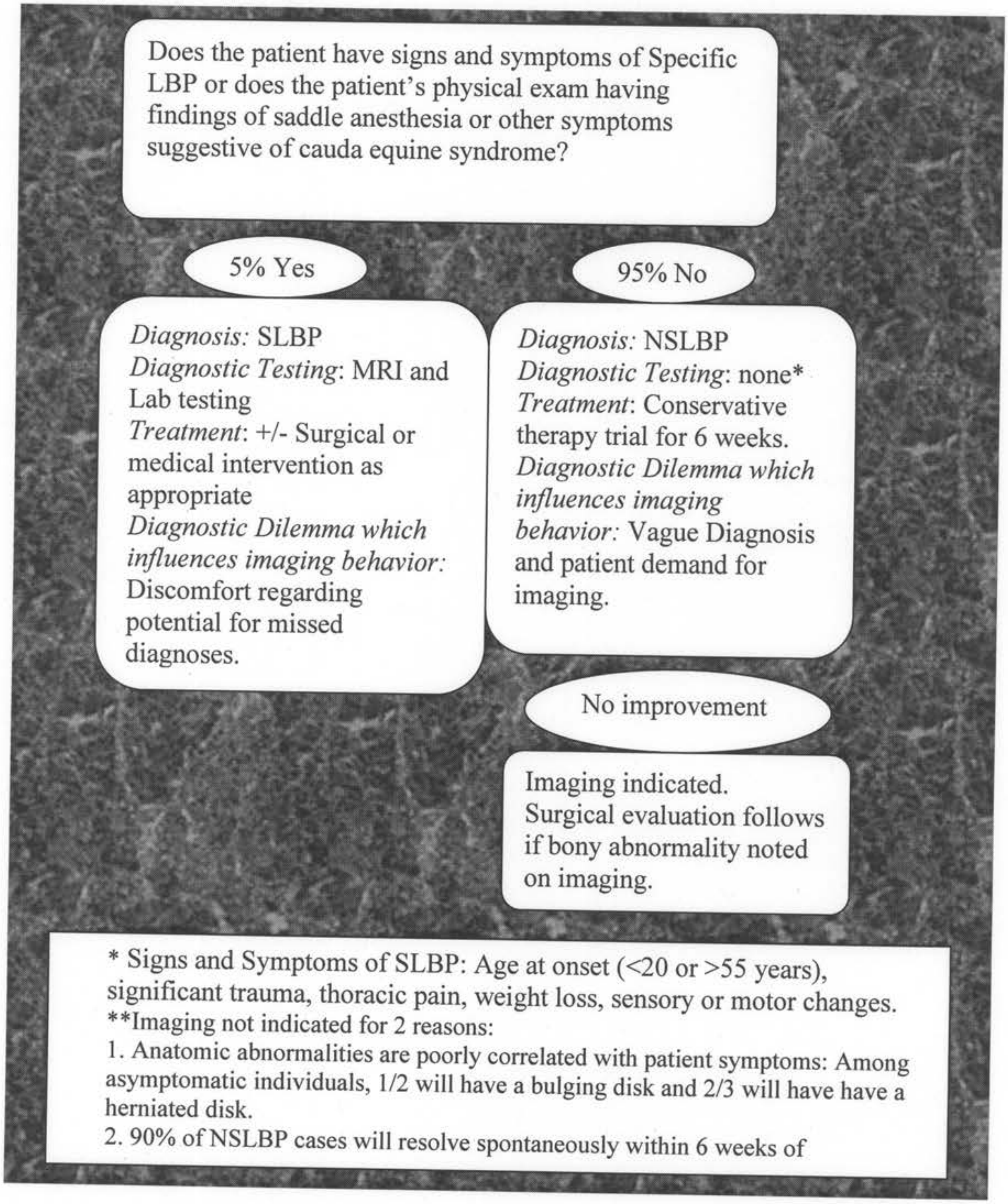
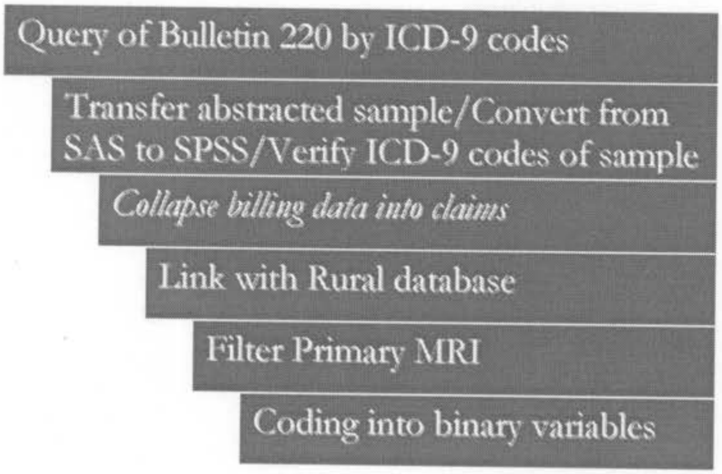
APPENDIX

APPENDIX I. The LBP Evaluation in the Primary Care Setting: Diagnostic triage

1. Focus on identifying the 5% of patients that have a cause of LBP requiring prompt medical or surgical intervention with a thorough patient history and physical exam.
2. Reevaluate the other 95% of patients at 6 weeks for persistent LBP symptoms.



APPENDIX II. Methods Flowsheet:



1. Identify medical diagnoses classified as non-specific LBP and obtain their ICD-9-CM diagnosis codes.
2. Provide DCBS analyst with ICD-9 codes of interest and record layout of requested data fields. Request abstractionspecified data fields on bills filed during the period 1999-2002 involving NON-SPECIFIC LBP, as identified by the provided ICD-9 Codes.
3. Obtain abstracted sample and convert from SAS to SPSS.
4. *Data Management*
   - SAS statistical programming database obtained from DCBA was converted to SPSS for the proposed study.
   - Identify claims of MCO enrollees with the service codes of MCOs provided in Bulletin 220. Identify injured workers with a lumbar MRI with CPT code 72148. Calculate the age of the low back pain case by subtracting the date of birth from the service date. Transform these data fields into binary categories with no MCO-enrollment, no MRI event, and age less than 50 as reference categories.
   - Generate an algorithm to identify primary MRIs within a given claim. Apply a filter so that only the primary MRI is included in the statistical analysis.
   - Create a dataset which lists all Oregon zip codes and assigns each as rural or non-rural consistent with the Oregon Office of Rural Health Affairs's rural designation of the hospital(s) within that zip code. Link this dataset to the DCBS dataset by a variable common to both datasets, specifically the provider zip code, to designate the locale within in where the provider worked as rural or non-rural.

II. Designation of ICD-9-CM Diagnosis Codes Identifying NON-SPECIFIC LBP	
Sprains and strains of sacroiliac region (lumbosacral joint/ligament is 846.0)	846.0-846.9
Sprains and strains of other and unspecified regions of the back (thoracic)	847.1
Sprains and strains of other and unspecified regions of the back (lumbar)	847.2
Sprains and strains of other and unspecified regions of the back (sacrum)	847.23
Sprains and strains of other and unspecified regions of the back (coccyx)	847.4
Sprains and strains of other and unspecified regions of the back (unspecified)	847.9
Lumbago (Low back pain, Low back syndrome, Lumbalgia)	724.2

Record Layout of Requested Data Fields

DESCRIPTION	ALPHA NUMERIC
Medical provider federal ID No.	X
Provider ZIP	X
Service code (MCO number)	X
ICD-9-CM diagnosis code	X
Procedure code	X
Date of birth (YYYYMMDD)4	X
Date of service (YYYYMMDD)4	9.00
Gender	X
Education level	9.00
Patient ID	X

9.00 = Numerical data X = Character or alphanumeric data.

APPENDIX III. Algorithm to identify duplicate MRIs:

```
SORT CASES BY id(A) servdate(A) service(A) .
MATCH FILES /FILE = * /BY id servdate service
/FIRST = PFirst /LAST = PLast.
DO IF (PFirst).
COMPUTE MatchS = 1 - PLast.
ELSE.
COMPUTE MatchS = MatchS + 1.
END IF.
LEAVE MatchS.
FORMAT MatchS (f7).
COMPUTE InDupGrp = MatchS > 0.
SORT CASES InDupGrp(D).
MATCH FILES /FILE = * /DROP = PLast InDupGrp MatchS.
VARIABLE LABELS PFirst 'Indicator of each first matching case as Primary' .
VALUE LABELS PFirst 0 'Duplicate Case' 1 'Primary Case'.
VARIABLE LEVEL PFirst (ORDINAL).
FREQUENCIES VARIABLES = PFirst.
FILTER BY PFirst.
EXECUTE.
```

APPENDIX IV. Summary of Measurement Variables:

Major Predictor Variables

Demographics: age (<50 years />50 years, gender (M/F)

MCO enrollment: (Yes/no)

Rural service (yes/no)

Year of claim (1999, 2000, 2001, 2002)

Outcome Variables

MRI of the lumbar spine (CPT code 72148):

Inclusion criteria:

- Accepted disabling claims of worker's compensation patients who are identified as having been diagnosed with NON-SPECIFIC LBP based on International Classification of Diseases Codes -9th Edition (ICD-9) from the first quarter of 1999 thru the second quarter of 2003.
- Primary MRI within a single claim.

Exclusion Criteria:

- Specific causes of LBP including cancer, infection, scoliosis, radiculopathy.
- MRIs other than the primary MRI within a single claim.