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The association between use of chiropractic care and costs of care among older Medicare patients with chronic low back pain and multiple comorbidities

William B Weeks, MD, PhD, MBA [Professor],
The Geisel School of Medicine at Dartmouth Director, Health Services and Clinical Research, Palmer College of Chiropractic

The Dartmouth Institute for Health Policy and Clinical Practice Palmer Center for Chiropractic Research

Brent Leininger, DC [Assistant Professor],
Integrative Health & Wellbeing Research Program, Center for Spirituality & Healing, University of Minnesota, Minneapolis, MN

Center for Spirituality & Healing, University of Minnesota

James M Whedon, DC, MS [Instructor],
The Geisel School of Medicine at Dartmouth Director, Health Services Research, Southern California University of Health Sciences, Whittier, CA

The Dartmouth Institute for Health Policy and Clinical Practice

Jon D Lurie, MD, MS [Associate Professor],
The Geisel School of Medicine at Dartmouth

The Dartmouth Institute for Health Policy and Clinical Practice

Tor D Tosteson, ScD [Professor],
The Geisel School of Medicine at Dartmouth

CORRESPONDING AUTHOR CONTACT INFORMATION, William B Weeks, MD, PhD, MBA, wbw@dartmouth.edu, TDI, 35 Centerra Parkway, Lebanon, NH 03766, 603 208 8963.

Contributorship

Concept development (provided idea for the research) Wbw, tdt, jmw, jdl, rs, cmg
Design (planned the methods to generate the results) Wbw, tdt, jmw, bl, jdl, rs, cmg, ajo
Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript) wbw
Data collection/processing (responsible for experiments, patient management, organization, or reporting data) wbw
Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results) Wbw, tdt, jmw, bl, jdl, rs, cmg, ajo
Literature search (performed the literature search) Wbw, tdt, jmw, bl, jdl, rs, cmg, ajo
Writing (responsible for writing a substantive part of the manuscript) wbw
Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking) Wbw, tdt, jmw, bl, jdl, rs, cmg, ajo

CONFLICTS OF INTEREST
No conflicts of interest were reported for this study.

Department of Biomedical Data Science

Rand Swenson, DC, MD, PhD [Professor],
The Geisel School of Medicine at Dartmouth

The Dartmouth Institute for Health Policy and Clinical Practice

Alistair J O'Malley, PhD [Professor], and
The Geisel School of Medicine at Dartmouth

Department of Biomedical Data Science The Dartmouth Institute for Health Policy and Clinical Practice

Christine M Goertz, PhD, DC [Vice Chancellor]
Palmer College of Chiropractic, Davenport, IA

Palmer Center for Chiropractic Research

Abstract

Objective—The purpose of this study was to determine whether use of chiropractic manipulative treatment (CMT) was associated with lower healthcare costs among multiply-comorbid Medicare beneficiaries with an episode of chronic low back pain (cLBP).

Methods—We conducted an observational, retrospective study of 2006–2012 Medicare fee-for-service reimbursements for 72,326 multiply-comorbid patients aged 66 and older with cLBP episodes and 1 of 4 treatment exposures: chiropractic manipulative treatment (CMT) alone, CMT followed or preceded by conventional medical care, or conventional medical care alone. We used propensity score weighting to address selection bias.

Results—After propensity score weighting, total and per-episode day Part A, Part B, and Part D Medicare reimbursements during the cLBP treatment episode were lowest for patients who used CMT alone; these patients had higher rates of healthcare use for low back pain but lower rates of back surgery in the year following the treatment episode. Expenditures were greatest for patients receiving medical care alone; order was irrelevant when both CMT and medical treatment were provided. Patients who used only CMT had the lowest annual growth rates in almost all Medicare expenditure categories. While patients who used only CMT had the lowest Part A and Part B expenditures per episode day, we found no indication of lower psychiatric or pain medication expenditures associated with CMT.

Conclusions—This study found that older multiply-comorbid patients who used only CMT during their cLBP episodes had lower overall costs of care, shorter episodes, and lower cost of care per episode day than patients in the other treatment groups. Further, costs of care for the episode and per episode day were lower for patients who used a combination of CMT and conventional medical care than for patients who did not use any CMT. These findings support initial CMT use in the treatment of, and possibly broader chiropractic management of, older multiply-comorbid cLBP patients

Keywords

Manipulation; Chiropractic; Medicare; Retrospective Studies; Propensity Score

Introduction

Controlling the growth of healthcare costs continues to be a critical health policy issue. An aging population and advances in the ability to extend life and manage chronic disease have conspired to produce approximately 75 million people in the US who have multiple concurrent chronic conditions:[1,2] sixty-two percent of Americans over age 65 have multiple chronic conditions,[3] and 23% of Medicare beneficiaries have 5 or more chronic conditions.[4] The care of individuals with chronic conditions is estimated to account for 78% of US healthcare spending, and Medicare beneficiaries with more than 1 chronic condition account for 95% - while those with more than 5 chronic conditions account for 66% - of all Medicare spending.[3] The likelihood that patients will use expensive health care resources such as hospital care increases substantially when comorbidities are present,[5,6] and resource consumption increases dramatically if patients are also depressed.[7] The Strategic Framework on Multiple Chronic Conditions has called for development of new models of care for multiply comorbid Medicare beneficiaries.[8]

In addition, it has become increasingly evident that chronic pain is associated with high rates of diagnosable psychopathology,[9] and that unrecognized and untreated psychopathology can interfere with rehabilitation.[10] Because anxiety can decrease pain thresholds and tolerance,[11] emotional distress can magnify medical symptoms,[12] and depression can worsen chronic pain treatment outcomes,[13] psychiatric comorbidities may be implicated in perpetuating pain-related dysfunction.[14]

Among older US adults, back pain is common and associated with co-morbidities and self-reported difficulty with most functional tasks.[15] Medicare data from the 1990s indicated that low back pain (LBP) diagnoses and related expenditures increased disproportionately,[16] the use of lumbar and facet injections for LBP increased dramatically,[17] and there was intensive use of pharmaceutical agents among LBP patients.[18] The escalating prevalence of LPB among Medicare beneficiaries, the increasing costs of its treatment, and the high use and costs of pharmaceuticals suggest a critical need to identify appropriate, cost-effective, and conservative treatments for older patients with LBP. Further, the tenacity and cost of chronic pain disorders, and the very high rates of comorbid depression,[19,20] undiagnosed mood disorders (reaching levels of 75% among those with cLBP),[21,22] and anxiety disorders[19,20,23] with chronic pain disorders suggest that exploring ways to disrupt the vicious cycle of pain, stress, and emotional dysfunction are warranted. Since simultaneous pharmacological treatment of pain symptoms and major depression has led to improved function and quality of life,[24] and longitudinal analyses have shown that changes in pain and depression symptoms influence 1 another,[25,26] it makes sense that concurrent treatment of both conditions is recommended.[10]

Most LBP in older adults can be managed non-surgically,[16] and randomized controlled clinical trials have demonstrated that chiropractic manipulative treatment (CMT) is an effective, conservative treatment option for LBP[27–30] that has been recommended for back pain in older adults by a variety of advisory bodies.[31,32] While CMT has been shown to result in slightly better pain and function outcomes compared to other active treatments for chronic LBP, a number of researchers have questioned the clinical importance of these

findings. From a healthcare system or societal perspective, small differences in clinical outcomes may be important if associated with minimal additional costs, or cost savings. Studies examining differences in healthcare expenditures between CMT users and non-users show that CMT users are younger, wealthier, and healthier than non-users.[33–35] After propensity score matching to adjust for such differences, 1 study of the Medical Expenditure Panel Survey found that chiropractic care was associated with a lower use of medical resources, overall.[36] However, to date, propensity score methods have not been applied to claims data for the purposes of evaluating costs of care for multiply-comorbid patients seeking CMT for treatment of LBP.

Therefore, to explore whether older Medicare fee-for-service beneficiaries with an episode of LBP and multiple comorbidities who obtained CMT during their episode had lower costs than those who did not, we used Medicare files and a propensity score weighting methodology to adjust for confounders and create equivalent groups for comparison.[37–40] Further, we sought to determine whether, for particular diagnostic mixes within these treatment groups, reduced expenditures on psychiatric care or pain medications might be associated with CMT.

Methods

Overview

We conducted an observational, retrospective study that used Medicare fee-for-service files from 2006–2012 to identify older (aged 66 to 99) patients who had a discrete episode of cLBP (lasting at least 90 days[41] and preceded and followed by 180 days in which no LBP diagnosis was recorded) and during which each patient also had an additional musculoskeletal disorder diagnosis and a mental health disorder diagnosis (details of inclusion and exclusion criteria are provided in the **online** Appendix). Although we had access to 7 years of data, because of a 1-year look-back and 1-year look forward period, our analyses included episodes of cLBP that occurred during 5 years, between 2007–2011. If an individual patient had multiple cLBP episodes during our study period, we included only the first.

Informed by Liliedahl[42] and Weigel,[43] we identified patients who used 1 of 4 treatments during their episode: 1) only CMT; 2) conventional medical care followed by CMT; 3) CMT followed by conventional medical care; and 4) only conventional medical care.

For these 4 treatment groups, we examined all un-weighted and propensity-score weighted inflation- and price-adjusted Medicare Part A, B, and D reimbursements during the episode (Medicare Part A covers hospital, skilled nursing facility, home health and hospice care expenditures; Medicare Part B covers doctors' services and other outpatient expenditures; and Medicare Part D covers prescription medications). We paid particular attention to Part B reimbursements for CMT care, psychiatric care, physical therapy care, and spinal manipulation therapy (SMT) provided by doctors of osteopathy (DOs) as well as to Part D reimbursements for pain medications. Because the length of an average episode of care varied according to group, we also calculated each of these costs per episode day for each group.

We also examined 2 longer-term patient outcomes: additional healthcare claims for LBP and rate of spine surgery within 1 year of the end of the episode. Also, from annual cohorts of patients who met our inclusion criteria, who had episodes of cLBP that lasted 2 years or less, and whose episodes began in 2007–2010, we calculated annual compound rates of growth for price and inflation-adjusted Medicare expenditures. Finally, for particular diagnostic groupings, we specifically considered expenditures for CMT visits and psychiatric visits that were reimbursed through Medicare Part B as well as expenditures for pain medications reimbursed through Medicare Part D (for this analysis, we limited our analysis to patients with cLBP whose additional diagnostic combinations (i.e., depression plus osteoarthritis) represented at least 2% of the entire treatment group).

Statistics

Because we anticipated that the different groups studied would have different patient characteristics that might confound results,[36,44,45] to adjust for those confounders and create equivalent groups for comparison,[37–39] we used multinomial stepwise logistic regression[46] to calculate each subjects' propensity to be in a particular treatment group (with criteria to enter the stepwise regression set at $p<0.05$ and criteria to exit set at $p>0.10$).[40] The variables used for propensity score calculation are described in **online** Appendix 1. To avoid complications due to time-varying predictors, the propensity score calculation was performed using predictors measured at baseline.

We then used all cases in linear or logistic regressions to compare means or proportions, respectively, of outcome variables associated with being in 1 treatment group after inversely weighting each case by the patient's propensity to be in that treatment group. In essence, this method relatively over-weighted patients who were least likely to be in their respective treatment group given their demographics, rendering each individual treatment group cohort more like the overall distribution of patients and thus more similar, demographically.[40] For the analysis that explored whether particular diagnostic combinations might have different treatment patterns or expenditures, we used the same methods to calculate a different propensity score that did not incorporate the categories of comorbidities that defined our study population.

Prior to performing the study, we correctly anticipated that the smallest group of patients in our study would be those who were enrolled in Medicare Part D with pain medication costs. We assumed that the medication categories we studied would account for 25%, or about $500, of all pharmaceutical costs, with a standard deviation of $200. We determined that, with a sample size of 17,000 patients, we would be able to discern a $25 difference in Medicare Part D costs across the groups at the 0.001 level (two-sided) with a power of 0.99. Our pharmaceutical cost estimates were accurate and our sample size for this analysis was the 56.3% of the 72,326 patients who were enrolled in Medicare Part D, or 40,720 patients,

Funding and Ethics Considerations

The Dartmouth College Committee for the Protection of Human Subjects approved the study (CPHS # 24094).

Results

Comparison of patients in our study to the Medicare fee-for-service population with chronic low back pain

Table 1 shows the impact of application of our exclusion and inclusion criteria on demographics, patient characteristics, and un-weighted spending for cLBP episodes in older Medicare beneficiaries. The multiply-comorbid population that we studied was generally older, less likely to be male, less likely to use CMT, more likely to be enrolled in Medicare Part D, endured longer cLBP episodes, and experienced higher Medicare costs in all expenditure categories (except for CMT expenditures) than the overall Medicare fee-for-service beneficiary population that had a cLBP episode. Our study population represented only 7.2% of the broader Medicare population that had cLBP episodes and to which the same criteria for participation in the study were applied. Most of the differences between our study cohort and the broader Medicare population appeared to be attributable to the presence of a mental health diagnosis.

Comparison of demographics of our study cohorts

Most patients that we studied did not use chiropractic services (Table 2, **top**). As anticipated, before propensity score weighting, patients who used any chiropractic care were younger, more likely to be white, more educated, less likely to have indicators of poverty, had less illness burden, had generated fewer Medicare expenditures in the year preceding their cLBP episode, and lived in regions with a higher per-capita supply of DCs than those who did not. Somewhat surprisingly, in this multiply-comorbid cohort, we found that males were more likely to use chiropractic care and that patients who used CMT lived in lower income ZIP Codes. A higher proportion of patients who did not use CMT were enrolled in Medicare Part D. After propensity score weighting, differences in these patient characteristics were mitigated across treatment groups (Table 2, **bottom**).

Patients using only CMT had the shortest back pain episodes and patients who obtained CMT followed by medical care had the longest back pain episodes (Table 3, **top**). Before propensity score weighting, patients who used only CMT had the lowest Medicare expenditures for every category of expenditures examined with the exception of expenditures for CMT. Application of inverse propensity score weighting resulted in similar, albeit less dramatic, differences between treatment groups. Nonetheless, even after propensity score weighting, patients who obtained only CMT had Medicare Part A expenditures that were about 80% lower, and Part B and D expenditures that were about 50% lower, than those of patients who did not use any CMT during their cLBP episode. When comparing patients who used only CMT to those who used no CMT, higher expenditures for CMT were offset by lower expenditures for psychiatric, PT, or DO services and with substantially lower pharmaceutical (and particularly pain medication) costs. While back surgery rates were substantially lower among patients who used only CMT as compared to the other groups, the proportion of patients who had additional claims for LBP after their episode ended were substantially higher for this treatment group.

When examining treatment groups that used both CMT and conventional medical care, patients who used CMT first had higher Part A, Part B, and Part D expenditures, but lower rates of back surgery and lower rates of use of additional care for back pain in the year following their cLBP episodes than patient who use conventional medical care first.

When examining expenditures per episode day (Table 3, **bottom**), after propensity score weighting, Part A expenditures were similar for patients who used both CMT and conventional medical care, regardless of the order in which that care was obtained. However, Part B and D expenditures were higher for patients who used conventional medical care first. Daily expenditures for CMT were higher in the groups that actually used chiropractic; however, daily expenditures on pharmaceuticals were lower for patients who used only CMT and for those who use CMT first. Despite lower pharmaceutical costs, there was no decrease in daily expenditures for psychiatric treatment amongst patients using CMT.

Examination of care provided by DCs, psychiatrists, PTs, and DOs across treatment groups

For each treatment group, Table 4 shows the mean number of visits, and their distribution, to a DC for CMT, a psychiatrist, a PT, or a DO for spinal manipulation during a cLBP episode. Interestingly, the plurality of patients who used any CMT (including 57% of those who used only CMT) had 13 or more visits during their episode. The vast majority of patients that we examined had no psychiatric, PT, or DO visits, and very few patients obtained SMT provided by DOs. While there was little overlap of providers among patients using only CMT, there was substantial overlap of providers among patients using both medical care and CMT.

Compound annual growth rate of Medicare expenditures

Table 5 shows the annually calculated and inverse propensity score weighted average length of an episode as well as price- and inflation-adjusted Medicare Part A, B, and D reimbursements during a cLBP episode that lasted less than 2 years and began in the year indicated, across the 4 treatment groups. Over time, episode lengths trended upward for all treatment groups while measures of reimbursement fluctuated year to year. When examining total episode costs, patients who used only CMT had lower compound annual growth rates than any other treatment group for all variables except overall Part B spending and spending on CMT. Part A, B, and D expenditure growth was highest for patients who used CMT first, and then used conventional medical care, but episode lengths increased most for this group as well. When examining reimbursements per episode day, the same patterns generally held. Over the 4 annual cohort years, spine surgery rates remained stable, but the proportion of patients who obtained additional healthcare for back pain decreased for all groups (data not shown).

Exploration of psychiatric or pain medication cost-offsets

The distribution of patients across diagnostic group combinations differed according to treatment group (Table 6). Regardless of their psychiatric diagnoses, patients with osteoarthritis were somewhat more likely to be in the treatment group that did not use CMT

while patients with other back and neck pain or with some other NMS condition were more likely to be in the treatment group that used only CMT. Episode lengths were invariably shorter for patients in the treatment group that only used CMT; with 1 exception (patients with anxiety and another NMS condition), patients who obtained CMT first and then conventional medical care had the longest episodes. Overall Part A and Part B expenditures were invariably lowest for patients who used only CMT. With 1 exception (depression and osteoarthritis) Part A expenditures were highest for patients who did not obtain any CMT. Overall part B expenditures varied considerably by diagnostic mix but, for all treatment groups that did not only use CMT, they were considerably higher when patients had both depression and anxiety.

CMT expenditures were highest for patients who only obtained CMT, and they were similar in groups who obtained both CMT and conventional medical care during their cLBP episode. Psychiatric visit expenditures varied considerably, but with 1 exception (depression and osteoarthritis) were highest when patients had both depression and anxiety. There was no indication of reduced psychiatric expenditures associated with CMT. However, there was evidence of lower overall and pain medication expenditures associated with CMT: with 1 exception (anxiety and osteoarthritis) patients who used CMT only had the lowest overall and pain medication expenditures.

When examining expenditures per episode day, with 1 exception (anxiety and osteoarthritis), patients who used only CMT had the lowest Part A and Part B expenditures per day (Table 7). Among patients who used any CMT, with 1 exception (anxiety plus depression and osteoarthritis), mean daily expenditures of CMT were highest for patients who used only CMT, next highest for those who used conventional medical services followed by CMT, and lowest for those who used CMT first and then conventional medical services. We found no indication that CMT was associated with lower psychiatric, overall medication, or pain medication expenditures per episode day.

Discussion

We examined 4 clinical treatment patterns for older, Medicare fee-for-service enrolled, multiply-comorbid patients who had a discrete episode of cLBP. After propensity score weighting that addressed differences in demographics across the treatment groups (including the finding that CMT patients had lower illness burdens), we found that patients who used only CMT during their cLBP episodes had lower overall costs of care, shorter episodes, and lower cost of care per episode day than patients in the other treatment groups. Further, costs of care for the episode and per episode day were lower for patients who used a combination of CMT and conventional medical care than for patients who did not use any CMT, although most cost differences were due to differences in inpatient care cost; Medicare part B and D expenditures for patients who used any conventional medical care for their cLBP were similar, as were compound annual expenditure growth rates. While costs of care, and annual growth of healthcare costs, were generally lower for patients who used only CMT, that advantage might be offset somewhat by higher rates of later treatment for chronic LBP within a year of the episode’s completion in this group.

A high proportion of CMT users had 13 or more chiropractic visits. Others have found substantial variation in the number and duration of episodes of chiropractic care and the number of visits associated with those episode.[43,47] However, the potential overall (and particularly pain medication) cost savings that we found when only DCs provided back pain treatment for patients with cLBP might warrant further exploration of a new role for DCs in managing such multiply-comorbid patients.[48,49].

In contrast to other studies' results,[42,43] we did not find that order of treatment was associated with large differences in treatment costs of care when both CMT and conventional medical care were used during an episode of care. This might be attributable to the fact that we examined a multiply-comorbid cohort of patients. We did find modestly higher daily Part B and Part D costs for patients who used conventional medical care before they used CMT, but this cost advantage was offset by longer episode lengths when CMT was obtained first.

We sought evidence that CMT might reduce expenditures for psychiatric care or pain medications among older Medicare fee-for-service beneficiaries with a cLBP episode who had an additional NMS diagnosis and anxiety, depression, or both. However, we found no reductions in psychiatric expenditures associated with CMT. While we found reductions in overall and pain medication expenditures associated with CMT at the episode level, these disappeared when examining those expenditures on a per-episode-day basis. We did find evidence that patients with osteoarthritis were less likely, and those with other NMS diagnoses were more likely, to use CMT; however, this may reflect that doctors of chiropractic and doctors of medicine have different coding practices.

Clinical and Policy application

Our findings suggest that, from a Medicare cost standpoint, CMT may be a cost-efficient first line treatment choice for older, multiply-comorbid patients with cLBP. If policymakers encouraged DCs to have a greater role in initially managing such patients, patients may have episodes of care that were shorter and less costly (both overall and per episode day), and they might have lower pharmaceutical expenditures for pain medications. Further, should such management require the addition of conventional medical care after an initial course of CMT, policymakers might expect that overall costs might be similar to those for episodes wherein CMT was added after conventional medical care.

Limitations and future studies

Our study has several limitations. First, findings from the multiply-comorbid group that we examined may not be generalizable either to the larger Medicare fee-for-service population or to the US population. Second, we were constrained by the use of large Medicare datasets. While these datasets generated relatively large numbers of patients in the 4 treatment groups and reflect actual care utilization patterns, we were unable to determine whether care provided was justified or resulted in better health outcomes, as determined by patients. Third, when patients choose a particular treatment, there exists the potential for selection bias due to unmeasured confounders. While we attempted to address selection bias through inverse propensity score weighting, ours is not a randomized controlled trial, and so there is

no guarantee that the distributions of any unmeasured risk factors do not vary between the weighted groups. Therefore, all findings are referred to as associations and do not necessarily imply causality. Finally, we analyzed discrete, defined episodes of cLBP; analyses that use other definitions of cLBP may generate different results.

Studies such as ours provide initial evidence that CMT use is associated with lower expenditures among Medicare beneficiaries with cLBP and multiple comorbidities. While the study design limits our ability to make strong conclusions, future exploration of causation through randomized controlled trials is warranted; such studies might be a reasonable next step in determining the most effective and efficient treatment for this multiply-comorbid and costly group of patients. Also, while we did not find reductions in expenditures for psychiatric or pain medication associated with CMT in this population, that patients who used only CMT had lower overall and per day Part A and Part B expenditures suggests that cost savings might be found in other areas. Future work should examine broader and younger populations, where such cost savings might be more readily found. Finally, future studies should attempt to examine patient centered health outcomes so that cost-effectiveness analyses could be conducted.

Conclusions

We found that older multiply-comorbid patients who used only CMT during their cLBP episodes had lower overall costs of care, shorter episodes, and lower cost of care per episode day than patients in the other treatment groups. Further, costs of care for the episode and per episode day were lower for patients who used a combination of CMT and conventional medical care than for patients who did not use any CMT. These findings support initial CMT use in the treatment of, and possibly broader chiropractic management of, older multiply-comorbid cLBP patients

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Appendix. Details of the methods used

Patient inclusion criteria

We studied fee-for-service Medicare beneficiaries using 100% Medicare Part A and Part B files and 40% Medicare Part D files for 2006–2012. The population was derived from Medicare beneficiaries with at least 1 evaluation and management visit in a calendar year with the following annual exclusions: a) any Medicare Advantage; b) less than full Part A and B enrollment for the entire period (or from the month turning 65 to month of death); c) residence outside the 50 United States or Washington, DC; d) residence in an unidentifiable county; and f) age<66 (because of a required 1-year look back period for exclusion criteria detailed below) or >99.

Following Cherkin's methodology,[50] we eliminated patients with ICD-9-CM codes that are unlikely to be responsive to non-surgical treatment: neoplasms (CPT-9-CM codes 140-239.9), intra-spinal abscess (324.1), osteomyelitis (730–730.99), vertebral fractures with spinal cord injury (806.0–806.9), open vertebral fractures without spinal cord injury (805.1, 805.3, 805.5, 805.7, 805.9), vertebral dislocations (839–839.59), chordotomy (03.2–03.29), and cervical and dorsal fusions (81.01–81.03). Because Doctors of Chiropractic (DCs) often treat patients for vertebral dislocations (ICD-9-CM diagnostic codes 839–

839.59) we did not exclude patients who had these codes if the code was recorded during a chiropractic visit.

Guided by Martin's analysis of the Medical Expenditures Panel Survey (MEPS) prevalence of diagnostic categories of back problems,[51] we defined low back pain (LBP) patients as those who had a primary ICD-9-CM diagnosis code in the 724 series: 724.2 (lumbago), 724.3 (sciatica), 724.4 (thoracic or lumbosacral neuritis or radiculitis, unspecified), 724.5 (backache, unspecified), 724.8 (other symptoms referable to back), and 724.9 (other unspecified back disorders). But because DCs frequently use additional ICD-9-CM codes, we also included patients with a primary ICD-9-CM diagnosis code in the following series if such diagnoses were made during a chiropractic visit: 722 (intervertebral disc disorders), 739 (non-allopathic subluxation), and 839 (other multiple and ill-defined dislocations).

Chronic low back pain (cLBP) lasts at least 3 months.[41] We therefore defined a cLBP episode as beginning with the recording of a low back pain diagnosis at least twice over at least a 90-day period following a period of 6 months during which no such diagnosis was recorded; the episode was defined to end on the day that the last such diagnosis was followed by at least 180 days without any such diagnosis. Although we had access to 7 years of data, because of the required 1-year look-back and 1-year look-forward periods, our analyses included cLBP episodes that occurred during 5 years, between 2007–2011. If an individual patient had multiple episodes during our study period, we counted only the first 1.

To evaluate patients with multiple comorbidities, we limited the study population to patients who had an ICD-9-CM code indicating at least 1 of the following additional musculoskeletal diagnoses during the episode or in the 12 months preceding episode onset: other back and neck pain (307.89, 722.3, 722.32, 722.8, 722.83, 846 series, 847.2, 847.3, 847.9, 996.41), non-back rheumatism (729.0), arthritis and other arthropathies (716.19, 716.68, 716.95) osteoarthritis (715.00, 715.09, 715.18, 715.21, 715.22, 715.28, 715.98), and diffuse diseases of the connective tissue (728.89, 728.9, 729.1, 729.3, 729.4). We further limited the study population to patients who had an ICD-9-CM code indicating at least 1 of the following psychological comorbidities during the episode or in the 12 months preceding episode onset: depression (296.3, 300.4, 309.0, 309.2, 309.8, 311), anxiety (293.84, 300.00, 300.09) or insomnia (327.01, 327.02).

Patients who used chiropractic manipulative therapy (CMT) were identified as having as at least 1 visit to a doctor of chiropractic (identified as code 35 in the provider specialty field) and generating at least 1 CPT based charge for CMT (code 98940 (1 or 2 regions), 98941(3 to 4 regions), or 98942 (5 regions)) during the episode of cLBP. We excluded costs of treatments that were 'expanded' for the purposes of conducting The Demonstration of Expanded Coverage of Chiropractic Services under Medicare.[44]

Informed by Liliedahl[42] and Weigel,[43] we identified 4 treatment groups: 1) Those in which only CMT was used; 2) Those in which the initial treatment for the episode consisted of non-chiropractic medical care, but where CMT was also obtained during the episode; 3) Those in which the initial treatment for the episode consisted of CMT, but where non-

chiropractic medical care was also obtained during the episode; and 4) Those in which no CMT was obtained during the episode.

Measures

Our primary outcome measures were inflation- and price-adjusted Medicare Part A, Part B, and Part D costs for a cLBP episode of care for each treatment group. Because the length of an average episode of care varied according to group, we also calculated each of these costs per episode day.

We were interested in whether the multiply-comorbid patients who obtained CMT might use psychiatric care, other care for back pain, or pain medications differently than those who did not, with the potential for seeing an offset effect. Therefore, for each episode, we calculated expenditures for CMT visits (described above) and psychiatric visits (defined as any visit wherein the provider has an AMA specialty code of ADP, CHP, PFP, P, or PYA). Further, anticipating that the 2 other types of providers that Medicare reimburses for spinal manipulative therapy (SMT) – doctors of osteopathy (DOs) and physical therapists (PTs)– might provide care to any of the treatment groups, we used CPT codes (for DOs, CPT codes 98925-98928 and for PTs, CPT code 97140) with a concurrently documented LBP diagnosis to identify, calculate the reimbursements for, and calculate the number of visits per episode for such care.

We also examined reimbursements for pain medications (including opiate analgesics, non-steroidal anti-inflammatory drugs, Cox-2 inhibitors, steroid injections, and other medications commonly used to treat recalcitrant low back pain (including gabapentin, other anti-seizure medications, oral steroids, and non-benzodiazepine muscle relaxants (as benzodiazepines are not reimbursed by the Medicare Part D program) that were identified by the relevant Part D drug reimbursement codes).

In addition, we examined 2 secondary measures that occurred within a year of the end of the episode. First, we considered future healthcare use, as measured by claims, for LBP after a 180-day period wherein no low back pain diagnoses were recorded, but within a year of the end of the cLBP episode. Second, we examined admission for back surgery (defined as admission for DRG 028, 029, or 030 before 2008; admission for MS DRG 491, 473, or 460 since) within 1 year of the end of the cLBP episode.

Analyses

Because we anticipated that we would find that the different treatment groups would have different distributions of patient characteristics,[36,44,45] we used the following propensity score methodology to adjust for confounders and create equivalent groups for comparison.[37–39] First, we used multinomial stepwise logistic regression[46] (with criteria to enter the stepwise regression set at $p<0.05$ and criteria to exit set at $p>0.10$) to calculate the estimated probability of each patient to be in each of the 4 treatment groups using the following variables (all of which were included in the model):

a. From Medicare files:

i. Socio-demographic variables (patient sex, patient race, whether the patient was concurrently enrolled in Medicaid, whether the patient was originally enrolled in Medicare by virtue of disability or age, and whether the beneficiary has a low-income subsidy for Medicare Part D (a measure of patient poverty)); and

ii. Diagnostic codes which we used to identify patients who had the aforementioned categorically defined comorbidities that defined our study population and from which we calculated modified Deyo-Charlson[52] scores and Iezzoni[53] scores.

b. From ZIP Code-linked datasets:

i. An estimate of patient income (ZIP Code specific mean annual household income in 2010) as well as the proportion of the population that lived under the federal poverty level;

ii. The per-capita supply of DCs in the Dartmouth Atlas Defined Hospital Referral Region.[54] We included this in the propensity score because the supply of DCs has been associated with CMT utilization in the Medicare population;[55,56] therefore, the supply of DCs represents a confounder that should be included in propensity score generation as it might be associated with both treatment exposure and overall CMT utilization.

iii. The regional carrier that was used by Medicare to process CMT claims in the region where the patient lived as a variable in generating propensity scores.

We then used all cases in linear or logistic regressions to compare means or proportions, respectively, of outcome variables before and after inversely weighting each case by the propensity to be in the treatment group to which they self-assigned. In essence, this method relatively over-weighted results for patients who were least likely to be in that treatment group given their demographics, rendering the cohorts more similar on observed variables, demographically.

Among older, multiply-comorbid Medicare beneficiaries with a chronic low back pain episode, chiropractic manipulative treatment was associated with lower overall episode costs and lower episode costs per day.

Most multiply-comorbid chronic low back patients who used any chiropractic manipulative treatment had at least 6 chiropractic visits; most of those who exclusively used chiropractic manipulative treatment had more than 12 visits.

Use of chiropractic manipulative treatment was associated with lower total Part A and Part D Medicare cost growth for multiply-comorbid patients with chronic low back pain episodes over the time period examined.

While we found overall Medicare cost-savings associated with use of chiropractic care, we found no evidence of lower psychiatric or pain medication expenditures associated with chiropractic manipulative treatment within diagnostic subgroups.

Table 1

Demographics and un-weighted spending results that show the impact of serial application of exclusion and inclusion criteria for chronic back pain episodes in older Medicare Part A and Part B enrollees in 2007–2012. CMT means chiropractic manipulation treatment.

	N	% of all	% after exclusion criteria applied	Mean age (yrs)	Male (%)	White race (%)	Used a DC for CMT (%)	Part D enrolled (%)	Mean days in an episode	Mean Medicare expenditures during the episode ($)						
										Total A, B, & D	Part A	Part B			Part D	
												Total	On CMT	On Psychiatric care	Total	On pain meds
All episodes of chronic back pain	2,267,643	100		75.4	38.0	88.6	21.1	48.3	409	14,553	4,245	3,967	79.64	16.00	3,235	320
After application of exclusion criteria	1,000,095	44.1	100	75.4	33.4	86.0	22.6	49.8	350	9,980	2,711	2,553	82.26	12.02	2,614	273
Those with a mental health diagnosis	190,566	8.4	19.1	76.5	21.0	88.6	14.6	55.7	415	15,469	5,333	3,667	53.80	43.12	4,104	583
Those with an additional musculoskeletal condition	327,914	14.5	32.8	75.5	30.3	85.9	26.9	50.7	373	11,690	3,321	3,080	98.43	15.07	2,956	347
Those with both	72,326	3.2	7.2	76.4	18.6	88.1	17.6	56.3	444	17,779	6,162	4,318	66.28	47.54	4,574	699

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Table 2

Mean values and standard errors of key demographics, measures of poverty and income, the per-capita supply of doctors of chiropractic, and measures of illness burden before and after propensity score weighting for the 4 treatment groups. DC means doctor of chiropractic; CMT means chiropractic manipulative treatment.

		N	Key demographics					Measures of poverty and income		Indicators of illness burden				
			Mean age (yrs)	Male (%)	White race (%)	Less than high school education* (%)	Enrolled in Medicare Part D	Part D poverty flag (%)	Medicaid enrolled (%)	Charlson score	Iezzoni score	Disability was original reason for Medicare eligibility	Total Medicare spending in year prior to episode	The per-10,000 capita supply of DCs in the HRR
Un-weighted	Only used CMT	3,909	73.7 (0.12)	24.6 (0.69)	96.1 (0.31)	5.61 (0.10)	51.6 (0.80)	11.8 (0.52)	8.4 (0.44)	1.30 (0.03)	0.90 (0.02)	7.8 (0.43)	4,718 (168)	2.68 (0.016)
	Used conventional medical care first, then CMT	3,563	74.3 (0.13)	23.4 (0.71)	93.8 (0.40)	5.99 (0.10)	51.4 (0.84)	13.2 (0.57)	10.2 (0.51)	1.51 (0.03)	1.03 (0.02)	9.7 (0.50)	5,420 (188)	2.49 (0.016)
	Used CMT first, then conventional medical care	5,235	74.6 (0.11)	24.4 (0.59)	94.0 (0.33)	5.99 (0.09)	50.0 (0.69)	14.1 (0.48)	10.6 (0.43)	1.35 (0.03)	0.95 (0.02)	8.6 (0.39)	4,425 (140)	2.58 (0.013)
	Did not use CMT	59,619	76.9 (0.03)	17.4 (0.16)	86.7 (0.14)	7.08 (0.03)	57.4 (0.20)	29.9 (0.19)	24.0 (0.17)	2.13 (0.01)	1.38 (0.01)	12.9 (0.14)	6,586 (51)	2.24 (0.004)
Propensity score weighted	Only used CMT	3,909	76.4 (0.06)	18.2 (0.14)	88.0 (0.12)	6.91 (0.05)	57.8 (0.18)	27.0 (0.16)	21.5 (0.15)	1.93 (0.02)	1.30 (0.01)	12.6 (0.12)	6,277 (91)	2.28 (0.007)
	Used conventional medical care first, then CMT	3,563	76.1 (0.06)	18.7 (0.15)	88.4 (0.12)	6.88 (0.05)	56.5 (0.19)	25.5 (0.16)	20.5 (0.15)	1.95 (0.02)	1.30 (0.01)	12.3 (0.12)	6,089 (91)	2.29 (0.007)
	Used CMT first, then conventional medical care	5,235	76.4 (0.06)	18.3 (0.14)	87.3 (0.12)	6.92 (0.05)	55.6 (0.19)	25.7 (0.16)	20.7 (0.15)	1.99 (0.02)	1.29 (0.01)	11.6 (0.12)	6,326 (92)	2.31 (0.007)
	Did not use CMT	59,619	76.4 (0.06)	18.5 (0.14)	88.1 (0.12)	6.87 (0.05)	55.9 (0.19)	26.9 (0.17)	21.4 (0.15)	1.99 (0.02)	1.31 (0.01)	12.1 (0.12)	6,280 (92)	2.30 (0.007)

Table 3

Un-weighted and propensity score weighted spending and outcomes results (with standard errors in parentheses) for the entire episode of care (top) and per episode day (bottom) for older Medicare Part A and Part B enrollees in 2007–2012 with chronic low back pain episodes multiple comorbidities across 4 treatment groups. DC means doctor of chiropractic; PT means physical therapy; DO means doctor of osteopathy; CMT means chiropractic manipulative treatment; and SMT means spinal manipulation therapy.

			N	Mean days in an episode	Medicare expenditures during the episode ($)									1 year post-episode events	
					Total Part A and Part B	Part A	Part B					Part D*		Back surgery (%)	Future claims for back pain treatment (%)
							Total	On CMT	On Psychiatric care	On PT care	For DO SMT	Total	On pain meds		
Expenditures during the entire episode	**Un-weighted**	Only used CMT	3,909	298 (4.9)	3,010 (144)	1,168 (94)	1,842 (50)	478.51 (4.01)	19.82 (2.70)	6.82 (1.24)	0.04 (0.07)	1,905 (164)	300.47 (37.59)	0.10 (0.051)	31.8 (0.75)
		Used conventional medical care first, then CMT	3,563	367 (5.6)	8,277 (251)	4,070 (185)	4,207 (80)	329.93 (3.49)	32.71 (3.64)	71.47 (4.19)	2.73 (0.61)	3,054 (209)	497.95 (48.79)	1.21 (0.183)	31.3 (0.78)
		Used CMT first, then conventional medical care	5,235	481 (5.3)	8,993 (216)	4,843 (166)	4,150 (65)	332.17 (2.89)	35.29 (3.12)	41.95 (2.65)	1.52 (0.38)	3,802 (200)	532.66 (43.28)	0.86 (0.128)	20.0 (0.55)
		Did not use CMT	59,619	455 (1.5)	11,231 (71)	6,730 (58)	4,501 (20)	0.00 (0.00)	51.32 (1.11)	34.08 (0.71)	1.49 (0.11)	4,882 (64)	747.54 (14.44)	0.54 (0.030)	12.6 (0.14)
	Propensity score weighted	Only used CMT	3,909	287 (2.1)	3,581 (66)	1,429 (45)	2,152 (25)	522.24 (3.97)	31.85 (1.67)	6.62 (0.57)	0.03 (0.02)	2,381 (75)	355.25 (15.74)	0.04 (0.008)	31.9 (0.17)
		Used conventional medical care first, then CMT	3,563	369 (2.4)	8,721 (105)	4,351 (80)	4,370 (37)	323.68 (3.18)	37.52 (1.85)	72.22 (1.91)	2.67 (0.23)	3,751 (95)	537.19 (19.58)	0.81 (0.034)	30.3 (0.17)
		Used CMT first, then conventional medical care	5,235	486 (2.8)	10,271 (113)	5,567 (90)	4,704 (38)	342.72 (3.25)	44.28 (1.99)	43.14 (1.47)	1.58 (0.18)	4,387 (106)	576.08 (21.01)	0.65 (0.030)	17.0 (0.14)
		Did not use CMT	59,619	454 (2.7)	11,039 (117)	6,593 (98)	4,446 (37)	0.00 (0.00)	49.06 (2.09)	35.88 (1.34)	1.61 (0.18)	4,744 (112)	734.27 (24.09)	0.62 (0.029)	13.1 (0.13)
Expenditures per episode day	**Un-weighted**	Only used CMT			10.10 (0.50)	3.92 (0.34)	6.18 (0.15)	1.61 (0.01)	0.07 (0.009)	.02287 (.00486)	.00014 (.00029)	6.30 (0.37)	0.99 (0.10)		
		Used conventional medical care first, then CMT			22.57 (0.70)	11.10 (0.53)	11.47 (0.20)	0.90 (0.01)	0.09 (0.010)	.19480 (.01338)	.00745 (.00198)	8.50 (0.40)	1.39 (0.11)		
		Used CMT first, then conventional medical care			18.69 (0.46)	10.06 (0.37)	8.63 (0.12)	0.69 (0.01)	0.07 (0.006)	.08718 (.00645)	.00317 (.00093)	7.98 (0.29)	1.12 (0.07)		

			N	Mean days in an episode	Medicare expenditures during the episode ($)									1 year post-episode events	
					Total Part A and Part B	Part A	Part B					Part D*		Back surgery (%)	Future claims for back pain treatment (%)
							Total	On CMT	On Psychiatric care	On PT care	For DO SMT	Total	On pain meds		
		Did not use CMT			24.69 (0.16)	14.80 (0.14)	9.90 (0.04)	0.00 (0.00)	0.11 (0.002)	.07492 (.00182)	.00328 (.00029)	10.67 (0.10)	1.63 (0.02)		
	Propensity score weighted	Only used CMT			12.50 (0.22)	4.99 (0.16)	7.51 (0.07)	1.82 (0.01)	0.11 (0.005)	.02311 (.00210)	.00010 (.00010)	8.57 (0.18)	1.28 (0.04)		
		Used conventional medical care first, then CMT			23.64 (0.28)	11.79 (0.22)	11.84 (0.08)	0.88 (0.01)	0.10 (0.004)	.19570 (.00547)	.00722 (.00080)	10.15 (0.17)	1.45 (0.04)		
		Used CMT first, then conventional medical care			21.13 (0.23)	11.45 (0.19)	9.68 (0.06)	0.71 (0.01)	0.09 (0.003)	.08874 (.00318)	.00325 (.00046)	9.12 (0.14)	1.20 (0.03)		
		Did not use CMT			24.32 (0.25)	14.52 (0.22)	9.79 (0.07)	0.00 (0.00)	0.11 (0.004)	.07905 (.00311)	.00355 (.00050)	10.39 (0.16)	1.61 (0.04)		

*Part D expenditures are calculated from only those patients who were enrolled in Medicare Part D

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Table 4

Mean number of visits (and standard errors), and visit distribution for care provided by doctors of chiropractic and psychiatrists (top) and physical therapists and doctors of osteopathy (bottom) during an episode for the 4 treatment groups. DC means doctor of chiropractic; PT means physical therapy; DO means doctor of osteopathy; CMT means chiropractic manipulation treatment; and SMT means spinal manipulation therapy.

	Numbers of visits per episode												
	To a DC for CMT							To a psychiatrist					
	Mean (SE)	% of patients in the cohort with the following number of visits						Mean (SE)	% of patients in the cohort with the following number of visits					
		0	1–2	3–5	6–9	10–12	13+		0	1–2	3–5	6–9	10–12	13+
Only used CMT	20.76 (0.34)	0.0	6.8	12.3	13.8	9.4	57.6	0.43 (0.08)	92.6	3.6	1.9	0.9	0.4	0.6
Used conventional medical care first, then CMT	13.75 (0.32)	0.0	21.5	18.6	16.1	8.2	35.7	0.58 (0.08)	90.7	4.5	2.2	1.0	0.6	1.0
Used CMT first, then conventional medical care	14.23 (0.29)	0.0	20.0	20.9	17.0	8.6	33.5	0.63 (0.05)	90.0	4.6	2.2	1.6	0.5	1.2
Did not use CMT	0.00	100	0.0	0.0	0.0	0.0	0.0	0.93 (0.02)	85.7	6.4	3.3	1.9	0.8	1.9

	Numbers of visits per episode												
	To a PT							To a DO for SMT					
	Mean (SE)	% of patients in the cohort with the following number of visits						Mean (SE)	% of patients in the cohort with the following number of visits					
		0	1–2	3–5	6–9	10–12	13+		0	1–2	3–5	6–9	10–12	13+
Only used CMT	0.26 (0.04)	97.4	0.5	0.5	0.5	0.2	0.8	0.00 (0.002)	99.9	0.1	0.0	0.0	0.0	0.0
Used conventional medical care first, then CMT	2.56 (0.17)	80.7	3.1	3.6	3.9	2.0	6.7	0.09 (0.015)	97.6	1.4	0.5	0.3	0.0	0.2
Used CMT first, then conventional medical care	1.55 (0.09)	86.3	2.3	2.9	3.1	1.8	3.6	0.05 (0.010)	98.7	0.8	0.3	0.1	0.0	0.1
Did not use CMT	1.23 (0.02)	89.0	2.1	2.1	2.1	1.3	3.3	0.05 (0.003)	98.8	0.8	0.2	0.1	0.0	0.1

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Table 5

Compound growth rate analysis. Data are for patients who had a chronic low back pain episode that lasted less than 730 days and whose episode started in a particular year between 2007 and 2010. Compound annual growth rates in expenditures during the episode and expenditures per day are shown. CMT means chiropractic manipulation treatment.

		Year in which episode started				Compound growth rate (2007–2010)	Compound growth rate (2007–2010)
		2007	2008	2009	2010	based on total episode costs	based on episode costs per day
Episode days	Only used CMT	236 (2.4)	241 (2.7)	242 (2.8)	244 (2.7)	1.2%	
	Used conventional medical care first, then CMT	279 (2.9)	291 (3.0)	284 (3.2)	293 (3.1)	1.7%	
	Used CMT first, then conventional medical care	313 (3.3)	319 (3.4)	321 (3.6)	350 (3.4)	3.8%	
	Did not use CMT	290 (3.2)	304 (3.4)	322 (3.4)	321 (3.2)	3.4%	
Part A spending ($)	Only used CMT	1127 (77)	1179 (88)	1088 (89)	1065 (104)	−1.9%	−3.0%
	Used conventional medical care first, then CMT	3471 (147)	3613 (159)	3977 (184)	4311 (218)	7.5%	5.8%
	Used CMT first, then conventional medical care	4183 (178)	3907 (178)	4171 (196)	5513 (249)	9.6%	5.6%
	Did not use CMT	5737 (207)	5771 (220)	5730 (220)	5669 (246)	−0.4%	−3.7%
Part B spending ($)	Only used CMT	1739 (34)	1932 (42)	1756 (43)	1928 (56)	3.5%	2.4%
	Used conventional medical care first, then CMT	3724 (54)	3670 (60)	3966 (70)	3946 (84)	1.9%	0.3%
	Used CMT first, then conventional medical care	3345 (56)	3594 (64)	3415 (67)	4476 (91)	10.2%	6.2%
	Did not use CMT	3542 (57)	3700 (66)	3802 (68)	3818 (82)	2.5%	−0.9%
Spending on CMT ($)	Only used CMT	477.08 (6.27)	463.86 (6.95)	483.31 (7.16)	564.73 (8.78)	5.8%	4.6%
	Used conventional medical care first, then CMT	313.50 (5.51)	315.35 (5.90)	315.55 (6.27)	287.81 (6.54)	−2.8%	−4.4%
	Used CMT first, then conventional medical care	306.97 (6.00)	315.79 (6.36)	286.54 (6.20)	280.95 (6.52)	−2.9%	−6.5%

		Year in which episode started				Compound growth rate (2007–2010)	Compound growth rate (2007–2010)
		2007	2008	2009	2010	based on total episode costs	based on episode costs per day
Spending on psychiatric care ($)	Did not use CMT	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.0%	0.0%
	Only used CMT	18.28 (1.60)	16.59 (1.88)	13.20 (1.66)	13.04 (1.76)	−10.7%	−11.6%
	Used conventional medical care first, then CMT	23.37 (1.96)	20.20 (2.14)	25.02 (2.48)	17.44 (2.12)	−9.3%	−10.8%
	Used CMT first, then conventional medical care	28.60 (2.39)	21.62 (2.38)	33.75 (2.99)	32.23 (2.91)	4.1%	0.3%
Part D* spending ($)	Did not use CMT	32.99 (2.55)	44.93 (3.50)	46.83 (3.37)	44.39 (3.33)	10.4%	6.7%
	Only used CMT	2279 (92)	2305 (111)	1938 (140)	2271 (122)	−0.1%	−1.2%
	Used conventional medical care first, then CMT	2620 (111)	2675 (128)	2734 (183)	2889 (131)	3.3%	1.6%
	Used CMT first, then conventional medical care	2651 (127)	2821 (145)	4833 (279)	3099 (159)	5.3%	1.5%
Pain medication spending ($)	Did not use CMT	3298 (140)	3119 (158)	3328 (211)	3459 (166)	1.6%	−1.8%
	Only used CMT	491.44 (30.34)	251.22 (22.32)	312.42 (30.15)	256.83 (24.76)	−19.5%	−20.3%
	Used conventional medical care first, then CMT	402.09 (30.70)	529.86 (34.81)	581.79 (45.27)	351.16 (27.43)	−4.4%	−6.0%
	Used CMT first, then conventional medical care	534.96 (40.27)	329.90 (30.29)	549.99 (50.33)	357.97 (32.46)	−12.5%	−15.7%
	Did not use CMT	616.37 (42.94)	534.94 (39.87)	549.43 (46.00)	499.42 (38.00)	−6.8%	−9.9%

*Part D expenditures are calculated from only those patients who were enrolled in Medicare Part D

Table 6

Numbers of patients, proportions of patients of each diagnostic mix within a treatment group, episode lengths, and Medicare expenditures during the chronic low back pain episode for the different Medicare spending categories. CMT means chiropractic manipulation treatment.

			N	% of the treatment group	Episode length in days	Medicare expenditures ($)					
						Part A	Part B			Part D*	
							Total	For CMT	For psychiatric care	Total	For pain medications
Anxiety	**Osteoarthritis**	Only used CMT	172	4.4%	260 (7.4)	1417 (150.7)	1868 (78.8)	502 (12.5)	8.09 (2.11)	2357 (195.9)	392 (44.9)
		Used medical services first, then CMT	212	6.0%	372 (8.0)	3713 (219.5)	4107 (105.2)	323 (9.0)	7.65 (1.85)	1804 (147.0)	220 (28.9)
		Used CMT first, then medical care	303	5.8%	531 (9.7)	4465 (245.0)	4304 (109.6)	350 (9.5)	16.44 (2.76)	2874 (206.9)	244 (33.9)
		Did not use CMT	6313	10.6%	458 (7.1)	5117 (206.2)	3743 (80.4)	0 (0.0)	23.11 (2.57)	3868 (195.6)	413 (35.9)
	Other neck & back pain	Only used CMT	413	10.6%	300 (8.1)	1670 (245.5)	1870 (96.8)	450 (15.9)	21.78 (4.60)	1748 (177.4)	117 (23.8)
		Used medical services first, then CMT	306	8.6%	322 (8.9)	3292 (366.9)	3464 (140.3)	301 (13.8)	11.78 (3.60)	2198 (205.4)	251 (35.8)
		Used CMT first, then medical care	476	9.1%	457 (10.6)	3391 (374.6)	3378 (139.4)	320 (14.3)	8.22 (3.03)	3099 (222.6)	226 (31.1)
		Did not use CMT	2789	4.7%	403 (12.7)	4295 (535.8)	3536 (181.2)	0 (0.0)	16.98 (5.53)	3044 (311.0)	265 (47.3)
	Any other NMS	Only used CMT	508	13.0%	267 (6.0)	812 (98.5)	2059 (73.9)	483 (10.4)	7.43 (1.60)	2289 (159.1)	125 (19.9)
		Used medical services first, then CMT	378	10.6%	347 (7.7)	4048 (248.9)	3972 (116.2)	333 (9.7)	12.05 (2.30)	2915 (203.4)	215 (29.6)
		Used CMT first, then medical care	544	10.4%	424 (8.6)	3387 (229.6)	3551 (110.8)	295 (9.2)	6.87 (1.75)	2747 (206.2)	325 (38.0)
		Did not use CMT	4802	8.1%	436 (9.4)	4621 (290.2)	3801 (124.0)	0 (0.0)	14.13 (2.72)	3714 (255.3)	439 (47.1)
Depression	**Osteoarthritis**	Only used CMT	285	7.3%	306 (18.2)	1708 (134.9)	2576 (72.0)	563 (10.2)	106.02 (6.76)	3 063 (258.3)	491 (46.5)
		Used medical services first, then CMT	290	8.1%	378 (20.1)	4362 (226.6)	4566 (100.7)	339 (8.3)	60.16 (5.35)	4878 (378.5)	814 (69.5)

			N	% of the treatment group	Episode length in days	Medicare expenditures ($)					
						Part A	Part B			Part D*	
							Total	For CMT	For psychiatric care	Total	For pain medications
		Used CMT first, then medical care	458	8.7%	506 (18.5)	6965 (265.4)	4486 (92.5)	345 (7.7)	42.01 (4.15)	4953 (358.6)	731 (61.9)
		Did not use CMT	11613	19.5%	450 (3.5)	6452 (187.4)	4222 (65.9)	0 (0.0)	49.2 4 (3.29)	5183 (267.3)	787 (46.8)
	Other neck & back pain	Only used CMT	621	15.9%	301 (11.8)	1386 (135.5)	1819 (55.1)	463 (10.8)	14.53 (2.09)	3270 (269.6)	444 (49.1)
		Used medical services first, then CMT	473	13.3%	351 (14.5)	3929 (236.8)	3500 (79.4)	318 (9.3)	16.42 (2.31)	3681 (286.5)	464 (50.2)
		Used CMT first, then medical care	635	12.1%	400 (13.4)	5149 (293.8)	3647 (87.8)	288 (9.6)	28.99 (3.32)	4853 (411.7)	531 (67.3)
		Did not use CMT	4480	7.5%	393 (5.0)	6303 (386.4)	4075 (110.4)	0 (0.0)	36.61 (4.44)	4104 (443.1)	611 (84.4)
	Any other NMS	Only used CMT	821	21.0%	254 (4.4)	798 (76.7)	1870 (55.2)	529 (11.5)	20.34 (2.64)	2031 (177.0)	261 (39.5)
		Used medical services first, then CMT	519	14.6%	338 (6.1)	3232 (187.3)	3793 (95.3)	339 (11.2)	15.48 (2.80)	3423 (239.1)	560 (60.3)
		Used CMT first, then medical care	839	16.0%	467 (6.9)	4991 (221.6)	4642 (100.4)	340 (10.7)	50.83 (4.83)	4492 (280.6)	604 (64.1)
		Did not use CMT	8108	13.6%	418 (6.8)	5957 (252.3)	4110 (98.4)	0 (0.0)	37.15 (4.30)	4647 (308.8)	814 (80.5)
Anxiety and depression	**Osteoarthritis**	Only used CMT	98	2.5%	287 (9.4)	1121 (166.6)	2386 (124.6)	563 (16.3)	44.81 (7.72)	3997 (358.7)	613 (85.3)
		Used medical services first, then CMT	105	2.9%	463 (12.0)	8105 (450.5)	5888 (196.9)	230 (10.5)	80.32 (10.40)	9603 (513.7)	1010 (101.2)
		Used CMT first, then medical care	199	3.8%	599 (11.8)	8618 (400.3)	7132 (186.7)	398 (11.9)	136.56 (11.68)	4758 (324.1)	395 (56.7)
		Did not use CMT	5507	9.2%	530 (8.2)	9054 (304.5)	5288 (119.3)	0 (0.0)	105.98 (7.64)	6163 (300.3)	1033 (74.7)
	Other neck & back pain	Only used CMT	182	4.7%	313 (12.3)	1418 (227.5)	2003 (169.3)	459 (26.6)	26.48 (12.08)	1753 (394.4)	287 (75.4)
		Used medical services first, then CMT	175	4.9%	384 (12.9)	3515 (339.0)	5138 (256.6)	399 (23.5)	136.04 (25.92)	2783 (525.6)	576 (112.9)
		Used CMT first, then medical care	268	5.1%	514 (14.8)	6306 (447.6)	4878 (246.5)	381 (22.6)	88.55 (20.62)	5239 (608.1)	833 (114.5)

			N	% of the treatment group	Episode length in days	Medicare expenditures ($)					
						Part A	Part B			Part D*	
							Total	For CMT	For psychiatric care	Total	For pain medications
		Did not use CMT	1924	3.2%	471 (17.6)	7846 (622.1)	4755 (303.3)	0 (0.0)	83.89 (25.00)	5963 (939.2)	1012 (182.8)
	Any other NMS	Only used CMT	821	21.0%	323 (9.6)	1707 (210.9)	2340 (116.4)	607 (16.5)	46.08 (7.51)	1817 (217.5)	266 (47.6)
		Used medical services first, then CMT	519	14.6%	441 (10.6)	5206 (347.0)	4998 (160.2)	344 (11.7)	102.69 (10.56)	4849 (366.3)	812 (85.8)
		Used CMT first, then medical care	839	16.0%	550 (11.3)	7867 (406.9)	5431 (159.3)	280 (10.0)	78.76 (8.82)	4555 (339.9)	866 (84.7)
		Did not use CMT	8108	13.6%	481 (11.0)	8004 (429.2)	5075 (161.0)	0 (0.0)	79.47 (9.27)	4782 (355.4)	841 (85.2)

*Part D expenditures are calculated from only those patients who were enrolled in Medicare Part D

Table 7

Expenditures per day for the different Medicare spending categories. CMT means chiropractic manipulation treatment.

			Medicare expenditures per episode day ($)					
			Part A	Part B			Part D*	
				Total	For CMT	For psychiatric care	Total	For pain medications
Anxiety	**Osteoarthritis**	Only used CMT	5.46 (0.57)	7.19 (0.26)	1.93 (0.05)	0.031 (0.010)	8.80 (0.55)	1.46 (0.14)
		Used medical services first, then CMT	9.97 (0.58)	11.03 (0.24)	0.87 (0.02)	0.021 (0.006)	5.32 (0.33)	0.65 (0.07)
		Used CMT first, then medical care	8.40 (0.45)	8.10 (0.18)	0.66 (0.02)	0.031 (0.006)	6.03 (0.33)	0.51 (0.06)
		Did not use CMT	11.18 (0.44)	8.18 (0.15)	0.00 (0.00)	0.051 (0.007)	8.46 (0.32)	0.90 (0.06)
	Other neck & back pain	Only used CMT	5.56 (0.79)	6.22 (0.23)	1.50 (0.04)	0.073 (0.012)	5.98 (0.49)	0.40 (0.09)
		Used medical services first, then CMT	10.22 (1.10)	10.75 (0.31)	0.94 (0.04)	0.037 (0.009)	7.44 (0.56)	0.85 (0.14)
		Used CMT first, then medical care	7.43 (0.79)	7.40 (0.22)	0.70 (0.03)	0.018 (0.005)	6.79 (0.39)	0.50 (0.08)
		Did not use CMT	10.66 (1.28)	8.78 (0.32)	0.00 (0.00)	0.042 (0.011)	7.28 (0.60)	0.63 (0.13)
	Any other NMS	Only used CMT	3.04 (0.37)	7.70 (0.21)	1.81 (0.04)	0.028 (0.006)	8.49 (0.48)	0.46 (0.07)
		Used medical services first, then CMT	11.66 (0.72)	11.44 (0.26)	0.96 (0.03)	0.035 (0.007)	8.77 (0.50)	0.65 (0.08)
		Used CMT first, then medical care	7.98 (0.54)	8.37 (0.20)	0.70 (0.02)	0.016 (0.004)	5.83 (0.36)	0.69 (0.07)
		Did not use CMT	10.60 (0.67)	8.72 (0.22)	0.00 (0.00)	0.032 (0.006)	8.25 (0.46)	0.97 (0.09)
Depression	**Osteoarthritis**	Only used CMT	5.38 (0.44)	8.12 (0.19)	1.77 (0.03)	0.334 (0.018)	10.86 (0.52)	1.74 (0.13)
		Used medical services first, then CMT	11.48 (0.62)	12.01 (0.22)	0.89 (0.02)	0.158 (0.012)	13.28 (0.58)	2.22 (0.15)
		Used CMT first, then medical care	13.93 (0.55)	8.97 (0.15)	0.69 (0.01)	0.084 (0.007)	10.23 (0.42)	1.51 (0.10)

			Medicare expenditures per episode day ($)					
			Part A	Part B			Part D*	
				Total	For CMT	For psychiatric care	Total	For pain medications
		Did not use CMT	14.33 (0.43)	9.38 (0.12)	0.00 (0.00)	0.109 (0.006)	11.46 (0.34)	1.74 (0.08)
	Other neck & back pain	Only used CMT	4.76 (0.49)	6.25 (0.18)	1.59 (0.04)	0.050 (0.009)	9.67 (0.54)	1.31 (0.12)
		Used medical services first, then CMT	11.15 (0.71)	9.93 (0.22)	0.90 (0.03)	0.047 (0.008)	11.00 (0.58)	1.39 (0.13)
		Used CMT first, then medical care	12.96 (0.78)	9.18 (0.21)	0.73 (0.02)	0.073 (0.011)	11.74 (0.68)	1.28 (0.14)
		Did not use CMT	16.06 (1.04)	10.38 (0.27)	0.00 (0.00)	0.093 (0.015)	10.68 (0.79)	1.59 (0.19)
	Any other NMS	Only used CMT	3.14 (0.31)	7.37 (0.18)	2.08 (0.04)	0.080 (0.009)	8.40 (0.45)	1.08 (0.12)
		Used medical services first, then CMT	9.57 (0.57)	11.23 (0.24)	1.00 (0.03)	0.046 (0.007)	10.37 (0.44)	1.70 (0.14)
		Used CMT first, then medical care	10.69 (0.49)	9.94 (0.18)	0.73 (0.02)	0.109 (0.008)	8.98 (0.34)	1.21 (0.10)
		Did not use CMT	14.24 (0.62)	9.83 (0.20)	0.00 (0.00)	0.089 (0.008)	11.01 (0.44)	1.93 (0.14)
Anxiety and depression	**Osteoarthritis**	Only used CMT	3.91 (0.60)	8.31 (0.36)	1.96 (0.05)	0.156 (0.024)	11.48 (0.67)	1.76 (0.19)
		Used medical services first, then CMT	17.50 (1.01)	12.72 (0.35)	0.50 (0.02)	0.173 (0.020)	15.56 (0.54)	1.64 (0.13)
		Used CMT first, then medical care	14.38 (0.69)	11.90 (0.26)	0.66 (0.02)	0.228 (0.017)	9.75 (0.43)	0.81 (0.09)
		Did not use CMT	17.08 (0.60)	9.98 (0.19)	0.00 (0.00)	0.200 (0.013)	11.50 (0.36)	1.93 (0.11)
	Other neck & back pain	Only used CMT	4.54 (0.77)	6.40 (0.38)	1.47 (0.06)	0.085 (0.027)	6.11 (0.85)	1.00 (0.18)
		Used medical services first, then CMT	9.16 (0.93)	13.38 (0.47)	1.04 (0.05)	0.354 (0.047)	9.94 (1.16)	2.06 (0.28)
		Used CMT first, then medical care	12.26 (0.92)	9.48 (0.34)	0.74 (0.03)	0.172 (0.028)	10.98 (0.78)	1.75 (0.17)
		Did not use CMT	16.66 (1.39)	10.10 (0.46)	0.00 (0.00)	0.178 (0.037)	11.80 (1.14)	2.00 (0.25)

			Medicare expenditures per episode day ($)					
			Part A	Part B			Part D*	
				Total	For CMT	For psychiatric care	Total	For pain medications
	Any other NMS	Only used CMT	27.47 (4.69)	7.25 (0.31)	1.88 (0.05)	0.143 (0.024)	6.26 (0.54)	0.92 (0.14)
		Used medical services first, then CMT	18.17 (2.48)	11.34 (0.32)	0.78 (0.03)	0.233 (0.024)	10.93 (0.59)	1.83 (0.17)
		Used CMT first, then medical care	10.64 (1.46)	9.88 (0.25)	0.51 (0.02)	0.143 (0.016)	8.93 (0.48)	1.70 (0.14)
		Did not use CMT	19.61 (2.72)	10.55 (0.29)	0.00 (0.00)	0.165 (0.020)	10.29 (0.55)	1.81 (0.16)

*Part D expenditures are calculated from only those patients who were enrolled in Medicare Part D