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Cost-Utility of Cognitive Behavioral Therapy for Low Back Pain From the Commercial Payer Perspective

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Abstract

Study Design—Markov cost-utility model.

Objective—To evaluate the cost-utility of cognitive behavioral therapy (CBT) for the treatment of persistent nonspecific low back pain (LBP) from the perspective of US commercial payers.

Summary of Background Data—CBT is widely deemed clinically effective for LBP treatment. The evidence is suggestive of cost-effectiveness.

Methods—We constructed and validated a Markov intention-to-treat model to estimate the cost-utility of CBT, with 1-year and 10-year time horizons. We applied likelihood of improvement and utilities from a randomized controlled trial assessing CBT to treat LBP. The trial randomized subjects to treatment but subjects freely sought health care services. We derived the cost of equivalent rates and types of services from US commercial claims for LBP for a similar population. For the 10-year estimates, we derived recurrence rates from the literature. The base case included medical and pharmaceutical services and assumed gradual loss of skill in applying CBT techniques. Sensitivity analyses assessed the distribution of service utilization, utility values, and rate of LBP recurrence. We compared health plan designs. Results are based on 5000 iterations of each model and expressed as an incremental cost per quality-adjusted life-year.

Results—The incremental cost-utility of CBT was \$7197 per quality-adjusted life-year in the first year and \$5855 per quality-adjusted life-year over 10 years. The results are robust across numerous sensitivity analyses. No change of parameter estimate resulted in a difference of more than 7% from the base case for either time horizon. Including chiropractic and/or acupuncture care did not substantively affect cost-effectiveness. The model with medical but no pharmaceutical costs was more cost-effective (\$5238 for 1 yr and \$3849 for 10 yr).

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Conclusion—CBT is a cost-effective approach to manage chronic LBP among commercial health plans members. Cost-effectiveness is demonstrated for multiple plan designs.

Keywords

cognitive behavioral therapy; cost-utility; cost-effectiveness; Markov model; nonspecific low back pain; health plan design; low back pain; commercial health plan

Persistent, nonspecific low back pain (LBP), which lacks a specific, identifiable physical impairment or pathology, is widely considered to be a phenomenon in which biological, psychological, and social factors interact.^{1–6} Treatment for a multifaceted condition requires a multifaceted approach. Although some treatments such as spinal stimulation show increasing promise, among psychotherapeutic treatments for LBP, cognitive behavioral therapy (CBT) is of particular interest because it targets modifiable risk factors.⁷ CBT affects pain and disability outcomes by addressing fear-based avoidance and catastrophizing. Fear-based avoidance predicts impairment⁸ and directly affects function.^{1,9} Catastrophizing addresses anxiety and depression, which can directly decrease pain severity and disability^{10–12} as well as mediating the effect of predictors such as educational attainment and depression.^{13–15}

In general, CBT has demonstrated better outcomes than other treatments for nonspecific LBP, particularly alternatives against which it has been directly compared, such as back pain education and manual therapy.^{16–18} Long-term studies have suggested sustained effects of CBT, decreasing health care visits or sick days up to 10 years, alone or in combination with physiotherapy.^{18–20} Guidelines produced by the American College of Physicians and the American Pain Society and by the European Spine Society, European Spinal Deformity Society, and European Section of the Cervical Spine Research Society recommend that physicians consider CBT for patients with LBP.^{6,21}

In the face of this clinical evidence of effectiveness, there is great interest in determining the cost-effectiveness of CBT treatment. The cumulative evidence is suggestive of cost-effectiveness but not definitive.^{18,22} Numerous European studies from the employer, societal, and national health care perspectives have found cost-effectiveness in various circumstances.^{17,23–25} No study has investigated whether CBT is cost-effective from the US commercial payer perspective, which is the goal of this study.

MATERIALS AND METHODS

Model Structure

We constructed a Markov decision tree model in Microsoft Excel to estimate cost-effectiveness of advice with CBT relative to advice without CBT at 1 and 10 years. Incremental costs were measured from the US commercial payer perspective. Incremental effectiveness was measured as quality-adjusted life-years (QALYs) gained. The outcome was the incremental cost-effectiveness ratio (ICER). Costs and effects were discounted at 3%.²⁶

The model (Figure 1) represents the experience of subjects in the Back Skills Training Trial (BSTT), a pragmatic, multicenter, randomized controlled trial (RCT) used as a source for this study.²⁷ Adults with LBP lasting at least 6 weeks were recruited from general practitioners' clinics. All received educational material and information on the benefit of remaining active *versus* bed rest, appropriate use of pain medication, and managing symptoms. Subjects randomized to the treatment arm (n = 468) attended a 1.5-hour individual assessment and up to 6-group CBT sessions (n = 233).

At the end of the follow-up year, 59% of subjects in the CBT group reported improvement in pain and function compared with 31% in the standard care group.¹⁷ The BSTT collected utilities using the EuroQol 5-dimension (EQ-5D) instrument. Subjects who improved reported an average utility score of 0.640 (0.016), somewhat higher than the average 0.592 (0.023) reported by those who did not improve.²⁷

To estimate 10-year cost-effectiveness, our model probabilistically distributes subjects into 3 possible health states—improved, not improved, and dead—at the end of years 2 through 10. We applied the probability of mortality starting at 54 years of age (0.005939), the mean age of subjects in the BSTT, and increased it annually.²⁸ A surviving subject entering a year in the Not Improved state may improve that year. We assume skill degradation in the CBT group, decreasing their initial 59% chance of improvement by a conservative 20% each year, as little research has assessed long-term effectiveness.²⁹ A subject entering a year in the Improved state may relapse. We applied an annual 0.60 probability of recurrence of LBP during the year, a rate reflected in multiple studies of similar populations (range: 0.27–0.85).^{30–32} Each subject is assigned the utility value for his or her health state at the end of each year. Death is expected to be evenly distributed throughout a year, so people who die are assigned the utility for half the year.

The intention-to-treat analysis includes subjects randomized to the CBT arm who did not attend the number of sessions deemed necessary to benefit *a priori*.¹⁷ They are assigned the control group improvement probability. Table 1 provides the full set of model parameters.

Valuation of Costs

Intervention costs from the BSTT, in 2008 British pounds, were converted to US dollars and adjusted for US inflation rates for medical care services. Calculating the cost of health care was more complicated. Critically, subjects in the RCT were free to seek the type and volume of services they wished from public or private providers. The study reported the mean and standard deviation (SD) of services received by subjects in each study arm. Categories included visits to general practitioners, nurses, osteopaths, physical or occupational therapists, psychologists, counselors, acupuncturists, chiropractors, and emergency rooms; diagnostics including radiological scanning, computed tomography, magnetic resonance imaging, and blood tests; medications including antidepressants, nonsteroidal anti-inflammatories, painkillers, and sleeping pills; and outpatient and inpatient procedures.

We derived the US costs of these services from an administrative database by selecting claims for adults with LBP. The Ingenix Impact Research Database includes adjudicated inpatient and outpatient medical and pharmaceutical claims for more than 60 million lives.

The data are nationally representative and so are not biased by geographic variation. Standard unit prices have been applied to all services.

We identified patients similar to subjects in the RCT: adults who received treatment for nonspecific LBP within 6 months prior to an index diagnosis of LBP. We reviewed studies that used administrative data to identify patients with LBP and selected International Classification of Diseases, Ninth Revision (*ICD-9*) codes supported by the majority of the research (Table 2).^{33–37} We then excluded people with evidence of specific causes of LBP (Table 3) or other plausible causes including pregnancy, trauma, neoplasm, infection, and inflammation.

For these adults, all of whom had continuous medical and pharmaceutical insurance coverage, we collected claims with a primary diagnosis of LBP during a 12-month period after their index diagnosis. From those claims, we derived a cost for each type of service. First, we selected claims with service-specific combinations of provider types and Current Procedural Terminology codes or facility-based revenue codes. Second, we calculated a weighted mean cost for each type of service.

Pharmaceutical claims do not have diagnoses, so to derive costs for medications, we identified medications associated with an episode, not diagnosis, of LBP. Episodes were produced using Symmetry Episode Treatment Grouper software, which has been used in peer-reviewed health services research.^{38,39}

Service costs reflect the total allowed amount, that is, the total cost to the payer. Costs borne by the patient, such as deductible or copayment, are not included. For every model, we simulated 5000 estimates, using the SD around the rate of each type of service to produce a mean, minimum, and maximum total cost of LBP health care per subject, per arm.

Sensitivity Analyses

Cost-utility estimates are strongly influenced by the model parameters. We accommodated uncertainty in the model inputs in numerous ways. First, as noted, every model is run 5000 times to accommodate the reported variation in utilizing each type of health care. In addition to the mean ICER, the standard result reported for cost-effectiveness studies, we report the minimum and maximum ICER to demonstrate the range of results.

Second, we performed numerous sensitivity analyses. To assess uncertainty around service utilization, we increased and decreased the rate of reported health care by 2 and 3 times the SD for each type of service. To assess uncertainty around annual recurrence of LBP, we applied high and low values found in the literature. To assess uncertainty around utility estimates, we increased (decreased) each reported value by 3 SDs. We modeled a “worst case” scenario from the perspective of a commercial payer, the scenario expected to produce the highest raw costs: high annual recurrence rate (85%) and high service utilization estimate (plus 3 SDs).

Third, we examine cost-effectiveness in various insurance plan designs. We added chiropractic, acupuncture, and then both services to the base case and then modeled a medical-only plan that does not include the cost of pharmaceuticals.

RESULTS

Base Case Analysis

The base case demonstrated that CBT is cost-effective in the first year, at \$7197 per QALY gained (Table 4). The cost per QALY is lower at 10 years, \$5855 as the CBT arm accrues utilities more quickly than it accrues costs.

Total costs were \$2,236,553 for the CBT arm in year 1 and \$18,434,406 total. About half as many control subjects accrued far lower total costs, \$1,186,206 and \$10,514,125 for more than 10 years. On average, control subjects' LBP health care cost more, \$5091 *versus* \$4779 for CBT subjects in year 1 and \$45,125 *versus* \$39,390 for more than 10 years.

Sensitivity Analyses

Sensitivity analyses produced overall extremely consistent results. Figure 2 demonstrate the results of the base case and each sensitivity analysis. Across all models, variation across the 5000 iterations had less than a 2% effect on any estimate.

Applying lower and higher utility estimates for the Improved health state had a moderate, approximately 5%, effect on the 1-year results, \$7582 and \$6849, respectively. The effect was lower, less than 3%, for more than 10 years (\$6026 and \$5693, respectively). Increasing the rate at which subjects received LBP services had an increasing effect over time, rising from a 4% to 5% difference for a 2 SD increase (\$6943 and \$5573) and from a 5% to a 7% difference for an increase of 3 SD (\$6826 and \$5454). Notably, increasing the estimated service volume decreased the ICERs, reflecting greater cost-effectiveness of CBT but higher total costs. By definition, the “worst case” scenario had the same 1-year ICER as the model increasing services by 3 SDs. Its 10-year ICER was just 6% from the base case (\$5487). No other sensitivity analysis differed from the base case more than 2%.

Insurance plan design had varied effects. We modeled adding acupuncture, chiropractic, or both types of services, with little effect on the 1-year ICER (\$7292, \$7333, and \$7427, respectively) or 10-year ICER (\$5952, \$5993, and \$6090, respectively). Not including pharmaceutical coverage had the strongest effect of any model, decreasing the ICER by 27% (\$5238) for 1 year and 34% (\$3849) for 10 years.

CONCLUSION

We used costs from a nationally generalizable US commercial claims database and recovery rates, utility values, and health care utilization from a UK-based RCT to model cost-effectiveness from the US commercial payer perspective. We extend the 1-year results of the RCT to 10 years. CBT is a cost-effective addition to active management of existing, nonspecific LBP at \$7197 per QALY in the first year and \$5855 for more than 10 years, despite assumed decline in effectiveness. There is no consensus on acceptable ICERs. However, as the ICER increases, acceptability and the likelihood of adoption decrease as the value of the intervention declines.⁴⁰ Although \$50,000 and \$100,000 have been cited as benchmarks in the United States,^{40,41} every payer, public or commercial, has its own

standards or guidelines. The QALY achieved in this study compares favorably with others published recently for LBP treatment.^{42,43}

Although consistent with prior findings,^{17,23,24,44} this study is the first to assess cost-effectiveness of all services for LBP from the US commercial payer perspective. Cost-effectiveness was achieved even in the first year. This finding has important implications in the US commercial context, in which risks are assessed annually.

The extremely stable results across sensitivity analyses accessing uncertainty in all model parameters support the finding of cost-effectiveness. Sensitivity analyses were performed to assess variation in utility values, annual recurrence rates, and skill retention. Mean estimates were within 7% of the base case with 1 exception. Notably, the “worst case” scenario, which assumed that the CBT intervention had weaker effectiveness and that subjects sought more LBP care than seen in the source study, was just 6% off the base case after 10 years. This finding will be of interest to health plans.

A second set of sensitivity analyses assessed the effect of particular health plan benefits, which is of specific interest to decision makers. Adding acupuncture and chiropractic services had a negligible effect due to low unit costs and low utilization rates in the BSTT. Removing pharmaceutical coverage from the plan design, hence removing cost of medications from the model, decreased overall costs and, therefore, the ICER (\$5238). The medical-only plan was both lower-cost and more cost-effective. However, pharmaceuticals were by far the most frequently used treatment. Assessing potential use of treatments will help inform plan design.

Self-insured employers, in particular, may be interested in our results. Employees with LBP may have decreased productivity as well as higher health care costs.^{24,45,46} Some studies have suggested that CBT resulted in fewer days of sick leave up to 10 years after intervention, particularly when combined with physical therapy.^{18–20}

Further research on the effect of recent changes in insurance plan structures, particularly increasing deductibles, coinsurance, and copayments, on the willingness of patients to pay for CBT or other services for LBP care would contribute to better understanding of patient’s perceptions of value.

Strengths and Limitations

Strengths of the study include the data sources, cost specification, transparency of methods, and extremely consistent results. The source study for utilization and recovery rates and utility values combines the benefits of randomization to treatment, generalizability, with observation of patient’s health care choices over time, as the study imposed no restrictions on the health care services the subjects could seek for their back pain.

Costs reflect the actual experience of a large set of adult patients with LBP, accounting for variations in severity and complications. Providing a minimum and maximum result for each model allows the reader to assess the effect of this variation. We identified subjects using a transparent, literature-based definition, which contributes to interpretation of the results.⁴⁷ For each category of care, we selected only directly relevant services from claims with a

first-listed diagnosis of LBP, which suggests primacy. We derived weighted costs, applying predefined, service-specific algorithms. Costs were standardized across payers, eliminating effects of geographical or contractual variation.

The source study collected data on all relevant services, including professional, diagnostic, outpatient, inpatient, complementary, pharmaceutical, and ancillary. Similar studies are not as comprehensive.⁴⁸ BSTT authors supplemented the published data with additional detail, allowing us to specify associated costs with accuracy. Studies are rarely so transparent about services included in costing.⁴⁵ The results were extremely consistent, whether assessing uncertainty in the data or the effect of different health plan designs.

Although it is common practice to apply the results of RCTs in one health system to other populations, even when explicitly recognizing that treatment availability differs across countries,^{49,50} there is some risk in assuming that US patients would seek services at the same rate as patients in the United Kingdom. Provider availability, referral requirements, and financial considerations could affect treatment choices. To assess the validity of using service rates from the BSTT, we compared US rates from the data set from which we derived costs to the control group. The US patients had similar mean treatment rates from general practitioner (+3%), nurses (−1%), and physical or occupational therapists (+1%). They had somewhat (13%–28%) lower rates of diagnostic services, prescriptions, or mental health care but higher rates of surgical admissions. The rate of emergency room visits was much higher, +50%, but emergency room visits are rare in the BSTT (0.03 in the CBT group and 0.02 among controls) and so would not have a large influence on the results. Stable results despite varying utilization rates up to 3 SD suggest that the results are driven by different improvement rates in the study arms and not by differences in health care utilization.

Service data are based on subject recall, not direct measurement, and could be biased in either direction. The combined effect of multiple runs and sensitivity analyses may not adequately address the unknowns. The inherent limitations of using administrative data, the source for costs, are well documented.⁵¹ This study avoided many common flaws of using administrative data⁴⁷ and provides transparency regarding which codes are used.

The overall conservative design, factoring in skill degradation, supports the finding of cost-effectiveness.

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➤ Key Points

- ❑ Cognitive Behavioral Therapy is cost-effective LBP care from the US commercial payer perspective.
- ❑ Cost-effectiveness was achieved in the first year, which is important in the US commercial context.
- ❑ Cognitive Behavioral Therapy is cost-effective in varied health plan designs.

Figure 1. Model depicting probability of study subjects being in each health state (Improved, Not Improved, Dead) at the end of years 1 through 10. CBT indicates cognitive behavioral therapy.

Figure 2. Incremental cost-effectiveness ratios (ICER) for all models. **A**, One-year ICERs; **B**, ten-year ICERs.

TABLE 1

Model Parameters

Model	CBT Pr(Better)*	Control Pr(Better)	Relapse	Utility, Improved	Utility, Not Improved
Base case	59%	31%	60%	0.640	0.592
Relapse rate					
Low	59%	31%	27%	0.640	0.592
High	59%	31%	85%	0.640	0.592
Utility values for health states					
Improved-low	59%	31%	60%	0.592	0.592
Improved-high	59%	31%	60%	0.688	0.592
Not Improved-low	59%	31%	60%	0.640	0.523
Not Improved-high	59%	31%	60%	0.640	0.661
“Worst case”	59%	31%	85%	0.640	0.592

Every model produces a mean, minimum, and maximum incremental cost-effectiveness ratio based on 5000 iterations varying the distribution of health care services received by each study arm.

Boldface indicates parameters which were changed for the model.

CBT indicates cognitive behavioral therapy; Pr(Better), proportion of subjects improving in year 1; Pr(Better) for CBT group reduced by 20% each year to reflect skill degradation; Base Case, set of parameters used for main model and to support analyses varying volume of health care services or varying health plan design; Relapse, annual likelihood of having low back pain given not having it at the beginning of the year; Utility, health-related quality of life; Improved, having less pain or disability at the end of the year; Not Improved, having pain or disability at the end of the year; Worst case, high relapse rate and service utilization inflated by 3 SD.

TABLE 2

Diagnosis Codes Used to Identify Nonspecific Causes of Lumbar Pain for Inclusion in Study Sample

ICD-9-CM Code*	Description
353.4	Lumbosacral root lesions, not elsewhere classified
721.3	Lumbosacral spondylosis without myelopathy
721.4	Thoracic or lumbar spondylosis with myelopathy [†]
721.42	Spondylosis with myelopathy, lumbar region
721.5	Kissing spine
721.6	Ankylosing vertebral hyperostosis
721.7	Traumatic spondylopathy
721.8	Other allied disorders of spine
721.9	Spondylosis of unspecified site
721.90	Spondylosis of unspecified site without mention of myelopathy
721.91	Spondylosis of unspecified site with myelopathy
722.1	Displacement of thoracic or lumbar intervertebral disc without myelopathy [†]
722.3	Schmorl nodes
722.30	Unspecified region
722.32	Lumbar region
722.5	Degeneration of thoracic or lumbar intervertebral disc [†]
722.52	Lumbosacral
722.90	Other and unspecified disc disorder of unspecified region
722.93	Lumbar region
724.2	Lumbago
724.3	Sciatica
724.4	Thoracic or lumbosacral neuritis or radiculitis, unspecified [†]
724.5	Unspecified backache
724.6	Disorders of sacrum
724.8	Other symptoms referable to back
724.9	Other unspecified back disorders
739.3	Nonallopathic lesion of lumbar region, not elsewhere classified
739.4	Nonallopathic lesion of sacral region, not elsewhere classified
846	Sprain and strain of sacroiliac region
846.0	Sprain and strain of lumbosacral (joint) (ligament)
846.1	Sprain and strain of sacroiliac (ligament)

ICD-9-CM Code[*]	Description
846.2	Sprain and strain of sacrospinatus (ligament)
846.3	Sprain and strain of sacrotuberous (ligament)
846.8	Other specified sites of sacroiliac region sprain and strain
846.9	Unspecified site of sacroiliac region sprain and strain
847.2	Lumbar sprain and strain
847.3	Sprain and strain of sacrum
847.4	Sprain and strain of coccyx
847.9	Sprain and strain of unspecified site of back

^{*} *The International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) is the official system of assigning codes to diagnoses and procedures for billing purposes in the United States.*

[†] The vast majority of people identified with this code (59%–100%) had additional claims specific to lumbar low back pain.

TABLE 3

Diagnosis Codes Used to Identify Congenital, Mechanical, or Traumatic Causes of Lumbar Pain for Exclusion From the Study Sample

Exclusion Criteria—Specific Causes of Lumbar Pain	
ICD-9-CM Code *	Description
720.0–720.9	Ankylosing spondylitis
722.10	Intervertebral disk herniation
722.2	
722.6	
722.73	
724.00	Spinal stenosis
724.02	
724.03	
724.09	
737–737.9	Curvatures of the spine
738.4–738.5	Spondylolisthesis
756.11–756.12	
739.1–739.4	Nonallopathic lesions of the spine
756.1–756.2	Anomalies of the spine
805.0–806.9	Open or closed spinal fractures
839.0–839.5	Vertebral dislocations

* *The International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) is the official system of assigning codes to diagnoses and procedures for billing purposes in the United States.*

TABLE 4**One-Year and 10-Year Incremental Cost-effectiveness Ratios**

Base Case	1-Year ICER			10-Year ICER		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
	\$7197	\$7170	\$7234	\$5855	\$5827	\$5892
Vary annual relapse rates						
Low	N/A	N/A	N/A	\$5771	\$5743	5808
High	N/A	N/A	N/A	\$5888	\$5860	5926
Vary utility values for health states						
Improved—low	\$7582	\$7554	\$7621	\$6026	\$5997	\$6064
Improved—high	\$6849	\$6823	\$6884	\$5693	\$5666	\$5730
Not Improved—low	\$7289	\$7261	\$7326	\$6000	\$5971	\$6038
Not Improved—high	\$7108	\$7081	\$7144	\$5717	\$5690	\$5753
Vary volume of health care services received						
Decrease by 3 SD	\$7200	\$7174	\$7219	\$5836	\$5809	\$5855
Decrease by 2 SD	\$7206	\$7172	\$7207	\$5842	\$5807	\$5843
Increase by 2 SD	\$6943	\$6917	\$6943	\$5573	\$5547	\$5573
Increase by 3 SD	\$6826	\$6762	\$6839	\$5454	\$5389	\$5467
Vary insurance plan design						
Do not cover medications	\$5238	\$5179	\$5274	\$3849	\$3789	\$3886
Cover acupuncture	\$7292	\$7258	\$7325	\$5952	\$5917	\$5986
Cover chiropractic	\$7333	\$7302	\$7366	\$5993	\$5962	\$6027
Cover acupuncture and chiropractic	\$7427	\$7390	\$7457	\$6090	\$6052	\$6121
“Worst case”	\$6826	\$6762	\$6839	\$5487	\$5421	\$5500

ICER indicates incremental cost-effectiveness ratio; Base Case, model with data sourced from randomized controlled trial or mean estimates and effect of treatment reduced by 20% each year to reflect skill degradation; N/A, not applicable; Relapse, annual likelihood of having low back pain; Utility, health-related quality of life, Improved, less pain or disability at the end of the year; Not Improved, pain or disability at the end of the year; Worst case, high relapse rate and service utilization inflated by 3SD.