**Technical Appendix**

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**Section A: Model Assumptions**

A number of assumptions went into this model. Our model categorized all patients into one of four health states and was based on a 6-week cycle. Therefore, two model assumptions were that all patients in each health state experienced the same average costs and utility levels (see Table A.1), and that patients’ costs and utility levels were constant for the 6-week period that made up each cycle. These are usual and necessary modeling assumptions. We did find that average values for utilities and productivity were relatively stable for each health state across study samples.1 We chose a 6-week cycle because it was short enough to capture the major changes in outcomes seen in trial data over time, yet long enough to allow for stable input estimates. The trials included in our model did not collect data on a regular 6-week cycle. For studies that did not collect data at 6-week intervals we assumed that patients would progress at constant rate between data collection points over the study year so that we could estimate their progress every 6 weeks. Nevertheless, the model followed the Markov property of being memoryless—i.e., the transition probabilities applied for each cycle to all individuals were independent of how that individual reached that state—and patients moved through the model following a Markov chain Monte Carlo approach.2

**Table A.1. Model Inputs: 6-Week Healthcare Costs (2015$), Productivity Loss (2015$), and Utilities Used to Calculate Quality-Adjusted Life-Years (QALYs), Mean (SE)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Health States** | **Back-Related Healthcare Costsa** | **Productivity Loss (from Absenteeism)b** | **Utilities (Measure of Health-Related Quality of Life)c** |
| No pain (no-to-low disability) | $ -- | $3.76 ($2.66) | 0.806 (0.004) |
| Low-impact chronic pain (low pain, low activity limitations) | $265.34 ($37.89) | $31.90 ($14.75) | 0.763 (0.003) |
| Moderate-impact chronic pain (high pain, low activity limitations) | $496.30 ($56.48) | $47.55 ($9.61) | 0.704 (0.006) |
| High-impact chronic pain (substantial activity limitations) | $689.91 ($54.38) | $288.93 ($51.88) | 0.610 (0.007) |

aEstimated from 2003-2015 Medical Expenditures Panel Survey data. Societal perspective (includes healthcare costs paid by patients).

bPatient self-report absenteeism from the Hurwitz et al, 2002,3 study. Valued using the Bureau of Labor Statistics 2015 Employer Cost of Employee Compensation of $33.19 per hour.

cUtilities (SF-6D scores) from the Cassidy et al, 2005,4 study. These amounts are multiplied by 6/52 to generate the quality-adjusted life-years (QALYs) added for each 6-week period.

We only had two trials that lasted less than a year: one of yoga in the original model5 and one of acupuncture in the model update.6 We held those studies’ ending (6-month) values constant to one year based on what was seen in another yoga trial7 and another acupuncture trial8 with 12-month follow up duration.

One of the strengths of this model is that all transition probabilities – the probability of moving from one health state to another in each cycle – are calculated from the individual-level data gathered during the clinical effectiveness trials. Therefore, the actual use of each therapy, including its use by the control group, is that seen in each of these trials. Because these are effectiveness trials, there was minimal control over what patients actually did during the study year. Nevertheless, it is likely that their use of the therapy during the trial may differ from what would be seen in regular practice.

Finally, because these therapies are all used as adjuncts to usual care, we assumed that the generalizable effect of each intervention is its effectiveness over what would be seen with its version of usual care alone. That is, we assumed the incremental effectiveness of yoga added to one study’s version of usual care would be the same as its incremental effectiveness when added to a different version of usual care. This is an assumption that is regularly made in systematic reviews and meta-analyses.

**Section B: Treatment Costs**

The treatment (intervention) costs for each nonpharmacologic intervention and its usual care arm were captured from the information available in each study’s publications and valued at the costs shown in Table B.1. Table B.2 shows the information available regarding the resources used for each intervention and the resulting total treatment cost assumed for each arm. Note that all studies except the UK BEAM were US-based.

**Table B.1. Unit Costs Used to Calculate the Treatment Costs of Interventions for CLBP**

|  |  |  |
| --- | --- | --- |
| **Resources (Units)** | **Cost per Unit – 2015$\*** | **Source** |
| Acupuncturist (per visit) | $57.70 (23.98) | MEPS – mean (SD) after top/bottom 5% trim |
| Chiropractor (per visit) | $43.52 (23.44) | MEPS – mean (SD) after top/bottom 5% trim |
| General Practitioner (per visit) | $81.91 (60.37) | MEPS – mean (SD) after top/bottom 5% trim |
| Massage Therapist (per 1-hour visit) | $52.88 (20.57) | MEPS – mean (SD) after top/bottom 5% trim |
| Psychologist (per 1-hour visit) | $71.62 (34.70) | MEPS – mean (SD) after top/bottom 5% trim |
| Physical Therapy (per 1-hour visit) | $91.24 (54.44) | MEPS – mean (SD) after top/bottom 5% trim |
| Exercise Therapist (physiologist; per 1-hour visit) | $52.64 | Bureau of Labor Statistics ratio of physiologist to physical therapist wages applied to physical therapy estimate from MEPS |
| Yoga class (per session) | $33.58 | Based on average of costs used in three other studies: Aboagye et al (2015),9 Chuang et al (2012),10 and Saper et al (2017)11 |
| Book (21 pg The Back Book) | $2.15 | Actual cost from Saper et al (2017)11 |
| Book (168 pg The Back Pain Helpbook) | $18.37 | Actual cost from Saper et al (2017)11 |
| Book (368 pg Your Aching Back) | $21.54 | [www.amazon.com](http://www.amazon.com) |

MEPS = Medical Expenditure Panel Survey administered by Agency for Healthcare Research and Quality.

\*All costs adjusted as appropriate to 2015 US dollars using the Consumer Price Index for medical care.

**Table B.2. The Intervention and Usual Care Arms Included in the Model, the Description Contained in Each Study Regarding the Resources Used in Each, and the Resulting Treatment Costs Used** (The new model update studies are shown in red.)

| **Intervention arms** | **First author of study** | **Treatment cost 2015$** | **Description of the intervention and the usual care (UC) arm used for each intervention** |
| --- | --- | --- | --- |
| Active Trunk Exercise | Cambron12 | $1,094.88 | "Treatment over four weeks, 2-4 times per week at discretion of provider" "administered by physical therapists" assumed 12 treatments on average per patient. Data collection: BL, 5 (not used), 13, 25 and 53 weeks. Study did not contain a UC arm. Two UCs with closest first 3-month data collection patterns: Usual care (Moore) and Usual care (Sherman). |
| CBT Educational Program | Moore13 | $98.28 | Intervention consisted of 1) two two-hour group sessions, with 12-16 participants (assumed avg of 14), led by one of two psychologists; then within 2 weeks each participant met individually with his or her leader for approximately 45 minutes; then Leaders made one brief (approximately 3 min) follow-up telephone call + 168 pg book + videos. 83% of participants attended individual sessions. Cost estimated as 4 hours of psychologist time/14 + .83\*psychologist time + cost of The Back Pain Helpbook. UC = Usual care (Moore) |
| Chiropractic Care | Hurwitz3 | $199.32 | No real difference in chiropractic arms in the study, so combined with and without physical modality arms. "[S]tudy protocol did not prescribe the type or amount of care that should be received by participating patients. Frequency of ... visits were at the discretion of the" provider. Study records showed an average of 4.58 visits per patient. Data collection: BL, 2, 6, 26, 52 and 78 weeks. UC = Medical care (Hurwitz) |
| Exercise | UK BEAM14 | $142.94 | "[A]n initial assessment [40 mins] and up to nine classes [up to 10 participants each] in community settings over 12 weeks." Taught by physical therapists. Data collection: BL, 1, 3 and 12 months. UC = General practice (UK BEAM) |
| Exercise + Manipulation | UK BEAM14 | $510.69 | Combination of exercise and manipulation arms; estimate that they used 7.45 chiro visits; assumed had both initial consultations/assessments. Data collection: BL, 1, 3 and 12 months. UC = General practice (UK BEAM) |
| Flexion Distraction | Cambron12 | $522.25 | "Treatment over four weeks, 2-4 times per week at discretion of provider" treatment by chiropractors - assumed 12 treatments on average. Data collection: BL, 5 (not used), 13, 25 and 53 weeks. Study did not contain a UC arm. Two UCs with closest first 3-month data collection patterns: Usual care (Moore) and Usual care (Sherman) |
| Individualized Acupuncture | Cherkin (2009)8 | $482.38 | "All acupuncture treatments ... occurred twice weekly for 3 weeks and then weekly for 4 weeks (10 treatments total)." Paper reports that 84% had at least 8 visits. Estimated average number of visits as 0.84\*(average of 8 and 10 visits)+(1-.84)\*5 visits = 8.36 visits. Data collection: BL, 8, 26 and 52 weeks. UC = Usual care (Cherkin 2009) |
| Manipulation | UK BEAM14 | $482.21 | After initial consultation (40 mins) participants invited "to attend up to eight 20 minute sessions, if necessary, over 12 weeks" but looks like they attended 10.08 sessions. Data collection: BL, 1, 3 and 12 months. UC = General practice (UK BEAM) |
| Multidisciplinary Program | Von Korff15 | $259.68 | An initial 90-min visit with a psychologist; The second 60-min visit, with a physical therapist; A third visit (30 min) with a physical therapist; a fourth visit (30 min) with the psychologist; Intervention patients received a book on back pain self-management (168 page Back Pain Helpbook) and a 40-min videotape; Among the 119 patients randomly assigned to the Intervention group, 98 (82.4%) completed at least four intervention sessions, while 12 patients (10.1%) did not attend any sessions. Data collection: BL and 2, 6, 12 and 24 months. UC = Usual care (Von Korff). |
| Physical Therapy | Hurwitz3 | $406.02 | Everyone who saw a physical therapist was included in this arm. "[S]tudy protocol did not prescribe the type or amount of care that should be received by participating patients. Frequency of ... visits were at the discretion of the" provider. Only included cost of physical therapist here. MD visits were similar to PT arm. Used 12 weeks as the treatment period. Study records showed an average of 4.45 visits per patient. Data collection: BL, 2, 6, 26, 52 and 78 weeks. UC = Medical care (Hurwitz) |
| Relaxation Massage | Cherkin (2011)16 | $461.18 | "Both massage protocols prescribed 10 weekly treatments, with first visits lasting 75 to 90 minutes and follow-up visits lasting 50 to 60 minutes." Paper reports 93% adherence with adherence defined as having at least 8 visits. Estimated average number of visits as 0.93\*(average of 8 and 10 visits)+(1-.93)\*5 visits = 8.72 visits. Data collection: BL and 10, 26 and 52 weeks. UC = Usual care (Cherkin 2011) |
| Spinal Manipulation | Haas17 | $522.25 | Subjects received 6, 12 or 18 sessions of spinal manipulation by a chiropractor. We combined the effects of these arms since their results were very similar (see graphs in Haas paper) and assumed that the same effect could be achieved with 12 visits. Data collection: BL, 6, 12, 18, 24, 39, and 52 weeks. Study did not contain a UC arm. Two UCs with closest first 3-month data collection patterns: Self-care education (Cherkin 2001) and Usual care (Cherkin 2009). |
| Standardized Acupuncture | Cherkin (2009)8 | $489.30 | "All acupuncture treatments ... occurred twice weekly for 3 weeks and then weekly for 4 weeks (10 treatments total)." Paper reports that 87% had at least 8 visits. Estimated average number of visits as 0.87\*(average of 8 and 10 visits)+(1-.87)\*5 visits = 8.48 visits. Data collection: BL, 8, 26 and 52 weeks. UC = Usual care (Cherkin 2009) |
| Structural Massage | Cherkin (2011)16 | $450.60 | "Both massage protocols prescribed 10 weekly treatments, with first visits lasting 75 to 90 minutes and follow-up visits lasting 50 to 60 minutes." Paper reports 88% adherence with adherence defined as having at least 8 visits. Estimated average number of visits as 0.88\*(average of 8 and 10 visits)+(1-.88)\*5 visits = 8.52 visits. Data collection: BL and 10, 26 and 52 weeks. UC = Usual care (Cherkin 2011) |
| TCM Acupuncture | Cherkin (2001)18 | $461.61 | "Up to 10 sessions over 10 weeks" - paper reports that they used an average of 8.0 visits. Data collection: BL and 4, 10 and 52 weeks. UC = Self-care education (Cherkin 2001) |
| Therapeutic Massage | Cherkin (2001)18 | $438.97 | "Up to 10 sessions over 10 weeks" - paper reports that they used an average of 8.3 visits. Data collection: BL and 4, 10 and 52 weeks. UC = Self-care education (Cherkin 2001) |
| Yoga | Sherman5 | $402.99 | "Series of 12 standardized, weekly 75-minute yoga classes." Data collection: BL, 12 and 26 weeks. UC = Usual care (Sherman) |
| Acupuncture (GERAC) | Haake6 | $721.26 | “[T]en 30-minute sessions, generally 2 sessions per week, plus possible 5 additional sessions.” Paper reports an average of 12.5 sessions. Data collection: BL, 6 weeks, 3 months, and 6 months. UC = Standard therapy (Haake) |
| Group CBT (UK) | Lamb19 | $73.36 | “[I]ndividual assessment (up to 1.5 h duration) and six sessions of group therapy (1.5 h duration each);” most with physiotherapists and some with psychologists + The Back Book; average group size was 8 participants. Data collection: BL, 3, 6, and 12 months. UC = Control (Lamb) |
| Group CBT (US) | Cherkin20 | $101.41 | “2 hours/week for 8 weeks;” average group size was 11.3 participants. Data collection: BL, 4, 8, 26, and 52 weeks. UC = Usual care (Cherkin 2016) |
| Mindfulness-based stress reduction (MBSR) | Cherkin20 | $98.48 | “2 hours/week for 8 weeks” + optional 6-hour retreat; used same ratio of MBSR instructor to psychologist cost as this study’s CEA;21 average group size was 11.6 participants. Data collection: BL, 4, 8, 26, and 52 weeks. UC = Usual care (Cherkin 2016) |
| Physical therapy (PT) | Saper11 | $681.60 | “[F]ifteen 60-minute appointments over 12 weeks” during treatment phase + up to 5 booster sessions for those randomized to maintenance. Paper reports a median of 7 sessions during treatment + 23.3% had a median of 2 booster sessions. Data collection: BL, 6, 12, 26, 40, and 52 weeks. UC = Education (Saper) |
| Yoga (US) | Saper11 | $509.56 | “12 weekly 75-minute classes” during treatment phase + weekly drop-in yoga classes for those randomized to maintenance. Paper reports a median of 7 sessions during treatment + 23.3% attended at least one drop-in class, median 13. Data collection: BL, 6, 12, 26, 40, and 52 weeks. UC = Education (Saper) |
| Yoga (UK) | Tilbrook7 | $405.14 | “[T]welve 75-minute classes (1 class per week)” + The Back Book. Data collection: BL, 3, 6, and 12 months. UC = Usual care (Tilbrook) |
| Usual care arms | | | |
| General practice (UK BEAM) | UK BEAM14 | $2.15 | “Best care” in general practice + The Back Book. Data collection: BL, 1, 3 and 12 months |
| Medical care (Hurwitz) | Hurwitz3 | $0.00 | Everyone who did not see a chiropractor or physical therapist was included in this arm. "[S]tudy protocol did not prescribe the type or amount of care that should be received by participating patients. Frequency of ... visits were at the discretion of the" provider. Data collection: BL, 2, 6, 26, 52 and 78 weeks. |
| Self-care education (Cherkin 2001) | Cherkin (2001)18 | $2.15 | Self-care education consisted of The Back Book + 2 videotapes; assumed zero cost for videotapes because most are now available online. Data collection: BL and 4, 10 and 52 weeks. |
| Usual care (Cherkin 2009) | Cherkin (2009)8 | $0.00 | "Participants in the usual care group received no study-related care—just the care, if any, they and their physicians chose (mostly medications, primary care, and physical therapy visits)." Data collection: BL, 8, 26 and 52 weeks. |
| Usual care (Cherkin 2011) | Cherkin (2011)16 | $0.00 | No special care. Data collection: BL and 10, 26 and 52 weeks. |
| Usual care (Moore) | Moore13 | $21.54 | Received usual care supplemented by a popular book on back pain care, Augustus White's Your Aching Back 368 pages. Data collection: BL and 3, 6 and 12 months. |
| Usual care (Sherman) | Sherman5 | $18.37 | Usual care + Back Pain Helpbook. Data collection: BL, 12 and 26 weeks. |
| Usual care (Von Korff) | Von Korff15 | $0.00 | Just usual care. Data collection: BL and 2, 6, 12 and 24 months. |
| Standard therapy\* | Haake6 | $775.10 | “10 sessions with personal contact with a physician or physiotherapist who administered physiotherapy, exercise, and such;” “guideline-based conventional therapy;” The therapies given in the conventional  group were physiotherapy (n=197; mean, 11.7 sessions  per patient), massage (n=180; mean, 9.5 sessions  per patient), heat therapy (n=157; mean, 9.7 sessions per  patient), electrotherapy (n=65; mean, 8.8 sessions per  patient), back school (ie, a practical education in the management of back pain) (n=36; mean, 8.1 sessions per patient), injections (n=48; mean, 5.6 per patient), and guidance (n=56; mean, 4.2 sessions per patient).” Paper reports an average of 10.5 sessions.” Data collection: BL, 6 weeks, 3 months, and 6 months. |
| Control | Lamb19 | $2.15 | Usual care + The Back Book. Data collection: BL, 3, 6, and 12 months. |
| Education | Saper11 | $18.37 | Usual care + The Back Pain Helpbook. Data collection: BL, 6, 12, 26, 40, and 52 weeks. |
| Usual care | Cherkin20 | $0.00 | Just usual care. Data collection: BL, 4, 8, 26, and 52 weeks. |
| Usual care | Tilbrook7 | $2.15 | Usual care + The Back Book. Data collection: BL, 3, 6, and 12 months. |

BL = Baseline; CBT = Cognitive behavioral therapy; GERAC = German Acupuncture Trials; MBSR = Mindfulness based stress reduction; PT = Physical therapy in the Saper et al11 study; TCM = Traditional Chinese acupuncture; UC = Usual care; UK = Trial of similar intervention in the United Kingdom; US = Trial of a similar intervention in the United States.

\*The Haake paper provided this detail on the therapies received by the Standard therapy group but did not indicate whether the acupuncture groups also received some of these therapies. For all other studies, all patients were said/assumed to have access to some form of usual care; thus, the incremental cost of usual care was zero or near zero. Our analyses here assume that no one in the acupuncture group received any of the therapies listed here for the Standard therapy group, which results in a cost advantage for the acupuncture group. This Standard therapy estimate would be reduced by the amount that represents what both groups received.

**Section C: Choice of Usual Care for Studies Without a Usual Care Arm**

Eight of the trials entered into the original model and all five of the trials included in this update had usual care arms. These arms and the QALYs the model calculated for each are shown in Table C.1. This table also shows the data collection schedule for each study.

**Table C.1. Available Usual Care Arms from Studies for Chronic Low Back Pain** (The new model update studies are shown in red.)

|  |  |  |
| --- | --- | --- |
| **Study** | **QALYs** | **Data Collection Schedule** |
| Usual care (Cherkin 201116) | 0.716888 | Baseline, 10, 26 and 52 weeks |
| Medical care (Hurwitz3) | 0.723844 | Baseline, 2, 6, 26, 52 and 78 weeks |
| Usual care (Von Korff15) | 0.726150 | Baseline, 2, 6, 12 and 24 months |
| Usual care (Cherkin 20098) | 0.732841 | Baseline, 8, 26 and 52 weeks |
| General practice (UK BEAM14) | 0.734545 | Baseline, 1, 3 and 12 months |
| Usual care (Sherman5) | 0.740823 | Baseline, 12 and 26 weeks |
| Usual care (Cherkin 200118) | 0.743993 | Baseline, 4, 10 and 52 weeks |
| Usual care (Moore13) | 0.750154 | Baseline, 3, 6 and 12 months |
| Education (Saper11) | 0.714204 | Baseline, 6, 12, 26, 40, and 52 weeks |
| Standard therapy (Haake6) | 0.725210 | Baseline, 6 weeks, 3, and 6 months |
| Usual care (Cherkin 201620) | 0.727470 | Baseline, 4, 8, 26, and 52 weeks |
| Control (Lamb19) | 0.732180 | Baseline, 3, 6 and 12 months |
| Usual care (Tilbrook7) | 0.739944 | Baseline, 3, 6 and 12 months |

The two studies without usual care arms in the original version of the model and their data collection schedules are:

* Cambron12 (Active Trunk Exercise and Flexion-Distraction) – Baseline, 13, 25 and 53 weeks
* Haas17 (Spinal Manipulation) – Baseline, 6, 12, 18, 24, 39, and 52 weeks

We assigned usual care arms to these studies following two criteria: 1) that the usual care arm was from the same country; and 2) that the data collection schedules roughly matched, especially in the first 3 months where most changes in symptoms usually occur. Both studies in need of usual care arms and all usual care arms other than General practice (UK BEAM), Standard therapy (Haake), Control (Lamb), and Usual care (Tilbrook) were from the US. The data collection schedule for the Cambron study did collect some data at 6 weeks, but the range of variables collected was insufficient for health state estimation. Therefore, the first data point past baseline for the Cambron study was at 13 weeks. The Sherman and Moore studies had similar data collection schedules and their usual care arms were used for the Cambron study. No other study in the original model had (usable) data collection at 6 weeks, so we used the Cherkin 2001 (4 weeks) and the Cherkin 2009 (8 weeks) as two potential usual care arms for the Haas study.

**Section D: Baseline Mix of Patients by Health State for Each Study**

This table shows that the baseline mix of patients in terms of health state (chronic pain impact level) varied widely across both the studies included in the original model and those added. Due to successful randomization, the baseline mix for each arm generally followed what was seen for the whole sample. However, some variation there could affect the outcomes reported in the study publications and be one reason why the model (balanced) results are different.

**Table D.1. Number (%) Participants Reported or Estimated to be in Each Chronic Pain Impact Level at Baseline for Each Dataset** (The new model update studies are shown in red.)

|  |  |  |  |
| --- | --- | --- | --- |
| Dataset | Low Impact Chronic Pain | Moderate Impact Chronic Pain | High Impact Chronic Pain |
| Datasets that contained direct measurement of chronic pain impact level | | | |
| Cassidy et al, 2005 | 530 (66.9%) | 136 (17.2%) | 126 (15.9%) |
| Haas et al, 2014 | 105 (26.3%) | 46 (11.5%) | 249 (62.2%) |
| Mehling et al, 20121 | 176 (69.0%) | 39 (15.3%) | 40 (15.7%) |
| Moore et al, 2000 | 55 (24.3%) | 43 (19.0%) | 128 (56.6%) |
| UK BEAM, 2004 | 170 (22.7%) | 295 (39.5%) | 282 (37.8%) |
| Von Korff et al, 2005 | 47 (19.8%) | 48 (20.2%) | 144 (60.1%) |
| Haake et al, 2007 | 61 (5.7%) | 341 (32.1%) | 660 (62.1%) |
| Lamb et al, 2010 | 182 (28.9%) | 279 (44.3%) | 169 (26.8%) |
| Datasets in which chronic pain impact level was imputed | | | |
| Cambron et al, 2006 | 125 (53.1%) | 73 (31.0%) | 37 (15.9%) |
| Cherkin et al, 2001 | 33 (12.5%) | 109 (41.6%) | 120 (45.9%) |
| Cherkin et al, 2009888 | 209 (32.7%) | 279 (43.8%) | 150 (23.5%) |
| Cherkin et al, 2011 | 114 (28.5%) | 176 (43.8%) | 111 (27.7%) |
| Hurwitz et al, 2002 | 121 (17.8%) | 309 (45.4%) | 251 (36.8%) |
| Sherman et al, 2005 | 20 (19.7%) | 66 (65.2%) | 15 (15.2%) |
| Cherkin et al, 2016 | 34 (10.0% | 198 (58.4%) | 107 (31.6%) |
| Saper et al, 2017 | 9 (2.8%) | 87 (27.3%) | 223 (69.9%) |
| Tilbrook et al, 2011 | 139 (50.7%) | 73 (26.6%) | 62 (22.6%) |

1The Mehling et al, 2012, dataset only measured chronic pain impact levels at 2 years.

**Section E: Model Results: Point Estimates and Confidence Intervals from the Societal and Payer Perspectives Assuming a Typical Mix of Patients at Baseline and Assuming All Patients Have High-Impact Chronic Pain at Baseline**

**Table E.1. One-Year Model Results for Each Nonpharmacologic Therapy Compared to Usual Care from the Societal and Payer Perspectives and Assuming a ‘Typical’\* Mix of Chronic Low Back Pain Patients at Baseline** (The new model update studies are shown in red.)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Treatment Costs | Other Healthcare Costs (Societal)† | Produc-tivity Costs‡ | Total Costs (Societal) | Total Costs (Payer)§ | QALYs |
| Active Trunk Exercise (1) | $1077 | -$898 | -$419 | -$241 (-1,060, 934) | $188 (-433, 993) | 0.033 (0.00, 0.06) |
| Active Trunk Exercise (2) | $1073 | -$536 | -$364 | $173 (-460, 1,042) | $530 (103, 1,073) | 0.024 (0.00, 0.04) |
| CBT Educational Program | $77 | -$286 | -$101 | -$310 (-1,040, 517) | -$197 (-692, 341) | 0.010 (-0.01, 0.03) |
| Chiropractic Care | $199 | -$252 | -$88 | -$142 (-1,655, 1,362) | -$40 (-1,012, 935) | 0.008 (-0.03, 0.04) |
| Exercise | $141 | -$284 | -$211 | -$354 (-696, 46) | -$146 (-369, 96) | 0.013 (0.00, 0.02) |
| Exercise + Manipulation | $509 | -$410 | -$235 | -$136 (-459, 257) | $117 (-84, 376) | 0.016 (0.01, 0.03) |
| Flexion Distraction (1) | $504 | -$906 | -$416 | -$818 (-1,557, 292) | -$389 (-929, 289) | 0.033 (0.01, 0.05) |
| Flexion Distraction (2) | $501 | -$544 | -$360 | -$403 (-941, 230) | -$47 (-415, 358) | 0.024 (0.01, 0.04) |
| Individualized Acupuncture | $480 | -$717 | -$355 | -$592 (-1,430, 367) | -$202 (-708, 496) | 0.025 (0.00, 0.05) |
| Manipulation | $480 | -$362 | -$225 | -$106 (-429, 282) | $120 (-100, 357) | 0.015 (0.01, 0.02) |
| Multidisciplinary Program | $260 | -$449 | -$181 | -$369 (-1,168, 563) | -$172 (-699, 450) | 0.015 (-0.01, 0.04) |
| Physical Therapy | $406 | -$439 | -$190 | -$223 (-1,777, 1,658) | -$13 (-1,108, 1,130) | 0.015 (-0.03, 0.05) |
| Relaxation Massage | $459 | -$592 | -$359 | -$491 (-1195, 431) | -$116 (-566, 529) | 0.023 (0.00, 0.04) |
| Spinal Manipulation (3) | $520 | -$13 | $6 | $513 (91, 888) | $457 (190, 726) | 0.004 (-0.01, 0.02) |
| Spinal Manipulation (4) | $520 | -$472 | -$85 | -$37 (-774, 689) | $47 (-382, 514) | 0.016 (0.00, 0.03) |
| Standardized Acupuncture | $487 | -$637 | -$252 | -$402 (-1,208, 447) | -$117 (-614, 481) | 0.021 (0.00, 0.04) |
| Structural Massage | $448 | -$406 | -$286 | -$244 (-978, 722) | $54 (-447, 658) | 0.017 (-0.01, 0.04) |
| TCM Acupuncture | $459 | -$139 | -$19 | $302 (-304, 875) | $328 (-83, 691) | 0.004 (-0.01, 0.02) |
| Therapeutic Massage | $437 | -$376 | -$258 | -$197 (-649, 296) | $69 (-202, 393) | 0.015 (0.00, 0.03) |
| Yoga | $385 | -$1626 | -$531 | -$1,773 (-2,730, -372) | -$1,136 (-1,784, -151) | 0.048 (0.02, 0.07) |
| Acupuncture (GERAC) | -$54 | -$851 | -$390 | -$1295 (-2191, -58) | -$877 (-1425, -28) | 0.029 (0.00, 0.05) |
| Group CBT (UK) | $71 | -$355 | -$142 | -$426 (-1296, 534) | -$268 (-858, 410) | 0.012 (-0.01, 0.04) |
| Group CBT (US) | $101 | -$164 | -$102 | -$165 (-1471, 1440) | -$67 (-997, 826) | 0.007 (-0.03, 0.04) |
| MBSR | $98 | -$149 | -$129 | -$180 (-1616, 1192) | -$52 (-917, 925) | 0.007 (-0.03, 0.04) |
| PT | $663 | -$501 | -$64 | $98 (-1351, 1504) | $196 (-623, 1180) | 0.012 (-0.02, 0.05) |
| Yoga (UK) | $403 | -$475 | -$154 | -$226 (-1722, 1359) | -$47 (-963, 972) | 0.015 (-0.02, 0.05) |
| Yoga (US) | $659 | -$542 | -$231 | -$114 (-1463, 1443) | $138 (-688, 1022) | 0.018 (-0.02, 0.06) |

CBT = Cognitive behavioral therapy; GERAC = German Acupuncture Trials; MBSR = Mindfulness based stress reduction; PT = Physical therapy in the Saper et al11 study; QALY = Quality-adjusted Life-Year; TCM = Traditional Chinese acupuncture; UK = Trial of similar intervention in the United Kingdom; US = Trial of a similar intervention in the United States.

\*Typical mix of chronic low-back pain patients was assumed to be 25% low-impact chronic pain, 35% moderate-impact chronic pain, and 40% high-impact chronic pain. The proportions roughly correspond to the average baseline proportions seen in the studies included in the model.

†Other Healthcare Costs (Societal) are the differences between the treatment and usual care arms in terms of the cost of all back-related healthcare used other than the cost of the intervention itself. These are healthcare costs from the societal perspective since they include both what is reimbursed by a payer (health insurer) and what the patient or their family pays out-of-pocket (e.g., copays). These costs by health state are shown up in Table A.1 and were estimated using the Medical Expenditures Panel Survey as described in Herman et al, *Spine*. 2019;44(16):1154-1161.

‡Productivity Costs are the differences between the treatment and usual care arms in terms of the cost to employers of lost productivity due to absenteeism. These costs are included in the societal perspective and were estimated based on the number of absentee days per patient per health state from a large study of chronic low back pain patients as described in Herman et al, *The Spine Journal.* 2019;19(8), 1369-1377. Absentee days were valued using the Bureau of Labor Statistics 2015 Employer Cost of Employee Compensation of $33.19 per hour and the productivity costs by health state are shown up in Table A.1.

§The payer perspective used an estimate of other healthcare costs that excluded patient out-of-pocket payments and assumed that the payer covered all treatment costs. Note that the assumption of full coverage for treatment costs is in contrast with current payer policies (see Heyward et al, JAMA Network Open. 2018;1(6):e183044-e). Thus, these payer perspective costs are likely overstated.

Each intervention is compared to the usual care arm of their study with the exception of the two studies (three interventions) that did not include usual care arms. For these we assigned two of the other US-based usual care arms based on the closest matches in terms of data collection schedules. The usual care arms assigned for each are: (1) Usual care (Sherman); (2) Usual care (Moore); (3) Self-care education (Cherkin 2001); (4) Usual care (Cherkin 2009).

**Table E.2. One-Year Model Results for Each Nonpharmacologic Therapy Compared to Usual Care from the Societal and Payer Perspectives and Assuming That All Chronic Low Back Pain Patients Have High-Impact Chronic Pain at Baseline** (The new model update studies are shown in red.)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Treatment Costs | Other Healthcare Costs (Societal)\* | Produc-tivity Costs† | Total Costs (Societal) | Total Costs (Payer)‡ | QALYs |
| Active Trunk Exercise (1) | $1077 | -$1824 | -$915 | -$1662 (-2,977, 1,293) | -$707 (-1,499, 1,106) | 0.067 (-0.00, 0.11) |
| Active Trunk Exercise (2) | $1073 | -$655 | -$457 | -$39 (-1,241, 1,719) | $413 (-339, 1,446) | 0.029 (-0.01, 0.06) |
| CBT Educational Program | $77 | -$257 | -$89 | -$269 (-1,731, 1,434) | -$167 (-1,046, 488) | 0.008 (-0.04, 0.05) |
| Chiropractic Care | $199 | -$537 | -$263 | -$601 (-3,275, 2,420) | -$318 (-1,510, 1,411) | 0.019 (-0.06, 0.09) |
| Exercise | $141 | -$170 | -$208 | -$238 (-928, 505) | -$40 (-707, -5) | 0.010 (-0.01, 0.03) |
| Exercise + Manipulation | $520 | -$472 | -$354 | -$307 (-884, 419) | $54 (-456, 281) | 0.020 (0.00, 0.04) |
| Flexion Distraction (1) | $504 | -$1939 | -$980 | -$2,415 (-3,425, 341) | -$1,386 (-2,063, 389) | 0.072 (0.00, 0.10) |
| Flexion Distraction (2) | $501 | -$770 | -$522 | -$791 (-1,822, 359) | -$266 (-901, 466) | 0.033 (0.01, 0.06) |
| Individualized Acupuncture | $480 | -$1100 | -$651 | -$1,271 (-2,646, 439) | -$577 (-1,400, 380) | 0.042 (0.00, 0.08) |
| Manipulation | $480 | -$395 | -$339 | -$255 (-878, 430) | $83 (-492, 231) | 0.019 (0.00, 0.04) |
| Multidisciplinary Program | $260 | -$360 | -$145 | -$245 (-1,760, 1,237) | -$86 (-1,193, 653) | 0.012 (-0.02, 0.05) |
| Physical Therapy | $406 | -$979 | -$466 | -$1,039 (-4,351, 2,588) | -$525 (-1,849, 1,607) | 0.033 (-0.06, 0.18) |
| Relaxation Massage | $459 | -$722 | -$480 | -$744 (-1,938, 1,108) | -$250 (-1,218, 426) | 0.030 (-0.01, 0.06) |
| Spinal Manipulation (3) | $520 | -$451 | -$238 | -$168 (-1,174, 702) | $38 (-505, 634) | 0.021 (-0.00, 0.05) |
| Spinal Manipulation (4) | $520 | -$1172 | -$547 | -$1,199 (-2,269, 86) | -$630 (-966, 603) | 0.044 (0.01, 0.07) |
| Standardized Acupuncture | $487 | -$952 | -$450 | -$915 (-2,426, 873) | -$419 (-1,121, 611) | 0.033 (-0.01, 0.07) |
| Structural Massage | $448 | -$534 | -$422 | -$508 (-1,764, 1,166) | -$76 (-1,116, 702) | 0.024 (-0.02, 0.06) |
| TCM Acupuncture | $459 | $63 | $65 | $587 (-924, 1,823) | $517 (-268, 888) | -0.002 (-0.03, 0.03) |
| Therapeutic Massage | $437 | -$756 | -$468 | -$787 (-1,734, 296) | -$293 (-193, 381) | 0.029 (0.00, 0.06) |
| Yoga | $385 | -$2717 | -$1086 | -$3,419 (-4,930, -71) | -$2,174 (-2,370, -145) | 0.087 (0.01, 0.13) |
| Acupuncture (GERAC) | -$54 | -$1024 | -$519 | -$1597 (-2205, 13) | -$993 (-1856, 29) | 0.037 (0.00, 0.06) |
| Group CBT (UK) | $71 | -$508 | -$297 | -$734 (-2314, 684) | -$418 (-1299, 416) | 0.019 (-0.02, 0.06) |
| Group CBT (US) | $101 | -$200 | -$129 | -$227 (-2207, 1991) | -$100 (-1192, 1054) | 0.008 (-0.05, 0.06) |
| MBSR | $98 | -$327 | -$268 | -$497 (-2363, 1280) | -$222 (-1275, 782) | 0.015 (-0.03, 0.06) |
| PT | $663 | -$579 | -$177 | -$93 (-1748, 1546) | $118 (-799, 1104) | 0.017 (-0.02, 0.06) |
| Yoga (UK) | $403 | -$532 | -$180 | -$309 (-2431, 2096) | -$104 (-1483, 1422) | 0.018 (-0.04, 0.07) |
| Yoga (US) | $659 | -$480 | -$240 | -$60 (-1694, 1623) | $197 (-652, 1158) | 0.017 (-0.03, 0.06) |
|  |  |  |  |  |  |  |

CBT = Cognitive behavioral therapy; GERAC = German Acupuncture Trials; MBSR = Mindfulness based stress reduction; PT = Physical therapy in the Saper et al11 study; QALY = Quality-adjusted Life-Year; TCM = Traditional Chinese acupuncture; UK = Trial of similar intervention in the United Kingdom; US = Trial of a similar intervention in the United States.

\*Other Healthcare Costs (Societal) are the differences between the treatment and usual care arms in terms of the cost of all back-related healthcare used other than the cost of the intervention itself. These are healthcare costs from the societal perspective since they include both what is reimbursed by a payer (health insurer) and what the patient or their family pays out-of-pocket (e.g., copays). These costs by health state are shown up in Table A.1 and were estimated using the Medical Expenditures Panel Survey as described in Herman et al, *Spine*. 2019;44(16):1154-1161.

†Productivity Costs are the differences between the treatment and usual care arms in terms of the cost to employers of lost productivity due to absenteeism. These costs are included in the societal perspective and were estimated based on the number of absentee days per patient per health state from a large study of chronic low back pain patients as described in Herman et al, *The Spine Journal.* 2019;19(8), 1369-1377. Absentee days were valued using the Bureau of Labor Statistics 2015 Employer Cost of Employee Compensation of $33.19 per hour and the productivity costs by health state are shown up in Table A.1.

‡The payer perspective used an estimate of other healthcare costs that excluded patient out-of-pocket payments and assumed that the payer covered all treatment costs. Note that the assumption of full coverage for treatment costs is in contrast with current payer policies (see Heyward et al, JAMA Network Open. 2018;1(6):e183044-e). Thus, these payer perspective costs are likely overstated.

Each intervention is compared to the usual care arm of their study with the exception of the two studies (three interventions) that did not include usual care arms. For these we assigned two of the other US-based usual care arms based on the closest matches in terms of data collection schedules. The usual care arms assigned for each are: (1) Usual care (Sherman); (2) Usual care (Moore); (3) Self-care education (Cherkin 2001); (4) Usual care (Cherkin 2009).

**Section F: External Consistency**

We performed two tests of external consistency. For the studies that contained more than one treatment arm we examined whether the model resulted in a similar ranking of effect sizes (Table F.1). In our second test across studies, we compared crude difference-in-differences between published unadjusted baseline and 12-month measures of function for each intervention and its usual care to the incremental change in QALYs estimated by the model (Table F.2 and Figure F.1). We would not expect complete consistency between crude function-based difference-in-differences and QALYs for a number of reasons: 1) the model balanced baseline patient mixes across studies; 2) QALYs are not entirely determined by function; and 3) whereas, the difference-in-difference calculations only look at linear changes between baseline and 12 months, the model accumulates QALYs every 6 weeks resulting in more gain when improvements occur more quickly even if the end point is the same. Nevertheless, the model’s ranking of within-study effectiveness across arms was generally consistent with that seen in the published studies and we also saw a consistent relationship between difference-in-difference estimates of function and incremental QALYs.

**Table F.1. Comparison of Model Results to the Relationships Shown Over One Year in the Published Studies for All Studies with At Least Two Treatment Arms** (The new model update studies are shown in red.)

|  |  |  |
| --- | --- | --- |
| **First author of the study** | **Relative effectiveness from papers** | **Comp-ared to model** |
| Cambron12 | Effect (RMDQ): Flexion distraction~Active trunk exercise | Same |
| Cherkin 200118 | Effect (RMDQ): Massage>TCM Acupuncture~Self-care | Same |
| Cherkin 20098 | Effect (RMDQ): Individualized~Standardized>Usual care | Same |
| Cherkin 201116 | Effect (RMDQ): Relaxation massage>Structural massage>Usual care | Same |
| Hurwitz3 | Effect (RMDQ): Physical therapy>Chiropractic care~Medical care | Same |
| UK BEAM14 | Effect (MVKD): Manipulation+exercise>Manipulation>Exercise>GP care  Effect (EQ-5D): Manipulation+exercise>Exercise>Manipulation>GP care | Same  Partial |
| Cherkin 201620 | Effect (RMDQ): CBT~MBSR>Usual care | Same |
| Saper11 | Effect (RMDQ): Yoga~Physical therapy>Usual care | Partial |

CBT = Cognitive based therapy; MBSR = Mindfulness based stress reduction; MVKD = Modified Von Korff Disability score; QALY = Quality-adjusted life-years; RMDQ = Roland-Morris Disability Questionnaire; TCM = Traditional Chinese Medicine

**Table F.2. Comparison of Published Study results to Model Results** (The new model update studies are shown in red.)

|  | **Unadjusted results reported in published studies** | | | | | | **Model Results** | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Pain Scores\*** | | **RMDQ** | | **Change in RMDQ** | **Diff-in-Diff\*\*** | **QALYs** | **Incre-mental QALYs** |
|  | **Baseline** | **12-month** | **Baseline** | **12-month** |
| Flexion Distraction (1) | 3.8 | 2.1 | 6.6 | 2.9 | 3.7 | 2.3 | 0.7739 | 0.0331 |
| Usual care (Sherman) | 5.4 | 4.0 | 8.0 | 6.6 | 1.4 |  | 0.7408 |  |
| Active Trunk Exercise (1) | 3.6 | 2.2 | 6.8 | 3.2 | 3.6 | 2.2 | 0.7738 | 0.0330 |
| Usual care (Sherman) | 5.4 | 4.0 | 8.0 | 6.6 | 1.4 |  | 0.7408 |  |
| Flexion Distraction (2) | 3.8 | 2.1 | 6.6 | 2.9 | 3.7 | 1.0 | 0.7739 | 0.0238 |
| Usual care (Moore) | 5.2 | 3.0 | 8.3 | 5.6 | 2.7 |  | 0.7502 |  |
| Active Trunk Exercise (2) | 3.6 | 2.2 | 6.8 | 3.2 | 3.6 | 0.9 | 0.7739 | 0.0238 |
| Usual care (Moore) | 5.2 | 3.0 | 8.3 | 5.6 | 2.7 |  | 0.7502 |  |
| TCM Acupuncture | 6.2 | 4.5 | 12.8 | 8.0 | 4.8 | -0.8 | 0.7483 | 0.0043 |
| Self-care education (Cherkin 2001) | 6.1 | 3.8 | 12.0 | 6.4 | 5.6 |  | 0.7440 |  |
| Therapeutic Massage | 6.2 | 3.2 | 11.8 | 6.8 | 5.0 | -0.6 | 0.7594 | 0.0154 |
| Self-care education (Cherkin 2001) | 6.1 | 3.8 | 12.0 | 6.4 | 5.6 |  | 0.7440 |  |
| Individualized Acupuncture | 5.0 | 3.7 | 10.8 | 6.0 | 4.8 | 1.7 | 0.7582 | 0.0253 |
| Usual care (Cherkin 2009) | 5.4 | 4.1 | 11.0 | 7.9 | 3.1 |  | 0.7328 |  |
| Standardized Acupuncture | 5.0 | 3.5 | 10.8 | 6.0 | 4.8 | 1.7 | 0.7538 | 0.0209 |
| Usual care (Cherkin 2009) | 5.4 | 4.1 | 11.0 | 7.9 | 3.1 |  | 0.7328 |  |
| Structural Massage | 5.6 | 4.6 | 10.1 | 7.2 | 2.9 | -0.2 | 0.7343 | 0.0174 |
| Usual care (Cherkin 2011) | 5.8 | 4.2 | 10.5 | 7.4 | 3.1 |  | 0.7169 |  |
| Relaxation Massage | 5.6 | 3.9 | 11.6 | 6.0 | 5.6 | 2.5 | 0.7403 | 0.0234 |
| Usual care (Cherkin 2011) | 5.8 | 4.2 | 10.5 | 7.4 | 3.1 |  | 0.7169 |  |
| Spinal Manipulation (3)† | 5.1-5.2 | 2.9-3.2 | 8.7 | 3.6 | 5.1 | -0.5 | 0.7483 | 0.0044 |
| Self-care education (Cherkin 2001) | 6.1 | 3.8 | 12.0 | 6.4 | 5.6 |  | 0.7440 |  |
| Spinal Manipulation (4)† | 5.1-5.2 | 2.9-3.2 | 8.7 | 3.6 | 5.1 | 2.0 | 0.7483 | 0.0155 |
| Usual care (Cherkin 2009) | 5.4 | 4.1 | 11.0 | 7.9 | 3.1 |  | 0.7328 |  |
| Chiropractic Care | 4.5-4.7 | 1.5-2.1 | 10.3-11.3 | 3.6-3.4 | 7.3 | 1.0 | 0.7315 | 0.0076 |
| Medical care (Hurwitz) | 4.4 | 2.4 | 10.5 | 4.2 | 6.3 |  | 0.7238 |  |
| Physical Therapy | 4.9 | 1.9 | 11.7 | 3.2 | 8.5 | 2.2 | 0.7386 | 0.0148 |
| Medical care (Hurwitz) | 4.4 | 2.4 | 10.5 | 4.2 | 6.3 |  | 0.7238 |  |
| CBT Educational Program | 5.4 | 2.7 | 8.6 | 4.8 | 3.7 | 1.0 | 0.7597 | 0.0095 |
| Usual care (Moore) | 5.2 | 3.0 | 8.3 | 5.6 | 2.7 |  | 0.7502 |  |
| Yoga‡ | 5.4 | 1.8 | 8.1 | 3.1 | 5.0 | 3.6 | 0.7893 | 0.0485 |
| Usual care (Sherman) | 5.4 | 4.0 | 8.0 | 6.6 | 1.4 |  | 0.7408 |  |
| Exercise | 6.1 | 4.2 | 9.2 | 5.7 | 3.5 | 0.6 | 0.7472 | 0.0126 |
| General practice (UK BEAM) | 6.1 | 4.8 | 9.0 | 6.1 | 2.9 |  | 0.7345 |  |
| Manipulation | 6.1-6.2 | 4.2 | 8.9-8.9 | 5.2 | 3.8 | 0.9 | 0.7498 | 0.0152 |
| General practice (UK BEAM) | 6.1 | 4.8 | 9.0 | 6.1 | 2.9 |  | 0.7345 |  |
| Exercise + Manipulation | 6.0-6.1 | 4.0 | 8.9-9.1 | 4.7 | 4.3 | 1.4 | 0.7505 | 0.0160 |
| General practice (UK BEAM) | 6.1 | 4.8 | 9.0 | 6.1 | 2.9 |  | 0.7345 |  |
| Multidisciplinary Program | 5.7 | 4.0 | 12.3 | 8.4 | 3.9 | 1.6 | 0.7415 | 0.0154 |
| Usual care (Von Korff)) | 5.8 | 4.7 | 11.4 | 9.1 | 2.3 |  | 0.7261 |  |
| Group CBT (US) | 6.0 | 4.1 | 11.5 | 6.7 | 4.8 | 1.4 | 0.7342 | 0.0068 |
| MBSR | 6.1 | 4.3 | 11.8 | 6.5 | 5.3 | 1.9 | 0.7345 | 0.0071 |
| Usual care (Cherkin 2016) | 6.0 | 4.9 | 10.9 | 7.5 | 3.4 |  | 0.7275 |  |
| Acupuncture (GERAC)‡ | 6.8 | 4.0 | 12.9 | 8.0 | 4.9 | 2.8 | 0.7547 | 0.0295 |
| Standard therapy (Haake) | 6.8 | 5.2 | 12.8 | 10.6 | 2.2 |  | 0.7252 |  |
| Group CBT (UK) | 5.9 | 5.1 | 9.0 | 6.6 | 2.4 | 1.3 | 0.7439 | 0.0117 |
| Control (Lamb) | 5.9 | 5.5 | 9.0 | 7.9 | 1.1 |  | 0.7322 |  |
| Yoga (US) | 7.1 | 4.4 | 14.8 | 9.0 | 5.8 | 2.0 | 0.7326 | 0.0183 |
| PT | 7.2 | 4.1 | 14.8 | 9.0 | 5.8 | 2.0 | 0.7264 | 0.0122 |
| Education (Saper) | 7.0 | 5.2 | 14.8 | 11.0 | 3.8 |  | 0.7142 |  |
| Yoga (UK)§ |  |  | 7.8 | 5.8 | 2.0 | 1.6 | 0.7549 | 0.0150 |
| Usual care (Tilbrook) |  |  | 7.8 | 7.3 | 0.5 |  | 0.7399 |  |

CBT = Cognitive behavioral therapy; GERAC = German Acupuncture Trials; MBSR = Mindfulness based stress reduction; PT = Physical therapy in the Saper et al11 study; QALY = Quality-adjusted Life-Year; RMDQ = Roland-Morris Disability Questionnaire score; TCM = Traditional Chinese acupuncture; UK = Trial of similar intervention in the United Kingdom; US = Trial of a similar intervention in the United States.

Two studies (the ones followed by numbers in parentheses) did not have usual care arms. Those interventions were each assigned two usual care options based on similar timing of data collection in the intervention and usual care studies. The numbers in parentheses help indicate in graphs the usual care arm used.

\*Pain scores that were reported on a 0-100 scale were divided by 10.

\*\*Difference in RMDQ between baseline and 12-months between the intervention and usual care arms. When the study gave a range of RMDQ values for an intervention (e.g., the UK BEAM study reported baseline values for the group who received the intervention in a National Health Service clinic versus a private clinic), we used an average in our calculations.

†The Haas et al study17 did not measure function/disability using the RMDQ. We adjusted the modified Von Korff disability scores they reported with the ratios of the RMDQ to the modified Von Korff disability scores for the manipulation arm of the UK BEAM study14 at baseline and 12 months.

‡These studies (Sherman and Haake) only went out 6 months and their 6-month values were reported for their 12-month values since in each case outcomes were assumed constant from 6 to 12 months. Also, the Haake study used the Hanover Functional Ability Questionnaire (HFAQ) where higher values indicate better outcomes. For this table we estimated the 0-24 RMDQ from the 0-100 HFAQ using this formula: RMDQ = (100-HFAQ)/100\*24.

§The Tilbrook study used the Aberdeen Pain Scale which does not translate well into a 0-10 pain intensity scale. When estimating health states for this dataset, we first predicted what individuals’ pain scores would be using the SF-12 and SF-12 and pain VAS data from another dataset.



**Figure F.1. Relationship Between Model-Calculated Incremental QALYs and Published Unadjusted Baseline to 12-Month Difference-In-Difference Measures of Function Between Interventions and Usual Care**

CBT = Cognitive behavioral therapy; GERAC = German Acupuncture Trials; MBSR = Mindfulness based stress reduction; PT = Physical therapy in the Saper et al11 study; TCM = Traditional Chinese acupuncture; UK = Trial of similar intervention in the United Kingdom; US = Trial of a similar intervention in the United States.

The interventions represented by the diamond shapes are from the new studies added to the model in this update. Each intervention represented by a solid circle is from the original model and is compared to the usual care arm of its study. The three interventions identified with open circles are from the original model and came from two studies that did not include usual care arms. For these we assigned two US-based usual care arms from other studies. The usual care arms assigned for each are: (1) Usual care (Sherman);5 (2) Usual care (Moore);13 (3) Self-care education (Cherkin 2001);16 (4) Usual care (Cherkin 2009).8

The trendline shows the average relationship between the difference-in-difference estimates and incremental QALYs across all studies; R2 = 0.41.

**Section G: Acknowledgments**

We include here the acknowledgments made in the original article since without those this update would not be possible, and we have added a new set of acknowledgments for our update.

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**References**

1. Herman PM, Broten N, Lavelle TA, Sorbero ME, Coulter ID. Exploring the Prevalence and Characteristics of High-Impact Chronic Pain Across Chronic Low-Back Pain Study Samples. *Spine Journal.* 2019;19(8):1369-1377.

2. Komorowski M, Raffa J. Markov Models and Cost Effectiveness Analysis: Applications in Medical Research. In: MIT Critical Data, ed. *Secondary Analysis of Electronic Health Records*. Cambridge, MA: Springer, Cham; 2016:351-367

3. Hurwitz EL, Morgenstern H, Harber PM, et al. A randomized trial of medical care with and without physical therapy and chiropractic care with and without physical modalities for patients with low back pain: 6-month follow-up outcomes from the UCLA low back pain study. *Spine.* 2002;27(20):2193-2204.

4. Cassidy JD, Cote P, Carroll LJ, Kristman V. Incidence and course of low back pain episodes in the general population. *Spine.* 2005;30(24):2817-2823.

5. Sherman KJ, Cherkin DC, Erro J, Miglioretti DL, Deyo RA. Comparing yoga, exercise, and a self-care book for chronic low back pain: a randomized, controlled trial. *Ann Intern Med.* 2005;143(12):849-856.

6. Haake M, Müller H-H, Schade-Brittinger C, et al. German Acupuncture Trials (GERAC) for chronic low back pain: randomized, multicenter, blinded, parallel-group trial with 3 groups. *Arch Intern Med.* 2007;167(17):1892-1898.

7. Tilbrook HE, Cox H, Hewitt CE, et al. Yoga for chronic low back pain: a randomized trial. *Ann Intern Med.* 2011;155(9):569-578.

8. Cherkin DC, Sherman KJ, Avins AL, et al. A randomized trial comparing acupuncture, simulated acupuncture, and usual care for chronic low back pain. *Arch Intern Med.* 2009;169(9):858-866.

9. Aboagye E, Karlsson ML, Hagberg J, Jensen I. Cost-effectiveness of early interventions for non-specific low back pain: a randomized controlled study investigating medical yoga, exercise therapy and self-care advice. *J Rehabil Med.* 2015;47(2):167-173.

10. Chuang L-H, Soares MO, Tilbrook H, et al. A pragmatic multicentered randomized controlled trial of yoga for chronic low back pain: economic evaluation. *Spine.* 2012;37(18):1593-1601.

11. Saper RB, Lemaster C, Delitto A, et al. Yoga, physical therapy, or education for chronic low back pain: a randomized noninferiority trial. *Ann Intern Med.* 2017;167(2):85-94.

12. Cambron JA, Gudavalli MR, Hedeker D, et al. One-year follow-up of a randomized clinical trial comparing flexion distraction with an exercise program for chronic low-back pain. *J Altern Complement Med.* 2006;12(7):659-668.

13. Moore JE, Von Korff M, Cherkin D, Saunders K, Lorig K. A randomized trial of a cognitive-behavioral program for enhancing back pain self care in a primary care setting. *Pain.* 2000;88(2):145-153.

14. UK Beam Trial Team. United Kingdom back pain exercise and manipulation (UK BEAM) randomised trial: effectiveness of physical treatments for back pain in primary care. *BMJ.* 2004;329(7479):1377.

15. Von Korff M, Balderson BH, Saunders K, et al. A trial of an activating intervention for chronic back pain in primary care and physical therapy settings. *Pain.* 2005;113(3):323-330.

16. Cherkin DC, Sherman KJ, Kahn J, et al. A comparison of the effects of 2 types of massage and usual care on chronic low back pain: a randomized, controlled trial. *Ann Intern Med.* 2011;155(1):1-9.

17. Haas M, Vavrek D, Peterson D, Polissar N, Neradilek MB. Dose-response and efficacy of spinal manipulation for care of chronic low back pain: a randomized controlled trial. *Spine J.* 2014;14(7):1106-1116.

18. Cherkin DC, Eisenberg D, Sherman KJ, et al. Randomized trial comparing traditional Chinese medical acupuncture, therapeutic massage, and self-care education for chronic low back pain. *Arch Intern Med.* 2001;161(8):1081-1088.

19. Lamb SE, Hansen Z, Lall R, et al. Group cognitive behavioural treatment for low-back pain in primary care: a randomised controlled trial and cost-effectiveness analysis. *The Lancet.* 2010;375(9718):916-923.

20. Cherkin DC, Sherman KJ, Balderson BH, et al. Effect of mindfulness-based stress reduction vs cognitive behavioral therapy or usual care on back pain and functional limitations in adults with chronic low back pain: a randomized clinical trial. *JAMA.* 2016;315(12):1240-1249.

21. Herman PM, Anderson ML, Sherman KJ, Balderson BH, Turner JA, Cherkin DC. Cost-effectiveness of mindfulness-based stress reduction versus cognitive behavioral therapy or usual care among adults with chronic low back pain. *Spine.* 2017;42(20):1511-1520.