**Technical Appendix**

|  |  |
| --- | --- |
| **Sections and tables** | **Page** |
| Section A: Model Assumptions | 2 |
| Section B: Treatment Costs | 3 |
| Table B.1. Unit Costs Used to Calculate the Treatment Costs of Interventions for Chronic Low-Back Pain | 3 |
| 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 | 4 |
| Section C: Choice of Usual Care for Studies Without a Usual Care Arm | 8 |
| Table C.1. Available Usual Care Arms from Studies for Chronic Low Back Pain | 8 |
| Section D: Relative Effectiveness and Cost-Effectiveness Across All Interventions | 9 |
| Table D.1. Comparison of Cost-Effectiveness from the Societal Perspective for a Typical\* Patient Mix Across All Nonpharmacologic Interventions for Chronic Low Back Pain in the Markov Model | 9 |
| Section E: External Consistency Checks | 11 |
| Table E.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 | 11 |
| Table E.2. Comparison of Published Study results to Model Results | 12 |
| Figure E.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 | 14 |
| References | 15 |

**Section A: Model Assumptions**

A number of assumptions went into this model. Our model categorizes all patients into one of four health states and is based on a 6-week cycle. Therefore, two model assumptions are that all patients in each health state experience the same average costs and utility levels, and that patients’ costs and utility levels are constant for the 6-week period that makes 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 each cycle to all individuals in a health state were independent of how that individual reached that state. We only had one trial that lasted less than a year.2 We held that study’s ending (6-month) values constant to one year based on what was expected based on one yoga trial with longer follow up duration.3

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),4 Chuang et al (2012),5 and Saper et al (2017)6 |
| Book (21 pg The Back Book) | $2.15 | Actual cost from Saper et al (2017)6 |
| Book (168 pg The Back Pain Helpbook) | $18.37 | Actual cost from Saper et al (2017)6 |
| 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

| **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 | Cambron7 | $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 | Moore8 | $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 | Hurwitz9 | $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 BEAM10 | $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 BEAM10 |  $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 | Cambron7 | $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)11 | $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 BEAM10 | $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 Korff12 | $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 | Hurwitz9 | $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)13 | $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 | Haas14 | $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)11 | $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)13 | $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)15 | $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)15 | $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 | Sherman2 | $402.99 | "Series of 12 standardized, weekly 75-minute yoga classes." Data collection: BL, 12 and 26 weeks. UC = Usual care (Sherman) |
| Usual care arms |
| General practice (UK BEAM) | UK BEAM10 | $2.15 | “Best care” in general practice + The Back Book. Data collection: BL, 1, 3 and 12 months |
| Medical care (Hurwitz) | Hurwitz9 | $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)15 | $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)11 | $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)13 | $0.00 | No special care. Data collection: BL and 10, 26 and 52 weeks. |
| Usual care (Moore) | Moore8 | $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) | Sherman2 | $18.37 | Usual care + Back Pain Helpbook. Data collection: BL, 12 and 26 weeks. |
| Usual care (Von Korff) | Von Korff12 | $0.00 | Just usual care. Data collection: BL and 2, 6, 12 and 24 months. |

BL = Baseline; CBT = Cognitive behavioral therapy; TCM = Traditional Chinese medicine; UC = Usual care

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

Eight of the trials for which we had individual-level data 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

|  |  |  |
| --- | --- | --- |
| Study | QALYs | Data Collection Schedule |
| Usual care (Cherkin 201113) | 0.716888 | Baseline, 10, 26 and 52 weeks |
| Medical care (Hurwitz9) | 0.723844 | Baseline, 2, 6, 26, 52 and 78 weeks |
| Usual care (Von Korff12) | 0.726150 | Baseline, 2, 6, 12 and 24 months |
| Usual care (Cherkin 200911) | 0.732841 | Baseline, 8, 26 and 52 weeks |
| General practice (UK BEAM10) | 0.734545 | Baseline, 1, 3 and 12 months |
| Usual care (Sherman2) | 0.740823 | Baseline, 12 and 26 weeks |
| Usual care (Cherkin 200115) | 0.743993 | Baseline, 4, 10 and 52 weeks |
| Usual care (Moore8) | 0.750154 | Baseline, 3, 6 and 12 months |

The two studies without usual care arms and their data collection schedules:

* Cambron7 (Active Trunk Exercise and Flexion-Distraction) – Baseline, 13, 25 and 53 weeks
* Haas14 (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) 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 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. Relative Effectiveness and Cost-Effectiveness Across All Interventions**

One benefit of using simulation modeling to calculate cost-effectiveness is that all interventions can be compared to each other. This is especially appropriate when all interventions are true potential substitutes for each other—i.e., equally available, accessible and acceptable—and when the model contains all options. This model does not yet contain all recommended nonpharmacologic interventions, and these interventions differ widely in terms of availability (e.g., varying numbers of practitioners trained, licensed and credentialed to offer each intervention), accessibility (e.g., coverage) and acceptability (e.g., someone afraid of needles may not want to try acupuncture). Nevertheless, Table D.1 presents the relative cost-effectiveness of the interventions included in the current model. After sorting on costs from lowest to highest, we compare the effects and costs of the lowest cost intervention to the next lowest cost intervention. If both costs and effectiveness increase then an incremental cost-effectiveness ratio (ICER) is calculated and compared to some established threshold for the value of an additional QALY. If the ICER is below the threshold, that intervention is considered cost-effective compared to the lower-cost therapy, and the analysis continues down the list. However, if the lowest cost therapy is both lower cost and more effective it is said to dominate the higher cost therapy. As can be seen, in the case of the interventions included in our model, yoga dominates all other interventions.

Table D.1. Comparison of Cost-Effectiveness from the Societal Perspective for a Typical\* Patient Mix Across All Nonpharmacologic Interventions for Chronic Low Back Pain in the Markov Model

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Intervention | Incremental QALYs over UC | Incremental Societal Costs over UC | ICER ($/QALY) |  |
| Yoga | 0.048 | -$1,772.53 |  |  |
| Flexion Distraction (1) | 0.033 | -$817.87 | --- | Dominated |
| Individualized Acupuncture | 0.025 | -$591.59 | --- | Dominated |
| Flexion Distraction (2) | 0.024 | -$403.39 | --- | Dominated |
| Standardized Acupuncture | 0.021 | -$401.61 | --- | Dominated |
| Multidisciplinary Program | 0.015 | -$369.48 | --- | Dominated |
| Exercise | 0.013 | -$354.46 | --- | Dominated |
| CBT Educational Program | 0.010 | -$310.36 | --- | Dominated |
| Relaxation Massage | 0.017 | -$244.28 | --- | Dominated |
| Structural Massage | 0.017 | -$244.28 | --- | Dominated |
| Active Trunk Exercise (1) | 0.033 | -$241.08 | --- | Dominated |
| Physical Therapy | 0.015 | -$223.39 | --- | Dominated |
| Therapeutic Massage | 0.015 | -$197.36 | --- | Dominated |
| Chiropractic Care | 0.008 | -$141.64 | --- | Dominated |
| Exercise + Manipulation | 0.016 | -$135.93 | --- | Dominated |
| Manipulation | 0.015 | -$106.29 | --- | Dominated |
| Spinal Manipulation (4) | 0.016 | -$36.98 | --- | Dominated |
| Active Trunk Exercise (2) | 0.024 | $173.40 | --- | Dominated |
| TCM Acupuncture | 0.004 | $301.99 | --- | Dominated |
| Spinal Manipulation (3) | 0.004 | $513.43 | --- | Dominated |

CBT = Cognitive behavioral therapy; ICER = Incremental cost-effectiveness ratio; QALY = Quality-adjusted Life-Year; TCM = Traditional Chinese acupuncture

\*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.

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 E: 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 E.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 E.2 and Figure E.1). Even though we would not expect complete consistency since the model balanced baseline patient mixes across studies and estimated QALYs, the model’s ranking of within-study effectiveness across arms was identical to that seen in the published studies for their measures of function. We also saw a consistent relationship between difference-in-difference estimates of function and incremental QALYs.

Table E.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

|  |  |  |
| --- | --- | --- |
| First author of the study | Relative effectiveness and costs from papers | Compared to model |
| Cambron7 | Effect (RMDQ): Flexion distraction~Active trunk exercise | Same |
| Cherkin 200115 | Effect (RMDQ): Massage>TCM Acupuncture~Self-care | Same |
| Cherkin 200911 | Effect (RMDQ): Individualized~Standardized>Usual care | Same |
| Cherkin 201113 | Effect (RMDQ): Relaxation massage>Structural massage>Usual care | Same |
| Hurwitz9 | Effect (RMDQ): Physical therapy>Chiropractic care~Medical care | Same |
| UK BEAM10 | Effect (MVKD): Manipulation+exercise>Manipulation>Exercise>GP careEffect (EQ-5D): Manipulation+exercise>Exercise>Manipulation>GP care | SamePartial |

RMDQ = Roland-Morris Disability Questionnaire; MVKD = Modified Von Korff Disability score; EQ-5D = EuroQuol 5-Dimensions; UK = United Kingdom

Table E.2. Comparison of Published Study results to Model Results

|  | 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 |  |

RMDQ = Roland-Morris Disability Questionnaire score; QALY = Quality-adjusted life years; CBT = Cognitive behavioral therapy.

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 study14 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 study10 at baseline and 12 months.



Figure E.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; TCM = Traditional Chinese medicine

The trendline shows the average relationship between the difference-in-difference estimates and incremental QALYs for those studies that included usual care arms (solid circles); R2 = 0.54. The usual care arms assigned to the interventions whose studies did not include a usual care arm (open circles) were:

1. Usual care (Sherman)2
2. Usual care (Moore)8
3. Self-care education (Cherkin 2001)15
4. Usual care (Cherkin 2009)11

**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;[in press].

2. 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.

3. 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.

4. 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.

5. 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.

6. 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.

7. 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.

8. 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.

9. 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.

10. 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.

11. 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.

12. 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.

13. 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.

14. 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.

15. 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.