Report to the New Hampshire Insurance Department: Copayments for Chiropractic Care and Physical Therapy Services

Prepared for the
State of New Hampshire Insurance Department

December 12, 2014

Prepared by
Compass Health Analytics, Inc.

Report to the New Hampshire Insurance Department: Copayments for Chiropractic Care and Physical Therapy Services

Table of Contents

This report was prepared by Devin Anderson and James P. Highland, PhD.

Report to the New Hampshire Insurance Department: Copayments for Chiropractic Care and Physical Therapy Services

Executive Summary

The state of New Hampshire has proposed legislation that increases patients' access to chiropractic care and physical therapy services by lowering patient out-of-pocket costs. The purpose of this study is to better understand the impact of this legislation, specifically how the member cost sharing changes are likely to affect both cost and utilization for these services as well as their impact on overall cost. Using the NH CHIS dataset, Compass used empirical methods to assign copayment levels to roughly 300,000 commercial patients in calendar year 2013 and then performed several analyses to determine the relationship between copayment level and use of chiropractic and physical therapy services.

Consistent with the results found in the landmark RAND Health Insurance Experiment (RAND HIE), Compass found that for both chiropractic and physical therapy services lower copayment levels were associated with higher spending on those services.

The relationship between copayment level and overall combined medical and pharmacy cost for patients who used chiropractic or physical therapy services is more complex. For patients who used chiropractic services, increased use of chiropractic services corresponded to a statistically significant increase in overall cost. However, there was also a smaller but statistically significant relationship between increased chiropractic costs and lower non-chiropractic costs. As has been demonstrated for specific conditions in the literature[1], this finding suggests that there is a partial substitution effect between chiropractic services and other medical services, although not enough to offset the system-wide cost of chiropractic care.

For patients who used physical therapy services, there was a statistically significant increase in both non-physical therapy cost and overall medical cost associated with increased use of physical therapy services. However, it is very likely that the risk adjustment used in the model did not adequately adjust for the underlying health status of the population that used physical therapy services.

Finally, Compass examined the relationship between chiropractic and physical therapy services and several outcome measures related to opioid use. Again, consistent with past studies,[2] Compass found that any use of and the amount of use of chiropractic care was associated with lower use of opioids. Compass also found that any use of and the amount of use of physical therapy services was associated with higher opioid use. However, data related to the severity of the conditions requiring pain management were not available. As a result, the relationship between physical therapy services and opioid use outcomes could be the result of failing to properly control for the morbidity in the underlying population. This portion of the analysis does not establish causation between use of physical therapy services and opioid use.

The results of the study as a whole indicate that copayment level and use of chiropractic and physical therapy services are related, and that, although the results of the study could be limited by selection bias, it is likely that lowering copayment levels will lead to increased use of these services, which will likely lead to higher overall costs that are not completely offset by reductions in costs for other services.

Introduction

New Hampshire House Bill 1281 requires the New Hampshire Insurance Department (the Department) to study the relationship of insurance copayments with use of chiropractic and physical therapy services:

> "The commissioner shall compile available data and prepare reports concerning member cost sharing and the impact on utilization of services for physical therapy and chiropractic care. The first report shall…analyze all New Hampshire Insurance markets and identify differences in cost sharing and utilization of health services for the purpose of determining if there is a statistical association between the use of physical therapy and chiropractic care services and copayment amounts. The commissioner shall also seek to determine whether the overall costs of patients that utilize chiropractic care or physical therapists are less when the patient has lower copayment amounts for these services, and if any observed lower overall patient costs are caused by reductions in other health care services and better health care outcomes, not patient health status."

The Department retained Compass Health Analytics, Inc. to perform the requested study, and this document presents the results of that study.

Current estimates from the National Center for Health Statistics indicate that 8.5% of adults in the United States use chiropractic care in a 12 month period.[3] In addition, lower back pain is one of the most prevalent diagnoses in the United States, with an estimated 31 million Americans experiencing low-back pain at any given time.[4] There are substantial direct and indirect costs, such as worker absenteeism, associated with this condition that are expected to increase as the population ages.[5,6] Studies have shown that chiropractic care and physical therapy can be effectively used to treat this prevalent condition.[7]

Past studies have shown that chiropractic care is sensitive to levels of cost sharing.[8] The results of the landmark federally-funded health insurance experiment conducted by the RAND Corporation (RAND HIE) indicated that both the likelihood of using any services and the amount of services used were higher at lower levels of cost sharing.[9] The proposed legislation in New Hampshire states that cost sharing mechanisms such as copayments, coinsurance, and office visit deductibles for chiropractors and physical therapists cannot be greater than the copayments, coinsurance, and office visit deductibles for primary care physicians. This study uses data from the state of New Hampshire to evaluate the relationship between copayment level and use of chiropractic and physical therapy services.

Additionally, the proposed legislation seeks to understand the relationship between chiropractic and physical therapy copayment levels and the overall costs for patients who utilize those services. Studies of cost-effectiveness for various methods of treating conditions like low-back pain have reached conflicting results,[10] though there is evidence that for certain conditions treated by chiropractors, such as neck pain, there are no additional overall costs.[11] As required by HB 1281, this study assesses the much broader subject of the full spectrum of conditions treated by chiropractors and physical therapists in the state of New Hampshire and analyzes both medical and

pharmacy administrative claims data in an effort to understand the relationships between use of chiropractic or physical therapy services and overall patient cost.

Methods

There are three major sections of the study: (1) evaluation of the relationship between copayment level for chiropractic and physical therapy services and use of these services, (2) evaluation of the relationship between copayment level and overall cost in patients who utilize chiropractic or physical therapy services, and (3) assessment of the relationship between use of chiropractic or physical therapy services and selected outcome measures. Each is discussed in turn below.

Relationship Between Copayment Level and Use of Chiropractic and PT Services

To evaluate the relationship between copayment level and the use of chiropractic or physical therapy services, Compass used a two-part model similar to the methodology used in the evaluation of chiropractic services in the RAND HIE. The first part of the model uses a logistic regression to predict the likelihood of using any services, and the second part of the model evaluates the cost of services given any use of services.

Compass constructed a patient-level dataset containing copayment level and cost variables for chiropractic care, physical therapy services, and overall medical and pharmacy. All cost variables were based on allowed cost (i.e., the sum of plan paid, copayment, coinsurance, and deductible amounts). The dataset was based on data from calendar year 2013 and was limited to patients who had continuous medical eligibility and continuous enrollment in a single copayment level throughout the year. To adjust for differences in patient health risk and cost levels, Compass also used CMS's publicly available HCC software to assign hierarchical condition categories (HCCs) to each patient in the dataset. These values were assigned concurrently (i.e., using 2013 medical claims data). Compass dropped from the final dataset any HCCs that occurred less frequently than once per ten thousand patients. Compass created a continuous age variable defined as 2013 minus the year of birth. The dataset also contained a variable indicating whether the patient had continuous pharmacy eligibility. Compass used this field to limit the dataset when analyzing overall (medical and pharmacy) cost.

The two-part model and specifically the transformation from nominal dollars to the natural log of dollars in the second part of the model are two very common but not the only economic approaches for handling health care cost data, which tend to be highly skewed and have a large portion of observations with a value of zero. Compass also set up a second model that used the generalized linear model technique with a Gamma distribution and log link proposed by Manning and Mullahy.[12] In general, Compass prefers this approach for modeling cost data, and both approaches yielded equivalent results in terms of directionality and statistical significance. However, there were instances of extremely high chiropractic cost outliers that appeared to be handled more accurately through the log of cost models. Rather than report on a truncated subset of the data that excluded outliers, Compass used the log of cost models for this section of the analysis.

The setup for the first part of the model was to use a logistic regression where the dependent variable was a binary variable indicating whether the patient used chiropractic or physical therapy services, and the independent variables were a categorical variable of copayment level, a binary gender variable (male), age, and the set of HCCs (set up as an array of binary variables indicating the presence of the condition), which served as a proxy for health status. Only HCCs that were statistically significant ($p < 0.05$) were kept in the model. Compass used this general process three times, once for the combination of chiropractic and physical therapy services, once for chiropractic services only, and once for physical therapy services only. The set of HCCs that were significant varied among these models.

For the purposes of reporting the results of part one of the model, Compass calculated the average predicted value for each level of copayment in the model. This was done by using the predicted values of each observation generated by the model and applying the effect of each copayment once per level of copayment, effectively generating a predicted value for each level of copayment on every observation in the dataset. After transforming the results to percentages, Compass calculated the mean for each level of copayment. Compass also reported the odds ratios given by the model.

The setup for the second part of the model was to use ordinary least squares (OLS) regression where the dependent variable was the natural log of cost, where cost was defined as the sum of chiropractic and physical therapy costs, and the independent variables were a categorical variable of copayment level, a binary gender variable (male), age, and the set of HCCs, which served as a proxy for health status. This model was limited to cases where the patient had any chiropractic or physical therapy services, so there were no cases of cost equal to zero. Only HCCs that were statistically significant ($p <0.05$) were kept in the model. The final list of HCCs used in the second part of the two-part model did not have to be the same as the final list used in the first part. The other independent variables used were the same in both parts of the model. As in part one of the process, the second part of the model was estimated three times, once for both chiropractic and physical therapy services, once for chiropractic services, and once for physical therapy services, using the appropriate sample selection and cost criteria for each model run.

Because of concerns that the use of concurrent risk adjustment would "over-adjust" and wash out true variation, Compass ran an additional model without the HCC variables. The overall model fit was worse, but none of the estimates for the other independent variables materially changed.

In reporting results, Compass calculated Duan's smearing estimator as described by Manning and Mullahy[13] from the model residuals, then used that estimator to back-transform the results of the model from log dollars into the nominal dollar scale.

As additional confirmation, Compass also estimated a generalized linear model for the second part of the two-part model. The dataset and independent variables were the same, but the model used chiropractic and physical therapy cost in nominal dollars rather than the natural log of cost, and the model specified an underlying Gamma distribution with a log link. A modified Park test as described by Manning and Mullahy[14] confirmed that Gamma was the most appropriate distribution. As described above, this approach had directionally similar results but appeared to be less robust to

the effect of the chiropractic cost outliers which caused the model to likely overstate the differences among copayment levels.

One additional approach that Compass explored was to attempt to directly measure the effect of changing copayment levels through longitudinal analysis. Compass created a similar patient-level dataset using data from calendar year 2012, then combined the 2012 and 2013 datasets and limited it to patients with continuous medical and pharmacy eligibility in both periods. This cut the sample size roughly in half. Unfortunately, the resulting sample of patients switching from low copayment to high copayment plans or vice versa was too small to produce reliable estimates.

Relationship Between Use of Chiropractic and PT Services and Overall Cost

Compass explored the possibility of directly measuring the relationship between chiropractic and physical therapy copayment level and overall costs in patients who utilize chiropractic or physical therapy services, but determined that direct model evaluation was infeasible due to the confounding factor of the general copayment level. From the RAND HIE it is likely that overall cost is affected by the general copayment level of the plan. Additionally, the chiropractic and physical therapy portion of the overall costs are affected by the copayment level for chiropractic and physical therapy services. Compass assigned both a general plan copayment level and a chiropractic and physical therapy specific copayment level and included both of these terms in early model attempts. However, this approach was discarded due to the presence of collinearity between the general copayment level and the chiropractic and physical therapy specific copayment level. The strong correlation between these two terms led to unreliable estimates when both were included in a regression model.

Instead Compass set up a model to evaluate the relationship between chiropractic and physical therapy costs and overall costs. The sample for this model was limited to patients who had chiropractic or physical therapy services. The model was a generalized linear model with a Gamma distribution and log-link and specified the overall cost (defined as the sum of medical and pharmacy costs) as the dependent variable. The independent variables were the general copayment level category, the sum of chiropractic and physical therapy cost, a binary gender variable (male), age, and the HCCs to adjust for patient health status. The first portion of this study established the relationship between chiropractic and physical therapy copayment level and use of chiropractic and physical therapy services. From the combination of the first portion of the study and this new model framework, the relationship between chiropractic and physical therapy copayment level and overall cost can be inferred. There is a correlation between the general copayment level and the amount of chiropractic and physical therapy services, but it is weaker than the correlation between the general copayment level and the chiropractic and physical therapy copayment level. Additionally, Compass ran models that alternately dropped general copayment level and chiropractic and physical therapy cost and found that the estimates on each of the terms remained stable, indicating that the collinearity was not strong enough to invalidate the estimated effects.

In addition to using overall cost, Compass ran a set of models using non-chiropractic, non-physical therapy costs (i.e., overall cost minus any chiropractic and physical therapy costs) as the dependent variable. These models used the same general setup as the models that used overall cost as the

dependent variable (i.e., generalized linear models with a Gamma distribution and log link and the same set of independent variables). This set of models was an attempt to detect any substitution effects of patients that utilize chiropractic or physical therapy services.

Compass ran both sets of models three times, once for chiropractic and physical therapy services, once for chiropractic services alone, and once for physical therapy services alone.

Similar to the methodology used in part two of the models analyzed in the first part of the study, Compass only kept HCCs that were statistically significant ($p < 0.05$) in the final set of models. The sets of HCCs used when analyzing models that varied by dependent variable and sample selection criteria (i.e., chiropractic and physical therapy services, chiropractic services, and physical therapy services) were different.

Compass also ran a set of models on a subset of the population sample that excluded the bottom 1% and top 1% of overall patients by overall cost. This was an attempt to mitigate the effect of outliers on the model estimates. These models used the same modeling technique, dependent variables, and independent variables as the models that were run on the full population.

Assessment of the Relationship Between Use of Chiropractic or PT Services and Selected Outcome Measures

Part of the proposed legislation states the need for consultation with providers regarding the scope of and issues relevant to the study. In addition, the legislation recognizes that information regarding patient outcomes is needed in addition to the above information about cost. One of the provider recommendations for a patient outcome that can be assessed using administrative claims data rather than more detailed clinical data was the relationship between chiropractic and physical therapy care and opioid use.

Using opioid classifications that Compass had previously developed, Compass constructed several opioid use variables: a binary variable indicating any opioid use, a binary variable indicating a total days supply of opioids greater than or equal to 30 days, a binary variable indicating a total days supply of opioids greater than or equal to 90 days, and the total days supply of opioids. These measures were then added to the patient level dataset.

During the initial model testing, Compass determined that the relationship between chiropractic care and opioid use was different than the relationship between physical therapy services and opioid use. This finding aligned with published research regarding these relationships.[15] Because of this, Compass included separate terms for chiropractic care and physical therapy services in all of the models evaluating opioid use.

In an attempt to control for underlying differences in patient health status, Compass used presence of a given HCC as a method for limiting the sample size. First, Compass produced descriptive statistics on the prevalence of the HCCs in the patient sample as well as portions of patients with those HCCs that used chiropractic, physical therapy, or opioid services. See Appendix A for details. Next Compass, evaluated HCCs that showed indications of having a reasonably large sample size

and a comparatively large portion of patients with the HCC utilizing all three of the services of interest.

For each of the three binary response variables, Compass estimated two logistic models. Both sets of models used age and the binary variable male as independent variables but did not include any HCCs since the sample had already been limited to patients with a specified HCC. The other independent variables were either binary indicators for any use of chiropractic services and any use of physical therapy services or continuous variables of chiropractic cost and physical therapy cost.

Compass also estimated two models to evaluate the effect on the total days supply of opioids outcome variable. The first model was a generalized linear model with a Gamma distribution and log link that included age, the binary variable male, and binary variables for any use of chiropractic services and any use of physical therapy services as independent variables and used the total days supply as the dependent variable. The second model used a similar setup except for using continuous variables of chiropractic cost and physical therapy cost rather than binary variables indicating any use of services.

Data

The data source used in this study is the New Hampshire multi-payer claims database, the New Hampshire Comprehensive Health Care Information System (NH CHIS). The version of the NH CHIS data provided to Compass contains detailed claims and eligibility information for individuals with Commercial or Medicaid insurance from 2010 through 2013. For this study, Compass limited the sample to calendar year 2013. Compass did an initial data review to limit the data only to payers that did not have obviously incomplete data (i.e., payers with plausible PMPMs and no missing paid or incurred months). This included removing patients eligible for Medicaid or Medicare since there were limited Medicare claims in the dataset and the Medicaid claims were incomplete for 2013.

Due to known discrepancies in the coverage of medical behavioral health services across payers and plans as well as concerns about the completeness and reliability of the behavioral health indicator on the medical eligibility files, Compass excluded medical behavioral health payers and services (but not pharmacy claims) from the study.

Compass used the "person_key" field within the NH CHIS data as the unit of analysis. This field is the single ID that aggregates patients who have membership in multiple plans or across multiple payers.

Compass used the "group_id" field in the NH CHIS data to empirically assign copayment level. Investigation showed reasonably good consistency of copayment levels within a single group for a selected set of services. Compass summarized claim lines to the claim level and examined all groups for which there were at least 10 claims of interest in the period and then used the following methodology to assign copayment levels:

- Average copayment level of $0 was assigned to 'a) Zero Copay'

- Average copayment of greater than $0 and up to $10 was assigned to 'b) Low Copay'
- Average copayment of greater than $10 and up to $20 was assigned to 'c) Med Copay'
- Average copayment of greater than $20 was assigned to 'd) High Copay'

Compass used this same method and criteria for assigning a 'Chiropractic and PT Copay Level' as well as a 'General Copay Level' which took into account all professional services.

As expected, there was a strong but not perfect correlation between Chiropractic and PT Copay Level and the General Copay level:

Crosstab of Chiro/PT Copay Level vs. General Copay Level:

		General Copay Level					
		Zero	Low	Medium	High	Total	
Chiropractic / PT Copay Level	Zero	36,111	26,359	4,120	937	67,527	*22%*
	Low	0	45,633	12,093	1,620	59,346	*19%*
	Medium	0	26,409	77,800	103	104,312	*34%*
	High	0	5,199	61,608	12,272	79,079	*25%*
	Total	36,111	103,600	155,621	14,932	310,264	
		12%	*33%*	*50%*	*5%*		

Compass assessed the chiropractic and physical therapy claims in the population of interest to determine how effective empirical assignment of the Chiropractic and PT Copay Level was. The results show that the copayment level assignment appears to be effective for the majority of claims and patients.

Evaluation of Copay on Chiropractic and PT Claims by Assigned Chiropractic and PT Copay Level

		N	Copay Mode	Copay Quartile1	Copay Median	Copay Quartile3	Copay Mean	Coins Mean	Deduct Mean
Chiropractic / PT Copay Level	Zero	49,329	$0.00	$0.00	$0.00	$0.00	$0.00	$3.80	$27.97
	Low	96,011	$0.00	$0.00	$0.00	$5.00	$4.60	$1.64	$4.14
	Medium	110,998	$20.00	$10.00	$15.00	$20.00	$16.43	$0.62	$1.94
	High	60,815	$50.00	$25.00	$38.39	$50.00	$38.57	$0.32	$1.82
	Total	317,153	$0.00	$0.00	$10.00	$20.00	$14.54	$1.36	$14.54

It is important to note that the 'Zero Copay Level' is a combination of benefit plans that have no cost sharing and plans that use alternative methods of cost sharing, such as coinsurance or deductibles. The fields at the end of the table, 'Coins Mean' and 'Deduct Mean' show the average coinsurance and deductible levels on the set of chiropractic and physical therapy claims.

For risk adjustment, Compass downloaded and implemented mappings and logic for creating CMS's Hierarchical Condition Categories (HCCs).[16] Compass used the primary diagnosis from the available medical claims data to assign binary flags for the HCCs at the patient level.

Results

Results for each of the three study areas are presented below.

Relationship Between Copayment Level and Use of Chiropractic and Physical Therapy Services

There is significant evidence that the use of chiropractic and physical therapy services was related to copayment level. The following table shows descriptive statistics based on unadjusted allowed cost.

Unadjusted Results of Chiropractic and PT Services

			N	% w/ Svcs	Mean Cost[1]	Mean Cost per Util Mbr[2]	Median Cost per Util Mbr	Mean Cost per Util Mbr in 98% Subsample[3]
Chiropractic or PT Services	Chiropractic / PT Copay Level	Zero	67,527	8.9%	$53	$600	$379	$585
		Low	59,346	16.9%	$214	$1,264	$445	$729
		Medium	104,312	12.9%	$74	$578	$359	$564
		High	79,079	10.2%	$55	$537	$337	$528
		Total	310,264	12.1%	$92	$756	$381	$603
Chiropractic Services	Chiropractic / PT Copay Level	Zero	67,527	5.6%	$22	$385	$253	$379
		Low	59,346	13.0%	$156	$1,205	$338	$540
		Medium	104,312	9.5%	$35	$371	$263	$368
		High	79,079	5.4%	$26	$365	$238	$361
		Total	310,264	8.7%	$53	$608	$271	$416
PT Services	Chiropractic / PT Copay Level	Zero	67,527	3.7%	$32	$856	$619	$822
		Low	59,346	5.1%	$58	$1,121	$732	$1,022
		Medium	104,312	4.1%	$39	$946	$665	$900
		High	79,079	3.6%	$29	$791	$592	$772
		Total	310,264	4.1%	$38	$936	$657	$885

[1]Cost is defined as the allowed cost for the services specified in the first column (i.e., chiropractic and PT services, chiropractic services, PT services)

[2]Per Util Mbr means the total cost divided by the numbers of patients with any of the specified services

[3]The 98% subsample is a subset of the utilizing member dataset with the bottom 1% and top 1% of costs removed in order to mitigate the effect of outliers

Both chiropractic and physical therapy services show increased use of services with lower copayment levels. Because they display the same general pattern it is appropriate to pool them together in the analysis. The unadjusted data show that there are cost outliers in the use of chiropractic services within the low copayment level.

Compass used a two-part model to evaluate the relationship between Chiropractic and PT Copay Level and use of chiropractic and physical therapy services. The results show that there are statistically significant relationships between Chiropractic and PT Copay Level and the likelihood of using chiropractic or physical therapy services as well as between Chiropractic and PT Copay Level and the amount of chiropractic and physical therapy services used given any use of those services. Together, these results indicate that lower copayment levels on chiropractic and physical therapy services are related to higher use of these services.

After controlling for age, gender, and health status, the results for the first part of the model when analyzing the likelihood of patients having either chiropractic or physical therapy services is a statistically significant difference ($p < 0.0001$) between low and high copayment levels, with an odds ratio of 1.748 (95% Confidence Interval: 1.693 to 1.804).

The results for the first part of the model when analyzing chiropractic and physical therapy services separately are similar. Service use at low copayment levels is statistically significantly ($p <0.0001$) higher in both cases, but the likelihood of receiving chiropractic services is more sensitive to copayment level (low copayment to high copayment odds ratio of 1.884 for chiropractic care and 1.389 for physical therapy services).

The following table shows the estimated results for each of the three sets of services by copayment level:

Estimated Likelihood of Using Services by Chiropractic/PT Copay Level

	Chiropractic or Physical Therapy Services	Chiropractic Services	Physical Therapy Services
Zero Copay	11.9%	5.6%	3.7%
Low Copay	16.6%	12.7%	5.1%
Medium Copay	13.0%	9.6%	4.2%
High Copay	8.8%	7.3%	3.6%

Similarly, after controlling for age, gender, and health status, the results for the second part of the model when analyzing the cost of chiropractic and physical therapy services among patients who had any chiropractic or physical therapy services show a statistically significant difference ($p <0.0001$) between low and high copayment plans. Patients with any chiropractic or physical therapy costs in low copayment plans had estimated chiropractic and physical therapy costs nearly 40% higher than patients in high copayment plans ($874 vs. $628). As was the case in part one of

the model, there was a stronger relationship between the use of chiropractic care and copayment level than between physical therapy services and copayment level ($706 vs. $474, 52% higher in chiropractic and $1,057 and $820, 29% higher in physical therapy).

It is useful to note that the copayment level is not the only member cost sharing mechanism and that plans with zero copayment but evidence of alternative member cost sharing mechanisms displayed a lower likelihood of use of services but a higher use of services in cases where there was any service use. This is consistent with the results from the RAND HIE, which observed that there is a "blunting effect" around the effect of cost-sharing in the presence of a stop-loss limit as is common in high deductible plans.

Relationship Between Use of Chiropractic and Physical Therapy Services and Overall Cost

The analysis shows that the use of chiropractic services and the use of physical therapy services have different relationships with overall cost (defined in this analysis as the sum of pharmacy and non-behavioral health medical costs). For this section of the study, pooling chiropractic and physical therapy services is inappropriate.

Higher use of chiropractic services in patients with any chiropractic services is statistically significantly related ($p < 0.0001$) to higher overall cost after controlling for age, gender, health status, and plan design. Examination of the results showed that in general, adding $1 of chiropractic costs resulted in less than $1 in additional overall cost, indicating that the chiropractic services could be partially offsetting other services, which is consistent with the literature with regard to certain conditions commonly treated by chiropractors.[17]

When evaluating the relationship between the amount of use of chiropractic services used by patients who had any chiropractic care and the non-chiropractic costs of those patients, Compass found a small negative relationship ($p = 0.02$). This supports the previous result indicating that higher chiropractic costs are associated with higher overall costs but also with lower non-chiropractic costs.

Evaluation of the datasets that removed outliers produced directionally equivalent results although the result of the relationship between the amount of use of chiropractic services and non-chiropractic costs was less significant ($p = 0.17$).

Administrative claims data do not have the information necessary to support risk-adjusted analyses of the effect of physical therapy on overall cost. General health status adjustments from claims data without clinical information, such as functional status or severity indexes, do not accurately capture the underlying morbidity for the specific condition that led the patient to utilize physical therapy services. The HCCs were designed to capture a wide range of conditions that contribute to overall cost. The HCCs set up hierarchies within some conditions in order to account for increased severity of related illnesses, but not all of the conditions have these hierarchies and it's possible that more detailed clinical information than is available in administrative claims data would be needed in order to accurately assign severity levels to all conditions. For example, rheumatoid arthritis is a

single HCC but is a disease that tends to progress to other functional areas and result in joint damage over time, and costs per patient would be expected to have a wide range of severity within this category. Controlling for age, gender, and general health status the analysis finds that increased use of physical therapy services in patients with any physical therapy is statistically significantly related to both higher overall costs and higher non-physical therapy costs (both $p < 0.0001$). Examination of the results shows an increase of $1 in physical therapy cost corresponds to an increase in overall cost far greater than $1, and around $3-$4 in many of the observed results. An effect that large is much more likely to be related to unmeasured underlying morbidity for the condition being treated by physical therapy for which the model has not accounted than for an increase caused by the physical therapy services. Additionally, the general copayment level is not statistically significantly related to overall cost in patients who had any physical therapy services. Since the first stage of this analysis demonstrated that use of physical therapy services are related to copayment level, this suggests that there are underlying population characteristics that are washing out the other effects that the analysis is trying to detect.

Relationship Between Use of Chiropractic and PT Services and Outcomes

The literature contains numerous examples of studies demonstrating both positive patient outcomes and decreased likelihood of negative patient outcomes through the use of chiropractic and physical therapy services.[18,19,20] This analysis focuses on the relationship between chiropractic and physical therapy services and opioid use. Again, it is necessary to analyze chiropractic care and physical therapy services separately.

The analysis examined four opioid use outcomes in patients with a diagnosis of rheumatoid arthritis: any opioid use, opioid use for 30+ days, opioid use for 90+ days, and the total days for patients who had any days of opioid use. In all four outcomes, either the use of chiropractic services or the amount of chiropractic services received was statistically significantly related to reductions in the outcomes of interest. The p-values ranged from < 0.0001 to 0.0153.

The use of physical therapy services and the amount of physical therapy services used were both statistically significantly related to an increased likelihood of any opioid use and long-term opioid use, with p-values ranging from < 0.0001 to 0.0111. There was no statistically significant relationship between either use of physical therapy services ($p = 0.96$) or the amount of physical therapy services ($p = 0.85$) used and the total days of opioid use in patients who had any opioid use.

The analysis uses a health status risk adjustment that is based only on administrative claims data and does not have access to clinical information. The analysis assumes homogeneity of severity/patient risk within patients with a diagnosis of rheumatoid arthritis, but the observed associations between chiropractic care and opioid use and physical therapy and opioid use could be the result of underlying population differences for which the analysis has not controlled.

Compass examined several other HCCs, but was only able to find any statistically significant effects in rheumatoid arthritis. The other HCCs generally showed similar directionality but were not statistically significant at the 0.05 level.

Additional Results

In order to validate the completeness of the data being evaluated, Compass empirically derived the 50 most common primary ICD 9 diagnoses treated by chiropractors or physical therapists and then tabulated the percent of patients in the sample who had those diagnoses during calendar year 2013. The results are found in Appendix B.

Conclusions

The results of the study show that there is a negative and statistically significant relationship between the copayment level and the use of chiropractic care or physical therapy services. The analysis shows that lower copayment levels are associated with both increased likelihood of using the services and increased amount of services used for patients with any service use. This is true for both chiropractic care and physical therapy services and is true after controlling for age, gender, and health status.

The study also shows that an increase in either chiropractic care costs or an increase in physical therapy costs are statistically significantly related to increases in overall costs. For chiropractic care costs, there is evidence that chiropractic care has partial substitution effects for medical services. There is strong evidence that risk adjustment using information not available through administrative claims data is needed in order to determine if physical therapy costs offset other medical or pharmacy costs.

Similarly, the outcome measures evaluated in this study may require additional risk adjustment. There is evidence that increased use of chiropractic care is associated with lower opioid use and that increased use of physical therapy services is associated with increased opioid use, but it is unclear whether these differences are due to underlying differences in patient severity.

Overall, in the commercially insured population in New Hampshire, lower copayment levels for chiropractic and physical therapy services are associated with increased likelihood of using and increased amount of use of those services as well as higher overall patient costs. Through the evaluation of the 'zero copay' plans, there is evidence that cost sharing through mechanisms such as coinsurance and deductibles to some extent behave similarly.

It is important to note that although this analysis shows a relationship between lower copayment for chiropractic and physical therapy services and increased use of and cost of both these services and overall medical and pharmacy costs, it is a cross-sectional study that shows correlation not causation. There could be selection bias effects (i.e., patients more likely to use services self-select into plans with lower copayment levels). This study also only analyzes direct costs, and does not consider other societal benefits such as reduced worker absenteeism. Finally, the value proposition for medical services needs to consider costs, both direct and indirect, but also quality, patient outcomes, and patient satisfaction. The research literature supports significant patient outcome benefits and patient satisfaction in use of both chiropractic and physical therapy services.

Appendix A

HCC	Description	Patients	Patient %	PT Users	PT %	Chiro Users	Chiro %	Opioid Users	Opioid %	PT w/in HCC %	Chiro w/in HCC %	Opioid w/in HCC %
1	HIV/AIDS	146	0.0%	6	0.0%	10	0.0%	38	0.1%	4.1%	6.8%	26.0%
2	Septicemia/Shock	319	0.1%	27	0.2%	24	0.1%	190	0.4%	8.5%	7.5%	59.6%
5	Opportunistic Infections	68	0.0%	10	0.1%	9	0.0%	31	0.1%	14.7%	13.2%	45.6%
7	Metastatic Cancer and Acute Leukemia	512	0.2%	32	0.3%	40	0.1%	306	0.6%	6.3%	7.8%	59.8%
8	Lung, Upper Digestive Tract, and Other Severe Cancers	276	0.1%	15	0.1%	28	0.1%	135	0.3%	5.4%	10.1%	48.9%
9	Lymphatic, Head and Neck, Brain, and Other Major Cancers	1,097	0.4%	68	0.5%	120	0.4%	380	0.7%	6.2%	10.9%	34.6%
10	Breast, Prostate, Colorectal and Other Cancers and Tumors	4,592	1.5%	297	2.3%	576	2.1%	1,523	3.0%	6.5%	12.5%	33.2%
15	Diabetes with Renal Manifestation	494	0.2%	27	0.2%	46	0.2%	182	0.4%	5.5%	9.3%	36.8%
16	Diabetes with Neurologic or Peripheral Circulatory Manifestation	858	0.3%	63	0.5%	95	0.4%	333	0.7%	7.3%	11.1%	38.8%
17	Diabetes with Acute Complications	191	0.1%	9	0.1%	14	0.1%	55	0.1%	4.7%	7.3%	28.8%
18	Diabetes with Ophthalmologic Manifestation	708	0.2%	41	0.3%	74	0.3%	195	0.4%	5.8%	10.5%	27.5%
19	Diabetes with No or Unspecified Complications	9,891	3.2%	527	4.1%	1,044	3.8%	2,750	5.4%	5.3%	10.6%	27.8%
21	Protein-Calorie Malnutrition	168	0.1%	15	0.1%	21	0.1%	63	0.1%	8.9%	12.5%	37.5%
25	End-Stage Liver Disease	96	0.0%	5	0.0%	5	0.0%	46	0.1%	5.2%	5.2%	47.9%
26	Cirrhosis of Liver	237	0.1%	4	0.0%	25	0.1%	95	0.2%	1.7%	10.5%	40.1%
27	Chronic Hepatitis	271	0.1%	20	0.2%	24	0.1%	84	0.2%	7.4%	8.9%	31.0%
31	Intestinal Obstruction/Perforation	514	0.2%	40	0.3%	51	0.2%	310	0.6%	7.8%	9.9%	60.3%
32	Pancreatic Disease	1,124	0.4%	98	0.8%	153	0.6%	477	0.9%	8.7%	13.6%	42.4%
33	Inflammatory Bowel Disease	1,614	0.5%	94	0.7%	196	0.7%	525	1.0%	5.8%	12.1%	32.5%
37	Bone/Joint/Muscle Infections/Necrosis	374	0.1%	69	0.5%	52	0.2%	227	0.4%	18.4%	13.9%	60.7%
38	Rheumatoid Arthritis and Inflammatory Connective Tissue Disease	2,940	0.9%	336	2.6%	499	1.8%	1,176	2.3%	11.4%	17.0%	40.0%
44	Severe Hematological Disorders	98	0.0%	7	0.1%	10	0.0%	33	0.1%	7.1%	10.2%	33.7%
45	Disorders of Immunity	1,267	0.4%	110	0.9%	195	0.7%	491	1.0%	8.7%	15.4%	38.8%
51	Drug/Alcohol Psychosis	306	0.1%	17	0.1%	29	0.1%	120	0.2%	5.6%	9.5%	39.2%
52	Drug/Alcohol Dependence	1,428	0.5%	64	0.5%	120	0.4%	810	1.6%	4.5%	8.4%	56.7%
54	Schizophrenia	163	0.1%	6	0.0%	4	0.0%	35	0.1%	3.7%	2.5%	21.5%
55	Major Depressive, Bipolar, and Paranoid Disorders	9,319	3.0%	677	5.3%	1,267	4.7%	2,789	5.5%	7.3%	13.6%	29.9%
67	Quadriplegia, Other Extensive Paralysis	76	0.0%	13	0.1%	6	0.0%	21	0.0%	17.1%	7.9%	27.6%
68	Paraplegia	47	0.0%	11	0.1%	1	0.0%	22	0.0%	23.4%	2.1%	46.8%
69	Spinal Cord Disorders/Injuries	336	0.1%	56	0.4%	41	0.2%	139	0.3%	16.7%	12.2%	41.4%
70	Muscular Dystrophy	59	0.0%	8	0.1%	2	0.0%	12	0.0%	13.6%	3.4%	20.3%
71	Polyneuropathy	962	0.3%	134	1.1%	134	0.5%	434	0.9%	13.9%	13.9%	45.1%
72	Multiple Sclerosis	713	0.2%	65	0.5%	84	0.3%	204	0.4%	9.1%	11.8%	28.6%
73	Parkinson's and Huntington's Diseases	109	0.0%	13	0.1%	10	0.0%	31	0.1%	11.9%	9.2%	28.4%
74	Seizure Disorders and Convulsions	1,789	0.6%	118	0.9%	173	0.6%	426	0.8%	6.6%	9.7%	23.8%
75	Seizure Disorders and Convulsions	95	0.0%	9	0.1%	9	0.0%	31	0.1%	9.5%	9.5%	32.6%
79	Cardio-Respiratory Failure and Shock	625	0.2%	56	0.4%	63	0.2%	306	0.6%	9.0%	10.1%	49.0%
80	Congestive Heart Failure	1,139	0.4%	70	0.6%	102	0.4%	433	0.9%	6.1%	9.0%	38.0%
81	Acute Myocardial Infarction	257	0.1%	12	0.1%	24	0.1%	85	0.2%	4.7%	9.3%	33.1%
82	Unstable Angina and Other Acute Ischemic Heart Disease	249	0.1%	19	0.1%	22	0.1%	104	0.2%	7.6%	8.8%	41.8%
83	Angina Pectoris/Old Myocardial Infarction	315	0.1%	21	0.2%	37	0.1%	94	0.2%	6.7%	11.7%	29.8%
92	Specified Heart Arrhythmias	2,312	0.7%	177	1.4%	246	0.9%	718	1.4%	7.7%	10.6%	31.1%
95	Cerebral Hemorrhage	148	0.0%	14	0.1%	18	0.1%	68	0.1%	9.5%	12.2%	45.9%
96	Ischemic or Unspecified Stroke	406	0.1%	37	0.3%	35	0.1%	146	0.3%	9.1%	8.6%	36.0%
100	Hemiplegia/Hemiparesis	113	0.0%	14	0.1%	14	0.1%	31	0.1%	12.4%	12.4%	27.4%
101	Diplegia (Upper), Monoplegia, and Other Paralytic Syndromes	96	0.0%	21	0.2%	9	0.0%	21	0.0%	21.9%	9.4%	21.9%
104	Vascular Disease with Complications	625	0.2%	59	0.5%	51	0.2%	299	0.6%	9.4%	8.2%	47.8%
105	Vascular Disease	1,673	0.5%	135	1.1%	170	0.6%	708	1.4%	8.1%	10.2%	42.3%
107	Cystic Fibrosis	57	0.0%	7	0.1%	5	0.0%	10	0.0%	12.3%	8.8%	17.5%
108	Chronic Obstructive Pulmonary Disease	1,898	0.6%	115	0.9%	189	0.7%	796	1.6%	6.1%	10.0%	41.9%
111	Aspiration and Specified Bacterial Pneumonias	94	0.0%	10	0.1%	11	0.0%	39	0.1%	10.6%	11.7%	41.5%
112	Pneumococcal Pneumonia, Empyema, Lung Abscess	119	0.0%	9	0.1%	14	0.1%	48	0.1%	7.6%	11.8%	40.3%
119	Proliferative Diabetic Retinopathy and Vitreous Hemorrhage	188	0.1%	10	0.1%	10	0.0%	58	0.1%	5.3%	5.3%	30.9%
131	Renal Failure	958	0.3%	56	0.4%	84	0.3%	372	0.7%	5.8%	8.8%	38.8%
132	Nephritis	103	0.0%	2	0.0%	13	0.0%	31	0.1%	1.9%	12.6%	30.1%
148	Decubitus Ulcer of Skin	75	0.0%	9	0.1%	2	0.0%	40	0.1%	12.0%	2.7%	53.3%
149	Chronic Ulcer of Skin, Except Decubitus	446	0.1%	44	0.3%	43	0.2%	197	0.4%	9.9%	9.6%	44.2%
155	Major Head Injury	468	0.2%	46	0.4%	59	0.2%	205	0.4%	9.8%	12.6%	43.8%
157	Vertebral Fractures	334	0.1%	60	0.5%	38	0.1%	191	0.4%	18.0%	11.4%	57.2%
158	Hip Fracture/Dislocation	255	0.1%	60	0.5%	24	0.1%	144	0.3%	23.5%	9.4%	56.5%
161	Traumatic Amputation	64	0.0%	7	0.1%	11	0.0%	33	0.1%	10.9%	17.2%	51.6%
164	Major Complications of Medical Care and Trauma	1,384	0.4%	251	2.0%	158	0.6%	891	1.8%	18.1%	11.4%	64.4%
174	Major Organ Transplant Status	100	0.0%	5	0.0%	10	0.0%	37	0.1%	5.0%	10.0%	37.0%
176	Artificial Openings for Feeding or Elimination	391	0.1%	25	0.2%	35	0.1%	198	0.4%	6.4%	9.0%	50.6%

Appendix B

Code	Description	Patients w/ Diagnosis	% of Patients w/ Diagnosis
739.1	NONALLOPATHIC LESIONS OF CERVICAL REGION NOT ELSEWHERE CLASSIFIED	5,383	1.8%
724.2	LUMBAGO	12,027	3.9%
739.3	NONALLOPATHIC LESIONS OF LUMBAR REGION NOT ELSEWHERE CLASSIFIED	3,961	1.3%
723.1	CERVICALGIA	9,266	3.0%
719.46	PAIN IN JOINT INVOLVING LOWER LEG	10,937	3.6%
719.41	PAIN IN JOINT INVOLVING SHOULDER REGION	7,800	2.5%
739.2	NONALLOPATHIC LESIONS OF THORACIC REGION NOT ELSEWHERE CLASSIFIED	2,032	0.7%
847.0	SPRAIN OF NECK	2,894	0.9%
839.20	CLOSED DISLOCATION LUMBAR VERTEBRA	1,589	0.5%
839.08	CLOSED DISLOCATION MULTIPLE CERVICAL VERTEBRAE	1,471	0.5%
847.2	SPRAIN LUMBAR REGION	2,451	0.8%
739.4	NONALLOPATHIC LESIONS OF SACRAL REGION NOT ELSEWHERE CLASSIFIED	1,200	0.4%
719.45	PAIN IN JOINT INVOLVING PELVIC REGION AND THIGH	4,539	1.5%
724.1	PAIN IN THORACIC SPINE	2,369	0.8%
724.4	THORACIC OR LUMBOSACRAL NEURITIS OR RADICULITIS UNSPECIFIED	3,058	1.0%
722.10	DISPLACEMENT OF LUMBAR INTERVERTEBRAL DISC WITHOUT MYELOPATHY	2,720	0.9%
726.10	DISORDERS OF BURSAE AND TENDONS IN SHOULDER REGION UNSPECIFIED	2,486	0.8%
724.5	BACKACHE UNSPECIFIED	7,393	2.4%
719.47	PAIN IN JOINT INVOLVING ANKLE AND FOOT	5,407	1.8%
846.0	LUMBOSACRAL (JOINT) (LIGAMENT) SPRAIN	991	0.3%
724.3	SCIATICA	1,837	0.6%
723.4	BRACHIAL NEURITIS OR RADICULITIS NOT OTHERWISE SPECIFIED	1,869	0.6%
739.5	NONALLOPATHIC LESIONS OF PELVIC REGION NOT ELSEWHERE CLASSIFIED	431	0.1%
722.52	DEGENERATION OF LUMBAR OR LUMBOSACRAL INTERVERTEBRAL DISC	3,243	1.1%
847.1	SPRAIN THORACIC REGION	1,056	0.3%
726.2	OTHER AFFECTIONS OF SHOULDER REGION NOT ELSEWHERE CLASSIFIED	1,427	0.5%
728.71	PLANTAR FASCIAL FIBROMATOSIS	2,488	0.8%
715.16	OSTEOARTHROSIS LOCALIZED PRIMARY INVOLVING LOWER LEG	2,265	0.7%
726.71	ACHILLES BURSITIS OR TENDINITIS	903	0.3%
723.3	CERVICOBRACHIAL SYNDROME (DIFFUSE)	419	0.1%
839.42	CLOSED DISLOCATION SACRUM	529	0.2%
840.4	ROTATOR CUFF (CAPSULE) SPRAIN	1,006	0.3%
844.2	SPRAIN OF CRUCIATE LIGAMENT OF KNEE	707	0.2%
727.61	COMPLETE RUPTURE OF ROTATOR CUFF	525	0.2%
726.0	ADHESIVE CAPSULITIS OF SHOULDER	721	0.2%
721.0	CERVICAL SPONDYLOSIS WITHOUT MYELOPATHY	1,726	0.6%
724.6	DISORDERS OF SACRUM	765	0.2%
839.00	CLOSED DISLOCATION CERVICAL VERTEBRA UNSPECIFIED	306	0.1%
781.2	ABNORMALITY OF GAIT	593	0.2%
719.7	DIFFICULTY IN WALKING	165	0.1%
839.21	CLOSED DISLOCATION THORACIC VERTEBRA	569	0.2%
722.0	DISPLACEMENT OF CERVICAL INTERVERTEBRAL DISC WITHOUT MYELOPATHY	1,117	0.4%
726.5	ENTHESOPATHY OF HIP REGION	1,347	0.4%
722.4	DEGENERATION OF CERVICAL INTERVERTEBRAL DISC	1,726	0.6%
845.00	UNSPECIFIED SITE OF ANKLE SPRAIN	2,761	0.9%
739.0	NONALLOPATHIC LESIONS OF HEAD REGION NOT ELSEWHERE CLASSIFIED	319	0.1%
V43.65	KNEE JOINT REPLACEMENT	496	0.2%
729.1	MYALGIA AND MYOSITIS UNSPECIFIED	2,915	0.9%
717.7	CHONDROMALACIA OF PATELLA	962	0.3%
726.32	LATERAL EPICONDYLITIS ELBOW REGION	1,464	0.5%

Endnotes

[1]Brook I. Martin, Mary M. Gerkovich, Richard A. Deyo, Karen J. Sherman, Daniel C. Cherkin, Bonnie K. Lind, Christine M. Goertz, William E. Lafferty. The Association of Complementary and Alternative MedicineUse and Health Care Expenditures for Back and Neck Problems. Med Care. 2012 December ; 50(12): 1029–1036.

[2] Vogt, Molly T., PhD, Kwoh, C. Kent, MD, Cope, Doris K., MD, Osial, Thaddeus A., MD, Culyba, Michael, MD, Starz, Terence W., MD. Analgesic Usage for Low Back Pain: Impact on Health Care Costs and Service Use. Spine 2005; Volume 30, Number 9, 1075-1081.

[3]Peregoy, Jennifer A, MPH, Clarke, Tainya C, PhD, MPH, Jones, Lindsey I, MPH, Stussman, Barbara J, BA, Nahin, Richard L, PhD, MPH. Regional Variation in Use of Complementary Health Approaches by U.S. Adults. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention. NCHS Data Brief, Number 146, April 2014.

[4]Jensen M, Brant-Zawadzki M, Obuchowski N, et al. Magnetic Resonance Imaging of the Lumbar Spine in People Without Back Pain. N Engl J Med 1994; 331: 69-116.

[5] Dagenais, S, Caro J, Haldeman, S. A systematic review of low back pain cost of illness studies in the United States and internationally. Spine 2008 Jan-Feb;8(1):8-20.

[6]Wynne-Jones , Gwenllian , Cowen, Jemma, Jordan, Joanne L, Uthman, Olalekan, Main, Chris J, Glozier, Nick, van der Windt, Danielle. Absence from work and return to work in people with back pain: a systematic review and meta-analysis. Occup Environ Med. Jun 2014; 71(6): 448–456.

[7] Hurwitz EL, Morgenstern H, Kominski GF, Yu, F Chiang, LM. A randomized trial of chiropractic and medical care for patients with low back pain: eighteen-month follow-up outcomes from the UCLA low back pain study. Spine 2006 Mar 15;31(6):611-21.

[8]Shekele, Paul G., MD, PhD, Rogers, William H., PhD, Newhouse, Joseph P., PhD. The Effect of Cost Sharing on the Use of Chiropractic Services. 1996 September ; 34(9): 863–872.

[9]Joseph P. Newhouse, and Rand Corporation. Insurance Experiment Group, eds. Free for all?: lessons from the RAND health insurance experiment. Harvard University Press, 1993.

[10]Baldwin, Marjorie L., et al. "Cost-effectiveness studies of medical and chiropractic care for occupational low back pain: A critical review of the literature." The Spine Journal 1.2 (2001): 138-147.

[11]Brook I. Martin, Mary M. Gerkovich, Richard A. Deyo, Karen J. Sherman, Daniel C. Cherkin, Bonnie K. Lind, Christine M. Goertz, William E. Lafferty. The Association of Complementary and Alternative Medicine Use and Health Care Expenditures for Back and Neck Problems. Med Care. 2012 December ; 50(12): 1029–1036.

[12] Manning, Willard G., and John Mullahy. Estimating log models: to transform or not to transform?. Journal of health economics 20.4 (2001): 461-494.

[13] Manning, Willard G., and John Mullahy. Estimating log models: to transform or not to transform?. Journal of health economics 20.4 (2001): 461-494.

[14] Manning, Willard G., and John Mullahy. Estimating log models: to transform or not to transform?. Journal of health economics 20.4 (2001): 461-494.

[15] Vogt, Molly T., PhD, Kwoh, C. Kent, MD, Cope, Doris K., MD, Osial, Thaddeus A., MD, Culyba, Michael, MD, Starz, Terence W., MD. Analgesic Usage for Low Back Pain: Impact on Health Care Costs and Service Use. Spine 2005; Volume 30, Number 9, 1075-1081.

[16] HCCs are created by and are the property of CMS and are publicly available on their website: http://www.cms.gov/Medicare/Health-Plans/MedicareAdvtgSpecRateStats/Risk-Adjustors-Items/Risk2013.html?DLPage=1&DLSort=0&DLSortDir=descending

[17]Brook I. Martin, Mary M. Gerkovich, Richard A. Deyo, Karen J. Sherman, Daniel C. Cherkin, Bonnie K. Lind, Christine M. Goertz, William E. Lafferty. The Association of Complementary and Alternative MedicineUse and Health Care Expenditures for Back and Neck Problems. Med Care. 2012 December ; 50(12): 1029–1036.

[18]Bronfort, G, Haas M, Evans, RL, Bouter, LM. Efficacy of spinal manipulation and mobilization for low back pain and neck pain: a systematic review and best evidence synthesis. Spine 2004 May-Jun;4(3):335-56.

[19]Bryans et al. Evidence-Based Guidelines for the Chiropractic Treatment of Adults with Neck Pain. Journal of Manipulative & Physiological Therapeutics. 2014 January; 37(1): 42–63.

[20]Hurwitz EL, Morgenstern H, Kominski GF, Yu, F Chiang, LM. A randomized trial of chiropractic and medical care for patients with low back pain: eighteen-month follow-up outcomes from the UCLA low back pain study. Spine 2006 Mar 15;31(6):611-21.