THE JOURNAL OF ALTERNATIVE AND COMPLEMENTARY MEDICINE
Volume 25, Number 1, 2019, pp. 32–39

DOI: 10.1089/acm.2018.0276

JACM

ORIGINAL RESEARCH

Use of Complementary and Integrated Health: A Retrospective Analysis of U.S. Veterans with Chronic Musculoskeletal Pain Nationally

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Abstract

Objective: To partially address the opioid crisis, some complementary and integrative health (CIH) therapies are now recommended for chronic musculoskeletal pain, a common condition presented in primary care. As such, health care systems are increasingly offering CIH therapies, and the Veterans Health Administration (VHA), the nation's largest integrated health care system, has been at the forefront of this movement. However, little is known about the uptake of CIH among patients with chronic musculoskeletal pain. As such, we conducted the first study of the use of a variety of nonherbal CIH therapies among a large patient population having chronic musculoskeletal pain.

Materials and methods: We examined the frequency and predictors of CIH therapy use using administrative data for a large retrospective cohort of younger veterans with chronic musculoskeletal pain using the VHA between 2010 and 2013 ($n = 530{,}216$). We conducted a 2-year effort to determine use of nine types of CIH by using both natural language processing data mining methods and administrative and CPT4 codes. We defined chronic musculoskeletal pain as: (1) having 2+ visits with musculoskeletal diagnosis codes likely to represent chronic pain separated by 30–365 days or (2) 2+ visits with musculoskeletal diagnosis codes within 90 days and with 2+ numeric rating scale pain scores ≥4 at 2+ visits within 90 days.

Results: More than a quarter (27%) of younger veterans with chronic musculoskeletal pain used any CIH therapy, 15% used meditation, 7% yoga, 6% acupuncture, 5% chiropractic, 4% guided imagery, 3% biofeedback, 2% *t'ai chi*, 2% massage, and 0.2% hypnosis. Use of any CIH therapy was more likely among women, single patients, patients with three of the six pain conditions, or patients with any of the six pain comorbid conditions.

Conclusions: Patients appear willing to use CIH approaches, given that 27% used some type. However, low rates of some specific CIH suggest the potential to augment CIH use.

Keywords: alternative medicine, musculoskeletal pain, chronic pain, veterans

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Introduction

According to the National Academy of Medicine's (formerly the Institute of Medicine) *Relieving Pain in America*, chronic pain affects more than 100 million adults[1] and is associated with high economic costs.[2] The most common type of chronic pain is musculoskeletal, including back and neck problems and osteoarthritis. To partially address the high prevalence of pain and the opioid epidemic, nonpharmacological treatment options for pain are being given consideration in national pain management strategies for the general public[3,4] and the military and veterans,[5] and in the American College of Physicians' clinical practice guidelines.[6] These nonpharmacologic options include complementary and integrative health (CIH) therapies, such as yoga, meditation, and acupuncture. The National Academy of Medicine and others report that patients often integrate CIH therapies into their care because they often preferred nonpharmacological self-management options, could not afford traditional medical care, experienced unwanted side effects, or had limited response to pharmacologic and other common treatments.[7–9]

Several systematic reviews and reviews of systematic reviews have evaluated the evidence and found that some CIH therapies are effective for some chronic musculoskeletal pain. For example, NIH researchers'[10] recent review of randomized controlled trials of CIH on pain found: ''based on a preponderance of positive trials versus negative trials, current evidence suggests the following [CIH] may help…: acupuncture and yoga for back pain, acupuncture and tai chi for [osteoarthritis] of the knee, and massage therapy for neck pain. Weaker evidence suggests that massage therapy, spinal manipulation …might also be of benefit to those with back pain and relaxation approaches and tai chi might help those with fibromyalgia.'' Similar results were found in other reviews of systematic reviews. Specifically, acupuncture appears to be an appropriate treatment for back and neck pain, osteoarthritis, and chronic headache pain[11]; yoga is effective for low-back pain[12]; and *t'ai chi* is ''promising'' for joint pain.[13] Reviewers also found that mindfulness ''has evidence of a potential positive effect'' on pain[14] and is effective for chronic pain,[15] spinal manipulation has support for low-back pain but little evidence for neck pain,[16] and massage ''holds promise'' for musculoskeletal pain.[17]

Accordingly, health care systems have increasingly made CIH therapies available[18–21] to satisfy patient demand for nonpharmacological treatment options, both as alternatives to opioids and potentially to improve patient outcomes[1] and reduce health care costs.[20] In 2010, 43% of American Hospital Association-affiliated hospitals offered CIH therapies.[18] However, the Veterans Health Administration (VHA), the nation's largest integrated health care system, has made a concerted effort to provide CIH for pain.[21] In 2011, 89% of VHA medical centers offered CIH therapies[19] and in 2015, 93% offered them.[22]

Given that some CIH therapies might be effective for some types of patients' musculoskeletal pain, it is important to explore patients' uptake of CIH therapies for pain. Knowledge of this can elucidate opportunities for health care to improve patient access to those therapies. However, to date, no one has examined the use of a variety of nonherbal CIH therapies among any large patient population having chronic pain. Barnes et al.[8] and Clarke et al.[23] examined the use of a variety of CIH therapies, but they did so among a large nonpatient population (i.e., the general population responding to the National Health Interview Survey) and did not separately examine that use among respondents with pain. This article addresses that gap by exploring the frequency and predictors of CIH therapy use among a national population of VHA users with chronic musculoskeletal pain. We focused on VHA users who fought in recent wars (e.g., the Iraq and Afghanistan Operation Enduring Freedom [OEF], Operation Iraqi Freedom [OIF], and Operation New Dawn [OND] wars) because these younger veterans have a high prevalence of pain.[24,25]

Materials and Methods

We identified a national cohort of veterans with chronic musculoskeletal pain receiving care at the VA between 2010 and 2013. In a 2-year process, we then found data on the veterans' use of nine CIH therapies by examining VA medical record data for the presence of CIH-related procedure and administrative codes or for the presence of CIH-use text terms (using natural language processing [NLP] and machine learning). We received IRB approval from the Los Angeles VA.

Chronic musculoskeletal pain cohort

We first identified veterans who were most likely involved in the OEF/OIF/OND conflicts as those who would have been 18–40 years of age at the time of these conflicts (i.e., those born 1965–1995). We then identified those with chronic musculoskeletal pain as those met either of two validated criteria:

(1) Having 2+ occurrences of any of 69 musculoskeletal International Classification of Disease, Version 9, Clinical Modification (ICD-9-CM) diagnosis codes ''likely to represent chronic pain'' identified by Tian et al.[26] (Appendix Table 1) and recorded at visits separated by at least 30 days within a year during the 2010–2013 period, or
(2) Having high-impact chronic pain = 2+ occurrences of 201 common musculoskeletal ICD-9-CM codes (adapted from Goulet et al.[27]) within a 90-day period during the study period and two or more pain scores ≥4 within 90 days during 2010–2013. These top 201 musculoskeletal ICD-9-CM codes were identified as representing more than 90% of those with musculoskeletal diagnoses and included the 69 musculoskeletal ICD-9-CM codes from Tian et al.[26] For pain scores, we used the 0–10 numeric pain rating scale that is routinely collected at the VA.[28]

We counted two ICD-9-CM codes or pain scores recorded on the same day as one code/score. This resulted in identifying 530,216 veterans having chronic musculoskeletal pain, with 99% ($n = 524,914$) of our cohort meeting the first criterion and 91% (482,497) meeting the second.

Measures

CIH use. A national advisory group of pain and CIH experts recommended we focus on nine CIH therapies because of the evidence base and relevance to pain: acupuncture, biofeedback, guided imagery, therapeutic massage,

meditation, *t'ai chi*, yoga, hypnosis, and chiropractic visits. Although chiropractic care is accepted as a relatively mainstream treatment, especially in the VHA (chiropractic care was added to the VA's list of approved medical treatments around a decade ago), we include it in our analyses because of its traditional association with CIH.

To identify CIH practice use, we conducted electronic searches of patients' medical records for: (1) structured data (i.e., clinic procedure [CPT4] codes, VA administrative [''CHAR''] codes used to note CIH use in medical records, or chiropractic provider codes); and (2) unstructured narrative clinical notes on CIH use. It was difficult to rely solely on structured/coded data for two reasons. First, only five types of CIH have assigned CPT or provider codes. Also, during our study period (2010–2013), most VA facilities were only beginning to use the VA's recently established administrative [''CHAR''] codes. Accordingly, use of most CIH therapies is recorded in VA medical records solely in unstructured narrative clinical note form. Finally, many patients obtain CIH therapies outside the VA, which would not be captured by VA structured data but could be captured in the narrative notes.

To capture the unstructured narrative notes, we used NLP text mining and machine learning techniques for six CIH therapies: acupuncture, biofeedback, guided imagery, meditation, *t'ai chi*, and yoga. The NLP is a relatively recent valid method for extracting CIH use from the VA's free text clinical notes[29] and for extracting health care use in general.[30] We did not use NLP to look for the use of massage because most cases of ''massage'' found were for non-CIH therapies (e.g., cardiopulmonary massage). Nor were we able to use NLP for hypnosis and chiropractic care because it did not find enough text examples to conduct testing and validation. As such, we used solely CPT4 and VA administrative/provider codes (i.e., did not use NLP) for massage, hypnosis, and chiropractic care. However, chiropractors do deliver therapies for conditions other than pain and spinal manipulation that can be delivered by other providers, so we likely did not capture the full, accurate count of chiropractic care cases.

To conduct the NLP search, we first selected CIH-related keywords with input from our advisory board for (e.g., acupuncture keywords included ''acupuncture,'' ''ACUP,'' ''needling,'' etc.). When a keyword was found, a snippet composed of the keyword together with 30 words before and 30 words after was extracted. For each of the six CIH practices, a subset ($n = 500 \sim 600$) of snippets was selected for human annotation and we developed and iteratively revised an annotation guideline. Next, two independent investigators (S.L.T., N.J.M.) with CIH experience annotated the snippets, independently assigning each to one of four categories based on its indication of use of CIH therapy: (1) ''definite'' indication of current CIH use, (2) ''probable'' indication of current CIH use, (3) ''unclear'' indication (CIH therapy was mentioned but it was unclear whether it was actually used [vs. only a referral was made] or used currently [vs. used in the past]), and (4) ''no'' indication of CIH use. When the two investigators disagreed on a classification, they discussed the case until agreement was reached and, when consensus could not be reached, the fuller study team discussed it. These annotations were then used to generate the NLP search algorithm to identify the four categories of CIH therapy use among the *entire* cohort.

We first ''tokenized'' the snippets by converting all upper cases to lower and removing all punctuations and numbers. Then, we used the remaining words to build features and generated both 1-gram (i.e., word) and 2-gram bag-of-words features (1-gram features are unique words and 2-gram features are two adjacent words that are separated by only white spaces). Because of the large number of 2-gram features, we selected features based on discriminative power. For a category ''c'' and a feature ''w,'' the discriminative power of w with respect to c was defined to be $D\_c\ (w) = [1 - p(c)]/[1 - p\_w\ (c)]$, where p(c) is the proportion of snippets in category c among the training snippets, and p_w (c) is the proportion of snippets in category c among the training snippets containing the feature w. We selected features that occurred in ≥2 snippets and had discriminative power ≥1.5 in either positive or negative category.

We used a support vector machine for classification of the snippets, which is among the best machine learning algorithms for text classification, and linear kernel as it yielded the best performance after experimenting with other types. We used 10-fold cross-validation to measure the classification performance (i.e., splitting the annotated data into 10 subsets, using 9 subsets for training and 1 subset for testing, and repeat the process 10 times). Finally, we calculated performance metrics including area under curve (AUC), accuracy, sensitivity, and specificity, as shown in Table 1. We chose AUC to be the primary metric and the other metrics as secondary metrics. The support vector machine classifiers were tuned to optimize AUC for all experiments. The reported performance was micro-averaged over the 10-folds for each metric. The AUC ranged from 82.8% to 91.8%.

Finally, we then defined ''CIH use'' as having either a structured code signifying CIH use or an NLP ''definite'' or ''probable'' CIH use category. We defined ''no CIH use'' as having no structured code signifying CIH and being in the NLP ''no'' CIH use category.

Musculoskeletal pain and pain comorbidities. We examined six types of musculoskeletal pain (e.g., back pain, neck pain, joint pain, osteoarthritis, temporomandibular disorder, and fibromyalgia) and six types of common pain comorbid conditions (e.g., anxiety, post-traumatic stress disorder, traumatic brain injury, depression, substance abuse, and sleep disorder), as identified by ICD-9 codes. Depression and anxiety included both minor and major conditions.

Sociodemographic variables. As covariates, we examined age, gender, race/ethnicity, and copayment status, which in the VA reflects patients' income and disability levels (those

Table 1. Performance Metrics

	Support vector machine + Bag of words (1, 2-grams)	
	AUC	*Accuracy*
Acupuncture	0.918	0.858
Biofeedback	0.864	0.804
Guided imagery	0.910	0.854
Meditation	0.828	0.833
t'ai chi	0.879	0.818
Yoga	0.856	0.798

AUC, area under curve.

Table 2. Frequency of Complementary and Integrative Health Therapy Use Among Patients with Chronic Musculoskeletal Pain ($N = 468,806$)

CIH Therapy	n *(%)*
Acupuncture	27,605 (5.9)
Biofeedback	13,285 (2.8)
Guided imagery	17,709 (3.8)
Massage	10,460 (2.2)
Meditation	72,008 (15.4)
t'ai chi	9894 (2.1)
Yoga	31,601 (6.7)
Hypnosis	796 (0.2)
Chiropractic	22,314 (4.8)
Any of the above	127,832 (27.3)

CIH, complementary and integrative health.

with no copayments have less income and more disability). Many veterans have additional insurance, so we also assessed the effects of having: the military health insurance TRICARE, formerly known as the Civilian Health and Medical Program of the Uniformed Services (CHAMPUS), private insurance, and Medicare/Medicaid.

Analysis. We first calculated the frequency of each type of CIH therapy use. We then examined differences in patient characteristics between those who used and did not use CIH therapies with cross-tabular (bivariate) analyses using chi-square statistics. For these univariate and bivariate analyses, we removed the ''uncertain'' CIH users ($n = 61,410$), for an analytic sample of 468,806. The results from the NLP process showed that the indication of CIH use in those cases was too unclear to be counted as having used CIH with sufficient certainty. However, we used the full cohort ($n = 530,216$) in a multivariate logistic regression analysis, which included sociodemographic and health factors in the model. For that, we used the model's estimated relationships (coefficients) to estimate the predicted probabilities of CIH use (setting each confounder to its mean value) to increase the interpretability of our findings given our large sample size.[31]

We also conducted two sensitivity analyses using reduced samples: (1) patients having only CIH use codes, designating CIH therapies with available codes and used solely in the VA and (2) patients having only CIH use codes or definite use via NLP (i.e., the ''NLP probable CIH use'' category was dropped).

Three variables were missing some data (marital status = 0.31%, copayment status = 2.1%, and race/ethnicity = 4.9%), so we combined those missing data with ''other'' or ''unknown'' categories as shown in Table 2. Also, given the number of covariates we examined with potentially slightly theoretical overlap, we usually would have explored the degree of multicollinearity present. However, our findings were so highly significant that any multicollinearity present did not inflate the standard errors beyond significance. Also, we did not transform any variables. All analyses were conducted with *STATA* V14.

Results

More than a quarter (27%) of our cohort of younger veterans with chronic musculoskeletal pain appeared to have used at least one of the nine CIH therapies we examined (Table 2). Specifically, 15% used meditation, 7% yoga, 6% acupuncture, 5% chiropractic, 4% guided imagery, 3% biofeedback, 2% *t'ai chi*, 2% massage, and 0.2% hypnosis.

Table 3 shows that veteran CIH users and nonusers differed on each of the veteran characteristics we examined. For

Table 3. Bivariate Associations Between Complementary and Integrative Health Use and Patient Characteristics Among Patients with Chronic Musculoskeletal Pain ($N = 468,806$)

	CIH use n = *127,832* *(27%)*	*No CIH use* n = *340,974* *(73%)*
Age	[a]	[a]
18–34	40,381 (31.6)	105,297 (30.8)
35–44	40,554 (31.7)	106,668 (31.3)
45–54	46,897 (36.7)	129,009 (37.8)
Gender	[a]	[a]
Female	28,463 (22.3)	51,074 (15.0)
Male	99,369 (77.7)	289,900 (85.0)
Race/Ethnicity	[a]	[a]
Non-Hispanic white	76,691 (60.0)	201,440 (59.1)
Non-Hispanic black	28,320 (22.1)	81,616 (23.9)
Hispanic or Latino	12,660 (9.9)	27,697 (8.1)
Non-Hispanic other	5277 (4.1)	11,882 (3.5)
Missing	4884 (3.8)	18,339 (5.4)
Marital status	[a]	[a]
Married	52,821 (41.3)	166,294 (48.8)
Divorced/Separated/ Widowed	41,732 (32.7)	93,395 (27.4)
Single/Never married	33,066 (25.9)	80,026 (23.5)
Missing/Unknown	213 (0.2)	1259 (0.4)
Copayment	[a]	[a]
Exempt	110,525 (86.5)	280,355 (82.2)
Required	8154 (6.4)	43,040 (12.6)
Other+missing	9153 (7.2)	17,579 (5.2)
Insurance status	[a]	[a]
VA+TRICARE/ CHAMPUS[b]	77,144 (60.3)	202,463 (59.9)
Private	23,883 (18.7)	88,744 (26.0)
Medicare/Medicaid	26,805 (21.0)	49,767 (14.6)
Common pain comorbid diagnoses		
Anxiety	46,461 (36.4)[a]	61,092 (17.9)[a]
Post-traumatic stress disorder	70,409 (55.1)[a]	97,581 (28.6)[a]
Traumatic brain injury	21,906 (17.1)[a]	24,239 (7.1)[a]
Depression	84,520 (66.1)[a]	118,055 (34.6)[a]
Substance abuse	71,784 (56.2)[a]	134,089 (39.3)[a]
Sleep disturbance	40,622 (31.8)[a]	75,691 (22.2)[a]
Any of the above	115,539 (90.4)[a]	242,445 (71.1)[a]
Musculoskeletal pain diagnoses		
Back pain	70,259 (55.0)[a]	170,951 (50.1)[a]
Neck pain	25,621 (20.0)[a]	50,470 (14.8)[a]
Joint pain	41,872 (32.8)[a]	142,944 (41.9)[a]
Osteoarthritis	8937 (7.0)[a]	26,410 (7.8)[a]
Tempo-mandibular disorder	812 (0.6)	1368 (0.4)[a]
Fibromyalgia	10,610 (8.3)[a]	22,372 (6.6)[a]

[a]Significant at the $p < 0.0001$ level.
[b]TRICARE, formerly known as the Civilian Health and Medical Program of the Uniformed Services (CHAMPUS).
CIH, complementary and integrative health.

Table 4. Multivariate Predicted Probabilities of Using Complementary and Integrative Health Therapies Among Patients with Chronic Musculoskeletal Pain ($N = 468,806$)

	Predicted probability[a]	*95% CI*
Age		
18–34	0.22	0.22–0.22
35–44	0.25	0.25–0.25
45–54	0.25	0.25–0.25
Gender		
Male	0.23	0.23–0.23
Female	0.33	0.33–0.33
Race/Ethnicity		
Non-Hispanic white	0.24	0.24–0.24
Non-Hispanic black	0.23	0.23–0.24
Hispanic or Latino	0.29	0.29–0.30
Non-Hispanic other	0.28	0.28–0.29
Missing	0.21	0.21–0.22
Marital status		
Married	0.22	0.22–0.22
Single/Never married	0.27	0.27–0.27
Divorced/Separated/Widowed	0.25	0.25–0.25
Missing	0.17	0.17–0.17
Insurance		
VA+TRICARE/CHAMPUS[b]	0.24	0.24–0.24
Medicare/Medicaid	0.29	0.29–0.29
Private	0.22	0.21–0.22
Insurance copayment		
Required	0.17	0.17–0.17
Exempt	0.25	0.25–0.25
Other	0.31	0.30–0.31
Anxiety		
Yes	0.31	0.30–0.31
No	0.23	0.22–0.23
Depression		
Yes	0.33	0.33–0.33
No	0.18	0.18–0.19
Post-traumatic stress disorder		
Yes	0.32	0.32–0.32
No	0.20	0.20–0.20
Traumatic brain injury		
Yes	0.35	0.35–0.35
No	0.23	0.23–0.23
Substance abuse		
Yes	0.28	0.28–0.29
No	0.21	0.21–0.21
Sleep disorder		
Yes	0.27	0.27–0.27
No	0.23	0.23–0.24
Back pain		
Yes	0.26	0.25–0.26
No	0.23	0.23–0.23
Neck pain		
Yes	0.27	0.27–0.27
No	0.24	0.24–0.24
Joint pain		
Yes	0.22	0.22–0.22
No	0.26	0.26–0.26
Osteoarthritis		
Yes	0.23	0.23–0.23
No	0.24	0.24–0.24
Tempo-mandibular disorder		
Yes	0.29	0.29–0.29
No	0.24	0.24–0.24
Fibromyalgia		
Yes	0.27	0.27–0.27
No	0.24	0.24–0.24

[a]All were significant at the $p < 0.0001$.
[b]TRICARE, formerly known as the Civilian Health and Medical Program of the Uniformed Services (CHAMPUS).
CI, confidence interval.

example, women represented 22% of CIH users but only 15% of nonusers. Single and divorced/widowed/separated represented 26% and 33% (respectively) of CIH users but they represented only 23% and 27% (respectively) of nonusers. CIH users also had higher percentages of patients with common pain comorbid conditions (e.g., 66% of CIH users had depression whereas only 35% of nonusers did). Also, for four of the six of the pain conditions we examined, CIH users reported more pain. However, lower percentages of CIH users had osteoarthritis and joint pain than nonusers.

Table 4 reports the multivariate analysis results. It shows that all the covariates that were found to be significant in the bivariate analyses (Table 3) continued to be associated with CIH therapy use. For example, women had a 33% probability of using any CIH whereas men had a 23% probability, Hispanics/Latinos had a 30% probability whereas non-Hispanic blacks had a 23% probability, and single patients had a 27% probability whereas married patients had a 22% probability. When we conducted sensitivity analyses (restricting the sample to patients having only CIH use codes or definite use via NLP; not shown), similar results were produced.

Discussion

Our examination of younger veterans who received care at VHA facilities in 2010–2013 provides the first study of the use of a variety of nonherbal CIH therapies among a large patient population having chronic musculoskeletal pain. We used machine learning and NLP, a novel approach, to identify cases in electronic health record data. We showed that more than a quarter had documented use of CIH therapy. Meditation (15.4%) was the most common type of CIH used, followed by yoga (6.7%) and acupuncture (5.9%). To put our findings into context, our utilization rates are higher than those found in the general population in 2012 (who did not necessarily have pain) for past year use of meditation (8.0%) and acupuncture (1.5), but lower for yoga (9.5).[22] These differences could possibly reflect that meditation and acupuncture are usually provided at no to relatively low cost to veterans in the VA, and evidence from our current study shows that many veterans perceive yoga as being for ''girls.''[32] Also, we found that younger, male, or black veterans were less likely to use CIH therapies, which are similar to findings in the general population.[7,23]

Appropriately resourced CIH therapies might contribute to patient-centered self-management and offer clinicians a feasible alternative to opiates for patients' pain. Busy clinicians are often overwhelmed by patients with pain, and prescribing drugs can be a quick solution when nonpharmacologic options are not readily available, unpopular, unknown, or poorly provisioned. CIH utilization in the VA will likely increase in the near future given the expansion of CIH provision as a nonpharmacological treatment for pain in the VA[21] mandated by Congress in the 2016 Comprehensive Addiction and Recovery Act (CARA).[33]

Our approach has some limitations. First, although we examined patients with chronic musculoskeletal pain, we cannot be certain that CIH therapies were specifically used to manage pain. Documentation available in the records was often unclear or incomplete on the specific purpose of the CIH use. To address this, we only included CIH therapy use that began after a patient's receipt of a musculoskeletal diagnosis and we focused on therapies with promising evidence for pain. Second, the VA chronic musculoskeletal pain patient population is not generalizable to the entire population of chronic musculoskeletal pain patients, even when considering those of the same age. Eighty percent of veteran patients are male, tend to have higher rates of pain, and may have incurred their musculoskeletal pain through active duty situations that incur psychological as well as physical stress not experienced by the general population.[34] However, the VA offers a setting in which to understand the application of CIH toward pain because although twice as many VA as non-VA hospitals offered CIH a few years ago,[18,19] in the near future, CIH will be even more available in the VA with the passage of CARA in 2016 mandating CIH expansion.[33] However, it is not a limitation that we do not know whether the veterans used CIH to treat their pain or any pain comorbid conditions. We did not intend to explore why they used CIH; our intent was simply to explore frequency and predictors of CIH usage.

Although a large strength of our study is that it did not depend on patient self-report, all methods of identifying CIH use in administrative data have challenges. Some structured codes clearly indicate VA provision of CIH therapies; however, only five CIH therapies have CPT4 codes, and the VA's use of structured administrative (CHAR) codes to designate CIH use was nascent at the time. In addition, VA clinicians have high workloads, preventing them from realistically being able to accurately code all patients' use of CIH therapies. As such, our examination of CIH use depended heavily on NLP.

NLP has some limitations in it that involved a somewhat subjective interpretation of clinical notes and, as such, produced some cases of ambiguous use of CIH practices. Accordingly, we excluded those ambiguous cases (the ''uncertains'') from some analyses, but if all the ''uncertains'' were actually CIH users, the upper bounds of CIH use would be 35%, not 27%.

In addition, NLP depends on clinicians actually noting things in medical records, something that busy clinicians do not always have time to do. This could result in an under-reporting of CIH therapy use. Under-reporting of CIH therapy use also can occur when patients neglect to mention it to their physician.

We found that the NLP process performed well for our purposes, as evidenced by the relatively high-performance metrics. Also, NLP can detect CIH use provided by either the VA or non-VA providers; an ability will become increasingly important as the VA expands its care provision via non-VA community-based providers through the CHOICE program. Although NLP has its limitations, this is the first example of using it to identify use of CIH therapies for pain among veterans. Using solely administrative data to detect use of many types of health care, especially CIH therapies (which are known to be poorly coded), can be problematic. This article demonstrates the importance of using both coding and medical record text fields. The value of and demand for NLP has been recognized in various health care arenas, including health outcomes,[30] injury surveillance,[35] and national biomedical efforts such as the Consortium for Health Informatics Research[36] Strategic Health IT Advanced Research Projects,[37] Electronic Medical Records and Genomics.[38]

Conclusions

Veterans with chronic musculoskeletal pain appear to accept CIH therapies, as 27% used them. Use was more common among women and Latino veterans who represent some of the faster growing groups of veterans. However, low rates of some specific CIH suggest the potential to augment CIH use.

Our findings can inform practice in that they demonstrate patients' willingness to use CIH approaches. Given the search for nonopioid pain management options, this is encouraging news for those trying to improve access and use of CIH therapies as a patient-centered, nonpharmacologic alternative for pain. These findings also can inform future research. For example, once the VA has completed widespread implementation of structured CIH use codes, another analysis should be conducted to provide more valid findings that reflect the current national VA emphasis to expand the provision of CIH.

Acknowledgments

This material is based on work supported by the Department of Veterans Affairs, Veterans Health Administration, Office of Research and Development, VA study number IIR 14-435/NIH study number 1 R01 HX001704-1. The authors also would like to acknowledge the help of Michael McGowan and Nui Brown.

Author Disclosure Statement

No competing financial interests exist.

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Appendix Table 1. Musculoskeletal ICD-9 Codes Likely to Represent Chronic Pain

719.41	Joint Pain, Shoulder
719.49	Joint Pain Multiple Sites
719.45	Joint Pain, Hip or Thigh
719.46	Pain Joint—Lower Leg, Knee
719.47	Joint Pain—Ankle
720	Ankylosing Spondylitis
720.2	Inflammation of Sacroiliac Joint, Not otherwise specified
720.9	Inflammatory Spondylopathy, Not otherwise specified
721	Cervical Arthritis
721.1	Anterior Spinal Artery Compression Syndrome
721.2	Thoracic Arthritis
721.3	Lumbar and Sacral Arthritis
721.41	Spondylogenic Compression of Thoracic Spinal Cord
721.42	Lumbar Spondylosis with Myelopathy
721.6	Ankylosing Vertebral Hyperostosis
721.8	Other Allied Disorders of Spine
721.9	Degenerative Spinal Arthritis
721.91	Spondylogenic Compression of Spinal Cord, Not otherwise specified
722	Cervical Disk Displacement
722.1	Displacement of Lumbar Intervertebral Disk without Myelopathy
722.11	Displacement of Thoracic Intervertebral Disk without Myelopathy
722.2	Disk Displacement, Not otherwise specified
722.3	Schmorl's Disease
722.31	Schmorl's Nodes of Thoracic Region
722.32	Schmorl's Nodes of Lumbar Region
722.39	Schmorl's Nodes of Other Region, Not elsewhere classified
722.4	Cervical Disk Degeneration
722.51	Degeneration of Thoracic Intervertebral Disk
722.52	Degeneration of Lumbar Intervertebral Disk
722.6	Degeneration of Intervertebral Disk, Not otherwise specified
722.7	Disk Disease with Myelopathy, Not otherwise specified
722.71	Cervical Disk Disease with Myelopathy
722.73	Intervertebral Disk Disorder of Lumbar Region with Myelopathy
722.8	Postlaminectomy Syndrome, Not otherwise specified
722.81	Postlaminectomy Syndrome—Cervical
722.82	Postlaminectomy Syndrome—Thoracic
722.83	Postlaminectomy Syndrome—Lumbar
722.9	Calcification of Intervertebral Cartilage or Disk, Not otherwise specified
722.91	Calcification of Intervertebral Cartilage or Disk of Cervical Region
722.92	Calcification of Intervertebral Cartilage or Disk of Thoracic Region
722.93	Calcification of Intervertebral Cartilage or Disk of Lumbar Region
723	Cervical Spinal Stenosis
723.1	Cervicalgia
723.3	Cervicobrachial Syndrome
723.4	Brachial Neuritis, Not otherwise specified
723.5	Contracture of Neck, Not otherwise specified
723.6	Panniculitis Affecting Neck
723.7	Ossification Cervical Ligament
723.8	Cervical Syndrome, Not elsewhere classified
723.9	Disorder of Cervical Region, Not elsewhere classified
724	Spinal Stenosis, Not otherwise specified
724.01	Spinal Stenosis of Thoracic Region
724.02	Spinal Stenosis of Lumbar Region
724.09	Spinal Stenosis, Not otherwise specified
724.1	Pain in Thoracic Spine
724.2	LBP [Low-Back Pain]
724.3	Cotungo's Disease
724.4	Lumbosacral Neuritis, Not otherwise specified
724.5	Back Pain
724.6	Ankylosis of Lumbosacral Joint
724.7	Disorder of Coccyx, Not otherwise specified
724.79	Coccydynia
724.8	Ossification of Posterior Longitudinal Ligament, Not otherwise specified
724.9	Ankylosis of Spine, Not otherwise specified
729	Fibrositis, Not otherwise specified
729.1	Fibromyalgia
729.2	Neuralgia, Not otherwise specified
729.4	Fasciitis
729.5	Pain in Limb

Source: Tian et al.[26]
ICD-9-CM, International Classification of Disease, Version 9, Clinical Modification.