The Effect of Acupuncture Utilization on Healthcare Utilization

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Objective: To determine whether acupuncture is a complement to or substitute for various medical services.

Data Source: This study used managed care claims data from a midsize metropolitan insurance company from 2002. Zip code level data from the 2000 US Census was also incorporated. The original dataset contained medical and drug claims data for every eligible acupuncture user (n = 1688) and every 18th eligible nonacupuncture user (n = 16,282) covered by the data provider.

Study Design: Simultaneous equations models with an exclusion restriction were used in this cross-sectional study. The influence of acupuncture utilization was assessed independently on each conventional service of interest, controlling for numerous clinical and demographic characteristics. Bivariate probit models were estimated using distance to the nearest acupuncturist as the exclusion restriction.

Results: Acupuncture was a statistically significant ($P < 0.05$) substitute for primary care, all outpatient services, pathology services, all surgery, and gastrointestinal medications. Acupuncture seemed to complement numerous therapies, particularly chiropractic and physical therapy; however, acupuncture did not statistically significantly complement any therapies after controlling for unobservable characteristics that influence the use of acupuncture and/or conventional medicine.

Conclusions: Acupuncture is an economic substitute for some medical services and pharmaceuticals, a finding of some importance to insurers, healthcare practitioners, and policy makers. The fact that acupuncture has an effect on other medical services needs to be explored more fully with an emphasis on how this substitution impacts patient health.

Key Words: acupuncture, bivariate probit model, claims data, healthcare utilization

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Acupuncture is a distinct healing tradition whose scope in terms of utilization, spending, and research has increased significantly in recent years. Despite these trends, little is known about acupuncture's relationship with other medical services. The central aim of this study is to determine the degree to which acupuncture is a substitute for or complement to other medical services. Acupuncture can plausibly be complementary medicine, leading to additional medical expenditures and an increase in the utilization of other medical services. It is equally plausible that acupuncture is alternative medicine, replacing other, possibly more expensive services, lowering total medical expenditures.

The use of acupuncture increased through the 1990s, as 0.4% of the general population saw a practitioner in 1994 compared with 1% of the population in 1997.[1,2] A 1997 survey of a managed care plan with 650,000 enrollees similarly estimated that 1% used acupuncture.[3] During the mid-1990s, approximately $500 million was spent on between 9 and 12 million visits to acupuncturists each year.[4] In a survey of the major insurance providers in the New York, New Jersey, and Connecticut tristate area, Cleary-Guida and coworkers found that less than half (17 of 43) covered acupuncture, which is similar to national estimates.[5,2]

A substantial amount of research exists to suggest that acupuncture may be a substitute for some conventional medical practices. A survey of 26 chronic migraine patients using acupuncture reported a 50% decrease in drug intake during the study period; the methodology for recording drug intake, however, was not reported.[6] In a survey of 575 acupuncture users, participants were asked to give their opinion on their healthcare utilization changes as a result of acupuncture.[7] With acupuncture, 84% of the participants reported that they were able to reduce physician visits. Similarly, 79% reported reduced prescription medicine use, 78% reported reduced physical therapist use, and 70% reported avoiding surgery. Seventy-seven percent of the respondents reported that acupuncture reduced insurance reimbursement claims.

In 2004, the NIH issued a Consensus Statement on Acupuncture, supporting the use of acupuncture for adult postoperative and chemotherapy nausea and vomiting, and postoperative dental pain. The statement also indicated that acupuncture might be an effective treatment option for addiction, stroke rehabilitation, headache, menstrual cramps, fibromyalgia, myofascial pain, osteoarthritis, low back pain,

carpal tunnel syndrome, and asthma, suggesting that using acupuncture is reasonable and likely has therapeutic benefit.[8]

Background

There is little analytic literature regarding the use of acupuncture and its relationship with conventional medicine. Where necessary, significant background information is drawn from other, nonconventional medical therapies commonly referred to as CAM. According to the National Center for Complementary and Alternative Medicine, CAM refers to "a group of diverse medical and health care systems, practices, and products that are not presently considered to be part of conventional medicine."[8]

Research suggests that women use CAM significantly more than men.[2,9,10] The relationship between age and CAM use resembles a bell-curve, with CAM use most likely among those aged 35–49 than those younger or older.[2] Other researchers have reported similar results with slightly different age categories.[1,9,10] Limited but consistent research suggests that racial and ethnic minorities are significantly less likely than whites to use CAM.[2,10,11]

Several cross-sectional surveys have found poorer health status to be a predictor of CAM use.[2,12–15] Similarly, several studies have found that CAM users also have higher prevalence of chronic conditions than CAM nonusers.[2,14,16–19] CAM users also tend to have a greater number of physical symptoms, greater symptomatic intensity, and longer disease duration than CAM nonusers.[17,20,21] At the same time, limited research suggests that CAM users are more preventive minded than non-CAM users and more commonly practice good health habits, such as reducing stress and getting proper sleep.[16,17,22] The cultural experiences of CAM users have also been explored, suggesting that CAM users and nonusers differ in how they view and use medicine.[12,22] From an analytic standpoint using claims data, these unobservable cultural differences that guide healthcare use are captured by the error term. If these cultural differences affect the use of acupuncture and conventional medicine differently, they could introduce endogeneity bias.

There is considerable evidence supporting an inverse relationship between distance to other medical services and utilization of those services,[23–26] even in relatively small geographic areas.[27] Distance to a provider has also been successfully used as an instrumental variable to produce causal estimates.[28]

METHODS

All statistical procedures used in this evaluation were done using Stata Statistical Software Version 8.0.[29]

This study used claims data from a large insurance company in New York State. The anonymous data provider, referred to as "The Company," insures over 80% of the area's midsize metropolitan market. The Company provided all claims data for 2002 for a sample of its managed care population, including every acupuncture user and 5.6% of nonacupuncture users (every 18th), based on an enrollee's randomly generated unique identifier. The original dataset from The Company included 25,824 individuals who had a medical claim in 2002. After eliminating enrollees <18 years of age, not living in 1 of the 6 contiguous counties that The Company primarily served, and without a valid zip code, the final sample size was 17,970, including 1688 acupuncture users. Valid zip codes were required to pair enrollees with data from the 2000 United States Census for neighborhood measures and to determine minimum distance to the nearest acupuncturist in conjunction with acupuncturists' street address. Pharmacy data were only included for those people with a medical claim. Enrollees in the dataset belonged to 1 of 5 managed care plans, which contained varied and unspecified levels of coverage for services other than acupuncture and an identical 50% copayment for acupuncture across all managed care plans.

The Company censored data for all enrollees pertaining to Protected Health Information (PHI), which entailed the omission of claims where the primary diagnosis or reimbursed procedure related to mental illness, substance abuse, HIV/AIDS, genetic testing, abortion, and sexually transmitted diseases.

Measures

Acupuncture use was defined as having received acupuncture as indicated by a Current Procedure Terminology (CPT) code of 97780 or 97781,[30] implemented as a dichotomous variable. In The Company's state, acupuncturists can only perform acupuncture and cannot prescribe medications or perform other manipulations. Similar outcome variables were constructed for analyses of conventional services and are listed in Tables 2 and 3.

Age was defined as the age of the enrollee as of January 1, 2002, and were grouped into the following categories: 18–30, 31–40, 41–50, 51–60, 61–70, and 71–105, with age 41–50 being the reference group in analytic models. Age was not used as a continuous variable because background literature suggests a nonlinear relationship between age and CAM use.

The Johns Hopkins' Adjusted Clinical Groups (ACG) Case-Mix System (Version 6.1) was used to account for differences in patients' illness profiles.[31] The ACG system assigns all ICD-9 codes that patients had over a 1-year period to 1 of 32 mutually exclusive Ambulatory Diagnostic Groups (ADG). This assignment is based on the following illness characteristics: duration, severity, diagnostic certainty, etiology, and specialty care. There is a significant amount of literature supporting the use of ACGs as a case-mix tool, especially for claims data.[32,33]

Distance and travel time to the nearest acupuncturist were calculated using enrollee's zip codes and the street addresses for acupuncturists. The Internet based program Mapquest was used to compute the minimum driving distance (in miles) and time (in minutes) from the street address to the center of the enrollee's zip code.[34]

Analysis

Bivariate analyses were performed at the person level to compare acupuncture users and nonusers; t tests and χ^2 tests were used where appropriate. All tests were conducted with an α of 0.05. All comparisons and regression analysis were weighted to account for the relative oversampling of

acupuncture users and to generate results that are representative of the original sampling universe.

Maximum likelihood probit models were used throughout the study. A probit model was estimated that contained acupuncture use as the dependent variable and served as the first equation for simultaneous equations models. This model determined the influences of demographic characteristics, illness profiles, and distance to the nearest acupuncturist on the probability of acupuncture use. Probit models were also used to analyze the influence of acupuncture use on the use of various conventional medical services. For this set of models, acupuncture use was included as an independent variable in a series of models with each conventional medical service included, one at a time, as the dependent variable. By default, Stata calculates Huber-White robust standard errors when using weighted data. All regression analyses were clustered by zip code.

Numerous unobservable characteristics (beliefs, culture, and religion) are captured in the error term and may differentially affect the use of acupuncture and conventional medicine or their relationship to each other, causing both acupuncture and conventional medicine to be correlated with the error term. This endogeneity bias can be addressed using simultaneous equations models, which can be used to produce quasi-randomization in the absence of temporality, thus generating unbiased estimates of causal relationships.[35,36] Applying 2 key assumptions described by McClellan and Newhouse[36] for the use of instrumental variables to this study means that distance to the nearest acupuncturist cannot have an independent effect on the use of conventional medicine and must be a significant predictor of acupuncture use.

The ability of this study to produce causal estimates rests heavily on the strength of the exclusion restriction (ie, the instrument). An assumption of this current work is that being close to an acupuncturist matters in the decision to use acupuncture. Another assumption is that there is sufficient geographic distribution of acupuncturists and that distance to the nearest acupuncturist is not related to other covariates. This should be satisfied by the variety of neighborhood-level measures found in the 105 zip codes included in this dataset. For the exclusion restriction to identify the effect of acupuncture, distance to the nearest acupuncturist cannot be correlated with distance to the nearest conventional provider. This is assessed by adding distance to the nearest acupuncturist as a covariate in the models predicting the various conventional medical services. [We later establish that acupuncture use is statistically significantly negatively associated with distance to the nearest acupuncturist. The literature suggests that we can assume that the same relationship exists for distance to the nearest conventional practitioner and utilization of conventional medicine.[23–27] If distance to the nearest acupuncturist is correlated with distance to the nearest conventional practitioner, we would expect distance to the nearest acupuncturist to be associated with conventional medical utilization, which we did not find to be the case. Although this does not prove that distance to the nearest acupuncturist and distance to the nearest conventional practitioner are not correlated, it does suggest that they are not strongly correlated.]

Bivariate probit models were estimated with an exogenous exclusion restriction in 1 equation, allowing for the prediction of 2 separate but potentially related outcomes.[35] Simultaneous equations models with the following structure were used:

Y_1 = Use of acupuncture

Y_2 = Use of Conventional Service (all inpatient, outpatient primary care, outpatient neurology, chiropractic, physical therapy, all surgery, surgery – non-musculoskeletal, surgery – musculoskeletal, allergy services, all pharmacy, pain medications, steroids, migraine medications, gastro–intestinal (GI) medications, antibiotics, antihistamines, cardiotonics, and diabetes medications)

$$Y_1^* = \beta_1 X + Z_1 + \varepsilon_1$$

$$Y_2^* = \alpha_2 Y_1 + \gamma_1 X + \varepsilon_2$$

$$Y_1 = 1 \quad \text{if} \quad Y_1^* > 0,$$

0, otherwise

$$Y_2 = 1 \quad \text{if} \quad Y_2^* > 0,$$

0, otherwise

where X is the covariates discussed above (gender, age categories, race/ethnicity categories, median income, urban population, ADG categories, insurance plan);

where Z is the exclusion restriction (distance to the nearest acupuncturist).

This set of models estimates the effect of acupuncture use on the probability of using various conventional services, with a separate model for each service listed after Y_2.

Because of the inherent difficulty in interpreting coefficients of nonlinear models, the mean prediction effects of acupuncture use on the various conventional services were estimated. To identify the effect attributable to acupuncture use, controlling for all other factors, the marginal probability of using the specified conventional service was estimated after assigning everyone to having received acupuncture (denoted p1). The marginal probability was then calculated after assigning everyone to having not received acupuncture (denoted p0). The difference between these 2 probabilities is the mean effect of acupuncture use on the probability of the specified conventional service (p1 − p0) and indicates the absolute expected change in the utilization of a particular service if everyone used acupuncture.

RESULTS

Acupuncture users were older, with a mean age of 46.8-year-old compared with 42.1 year for nonusers ($P < 0.001$), and more likely to be female, as 57% of acupuncture users were female compared with 30.2% of nonusers ($P < 0.001$). Travel time and distance to the nearest acupuncturist were both found to be significantly less for acupuncture users compared with nonusers. Acupuncture users lived an average of 6.2 miles, or 11.8 minutes, away from the nearest acu-

puncturist compared with 8.7 miles, or 15.4 minutes, for nonacupuncture users (both $P < 0.001$).

Based on data from the 2000 US Census and the zip code level address provided in the dataset, numerous zip code level characteristics were included in this study. The US Census reports median income at the zip code level to the nearest dollar. Acupuncture users lived in zip codes with a higher mean family income than nonusers ($52,042 vs. $49,431, $P < 0.001$). Acupuncture users were more likely than nonusers to live in an urban compared with a rural area (84% vs. 77.4%, $P < 0.001$), where rural is defined by the US Census Bureau as having a population density of <1000 people per square mile.[37] The other zip code level comparisons found that acupuncture users and nonusers lived in neighborhoods with similar racial and ethnic composition but that acupuncture users' neighborhoods had higher levels of educational attainment.

The prevalence of acupuncture use was calculated in the total sample, as well as in certain, nonmutually exclusive diagnostic subgroups. Table 1 summarizes the different subgroups and their prevalence. Comparing the percentages in columns 2 and 3 indicates that every disease subgroup is more common among acupuncture users than in the dataset population. The difference can be quite marked, for example, as 88% of acupuncture users suffer from a musculoskeletal disorder, compared with 36% of the total population. Acupuncture use was found to be higher in several disease subgroups than in the total population. Although acupuncture prevalence was 0.61% in the total sample, 5.1% of people suffering from headaches used acupuncture.

Acupuncture users had both higher member expenditures ($381 vs. $100, $P < 0.001$) and higher plan expenditures ($3322 vs. $1644, $P < 0.001$), than nonusers. Acupuncture users were also more likely to have prescription drug expenditures (87.9%), compared with nonusers (77.7%), with nearly double the expenditures per prescription drug user ($1751 vs. $958, $P < 0.001$).

TABLE 1. Diagnostic Subgroup Prevalence

Diagnostic Subgroup	Diagnostic Subgroup Prevalence in the Total Sample N (%)*	Diagnostic Subgroup Prevalence Among Acupuncture Users N (%)
Digestive disorders	6187 (38.0)†	817 (48.4)
Musculoskeletal disorders	5927 (36.4)	1485 (88.0)
Respiratory disorders	5845 (35.9)	701 (41.5)
Circulatory disorders	3647 (22.4)	456 (27.0)
Pain	3175 (19.5)	994 (58.9)
Cancer	2442 (15.0)	419 (24.8)
Infectious diseases	1579 (9.7)	214 (12.7)
Headaches	472 (2.9)	408 (24.2)
Total	16,282	1688

*Sample sizes are unweighted.
†All between group tests of equivalence on percentage of users with each diagnosis were significant at $P < 0.0001$.

TABLE 2. Service Utilization and Expenditures: Descriptive Results

	Acupuncture Users		Nonusers	
Conventional Service	Utilization N Proportion (SD)	Mean Expenditure per User (US$) (SD)	Utilization N Proportion (SD)	Mean Expenditure per User (US$) (SD)
Total medical expenditures	1688	3703 (9219)‡	16,282	1743 (5643)
	1.0 (NA)		1.0 (NA)	
Chiropractic	608		1612	
	0.36 (0.48)‡	352 (293)‡	0.099 (0.30)	270 (209)
Allergy services	108		391	
	0.064 (0.25)‡	556 (515)	0.024 (0.15)	475 (372)
Pathology	1350		11,397	
	0.80 (0.40)‡	89 (180)‡	0.70 (0.46)	62 (142)
Surgery: all	776		5047	
	0.46 (0.50)‡	1187 (57)‡	0.31 (0.46)	900 (1703)
Surgery: musculoskeletal	236		1026	
	0.14 (0.34)‡	1029 (1266)	0.063 (024)	890 (1166)
Physical therapy	236		602	
	0.14 (0.34)‡	574 (556)‡	0.037 (0.19)	401 (0.328)
Outpatient neurology	68		277	
	0.040 (0.20)‡	118 (88)	0.017 (0.13)	112 (89)
Outpatient primary care	743		6838	103
	0.44 (0.50)	122 (93)‡	0.42 (0.49)	103 (79)
Emergency	9		88	
	0.0053 (0.073)	87 (46)	0.0054 (0.073)	104 (145)

*P value <0.1; †P value <0.05; ‡P value <0.01; and §P value <0.001. P values refer to tests of equivalence between acupuncture users and nonusers.

Table 2 describes the utilization and expenditure patterns of acupuncture users and nonusers for several conventional medical services. Columns 2 and 4 indicate the proportion of acupuncture users and nonusers, respectively, which used the conventional medical service of interest. Columns 3 and 5 present the average expenditures on the conventional service among only those who used the service. Table 2 illustrates that acupuncture users are not only more likely to use nearly every type of service, but they also spend significantly more on each service. Table 3 summarizes drug utilization and expenditures by class of drug, following the same format as Table 2, found above.

Table 3 shows that acupuncture users were more likely than nonusers to use several classes of pharmaceuticals, including antibiotics, cardiotonics, GI medications, pain medications, antihistamines, chemotherapy, migraine medications, and steroids. Acupuncture users also spent significantly more on GI medications, pain medications, and antihistamines than nonusers.

First stage modeling predicting acupuncture use did not produce results that differ greatly from the existing literature. Gender was a significant predictor of acupuncture use with a mean predicted probabilities difference of −0.0017 for males ($P < 0.001$). Those in the age categories of 18–30, 31–40, and 61–70 were all statistically significantly less likely to use acupuncture than those of age 41–50, with differences in predicted means of −0.0046, −0.0027, and −0.0019, respectively (P values of <0.001, <0.001, and 0.033, respectively).

First stage modeling also found distance to the nearest acupuncturist to be significantly related to acupuncture use with a coefficient of −0.013 ($P < 0.001$). Artificially changing distance to the nearest acupuncture indicates that acupuncture use is fairly sensitive to changes in distance. For example, if everyone lived 20 miles from the nearest acupuncturist, the predicted probability of acupuncture use would be 47% less than if everyone lived right next to an acupuncturist. First stage modeling was also estimated using travel time to the nearest acupuncturist in place of and together with distance to the nearest acupuncturist; the findings from this analysis were not substantively different and the predictive power of the model did not improve (data not shown). Although not a verifiable proof that distance to the nearest acupuncturist is unrelated to conventional provider use, distance to the nearest acupuncturist was not directly associated with any of the conventional services (data not shown). The first stage model was estimated using linear regression as a test for weak instruments, yielding an F statistic of 32.18. This exceeds the threshold for weak instruments proposed by Stock et al.[38]

Table 4 outlines the results of 2 parallel utilization models, both analyzing the impact of acupuncture on the use of various conventional services. Each row represents a different pair of probit and bivariate probit models, such that each model only contains 1 conventional service at a time. The last column presents results specific to each bivariate probit model, indicating the characteristics of ρ, or the cor-

TABLE 3. Pharmacy Utilization and Expenditures: Descriptive Results

	Acupuncture Users		Nonusers	
Drug Class	**Utilization N Proportion (SD)**	**Mean Expenditure per User (US$) (SD)**	**Utilization N Proportion (SD)**	**Mean Expenditure per User (US$) (SD)**
All pharmacy expenditures	1458 0.88 (0.33)‡	1751 (3236)‡	12,700 0.78 (0.42)	958 (2175)
Antiobiotics	928 0.55 (0.50)‡	167 (627)	7001 0.43 (0.50)	133 (1053)
Cardiotonics	540 0.32 (0.47)‡	617 (1102)	4071 0.25 (0.43)	612 (1355)
Diabetes	66 0.039 (0.19)	2141 (2216)	700 0.043 (0.20)	1742 (1754)
GI	354 0.21 (0.40)‡	870 (1328)†	2279 0.14 (0.34)	634 (969)
Pain	793 0.47 (0.50)‡	436 (1121)§	4559 0.28 (0.45)	240 (1070)
Antihistamines	692 0.41 (0.49)‡	463 (715)‡	4071 0.25 (0.43)	280 (472)
Chemotherapy	35 0.021 (0.14)†	2413 (5417)	179 0.011 (0.10)	2118 (3993)
Migraine	122 0.072 (0.26)‡	1374 (1890)	391 0.024 (0.15)	742 (1138)
Steroids	439 0.26 (0.44)‡	186 (222)	2117 0.13 (0.34)	164 (288)

*P value <0.1; †P value <0.05; ‡P value <0.01; and §P value <0.001. P values refer to tests of equivalence between acupuncture users and nonusers.

TABLE 4. Association with and Effect of Acupuncture Other Medical Services

	Probit		Bivariate Probit		
Service	Coefficient on Acupuncture (SE)	Diff	Coefficient on Acupuncture (SE)	Diff	ρ (SE)
Inpatient: all	−0.21 (0.11)*	−0.0045	−0.21 (0.47)	−0.0045	0.0018 (0.17)
Chiropractic	0.55 (0.051)§	0.11	0.16 (0.19)	0.026	0.15 (0.065)†
Primary care	−0.26 (0.041)§	−0.085	−0.44 (0.19)†	−0.14	0.071 (0.058)
Neurology	−0.020 (0.063)	−0.00082	−0.48 (1.02)	−0.014	0.20 (0.48)
Pathology	−0.33 (0.045)§	−0.075	−0.48 (0.13)§	−0.11	0.056 (0.048)
Emergency	−0.21 (0.080)‡	0.60	−0.63 (0.34)*	−0.024	0.17 (0.14)
Preventive	−0.033 (0.045)	−0.0067	0.28 (0.33)	0.064	−0.12 (0.12)
Surgery: all	−0.22 (0.035)§	−0.052	−0.28 (0.10)‡	−0.068	0.026 (0.037)
Surgery: nonmusculoskeletal	−0.20 (0.033)§	−0.046	−0.31 (0.08)§	−0.070	0.045 (0.040)
Surgery: musculoskeletal	−0.025 (0.047)	−0.0024	−0.32 (0.17)*	−0.026	0.12 (0.057)†
Digestive	−0.22 (0.059)§	−0.022	−0.21 (0.18)	−0.021	0.00002 (0.067)
Outpatient: all	−0.14 (0.059)†	−0.027	−0.30 (0.11)†	−0.059	0.056 (0.035)
Physical therapy	0.18 (0.048)§	0.015	−0.35 (0.30)	−0.021	0.22 (0.11)*
Allergy	0.17 (0.092)*	0.0069	0.46 (0.23)†	0.023	−0.12 (0.084)
Evaluative	−0.94 (0.094)§	−0.13	−1.97 (0.58)‡	−0.30	0.36 (0.20)*

Each service type was included in a separate model with acupuncture use as an independent variable.
*P value <0.1; †P value <0.05; ‡P value <0.01; and §P value <0.001.

TABLE 5. Association With and Effect of Acupuncture on Relevant Pharmaceuticals

	Probit		Bivariate Probit		
Drug Class	Coefficient on Acupuncture (SE)	Diff	Coefficient on Acupuncture (SE)	Diff	ρ (SE)
Pharmacy: all	−0.087 (0.055)	−0.022	−0.45 (0.16)‡	−0.12	0.13 (0.056)†
Pain	−0.054 (0.033)*	−0.016	−0.80 (0.25)‡	−0.18	0.29 (0.088)‡
Steroids	0.028 (0.048)	0.0050	−0.40 (0.30)	−0.060	0.17 (0.14)
Migraine	0.24 (0.064)§	0.016	−0.54 (0.50)	−0.019	0.33 (0.26)
GI	−0.30 (0.043)§	−0.050	−1.24 (0.17)§	−0.13	0.39 (0.091)§
Antibiotics	−0.0034 (0.042)	−0.0011	−0.19 (0.19)	−0.059	0.070 (0.065)
Antihistamines	0.16 (0.043)§	0.043	−0.13 (0.42)	−0.033	0.11 (0.17)
Chemotherapy	0.014 (0.075)	0.00035	0.088 (0.31)	0.0023	−0.029 (0.12)
Diabetes	−0.19 (0.080)†	−0.012	−0.051 (0.28)	−0.0036	−0.052 (0.12)
Vitamins	−0.076 (0.075)	−0.0029	0.033 (0.44)	0.0014	−0.041 (0.18)
Cardiotonics	−0.14 (0.045)‡	−0.030	−0.21 (0.17)	−0.045	0.029 (0.065)

Each drug class was included in a separate model with acupuncture use as an independent variable.
*P value <0.1; †P value <0.05; ‡P value <0.01; and §P value <0.001.

relation of the error terms in the 2 equations in the bivariate probit model. Table 5 uses the same structure for pharmacy utilization comparisons.

Numerous conventional services were negatively associated with acupuncture use (Table 4). Reporting the difference in mean predicted probabilities measure, acupuncture was statistically significantly associated with the following services: outpatient primary care (−0.085), pathology (−0.075), emergency (−0.60), all surgery (−0.052), nonmusculoskeletal surgery (−0.046), anesthesia (−0.021), digestive services (−0.022), all outpatient services (−0.027), and evaluative services (−0.13). Again, the difference in mean predicted probabilities indicates the predicted absolute change in utilization of that service if everyone used acupuncture. Bivariate probit analysis determined that some services were statistically significantly substituted by acupuncture, including primary care (−0.14), pathology (−0.11), all surgery (−0.068), nonmusculoskeletal surgery (−0.070), all outpatient services (−0.059), and evaluative services (−0.30).

Fewer services were found to be complements of acupuncture use. From the probit models, chiropractic (0.11), physical therapy (0.015), and allergy services (0.0069), were the only services that reached statistical significance. Of these, only allergy service utilization was statistically significant in the bivariate probit model (0.023).

Acupuncture use was significantly associated with the use of many pharmaceuticals, as seen in Table 5. In the probit

models, acupuncture was negatively associated with GI medications (−0.050), diabetes medications (−0.012), and cardiotonics (−0.030). Of these, only the use of GI medications (−0.13) was statistically significant in the bivariate probit model. Some pharmaceuticals were statistically significantly substituted by acupuncture as determined by the bivariate probit models after being statistically unrelated to acupuncture use in the probit models. The use of any pharmaceuticals was an example of this (−0.12), as was pain medications (−0.18).

DISCUSSION

In analyzing the effect of acupuncture on other medical services, unobserved characteristics not recorded in claims data may impact acupuncture and its relationship with conventional medicine, introducing endogeneity bias. A simultaneous equations approach can sort out the effects of the unobservable characteristics to identify the causal effect of acupuncture on conventional medical care use. From these analyses, acupuncture use does affect the utilization of other medical services and pharmaceuticals; failure to account for the unobservable factors can lead to incorrect conclusions about the effect of acupuncture on other medical services. For example, simple probit analyses did not find a statistically significant relationship between acupuncture and pain medications. Isolating the effect of acupuncture and controlling for unobservable characteristics, indicates that acupuncture is a statistically significant substitute for pain medications, with a decrease in predicted probability of 18% ($P < 0.01$). The simultaneous equations models isolate the effects of using acupuncture, separately from who uses acupuncture, showing a very different relationship than the initial probit models. In the case of pain medications, the decision to use the bivariate probit model is bolstered by a large and statistically significant correlation parameter between the 2 equations errors ($\rho = 0.29$, $P < 0.01$).

Reluctance to cover acupuncture by insurance companies for fear of increased costs may be unfounded; however, additional expenditures research is necessary. This study suggests that expenditures on acupuncture may be offset through reductions in other healthcare utilization. Further, there is conflicting suggestive evidence as to whether or not offering CAM coverage attracts healthier, more preventive oriented people[3,39] or typical CAM users, who tend to be sicker.[2,11,40] Although this study did determine that insurance-covered acupuncture users are substantially sicker than insurance-covered nonacupuncture users, the substituting nature of acupuncture may offset these illness profile changes, a relationship that warrants further investigation.

One finding that warrants further investigation is the highly substitutive effect of acupuncture on evaluative services with a decreased predicted probability of nearly 30%. This suggests that acupuncture may offer a different rationale for evaluation and disease management from other insured medical services. The same applies to pathology, which acupuncture also significantly substituted, implying that acupuncture provides different criteria or explanation for diagnosis. These results, coupled with acupuncture's substitutive effect on primary care supports the notion that acupuncture provides an explanatory framework for health that differs from other medical services. Although this analysis suggests that acupuncture complements preventive services, future research should investigate specific preventive services, such as cancer screening, to determine the full impact of acupuncture's substitution effect on patient health.

The strong statistically significant substitution of GI medications by acupuncture could be due to acupuncture as well as its place in the broader practice of Traditional Chinese Medicine. A typical Traditional Chinese Medicine visit includes dietary and lifestyle recommendations, such as stress management techniques and relaxation exercises, which could have an effect on the utilization of laxatives, antacids, antidiarrheals, antiemetics, ulcer medications, and digestive aids.[41] This, coupled with evidence of acupuncture's effectiveness in this clinical area, could explain the strong substitution effect of acupuncture on GI medications.[8]

It is arguably as important to understand what conventional services acupuncture does not replace as it is to understand what conventional services acupuncture does replace. Although several of the statistically significant findings warrant attention, caution should be exercised before dismissing nonstatistically significant findings as not being impacted by acupuncture. Many of the nonstatistically significant findings had relatively large point estimates and changes in predicted probabilities but were imprecisely estimated (eg, preventive visits, digestive care visits, physical therapy, antihistamines, and migraine medications). These should be analyzed with a larger dataset of acupuncture users to determine if acupuncture truly has no effect on their utilization. These findings are different than more precisely estimated results that are close to zero, such as with the use of chemotherapy, diabetes medications, and vitamins, for which acupuncture seems to have no effect.

The methods used in this study are subject to certain limitations and conditions. The exclusion restriction met the requirements described by McClellan and Newhouse,[36] in that it was a predictor of acupuncture use but was not a predictor of conventional medicine use. This satisfies the condition that the exclusion restriction predicts only the endogenous regressor and, by extension, suggests that distance to the nearest acupuncturist is not strongly correlated with distance to the nearest conventional practitioner. First stage modeling supports that distance to the nearest acupuncturist is not a weak instrument, as evidenced by an F statistic of 32.18 from linear regression analysis.[38] In addition to having a strong instrument, the nonlinearities of simultaneous equations modeling aided in identifying the causal effect of acupuncture on other medical services, helping to account for unobservable characteristics (culture, beliefs, religion) that influence the use of both acupuncture and conventional medicine.

Some limitations of this study are inherent in any research using claims data. Claims data only captures insured utilization, affecting the patient record for many CAM therapies as well as all over-the-counter pharmaceuticals. The dataset also only contained nonzero utilization for 2002. Further, claims databases capture diagnosed and not self-

reported conditions, potentially introducing bias if the discrepancy between having a condition and having a diagnosis for a condition differs between the 2 groups.

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