Published in final edited form as:
Matern Child Health J. 2010 November ; 14(6): 922–930. doi:10.1007/s10995-009-0519-5.

Pediatric Vaccination and Vaccine-Preventable Disease Acquisition: Associations with Care by Complementary and Alternative Medicine Providers

Lois Downey,
Harborview Medical Center, Division of Pulmonary and Critical Care, Department of Medicine, School of Medicine, University of Washington, Box 359765, 325 Ninth Avenue, Seattle, WA 98104, USA

Patrick T. Tyree,
Department of Health Services, School of Public Health, University of Washington, Seattle, WA, USA

Colleen E. Huebner, and
Department of Health Services, School of Public Health, University of Washington, Seattle, WA, USA

William E. Lafferty
Office of Health Services and Public Health Outcomes Research, University of Missouri – Kansas City, Kansas City, MO, USA

Lois Downey: ldowney@u.washington.edu

Abstract

This study investigated provider-based complementary/alternative medicine use and its association with receipt of recommended vaccinations by children aged 1–2 years and with acquisition of vaccine-preventable disease by children aged 1–17 years. Results were based on logistic regression analysis of insurance claims for pediatric enrollees covered by two insurance companies in Washington State during 2000–2003. Primary exposures were use of chiropractic, naturopathy, acupuncture, or massage practitioner services by pediatric enrollees or members of their immediate families. Outcomes included receipt by children aged 1–2 years of four vaccine combinations (or their component vaccines) covering seven diseases, and acquisition of vaccine-preventable diseases by enrollees aged 1–17 years. Children were significantly less likely to receive each of the four recommended vaccinations if they saw a naturopathic physician. Children who saw chiropractors were significantly less likely to receive each of three of the recommended vaccinations. Children aged 1–17 years were significantly more likely to be diagnosed with a vaccine-preventable disease if they received naturopathic care. Use of provider-based complementary/alternative medicine by other family members was not independently associated with early childhood vaccination status or disease acquisition. Pediatric use of complementary/alternative medicine in Washington State was significantly associated with reduced adherence to recommended pediatric vaccination schedules and with acquisition of vaccine-preventable disease. Interventions enlisting the participation of complementary/alternative medicine providers in immunization awareness and promotional activities could improve adherence rates and assist in efforts to improve public health.

Correspondence to: Lois Downey, ldowney@u.washington.edu.

Keywords

Pediatric vaccination; Complementary/alternative medicine; Public health; Vaccine-preventable diseases; Chiropractic; Naturopathy

Introduction

Experts have hailed vaccination as one of ten great Twentieth Century achievements in public health in the United States (US) [1]. Pediatric vaccines have dramatically reduced infectious disease and childhood mortality [2]. The US government's “Healthy People 2010” initiative has set coverage goals for six vaccines recommended for universal use in young children [3].

However, the recommendations are not without controversy. Some parents choose to delay vaccinating their children or forgo vaccination altogether for at least some of the targeted diseases. Research has consistently found associations between parental support for complementary and alternative medicine (CAM) therapies and opposition to pediatric vaccination. One research group reported an association between family use of CAM providers, particularly chiropractors, and application for nonmedical exemptions from compulsory school entry vaccinations [4]. Another linked parental orientation toward alternative medicine with greater concern for side effects and a likelihood of opting out of vaccinations [5]. Still another found that decisions against pediatric vaccination were more common among parents who preferred obtaining vaccination information from CAM providers instead of conventional providers or public health experts [6].

Surveys of North American providers have reported mixed findings regarding chiropractors' attitudes toward vaccination. A national study of US chiropractors conducted in the mid-1990s found that two-thirds of respondents agreed that immunizations should never be given to infants under 1-year-old. Almost half believed the chiropractic profession should officially oppose the American Public Health Association's vaccination guidelines. More than one-third believed that immunizations cause more disease than they prevent, that contracting an infectious disease is safer than being immunized against it, and that there is no scientific proof that immunization prevents disease [7]. Researchers since that time have continued to detect vaccination hesitancy among chiropractors [8]. However, two articles concluded that only a minority of the chiropractic profession, fueled by the writings of a handful of vocal opponents, holds extreme anti-vaccination views [9,10]. Surveys of students and practitioners have confirmed that a majority of the rank-and-file offer general support for vaccination and the provision of the full spectrum of risk-benefit information to patients [11–13]. A 1998 survey of Boston family-practice chiropractors found that the majority provided education to parents but made no explicit recommendation, 30% actively recommended in favor, and only 7% actively recommended against pediatric vaccination [11]. Currently neither the American Chiropractic Association (ACA) nor the International Chiropractors Association (ICA) takes an official stand regarding the relative risks and benefits. Both groups oppose mandatory vaccination and emphasize the need for individual freedom of choice. The ACA calls for “informed awareness of the benefits and possible adverse effects of vaccination,” [14] whereas the ICA emphasizes risk over benefit [15]. An early study found significantly greater agreement with anti-vaccination statements among ICA than among ACA members [7]. The International Chiropractic Pediatric Association's position is similar to that of the ICA, focusing on adverse consequences. Its main vaccination web page emphasizes risk information and includes links to additional pages focusing on risks of specific vaccines [16].

Evidence about associations between naturopathy and pediatric vaccination is less plentiful, but published reports suggest that only a minority of naturopathic physicians actively support

full vaccination [17–20]. A survey of naturopathic physicians in Massachusetts found most making no recommendation, 20% actively recommending, and 7% actively opposing pediatric vaccination [17].

Doubts about vaccination have centered on several arguments. First is a belief that vaccinations do not produce immunity or that they actually cause disease [4,6–10,12]. Second are concerns about vaccine safety, side effects and adverse events, links to autism, and general interference with appropriate development of the immune or nervous systems [4,5,7–10,21,22]. A third argument emphasizes preference for infection-driven immunization as more permanent or less risky than vaccine-induced protection. [7,8,12]. Fourth are arguments that minimize risk of disease acquisition [4,6] or effects [4,6,9]. Finally, some vaccination opponents voice disbelief in pro-vaccination information provided by allopathic providers, government agencies, public health experts, and immunization safety and efficacy research [4,6,7,18].

With increased CAM use in the US during the latter half of the Twentieth Century [23–25], users' attitudes toward pediatric vaccination have wielded potentially greater influence on vaccination rates. Estimates of pediatric CAM use suggest substantially lower utilization among children than adults, but the estimates vary widely, depending upon the year of data collection, time period considered, study design and sample, geographic area, and types of CAM included. In a 1996 national self-report survey, fewer than 2% of parents reported use of any CAM therapies, broadly defined, in the previous year by their children through age 18 years [26]. Reported rates of use were considerably higher in two 1999 surveys that asked parents whether their children had *ever* used CAM therapies. When asked about lifetime use, 6% of those seeking care in Detroit-area pediatric practices [27] and 12% seeking care in the emergency department of a Pittsburgh children's hospital [28] reported pediatric CAM use. Data from Washington State insurance claims revealed 6% of pediatric enrollees through age 17 years had used provider-based CAM therapies during calendar year 2002 [29]. Estimated rates of pediatric use of chiropractic and naturopathy have typically been higher than estimates for other CAM therapies [28–31]. Despite relatively low pediatric use of provider-based CAM, CAM practitioners may exert direct influence on vaccination rates through information provided to parents who see them strictly for adult care [32]. Additional influence on parents may occur through websites that are affiliated with CAM groups [33] or that refer to CAM literature [34].

Indications of considerable vaccination hesitancy among CAM users and providers notwithstanding, a study based on the 2002 National Health Interview Survey found that *adult* users of CAM were *more* likely than non-users to report having had vaccinations themselves [35]. This finding suggests that CAM users may be more “health conscious” than non-users and may engage in a wide variety of disease-prevention measures. Whether increased health consciousness among adults enhances prevention activities with their children is of interest. To date, however, studies related to pediatric vaccination have typically focused on the following: (1) vaccination attitudes or recommendations rather than uptake rates [5,7–18], (2) activities related to compulsory vaccination [4], or (3) rates among localized samples of pediatric CAM users [19,20]. In the current article we examine the use of provider-based CAM therapy and receipt of recommended pediatric vaccinations in a statewide sample. The sample comprised non-Medicaid pediatric enrollees in two large insurance companies in Washington State, where insurance coverage of provider-based CAM therapy is required by law. Because research has shown that exemptions from school immunization requirements are correlated with higher rates of infectious disease [36], we also examine the association between pediatric CAM use and vaccine-preventable disease occurrence.

Methods

Study Sample and Outcomes

The study was based on secondary analysis of de-identified enrollment and claims data collected in 2000–2003 by two large Washington State insurance companies. We used two subsets of these data for analyses.

Analysis of pediatric vaccination included data for enrollees whose first and second birthdays occurred during the data collection period and who were continuously enrolled during the two calendar years in which those birthdays occurred. The data record for each enrollee encompassed this 2-year time slice and included dichotomous indicators for CAM provider use and vaccination receipt occurring any time during the 2-year period.

Analysis of disease acquisition included data for enrollees for any of the data-collection years in which they were between the ages of 1 and 17 years and were enrolled for the full calendar year. The data record for each enrollee encompassed a 1- to 4-year time slice, depending upon the number of years during the data collection period when they met the age and continuous-enrollment requirements. Each record included yes/no indicators for CAM provider use, a yes/no indicator for diagnosis with any vaccine-preventable disease, and the number of complete years of pediatric coverage during the time slice.

For each of the two analyses we included only records containing at least one claim for healthcare service. The University of Washington Human Subjects Division approved all research procedures.

We used the healthcare effectiveness data and information set (HEDIS) [37] standards as our benchmark for evaluating vaccination adherence. HEDIS criteria are stricter than the goals set forth in Healthy People 2010. HEDIS vaccination standards for 2003 required four vaccinations between ages 1 and 2 years: measles/mumps/rubella, chickenpox, diphtheria/tetanus/pertussis, and *H. influenzae* type B. (Although HEDIS standards exist for additional vaccinations recommended for universal pediatric use, they can be met by treatment prior to the child's first birthday—a year for which we lacked complete data.) A child met the measles/mumps/rubella standard with receipt of a vaccination for each of the three diseases, either separately or in combination, on or between the first and second birthdays. The chickenpox standard required receipt of a vaccination on or between the first and second birthdays. Diphtheria/tetanus/pertussis immunization required four vaccinations by the second birthday, with one or more vaccinations for (at least) diphtheria and tetanus occurring on or between the first and second birthdays. The *H. influenzae* type B standard was met with three vaccinations by the second birthday, at least one occurring on or between the first and second birthdays. We evaluated vaccination status using codes from Current Procedural Terminology (CPT) [38] (Appendix 1).

Because of restrictions imposed by the health insurance portability and accountability act (HIPAA) [39], insurance companies provided us with only the child's year of birth, rather than the exact birth date. Lacking the ability to evaluate whether vaccinations occurred precisely “on or between the first and second birthdays,” we gave credit for all vaccinations received at any time during the calendar years of first and second birthdays. Thus, we almost certainly included some vaccinations that occurred outside the HEDIS windows. We coded each of the four vaccinations as a dichotomy: 0 = not received during the 2-year period; 1 = received during the period.

Because incidence of vaccine-preventable disease in the sample was low, we used a single outcome to evaluate pediatric disease acquisition. The dichotomous outcome indicated an

insurance claim showing diagnosis with any of ten diseases included in federal pediatric vaccination guidelines: diphtheria, tetanus, pertussis, polio, measles, mumps, rubella, *H. influenzae* type B, hepatitis B, or chickenpox. The result was a dichotomous outcome based on codes from the International Classification of Diseases (ICD-9) [40]: 0 = no diagnoses during the time period, 1 = diagnosis with one or more vaccine-preventable diseases (Appendix 2).

Predictors

Six dichotomous predictors for the vaccination outcomes measured whether there were visits with each of five specific provider types (naturopathic physician, chiropractor, acupuncturist, massage therapist, or conventional care provider) and whether other members of the enrollee's family received care from a CAM provider. For analysis of disease acquisition, predictors of interest were the four variables measuring use of each CAM provider type by the pediatric enrollee and a variable measuring family use of any CAM provider during the enrollee's relevant time slice.

Covariates

We adjusted for the following covariates in multiple regression models of vaccination: insurance company, gender, birth year, insurance product type, and the enrollee's residential rural–urban-commuting-area (RUCA) code. In addition to these adjustments, we adjusted the disease acquisition model for the number of years of insurance coverage reflected in the enrollee's data record. Insurance product type had four values: preferred provider organization, point of service, health maintenance organization, and fee-for-service. The RUCA code is an ordinal variable measuring the “rural-ness” of the enrollee's place of residence: 0 (metropolitan core) to 10 (rural) [41].

Analyses

We used logistic regression models to evaluate both vaccination status and disease acquisition. Software included Microsoft Access for data management, SPSS [42] for descriptive statistics, and Stata [43] for regression models.

Results

The Vaccination Sample

The insurance companies provided continuous coverage to 11,144 children for whom claims were made during the years of first and second birthday (Table 1). Most children were enrolled in preferred-provider or point-of-service products and lived in metropolitan areas. They were spread relatively evenly over the two genders and three birth years. Most received all health care from conventional providers, with fewer than 4% having visits to any CAM provider. About 30% of the children had other family members with claims for CAM services. Children were significantly more likely to have seen a naturopathic physician if they were enrolled in a health maintenance organization (2.9%) or point-of-service product (2.2%) than if they had preferred-provider (1.5%) or fee-for-service coverage (1.2%; $\chi^2 = 11.37$, $df = 3$, $P = .010$). By contrast, more preferred-provider (2.8%) than point-of-service (1.7%), fee-for-service (1.5%) or health-maintenance-organization enrollees (0.6%) saw chiropractors ($\chi^2 = 22.56$, $df = 3$, $P = .000$). Receipt of acupuncture and massage services did not differ significantly by product type. During the years of first and second birthday, about 75% of the enrollees received vaccinations for diphtheria/tetanus or *H. influenzae* type B, 67% received measles/mumps/rubella vaccinations, and 51% had chickenpox vaccinations.

Predictors of Pediatric Vaccination

Because few enrollees received acupuncture or massage, we excluded these predictors from regression models. After adjustment for insurance company, rates of vaccination for chickenpox increased significantly over the study period; all vaccination types were more likely in urban than in rural areas; and all rates were highest in point-of-service and health-maintenance-organization plans, lower in preferred-provider plans, and lowest among fee-for-service enrollees (Table 2).

Uptake rates for each vaccination type were significantly lower among children who received either chiropractic or naturopathic care and among children whose family members received care from CAM providers than among their counterparts. Compared with children who received all health care from conventional providers, those who saw both conventional and CAM providers had significantly lower rates of all four vaccinations, and rates among children who received care exclusively from CAM providers were lower still.

In multivariate models (Table 3), naturopathic care remained a significant predictor of reduced rates of all vaccinations, and chiropractic care was a significant predictor of all except diphtheria/tetanus. Use of CAM by other family members did not have a significant independent association with vaccination rates—the reduction in the strength of association resulting from confounding of CAM use with product type.

The Disease Acquisition Sample

Our data included information for 213,884 enrollees with at least 1 full year of coverage between the ages of 1 year and 17 years. Over 7% of the enrollees saw a CAM provider, typically a chiropractor, during this period, and about 30% came from families with some use of CAM providers (Table 4). Disease acquisition was low, with just over 1% of the enrollees receiving diagnoses of vaccine-preventable disease during their measurement period. Of the diagnosed cases, 85% involved chickenpox, 7% pertussis, 5% rubella, 2% hepatitis B, 1% mumps, and 1% all other diseases combined.

Predictors of Disease Acquisition

Diagnosis with a vaccine-preventable disease was significantly more likely among enrollees aged 1–17 years who saw a CAM provider during 2000–2003 than among those who used conventional care exclusively: 1.5% versus 1.3%, respectively. In a multivariate model including all five CAM predictors, and with adjustment for the number of years of insurance enrollment during the period, only naturopathy was associated with increased disease acquisition (Table 5).

Discussion

To our knowledge, this is the largest study to date of CAM provider use and immunization rates among young children enrolled in private insurance plans. We found that, among non-Medicaid pediatric enrollees in two Washington State insurance companies, those who received care from naturopathic physicians or chiropractors during the years of their first or second birthdays were significantly less likely to have met the HEDIS schedule for vaccination against measles/mumps/rubella, chickenpox, or *H. influenzae* type B than were their counterparts. Additionally, children who received care from naturopathic physicians were significantly less likely to have received timely protection against diphtheria/tetanus. Diagnosis with vaccine-preventable diseases among children through age 17 years was rare. However, pediatric use of naturopathy was associated with significantly more diagnoses, and chickenpox was the diagnosis most frequently made.

Although studies over the last quarter century have suggested a lack of support for pediatric vaccination among a subset of CAM practitioners, there has been little information regarding associations between use of provider-based CAM therapies and parents' adherence to national vaccination guidelines. Our study suggests that parents who use naturopathic physicians or chiropractors for pediatric care are less likely to meet recommendations for vaccinations as measured by HEDIS specifications. The national Healthy People 2010 goals use an age range of up to 35 months to assess adherence, and our results, based on the stricter HEDIS standards, provide more conservative estimates of overall vaccination rates. However, our findings, in combination with current evidence of insufficient progress toward Healthy People 2010 goals in Washington State [45] and the US as a whole [51], underscore the public health importance of improving vaccination rates among CAM providers' pediatric patients.

This study has several limitations. First, we used insurance claims as our sole source of evidence. Previous studies have found that claims underestimate true immunization levels [46] and include inaccuracies in diagnosis [47]. However, our findings are consistent with those based on provider and parent surveys, thus extending the knowledge base with information from insurance claims. Second, our insurance dataset began with the calendar year of the child's first birthday, thereby omitting information for a portion of the first year of life for most children. As a result, we could estimate adherence related to only a portion of the HEDIS vaccination schedule. Moreover, because we did not have precise date-of-birth information, we adopted a generous definition of adherence for even this portion of the standards and almost certainly over-estimated adherence to the schedule. However, we have no reason to believe that these deficits discriminated against CAM users. Third, our results are based on claims for children enrolled in non-Medicaid-funded insurance plans in Washington State. Vaccination rates in this sample may differ from those for the totality of Washington State children. Except for chickenpox, the vaccination coverage levels in our sample were lower than statewide estimates for children aged 19–35 months in 2000–2003 [48]. Previous studies have suggested that some children enrolled in private insurance plans may not have full vaccination coverage and that government-sponsored programs may lead to higher uptake rates among children without private insurance [49,50]. We cannot evaluate the extent to which differences between our findings and statewide estimates were the result of our sample's more restrictive age range, private insurance coverage, or other unmeasured factors that differentiated this sample from the one used to estimate statewide rates. Again, however, we have no reason to suspect that this limitation would differentially affect users versus non-users of CAM. Fourth, our data covered too short a time period for determining whether parents chose to delay vaccinations until their children were older or to forgo vaccination altogether. Fifth, although we have shown associations between use of CAM providers and both reduced vaccination and increased disease incidence, our data do not allow attribution of causality. Lower vaccination rates among pediatric CAM users may reflect either a tendency for parents who prefer natural approaches to health and who are already vaccine-hesitant to seek out CAM professionals, or a pattern of direct influence by CAM providers on parents' attitudes. Some researchers have suggested that vaccine-hesitant parents may prefer CAM practitioners, in part, because they are less likely to introduce pro-vaccination pressure [32]. Washington State, where our study took place, has demonstrated strong acceptance of chiropractic and naturopathy into mainstream medical care [44]. Although pediatric vaccination rates in the state have increased dramatically in recent years, Washington currently lags behind 40 other states in childhood vaccination [45]. Our data were not sufficient for evaluating whether these two factors are related. Finally, our insurance data did not include information on factors such as income, education, and racial-ethnic status, which may confound associations between CAM use and both vaccination and diagnosis rates.

Our findings suggest that interventions with CAM practitioners and parents may be needed to increase support for pediatric vaccination. Future research aimed at developing successful

interventions must include in-depth studies of parents and CAM providers to assist in understanding more precisely the important provider-related deterrents to vaccination. Intervention protocols will need to be responsive to the extent to which CAM providers are directly instrumental in reducing immunization or merely incidental to the patient population served. Also important will be an understanding of the mechanisms whereby direct influence is exerted (e.g., whether providers explicitly advise against vaccination or influence patients through more indirect means, such as pamphlets made available in waiting rooms or opinions expressed about where to turn for reliable information).

Irrespective of the causal dynamics, interventions with naturopathic physicians and chiropractors to increase active support for vaccination programs may be beneficial. Studies indicate that a majority of CAM practitioners make no explicit recommendations, and only a minority actively recommend against vaccination. Thus, many providers may be open to more active support of vaccination in conversations with parents. A recent survey found chiropractors in Alberta amenable to participation in immunization awareness and promotional activities [52]. Interventions enlisting assistance from CAM providers in the US might be productive, as well.

Acknowledgments

Yuki Durham, Research Consultant, Department of Health Services, University of Washington, provided assistance with literature review for this article. Financial support came from the National Center for Complementary and Alternative Medicine (Grant #5R01-AT000891). The Center approved the basic design of the study but had no role in management, analysis, or interpretation of data, nor did it assist in preparation, review, or approval of this manuscript. The authors are solely responsible for the article's content, which does not necessarily represent the official views of the National Center for Complementary and Alternative Medicine or the National Institutes of Health.

Appendix 1: Current Procedural Terminology (CPT) Codes Designating Vaccination

Vaccination against measles, mumps, and rubella

Either of the following:

1. Combination vaccine—CPT = 90707 or 90710
2. Measles vaccine—CPT = 90705 or 90708

   AND

   Mumps vaccine—CPT = 90704 or 90709

   AND

   Rubella vaccine—CPT = 90706 or 90708

Vaccination against chickenpox

CPT = 90710 or 90716

Vaccination against diphtheria and tetanus (with or without vaccination against pertussis)

Either of the following:

1. Combination vaccine—CPT = 90700, 90701, 90702, 90720, 90721, or 90723
2. (2) Diphtheria vaccine—CPT = 90719

   AND

Tetanus vaccine—CPT = 90703

Vaccination against *H. influenzae* type B

CPT = 90645, 90646, 90647, 90648, 90720, 90721, or 90748

Appendix 2: International Classification of Diseases (ICD-9) Codes Designating Disease Diagnoses

Chickenpox: ICD-9 beginning with 052 or 053

Diphtheria: ICD-9 beginning with 032 or V024

H. influenzae type B: ICD-9 = 038.41 or beginning with 041.5, 320.0, or 482.2

Hepatitis B: ICD-9 beginning with 070.2 or 070.3

Measles: ICD-9 beginning with 055

Mumps: ICD-9 beginning with 072

Pertussis: ICD-9 beginning with 033

Polio: ICD-9 beginning with 045

Rubella: ICD-9 beginning with 056

Tetanus: ICD-9 beginning with 037

References

1. Centers for Disease Control and Prevention. Ten great public health achievements—United States, 1900–1999. MMWR 1999;48:241–243. [PubMed: 10220250]
2. Centers for Disease Control and Prevention. Achievements in public health, 1900–1999: Impact of vaccines universally recommended for children—United States, 1900–1998. MMWR 1999;48:243–248. [PubMed: 10220251]
3. Healthy People. Objectives. 2010 [November 18, 2008]. Available at http://www.healthypeople.gov/document/html/objectives/14-24.htm and http://www.healthypeople.gov/document/html/objectives/14-22.htm
4. Salmon DA, Moulton LH, Orner SB, deHart MP, Stokley S, Halsey NA. Factors associated with refusal of childhood vaccines among parents of school-aged children: A case—Control study. Archives of Pediatrics and Adolescent Medicine 2005;159:470–476. [PubMed: 15867122]
5. Gellin BG, Maibach EW, Marcuse EK. Do parents understand immunizations? a national telephone survey. Pediatrics 2000;106:1097–1102. [PubMed: 11061781]
6. Benin AL, Wisler-Scher DJ, Colson E, Shapiro ED, Holmboe ES. Qualitative analysis of mothers' decision-making about vaccines for infants: The importance of trust. Pediatrics 2006;117:1532–1541. [PubMed: 16651306]
7. Colley F, Haas M. Attitudes on immunization: A survey of American chiropractors. Journal of Manipulative and Physiological Therapeutics 1994;17:584–590. [PubMed: 7884327]
8. Russell ML, Injeyan HS, Verhoef MJ, Eliasziw M. Beliefs and behaviours: Understanding chiropractors and immunization. Vaccine 2004;23:372–379. [PubMed: 15530683]
9. Campbell JB, Busse JW, Injeyan HS. Chiropractors and vaccination: A historical perspective. Pediatrics 2000;105:E43. [PubMed: 10742364]
10. Busse JW, Morgan L, Campbell JB. Chiropractic antivaccination arguments. Journal of Manipulative and Physiological Therapeutics 2005;28:367–373. [PubMed: 15965414]
11. Lee AC, Li DH, Kemper KJ. Chiropractic care for children. Archives of Pediatrics and Adolescent Medicine 2000;154:401–407. [PubMed: 10768681]

12. Busse JW, Kulkarni AV, Campbell JB, Injeyan HS. Attitudes toward vaccination: A survey of Canadian chiropractic students. CMAJ 2002;166:1531–1534. [PubMed: 12074119]

13. Hawk C, Long CR, Perillo M, Boulanger KT. A survey of US chiropractors on clinical preventive services. Journal of Manipulative and Physiological Therapeutics 2004;27:287–298. [PubMed: 15195036]

14. American Chiropractic Association. Current policies: Vaccination, revised and ratified, June, 1998. 2008 [November 18, 2008]. Available at http://www.amerchiro.org/level2_css.cfm?T1ID=10&T2ID=117

15. International Chiropractors Association. ICA policy statements: Immunization and vaccination. 2008 [November 18, 2008]. Available at http://www.chiropractic.org/index.php?p=ica/policies#immunization

16. International Chiropractic Pediatric Association. Research foundation. Vaccinations. 2008 [November 18, 2008]. Available at http://www.icpa4kids.org/research/children/vac_info.htm

17. Lee ACC, Kemper KJ. Homeopathy and naturopathy: Practice characteristics and pediatric care. Archives of Pediatrics and Adolescent Medicine 2000;154:75–80. [PubMed: 10632255]

18. Wilson K, Mills E, Boon H, Tomlinson G, Ritvo P. A survey of attitudes towards paediatric vaccinations amongst Canadian naturopathic students. Vaccine 2004;22:329–334. [PubMed: 14670313]

19. Wilson K, Busse JW, Gilchrist A, Vohra S, Boon H, Mills E. Characteristics of pediatric and adolescent patients attending a naturopathic college clinic in Canada. Pediatrics 2005;115:338–343.

20. Weber W, Taylor JA, McCarty RL, Johnson-Grass A. Frequency and characteristics of pediatric and adolescent visits in naturopathic medical practice. Pediatrics 2007;120:142–146. [PubMed: 17606571]

21. Sugarman SD. Cases in vaccine court—Legal battles over vaccines and autism. NEJM 2007;357:1275–1277. [PubMed: 17898095]

22. Honey K. Attention focuses on autism. Journal of Clinical Investigation 2008;118:1586–1587. [PubMed: 18451989]

23. Eisenberg DM, Davis RB, Ettner SL, Appel S, Wilkey S, Van Rompay M, et al. Trends in alternative medicine use in the United States, 1990–1997: Results of a follow-up national survey. JAMA 1998;280:1569–1575. [PubMed: 9820257]

24. Kessler RC, Davis RB, Foster DF, Van Rompay MI, Walters EE, Wilkey SA, et al. Long-term trends in the use of complementary and alternative medical therapies in the United States. Annals of Internal Medicine 2001;135:262–268. [PubMed: 11511141]

25. Tindle HA, Davis RB, Phillips RS, Eisenberg DM. Trends in the use of complementary and alternative medicine by US adults: 1997–2002. Alternative therapies in health and medicine 2005;11:42–49. [PubMed: 15712765]

26. Davis MP, Darden PM. Use of complementary and alternative medicine by children in the United States. Archives of Pediatrics and Adolescent Medicine 2003;157:393–396. [PubMed: 12695237]

27. Sawni-Sikand A, Schubiner H, Thomas RL. Use of complementary/alternative therapies among children in primary care pediatrics. Ambulatory pediatrics 2002;2:99–101. [PubMed: 11926840]

28. Pitetti R, Singh S, Hornyak D, Garcia SE, Herr S. Complementary and alternative medicine use in children. Pediatric Emergency Care 2001;17:165–169. [PubMed: 11437139]

29. Bellas A, Lafferty WE, Lind B, Tyree PT. Frequency, predictors, and expenditures for pediatric insurance claims for complementary and alternative medical professionals in Washington state. Archives of Pediatrics and Adolescent Medicine 2005;159:367–372. [PubMed: 15809392]

30. Spigelblatt L, Laîné-Ammara G, Pless IB, Guyver A. The use of alternative medicine by children. Pediatrics 1994;94:811–814. [PubMed: 7970994]

31. Cherkin DC, Deyo RA, Sherman KJ, Hart LG, Street JH, Hrbek A, et al. Characteristics of visits to licensed acupuncturists, chiropractors, massage therapists, and naturopathic physicians. Journal of the American Board of Family Practice 2002;15:463–472. [PubMed: 12463292]

32. Page SA, Russell ML, Verhoef MJ, Injeyan HS. Immunization and the chiropractor-patient interaction: A western Canadian study. Journal of Manipulative and Physiological Therapeutics 2006;29:156–161. [PubMed: 16461176]

33. Nasir L. Reconnoitering the antivaccination web sites: News from the front. Journal of Family Practice 2000;49:731–733. [PubMed: 10947140]
34. Wolfe RM, Sharp LK, Lipsky MS. Content and design attributes of antivaccination web sites. JAMA 2002;287:3245–3248. [PubMed: 12076221]
35. Stokley S, Cullen KA, Kennedy A, Bardenheier BH. Adult vaccination coverage levels among users of complementary/alternative medicine—Results from the 2002 National Health Interview Survey (NHIS). BMC complementary and alternative medicine 2008;8:1–8. [PubMed: 18173849]
36. Omer SB, Pan WK, Halsey NA, Stokley S, Moulton LH, Navar AM, et al. Nonmedical exemptions to school immunization requirements: Secular trends and association of state policies with pertussis incidence. JAMA 2006;296:1757–1763. [PubMed: 17032989]
37. National Committee for Quality Assurance (NCQA). National Committee for Quality Assurance (NCQA). Washington, DC: NCQA; 2002.
38. American Medical Association. CPT 2002: Current procedural terminology and CPT 2004: Current procedural terminology. Chicago: AMA Press; 2001, 2003.
39. Office for Civil Rights. OCR privacy brief: Summary of the HIPAA privacy rule. US Department of Health and Human Services; Washington DC: 2008 [November 18, 2008]. Available at http://www.hhs.gov/ocr/privacysummary.pdf
40. International classification of diseases, 9th revision, clinical modification: Physician ICD-9-CM, 2004: Volumes 1 and 2. American Medical Association; Chicago: AMA Press; 2003.
41. WWAMI Rural Health Research Center. RUCA data: ZIP code RUCA approximation. 2008 [November 18, 2008]. Available at http://depts.washington.edu/uwruca/approx.html
42. SPSS, Inc.. SPSS for windows, release 14.0.0. Chicago: SPSS Inc.; 2005.
43. StataCorp.. Stata statistical software: Release 8.0. College Station, TX: Stata Corporation; 2003.
44. Lafferty WE, Tyree PT, Bellas AS, Watts CA, Lind BK, Sherman KJ, et al. Insurance coverage and subsequent utilization of complementary and alternative medicine providers. The American journal of managed care 2006;12:397–404. [PubMed: 16834526]
45. Black, C. Washington lags behind 40 states, DC. Seattle Post-Intelligencer 4/22/2008, page B2. 2008 [November 18, 2008]. Available at http://seattlepi.nwsource.com/local/360172_immunization23.html
46. Cotter JJ, Smith WR, Rossiter LF, Pugh CB, Bramble JD. Combining state administrative databases and provider records to assess the quality of care for children enrolled in Medicaid. American Journal of Medical Quality 1999;14:98–104. [PubMed: 10446671]
47. Aronsky D, Haug PJ, Lagor C, Dean NC. Accuracy of administrative data for identifying patients with pneumonia. American Journal of Medical Quality 2005;20:319–328. [PubMed: 16280395]
48. Centers for Disease Control and Prevention. Vaccines & immunizations: National Immunization Survey (NIS)—Children only, NIS data in chart by year. 2008 [November 20, 2008]. Available at http://www.cdc.gov/vaccines/stats-surv/
49. Lee GM, Santoli JM, Hannan C, Hessonnier ML, Sabin JE, Rusinak D, et al. Gaps in vaccine financing for underinsured children in the United States. JAMA 2007;298:638–643. [PubMed: 17684186]
50. Davis MM. Reasons and remedies for underinsurance for child and adolescent vaccines. JAMA 2007;298:680–682. [PubMed: 17684192]
51. Luman ET, Shaw KM, Stokley SK. Compliance with vaccination recommendations for US children. American Journal of Preventive Medicine 2008;34:463–470. [PubMed: 18471581]
52. Russell ML, Verhoef MJ, Injeyan HS. Are chiropractors interested in participating in immunization awareness and promotion activities? Canadian Journal of Public Health. Revue Canadienne de Sante Publique 2005;96:194–196. [PubMed: 15913083]

Table 1

Characteristics of 11,144 children with continuous enrollment for calendar years of 1st and 2nd birthdays

	n (%)
Year of birth (claims data for 2-year time slice)	
1999 (1st–2nd birthdays in 2000–2001)	3,698 (33.2)
2000 (1st–2nd birthdays in 2001–2002)	4,001 (35.9)
2001 (1st–2nd birthdays in 2002–2003)	3,445 (30.9)
Gender	
Male	5,823 (52.3)
Female	5,321 (47.7)
Area of residence—extent rural[a]	
Metropolitan area core	7,602 (68.2)
Metropolitan area—high commuting	1,775 (15.9)
Micropolitan area core	411 (3.7)
Micropolitan area—high commuting	111 (1.0)
Micropolitan area—low commuting	8 (0.1)
Small town core	241 (2.2)
Small town—high commuting	83 (0.7)
Rural area	148 (1.3)
Unknown	765 (6.9)
Product type	
Preferred provider organization	4,878 (43.8)
Point of service	4,859 (43.6)
Health maintenance organization	485 (4.4)
Fee for service	922 (8.3)
Types of health care—pediatric enrollee	
Any conventional care	11,095 (99.6)
Any CAM care	425 (3.8)
Naturopathy	206 (1.8)
Chiropractic	240 (2.2)
Acupuncture	13 (0.1)
Massage	3 (0.0)
Type(s) of care	
Conventional care only	10,719 (96.2)
Both conventional and CAM care	376 (3.4)
CAM care only	49 (0.4)
Any CAM care—other family members	3,368 (30.2)
Vaccinations received during years of 1st or 2nd birthday	
1+ vaccination for measles, mumps, and rubella	7,500 (67.3)
1+ vaccination for chickenpox[b]	5,724 (51.4)
1+ vaccination for diphtheria and tetanus	8,377 (75.2)
1+ vaccination for *H. influenzae* type B	8,340 (74.8)

[a]The United States Bureau of Census introduced the term “micropolitan” in 2000 to designate urban clusters of 10,000–49,999 population. High commuting areas are those with primary flow of 30% or more to a denser population area; low commuting areas are those with primary flow of 10–30% to a denser population area

[b]In addition to the 5,724 children who received vaccinations for chickenpox, 97 were immunized by virtue of acquiring the disease

Table 2

Models of vaccination status: 11,144 children with continuous enrollment during years of 1st and 2nd birthdays, adjusted for insurance company only

	MMR[a] OR(95% CI)	Chickenpox[b] OR (95% CI)	Diphtheria/tetanus[c] OR (95% CI)	*H. influenzae* type B[d] OR (95% CI)
Year of birth	0.97 (0.92–1.02)	**1.05 (1.01–1.10)**	1.02 (0.96–1.07)	1.03 (0.97–1.08)
Female	1.00 (0.93–1.08)	0.98 (0.91–1.05)	1.02 (0.94–1.12)	1.01 (0.93–1.10)
Urban–rural residence	**0.84 (0.82–0.86)**	**0.85 (0.83–0.87)**	**0.85 (0.83–0.87)**	**0.83 (0.81–0.85)**
Product type				
Preferred provider	1.00	1.00	1.00	1.00
Point of service	**1.84 (1.68–2.02)**	**1.31 (1.21–1.43)**	**1.55 (1.40–1.72)**	**1.51 (1.37–1.67)**
Health maintenance organization	**1.87 (1.50–2.33)**	**1.41 (1.16–1.70)**	**1.73 (1.34–2.23)**	**1.66 (1.30–2.14)**
Fee for service	**0.18 (0.15–0.21)**	**0.22 (0.19–0.26)**	**0.15 (0.13–0.18)**	**0.14 (0.12–0.16)**
CAM care—enrollee				
Naturopathy	**0.18 (0.14–0.25)**	**0.17 (0.12–0.25)**	**0.26 (0.20–0.34)**	**0.20 (0.15–0.27)**
Chiropractic	**0.58 (0.44–0.74)**	**0.50 (0.38–0.66)**	**0.65 (0.50–0.86)**	**0.59 (0.45–0.77)**
CAM care—other family members	**0.77 (0.71–0.84)**	**0.77 (0.71–0.83)**	**0.77 (0.70–0.84)**	**0.71 (0.64–0.77)**
Type(s) of care—enrollee				
Conventional care only	1.00	1.00	1.00	1.00
Both types of care	**0.44 (0.36–0.54)**	**0.40 (0.32–0.50)**	**0.51 (0.41–0.63)**	**0.47 (0.38–0.58)**
CAM care only	**0.03 (0.01–0.10)**	_[e]	**0.10 (0.05–0.20)**	**0.01 (0.00–0.06)**

Results were based on 32 regression models (4 outcomes shown in the columns by 8 predictors shown on the rows; the 3 dummy indicators for the product type predictor were tested in a single model, as were the 2 dummy indicators for types of care). Each model was adjusted for insurance company. Missing data on urban–rural residence reduced the sample size for those models to 10,379 cases. Statistically significant associations are shown in boldface

[a] At least one measles, mumps and rubella vaccination, given in combination or separately, in the year of the 1st or 2nd birthday

[b] At least one chickenpox vaccination in the year of the 1st or 2nd birthday

[c] Coverage for diphtheria and tetanus, with either a combination or separate vaccines, in the year of the 1st or 2nd birthday

[d] At least one *H. influenzae* type B vaccination in the year of the 1st or 2nd birthday

[e] CAM-only treatment perfectly predicted non-receipt of vaccination; this category could not be included in the model

Table 3

Independent associations of CAM care with pediatric vaccination status: children with continuous enrollment during years of 1st and 2nd birthdays

	MMR[a] OR (95% CI)	**Chickenpox[b] OR (95% CI)**	**Diphtheria/Tetanus[c] OR (95% CI)**	***H. influenzae* type B[d] OR (95% CI)**
CAM care—enrollee				
Naturopathy	**0.22 (0.16–0.32)**	**0.23 (0.16–0.35)**	**0.30 (0.21–0.42)**	**0.28 (0.20–0.39)**
Chiropractic	**0.67 (0.50–0.89)**	**0.58 (0.44–0.78)**	0.77 (0.57–1.05)	**0.70 (0.52–0.95)**
CAM care—other family members	1.00 (0.91–1.11)	0.93 (0.85–1.02)	0.95 (0.86–1.06)	0.90 (0.81–1.00)

Odds ratio estimates and confidence intervals were based on four models (one for each of the outcomes shown in the columns). Each model included 11 predictors: insurance company, year of birth, gender, urban–rural residence, 3 product type indicators, conventional care, and the 3 CAM care predictors. Missing data on the urban–rural predictor reduced the sample size to 10,379. Statistically significant associations are shown in boldface

[a] At least one measles, mumps and rubella vaccination, given in combination or separately, in the year of the 1st or 2nd birthday

[b] At least one chickenpox vaccination in the year of the 1st or 2nd birthday. This model omitted the conventional care predictor because no enrollees who were without conventional care received vaccinations

[c] Coverage for diphtheria and tetanus, with either a combination or separate vaccines, in the year of the 1st or 2nd birthday

[d] At least one vaccination for *H. influenzae* type B in the year of the 1st or 2nd birthday

Table 4

Number and percentage of enrollees with CAM care and vaccine-preventable diseases, 213,884 pediatric enrollees, aged 1–17 years

	n **(%)**
Any CAM care—enrollee	15,550 (7.3)
Naturopathy	3,050 (1.4)
Chiropractic	12,851 (6.0)
Acupuncture	435 (0.2)
Massage	597 (0.3)
Any CAM care—other family members	63,835 (29.8)
Diagnosed with a vaccine-preventable disease[a]	2,783 (1.3)

[a] Any of 10 diseases for which there were federal pediatric vaccination guidelines: diphtheria, tetanus, pertussis, polio, measles, mumps, rubella, *H. influenzae* type B, hepatitis B, and chickenpox

Table 5

Association of CAM care with acquisition of vaccine-preventable diseases; Any of 10 diseases for which there were federal pediatric vaccination guidelines: diphtheria, tetanus, pertussis, polio, measles, mumps, rubella, *H. influenzae* type B, hepatitis B, and chickenpox, 213,884 Pediatric Enrollees, Aged 1–17 Years

	OR (95% CI)[a]
Associations adjusted only for company	
Naturopathy—enrollee	**1.67 (1.31–2.15)**
Chiropractic—enrollee	1.13 (0.98–1.32)
Acupuncture—enrollee	1.82 (0.97–3.42)
Massage—enrollee	1.58 (0.89–2.80)
Any CAM care—other family members	**1.20 (1.11–1.30)**
Associations adjusted for all covariates[b]	
Naturopathy—enrollee	**1.44 (1.12–1.86)**
Chiropractic—enrollee	0.95 (0.81–1.11)
Acupuncture—enrollee	1.33 (0.70–2.52)
Massage—enrollee	1.21 (0.67–2.16)
Any CAM care—other family members	1.08 (0.99–1.17)

[a] Statistically significant associations are shown in boldface

[b] The multivariate model included the five CAM-care predictors, number of years of insurance coverage during the period, and company