



Published in final edited form as:

*J Dev Behav Pediatr.* 2014 January ; 35(1): 1–10. doi:10.1097/DBP.0000000000000013.

## Utilization Patterns of Conventional and Complementary/ Alternative Treatments in Children with Autism Spectrum Disorders and Developmental Disabilities in a Population-Based Study

CDR Roger Scott Akins, DO<sup>1,2,4</sup>, Paula Krakowiak, PhD<sup>2,3</sup>, Kathleen Angkustsiri, MD<sup>1,2</sup>,  
Irva Hertz-Picciotto, PhD<sup>2,3</sup>, and Robin L. Hansen, MD<sup>1,2</sup>

<sup>1</sup>Department of Pediatrics, School of Medicine, University of California, Davis

<sup>2</sup>MIND (Medical Investigation of Neurodevelopmental Disorders) Institute, University of California, Davis

<sup>3</sup>Division of Epidemiology, Department of Public Health Sciences, School of Medicine, University of California, Davis

<sup>4</sup>Department of Pediatrics, Naval Medical Center Portsmouth, Portsmouth, Virginia

### Abstract

**Objective**—This study compared the utilization of conventional treatments to utilization of complementary and alternative medicine (CAM) in preschoolers with autism spectrum disorders (ASD) and other developmental disabilities (DD).

**Methods**—Participants were 578 children who were part of an ongoing population-based, case-control study of 2 to 5 year-olds with ASD, DD, and the general population. Parents completed an interview on past and current services.

**Results**—Four hundred fifty-three children with ASD and 125 DD children were included. ASD families received more hours of conventional services compared to DD (17.8 vs. 11;  $p < 0.001$ ). The use of psychotropic medications was low in both groups (~3%). CAM use overall was not significantly different in ASD (39%) versus DD (30%). Hispanic families in both groups used CAM less often than non-Hispanics. Variables such as level of function, immunization status, and presence of an identified neurogenetic disorder were not predictive of CAM use. A higher level of parental education was associated with increased CAM use in ASD and DD. Families who utilized >20 hours per week of conventional services were more likely to use CAM, including potentially unsafe or disproven CAM. Under-immunized children were marginally more likely to use CAM, but not more likely to have received potentially unsafe or disproven CAM.

**Conclusion**—CAM use is common in families of young children with neurodevelopmental disorders and is predicted by higher parental education and non-Hispanic ethnicity but not developmental characteristics. Further research should address how healthcare providers can support families in making decisions about CAM use.

### Keywords

autism; developmental delay; complementary and alternative medicine; gluten-free; casein-free diet; chelation; dietary supplements

## INTRODUCTION

Autism spectrum disorders (ASD) affect approximately 1 in 88 children in the United States.<sup>1</sup> The core features of ASD include impairments in socialization, communication and behavior.<sup>2</sup> Medical, behavioral and educational interventions target these core symptoms.<sup>3</sup> The evidence base supporting the benefits of behavioral and educational treatments for the core symptoms of ASD has established many of these treatments as the standard of care for children with ASD.<sup>4–7</sup> However, these interventions take time to show benefits. Not all children show significant improvement, chronic management is required, and at this time, there are no “curative” treatments for ASD. Additionally, the issues faced by families of children with ASD are not restricted to the core symptoms. Associated symptoms such as hyperactivity, anxiety, aggression, insomnia and gastrointestinal (GI) symptoms are common in ASD and are frequent targets of both conventional treatments and complementary and alternative medicine (CAM) therapies.<sup>3,8,9</sup>

The National Center for Complementary and Alternative Medicine (NCCAM) defines complementary and alternative medicine as, “a group of diverse medical and health care systems, practices, and products that are not presently considered to be part of conventional medicine.” *Complementary* medicine is typically defined as non-traditional treatments that are used with conventional medicine. *Alternative* medicine is used in place of conventional medicine.<sup>10</sup> In the last decade, possibly hastened by improved access to information via various electronic media, CAM has become widely used by families of children with chronic health conditions, including neurodevelopmental disorders.<sup>11,6,12</sup> CAM use may be highest among families of children with ASD, with reported use in 28–95%.<sup>9,13–16</sup> Most families of children with ASD report using CAM therapies for general health maintenance, but some parents also report using CAM therapies to treat specific symptoms, such as irritability, hyperactivity, inattention, GI symptoms and sleep difficulties.<sup>9</sup> Higher rates of CAM have been reported in children with co-existing GI symptoms, seizure disorders and behavior problems.<sup>16</sup> Treatment of these associated symptoms is not as well standardized, with limited evidence from controlled studies demonstrating efficacy of therapies that treat these problems.<sup>3,6,9,17</sup> The lack of evidence-based treatments creates a dilemma for families who are struggling with these conditions.<sup>18,19</sup> Finally, the majority of families who are making treatment decisions for their child do so without a clear understanding of the underlying biological determinants of their child’s ASD, complicating any decision about which treatments may be biologically plausible for their child.<sup>19</sup>

Elevated CAM use has been reported in families with higher socioeconomic status, especially when at least one parent has completed a 4-year college degree.<sup>9,13,20</sup> CAM use in ASD has also been reported to be higher when access to conventional care is limited.<sup>21</sup> Few studies have objectively evaluated how culture, race and ethnicity influence CAM use in ASD. CAM use was initially found to be higher among a small subset of Hispanic children with ASD,<sup>21</sup> then found to be more consistent with reported use in non-Hispanic Caucasians in a recent, larger, multi-site analysis.<sup>16</sup> Other family characteristics have not been found to be associated with CAM use, including the presence of another child in the home with a developmental disability (DD), parental age, and a family history of DD.<sup>9</sup>

Although the severity of ASD has been reported to be associated with increased CAM utilization,<sup>16</sup> less is known about how other developmental characteristics, such as severity of associated symptoms, developmental trajectories or the presence of an identified neurogenetic disorder to which the family may attribute causality may influence family decision making about CAM. Few studies exploring CAM use in ASD have included preschool-aged children and, to our knowledge, specific patterns of utilization have not yet

been reported in this age group.<sup>9,13</sup> Additionally, much less is known about CAM use in young children with other DD.

Previous authors have reported that safety is the most important factor for parents who are considering a particular treatment for their children with ASD and that most CAM use has been safe,<sup>13</sup> yet some families report using therapies that may be less desirable in terms of the potential for harmful side effects or established lack of efficacy. There is little evidence about other critical issues, such as whether families of children with neurodevelopmental disorders frequently defer evidence-based interventions, such as immunizations or behavioral therapies, in favor of potentially unsafe and less efficacious or disproven CAM treatments, such as chelation or secretin. Are families who use CAM less likely to fully immunize their children with neurodevelopmental disorders? If these “high risk” groups exist, are there familial or child characteristics that are unique to these groups? Do service utilization patterns suggest that critical needs of families are unmet?

To explore these issues we examined the use of conventional services and treatments and CAM therapies in preschool aged children with ASD and DD in California, a geographic area of high CAM prevalence<sup>22</sup> who were enrolled in the CHARGE (Childhood Autism Risks from Genetics and Environment) study.<sup>23</sup> Specifically, we examined the following characteristics in relation to the likelihood of CAM use: household education level, race/ethnicity, family utilization of conventional services, child’s level of cognitive and adaptive functioning, presence of an identified neurogenetic diagnosis, use of psychotropic medications and vaccination status.

## METHODS

### Study Participants

The CHARGE (Childhood Autism Risks from Genetics and the Environment) Study is an ongoing population-based, case-control study with participants sampled from three strata: children with ASD, children with DD but not ASD, and children randomly selected from the general population.<sup>23</sup> Eligible children a) were between the ages of 24 and 60 months, b) lived with at least one biologic parent, c) had a parent who spoke English or Spanish, d) were born in California, and e) resided in the catchment areas of a specified list of Regional Centers in California. Children with ASD and DD were identified through California Regional Centers, which provide case management services to children with eligible developmental disorders across socioeconomic levels and racial/ethnic groups. No further exclusions were made based on genetics, family phenotype, or other characteristics, with the exception of children who had visual, hearing or motor impairments that precluded standardized developmental assessment. Institutional review boards of the University of California, Davis and the State of California approved this study. Written informed consent was obtained prior to participation.

### Clinic Assessments and Data Collection

Diagnosis of autism or ASD was confirmed using the Autism Diagnostic Interview–Revised (ADI-R)<sup>24</sup> and the Autism Diagnostic Observation Schedule (ADOS)<sup>25</sup> using criteria described by Risi *et al.* (2006).<sup>26</sup>

Cognitive function was measured using the Mullen Scales of Early Learning (MSEL).<sup>27</sup> Adaptive function was assessed by parent interview using the Vineland Adaptive Behavior Scales (VABS).<sup>28</sup> Children in the DD group were screened for ASD with the Social Communication Questionnaire (SCQ)<sup>29</sup> and in the study subset of children with DD, all had scores less than the cut-off of 15. For the present analysis, children classified as DD (n=125)

had standard scores on either the MSEL or VABS more than 2 standard deviations below the mean (MSEL or VABS composite <70). The majority (n=95) of the DD group scored <70 on both the MSEL and VABS, with an additional 16 children scoring <70 on one measure and <78 (within half a standard deviation above the cut-off) on the other measure (also used to define low-functioning ASD). Also included were fourteen children scoring <70 on one measure with a borderline-average score on the other measure.

Demographic data were obtained via telephone interview by trained study staff and from birth certificates. Psychometric assessments were administered at the clinic visit; child and family medical histories and a standardized medical evaluation of the child were performed by trained physicians. During the medical history they administered a Services and Treatment Interview to ask parents about the history of service utilization for the child, including hours per week participating in various types of educational, behavioral and other therapeutic interventions. Parents were also asked about use of conventional medications and CAM therapies, currently and in the past. For the purpose of this analysis, conventional medications and CAM therapies were grouped into categories. A category of psychotropic medications was created and included ADHD medications (stimulants and alpha-2 agonists), atypical antipsychotics, and selective serotonin reuptake inhibitors. Other categories were anticonvulsants, antihistamines, constipation medications, gastroesophageal reflux disease medications, insomnia medications and miscellaneous medications; this last group included inhalers, medically prescribed dietary supplements (e.g., duocal), prescribed nasal sprays, etc. Over-the-counter medications and short-term use medications such as antibiotics were not reported in this analysis.

CAM categories were also assigned based on the NCCAM model and, except for the category of mind-body medicine, all CAM treatments reported by our subjects were biologically based. Individual CAM products were assigned to representative categories, so that if a parent reported using a supplement (e.g., “BrainChild Spectrum Support”), the product contents were confirmed by Internet search and then the product was assigned to the appropriate category (alternative dietary supplement). CAM categories reported by CHARGE participants were: dietary supplements, the gluten-free, casein-free diet (GFCF), homeopathic remedies, mind-body medicine, melatonin, probiotics and a category of “Other CAM treatments,” which included other alternative diets and miscellaneous treatments such as: “antioxidants,” amino acid supplements, “immune support” products and natural products such as milk thistle. Daily multivitamins (“gummi vitamin”) were not included in this analysis. We also created individual categories for CAM therapies that we characterized as potentially unsafe (chelation), disproven (secretin) or invasive (B-12 injections). These CAM therapies included prescription antifungal medication, vitamin B-12 injections, intravenous immunoglobulin (IVIg), chelation therapy and secretin. These therapies were analyzed both individually and as a group.

The presence of a genetic (e.g. Trisomy 21 or Angelman Syndrome) or neurogenetic (e.g. metabolic or mitochondrial disorders, epilepsy) disorder was based on parent report obtained from the Child Medical History.

Parents completed a GI History questionnaire that asked about previous GI symptoms and those occurring within the last 3 months, with frequency self-reported by parents on a five-item Likert scale. Symptoms addressed by the questionnaire included the following: abdominal pain, gaseousness/bloating, diarrhea, constipation, pain on stooling, vomiting, sensitivity to foods, difficulty swallowing, blood in vomit and blood in stools. We focused here on the current symptoms.

To examine concerns that families of children with ASD who receive CAM may be more likely to be unimmunized or under immunized, we compared the immunization status of participants with ASD and DD. To control for the possibility that children with DD may be more likely to have immunizations deferred for medical reasons (refractory seizures, recurrent illness delaying vaccination), we compared immunization rates of both groups to the typically developing (TD) group of CHARGE participants. Typically developing participants in the CHARGE Study were recruited from the general population, did not have previous diagnoses of DD or ASD and scored <15 on the SCQ and 70 on both VABS and MSEL. Immunization status was obtained from the child's immunization records or from the Child Medical History obtained at the clinic visit. Children were regarded as being "up-to-date" if they had completed all immunizations required by the State of California for school entry for children aged 18 month to 5 years. When assigning immunization status, we did not consider any CDC recommended vaccines that were not required by the State of California for preschool attendance (i.e. Hepatitis A, Rotavirus), nor did we consider varicella because children may have naturally acquired immunity. For assignment of up-to-date status in 4-year olds, we did not require completion of State required 4 to 6 year old immunizations, since some children may not yet have enrolled in school. Our criteria for 'up-to-date' was intended to insure that subjects were only likely to be categorized as under-immunized if parents intended to defer or delay vaccines.

### Statistical Analyses

Descriptive analyses were performed using (1) Chi-square tests for categorical variables, (2) t-tests (Satterthwaite) or the Wilcoxon Two-Sample Test for continuous variables, such as parental age. Potential confounders were evaluated by bivariate analyses with each outcome (services, treatments) and predictor of interest (diagnosis). Covariates included child's age, sex, race/ethnicity, highest level of education in household and parental age. Effect modification was also evaluated using stratified analyses for the following potential effect modifiers: immunization status (up-to-date, behind/never vaccinated), presence of a genetic or neurogenetic disorder, GI symptoms (frequent, not frequent) and parental education level (Bachelor degree, no degree). Analyses adjusted for household education and child's diagnosis were performed using log-binomial regression to calculate prevalence ratios (aPR) and 95% confidence intervals (CI). A small sample adjustment of the prevalence ratio and 95% confidence interval was performed in analyses containing zero cell counts.<sup>30</sup> All analyses were carried out using SAS version 9.2 (Cary, NC).

## RESULTS

In this study, we included 453 children with ASD and 125 children with DD (N=578) whose parent had completed the Services and Treatment Interview. There were no significant differences between the ASD and DD groups with regard to child's race, age at the date of clinical evaluation or parental age at delivery (Table 1). Subjects in the ASD group were more likely to be male and to have a parent with a Bachelor's or higher degree whereas subjects in the DD group were more likely to have an identified genetic or neurogenetic disorder. Fifteen percent of children with ASD were classified as high-functioning (MSEL and VABS composite 70).

### Utilization of conventional services and treatments in ASD and DD

Virtually all children in both groups received one or more forms of conventional services. The median hours per week of receiving conventional services was significantly higher in children with ASD than in the DD group (Table 2). After adjusting for household education, children with ASD were twice as likely as those with DD to have seen a psychologist, 6 times as likely to have participated in social skills training and nearly 3 times as likely to

have participated in a behavior modification program. Children with DD were more likely to have received physical therapy, nutritional consultation, home nursing, and vision services. There were no differences in utilization of other services, such as occupational therapy or psychiatric care.

Participants in the DD group were nearly twice as likely as those in the ASD group to have ever received conventional medication for a chronic medical problem (48% vs. 30%, respectively) (Table 2). Treatment use was largely condition-specific, with subjects in the DD group significantly more likely to have received anticonvulsants, gastroesophageal reflux treatments, medically prescribed diets and medications to treat constipation. Utilization of conventional psychotropic medications, which included atypical antipsychotics, selective serotonin reuptake inhibitors (SSRIs) and ADHD medications, was quite low in both the ASD group (2.7%) and in the DD group (3.2%). Use of medications to treat other chronic conditions, such as asthma, allergies, and sleep problems, was higher in the DD group (29.6%) compared to the ASD group (17.4%),

### Utilization of CAM in ASD and DD

Overall, CAM utilization was more common in ASD (39.3%) than DD (29.6%) after adjustment for household education, although this was not statistically significant (Table 3). The most common CAM treatment was the use of dietary supplements, which was slightly more common among ASD children (ASD 24.7% vs. DD 18.4%; n.s.). The ASD group was far more likely to use the gluten-free, casein-free (GFCF) diet than the DD group ( $p=0.0009$ ) and this diet was slightly more likely to be utilized in children with ASD whose families reported frequent gastrointestinal (GI) symptoms.

Utilization of invasive, disproven, or potentially unsafe CAM was significantly higher in the ASD group than in the DD group (8.6% vs. 0%; Table 3). Antifungal medications (3.3%) chelation (4.4%) and vitamin B-12 injections (4.2%) were utilized infrequently in ASD. Use of secretin (0.2%) was essentially absent in our subjects, with use reported in only one subject from the ASD group and none reported in the DD group (Table 3).

Use of homeopathic remedies and mind-body medicine, such as massage or acupuncture, was more commonly reported by parents in the DD group, but reported use of these treatments was uncommon in both groups (Table 3). There were no differences in utilization of other types of CAM, such as melatonin, probiotics, and essential fatty acids.

### Sociodemographic characteristics and CAM use

**Household education**—In both ASD and DD, CAM use was nearly twice as frequent when at least one parent in the household had completed college; therefore, these groups were combined. After controlling for child's diagnosis, families where at least one parent has a Bachelor's degree were more likely than families without a Bachelor's degree to utilize CAM in general (44.9% vs. 26.9%; aPR 1.63; 95% CI 1.29, 2.08). Also, the use of potentially unsafe (chelation, antifungal medication, IVIg), definitively disproven (secretin) or invasive (Vitamin B-12 injections) CAM was twice as high in families with a Bachelor's degree than families without a Bachelor's degree (9.0% vs. 3.7%, aPR 2.16; 95% CI 1.05, 4.45).

**Ethnicity**—Hispanic families of children with either ASD or DD were less likely to have received CAM than non-Hispanic families; in a model adjusted for level of household education and child's diagnosis, Hispanic families were 29% less likely to have used CAM compared with non-Hispanic families (Table 4).

### Child diagnostic & phenotypic factors

**Neurogenetic diagnosis**—We had hypothesized that the presence of an underlying neurogenetic disorder, which parents might perceive as the causative factor of their child's ASD or DD, may be associated with lower CAM utilization. In fact, there was no association between the presence of a diagnosed neurogenetic disorder and frequency of CAM utilization (32.1% with identified disorder received CAM vs. 38.4% without received CAM).

**Developmental status**—Low-functioning children (defined as scoring <70 on MSEL or VABS and within half a standard deviation above the cut-off on the other measure) with ASD were neither more nor less likely to receive CAM than high-functioning children.

### Family medical utilization

**Immunization status**—The immunization status of children with ASD (66.2%) or DD (59.4%) was similar to the status of typically developing children in the CHARGE Study ( $n=276$ ; 66.7%). Immunization status was not predictive of CAM use in either DD or ASD although children who were not up-to-date on vaccinations were marginally more likely to use CAM than those with up-to-date vaccinations (41.5% vs. 34.1%; aPR 1.19; 95% CI 0.97, 1.48; Table 4). Children who had not received immunizations or were under-immunized did not differ from fully immunized children in regard to receipt of unsafe or invasive forms of CAM (19.2% vs. 16.8%;  $p=0.65$ ).

**Hours of services per week**—Families whose children were receiving 20 or more hours per week of conventional services were more likely to utilize CAM therapies (aPR 1.43; 95% CI 1.15, 1.78; Table 4). Those families receiving 20 or more hours of therapy per week for their child were twice as likely to utilize invasive, disproven, or potentially unsafe CAM (aPR 2.13; 95% CI 1.10, 4.12).

## DISCUSSION

We have demonstrated that families of preschool-aged children with ASD and DD utilize CAM frequently, even when they are able to access commonly recommended services such as behavioral therapy, speech therapy, and occupational therapy. The frequency at which conventional services were received and utilization patterns of both services and medications differed between groups. Children in the DD group were significantly more likely to have received physical therapy or anticonvulsants whereas behavioral modification or social skills training were more prevalent for the ASD children. This pattern of differences is consistent with the different developmental and adaptive needs of preschool-aged children with ASD and preschool-aged children with other types of developmental delays.

The significantly higher median total hours per week of services received by children with ASD vs. DD most likely reflects recommendations for service provision based on the current evidence base. To date, no practice guidelines specify the optimal level of services for children with DD, but clinical practice guidelines for children with ASD have recommended provision of intensive intervention, with active engagement of the child, at least 25 hours per week, 12 months per year.<sup>6,31</sup> Although most children in the ASD group received fewer than the recommended 25 hours per week, this may have been influenced by families differing in their progress of navigating autism-specific services at the time of the clinic visit. In this California population, families that were receiving the most intensive, autism-specific services were more likely to use CAM. This contradicts the theory that families utilize CAM due to the lack of availability of conventional services.<sup>32</sup> Instead, at

least in our sample of mostly well-educated families, it appears that CAM use may be more likely to be complementary than alternative.

Intentionally delaying or withholding immunizations in children with autism has been investigated<sup>32</sup> and physicians surveyed about use of CAM in ASD have endorsed “delaying” or “withholding” immunizations as some of the CAM treatments they would be most likely to discourage.<sup>33</sup> There is little information about immunization rates of young children with ASD, although some data suggests that families of children with ASD are more likely to refuse or delay vaccines<sup>34-36</sup>. However, in our study, up-to date immunization prevalence did not differ across ASD, DD and TD groups or predict CAM use.

Utilization of conventional psychotropic medications was quite low in both ASD and DD groups. In general, little is known about the relationship between CAM use and the use of psychotropic medications in children with ASD and other neurodevelopmental disorders. This is particularly true in preschool-aged children, where very limited age-specific data have been published about the safety and efficacy of either psychotropic medications or CAM treatments. Despite this lack of information, other studies have reported that the use of psychotropic medications in preschool-aged children with ASD is widespread. In 2008, Mandell et al.<sup>37</sup> examined the use of psychotropic medication in Medicaid-enrolled children with ASD and reported that factors unrelated to clinical presentation were highly associated with prescribing patterns, stating that, “socioeconomics and local health system factors drive medication use as much as the needs of individual children.” They reported much higher use of psychotropic medication than we found, even in children aged 0 to 2 years (18%) and 3 to 5 years (32%)<sup>37</sup> Others have also reported that factors external to clinical presentation likely affect the odds of psychotropic medication use among children with ASD,<sup>38</sup> with foster care placement and state-to-state variation in prescribing practices significantly associated with increased likelihood of being treated with multiple psychotropic medications.<sup>39</sup>

CAM utilization in CHARGE subjects was generally lower than CAM use previously reported in other studies. The reasons for this are unclear; possibilities include greater availability of behavioral and educational services as well as availability of educational and medical personnel with specialized training in autism. Parental under-reporting of use of CAM and a younger, less severely affected population are also possibilities. The low rates of reported psychotropic medication use may also be due to under-reporting although in previous studies, children with ASD living in areas with greater availability of pediatricians and pediatric specialists and those living in the West were modestly less likely to receive psychotropic medications.<sup>37</sup>

Factors unrelated to clinical presentation may also be likely to determine CAM use, as most of the factors that predicted increased CAM utilization in this study were not directly related to the child’s clinical presentation, but were related to family characteristics, such as level of household education, ability to access services and to some extent, ethnicity. Previous studies of CAM use have reported similar findings, with the most consistent predictor of CAM use being parents who use CAM themselves.<sup>11</sup> That the presence of an identified genetic or neurogenetic disorder was not associated with CAM use in either ASD or DD is of particular interest because uncertainty related to etiology has been postulated as an explanation for the high use of CAM in families of children with neurodevelopmental disorders and ASD in particular.<sup>40</sup> It may be, however, that decision-making regarding CAM use is more often related to searching for treatments that can fill gaps in conventional care or improve a child’s general health. Consistent with this explanation are findings from a survey of CAM use through the Autism Speaks Autism Treatment Network, in which parents reported higher rates of CAM use if their children had co-existing GI symptoms, seizures of behavior problems.<sup>16</sup>



ASD affected families in which the child received at least 20 hours per week of services were more likely to receive what we classified as unsafe, disproven or invasive forms of CAM. These types of CAM were also utilized more frequently in families with higher levels of education. As this group is most likely to have the resources and ability to benefit from consumer information, it appears that either the risks associated with these treatments are not sufficiently publicized or understood, or that parents are aware of them, but believe the potential benefit outweighs those risks. Providers may need to take a more active role in educating families about the wide array of CAM, the state of the science and the associated risks with both CAM and conventional treatments. That the prevalence in use of the potentially more risky types of CAM was nearly 9% underscores this concern and challenges us to understand more fully the decision-making process and willingness of some families to choose these interventions.

Secretin is one CAM treatment that has been exhaustively studied and definitively disproven.<sup>17</sup> We are encouraged to find that only 1 of 452 children in the ASD group had received secretin and suggest that this finding might be interpreted as a marker of the scientific community's ability to effectively communicate to families the results of well designed CAM trials in a manner which changes behavior when definitive results are widely publicized.

We must acknowledge several important limitations, the most significant of which is the absence of information about parental rationale for CAM use, which limits our ability to fully explore the underlying reasons for choosing CAM or conventional care and requires us to make some assumptions which should be clarified in future studies. We did not collect information on parental CAM use, which may also relate to parental rationale. CAM usage may be underestimated since time since diagnosis is not accounted for in our analysis. Many families may not consider CAM until after traditional therapies have been established.

Additionally, CHARGE participants are limited to preschool-aged children in California; utilization patterns of both CAM and conventional services may vary by region and child's age.<sup>22</sup> The possibility of selection bias must also be considered, in that families who agree to participate in a research study may be more able to identify and obtain resources for their children than other families who choose not to participate in research studies. Demographic data are consistent with this concern, with at least one parent holding a Bachelor degree in 61% of the families with a child with ASD and 47% of families with a child with DD. One difficulty of this ongoing population-based study involves estimating how many families declined to participate, as children continually age in and out of eligibility. As such, there is not a set eligible denominator that would be appropriate to provide accurate response rates. Another limitation pertains to the types of CAM reported by parents, as nearly all reported CAM use was of biologically based types of CAM. Factors such as the age of our subjects, regional preference for biologically-based CAM, the interviewer being a physician and the fact that the CAM questionnaire used in this study did not specifically ask about each of the major categories of CAM may explain the low utilization of other non-biologically based types of CAM, including mind-body medicine.

Although standardized questions were used to ask families about current and past CAM treatments, the questions were open-ended and follow-up questions were not standardized, which may have led to underreporting of treatments such as mind-body medicine. Additionally, the CAM history was obtained by a physician in a clinical research setting, which could contribute to underreporting of CAM use and possibly more so for use of "aggressive" forms of CAM, as previous authors have demonstrated that parents may be less likely to disclose CAM use to a physician.<sup>9,41</sup> Lastly, although the study population is quite

diverse and Hispanic families well represented, the study is only open to families who speak English or Spanish and therefore other minority populations are underrepresented.

## CONCLUSION

The vast majority of families in our study appear to be choosing to use CAM in a complementary manner in order to supplement conventional services and treatments. A large majority of families using CAM chose therapies that were likely to be safe. However, we do not know if families were using CAM therapies in coordination with their conventional health care provider. Gaining insight into how CAM therapies are utilized in the context of the complete plan of care for children with ASD and DD is critical. Regardless of how families make these decisions, healthcare providers should proactively seek to learn what therapies are being used and engage families in frank discussions about the importance of understanding concepts such as the hierarchy of evidence and of making treatment decisions based on current knowledge of safety and efficacy<sup>1111,42</sup>. Strengthening the evidence base for both conventional and CAM treatments for children with ASD and other developmental disorders is critical and efforts should be directed towards identifying and supporting successful methods of communicating best practices to the community of families affected by neurodevelopmental disorders.

## Acknowledgments

This work was supported by the National Institutes of Health (1 P01 ES11269), the U.S. Environmental Protection Agency through the Science to Achieve Results (STAR) program (R829388) and the MIND Institute, University of California, Davis.

This work was supported by the National Institute of Environmental Health Sciences (P01 ES11269 and R01 ES015359), the U.S. Environmental Protection Agency through the Science to Achieve Results (STAR) program (R833292 and R829388) and the UC Davis M.I.N.D. Institute, with additional funding from Cure Autism Now and Autism Speaks. We thank the project coordinator, Melissa Rose, and clinical staff including Crystal Gloria, Cynthia Contreras and Danielle Greenfield for their hard work. We are grateful to the hundreds of families who have contributed their time to participate in the study. We would also like to thank Ruth LeBlanc and June Brockman for their skillful editing and insightful advice.

## Biography

CDR Roger Scott Akins, MC, USN is a Navy Physician; however, the views expressed in this article are those of the author(s) and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense or the United States Government. Kathleen Angkustsiri, MD participates in clinical trials for fragile X syndrome and autism spectrum disorders funded by Novartis, Roche, Seaside Therapeutics, and Forest Laboratories.

## References

1. Autism and Disabilities Monitoring Network Surveillance Year 2008 Principal Investigators. Prevalence of Autism Spectrum Disorders --- Autism and Developmental Disabilities Monitoring Network, 14 Sites, United States, 2008. *MMWR Surveill Summ.* 2012; 61:1–19. Available at <http://www.cdc.gov/mmwr/preview/mmwrhtml/ss6103a1.htm>.
2. Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR). 4. Washington DC: American Psychiatric Association; 2002.
3. Matson JL, Nebel-Schwalm MS. Comorbid psychopathology with autism spectrum disorder in children: an overview. *Res Dev Disabil.* 2007; 28:341–352. [PubMed: 16765022]
4. National Autism Center. The national autism center's national standards report 2009. Randolph: National Autism Center; 2009. Available at <http://www.nationalautismcenter.org/pdf/NAC%20Standards%20Report.pdf> [Accessed May 30, 2013]

5. Johnson CP, Myers SM. Identification and evaluation of children with autism spectrum disorders. *Pediatrics*. 2007; 120:1183–1215. [PubMed: 17967920]
6. Myers SM, Johnson CP. Management of children with autism spectrum disorders. *Pediatrics*. 2007; 120:1162–1182. [PubMed: 17967921]
7. Rogers SJ, Vismara LA. Evidence-based comprehensive treatments for early autism. *J Clin Child Adolesc Psychol*. 2008; 37:8–38. [PubMed: 18444052]
8. Posey DJ, Erickson CA, Stigler KA, et al. The use of selective serotonin reuptake inhibitors in autism and related disorders. *J Child Adolesc Psychopharmacol*. 2006; 16:181–186. [PubMed: 16553538]
9. Wong HH, Smith RG. Patterns of complementary and alternative medical therapy use in children diagnosed with autism spectrum disorders. *J Autism Dev Disord*. 2006; 36:901–909. [PubMed: 16897395]
10. National Center for Complementary and Alternative Medicine. [Accessed July 20, 2010] Web Site <http://www.nih.gov/about/almanac/organization/NCCAM.htm>
11. Kemper KJ, Vohra S, Walls R. American Academy of Pediatrics. The use of complementary and alternative medicine in pediatrics. *Pediatrics*. 2008; 122:1374–1386. [PubMed: 19047261]
12. McDonagh MS, Morgan D, Carson S, et al. Systematic review of hyperbaric oxygen therapy for cerebral palsy: the state of the evidence. *Dev Med Child Neurol*. 2007; 49:942–947. [PubMed: 18039243]
13. Hanson E, Kalish LA, Bunce E, et al. Use of complementary and alternative medicine among children diagnosed with autism spectrum disorder. *J Autism Dev Disord*. 2007; 37:628–636. [PubMed: 16977497]
14. Harrington JW, Rosen L, Garnecho A, et al. Parental perceptions and use of complementary and alternative medicine practices for children with autistic spectrum disorders in private practice. *J Dev Behav Pediatr*. 2006; 27(2 Suppl):S156–161. [PubMed: 16685182]
15. Nickel RE, Gerlach EK. The Use of Complementary and Alternative Therapies by the Families of Children with Chronic Conditions and Disabilities. *Infants and Young Children*. 2001; 14:67–78.
16. Perrin JM, Coury DL, Hyman SL, Cole L, Reynolds AM, Clemons T. Complementary and alternative medicine use in a large pediatric autism sample. *Pediatrics*. 2012; 130 (Suppl 2):S77–82. [PubMed: 23118257]
17. Huffman LC, Sutcliffe TL, Tanner IS, et al. Management of symptoms in children with autism spectrum disorders: a comprehensive review of pharmacologic and complementary-alternative medicine treatments. *J Dev Behav Pediatr*. 2011; 32:56–68. [PubMed: 21160435]
18. Buie T, Campbell DB, Fuchs GJ 3rd, et al. Evaluation, diagnosis, and treatment of gastrointestinal disorders in individuals with ASDs: a consensus report. *Pediatrics*. 2010; 125 (Suppl 1):S1–18. [PubMed: 20048083]
19. Levy SE, Giarelli E, Lee LC, et al. Autism spectrum disorder and co-occurring developmental, psychiatric, and medical conditions among children in multiple populations of the United States. *J Dev Behav Pediatr*. 2010; 31:267–275. [PubMed: 20431403]
20. Eisenberg DM, Davis RB, Ettner SL, 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]
21. Levy SE, Mandell DS, Merhar S, et al. Use of complementary and alternative medicine among children recently diagnosed with autistic spectrum disorder. *J Dev Behav Pediatr*. 2003; 24:418–423. [PubMed: 14671475]
22. Birdee GS, Phillips RS, Davis RB, et al. Factors associated with pediatric use of complementary and alternative medicine. *Pediatrics*. Feb.2010 125:249–256. [PubMed: 20100769]
23. Hertz-Picciotto I, Croen LA, Hansen R, et al. The CHARGE study: an epidemiologic investigation of genetic and environmental factors contributing to autism. *Environ Health Perspect*. 2006; 114:1119–1125. [PubMed: 16835068]
24. Le Couteur, A.; Lord, C.; Rutter, M. *Autism Diagnostic Interview-Revised (ADI-R)*. Torrance: Western Psychological Services; 2003.
25. Lord, C.; Rutter, M.; DiLavore, P.; Risi, S. *Autism Diagnostic Observation Schedule*. Torrance: Western Psychological Services; 2001.

26. Risi S, Lord C, Gotham K, et al. Combining information from multiple sources in the diagnosis of autism spectrum disorders. *J Am Acad Child Adolesc Psychiatry*. 2006; 45:1094–1103. [PubMed: 16926617]
27. Mullen, E. Mullen scales of early learning. Circle Pines: American Guidance Services; 1995.
28. Sparrow, S.; Balla, D.; Cicchetti, D., et al. Vineland adaptive behavior scales: Interview edition, survey form manual. Circle Pines: American Guidance Services; 1084.
29. Rutter, M.; Bailey, A.; Lord, C. Social Communication Questionnaire (SCQ) - WPS. Torrance: Western Psychological Services; 2003.
30. Jewell, NP. Statistics for Epidemiology. 1. London: Chapman & Hall/CRC; 2004.
31. National Research Council. Educating children with autism. Washington, D.C: The National Academy Press; 2001.
32. Levy SE, Hyman SL. Use of complementary and alternative treatments for children with autistic spectrum disorders is increasing. *Pediatr Ann*. 2003; 32:685–691. [PubMed: 14606219]
33. Golnik AE, Ireland M. Complementary alternative medicine for children with autism: a physician survey. *J Autism Dev Disord*. 2009; 39:996–1005. [PubMed: 19280328]
34. Kuwaik GA, Roberts W, Zwaigenbaum L, et al. Immunization uptake in younger siblings of children with autism spectrum disorder. *Autism*. Oct 8.2012 Epub ahead of print.
35. Rosenberg RE, Law JK, Anderson C, et al. Survey of Vaccine Beliefs and Practices Among Families Affected by Autism Spectrum Disorders. *Clin Pediatr (Phila)*. Mar 2.2012 Epub ahead of print.
36. Capata M, Angkustsiri K, Plummer L, et al. Subpopulation of Children Who are Not Obtaining their 4–6 Year Booster Immunizations [eLetter response]. *Pediatrics*. 2012
37. Mandell DS, Morales KH, Marcus SC, et al. Psychotropic medication use among Medicaid-enrolled children with autism spectrum disorders. *Pediatrics*. 2008; 121:e441–448. [PubMed: 18310165]
38. Rosenberg RE, Mandell DS, Farmer JE, et al. Psychotropic medication use among children with autism spectrum disorders enrolled in a national registry, 2007–2008. *J Autism Dev Disord*. 2010; 40:342–351. [PubMed: 19806445]
39. Rubin DM, Feudtner C, Localio R, et al. State variation in psychotropic medication use by foster care children with autism spectrum disorder. *Pediatrics*. 2009; 124:e305–312. [PubMed: 19620187]
40. Levy SE, Hyman SL. Novel treatments for autistic spectrum disorders. *Ment Retard Dev Disabil Res Rev*. 2005; 11:131–142. [PubMed: 15977319]
41. Prussing E, Sobo EJ, Walker E, et al. Communicating with pediatricians about complementary/alternative medicine: perspectives from parents of children with down syndrome. *Ambul Pediatr*. 2004; 4:488–494. [PubMed: 15548099]
42. Liptak GS. Complementary and alternative therapies for cerebral palsy. *Ment Retard Dev Disabil Res Rev*. 2005; 11:156–163. [PubMed: 15977320]

**Table 1**

Demographic and clinical characteristics

Characteristic	ASD (n=453)	DD (n=125)	P-value
Sex, male [n (%)]	389 (85.9)	84 (67.2)	<0.0001
Child's age, months [mean±SD]	45.30±9.84	46.04±8.90	n.s.
Race/Ethnicity [n (%)]			
White, non-Hispanic	236 (52.2)	56 (45.5)	n.s.
Hispanic, any race	135 (29.9)	42 (34.2)	
Other <sup>1</sup>	81 (17.9)	25 (20.3)	
Mother's age at delivery, yrs [mean±SD]	31.19±5.38	30.02±6.67	n.s.
Father's age at delivery, yrs [mean±SD]	33.91±6.40	33.12±7.69	n.s.
Highest household education [n (%)]			
High school or less	64 (14.2)	37 (29.6)	<0.0001
Some college <sup>2</sup>	181 (40.0)	45 (36.0)	
Bachelor degree or higher	207 (45.8)	43 (34.4)	
Genetic/Neurogenetic disorder <sup>3</sup> [n (%)]	42 (9.3)	67 (53.9)	<0.0001
High functioning <sup>4</sup> [n (%)]	66 (14.6)	0 (0.0)	<0.0001

<sup>1</sup> Other race/ethnicity includes Black or African-American, Asian, Native Hawaiian or Pacific Islander, and multi-racial

<sup>2</sup> Includes 2-yr college and vocational degrees

<sup>3</sup> Includes conditions such as mitochondrial and metabolic disorders, cerebral palsy, non-febrile seizures, hydrocephaly

<sup>4</sup> MSEL>70 and VABS 70

**Table 2**

Utilization of conventional services and treatments

	ASD (n=453)	DD (n=125)	aPR [95% CI] <sup>†</sup>	P-value
Total hours of services/week [median (IQR)] <sup>‡</sup>	17.8 (4-27)	11 (3-17)		<0.0001
<b>Any conventional services [n (%)]</b>				
Psychologist [n (%)]	443 (97.8)	124 (99.2)	0.97 [0.92, 1.03]	n.s.
Social Skills [n (%)]	92 (20.3)	13 (10.4)	2.00 [1.16, 3.46]	0.0131
Behavior Modification [n (%)]	133 (29.4)	6 (4.8)	6.12 [2.77, 13.56]	<0.0001
Physical therapy [n (%)]	261 (57.6)	26 (20.8)	2.75 [1.94, 3.91]	<0.0001
Nutrition [n (%)]	68 (15.0)	73 (58.4)	0.26 [0.20, 0.34]	<0.0001
Home Nursing [n (%)]	43 (9.5)	33 (26.4)	0.37 [0.24, 0.55]	<0.0001
Vision Services [n (%)]	6 (1.3)	17 (13.6)	0.10 [0.04, 0.26]	<0.0001
Speech Therapy [n (%)]	43 (9.5)	30 (24.0)	0.39 [0.26, 0.61]	<0.0001
Occupational Therapy [n (%)]	414 (91.4)	117 (93.6)	0.97 [0.93, 1.01]	n.s.
Social Work [n (%)]	347 (76.6)	95 (76.0)	0.97 [0.87, 1.08]	n.s.
Psychiatry [n (%)]	122 (26.9)	32 (25.6)	1.10 [0.78, 1.54]	n.s.
Other service <sup>2</sup> [n (%)]	13 (2.9)	1 (0.8)	3.94 [0.52, 29.94]	n.s.
	338 (74.6)	102 (81.6)	0.91 [0.83, 1.01]	n.s.
<b>Any conventional treatments [n (%)]</b>				
Anticonvulsants [n (%)]	135 (29.8)	60 (48.0)	0.66 [0.52, 0.84]	0.0006
GERD medication [n (%)]	20 (4.4)	20 (15.2)	0.31 [0.17, 0.57]	0.0002
Medically prescribed diet [n (%)]	8 (1.8)	11 (8.8)	0.20 [0.08, 0.49]	0.0005
Constipation medication [n (%)]	33 (7.3)	20 (16.0)	0.47 [0.28, 0.80]	0.0056
Psychiatric Medications [n (%)]	12 (2.7)	10 (8.0)	0.34 [0.15, 0.77]	0.0101
Miscellaneous medication <sup>3</sup> [n (%)]	12 (2.7)	4 (3.2)	0.83 [0.27, 2.55]	n.s.
	79 (17.4)	37 (29.6)	0.64 [0.46, 0.89]	0.0087

<sup>†</sup> Log-binomial regression models with services as the outcome, adjusted for highest level of education in household (no Bachelor degree vs. Bachelor degree or higher); aPR = adjusted Prevalence Ratio, CI = confidence interval

<sup>‡</sup> Wilcoxon Two-Sample test; IQR = interquartile range

<sup>2</sup> Includes paraprofessional/home trainer, audiology, and respite care/daycare services

<sup>3</sup> Includes medications to treat allergies, asthma, insomnia and other chronic conditions

**Table 3**

Utilization of complementary alternative medicine

	ASD (n=453)	DD(n=125)	aPR [95%CI] <sup>†</sup>	P-value
<b>Any CAM treatments [n (%)]</b>	178 (39.3)	37 (29.6)	1.25 [0.94, 1.67]	n.s.
Dietary supplements [n (%)]	112 (24.7)	23 (18.4)	1.29 [0.86, 1.94]	n.s.
GFCF diet [n (%)]	83 (18.3)	2 (1.6)	10.40 [2.59, 41.65]	0.0009
Frequent GI symptoms <sup>‡</sup>	30 (38.0)	-	1.41 [0.95, 2.10]	0.0909
Invasive, disproven, or potentially unsafe CAM <sup>1</sup> [n (%)]	39 (8.6)	0 (0.0)	1.27 [1.19, 1.36]	0.0023
Antifungals	15 (3.3)	0 (0.0)	-	-
Chelation	20 (4.4)	0 (0.0)	-	-
B12 injections	19 (4.2)	0 (0.0)	-	-
IVIg	1 (0.2)	0 (0.0)	-	-
Secretin	1 (0.2)	0 (0.0)	-	-
Homeopathic remedies [n (%)]	1 (0.2)	3 (2.4)	0.07 [0.01, 0.66]	0.0205
Mind-body medicine [n (%)]	6 (1.3)	5 (4.0)	0.26 [0.08, 0.84]	0.0248
Melatonin [n (%)]	24 (5.3)	3 (2.4)	2.11 [0.64, 6.91]	n.s.
Probiotics [n (%)]	29 (6.4)	7 (5.6)	1.04 [0.47, 2.33]	n.s.
Other CAM treatments <sup>2</sup> [n (%)]	61 (13.5)	14 (11.2)	1.12 [0.65, 1.94]	n.s.

<sup>†</sup> Log-binomial regression models with CAM treatments as the outcome, adjusted for highest level of education in household (no Bachelor degree vs. Bachelor degree or higher); aPR = adjusted Prevalence Ratio, CI = confidence interval

<sup>‡</sup> Number of children on the GFCF diet and with frequent GI symptoms; 4 children on the GFCF diet and 19 children not on the GFCF diet were missing data on GI symptoms; 100 children not on the GFCF diet had frequent GI symptoms (of a total 351 not on the GFCF diet); log-binomial regression models, adjusted for highest level of education in household, were restricted to the ASD group only

<sup>1</sup> Small sample adjustment of prevalence ratio and 95% confidence interval (Jewell NP, 2004)

<sup>2</sup> Includes alternative diets other than GFCF, essential fatty acids, immune therapies other than IVIg

**Table 4**  
Family characteristics and complementary alternative medicine use among children with ASD or DD

Characteristic	Used CAM	No CAM	aPR [95% CI] <sup>†</sup>	P-value
Highest household education				
Bachelor degree or higher [n (%)]	149 (44.9)	183 (55.1)	1.63 [1.29, 2.08]	<0.0001
No Bachelor degree [n (%)]	66 (26.9)	179 (73.1)	1.00	
Ethnicity				
Hispanic [n (%)]	45 (25.4)	132 (74.6)	0.71 [0.53, 0.95]	0.0201
Not Hispanic [n (%)]	168 (42.2)	230 (57.8)	1.00	
Genetic/Neurogenetic disorder				
Present [n (%)]	35 (32.1)	74 (67.9)	1.05 [0.75, 1.47]	n.s.
Absent [n (%)]	180 (38.4)	289 (61.6)	1.00	
Child's immunizations				
Behind or not immunized [n (%)]	83 (41.5)	117 (58.5)	1.19 [0.97, 1.48]	n.s.
Up-to-date [n (%)]	125 (34.1)	242 (65.9)	1.00	
Hours of services per week				
20 hrs	109 (47.8)	119 (52.2)	1.43 [1.15, 1.78]	0.0012
<20 hrs	99 (31.3)	217 (68.7)	1.00	
<b>ASD only:</b>				
Child's immunizations				
Behind or not immunized [n (%)]	64 (42.7)	86 (57.3)	1.14 [0.91, 1.44]	n.s.
Up-to-date [n (%)]	108 (36.7)	186 (63.3)	1.00	
Function level <sup>‡</sup>				
Low [n (%)]	145 (37.5)	242 (62.5)	0.81 [0.62, 1.06]	n.s.
High [n (%)]	33 (50.0)	33 (50.0)	1.00	

<sup>†</sup>Log-binomial regression models with CAM use as the outcome, adjusted for highest level of education in household (no Bachelor degree vs. Bachelor degree or higher) and child's diagnostic group (ASD vs. DD); aPR = adjusted Prevalence Ratio, CI = confidence interval

<sup>‡</sup>Low function: <70 on both MSEL and VABS, or <70 on one assessment AND within 0.5SD above cutoff on other  
High function: MSEL>70 and VABS > 70