

## Computer decision support changes physician practice but not knowledge regarding autism spectrum disorders

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Keywords: computer-based decision support, pediatrics, clinical guidelines, autism spectrum disorder, primary care, screening

Word Count: 3268

This is the author's manuscript of the article published in final edited form as Bauer NS, Carroll AE, Saha C, Downs SM. Computer decision support changes physician practice but not knowledge regarding autism spectrum disorders. *Applied Clinical Informatics*. 2015; 6(3): 454-465. <http://dx.doi.org/10.4338/ACI-2014-09-RA-0084>

### ABSTRACT

**Objective:** To examine whether adding an autism module promoting adherence to clinical guidelines to an existing computer decision support system (CDSS) changed physician knowledge and self-reported clinical practice.

**Methods:** The CHICA (Child Health Improvement through Computer Automation) system, a CDSS, was enhanced with a module to improve management of autism in 2 of the 4 community pediatric clinics using the system. We examined the knowledge and beliefs of pediatric users using cross-sectional surveys administered at 3 time points (baseline, 12 months and 24 months post-implementation) between November 2010 and January 2013. Surveys measured knowledge, beliefs and self-reported practice patterns related to autism.

**Results:** A total of 45, 39, and 42 pediatricians responded at each time point, respectively, a 95-100% response rate. Respondents' knowledge of autism and perception of role for diagnosis did not vary between control and intervention groups either at baseline or any of the two post-intervention time points. At baseline, there was no difference between these groups in rates in the routine use of parent-rated screening instruments for autism. However, by 12 and 24 months post-implementation there was a significant difference between intervention and control clinics in terms of the intervention clinics consistently screening eligible patients with a validated autism tool. Physicians at all clinics reported ongoing challenges to community resources for further work-up and treatment related to autism.

**Conclusions:** A CDSS module to improve primary care management of ASD in pediatric practice led to significant improvements in physician-reported use of validated screening tools to screen for ASDs. However it did not lead to corresponding changes in physician knowledge or attitudes.

**Keywords:** computer-based decision support, pediatrics, clinical guidelines, autism spectrum disorder, primary care

## 1. BACKGROUND

The prevalence of autism spectrum disorders (ASD) is increasing and is a public health concern.[1] Primary care physicians play a central role in the early identification of ASDs as they are often the first providers to whom parents disclose concerns. However, the timely identification of ASD continues to be a challenge, particularly in the setting of a busy outpatient clinic.[2] Among families with children later found to be on the ASD spectrum, parents often started having concerns about their children's development within the first year of life. However, the national average for a confirmed diagnosis of an ASD is 4.5 years.[3, 4]

Tools exist to help primary care physicians identify ASDs in practice. These include clinical care guidelines [5, 6] and a brief, validated screening tool that can identify risk of autism as early as 18 months of age.[7] However, despite the existence of these tools, physicians find it hard to integrate these processes along with anticipatory guidance and other competing guidelines for routine surveillance and screening into the high volume and clinical flow of outpatient pediatric practice.[8, 9] While these efforts have been increasing since clinical care guidelines were published in 2001 and 2007 and scientific discoveries have accelerated what is known about ASDs,[5, 6] the rate of autism screening among community physicians has remained relatively unchanged over the last 5 years.[10, 11]

At our institution, we have developed a computer decision support system (CDSS) called the Child Health Improvement through Computer Automation system (CHICA), to support primary pediatric care. In 2009, we added module to CHICA to automate surveillance and screening for ASDs. Health information technology (HIT) such as CHICA can facilitate and support healthcare delivery at the point of care, improve physicians' decision-making and help prevent medical errors.[12] Indeed, previous work done by our group has shown CHICA's effectiveness in improving physicians' adherence to clinical practice guidelines for ADHD, smoking cessation, maternal depression and developmental screening.[13-17]

Little is known, however, about what impact CDSS has on physician knowledge or attitudes. One way to assess changes in screening practices is to measure self-reported knowledge and beliefs of physicians related to screening practices for ASD. The primary objective of this study was to examine whether exposure to

automation of screening and ASD-specific physician reminders and prompts would lead to measurable changes in physicians' knowledge and attitudes regarding autism screening. Based on our anecdotal observations we hypothesized it would improve their knowledge and attitudes about their role in the screening and management of ASD because CHICA delivers advice at the point of care, a much recognized "teachable moment".

Furthermore, we hypothesized that use of a CDSS for ASD screening would improve physician reported adherence to screening guidelines. To test this hypothesis, we surveyed physicians in the control and intervention clinics at baseline and over two time points after implementing the intervention.

## **2. METHODS**

### **2.1. Overview of the Autism Screening Module of the CHICA System**

CHICA is a CDSS and electronic health record (EHR) that is operational in 4 community pediatric clinics in CHICA. CHICA has been described in detail elsewhere,[18-21] but briefly, this system was designed to automate various aspects of preventive care and chronic disease management and work within the busy workflow of pediatric practice. The CHICA system was developed on an open-source electronic medical record framework ([www.openmrs.org](http://www.openmrs.org)), which is HL7-compliant and allows CHICA to link to an EHR.[22] CHICA produces two scannable and tailored paper forms, a pre-screener form (PSF) and a physician worksheet (PWS). On the PSF, CHICA prints a set of 20 health risk questions selected by the computer based on information in the child's EHR and the age of the child at the visit. The parent (or child if older than 12 years) completes the PSF in the waiting room prior to seeing the physician. See Figure 1 for a sample PSF form. The PSF is scanned into CHICA by a medical assistant prior to the encounter. The second scannable document, the PWS, is then generated. It contains a space for the physician to record notes and includes 6 prompts to guide decision-making at the point of care. CHICA selects these prompts based on the information obtained from the PSF and data in the EHR. See Figure 2 for a sample PWS that includes an autism-specific prompt.

In 2009, CHICA was enhanced with an autism module that included a set of autism-specific PSF questions, physician prompts, and Just-in-Time handouts (JITs) to supplement physician counseling.[23] When a child 22-26 months of age is seen in the clinic, the system adds questions to the PSF about autism risk and

generates a scannable version of a validated screening tool, the Modified Checklist for Autism in Toddlers (M-CHAT),[7] to identify at-risk children in need of further work-up. The M-CHAT is completed by the family in the waiting room, and scanned into CHICA. CHICA scores the M-CHAT and prints a report with an interpretation for the physician, along with follow-up interview questions based on concerning responses.[24-26] CHICA generates autism-specific JITs, as well, for the physician to share with the family should the screening be positive. For children who have a confirmed diagnosis of an ASD, additional educational JITs covering various aspects pertinent to ongoing management (for example, behavior problems, parent and financial resources, complementary and alternative medicine) are generated at subsequent visits based on parental concerns recorded on the PSF. Prior to implementation of the module, the intervention clinics were informed that the ASD was developed and study personnel provided a brief overview of the module, associated PSF and PWS prompts and handouts. This standardized process is employed before the launch of new CHICA modules so that physicians and clinic staff are aware of major changes prior to implementation. Because every module is designed to work within the existing structure of CHICA, providers did not need additional in-depth training.

## **2.2. Setting and Participants**

This study took place between November 2010 and January 2013. Data from this study are part of a larger cluster randomized controlled trial, in which 2 of the 4 clinics using CHICA were randomly assigned to receive the ASD module. The remaining two clinics were categorized as control sites as they had access to the CHICA system but not the ASD module. The decision to randomize at the clinic level was made to avoid potential contamination. When randomized at the provider level, providers in the same clinic assigned to different study conditions tend to communicate and share resources generated from CHICA. When randomized at the patient level, the intermittent printing of forms for some patients and not others leads staff at the clinic to believe CHICA was malfunctioning. Also, there is essentially no movement of the physicians between the four clinic sites and thus no risk of contamination due to physicians practicing in multiple clinics. For the present study, to understand whether the ASD module was associated with any change in physician knowledge about

ASD or change in practice, physicians at all 4 clinics were asked to complete a survey on autism knowledge and practice. The four clinics are part of the Eskenazi Health System in Indianapolis, Indiana. These clinics serve a large proportion of families that are uninsured and underserved. Families served by these clinics are typically 58% black, 30% Latino, 25% Spanish speaking, and 80% on Medicaid. Data used in the present study represent a repeated cross-sectional study design embedded within a larger cluster randomized controlled trial.

### **2.3. Data Collection and Analysis**

Physicians were asked to complete an adapted survey,[27] which was designed to capture physicians' knowledge about autism, perceptions of their role in the diagnosis and treatment of ASD, and physician demographics. The survey was administered at three time points (at baseline prior to implementation, 12 months post-implementation and again at 24 months post-implementation). The survey contained three domains: knowledge (20 items), attitudes towards diagnosis and treatment (4 items), and physician demographics (6 items). Physicians were asked to rate their agreement with ASD knowledge items (for example, autism is more frequently diagnosed in males than in females), using a 6-point rating scale (1=fully agree to 6=fully disagree). They were also asked to categorize their perceived role in establishing the diagnosis of autism, their typical use of parent-completed screening instruments when considering a diagnosis of autism in children aged 0 to 5 years, and their perceived role in the management of children with autism.

Demographics included physician gender, years in practice excluding residency, primary specialty, and the approximate number of children 18 years and younger seen per week. See Appendix/Supplementary Material for the full survey instrument.

Data were entered into a Microsoft excel database (Microsoft Corp, Redmond, WA) and then analyzed in SAS software version 9.3. We used double data entry whereby, two independent trained research assistants manually entered data into the database separately. Any discrepancies in entry were resolved by going back to the original paper copy of the data collection tool. This method was used to avoid data entry errors. Each survey administration was examined as separate cross-sectional samples since data were collected anonymously

and could not be linked across time points. In addition having only two clusters per group and only three to five physicians surveyed in one clinic, intra cluster correlation issue could not be considered in the data analyses.

While the knowledge items asked physicians to provide ratings on a 6-point Likert scale, some of the cell frequencies were zero and the sample size by treatment group small. Therefore, knowledge item responses were collapsed from the 6-point scale to a binary variable (agree or disagree) and then compared between intervention and control groups at each time point. Exact logistic regression models were used to analyze the dichotomous outcomes including reported use of validated parent rated screening tools. Within each of the two groups, we also assessed the change in proportion of subjects who responded ‘agree’ at each of the two post-intervention time points from baseline. We again used exact logistic regression model to compare the proportions of subjects who responded ‘agree’ at 12- and 24-month post-intervention with the proportions of subjects who responded ‘agree’ at baseline. This study was reviewed and approved by Indiana University Office of Research Administration.

### **3. RESULTS**

The number of respondents for each survey administration was as follows: 45 at baseline, 39 at 12 months and 42 at 24 months. The response rates for the surveys were 100% at baseline and 12 months and 95% at 24 months. Primary specialty was the only characteristic that varied significantly between intervention and control groups, with pediatrics making up more of the control group. All other physician characteristics were not significantly different between the intervention and control group respondents at baseline, 12 or 24 months (data not shown for 12 months or 24 months). See table I. for sample characteristics at baseline.

Respondents’ knowledge of autism or the perception of role in diagnosis did not vary significantly between the control and intervention groups for any of the items at any time point. See Table II. for a summary of the median autism knowledge scores at each time point and by treatment group. At baseline, physicians in both groups reported similar rates in the routine use of parent-rated screening instruments (for example, the Modified Checklist for Autism in Toddlers or the M-CHAT) as part of the assessment of autism (47% for intervention group vs. 42% for the control group). At 12 months, the rate of use of a parent-rated screening

instrument increased for the intervention group to 79%, while the rate for the control group remained essentially unchanged (46%). The change for the intervention group was not statistically significant based on the exact logistic regression analysis ( $p=0.085$ ) and group difference was also not statistically significant ( $p=0.057$ ). At 24 months, the difference between the control and intervention group was significant ( $p = 0.008$ , 88% for the intervention group vs. 42% for the control group) and the change for the intervention group was significantly different from baseline ( $p=0.023$ ). See Figure 3. The control group did not exhibit a statistically significant change in the use of parent-rated screening instruments throughout the duration of the study.

At 12 and 24 months post-ASD module implementation, a majority of physicians (77% of physicians in intervention group vs. 66% of physicians in control group) reported challenges associated with identifying resources in the community for further work-up and specialty treatment.

#### **4. DISCUSSION**

Our study shows that CHICA did not improve physicians' knowledge of or perceived role in ASD screening and diagnosis. Therefore, improved knowledge and attitudes cannot be the mechanism by which CHICA improved screening. Even though the intervention group reported increased use of a parent-rated ASD screening tool, specifically the M-CHAT, the control group's implementation of a similar tool remained unchanged. Our finding that clinics without CHICA were unable to implement ASD screening consistently despite widespread public health efforts at the community level to improve physician awareness and empower practices to implement universal screening for ASD emphasizes that publication and promotion of guidelines is often insufficient to change practice. Prior to the study, we did not assume any particular survey knowledge item would be changed by the ASD module given our hypothesis that exposure to the automated process of surveillance, screening and prompting of physicians would capitalize on the "teachable moment" that is often used at the point of care and heavily relied upon to train physicians at all points in their career.

However, our study highlights the fact that the use of health information technology, such as a CDSS, improves adherence to recommended clinical practices by integrating clinical care guidelines into clinical workflow. We found that CHICA increased rates of autism screening; this is consistent with previous work on



the CDSS in medical settings, especially for preventive care.[28-31] This study adds to previous work by our group showing that health information technology greatly facilitates physicians' abilities to adhere to clinical care guidelines into busy pediatric practices.[13-16, 23, 32, 33] Moreover, CHICA has characteristics of other successful CDSS in that it promotes routine screening and fits into the clinical workflow.[34, 35]

Approaches aimed solely at improving physician knowledge are limited in their effectiveness in promoting actual change in physician practice. Continuing medical education is the traditional modality that is often used to improve physician knowledge, with the ultimate goal of changing physician behavior. However, passive approaches are generally not effective or sufficient enough to change clinical practice.[36-39] Evidence shows no one single strategy of all available approaches for transferring evidence-based medicine into "real world" practice is superior;[40] however those that incorporate reminder systems, academic detailing and multiple interventions are relatively strong.[41] However, based on responses at the 12 and 24 month time points, there were no significant differences in the perceived role of the primary care physician with respect to various aspects of chronic care management, including ongoing care coordination delivered in the medical home. This suggests that changes in the system, in this case through automation, were the key to making a change in physician behavior that they were otherwise ready to make. Given these results, one might wonder if increased screening had a significant effect on patient outcomes. The larger RCT examining the effect of the CHICA autism module has recently been completed and final analysis of the data, including family interviews about care received, are underway.

Our findings are consistent those reported by Carbone et al, 2010 that few physicians viewed themselves as direct providers of comprehensive ASD care, but more as advocates, referral sources and care coordinators.[42] In our study, physicians in both intervention and control clinics felt finding resources for further evaluation and treatment of ASD was challenging. Our findings support the need for multi-faceted interventions to improve not only physician detection of ASD in primary care, but systems-change that also improves access to community services that medical homes often rely upon to provide comprehensive, coordinated care to these families. Moreover, health information technology has the potential to facilitate the sharing of patient data housed in electronic medical records and make it available to various members of the

interdisciplinary team. While there is value in supporting physicians during the actual patient encounter using a CDSS, continued work building and sustaining interdisciplinary collaboration and systems to ensure care coordination with community providers is critical in supporting the primary care medical home. Moreover, technological modifications to our existing CDSS can be done to facilitate these processes between the medical home and community providers. Other informatics work has been done using machine intelligence to aid in the rapid detection and clinical prioritization of children at risk for ASD. [43-47] Ongoing work that is aided by health information technology shows early promise to ensure families' needs are met in a timely manner.

Certain limitations of our study should be acknowledged. Data are from surveys that asked physicians about their knowledge and perceived role in identification and management of ASDs. Surveys are subject to social desirability bias. We tried to limit this by keeping surveys de-identified at each time point to encourage honest answers from respondents. However, in doing so, we were unable to measure individual changes in knowledge and beliefs over time. Also, even though the surveys did not ask for direct personal identifying information, the number of providers surveyed and granularity of the questions answered could potentially unmask the anonymity of the respondents. Moreover, physicians' self-reported practices to measure changes in adherence to screening guidelines may be less reliable than measuring the rate of screening via medical record data. We are undertaking external validation as part of the larger RCT. This work is underway, and preliminary results confirm the physicians' reports. Also, the actual process of inputting and outputting data with scannable documents is not commonly used by other CDSSs. This limits the external validity of the technology. However, the CHICA system is currently in the process of moving to a paperless environment. Lastly, the number of survey respondents, particularly in the intervention group, is quite small. Furthermore, because individual respondents could not be tracked and there were changes to the physician population, these had to be treated as independent samples. The result is some loss in statistical power, but this is unlikely to threaten the validity of the results. We acknowledge we may not have had adequate sample size to draw the conclusion that this intervention did not lead to knowledge change.

## **5. CONCLUSION**

Our CDSS improved physician-reported use of validated screening tools to identify children at-risk for ASD. A CDSS can improve clinical care, but the mechanism is not related to changes in knowledge or attitudes.

## **CLINICAL RELEVANCE STATEMENT**

Implementation of a CDSS within a busy pediatric practice promotes adherence to clinical care guidelines but does not lead to changes in physician knowledge or attitudes towards autism spectrum disorders.

## **CONFLICTS OF INTEREST**

The authors declare that they have no conflicts of interest in the research.

## **HUMAN SUBJECTS PROTECTIONS**

The study was conducted in compliance with the World Medical Association Declaration of Helsinki on Ethical Principles for Medical Research Involving Human Subjects, and was reviewed by the Indiana University Institutional Review Board.

## **ACKNOWLEDGEMENTS**

The authors wish to acknowledge the technical expertise and efforts of the individual members of the Child Health Improvement Research and Development Lab (CHIRDL) team, which provides programming and technical support for CHICA, the Pediatric Research Network (PResNet) at Indiana University for administering the Autism Practice Survey at the pediatric clinics with CHICA, specifically Amy Pottenger, Elaine Cuevas, Vickie Cater, Jaskaran Mahal and Kailie Stout. The authors wish to thank the clinic personnel who constantly help us evaluate and improve CHICA. This work was supported by grant number R01HS018453 from the Agency for Healthcare Research and Quality.

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Table I. Baseline Physician Characteristics

	<b>Intervention N (%)</b>	<b>Control N (%)</b>
Female gender	9 (56)	18 (62)
Years in practice (post-residency)		
1-5 years	5 (31)	5 (17)
6-10 years	2 (12)	5 (17)
11-20 years	4 (25)	4 (14)
20+ years	2 (13)	2 (7)
Resident	3 (19)	12 (41)
Primary Specialty		
Pediatrics	<b>7 (44)</b>	<b>25 (86)</b>
Internal Medicine / Pediatrics	<b>3 (19)</b>	<b>2 (7)</b>
Other	<b>5 (31)</b>	<b>1 (3)</b>
Completed residency / training in the following fields:		
Developmental-Behavioral Pediatrics	0 (0)	0 (0)
Psychiatry / Child Psychiatry	0 (0)	1 (3)
Other	2 (13)	3 (10)
Not Applicable	9 (56)	13 (45)
On average, how many children 18 years or younger seen per week		
1-25	8 (50)	14 (48)
26-50	6 (38)	5 (17)
51-75	1 (6)	3 (10)
76-100	1(6)	4 (14)
> 100	0 (0)	2 (7)
Average weekly time in clinic		
Full time	4 (25)	4 (14)
Part-time	11 (69)	23 (79)

\*totals may not equal 100% due to missing or skipped items

BOLD results indicate significant difference by the Fishers Exact test at the  $p \leq 0.05$  level





8151609156 **CHICA Physician Encounter Form** #99-2

**Patient:** Patient, Ima Great (F) **MRN:** #99-2  
**DOB:** 03/20/13 **Age:** 2 yo **Date:** Mar 20 2015  
**Doctor:** Other **Time:** 2:08PM

**Physical Exam:**  NI  Abnl  
**General:**    
**Head:**    
**Skin:**    
**Eyes:**    
**Ears:**    
**Nose / Throat:**    
**Teeth / Gums:**    
**Nodes:**    
**Chest / Lungs:**    
**Heart / Pulses:**    
**Abdomen:**    
**Ext. Genitalia:**    
**Back:**    
**Neuro:**    
**Extremities:**

**History / Exam Comments:**  Additional notes on back...  
 Two ID's Checked  
 Screened for abuse  
 Discussed physical activity  
 Discussed healthy diet  
**Informant:** \_\_\_\_\_

**Vital Signs:**  
**Height:** in. ( ) %  
**Weight:** kg.( ) %  
**BMI:** ( ) %  
**Head Circ:** cm.t ( ) %  
**Temp:** F ( )  
**Pulse:**  
**RR:**  
**BP:** ( )  
**Pulse Ox:** %  
**Hear (L):** **Hear (R):**  
**Vision (L):**  
**Vision (R):**  
**Weight:**  
**Prev WT:** ( )  
 \* = Abnormal, U = Uncooperative

**Legend:** \* = Previously Abnl  
 o = Needs Examination  Special Need Child **medications:** NONE **Allergies:** \_\_\_\_\_  
**Pain (0-10):** \_\_\_\_\_

**INSTRUCTIONS:** Check all applicable boxes. COMPLETELY fill space to right of each box to "uncheck" misfilled boxes.

**DENTAL:** Remind family to help child brush teeth twice daily, and to see a dentist every year. (Handout can be printed from CHICA)  
 Rec: NO BOTTLE  Rec: parent help brush BID  
 Advise to see dentist  Gave dentist handout  
 Completed oral exam  Has a dental home

**Maternal depression** is common and impairs child health and development. Depressed mood, not enjoying things (anhedonia), sleep and appetite disturbances may all suggest depression. Is Ima's mother depressed?  
 Depressed mood  May be depressed -> Referred  
 Anhedonia  NOT depressed  
 Sleep/appetite problem  Mom not present

The AAP recommends screening for all children for autism at 18 and 24 months. Ima is due for her formal 24-36 month developmental screening. Check below to indicate that you have scored ASQ and discussed with family. CPT 96110  
 Positive/Concerning Score ->  Refer to Sarkin/Dev Peds/RCDC  
 Autism known previously  Refer to Audiology  
 Previous Normal MCHAT  Normal score

**Suspect Delay ->**  Refer to First Steps  
 Activities for Children form  Sched follow-up 1 month  
 ASQ done, scored, discussed  Do not suspect delay

**Guns at home** or in homes where a child visits or is cared for increase the risk of injury to children. The AAP says removing guns from the home is the best way to prevent injury. If guns must be kept, they should be stored  
 No guns in home  Provided gun handout  
 Guns in home ->  Store unloaded, locked  
 Asked about guns at friends'  Store away from ammo

The AAP recommends screening for all children for autism at 18 and 24 months.

Positive/Concerning Score ->  Refer to Sarkin/Dev Peds/RCDC  
 Autism known previously  Refer to Audiology  
 Previous Normal MCHAT  Normal score

Figure 2. Sample Physician Worksheet (PWS) with autism prompt shown in insert

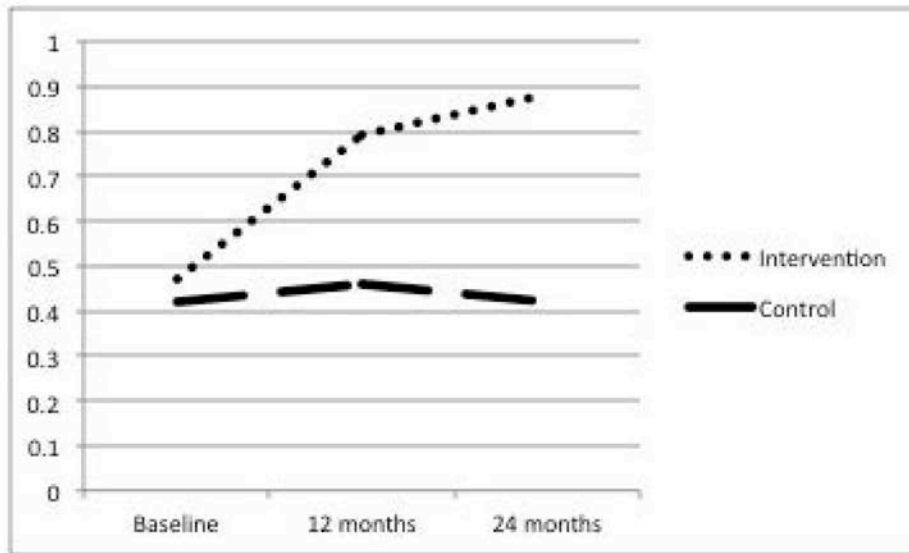


Figure 3. Percentage of physicians reporting routine use of parent-rated screening instrument for autism assessment

**Table II. Summary of physician knowledge regarding autism spectrum disorders presented as median score by survey time & treatment group**

Outcome	Baseline		12 Month	
	Control	Intervention	Control	Intervention
Autism is an emotional disorder	4	5	5	4
Early intervention in children's social and communication skills	1	1	1	1
All children with autism display poor eye contact	3	4	3	4.5
Children with autism typically perform better when tasks are presented visually than verbally	2	2	2	2.5
Problems with social relatedness in autism are different from others	3	3	3	3
Autism is more frequently diagnosed in males than in females	3	3	3	2.5
Children with autism do not show attachments to parents	4	4	4	4.5
sensory integration therapy is an effective treatment for autism	3	3	3	3
Children with autism are deliberately uncooperative	5	5.5	6	5
Most parents first concerns were related to the child's social behavior	3	3	3	3
Autism tends to run in families	4	3	3	3
We now have treatments that can cure autism	6	5	6	5
Children with autism can grow up to live independently	3	3	3	2.5
There is one approach/program that works for all children with autism	6	6	5	6
It's important that all children diagnosed with autism receive some form of special education services at school	2	2	2	2
Autism occurs more commonly among higher socioeconomic and educational levels	4	5	4	4
Autism can be diagnosed as early as 18 months	3	2	3	2
With the proper treatment, most children diagnosed with autism eventually outgrow the disorder	5	5	5	5
Children with autism do not show affection	5	5	4	5
The need for routines and sameness is one of the earliest behavioral features of autism	3	2	3	2