

# Nonmedical Interventions for Children With ASD: Recommended Guidelines and Further Research Needs

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## KEY WORDS

autism spectrum disorders, interventions, guidelines, standards

## ABBREVIATIONS

ASD—autism spectrum disorder

EPC—Evidence-based Practice Center

HRSA—Health Services Resources Administration

PECS—Picture Exchange Communication System

TEP—Technical Expert Panel

UCLA—University of California, Los Angeles

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## abstract

**OBJECTIVE:** To use the findings of a systematic review of scientific evidence to develop consensus guidelines on nonmedical interventions that address cognitive function and core deficits in children with autism spectrum disorders (ASDs) and to recommend priorities for future research.

**METHODS:** The guidelines were developed by a Technical Expert Panel (TEP) consisting of practitioners, researchers, and parents. A systematic overview of research findings was presented to the TEP; guideline statements were drafted, discussed, debated, edited, reassessed, and presented for formal voting.

**RESULTS:** The strength of evidence of efficacy varied by intervention type from insufficient to moderate. There was some evidence that greater intensity of treatment (hours per week) and greater duration (in months) led to better outcomes. The TEP agreed that children with ASD should have access to at least 25 hours per week of comprehensive intervention to address social communication, language, play skills, and maladaptive behavior. They agreed that applied behavioral analysis, integrated behavioral/developmental programs, the Picture Exchange Communication System, and various social skills interventions have shown efficacy. Based on identified gaps, they recommend that future research focus on assessment and monitoring of outcomes, addressing the needs of pre/nonverbal children and adolescents, and identifying the most effective strategies, dose, and duration to improve specific core deficits.

**CONCLUSIONS:** The creation of treatment guidelines and recommendations for future research represents an effort by leading experts to improve access to services for children with ASDs while acknowledging that the research evidence has many gaps. *Pediatrics* 2012;130:S169–S178

Autism spectrum disorders (ASDs) have emerged as a major public health and community challenge; most estimates of the prevalence of ASDs in children range from 6.5 to 6.6 per 1000.<sup>1–3</sup> More recent studies suggest that ASD prevalence might be higher than previously estimated, with ~11 per 1000 children between the ages of 3 and 17 years affected.<sup>4</sup> Nationally, between 500 000 and 673 000 children and adolescents are impacted by ASDs.<sup>1–4</sup>

ASD is a developmental disability characterized by early core deficits in social interaction and communication that profoundly influence development into adulthood.<sup>5,6</sup> Although autism is a neurobiological disorder, its pathophysiology remains obscure, and psychological and educational interventions are currently the primary treatments for addressing the core deficits in children. The interventions have various goals, including reducing detrimental behaviors, increasing social skills and cognitive ability, and facilitating child development.<sup>7</sup> Given the scope of the problem, there is a pressing need to clarify effective practices and to highlight gaps for additional intervention development.

As mandated by the Combating Autism Act of 2006, the Maternal and Child Health Bureau of the US Health Resources and Services Administration (HRSA) funded 2 research centers aimed at investigating treatment of ASDs: one for physical aspects, based at Massachusetts General Hospital, and one for behavioral aspects, based at the University of California, Los Angeles (UCLA). UCLA contracted with the Southern California Evidence-based Practice Center (EPC), based at the Rand Corporation, to conduct a systematic review of the scientific evidence on the efficacy of various interventions, assemble a report on the results, and develop evidence-based guidelines.

Because the scientific literature alone is often insufficient to make these kinds of clinically detailed judgments, we convened a multidisciplinary group of experts to develop the guidelines by using the evidence from the systematic review and their own individual backgrounds to make decisions. This document presents the final guideline statements.

## METHODS

The guidelines were developed by a Technical Expert Panel (TEP), with assistance from the EPC and UCLA. The TEP is a large, multidisciplinary group consisting of experts in psychology, developmental pediatrics, child psychiatry, and education as well as parents of children with autism. The members and their affiliations are presented in Table 1.

### Evaluation of Relevant Evidence

The process began with a thorough systematic review of the scientific evidence. Through conference calls, the TEP advised on the scope of the review, the intervention types and age groups to include, intervention characteristics to assess, and which outcomes were most important in assessing core deficits as well as cognitive function. Importantly, the panel expanded the project to include some interventions that may not necessarily be considered “psychosocial” but target the core deficits of autism, such as augmentative communication systems and auditory integration therapy. Thus, our scope covers comprehensive programs (behavioral, developmental, those integrating behavioral and developmental approaches, and environmental support), social skills programs, communication interventions for non-verbal children, speech and language therapy, and sensory motor interventions. A complete description of the methodology, including the literature

**TABLE 1** Technical Expert Panel (TEP)

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Anshu Batra, MD, Parent, Founder - Our Special Kids Pediatric Care
Tony Charman, PhD, Chair in Autism Education, Institute of Education (UK)
Janet Grillo, Parent, Filmmaker
Patricia Howlin, PhD, Institute of Psychiatry (UK)
Brooke Ingersoll, PhD, Dept of Psychology, Michigan State University
Portia Iversen, Parent, Cofounder - Cure Autism Now
Susan Levy, MD, Director, Regional Autism Center, Childrens Hospital Philadelphia
Catherine Lord, PhD, Director, Autism and Communication Disorders Center, University of Michigan
Brian King, MD, Professor of Psychiatry, University of Washington
Marsha Mailick Seltzer, PhD, Director, Waisman Center
Ann Neumeyer, MD, Medical Director, Lurie Family Autism Center
Ricki Robinson, MD, Descanso Medical Center for Development & Learning
Lawrence Scahill, PhD, Child Study Center, Yale School of Nursing
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Ilene Schwartz, PhD, Experimental Education Unit, University of Washington
Tristram Smith, PhD, Strong Center for Developmental Disabilities, University of Rochester
Aubyn Stahmer, PhD, Child & Adolescent Services Research Center (CASRC) Rady Childrens Hospital
Wendy Stone, PhD, Director, University of Washington Autism Center

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search strategy, is available in our full report.<sup>8</sup> To be included in the project, studies had to meet the following criteria:

- Include data on children or adolescents.
- Include specific outcome data on participants with ASDs. For example, if a study included subjects with autism, mental retardation, and other developmental disorders, the study had to report separate outcomes for individuals with autism.
- Report outcome data on cognitive function or core deficits, which include communication, language, social skills, behavior, restricted interest, and adaptive skills.

- Have a sample size of at least 10. A control group was not necessary; observational studies were included. However, single-subject research was excluded. Editorials, nonsystematic reviews, and background articles were excluded, although we searched their reference lists for any relevant studies.

Two researchers abstracted information about research design, search dates (for reviews/meta-analysis), population, intervention components, outcomes measuring cognitive function or core deficit areas, and any comparison groups from each study. We assessed each study's quality with the use of standard instruments.<sup>9–11</sup> Data were summarized to create evidence tables for each intervention type.

We assessed the overall strength of evidence for intervention effectiveness using guidance suggested by the US Agency for Healthcare Research and Quality (AHRQ) for its Effective Healthcare Program.<sup>12</sup> This method is based loosely on one developed by the Grade Working Group<sup>13</sup> and classifies the strength of evidence according to the following criteria:

High = High confidence that the evidence reflects the true effect. Further research is very unlikely to change our confidence on the estimate of effect.

Moderate = Moderate confidence that the evidence reflects the true effect. Further research may change our confidence in the estimate of effect and may change the estimate.

Low = Low confidence that the evidence reflects the true effect. Further research is likely to change our confidence in the estimate of effect and is likely to change the estimate.

Insufficient = Evidence either is unavailable or does not permit a conclusion. We also used this clas-

sification if studies showed no evidence of effectiveness.

The strength of evidence is based on 4 primary domains (required) and 4 optional domains. The required domains are risk of bias, consistency, directness, and precision; the additional domains are dose-response, plausible confounders that would decrease the observed effect, strength of association, and publication bias.

In April 2010, the TEP members received a copy of the draft evidence report<sup>8</sup> for review. To facilitate discussion and drafting of guidelines, we held a 2-day meeting on June 3 to 4, 2010. Although an effort was made to accommodate all members' schedules, some experts were unable to attend in person. Thus, a Web-based conference line (both audio and visual) was arranged so TEP members could attend remotely and participate in the discussion. Eighty percent of the TEP members attended in person, and the remaining 20% participated over the Web. All TEP members, whether attending in person or remotely, were encouraged to actively participate. All were required to complete a form disclosing any potential financial, business, or professional conflicts of interest before participating.

### Generation of Consensus Guidelines Statements

#### *Drafting Guidelines and Reaching Consensus*

At the meeting, the TEP members discussed the scientific evidence presented in the report, examined the strength of the evidence, and critiqued it in a series of open discussions led by EPC staff and the UCLA Autism Intervention Research – Behavioral Network Principal Investigator. TEP members expressed their points of view about the efficacy of the various interventions, relying upon both the evidence presented in the report and

their clinical or empirical knowledge and expertise. Parents commented on the findings in light of their personal experience. The meeting goal was to draft a series of consensus statements pertaining to interventions and to develop recommendations for the 5 top priority areas for future research. The face to face process was led by Paul Shekelle, MD, PhD, Director of the EPC. Guidelines statements were drafted individually for each area of evidence and discussed by the group. The panel spent as much time as was needed to discuss the proposed statement, and amendments were made to address various proposed concerns, issues, and suggestions.

Once the group reached a consensus that the proposed statement was well formulated, they voted electronically to determine the degree of agreement with the proposed statement. TEP members were asked to state the degree to which they agreed with a statement on a Likert scale with the following terms: “strongly disagree,” “disagree,” “neutral,” “agree,” or “strongly agree.” All voting participants in the room were provided with clickers that allowed them to anonymously choose an answer. Remote voting participants were assigned a proxy voter, who received communication from them via e-mail or telephone and used a the clicker to vote on their behalf. The results were pooled by using a computerized audience-response system. Outcomes were tallied and displayed in real time. Based on the outcomes, statements were renegotiated, debated, and reassessed in an open forum. The goal of this process was to reach a unanimous agreement on guideline statements and achieve a high level of enthusiastic agreement from all TEP members.

Because the body of evidence on many of the interventions is not robust,

because many of the findings are mixed, and because the various experts in the room subscribed to different philosophical schools and use differing methodological approaches (eg, single-study design versus controlled trials), some discussion was contentious. As a result, several areas received insufficient attention and not all statements were completed by the end of the second day.

To allow for continued progress, the panel agreed to continue the process via conference calls and electronic communication. Statements were drafted and presented by using Internet meeting technology. Because voting could not take place during the calls, all proposed statements were written and presented for electronic polling. Respondents could vote and post comments anonymously. This process allowed the EPC team to continue until a final set of guideline statements was agreed upon by the TEP members. Only statements that received unanimous votes for “Strongly Agree” or “Agree” were included in the final set.

### *Final Vote on Degree of Strength of Guideline Statements*

In the final stage, a rating for each approved guideline statement was developed. In February 2011, TEP members were asked to vote whether they considered each recommendation “weak” or “strong.” The percentage of TEP members who felt the guideline statement should be “strong” was tallied. This figure is presented after each guideline statement below and translated into a rating of A (90%–100%), B (80%–89%), or C (<80%). Of note, the rating for each guideline statement does not necessarily reflect the strength of evidence for a particular intervention, because the members of the TEP used their expertise and personal experience to inform their votes.

## **RESULTS**

### **Systematic Review of Scientific Evidence**

Of 325 reports of research selected for retrieval, 314 (85 reviews, 229 individual studies) were successfully retrieved and screened by our investigators. Thirty-three systematic reviews and 68 intervention studies (not already included in those reviews) met our inclusion criteria. In Table 2, we briefly summarize those results which pertain to the intervention areas included in the final guidelines. As stated above, only guideline statements with 100% TEP agreement are included. There were several intervention areas where we could not achieve consensus; scientific evidence for these areas is available in our report.<sup>8</sup> These areas include sensory integration, deep pressure therapy, and exercise.

In sum, according to commonly accepted standards, the evidence that comprehensive intervention programs, often referred to as “intensive” interventions, are effective at improving core deficits of ASD is moderate strength. Although controlled studies have been conducted, few have randomly selected their subjects or enrolled large samples. Several meta-analyses of programs based on applied behavioral analysis or the Lovass method have been conducted to increase statistical power; they have found promising results in the areas of language, adaptive skills, and IQ. Evidence is insufficient to suggest the superiority of one behavioral curriculum over others. There is moderate evidence that greater intensity of treatment (hours per week) and greater duration (in months) lead to better outcomes. Regarding developmentally based intensive programs and environmental programs such as TEACCH, the strength of evidence is lower. Overall, autonomous social skills programs for high-functioning children and adolescents have a moderate strength of evidence of

efficacy; however, our analyses could not determine which approaches, settings, and modalities were superior. For children with little or no verbal language, the Picture Exchange Communication System (PECS) has moderate strength of evidence of efficacy, and no controlled trials or uncontrolled observational studies of augmentative communication devices were identified. Auditory integration training was found ineffective in 4 of 5 trials. Further details about our results are available in the full report.<sup>8</sup>

### **The Guideline Statements**

The final guideline statements are presented below. Although the primary area of focus is comprehensive intervention programs for children, the panel also made recommendations for social skills and communication programs and suggested priorities for future intervention research. In presenting these priorities, we first present the consensus on the deficits that any comprehensive program for children with ASDs should address, followed by specific recommendation statements. The rationale behind each statement is presented, as is the percentage of TEP members who agreed that the recommendation should be considered “strong” rather than “weak.”

### *Comprehensive Interventions: Target Deficits*

A comprehensive intervention program should address deficits in the area of social communication, such as lack of appropriate joint attention capabilities (eg, spontaneous seeking to share interest or enjoyment), inability to respond to stimuli such as calling one's name, even when occupied in another task, lack of reciprocal communication and failure to develop developmentally appropriate peer relationships, and impaired ability to use and comprehend nonverbal cues.

**TABLE 2** Summary of Evidence

Findings	Strength of Evidence
<b>Comprehensive programs targeting multiple core deficits</b>	
<i>Behavioral programs based on Lovaas/ applied behavioral analysis (ABA)</i>	
We found 16 previous systematic reviews and meta-analyses <sup>14–17,19,20,42–51</sup> ; most reported significant effects in the areas of language, adaptive skills, and IQ. These reviews included only 2 randomized controlled trials; the other studies were either nonrandomized trials or observational studies. There was not enough evidence to suggest the superiority of 1 behavioral curriculum over others.	Moderate
A recent meta-analysis <sup>19</sup> found a dose-response relationship for intensive behavioral interventions on both language and adaptive skills outcomes. Higher intensity (hours per week) and higher duration (in months or years) led to better outcomes. Twenty hours per week was the minimum intensity of most comprehensive programs.	Moderate
<i>Developmental</i>	
We found one 10-month nonrandomized trial of the Scottish Autism Center comprehensive program. <sup>52</sup> Improvements in socialization, daily living skills, and motor and adaptive behavior were reported.	Low
<i>Integrative: Behavioral + Developmental</i>	
In a high-quality randomized controlled trial <sup>53</sup> and several observational studies, the Early Start Denver Model has reported significant gains in cognitive ability and other core deficits in preschool-aged children.	Moderate
Other programs such as STAR, <sup>54</sup> the Walden Toddler Program, <sup>55</sup> and ABA combined with TEACCH <sup>56</sup> showed improvements in core deficits in 1 uncontrolled observational study each.	Low
<i>Environmental support</i>	
There were 2 poor-quality nonrandomized controlled trials of TEACCH to nonspecific educational programs. <sup>57,58</sup> Improvements in cognitive function, social skills, and adaptive behavior were reported. Both small studies were conducted in Italy by the same researchers. In both studies, TEACCH was conducted in a residential setting; 1 study also had a TEACCH arm in a “natural setting.”	Low
<b>Social skills programs for higher-functioning children and adolescents</b>	
Many controlled trials <sup>21,23,24,29,59–65</sup> and observational studies <sup>25,26,30,31,66–70</sup> of social skills programs have been conducted. We conducted several meta-analyses on social skills studies that used similar outcome measures. There was moderate, consistent evidence that social skills programs as a whole are effective for both children and adolescents. Effect sizes tend to be significant and fairly large. However, our analyses could not determine which approaches are best for which children. Effective interventions took place in both individual and group settings.	Moderate
<b>Interventions for children with no or limited language</b>	
<i>Picture Exchange Communication System (PECS)</i>	
One previous systematic review <sup>32</sup> reported on 2 randomized controlled trials, 1 nonrandomized controlled trial, and 3 uncontrolled observational studies. Results in communication/social skills were consistently positive in the short term but inconsistent in the long term. The outcome effect sizes varied across studies.	Moderate
<i>Augmentative and alternative communication devices</i>	
There are no controlled trials or observational studies on the efficacy or effectiveness of Augmentative and Alternative Communication (AAC) interventions <sup>9</sup> ; only single-subject studies have been reported.	Insufficient
<i>Auditory integration training</i>	
A previous systematic review <sup>71</sup> reported no significant improvements in sound sensitivity in 3 controlled trials. None of these trials reported significant improvement in core deficits. There were 2 trials published after the review. One found no improvements in core deficits <sup>35</sup> ; the other found no improvement in sound sensitivity, but did find improvements in language, intelligence, and social skills. <sup>72</sup>	Moderate: for in effectiveness

A comprehensive intervention program should address deficits in the area of language, such as complete or partial lack of or delay in the development of

functional language, echolalia or repetitive use of language, significant phonologic decoding/articulation deficits, and difficulty in modulating vocal vol.

A comprehensive intervention program should address deficits in the area of play skills, such as lack of spontaneous make-believe play, lack of social imitation, and excessive interest in 1 type of play with a lack of interest in varied developmentally appropriate types of play.

A comprehensive intervention program should address deficits in the area of maladaptive function and maladaptive behavior, such as excessive preoccupation with restricted patterns of interests that are abnormal in focus or intensity or with specific objects, rigid adherence to routines or rituals, difficulty adjusting to relatively minor changes in schedules and routines, engagement in stereotypical motor mannerisms (eg, hand or finger flapping or twisting body movements), uncooperative behavior or withdrawal, and, in severe cases, aggression to others or toward property and self-injurious behavior.

Any comprehensive intervention program should offer an ongoing parent education component in the specific intervention technique used. Parents can enhance the child’s acquisition of skills and help transfer the newly acquired skills to home and community settings.

*Comprehensive Interventions: Suggested Standards*

Comprehensive programs have the potential for remediating multiple core deficits simultaneously and allow for potential synergistic effects of intervention components. Timely treatment can help maximize the impact of interventions on young children’s development and prevent further developmental delays or deterioration of functioning in older individuals. Thus, individuals with ASDs should receive comprehensive services within a reasonable time frame following identification. The literature provides little

information on the relative effectiveness of interventions delivered at different intervals from the time of identification, although 1 review of behavioral interventions suggests that treatments are more effective during the first 12 months following initial assessment.<sup>14</sup> Given the ability of interventions to address a wide range of deficits, there is no theoretical basis for delaying treatment initiation. Guideline: Individuals with ASDs should receive comprehensive intervention within 60 days of identification. Rating: A (94%)

The needs of a very young child differ from those of an adolescent or adult, and pre- or nonverbal individuals require different types of interventions from those with verbal skills. Programs must be customized to the needs of each individual to be successful and to avoid the fiscal and emotional costs of inappropriate or misdirected intervention efforts. Few interventions found in the literature demonstrate benefits across all core deficits, and some children experience both improvements and declines in different types of functioning following certain treatments.<sup>15–17</sup> This inconsistency suggests that comprehensive programs must be carefully selected to address the unique strengths and core deficits of each individual with ASDs. Little evidence exists to allow further customization of programs according to other characteristics of children (such as age) or intervention characteristics (such as specific methods), suggesting that flexibility needs to be built into comprehensive programs to allow for uncertainty in the effectiveness of interventions for children with different needs. Guideline: A comprehensive program must be individualized to the strengths and deficits of the person with ASD. Rating: A (100%)

Families play a key role in extending treatment programs into the home

setting, but are greatly impacted by the demands of caring for individuals with ASD.<sup>18</sup> Families require tools and education to enhance the effectiveness of treatments delivered at home. They also need support to maintain emotional strength and reduce burnout. Family needs that are not addressed may impede the progress of individuals with ASDs. The literature suggests that parental, behavior-based training programs can have significant benefits for children,<sup>18</sup> although the evidence was generally weak, inconsistent, and mainly limited to improvements in children's communication skills. Guideline: A comprehensive program must address the concerns of the family and offer opportunities for their active participation. Rating: A (94%)

The need for intervention for ASDs continues throughout an individual's life span and will vary depending on an individual's chronological age and developmental need. Interventions published in the literature reflect a wide range of intensities and duration,<sup>8</sup> and few studies systematically compare interventions with different intensities.<sup>8</sup> One review demonstrated dose-response relationships for language-based outcomes and psychosocial adaptive skills.<sup>19</sup> In that review, improvements in adaptive skills were most sensitive to the intensity of behavioral interventions, whereas language outcomes were most sensitive to the duration of these interventions. The vast majority of high-quality behavioral interventions found in the literature required 20 to 40 hours of treatment per week,<sup>14,19,20</sup> and the American Academy of Pediatrics recommends a minimum of 25 hours per week.<sup>7</sup> Comprehensive programs may be supplemented with additional programs to reach this minimum. Guideline: Children with ASD should be actively engaged in comprehensive intervention for a minimum of 25 hours per week throughout the year. Rating: C (56%)

The appropriate program type, intensity, and duration for adults with ASDs is not clear. Many of these individuals will need ongoing support throughout their life span to live productively. The comprehensive interventions we identified were targeted mainly to young children. These types of behavioral interventions, parent training programs, environmental support, and developmental interventions rarely studied adolescents<sup>8</sup> and thus provided limited information on the characteristics of effective programs for adolescents or adults. Guideline: Older individuals with ASD should also be actively engaged in comprehensive interventions, although more research is needed to better define the appropriate models of service delivery and number of hours per week. Rating: B (88%)

### *Programs That Address the Specific Deficit of Social Communication Focusing on Social Skills*

There is growing scientific evidence (from both controlled trials and observational studies) that specific interventions to improve social skills in children with autism (including Social Stories, video modeling, and peer modeling) are effective.<sup>21–26</sup> No specific setting or psychological approach has been found superior to others. One-on-one approaches have been found effective for young children, whereas group programs, often involving typical peers, have been found effective for older children.<sup>27,28</sup> Theory of Mind and other cognitive behavioral approaches have scientific evidence of effectiveness.<sup>29–31</sup> All programs with scientific evidence of effectiveness used written protocols or manuals.<sup>8</sup> Where length of program was reported, programs lasted at least 3 months.<sup>8</sup> Guideline: Individuals with ASDs should be offered interventions specifically targeting deficits in social communication

with a focus on social skills. The programs may be group or individually focused and should be based on empirically supported methods described in a protocol or manual. The recommended duration of the program is as needed. Progress should be assessed at least monthly, and ongoing interventions should be recommended according to developmental needs. Rating: A (94%)

### *Programs for Individuals With Limited or No Language*

There is scientific evidence (from controlled trials and observational studies) of the effectiveness of the Picture Exchange Communication System (PECS) in increasing child-to-adult initiated communication, primarily requesting communication acts.<sup>32</sup> Studies range in length from 3 months to 2 years. At least half the studies did not report intensity; in the studies that did report intensity, intensity ranged from 20 minutes, 3 times per week, to a total of 15 hours per week.<sup>32</sup> Guideline: Individuals with ASDs who have limited verbal language, or those who do not respond to multiple interventions aimed at improving communication, should be offered the opportunity to use the PECS. Monitoring and ongoing intervention are recommended to maintain gains in communication. Rating: B (80%)

We identified no controlled trials or observational studies on the efficacy or effectiveness of Augmentative and Alternative Communication devices.<sup>8</sup> A small number of single-subject studies have been conducted, with mixed results.<sup>33,34</sup> Because nonverbal individuals are an understudied and underserved population, well-designed studies could shed light on which devices are best for which individuals. Guideline: Augmentative and Alternative Communication interventions such as computers or other devices should be considered if PECS is unsuccessful

or if the individual is likely to benefit from the increased flexibility afforded by such devices. An interventionist should provide training on how to use the device effectively. Monitoring and ongoing intervention are recommended to maintain gains in communication. Rating: B (80%)

Small but well-designed controlled trials found auditory integration therapy ineffective in addressing any of the core deficits of autism.<sup>35</sup> Guideline: Given the current state of scientific evidence, auditory integration therapy cannot be recommended to address the core deficits of ASD. Additional research may be necessary to identify the characteristics of a select group of individuals who respond to this intervention. Rating: C (69%)

### *An Additional Guideline Pertaining to All Programs*

Measurements of a child's behavior, skills, and cognitive ability can be unreliable or prone to bias.<sup>36–39</sup> Guideline: Any treatment program must include a carefully designed assessment plan that includes a baseline assessment and periodic follow-up assessments measuring change in core deficits. Assessment should be done by using instruments with acceptable reliability and validity, as documented scientifically. Rating: C (75%)

### *Top Five Research Priorities*

The systematic review identified significant heterogeneity in outcome measures used in trials of interventions for ASD.<sup>8</sup> Many measures appeared to lack previous validation studies, and outcome measures were occasionally reported in nonstandardized ways, both of which limited the ability to pool results across studies. Given the small sample sizes of the studies, the inability to pool data significantly limited the authors' ability to draw meaningful conclusions from the review. Expert

panels are often convened to recommend standard outcome measure sets to advance research in a particular area; such an approach should be considered to enhance the measurement of program effectiveness for children with ASD. Research priority: Assessment and monitoring of outcomes. Rating: A (100%)

The needs of preverbal children may differ considerably from those of verbal children, but existing studies rarely focus on preverbal children (or children who are minimally verbal or nonverbal). In 1 trial we found that targeted this population, children experienced improvements in language acquisition following the intervention.<sup>40</sup> In another,<sup>41</sup> children with the least language (<5 words) benefited most from joint attention intervention. Although other studies may have enrolled preverbal children, results were not stratified accordingly. Research priority: Understanding and addressing the needs of pre- or nonverbal individuals with ASDs. Rating: A (100%)

The appropriate intensity, duration, and type of program for adolescents with ASDs cannot be determined from the current literature, because few studies report on the effectiveness of interventions for this age group. Adolescents may have distinct needs, and interventions may need to be tailored appropriately. Likewise, few studies have been conducted on interventions for adults. Research priority: Understanding and addressing the needs of adolescents and adults with ASDs. Rating: A (100%)

Although some reviews found that applied behavioral analysis is a highly effective component of a comprehensive intervention in addressing IQ and communication skills,<sup>19,42,43</sup> it is unclear which other components affect which specific core deficits.<sup>8</sup> Research priority: Identifying the most effective strategies to impact the specific core deficits

of ASDs (the “active ingredients”). Rating: A (94%)

Comparative effectiveness studies of different intensities and durations of ASD interventions are relatively lacking from the existing literature, but are important for at least 2 reasons. First, if dose-response relationships exist for certain interventions, then such studies could identify the dose that maximizes the effectiveness of each program while limiting the demands on families and reducing the possibility of burnout. Second, findings could help define appropriate evaluation periods for specific treatments, after which apparently ineffective ones should be considered for termination. Research priority: Identification of the most effective dose and duration of interventions. Rating: A (94%)

## DISCUSSION

An independent TEP developed guidelines and priorities for future research based on a systematic review of scientific evidence. The strength of evidence of efficacy of interventions designed to address the core deficits of autism varies among approaches. However, none of the evidence reaches the level of high strength according to established standards. Additional large, well-designed controlled trials are needed;

at this point, the strength of evidence for even the most-studied intervention types and approach modalities is moderate. Few head-to-head trials have compared the effects of different intervention approaches and components, so we can conclude little about the superiority of specific programs (other than pointing out that certain approaches have little or no evidence of effectiveness). Few studies are powered to identify specific program components associated with efficacy, and few follow participants long-term. In addition, few studies of interventions for pre- or nonverbal children were reported in the literature. These limitations of the body of scientific evidence were taken into consideration when formulating the priorities for future research.

We identified several previous systematic reviews; most focused on 1 particular intervention type, such as applied behavioral analysis for preschool-aged children or PEGS for children with limited verbal language. In contrast, our review had a broad focus: nonmedical interventions designed to address the core deficits of ASDs (communication, social skills, adaptive behavior, or cognitive function). In this way, we could identify the gaps in the overall scientific evidence to use as springboards to make recommendations for key areas of future research. In addition, the

criteria for including a study in our review were more rigorous than in previous reviews that included single-subject research designs. Such reviews have been used to create “evidence-based” standards that in fact do not reflect accepted principles of evidence-based practice. Still, our own guideline statements are based largely on expert opinion, with the systematic review as a starting point. Thus, recommendations may be based on a low to moderate level of evidence. To increase external validity, we only kept statements that everyone agreed or strongly agreed to. There were various areas where the panel could not come to agreement; these are discussed further in our full report.<sup>8</sup>

We realize that the recommended guidelines have substantial fiscal implications. In the current economic climate, resources to make comprehensive programs available to all children in need appear to be lacking. We also emphasize that not all children who attend these programs will make significant gains regarding core deficits; the scientific literature is not clear as to which individual participant characteristics are associated with success of various approaches. However, we feel that the level of evidence of effectiveness of these programs is sufficient to make availability a worthy goal.

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## Nonmedical Interventions for Children With ASD: Recommended Guidelines and Further Research Needs

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