# Systematic Review: Comparative Efficacy of the Picture Exchange Communication System (PECS) to Other Augmentative Communication Systems in Increasing Social Communication Skills in Children with Autism Spectrum Disorder

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**Abstract:**

**Purpose:** This systematic review aims to compare the efficacy of the Picture Exchange Communication System (PECS) to other forms of Augmentative and Alternative Communication (AAC) in increasing social communication skills in children with Autism Spectrum Disorder (ASD).

**Method**s: A systematic review of the literature on PECS and other forms of AAC written between 2007 and 2018 was conducted. Studies were selected based on the established inclusionary and exclusionary criteria. The inclusionary criteria incorporated subjects with a formal diagnosis of ASD under the age of 18. Exclusionary criteria included individuals with severe sensory, motor, and/or other medical conditions that may have affected their use of PECS. 25 articles of varying study designs were critically appraised for validity and reliability to minimize bias.

**Results:** Results suggest that both PECS and other forms of AAC are conducive to improving social communication in children (<18 years) with ASD. Advancements in conversation initiation, requesting behaviors and joint attention were noted, resulting in a global increase in communication interactions. However, studies demonstrated mixed results with specific consideration of rate of acquisition, modality preference, and overall effectiveness of the system.

**Conclusion:** Synthesis of results from the 25 studies suggest that both PECS and other AAC systems show favorable outcomes for encouraging social-communicative behavior. The clinical implications of these results suggest the implementation of an AAC system may be client dependent. Single design designs were included in this review due to the lack of research in the areas of ASD and AAC. Further research of this comparison should be conducted on larger

populations of children with ASD to improve clinical decision making to target social communication and increase generalizability.

**Keywords:** Asperger*, Asperger syndrome, Asperger's syndrome, ASD, autis*, autism spectrum disorder*, PDD, PDD-NOS, and pervasive developmental disorder*, augmentative communication, alternative communication, AAC, augmentative and alternative communication, Picture Exchange Communication System, and PECS.

## Systematic Review: Comparative Efficacy of the Picture Exchange Communication System (PECS) to Other Augmentative Communication Systems in Increasing Social Communication Skills in Children with Autism Spectrum Disorder

Autism Spectrum Disorder (ASD) is often incorrectly interchanged with social (pragmatic) communication disorder. The confusion arises due to the symptoms of both diagnoses including persistent deficits in social communication and social interaction. Specifically, this includes a lack of eye contact, poor turn-taking, and difficulty understanding social cues (e.g., facial expressions, body language, pitch changes in voice). However, the severity of social communication deficits in individuals with ASD may result in a failure to engage with others, a lack of verbal communication skills, and a presence of restricted and repetitive behaviors. The individualized symptomology of ASD causes clinically significant limitations in social, occupational, and communication functions that are not a result of a social communication disorder (American Psychiatric Association, 2013).

According to Flippin et al. (2010), delayed language development is another early marker for a possible diagnosis of ASD as opposed to a social communication disorder. Studies show that approximately 25% of children with ASD do not develop functional speech. In these cases,

they may have difficulty effectively making requests, engaging in joint attention, initiating interactions, and following conversational rules (Boesch et al., 2013). Due to the individualized characteristics that coincide with a diagnosis of ASD and variability in language outcomes, it is hard to predict what the best mode of communication for a child may be. There are currently no clear protocols for speech language pathologists (SLP) to use in determining which communication mode is the most effective for a specific child with ASD (Flippin, et al., 2010).

If speech emergence is of concern, a child may be provided with an Augmentative and Alternative Communication (AAC) system to support their communication (American Psychiatric Association, 2013). AAC systems are provided to supplement or substitute verbal communication to support expression of an individual's wants, needs, thoughts, and ideas. AAC systems may also be given to a child with ASD to help facilitate and promote social inclusion. There is currently a wide range of AAC systems that are categorized in unaided and aided systems. Unaided systems are those that do not require additional equipment such as gestures and manual signs (MS). Aided systems are those that incorporate additional external supports for communicative interactions to be made. The usage of aided AAC systems is continually increasing in the ASD community (Aguis, et al. 2016).

SGDs are common aided AAC systems used to support communication. These devices provide computerized speech output to assist individuals with minimal to no verbal output. Although SGDs have been found to increase verbal expression, few studies exist addressing the effectiveness of SGDs on increasing social-communicative skills (Boesch, et al. 2013).

One of the most widely used aided AAC systems is the Picture Exchange Communication System (PECS) (Frost & Bondy, 2002). This system was developed at the Delaware Autistic Program for young children with ASD and other social-communication

deficits. PECS involves a training program of six instructional phases with specific prompting and reinforcement strategies to facilitate the acquisition of functional communication. Children are given binders lined with Velcro that contain a set of pictures to request desired items or actions. The targets of each Phase in the PECS protocol are described below (Lerna, et al. 2012):

*Phase I:* Teaches the child to use a picture to make a request by exchanging a picture with a communication partner for a preferred toy, food item, or activity.

*Phase II:* Same strategy used in Phase I with an added distance between the child and communication partner to increase generalization.

*Phase III:* Teaches the child to discriminate between preferred and non-preferred items.

*Phase IV*: Teaches the child to make requests using complete sentences.

*Phase V:* Teaches the child how to answer questions.

*Phase VI:* Teaches the child how to make a variety of statement types.

Studies included in this systematic review discuss the use of Picture Exchange (PE). PE is not equivalent to PECS. Though both PE and PECS have many similarities, "PE is a mode of AAC whereas PECS is a comprehensive program for establishing basic and advanced use of PE for a range of communicative functions" (Sigafoos et al., p. 108, 2009). Articles in this systematic review that included PE generally focused on user preference rather than acquisition of skills, like initiation and requesting. These articles were included under consideration as an additional AAC method against which PECS could be compared.

**Purpose:**

Many studies in the current literature promote PECS as an effective intervention approach to improve social communication skills. However, research is limited on the comparison of PECS to other AAC systems and their role in facilitating the development of

social communication in children with ASD. The rationale for this review is to guide clinical decision making in selection of appropriate interventions when targeting an increase social communication. The objective of this systematic review is to determine if the use of PECS is a more effective treatment for increasing the social communication skills of requesting, initiating, joint attention, and communicative intent when compared to other AAC systems for preschool and school-aged children with ASD. Furthermore, rate of acquisition and modality preference is examined.

## Methods:

### *Procedures*

Studies were selected based on a collaborative search by all authors in the following databases: PubMed, CINAHL, PsycINFO, Ovid MEDLINE, and ERIC. The abstracts of selected articles were reviewed by each researcher to determine if it met the inclusionary criteria. Articles deemed adequate for inclusion were then compiled. Two researchers reviewed this list and removed duplicates. The articles on the final list were reviewed in full by each researcher to assess for validity and reliability. Once this process was complete, the researchers determined which studies were permissible for inclusion on a basis of group consensus. 25 studies were included in this final systematic review.

### *Inclusionary Criteria*

All studies in this review included subjects that were <18 years of age with the majority of participants having a formal diagnosis of ASD. Few included studies contained participants with developmental delays who presented with signs or symptoms of ASD but did not have a formal diagnosis. However, in these instances, the participants with developmental delays made up a minority of the total study population. Studies were selected if they discussed the

implementation of PECS or another form of AAC implemented by formally trained individuals. Each study was included if it discussed or targeted aspects of social communication. The research studies included the following outcome measures: standardized assessments or observational data that had been coded with an outlined protocol. For inclusion in this review, it was necessary that the outcome measures in each study included baseline and follow-up data. Articles with additional long-term follow-ups were included to investigate skill maintenance and generalizability. The following study designs were included in the review: meta-analyses, systematic reviews, randomized control trials (RCT), cohort studies, single case studies and follow-up studies based on the above study types.

***Exclusionary Criteria***

Studies were excluded from this review if the majority of participants did not have a formal diagnosis of ASD or did not present with similar signs and symptoms of ASD. Additionally, studies that included individuals who had severe sensory, motor, and/or other medical conditions that precluded their ability to effectively use PECS or another AAC system were excluded. Studies that did not report baseline data prior to treatment were also excluded as well as opinion pieces and observational studies.

***Quality Assessment:***

The quality of each article was assessed by at least two different group members independently. The criteria used for assessment of quality and validity can be seen in Appendix 1. Depending on the type of study design, the articles were assessed per 7 to 10 different criteria. A binary score (pass/fail) was used to measure each specific criterion. If the article met a criterion, it was awarded one point. If it did not meet a criterion, the article was not awarded a point. Articles that met 70 percent of their design-specific criteria were determined to have a

"high" level of quality. A study that was awarded between 40 and 70 percent of "design-specific criteria and had no fatal flaw" were awarded the quality level of "moderate." The quality level of "low" was awarded to articles that met less than 40 percent of the outlined criteria or had a "fatal flaw", as defined by the researchers. Once an agreed upon consensus was reached, a final quality score was assigned to the article. Any disagreements were remediated through discussion, followed by a group decision. Any articles that met quality levels of "moderate" or "high" were considered for inclusion in the final systematic review. Quality scores for the 25 included articles ranged from moderate to high. Fatal flaws that impacted the scores were a small sample size, the type of study design, and/or the absence of reliability and validity measures.

***Sources:***

Articles were obtained through the following databases: CINAHL, PubMed, PsycINFO, ERIC, and Ovid MEDLINE. Searches contained one of the following terms: autis*, autism spectrum disorder, ASD as well as one of these keywords: AAC, augmentative communication, alternative communication, augmentative and alternative communication, Picture Exchange Communication System, and PECS. Overall, 671 references were retrieved from electronic searches of PubMed (67), CINAHL (36), PsycINFO (179), Ovid MEDLINE (309), ERIC (80) and through manual searches (7). After parameters were added to each database, 133 articles were removed for year of publication, 135 were removed for age requirement of <18 years of age, 69 were removed non-human participants, and 204 were removed for a non-ASD diagnosis. Duplicates (63) were then removed resulting in 67 references remaining for further analysis. Their titles and abstracts were thoroughly examined for relevance to the study and whether they met initial inclusionary and exclusionary criteria. Of the 67 retrieved references, 5 studies were removed due to age, 34 due to being unrelated to targeted construct, and 2 were non-English

studies. Eight articles were excluded for targeting verbal language versus social communication. As of date, 25 articles have been fully reviewed, appraised, and included into the research study. See Figure 1 below for a detailed description of the article selection process at each step.

## Results:

The present review sought to examine the effectiveness of PECS compared to other types of AAC in regards to social communication in children with ASD. Many studies included in the present review operationalized social communication by identifying its key components and studying the effects of PECS and AAC on those components. The components of social communication are defined as follows: social interaction (e.g. accessing peer groups or cooperative play), social cognition (e.g. joint attention or Theory of Mind), pragmatics (e.g. requesting or demanding) and language processing (e.g. receptive language comprehension). However, due to the lack of research in this area, few studies only focused on a single aspect of social communication (e.g., requesting, initiation, labeling, and joint attention). Therefore, the findings of this review will be discussed based off the specific skills being targeted.

### *Direct Comparison of PECS to Other Forms of AAC*

Eight studies focused on the effectiveness of using MS, PE, PECS, and SGDs. Although not all 8 eight studies included these four AAC systems, many studies compared at least 2 to 3. These systems were specifically examined in regards to their effect in the development of requesting skills, the rate at which a system was acquired and mastered, as well as a system preference for children with ASD (Couper et al. 2014; Lorah et al. 2013; Meer et al. 2013; Still et al. 2014).

#### *Requesting*

Few studies have shown that children who use SGDs are more effective at initiating requesting (Lorah et al. 2013); while others suggested PE, SGDs, and PECS are equally effective at teaching children with ASD the socio-communicative skill of requesting (Aguis et al. 2016; Boesch et al., 2013; Sigafoos et al. 2009; Still, et al. 2014). There have been studies that concluded that PECS and SGDs offer mixed results regarding which method produces a greater increase in the amount of requesting behaviors. Hill & Flores's (2014) hypothesized that their study's mixed results may have been attributed to their research design and sample populations. Two of the five participants in this study did not have a formal diagnosis of ASD, but rather a diagnosis of a developmental delay. Additionally, three participants were in preschool while two participants attended elementary school, resulting in a wide range of ages. These inconsistencies of diagnosis and age as well as a small sample size may explain why the findings for requesting were mixed (Hill & Flores, 2014).

A study completed by Sigafoos et al. (2009), found that children's ability to accurately request using PECS and SDGs did not appear to affect their overall ability to participate. Social withdrawal for these children remained unchanged. These findings suggest that although requesting behaviors may increase during intervention, there may be limited carry- over of their functional communication skills to their daily activities.

*Rate of Acquisition*

AAC systems are typically chosen based on the communication needs of a targeted user, therefore the rate at which a user may acquire a system is an important consideration. Current research is mixed on whether one alternative mode of communication can be learned faster than another. Few studies indicated that children who use SGDs can reach mastery of their device overall or mastery of a specific skill (e.g., independent requesting) in fewer training sessions

when compared to those who use PECS, PE or MS (Couper et al. 2014; Lorah et al. 2013). However, other studies contradict these findings, indicating users learned to implement PECS and SGDs at the same rate. These same studies found that while both modes were mastered at the same rate, the children using a PECS based system were more efficient users and required less prompting for engagement (Agius et al., 2016; Boesch et al., 2013). Current research available makes it difficult to determine whether this increase in engagement with PECS has a positive correlation with increased intentional social interactions.

Few studies suggest that PECS resulted in a slightly larger number of social communicative behaviors due to the physical act of exchanging a picture card. More so, research results have eluded that different phases of PECS may result in more frequent socio-communicative behaviors than others. Boesch et al. (2013), completed a study comparing the traditional PECS to an adaptation of the PECS protocol to be used on an SGD. Overall findings were not clinically significant between PECS and SGDs. However, an unexpected finding was reported of a substantial increase in social communicative behaviors during Phase II of the protocol. They suggested that this higher occurrence of socio-communicative behaviors can be associated with the added manipulation of distance in Phase II. Due to the child having to walk across the room to request a preferred item, they had to put forth more effort to scan the room to look for the communicative partner, locate them, and then initiate the request. In the SGD condition of this study, there was no apparent increase in behaviors during Phase II as children were more focused on the features of the device (i.e., pressing buttons and listening for speech output). Before taking these findings into consideration, there needs to be further research conducted on whether the participants understood the exchange as a form of social communication and interaction.

Another recent study suggested children with ASD acquire skills in two to three step requesting, greetings, answering questions, and social etiquette responses at a slower rate when using a PE system in comparison to a SGD (Meer et al. 2013). Furthermore, Meer et al. (2013) found that although acquisition was slower in PE, several participants had a higher percentage of correct responses when compared to SGDs. However, a caveat that accompanies all discussion of rate of acquisition is its uncertain correlation to better performance. There are mixed results as to whether rate of acquisition is truly a strong predictor of higher accuracy.

*Modality Preference*

Modality preference is important to consider when discussing how alternative modes of communication are used to help facilitate social interactions. As children with ASD have restrictive interest, they also present with a strong preference towards a particular AAC system. This may influence clinical decision making, as choosing a higher preference system may lead to an increase in overall communicative success.

When it comes to preference for a specific communication system, several studies found that children with ASD often have a moderate-strong preference for one communication system over another (Couper et al. 2014; Meer et al. 2013; Sigafoos et al. 2009; & Lorah et al. 2013; Still et al. 2014). While there is a strong preference towards a specific modality, the specific system chosen remains variable across participants with no known pre-indicators. Three studies found that there was a much higher preference for SGD in children with ASD over other communication modes, but more research is needed as many of these studies were single case designs with small sample sizes (Couper, et al. 2014; Hill and Flores 2014; & Lorah et al. 2013). In contrast, 1 study found that children preferred a PE system over an SGD (Sigafoos et al. 2009). Further research conducted by Agius et al. (2016), stated that modality preference for an

AAC device over another was inconclusive and is often individual dependent. Evidence suggests that children with ASD are capable of learning multiple systems for requesting. While results of this systematic review are limited, more research may show that a combination of MS, PE, and SGD is a promising option (Couper et al. 2014).

### *PECS Effect on Initiation*

Initiation of interaction is a key component of successful social communication. Individuals with social communication deficits frequently engage in communication only in response to bids from others. The limited rates of initiation significantly reduce the amount of communicative interactions an individual will experience. This subsequently reduces their exposure to engagement in social contexts, furthering their social communication deficits. Increasing rates of initiation can enhance the social capabilities of individuals with ASD by providing more frequent exposure to social communicative interactions.

The results of 6 studies indicated that PECS training can increase rates of communication initiation in children with ASD to varying degrees. Participants in these studies showed improvements in child to adult initiation and demonstrated increased rates of linguistic communicative initiation (Carr & Felce, 2007). The PECS program finds particular success with this population when paired with a global classroom approach (i.e., having other individuals in the classroom such as peers or teachers trained in the program). In the cases in which a global classroom approach was employed, rates of initiation, peer directed interaction and requesting increased after PECS training was implemented (Howlin, et al., 2007; Thiemann-Bourque, K., et al., 2016). Additionally, at least 3 studies indicated that the PECS training helped to decrease disruptive (or "problem" behaviors) in some children (Alsayedhassan et al., 2016; Flippin et al., 2010; Ganz et. al, 2011).

Overall, current research suggests that the PECS training program can increase rates of initiation and improve overall communicative competence and social engagement in children with ASD, with rates of efficacy ranging from “significant” to “fairly effective” (Carr & Felce., 2007; Flippin et al., 2010;). Increases in functional communication after PECS training were achieved in 6 of the studies included in the current systematic review (Alsayedhassan et al., 2016; Flippin et al., 2010; Ganz et al., 2008; Ganz et al., 2011; Ganz et al., 2012; Thiemann-Bourque et al. 2016).

***PECS effects on general social communication & generalizability***

General social communication skills have a global impact on an individual’s ability to participate in occupational and functional tasks in everyday life. Four studies included in this systematic review focused their analysis on general social communication abilities in children with ASD. Three of these studies supported the use of PECS as an effective intervention strategy for improving social communication in young children who are functionally nonverbal, over the developmental age of 16 months and under the developmental age of 60 months (Lerna et al., 2012; Pasco & Tohill, 2011; Tanner et al.,2015). McDuffie et al. (2010) found that for children with a larger expressive vocabulary (i.e. less than ten words), PECS was not as effective in increasing object interest and social communicative attempts.

Given the highly structured nature of the PECS treatment protocol and restrictive behaviors associated with ASD, there is the possibility for children to become bound to either the environment or the communication partner (i.e. individual who is implementing PECS). This may effectively reduce their participation in everyday environments. To further assess the prevalence of this possibility, 2 studies investigated the generalizability of PECS. Greenberg et al. (2012), conducted a single case design involving generalization sessions at baseline, after

completion of Phase IV of PECS, and at follow-up. Throughout the study, playroom sessions, home sessions with therapist, home sessions with parent, and community sessions were conducted to assess generalizability of each participant. Results suggested PECS generalized to different communicative partners, interactional styles, materials, activities, and settings. Another study incorporated a parent-training component requiring use of PECS outside of the typical treatment conditions (Yoder & Lieberman, 2010). Both studies indicated that PECS is generalizable across settings and people when taught to children with ASD.

***Combination approach to AAC***

Recent studies published have focused on the effects of adapting the PECS protocol to an SGD. One study proposed an intervention involving an IPad with the Proloquo2go™ application as an SGD. Subjects participated in a multiple probe design that involved using the SGD as the communication device in the PECS protocol. Results indicated that during PECS Phases I-IV, this approach was effective in building a foundation of requesting skills for children with ASD (King et al., 2014).

Hill and Flores (2014) conducted a similar study by comparing PECS to an SGD with an adapted PECS protocol. Results of this study were mixed on both the systems effectiveness and modality preference. However, it is important to note that the authors of the study reported concerns regarding the subject's ability to comprehend the concept of communication. More specifically, it was difficult to teach requesting behaviors, reinforcement, and communicative intent with an SGD. Rather than combining AAC systems, the authors concluded that teaching PECS prior to an SGD may be a beneficial progression to teaching social communication skills in children with ASD.

**Discussion:**

The objective of the present systematic review was to investigate the efficacy of PECS on increasing social communication of individuals with ASD when compared with other AAC systems. 25 articles were chosen for inclusion in this systematic review. The results of the present review suggest that both PECS and other AAC systems are beneficial to higher social communication rates in children with ASD. Many studies suggest that while children tended to prefer one system over the other, there is little evidence to suggest that one particular mode is consistently more effective than another. Rather, success with a particular mode is better determined by the preferences of the individual user. It is recommended that additional research be conducted regarding the effects specific individual characteristics (e.g., age, joint attention abilities, general level of social abilities pre-treatment, etc.) may have on later performance with AAC systems. Most studies included in this review investigated the effect that communication modes had on basic communication skills such as initiation and requesting. Other areas of further research may include examining how PECS and other AAC systems effect more complex social communicative skills (e.g., turn-taking and higher-level discourse in older children).

The validity and reliability of the articles reviewed was moderate to high. A limitation of the present review is that fidelity of intervention was minimally discussed. However, the highly structured treatment protocol described in the PECS manual lends itself to a higher level of intervention fidelity. Reliability of the PECS intervention was high, as the authors of this review included only articles that stated the training was being presented by an individual who had been formally trained in the PECS program.

### *Results in light of available evidence*

Results suggest that both PECS and other forms of AAC are conducive to improving social communication in children with ASD. Advancements in conversation initiation and requesting behaviors were noted, resulting in a global increase in communication interactions. However, studies demonstrated mixed results with specific consideration of rate of acquisition, modality preference, and overall effectiveness of the system.

### *Strengths and Limitations*

The researchers thoroughly searched all databases available to them through the University of Vermont's network of medically related resources. Databases were searched in a methodological manner to ensure that a wide net was cast, and any relevant articles were obtained. A combination of database and manual searches allowed for thorough inspection of the available literature. The authors of this systematic review were well-versed in the topic of research allowing them to appropriately identify search terms, and thoroughly appraise each article according to the inclusionary/exclusionary criteria.

As with any review of this nature, limitations were present. This systematic review only included articles published in the author's native language of English, which may have restricted the articles considered for inclusion. The authors were only able to obtain articles hosted by the University of Vermont network, which may have further restricted the results. Additionally, the authors excluded any articles that were not formally published (i.e., dissertations and thesis).

Due to limited research in the areas of PECS, AAC, and ASD, studies originally taken out of the review due to sample size, blinding, and study design were added back in to conduct a more thorough review of the available evidence. Few studies included participants who did not have a formal diagnosis of ASD. In these cases, they were diagnosed with other comorbid

conditions (e.g., developmental delay) sharing similar symptoms typical of children with ASD. Additionally, children with ASD frequently present with co-morbid conditions, that may affect their performance with PECS or other AAC systems. These co-morbid conditions were not discussed in this review, but may be important in the clinical decision making process. More research should be conducted on the effects pre-existing characteristics may have on outcomes of AAC systems. Due to these limitations, the results of this review may not be generalizable to all children with ASD.

In initial drafts of this systematic review, single case design studies were excluded, as they are not considered as a high level of evidence. However, after completing additional research, the authors concluded that the inclusion of single case design was warranted due to the research available. The characteristics of children with ASD are unique and variable, and single case designs can include a high level of detail about individual participants in the study, which allows for a deeper understanding of research results. The single case designs chosen for inclusion were fully vetted on other aspects of reliability, validity and fidelity of intervention before being deemed appropriate for inclusion.

***Suggestions for future research***

More research is needed in the direct comparison of PECS and other AAC systems in supporting the social communication of children with ASD. While synthesizing studies for this review, it was difficult to find articles with a Level I quality. Studies were often single case designs with small sample sizes that focused on one particular mode of communication. The effectiveness of PECS on its own has been well established in the literature, but evidence is lacking in how PECS compares to other AAC options. Research regarding pre-treatment factors (e.g., level of joint attention abilities, developmental age, and cognitive ability) is needed to help

determine future success with a specific communication modality. Furthermore, research regarding the implementation progression of PECS to SGDs should be conducted to improve treatment outcomes and the clinical decision-making process.

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**Tables/Figures**

**Table 1: Inclusionary/ Exclusionary criteria**

| **Inclusion Criteria** | | | |
|---|---|---|---|
| **Population** | **Intervention and Comparison** | **Outcome** | **Study Type** |
| 1. Under the age of 18. | 1. Studies discussing PECS compared to other AAC systems in regards to social communication. | 1. Standardized assessments, observational data that has been coded within an outlined protocol | 1. Systematic Reviews |
| 2. Individuals with a formal diagnosis of ASD. | 2. Studies discussing only PECS or another AAC system on social communication. | 2. Measurement intervals: studies that include at least baseline and follow-up data. Articles with an additional long-term follow-up may be included as well to show skill maintenance. | 2. Randomized Control Trials (RCT)/Controlled Clinical Trials |
| 3. Persons **free** of severe sensory, motor, and/or other medical conditions that may limit the child's ability to effectively use PECS. | 3. PECS intervention implemented by individuals formally trained in PECS. | | 3. Cohort studies |
| 4. Range of severity: Individuals who have been formally and independently diagnosed with ASD. | | | 4. Follow-up studies based on the above study types |

| Exclusion Criteria | | | |
|---|---|---|---|
| **Population** | **Intervention and Comparison** | **Outcome** | **Study Type** |
| 1. Greater than 18 years of age | 1. Studies in which PECS intervention is administered by an individual **not** formally trained in PECS. | 1. Studies whereby baseline data is **not** taken prior to treatment. | 1. Expert opinions |
| 2. Individuals who do not have a formal diagnosis of ASD. | 2. Studies that do **not** address social communication. | 2. Studies in which outcome measures are **not** standardized or observational data that has **not** been coded within an outlined protocol | 2. Observational Studies |
| 3. Persons with severe sensory or motor deficits or known comorbid medical conditions | 3. Studies in which PECS or another AAC system is **not** discussed | | |

**Table 2.1: PubMed database search**

| PubMed Search | | |
|---|---|---|
| Boolean sentence: ("Autism Spectrum Disorder" or Autis*) and ("Picture Exchange Communication System" or PECS) | | |
| Search(s) + modifier | Number of articles | Why excluded? |
| Boolean sentence | 67 | N/A |
| Year of publication (<10 years) | 51 | Older than 10- years |
| Humans | 42 | Non-human studies |
| Age: Birth-18 years | 37 | Age >18 |

**Table 2.2: CINAHL database search**

| CINAHL Search | | |
|---|---|---|
| Boolean sentence: ("Autism Spectrum Disorder" or Autis*) and ("Picture Exchange Communication System" or PECS) | | |
| Search(s) + modifier | Number of articles | Why excluded? |
| Boolean sentence | 36 | N/A |
| Age | 31 | Age >18 |
| Year of publication (<10 years) | 23 | Older than 10- years |
| Duplicates | 8 | 15 articles |

**Table 2.3: PsycINFO database search**

| PsycINFO Search | | |
|---|---|---|
| Boolean sentence: ("Autism Spectrum Disorder" or Autis*) and ("Picture Exchange Communication System" or PECS) | | |
| Search(s) + modifier | Number of articles | Why excluded? |
| Boolean sentence | 179 | N/A |
| Year of publication (<10 years) | 139 | Older than 10- years |
| Age: Birth-18 years | 91 | Age >18 |
| Humans | 31 | Non-human studies |
| Duplicates | 10 | 21 articles |

**Table 2.4: Ovid MEDLINE database search**

| Ovid MEDLINE Search | | |
|---|---|---|
| Boolean sentence: ("Autism Spectrum Disorder" or Autis*) and ("Picture Exchange Communication System" or PECS) | | |
| Search(s) + modifier | Number of articles | Why excluded? |
| Boolean sentence | 309 | N/A |
| Age: Birth-18 years | 296 | Age >18 |
| English | 293 | Not written in English |
| Year of publication (<10 years) | 225 | Older than 10- years |
| Autism Spectrum Disorder (ASD) | 23 | Non-ASD specified |
| Duplicates | 1 | 22 articles |

**Table 2.5: ERIC database search**

| ERIC Search | | |
|---|---|---|
| Boolean sentence: ("Autism Spectrum Disorder" or Autis*) and ("Picture Exchange Communication System" or PECS) | | |
| Search(s) + modifier | Number of articles | Why excluded? |
| Boolean sentence | 80 | N/A |
| Age: Birth-18 years | 16 | Age >18 |
| Year of publication (<10 years) | 15 | Older than 10- years |
| Autism Spectrum Disorder (ASD) | 14 | Non-ASD specified |
| Duplicates | 9 | 5 articles |

**Figure 1: Flowchart of Search Strategy**

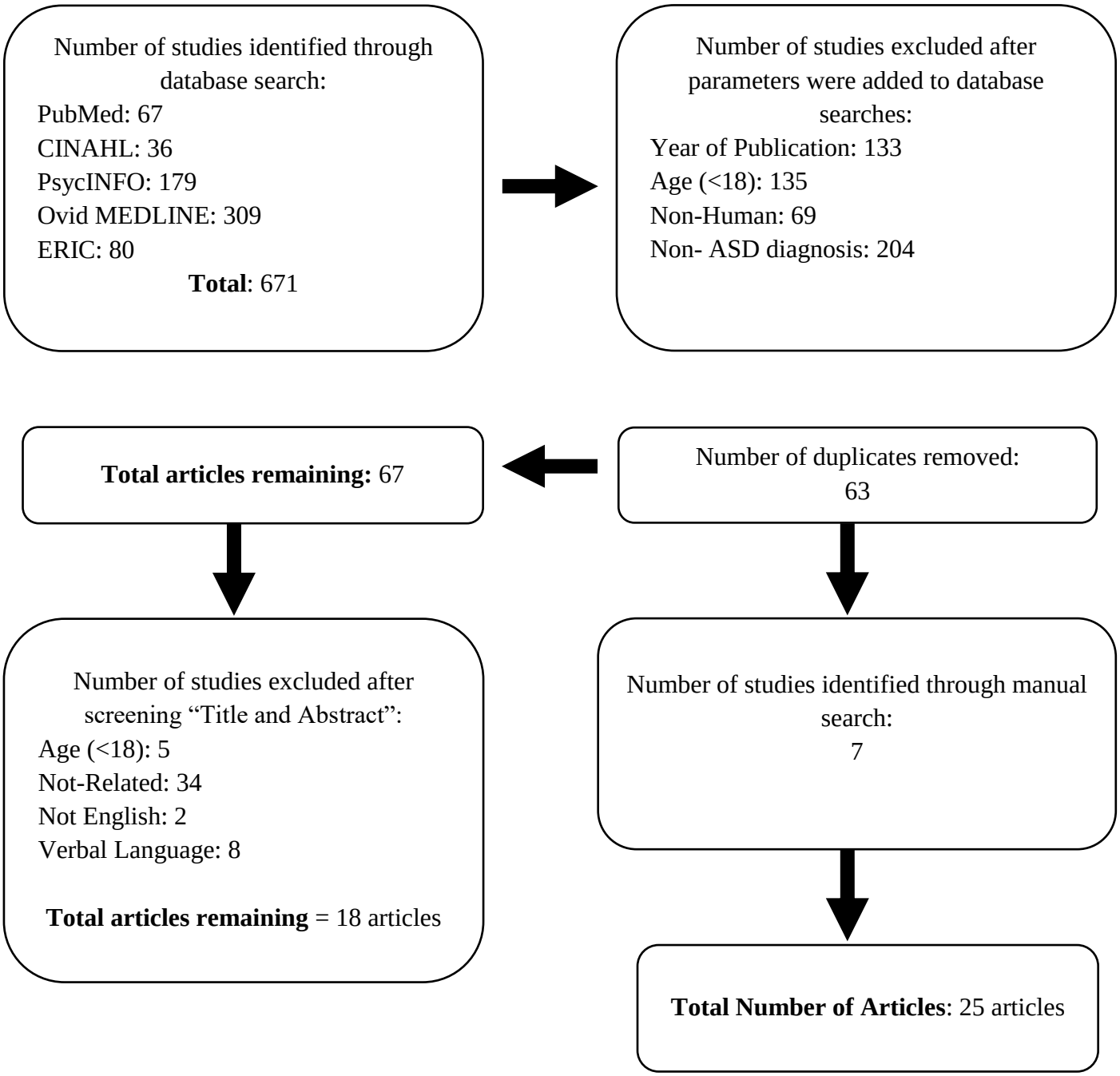

**Table 4: Quality Assessment**

| | | Criteria of Quality | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Study | Type of design | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Quality Level | Evidence Level |
| **Agius, et al. (2016)** | Single Case Design; Alternating Treatment | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | - | - | High | Level IV |
| **Alsayedhassan, et al. (2016)** | Systematic Review | 1 | 0 | 1 | 1 | 0 | 1 | 1 | - | - | - | Moderate | Level I |
| **Boesch, et al. (2013)** | Single Case Design; Multiple Baseline | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | - | - | High | Level IV |
| **Carr & Felce (2006)** | Nonequivalent Pretest-Posttest Control Group Design | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | Moderate | Level II |
| **Couper, et al. (2014** | Single Case Design; Alternating Treatment | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | - | - | Moderate | Level IV |
| **Flippin, et al. (2010)** | Systematic Review | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | High | Level I |
| **Ganz, et al. (2008)** | Single-Case Design; Multiple Baseline | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | - | - | Moderate | Level IV |
| **Ganz, et al. (2009)** | Single-Case Design; Multiple Baseline | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | - | - | High | Level IV |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ganz, et al., (2012**) | Meta-Analysis | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | High | Level I |
| **Ganz, et al. (2014)** | Meta-analysis | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | High | Level I |
| **Greenberg, Tomaino & Charlop (2012)** | Single-Case Design | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | - | - | Moderate | Level III |
| **Hill & Flores (2014)** | Single Case Design; Alternating Treatment | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | - | - | Moderate | Level IV |
| **Howlin, et al. (2007)** | RCT (Small) | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | Moderate | Level I |
| **King, et al. (2014)** | Single Case Design; Alternating Treatment | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | - | - | High | Level IV |
| **Lerna, et al. (2012)** | Nonequivalent Pretest-Posttest Control Group Design | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | High | Level II |
| **Lerna, et al. (2014)** | RCT (Small) | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | High | Level I |
| **Lorah, et al. (2013)** | One-Group Pretest-Posttest Design | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | - | - | Moderate | Level III |
| **Mcduffie, et al. (2012)** | RCT (Small) | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | Moderate | Level II |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Meer et al. (2013)** | Single Case Design; Alternating Treatment | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | - | - | Moderate | Level IV |
| **Pasco and Tohill (2011)** | One-Group Pretest-Posttest Design | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | - | - | Moderate | Level III |
| **Sigafoos et al., (2009**) | Single-Case Design | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | - | - | Moderate | Level IV |
| **Still, et al. (2014)** | Systematic Review | 1 | 1 | 1 | 0 | 1 | 1 | 0 | - | - | - | Moderate | Level II |
| **Tanner et al. (2015)** | Systematic Review | 1 | 0 | 1 | 1 | 1 | 1 | 0 | - | - | - | Moderate | Level IV |
| **Theimann-Bourque (2016)** | Single Case Design; AB Design | 1 | 1 | 1 | 1 | 1 | 0 | 0 | - | - | - | Moderate | Level VII |
| **Yoder et al., (2009)** | RCT (Small) | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | High | Level I |

**Table 5: Study Descriptions**

| Author | Populations | Types of AAC | Outcome |
|---|---|---|---|
| **Aguis, et al. (2016)** | 3 participants<br>Preschoolers | PECS<br>iPad-Based SGD | PECS and SGDs are equally effective interventions for supporting requesting behaviors in beginning communicators<br>No modality preference<br>PECS was maintained at a higher level |
| **Alsayedhassan, et al. (2016)** | 158 participants<br>Birth to 18 years' old<br>2 participants with comorbid diagnoses | PECS | 10 of the 13 studies in this review found that PECS increased mands, initiation, and general functional communication<br>PECS resulted in effective outcomes when parents/practitioners implemented the system in home or school settings |
| **Boesch, et al. (2013)** | 3 participants<br>6 to 10 years' old | PECS<br>SGD | SGD and PECS were equally effective in teaching requesting behaviors with the same rate of acquisition<br>PECS resulted in a *slightly* larger number of social communicative behaviors due to the physical act of exchanging with a picture card<br>Phase II had more social communicative behaviors that Phases I and III due manipulation of distance |
| **Carr & Felce (2007)** | 24 participants<br>3 to 7 years' old | PECS | When delivered under optimum conditions, PECS training was identified to considerably increase communicative initiations by children, and *decreased* adult initiations with no opportunity for child response<br>PECS training increased responsivity in children with ASD |
| **Couper, et al. (2014)** | 9 participants<br>4 to 12 years' old | PE<br>MS<br>SGD | SGD, PE, and MS were all effective for increasing requesting skills<br>Some participants required fewer training sessions to learn SGD<br>8/9 children preferred SGD over MS or PE (moderate-strong preference) |
| **Flippin, et al. (2010)** | 178 participants<br>1to 11 years' old | PECS | PECS had a small to moderate effect in increasing communication requests and initiations<br>Little evidence of generalization or maintenance ("single subject" literature)<br>Joint attention increased when PECS was implemented with young children |
| **Ganz, et al. (2008)** | 3 participants<br>3 to 5 years' old | PECS | PECS increased functional communication for 2/3 participants<br>Mastery of Phases I-IV of PECS occurred rapidly |

| | | | |
|---|---|---|---|
| | 2 participants with comorbid diagnoses | | |
| **Ganz, et al. (2009)** | 3 participants<br>3 to 8 years' old | PECS | Results were statistically significant for picture use when requesting items in all 3 participants |
| **Ganz, et al. (2012)** | 37 participants<br>3 to 17 years' old | PECS | PECS had moderately positive effects on making interaction initiations with an increase in socially valid behaviors<br>Preschool age children performed better than elementary age learners on initiation and overall communicative competence |
| **Ganz et al. (2014)** | 35 single case studies<br><18 years | PECS<br>SGD<br>Picture Based AAC | PECS was more effective for enhancing social communication skills than SGDs and other picture-based AAC systems<br>AAC interventions implemented in the general education setting yielded the strongest effects<br>Moderate to strong effects were obtained in the home, general education classroom, special education class and therapy room |
| **Greenberg, Tomaino & Charlop (2012)** | 4 participants (all male)<br>4 to 8 years | PECS | 3/4 participants began to generalize PECS upon completion of Phase I before they were prompted/taught to<br>Variability between participants and across settings<br>All participants used PECS at a higher rate in follow-up measures than at baseline measures |
| **Hill & Flores (2014)** | 5 participants<br>3 to 9 years' old<br>2 participants with DD diagnosis | PECS<br>SGD | Results were mixed when comparing PECS and SGDs with occurrence of requesting behaviors as well as modality preference<br>Hypothesis that AAC system effectiveness may be subjective to the participant |
| **Howlin, et al. (2007)** | 84 participants<br>4 to 11 years' old | PECS | Results indicated that children in groups that received PECS *consultation* increased their initiation rates as well as increased their rate of using PECS symbols to communicate |

| | | | |
|---|---|---|---|
| **King, et al. (2014)** | 3 participants<br>3 to 5 years' old | SGD | Results offered support that an SGD programed to function like PECS is successful at improving requesting skills<br>All participants mastered Phases I and II, finishing the study in Phases III and IV of PECS |
| **Lerna, et al. (2012)** | 18 participants<br>18-60 months' old | PECS<br>CLT | PECS showed an increase in social communication skills as measured by significantly higher scores on standardized measures<br>PECS participants engaged in more instances of joint attention, requests, initiations, and duration of cooperative play |
| **Lerna, et al. (2014)** | 14 participants<br>18-60 months' old | PECS | Maintenance of PECS shown by comparing baseline data to 1 year post treatment data suggests PECS is a viable long-term approach<br>Unstructured play supported improvements in cooperative play, joint attention, and initiation |
| **Lorah, et al. (2013)** | 5 participants (male)<br>3 to 5 years' old | PECS<br>iPad-based SGD | SGDs required fewer training sessions for participants to meet mastery criterion of 80% independent requesting<br>SGDs produced higher rates of independent requesting and maintenance<br>Preference for PE and SGDs remained variable across participants but 4/5 participants showed a stronger preference for a SGDs |
| **McDuffie, et al. (2010)** | 32 participants<br>18-60 months' old | PECS | For children with larger expressive vocabularies (i.e. less than ten words), PECS was not as effective in increasing object interest and social communicative attempts |
| **Meer, et al. (2013)** | 2 participants<br>10 to 11 years' old | PE<br>SGD<br>MS | PS, MS, and SGDs improved 2-3 step requesting, greetings, answering questions, and social etiquette responses<br>Preference was mixed between PS and SGD<br>1 participant had slower acquisition but had higher percentage of correct response on PE over SGD (PE slightly more effective) |
| **Pasco & Tohill (2011)** | 23 participants<br>5 to 6 years' old | PECS | Individuals with a developmental age of 16 months or older will master PECS Phase III and continue to succeed<br>Children with a developmental age of under 16 months have difficulty mastering and generalizing PECS due to their lack of understanding symbols and intentional requests |

| | | | |
|---|---|---|---|
| **Sigafoos, et al. (2009)** | 1 participant (male)<br>15-year-old | PECS<br>SGD | Subject acquired skill of requesting by the sixth training with both PECS and SGDs<br>Although requesting was accurately completed, social withdrawal remained unchanged.<br>Subject showed preference for PE over SGD, but relative location was observed to be an influential factor |
| **Still, et al. (2014)** | 46 participants<br><16 years old | SGD<br>PECS<br>MS | Requesting skills improved when using an SGDs, MS, and PE<br>Preference for PE and SGDs remained mixed and varied by participant- often a strong preference for one or the other<br>More research needed for use of SGD across social communicative skills |
| **Tanner, et al. (2015)** | 17 articles<br><18 years old | PECS<br>Naturalistic<br>Behavioral<br>Developmental<br>Classroom-based<br>Parent-mediated<br>Sensory Motor<br>Joint Attention<br>Imitation | PECS and joint attention strategies worked best for improving social communication with young children with ASD.<br>PECS may also be beneficial for children with comorbid intellectual disabilities |
| **Theimann-Bourque, et al. (2016)** | 4 participants<br>3 to 5 years' old | PECS<br>Pals<br>Intervention | PECS has been shown to increase initiation and overall social engagement in the classroom and school setting when others in the environment (teachers, peers, classroom aids) have been familiarized with the program<br>Overall increase social engagement was noted in 2/4 children |
| **Yoder & Leiberman (2010)** | 36 children<br>18-60 months' old | PECS | Young children who received PECS training increased the number of picture exchanges in a far transfer test |

**Appendices:**

**Appendix 1: Quality Assessment, Quality Level and Level of Evidence Used**
**Study** (First column):
*First author's last name et al. (YEAR); if two studies have the same first author and year, use the 1st two authors' last names.*

**Type of design** (Second column):
*Place the number from the list below that corresponds to the study design in the second column of the table. If you believe the study uses a different design, please contact your course instructor.*
1 = Meta-analysis (aka quantitative systematic review)
2 = Large (n>100) randomized clinical trial (RCT; aka Pretest-Posttest Control Group Design
3 = Small (n<100) RCT (Pretest-Posttest Control Group Design
4 = Qualitative systematic review
5 = Nonequivalent pretest-posttest control group design (p.228) OR Nonequivalent Posttest-only control group design (p.231) (i.e., RCT with inadequate approach to key elements)
6 = One-Group pretest-posttest design (p. 223) OR Time Series Design (p. 225)
7 = Single-case design; specify type: _____
8 = cohort study
9 = Case-control study

**Criteria of Quality: Criteria Description by Type of Design**
**1 and 4 = Systematic Reviews and Meta-analyses**
1. Are the inclusion/exclusion criteria for the selection of the studies clearly identified? Yes, if stated in terms of the following:
*Population*: The specific characteristics of the patients in whom the intervention will be evaluated.
*Intervention*: When the intervention concerns a form of treatment, the form of administration, dosing and duration of therapy is specified so the reader can reliably determine the treatment that is being evaluated
*Outcomes*: The outcome variables by which the effect of the intervention is measured is specified.
*Methodological design*: The type of studies to be included is specified
2. Does the review include only randomized control trials?
3. Is the literature search method systematic and exhaustive, minimizing the likelihood that relevant research has been omitted? Yes, if:
- All large, relevant electronic databases were searched
- The authors reviewed the cited papers in the retrieved articles to look for further eligible articles
- The authors hand-search publications specific to the question and perhaps not indexed in electronic databases
- Conducted personal communications with researchers or experts on the subject to identify unpublished articles, or to obtain data not included in the original publications
4. Were the identified studies been evaluated for quality using established quality criteria?

5. If studies were excluded because of important methodological shortcomings, did the author explain the reasons?
6. Was quality evaluation carried out, by more than one person independently, using pre-established criteria?
7. Was the degree of agreement between those reviewing study qualities reported?
+ the following criteria for meta-analysis only
8. Did the methods used to statistically combine the findings of the relevant studies (to reach a conclusion) go beyond simple averaging of results?
9. Was the analysis of the results (re)done excluding those studies of poor methodological quality to determine how they influence the overall results?
10. Are point estimates of effect reported with their confidence intervals?

**2 and 3 = RCTs**
1. Was the assignment to the treatment groups really random?
- Computer-generated random numbers
- Random numbers tables
2. Was the treatment allocation concealed?
Adequate approaches to concealment of randomization
- Centralized or pharmacy-controlled randomization
- Serially-numbered identical containers
- On-site computer based system with a randomization sequence that is not readable until allocation
- Other approaches with robust methods to prevent foreknowledge of the allocation sequence to clinicians and patients

Inadequate approaches to concealment of randomization
- Use of alternation, case record numbers, birth dates or week days
- Open random numbers lists
- Serially numbered envelopes (even sealed opaque envelopes can be subject to manipulation)

3. Were the groups similar at baseline on key characteristics? (selection/confounding bias)
4. Were the eligibility criteria specified and were they logical in terms of the intervention under study?
5. Were outcome assessors blinded to the treatment allocation? (detection bias)
6. Was (were) the outcome measure(s) valid and reliable?
7. Was the care provider blinded to the study purpose?
8. Were drop-outs and loss to follow-up reported? If so was it less than 20% and balanced between groups? (attrition bias)
9. Was the intervention based on reasonable, physiological plausibility?
10. Was fidelity of intervention explicitly addressed in the study?

**5 = Nonequivalent pretest-posttest control group design OR Nonequivalent Posttest-only control group design**
1. Is the study based on a representative sample of the population?
2. Were the eligibility criteria specified and logical in relation to the population and the intervention under study?
3. Were the groups similar at baseline? (selection/confounding bias)

4. Was attention bias addressed?
5. Were assessors blinded to the treatment allocation? (detection bias)
6. Was/were the care provider or subject blinded to the study purpose? (performance or attention bias)
7. Was (were) the outcome measure(s) valid and reliable?
8. Were drop-outs and loss to follow-up reported and balanced between groups? (attrition bias)
9. Was the intervention based on reasonable, physiological plausibility?
10. Was fidelity of intervention explicitly addressed in the study?

**6 = One-Group pretest-posttest design OR Time Series Design**
1. Is the study based on a representative sample of the population?
2. Were the eligibility criteria specified and logical in relation to the population and the intervention under study?
3. Were assessors blinded? (detection bias)
4. Was/were the care provider or subject blinded to the study purpose? (performance or attention bias)
5. Was (were) the outcome measure(s) valid and reliable?
6. Were drop-outs and loss to follow-up reported, and explained? (attrition bias)
7. Was the intervention based on reasonable, physiological plausibility?
8. Was fidelity of intervention explicitly addressed in the study?

**7 = Single-case design**
1. Did the type of design allow us to attribute change to the intervention (e.g., stable baseline, withdrawal/extinction phase, alternate treatment, follow-up)?
2. Were the subject eligibility criteria logical in relation to the population and the intervention under study?
3. Were the children's characteristics well described permitting determination who the results might apply too?
4. Was the intervention sufficiently described that it could be replicated?
5. Was fidelity of intervention addressed?
6. Was (were) the outcome measure(s) valid and reliable?
7. Was the assessor blinded to phases of the study (baseline vs. intervention)?
8. Was the intervention based on reasonable, physiological plausibility?

**Quality Levels – (second to last column)**

**High** A study that meets 70% or more of design-specific criteria well.

**Moderate** A study that meets at least 40% but than 70% of design-specific criteria and has no known "fatal flaw".

**Low** A study that meets less that 40% of design-specific criteria OR has at least one design-specific "fatal flaw". These studies' results should be interpreted with great caution as these studies are deemed to have limited ability to inform practice recommendations.

**Level of Evidence (last column)**

Levels of Evidence (adapted from Sackett, D.L., Rosenberg, W.M., Muir Gray, J.A., Haynes, R.B. & Richardson, W.S. (1996). Evidence-based medicine: What it is and what it isn't. British Medical Journal, 312, 71- 72).

Level I - Systematic reviews, meta-analyses, randomized controlled trials
Level II - Two groups, nonrandomized studies
Level III - One group, nonrandomized
Level IV - Descriptive studies that include analysis of outcomes (e.g., single subject design)
Level V - Case reports and expert opinion that include narrative literature reviews and consensus statements

**Appendix 2: Levels of recommendation chart.**

| **Grade of Recommendation** | **Description Benefit vs Risk and Burdens** | **Quality Level of Supporting Evidence** | **Implications** |
|---|---|---|---|
| **1A** strong recommendation, high-quality evidence | Benefits clearly outweigh risk and burdens, or vice versa | Preponderance of Level I RCTs or Level II studies with at least Level I 1 RTC supporting the recommendation | Strong recommendation, can apply to most patients in most circumstances without reservation |
| **1B** strong recommendation, moderate quality evidence | Benefits clearly outweigh risk and burdens, or vice versa | Preponderance of Level II studies or only one Level I study supporting the recommendation | Strong recommendation, can apply to most patients in most circumstances without reservation |
| **1C** strong recommendation, low-quality or very low quality evidence | Benefits clearly outweigh risk and burdens, or vice versa | A single Level II study or a preponderance of evidence from Level III and IV studies support the recommendation | Strong recommendation but may change when higher quality evidence becomes available |
| **2A** weak recommendation, high quality evidence | Benefits closely balanced with risks and burden | Preponderance of Level I RCTs or Level II studies with at least Level I 1 RTC | Weak recommendation, best action may differ depending on circumstances or patients' |

| | | | |
|---|---|---|---|
| | | supporting the recommendation | or societal values |
| **2B** weak recommendation, moderate-quality evidence | Benefits closely balanced with risks and burden | Preponderance of Level II studies or only one Level I study supporting the recommendation | Weak recommendation, best action may differ depending on circumstances or patients' or societal values |
| **2C** weak recommendation, low quality or very low-quality evidence | Uncertainty in the estimates of benefits, risks, and burden; benefits, risk, and burden may be closely balanced | A single Level II study or a preponderance of evidence from Level III and IV studies support the recommendation | Very weak recommendations; other alternatives may be equally reasonable |

***** Adapted from American College of Chest Physicians