Assistive technology interventions to support children: An evidence snapshot

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Contents

Disclaimer

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Abbreviations or Glossary

AAC	Augmentative and Alternative Communication
ASD	Autism Spectrum Disorder
AT	Assistive Technology
CI	Confidence Interval
CP	Cerebral Palsy
GUSs	Guides for understanding supports
ICF	International Classification of Functioning, Disability and Health Framework
NDIA	National Disability Insurance Agency
NDIS	National Disability Insurance Scheme
PECS	Picture Exchange Communication System
SGD	Speech Generating Device
SMD	Standardised Mean Difference
VOCA	Voice Output Communication Aid
VR	Virtual Reality

Summary

The NDIA is committed to providing participants with evidence-based information about disability-related supports. This evidence snapshot was undertaken to inform a new suite of Guides for understanding supports (GUSs) that aim to help families and carers understand assistive technology supports for children with physical or intellectual disability or developmental delay who have goals focused on communication, mobility, and participation (at home and in the community). The aim of the evidence snapshot was to summarise the available systematic reviews that looked at the effectiveness of assistive technology supports for children younger than 9 years old with physical or intellectual disability or developmental delay to inform the new GUSs.

A systematic search of databases was undertaken to identify systematic reviews and/or meta-analyses, scoping reviews, or evidence-based guidelines. The search was conducted from 2012 to November 2022. Reviews were included based on criteria set a priori. Thirty-four reviews were eligible for inclusion. Fourteen reviews looked at the effectiveness of augmentative and alternative communication (AAC) strategies for communication and language, specifically: sign and natural gestures, picture exchange communication systems (PECS), speech generative devices (SGDs) or speech output devices and eye gaze technology. Fifteen reviews included supports for upper and lower limb and supports to assist movement to improve overall mobility. These included anterior and posterior walkers, ankle foot orthoses, upper limb orthoses, powered mobility equipment, and supported seating. Five reviews explored supports for comfort and independence at home. They included adaptive seating, self-controlled technology, supported seating, standing and lying systems and microswitches.

Heterogeneity and a lack of quality assessment of included reviews and guidelines limits the generalisability of the research in this evidence snapshot but provides an overview of best available evidence. The importance of early intervention of assistive technology (AT), provision of training in the use of specific AT for children and families and child and family preference and satisfaction with AT were common themes addressed and discussed in included reviews, and relevant across all outcomes of interest.

1. Introduction

Early childhood interventions support children with disability and developmental delay, and their families and carers, to have the best possible start in life. Early interventions provide specialised supports and services for children and their families to promote development, wellbeing, and participation in their communities [1]. AT may provide support that can contribute to a child's wellbeing, self-esteem, self-image, and motivation to pursue important life goals [2]. AT can be any equipment, device, product or software that helps children to do things more easily and safely, allowing them to explore their environment, build independence and enhance socialisation and quality of life for them as well as their families and carers [3].

The NDIA is committed to providing participants with evidence-based information about disability-related supports. The purpose of this evidence snapshot is to inform a new suite of Guides for understanding supports [4] for families and carers to learn about assistive technology supports for children with physical or intellectual disability or developmental delay.

2. Aim

To summarise the available evidence, from systematic reviews, on the effectiveness of AT supports for children younger than 9 years old with physical or intellectual disability or developmental delay, who have goals focused on communication, mobility, and participation (at home and in the community).

3. Methods

A search of Medline, Embase, and CINAHL was undertaken using search terms specified in Appendix A to identify existing systematic reviews and evidence-based guidelines. The search was limited to reviews and guidelines published between 2012 to 2022 and in English language. Eligibility criteria was determined a priori as documented in Appendix B. Screening of eligible articles was conducted by three reviewers (ESM & MG & DC). An outline of the definitions of the specific AT items relevant to the three focus areas of this review are outlined in Appendix C. A review of the quality of included reviews and guidelines was not undertaken but included where review authors have described. This evidence snapshot provides a narrative summary of reviews that included effectiveness data. For outcomes of interest where no effectiveness data was available, we have included a summary of narrative results.

4. Results

The search of databases, conducted in November 2022, identified 637 articles. One additional review was retrieved using snowballing techniques (e.g., through the reference lists of included reviews). Following removal of duplicates, 572 abstracts and titles were screened by two reviewers, and articles not meeting eligibility criteria were removed. One-hundred and twenty-one studies were reviewed in full text. Thirty-four reviews were eligible for inclusion in this review. Appendix D provides an overview of the selection process and results. Appendix E provides a summary of included reviews and guidelines.

4.1 Assistive technology for communication and language

Nine systematic reviews [5-13], four scoping reviews [14-17] and one evidence-based clinical guideline [18] identified in our search included AT supports for children's communication and language. The reviews and guideline included participants with a range of disabilities across varied age groups. Most studies included in the reviews were conducted in the child's home or learning environment [6, 8-11, 14, 17]. Seven reviews did not specify the setting of interventions [5, 7, 12, 13, 15, 16, 18].

Three [6, 7, 11] out of 14 reviews and guidelines provided data on effectiveness of interventions. The remaining 11 reviews provided summaries of findings for interventions and outcomes of interest to this review with no effectiveness data available.

The reviews presented findings for the following AAC strategies, technologies and products:

- Sign and natural gestures [5, 8, 9, 11, 13, 16]
- PECS or communication boards [5, 6, 8-13, 16, 18]
- SGD or speech output devices, voice output communication aid (VOCA) [5, 8, 9, 13-17]
- Mobile technology (e.g. iPad) [10, 11, 14]
- Computer generated pictographs [5]
- Eye-gaze technology [7]

We did not identify any research (meeting our inclusion criteria) for the following interventions of interest: magnifiers (portable, video based, software), optical reading aids (to read printed documents), braille printer/embosser or refreshable braille. This may be due to the accepted general use and nature of these technologies and devices and current knowledge of their effectiveness to aid children with communication and language production.

The included reviews sought to identify current research and report effectiveness of AAC strategies, technologies and products and their impact on the outcomes listed in Box 1.

Box 1. Outcomes reported for effectiveness of AAC

- Expressive and receptive communication [5-9, 12-14, 16, 18]
- Functional communication [6-9, 12-14, 18]
- Reference/object matching [7-9, 16, 18]
- Interactions/socialisation [5-9, 13, 14, 16, 18]
- Speech or vocal output [6, 11, 13, 17]
- Frequency of speech [6, 13, 17]
- Vocabulary acquisition [15, 16]
- Self-determination [7, 8, 10, 15, 17]
- Literacy skills [15, 16]

4.1.1 Augmentative and Alternative Communication

AAC is a broad term used to describe when a person uses something other than speech to communicate. They may use body movements or gestures, sign language or different types of technology or devices. These technologies or devices are sometimes referred to as light/low and high technology as well as aided or unaided.

Sign and natural gestures

Signing or the use of natural gestures to communicate are used to replace or supplement vocal abilities for communication with others [11]. Five reviews [8, 9, 11, 13, 16] meeting our inclusion criteria were identified and included signing and natural gestures as interventions to aid the communication and language of children. Only one of the five reviews [11] presented data on the effectiveness of signing or natural gestures.

Lorah et al (2022) compared mobile technology and speech generating devices to other AAC modes (manual signing) for children with autism, aged three to 13 years in settings or activities described as 'where the learner is engaging' [11]. Of the 36 participants included in the review [11] only one participant, at baseline measure, experienced a strong positive effect of manual sign when compared to picture exchange for achieving vocal output. The review also reported no participants preferred interacting using no-tech manual sign.

Picture exchange communication systems (PECS) (low tech)

PECS are a way for children to communicate without relying on speech. Children can ask for or provide comments or answer questions using photographs or cards with pictures or symbols, object symbols, communication boards or books (usually a sheet of paper or a book of pictures and symbols a child can point to) or eye-gaze boards (similar to communication boards but for children who can only show their choices using their eyes). Ten reviews [5, 6, 8-13, 16, 18] meeting the inclusion criteria for this review were identified and included PECS as an intervention to aid the communication and language of children. Two [6, 11] of the ten reviews presented data on the effectiveness of PECS for children.

The review by Brignall et al (2018) identified one randomised controlled trial that compared the use of AAC (PECS) for minimally verbal children with autism spectrum disorder (ASD) with a control group (children in classes where teachers had not received active, direct, in class training with PECS consultants) [6]. For spoken communication, measured by frequency of speech, Brignall et al (2018) found no significant main effect of the PECS intervention (OR 1.10, 95% CI 0.46 to 2.62, P = 0.83) [6]. For non-verbal communication, measured by frequency of use of PECS symbols (expressed as rates per minute), children in the PECS group were 3.9 times more likely to be in a higher PECS-use category (higher rate per minute user) than children in the control group (OR 3.90, 95% CI 1.75 to 8.68, P < 0.001). For combined spoken and non-verbal communication, measured by verbal and non-verbal initiations, children in the PECS group were 2.72 times (OR 2.73, 95% CI 1.22 to 6.08, P < 0.05) more likely to be in the higher initiation-rate category than the control group. Finally, for social communication or pragmatic language, measured by reciprocal social interactions, there was no significant main effect of the PECS intervention on reciprocal social interactions (OR 0.55, 95% CI 0.25 to 1.19, P = 0.13). It is important to note that the results of the RCT presented in the Brignall et al (2018) review are considered very low quality of evidence [6].
Similar to the Brignall et al (2018) review, Lorah et al (2021) compared high tech (e.g., SGDs), low tech (e.g., PECS) and no-tech (manual sign) AAC modes for children with ASD aged between three and 13 years (mean age of 7 years) to determine participant preferences and performance among other outcomes [11]. The review found three out of 36 participants experienced a strong or moderate positive effect of PECS compared to SGDs and eight out of 36 participants experienced a strong to moderate positive effect of PECS compared to manual sign for verbal behaviour [11]. The review also reported four out of 36 participants preferred interacting using low-tech PECS [11].

Speech Generative Devices (SGDs) or speech output devices (high tech)

SGDs are portable electronic devices that allow children who are using them to create a message in writing or produce speech. Eleven reviews [5, 8-11, 13-17] included SGDs or speech output devices (e.g., mobile technology – iPads) to aid the communication and language of children. One [11] of the ten reviews presented data on the effectiveness of SGDs or high-tech speech output devices for children.

Lorah et al's (2022) review looked at AAC modes for children with ASD and found two out of 36 participants experienced a moderate positive effect of SDGs compared to PECS and ten out of 36 participants experienced a moderate or strong positive effect of SGD use compared to manual sign for verbal behaviour [11]. The review also reported 31 out of 36 participants preferred interacting using high-tech SGDs [11].

Eye gaze technology

One systematic review [7] reviewed the effectiveness of eye gaze technology for children and adults with cerebral palsy (CP), considered to have significant physical disability and complex communication needs. The review explored the effectiveness of eye gaze technology on achieving communication related goals [7]. Of particular interest to this review were goals related to interacting with others. While the review found most goals related to interacting with others (6/7, 68%) were achieved, the authors note the evidence is considered weak to support the positive impact of eye gaze technology for children with CP [7].

4.2 Assistive technology for mobility

Seven systematic reviews [19-25], three systematic review and meta-analyses [26-28], two scoping reviews [29, 30], two guidelines [31, 32] and one health technology assessment [33] included ATs to support children's mobility. The reviews and guideline included participants with a range of disabilities across varied age groups. Five reviews described the settings of included studies as at home, school, community, day care or clinical settings. Ten reviews did not specify the setting of interventions [21-26, 28, 30-32]. Five [24, 26-28, 31] out of fifteen reviews and guidelines identified provided data on effectiveness of interventions. The remaining ten [19-23, 25, 29, 30, 32, 33] reviews reported summaries of finding but no effectiveness data was available.

The reviews presented findings for the following mobility products and supports:

- Walking aids [20, 22]
- Gait trainers [23]
- Anterior or posterior walkers [24, 32]
- Ankle foot orthoses [20, 22, 25-29, 31]
- Therapeutic footwear [20, 30]
- Upper limb orthoses [22]
- Powered mobility (powered wheelchair, switches) [19, 21, 33]
- Supported seating [22]

We did not identify any research (meeting our inclusion criteria) for the following interventions: Dynamic supports (posture or seating), and AT supports for travel. This may be due to the narrow provision of support or that these types of devices are customised or made to order resulting in limited research evidence.

The included reviews sought to identify current research and reported effectiveness of mobility ATs and their impact on the outcomes listed in Box 2.

Box 2. Outcomes reported for effectiveness of mobility AT

- General movement, mobility [22, 31-33]
- Functional gait measures [20, 22, 24, 26, 28, 30, 31]
- ICF outcomes [20, 21, 23, 25, 27, 29]
- Participation, activities of daily living [19, 21, 24, 32, 33]
- Social interaction [19, 33]
- Pain [27, 30, 31]
- Safety [33]

4.2.1 Supports for walking

There are a range of products that can support children to walk and stand and improve functional mobility and alignment. Ten [20, 22-30] reviews and two evidence-based guidelines [31, 32] were identified and included the following supports for walking: walking aids, gait trainers, anterior or posterior walkers, ankle foot orthoses and therapeutic footwear. Five [24, 26-28, 31] out of 12 papers presented data on the effectiveness of anterior and posterior walkers and ankle foot orthoses. Only descriptive summaries of findings were provided for reviews looking at effectiveness of walking aids [20, 22], gait trainers [23] and therapeutic footwear [20, 30].

Anterior and posterior walkers

Poole et al (2018) reviewed anterior or posterior walkers for children aged two to 18 years with cerebral palsy [24]. The majority of included studies found statistically significant results ($p \leq .05$) demonstrating more upright posture (trunk angle/pelvic tilt) with the posterior walker were reported at all points in the gait cycle. No significant differences were seen at any point in the gait cycle for hip flexion. Reduced hip flexion using the posterior walker was observed at all points in the gait cycle to varying degrees. The majority of results supported the use of posterior walkers for knee flexion but were not significant. Mean velocities reported in included studies ranged from 0.21 to 0.45 m/s for the anterior walker and 0.28–0.48 m/s for the posterior walker. Generally, the posterior walker increased velocity greater than the anterior walker. No significant differences between posterior and anterior walkers were found for cadence (steps per minute). There was consensus that the posterior walkers significantly reduced double stance time compared to anterior walkers across included studies ($p<.05$) for double stance time. Results for step and stride length and oxygen cost were contradictory. Both significant and non-significant results were identified between posterior and anterior walkers. No effectiveness data was available for participant and parental preference, however the authors noted that most participants and parents preferred the posterior walker [24].

Ankle foot orthoses

Betancourt et al (2019) reviewed the effectiveness of ankle foot orthoses with "barefoot or shoes only" on ambulatory children with cerebral palsy [26]. Pooled results of the meta-analyses showed that stride length was significantly better in the ankle foot orthoses group as compared with the control group (mean differences between groups = 0.05 m [95% confidence interval (CI) = 0.04–0.06]). I^2 for this analysis was 91% indicating that the studies effects were heterogeneous. Although most effect sizes were positive, the high I^2 reflects variances in true effect sizes. The dorsiflexion angle was improved in patients with ankle foot orthoses as compared with barefoot or shoes (mean difference between groups = 8.62 degrees [95% CI = 8.05–9.20]). I^2 was 87%, indicating a high evidence of heterogeneity beyond chance [26].

Lintanf et al (2018) reviewed the effectiveness of ankle foot orthoses on gait, balance, gross motor function and activities of daily living in children with cerebral palsy [28]. The authors found strong evidence that ankle foot orthoses induce small improvements in gait speed and moderate evidence that ankle foot orthoses have a small to moderate effect on gross motor function. In children with equinus gait, there is strong evidence that posterior ankle foot orthoses induce large changes in distal kinematics. Ankle foot orthoses increased stride length (standardised mean difference (SMD) = 0.88, $P<0.001$) and gait speed (SMD = 0.28, $P<0.001$, and decreased cadence (SMD=-0.72, $P<0.001$). Gross motor function scores also improved. Data related to balance and activities of daily living were insufficient. Posterior ankle foot orthoses (solid, hinged, supra-malleolar, dynamic) increased ankle dorsiflexion at initial contact (SMD=1.65, $P<0.001$) and during swing (SMD=1.34, $P<0.001$), and decreased ankle power generation in stance (SMD=–0.72, $P<0.001$) in children with equinus gait [28].

Fellas et al (2017) reviewed the effectiveness of custom/customized foot orthoses in treating foot and ankle pain in children with juvenile idiopathic arthritis [27]. Meta-analyses for comparisons between custom/customised foot orthoses and a control intervention after 3 months were not significant for the outcomes of pain (mean difference, –8.97; 95% CI, –18.01 to 0.07), child-rated health-related quality of life (mean difference, 4.38; 95% CI, –3.68 to 12.44), and parent-rated health-related quality of life (mean difference, 1.77; 95% CI, –6.35 to 9.90) [27].

The Ottawa Panel Evidence-Based Clinical Practice Guidelines for Foot Care in the Management of Juvenile Idiopathic Arthritis [31] recommend the use of custom fitted preformed foot orthotics (versus 1-mm non-customised leather board control) for at least 6 months to decrease pain (100-mm VAS) after ≥24 weeks. The guideline also suggests the use of custom made semi-rigid orthotics (versus prefabricated off-the-shelf shoe inserts) for at least three months to decrease pain (intensity; Paediatric Pain Questionnaire VAS), activity limitation (FFI), foot pain (FFI), and disability (FFI) after ≥12 weeks [31].

4.2.2 Supports for upper limbs

Upper limb orthoses

Upper limb orthoses are devices applied to the body to stabilise joints, improve alignment, prevent deformity, or reduce pain. They may be applied to the shoulder, elbow, wrist, or hand. Some examples of upper limb orthoses include splints, slings, hinge-elbow braces, and elbow clasps.

One systematic review [22] was identified and reviewed upper limb orthoses for children aged 0-18 years with motor disabilities. Orthoses included in the review were: orthotic garments, therapeutic taping, and wrist to thumb braces [22]. The authors note that due to the nature of included studies, synthesis of effectiveness data was not available for the outcomes of interest (reported body posture and range of movement) [22].

4.2.3 Supports to move around

There are a range of products that can support children to move around in environments where they live, learn and play. Three systematic reviews [19, 21, 22] and one health technology assessment [33], meeting the inclusion criteria, were identified, and included the following supports: powered mobility (e.g., powered wheelchairs) and supported seating. Only descriptive summaries of findings were provided for these reviews. Outcomes of interest included general movement, functional gait measures, participation, social interaction, safety and components of the International Classification of Functioning, Disability and Health Framework (ICF).

Powered mobility

Powered mobility devices are wheeled supports that help children move around. There are small, powered wheelchairs designed for infants and young children, to provide an alternative method for independent movement. These may be used together with other mobility equipment. They are primarily designed as an introductory powered mobility device for children.

Two reviews [19, 33], focused on very young children (<6 and under), and one [21] included children aged 0-18.

While no conclusive evidence of effectiveness or cost-effectiveness could be found for powered mobility devices for children, Bray et al (2020) concluded, based on the abundance of evidence across age and diagnostic groups, that powered mobility interventions can have a positive impact on children's movement and mobility, as well as children's participation, play and social interactions and on the safety outcomes of accidents and pain [33]. Similar findings were reported by Cheung et al 2020, who despite the variability of results of included studies concluded a significant impact of the powered mobility device interventions on social skills for children aged between 0-6 years [19].

Livingstone et al (2014) reported the lack of research on effectiveness data on outcomes for children using powered mobility with most research being descriptive [21]. The authors concluded that powered mobility device use may have positive effects on overall development, independent mobility and self-initiated movement as well as supporting a range of ICF outcomes. The authors also note the importance of environmental factors which may influence successful power mobility use and skill development [21].

Supported seating

Support for seating may include supportive cushions, backrests, belts and harnesses, foot supports, and trays. These types of supports can be used with both manual and powered wheelchairs. The aim of these supports is to support positioning through maintaining alignment and enhancing comfort.

We found one systematic review [22] which included adaptive seating devices. The review included a range of technical devices for children with motor disabilities aged 0-18 years old. The review looked for outcomes which reported kinematic and kinetic parameters of gait, gross motor skills, lower limb articulation and body posture range of movement. The authors concluded that adaptive seating devices suggested a favourable outcome, but due to the nature of studies included, synthesis of effectiveness data was not available for the outcomes of interest [22].

4.3 Assistive technology for children at home and in the community

Four systematic reviews [34-37] and one overview of reviews [38] focused on AT supports for children at home and in the community. The reviews presented summaries of results for adaptive seating, self-controlled technologies, supported sleeping systems and use of microswitches. Supports to help with mealtime or in the bathroom were not identified in the research.

4.3.1 Supports for comfort and independence at home

Adaptive seating

Adaptive seating is designed to provide postural support to a child while seated. They aim to promote an upright position of the child, encouraging good alignment, comfort, and enhance communication, socialisation, and participation. Seating systems are commonly used with indoor posture chairs and wheelchairs.

Two reviews [34, 38] summarised the effects of adaptive seating devices on postural control/stability, upper extremity function as well as additional outcomes (quality of life, child comfort, parents/caregivers experience and daily life performance).

For children under the age of 19 with severe cerebral palsy, one review [34] suggested adaptive seating systems that include trunk and hip support may improve postural control outcomes and special purpose adaptive seating may improve self-care and play behaviour at home. However, the authors reported that with low level evidence robust conclusions about functional effect of seating devices in children with severe cerebral palsy are unable to be made. In another review [38] focused on adaptive seating for children with cerebral palsy, the authors noted there is inconclusive empirical evidence of the impact of seating devices on functional outcomes for this population.

Self-controlled technology

Self-controlled technology refers to technologies such as mobile devices (e.g. PDA, iPod, and iPad), robots, and virtual reality (VR). The effects of self-controlled technologies on learning and independence for people on the autism spectrum or people with mild to moderate intellectual disability was summarised in one review [36]. Technology was used to support three different learning strategies: (a) learning by prompting; (b) learning through interaction with robots; and (c) learning by practicing in the present, in a real life or virtual daily living situation. In the absence of effectiveness data, the authors noted that self-controlled technology supports daily living skills (e.g. preparing a hotdog in a microwave), vocational skills (e.g. folding a pizza box), transitioning within tasks, transitioning between tasks, engagement (e.g. following eye gazing), and safety (e.g. street crossing). The cognitive concepts mentioned were social convention skills (e.g. reasoning about where to sit), time perception (e.g. putting sequential actions in the right order), and imagination (e.g. using objects in an irregular way). Some of the cognitive concepts were emotionally oriented, such as concepts about understanding the emotions of others by asking users to empathise with the emotion of an avatar in a particular situation. The authors noted that task performance may increase during the intervention phase but declined during follow-up [36].

Supported seating, standing and lying systems

There are many devices to support children to sit, stand and lie down safely and comfortably. One review [35] summarised findings for overnight use of manufactured whole body sleep positioning systems for children with cerebral palsy aged between five and 16 years. The review found no significant differences between children with cerebral palsy using or not using sleep positioning systems on sleep quality and pain. The review did not identify any trials for the primary outcomes of interest: reduction or prevention of hip migration or number or frequency of hip problems, quality of life (family and child) or physical functioning [35].

Microswitches

Microswitches are devices designed to help access and control communication devices, environmental controls, and computer software. They are activated and controlled by body movements or actions such as moving a finger or arm, head turning, touching, or pushing, or chin movement.

One review [37] summarised the effects of microswitch technologies on children's abilities to make choices, accessing and choosing preferred stimuli and recruiting attention or social interactions. The authors [37] concluded that the use of microswitch technology in educational programs, benefits children with profound and multiple disabilities to impact their environment and interact with others. The review, however, did not provide any data on effectiveness.

5. Limitations

This evidence snapshot has potential limitations. We limited the search to ten years given that technology can advance at a rapid rate, however in doing so may have missed reviews of assistive technology that have been in use for a long period of time, considered effective and common practice so further research is not required. Quality assessment of included papers was not conducted. This was due to time constraints and available resources; therefore, care should be taken when interpreting the results and drawing conclusions of included papers. It's important to note that many of the included papers reported studies meeting the eligibility criteria were of low quality and included small sample sizes. Many of the included reviews investigated specific disability populations. This makes generalising the findings difficult across all disabilities. Reviews that included children under nine within a broader age range, for example children and adults were included. By excluding reviews for adults, we potentially have missed assistive technology that may be suitable and effective for children.

6. Summary of findings

This evidence snapshot provides a summary of the available evidence for assistive technology equipment, devices, products, or software available for children with physical or intellectual disability or developmental delay. The included reviews and guidelines presented some effectiveness data of AT supports across a wide range of disabilities, age groups, AT types, and outcomes. Heterogeneity and a lack of quality assessment of included reviews and guidelines limits the generalisability of this evidence snapshot. What is provided is an outline of available research as well as areas for future research. The importance of early intervention of AT, provision of training in the use of specific AT for children and families and child and family preference and satisfaction with AT were common themes addressed and discussed in included reviews, and relevant across all outcomes of interest.

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Appendix A. Search terms

Table 1: Search strategy

#	Search Term
1.	Communication Aids for Disabled/
2.	(augmentative communication).mp
3.	(speech ADJ2 device).mp
4.	Mobile Applications/
5.	ipad.mp
6.	Eye-Tracking Technology/
7.	exp Sensory Aids/
8.	(braill* ADJ1 (printer* OR emboss* or refreshable)).mp.
9.	magnifier*.mp.
10.	(communication board*).mp.
11.	exp Self-Help Devices/
12.	((assistive OR self-help) ADJ (technolog* OR device*)).mp.
13.	Foot Orthoses/
14.	(therapeutic footwear).mp.
15.	Orthotic Devices/
16.	(posture support).mp.
17.	exp Walkers/
18.	rollator*.mp.
19.	exp Wheelchairs/
20.	((power OR manual) ADJ1 wheelchair*).mp.
21.	exp Sensory Aids/
22.	(cognit* support*).mp.
23.	(prompting device*).mp.
24.	wayfinding.mp.
25.	GPS.mp.
26.	picture exchange.mp
27.	sign language.mp
28.	(augmentative and alternative communication).mp
29.	graphic symbol*.mp
30.	(speech-generating devices OR the Picture Exchange Communication System).mp
31.	(SGDs OR PECS).mp
32.	ACC.mp
33.	(aided augmentative and alternative communication).mp
34.	((aided) adj1 (communication OR language)).mp.
35.	tablets.mp.

#	Search Term
36.	voice output communication.mp.
37.	(eye gaze technolog* OR eye gaze control technology OR gaze based assistive technolog*).mp.
38.	Power* mobility device*.mp.
39.	Complex Communication Need*
40.	(aided OR assist* OR self-help) ADJ (technolog* OR device*).mp.
41.	(instrument* adj4 "augmentative and alternative communication").mp.
42.	speech production.mp.
43.	((anterior or exterior) adj2 walker).mp.
44.	(seat* ADJ2 postur* support).mp.
45.	(crutches adj3 mobility).mp.
46.	(stand* mobility).mp.
47.	(early adj2 powered mobility).mp.
48.	(lying adj2 system*).mp.
49.	standing frames.mp.
50.	special* bed*.mp.
51.	OR 1-50
52.	Autistic Disorder/
53.	Autism Spectrum Disorder/
54.	((Autis* OR Asperge*) ADJ1 (disord* OR disab*)).mp.
55.	exp Communication Disorders/
56.	((communicat* OR language) ADJ1 (disord* OR disab* OR dysfunction*)).mp.
57.	Learning Disabilities/
58.	((learning OR development*) ADJ1 (disord* OR disab* OR disturb*)).mp.
59.	Intellectual Disability/
60.	Developmental Disabilities/
61.	(mental* ADJ1 retard*).mp.
62.	(chronic* ADJ1 ill*).mp.
63.	(chronic* ADJ1 sick).mp.
64.	Mental Disorders/
65.	((mental* OR psych*) ADJ1 (abnormal* OR ailment* OR condition* OR deficien* OR derange* OR disab* OR disease* OR disorder* OR handicap* OR ill* OR infirm* OR impair* OR malad* OR problem* OR sick* OR syndrome* OR patholog*)).mp.
66.	(cognit* ADJ2 (impair* OR disability OR disease OR decline)).mp.
67.	Disabled Persons/
68.	Disability Studies/
69.	Cognition Disorders/
70.	disab*.mp.
71.	Mobility Limitation/

#	Search Term
72.	(walk* OR mobilit* OR ambula*) ADJ1 (difficult* OR limitation*).mp.
73.	pervasive developmental disorder.mp.
74.	developmental delay.mp.
75.	Down's syndrome.mp.
76.	developmental disabilit*.mp.
77.	complex disabilit*.mp.
78.	physical disabilit*.mp.
79.	multiple disabilities.mp.
80.	exp language disorder/
81.	hypotonia/
82.	dyspraxia/
83.	(profound and multiple learning disabilities).mp.
84.	PMLD.mp.
85.	OR 52-84
86.	Systematic review/
87.	Systematic Reviews as Topic/
88.	Meta-Analysis/
89.	exp Meta-Analysis as Topic/
90.	exp review/
91.	exp Review Literature as Topic/
92.	(systematic adj2 review).mp.
93.	meta analy*.mp.
94.	OR 86-93
95.	exp Child/
96.	Child, Preschool/
97.	child*.mp.
98.	minor*.mp.
99.	infant.mp.
100.	toddler*.mp.
101.	young.mp.
102.	OR 95-101
103.	51 and 85 and 94 and 102
104.	Limit 103 to yr="2012-Current"

Appendix B. PICO Framework

Table 2: PICO-S Framework

PICO-S Framework	Eligibility Criteria
Population	Children aged between 0-9 years with any disability, including multiple complex disabilities were eligible.
Interventions	AT used by children to support their communication, mobility or activities of daily living or participation. (AT used in conjunction with a clinician will be excluded). **AT for Communication:** • AAC (e.g., Communication books/boards, Speech generating devices, Eye gaze AT, mobile apps) • Magnifiers (portable, video based, software) • Optical reading aids (to read printed documents) • Braille printer/embosser • Refreshable braille **AT for Mobility:** • Lower limb and upper arm orthoses (e.g., Therapeutic footwear and foot orthoses) • Dynamic supports (posture or seating) • Night care and positioning for bed • Early powered mobility (e.g., Walkers/rollators) • Manual wheelchair (with or without power assist), power wheelchair • AT for travel **AT for activities of daily living and participation:** • AT for daily living (including dressing, self-care) • Supported seating, standing, laying systems • Toileting and bathing • Supported seating, standing, laying systems • Cognitive supports (day to day planning and routines) • Recreation (e.g., riding a bicycle, engaging in sports)

PICO-S Framework	Eligibility Criteria
	Specific exclusion: • Ride on mobility aids for children based on funded supports. • Studies that looked at the implementation methods of AT.
Comparator	Studies with or without comparators will be eligible.
Outcomes	Impact, effectiveness or participant experience of AT for communication, mobility or activities of daily living or participation.
Setting	Natural settings where children live, play, learn (solely clinical settings will be excluded).
Study design	Systematic reviews, meta-analysis, guidelines for practice, or a scoping review with a systematic search strategy.

Appendix C. Definitions of specific assistive technologies

Table 3: Communication definitions

Assistive Technology	Definition
Communication books/boards	A book or a board which helps a child use pictures to communicate their wants and needs.
Eye-gaze technology	A tool which allows people with physical disabilities to operate technology or electronics in their environment using their eyes. It consists of an eye tracker (which uses specialised infra-red video cameras) mounted to the bottom of a tablet or computer monitor as well as specialised software (Karlsson et al 2017 cited in Perfect et al, 2020). The computer tracks the eye movements, which in turn control the cursor on the screen. The person selects items either by holding their eye-gaze for a certain time, referred to as 'dwell', by blinking, or by clicking an external button (Allsop et al, 2018; Perfect et al, 2020).
Picture Exchange Communication system (PECS)	A communication system that involves children locating and using picture(s) that represent the message they wish to convey (typically a request) and point to it or exchange that picture for the item they are requesting (Graz et al,b, 2014).
Speech- generating devices (SGDs)	SGDs are portable devices that can play words or phrases when the user touches a switch or presses buttons or keys or 'speak' words as they are typed into a keyboard (Ganz et al b, 2014). A person can use an SGD to request, to label or comment, to ask questions or to answer questions (Rispoli et al, 2012 cited in Ganz et al b, 2014; Schlosser, 2003 cited in Ganz et al b, 2014).

Table 4: Mobility definitions

Assistive Technology	Definition
Anterior and posterior walkers	Devices used to help children who can bear weight to provide stability and assist with walking. Anterior walkers are placed in front of the user and have frames on both sides. Posterior (or reverse) walkers are placed behind the user and have frames on both sides.
Early powered mobility (e.g., Rollators, Wizzybugs, Scooter boards)	Any device that requires a battery or other electrical power source to move. Children use these to move from one place to another (Logan et al, 2016, cited in James et al, 2019).
Gait trainers	A supported walking device that provides trunk and pelvic support. These devices are also known as support walkers, posture control walkers or suspension body-weight support systems. They aim to provide additional assistance to children who may not be able to stand or walk without assistance (Paleg, 2015).

Assistive Technology	Definition
Manual wheelchairs (with or without power assist)	Manually wheelchairs are operated by an individual or attendant propelled (pushing). Wheelchairs can be divided into three categories, Self-propelled wheelchairs - where the child maneuvers it themselves, Transit wheelchairs - where a carer or attendant is required to move this type of wheelchair. Tilt and recline wheelchairs - wheelchairs with added functionality that allows a child to be tilted in space and/or reclined. (Bray, 2020)
Orthoses	Orthosis is a device that is applied to a person's body to support the structure and movement of a particular body part through applying structural support. Orthoses can be placed on different parts of the body such as the lower limbs (feet, ankle, foot orthoses AFOs) or the upper limb (arms or hands) (Garbellini, 2016).
Power/electric wheelchairs	Power/electric wheelchairs are an alternative for children who are unable to operate a wheelchair manually. They offer options for support, specialised seating, and control systems (Bray, 2020).
Sleep positioning systems	Sleep positioning systems are individualised, lying support systems that may contain one or more parts, that are held in position by a base layer or sheet (Polak, 2009, cited in Blake 2015). The system is designed to maintain the posture so that children sleep, positioned in this equipment, with the goal of maintaining one position overnight (Blake, 2015).
Therapeutic footwear	Therapeutic footwear are shoes that are designed to provide support to children with a mobility impairment and consists of three subgroups depending on their purpose. Corrective footwear is designed to bring about the correction of lower limb alignment. Accommodative footwear designed to reduce compression and stresses on children's feet and Functional footwear is designed to improve the balance of children with mobility impairment (Hill, 2020).
Upper arm orthoses	An upper arm orthosis is a device worn to improve the structure and movement of a child's body through applying support. In clinical practice orthosis, splint and brace refer to the same thing (Garbellini, 2016).

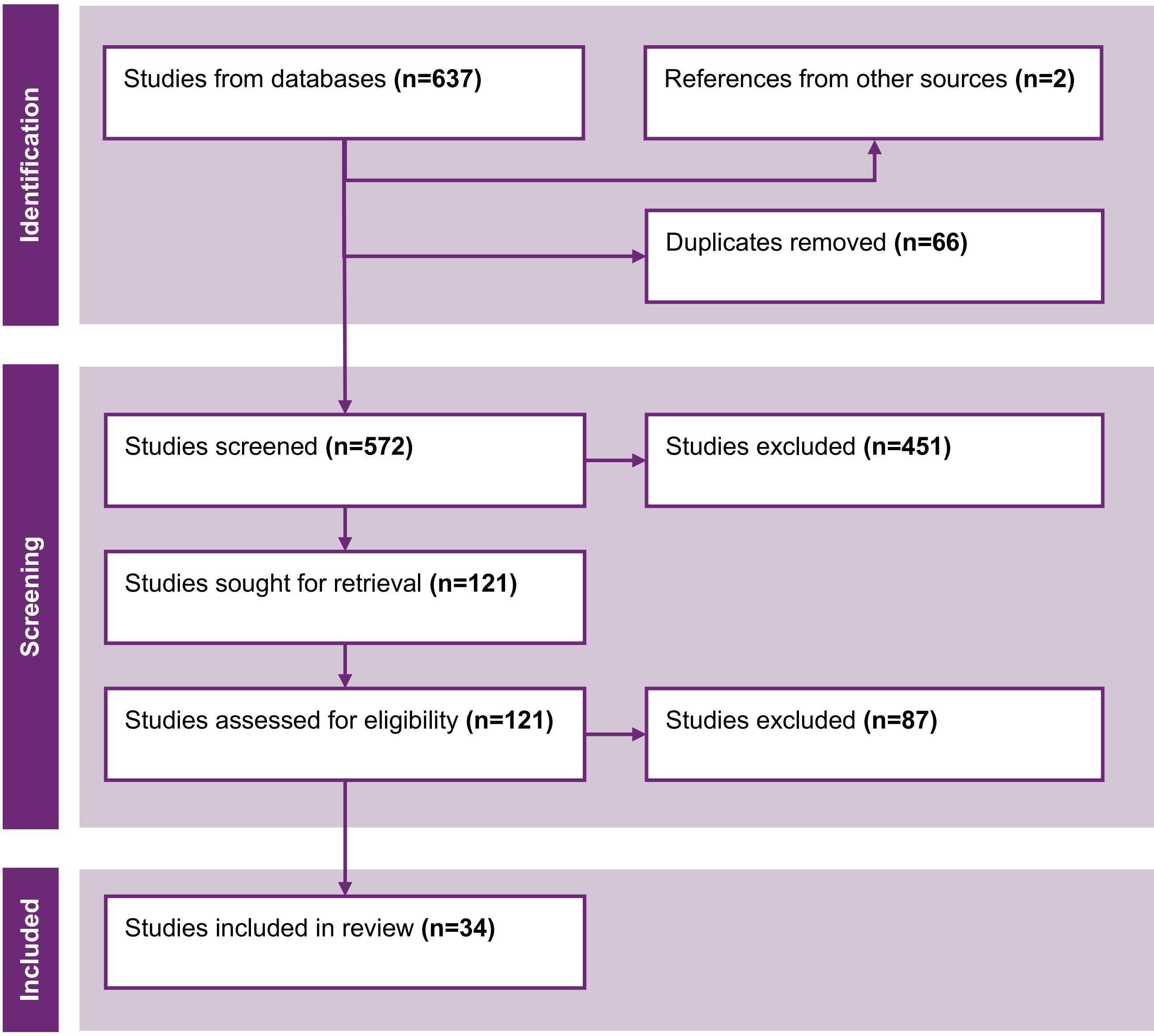
Table 5: Activities of daily living and participation definitions

Assistive Technology	Definition
Adaptive seating devices	Adaptive seating devices may be used for postural and positioning support to children while seated. They can be used on their own or be attached to another device such as a wheelchair. (Ryan, 2012)
Cognitive supports (including day to day planning and routines)	Devices to support cognitive tasks may include virtual reality, computers, handheld devices, use of pictures, and robots.
Eating and drinking equipment	Equipment that may be used to assist children to be independent when eating or drinking (e.g., Special cutlery, plates, cups and bottles).

Assistive Technology	Definition
Environmental control equipment (e.g., microswitches)	Microswitches are devices to help control technology and electronics. They can be controlled by body movements or actions such as moving a finger or arm, head turning, touching/pushing, or chin movement. They can be used to access communication devices, environmental control (e.g., turning on a TV), and computer software. For example, a child may use a microswitch by pushing an adapted button to turn on a device. Microswitches can also be found on toys to enable children to have increased independence and interact with their environment (Roche, 2015).
Grooming and dressing equipment	Some examples are stocking and sock aids (i.e., to help put shoes on), buttoning and zipping devices (either a device to support putting on clothes, or alternatives to buttons e.g., Velcro buttons)
Laying system	Often made up of lifters, hoists, and slings. Laying systems are commonly used in practice to support transfers.
Toileting and bathing devices	Toileting and bathing devices used to support a child to be more independent. Some examples are specialised toilet seats, sponges, and brushes with longer handles, shower chairs, non-slip matts.

Appendix D. Selection Process

Image 1: Prisma flow diagram



Appendix E. Summary of included reviews

Table 6: Summary of communication reviews

Author, Year	Study Type	Disability	Age Range	Setting	Intervention/ Comparators	Outcomes	Authors Conclusion
Lorah 2022	Systematic review	ASD	3-13yrs	Setting or activity where learner is engaging	Mobile technology (handheld devices – iPad) Speech Generating Devices compared to other AAC modes	Vocal output	**Effectiveness data provided:** Authors suggest that practitioners consider using mobile technology-based SGDs to promote verbal behaviour from children with a diagnosis of ASD. In both, with instruction and without instruction conditions, participants overall appeared to communicate the most using high-tech SGDs. Participants showed higher performance and higher preference for using high-tech SGDs. **Effectiveness data has been provided as mean intervention performance levels:** According to effect size estimations through Tau-U calculations, five participants in baseline (i.e., in the absence of instruction) experienced a moderate (n=3) or strong (n=2) positive effect of high-tech SGDs compared to

Author, Year	Study Type	Disability	Age Range	Setting	Intervention/ Comparators	Outcomes	Authors Conclusion
							picture exchange while two participants experienced a strong positive effect of picture exchange as compared to SGD use. Seven participants experienced a moderate (n=3) or strong (n=4) positive effect of high-tech SGDs as compared to manual sign while one participant experienced a strong positive effect of manual sign as compared to SGD use. Two participants experienced a strong (n=2) positive effect of picture exchange compared to manual sign while one participant experienced a strong (n=1) positive effect of manual sign compared to picture exchange.
White 2021	Systematic review	Children with ASD, PDD or NOS.	2 years to 26 years old mean age of 6 years.	Several settings (specific settings are not mentioned)	AAC: • PECS • SGD • Sign language • Responsive Education	Speech development/production- may be referred to as speech, words, word approximations, vocalisations, verbalizations, verbal/vocal requests, and any related speech.	**Effectiveness data provided:** Overall, AAC resulted in improved speech production. Researchers used the Single-Case Analysis and Framework (SCARF- outcome scores are based on visual analysis). Of the 25 single case design articles evaluated, 10 articles

Author, Year	Study Type	Disability	Age Range	Setting	Intervention/ Comparators	Outcomes	Authors Conclusion
					and Prelinguistic Milieu Teaching (RPMT)		demonstrated a functional relation (scoring 3–4 using SCARF) between intervention and positive AAC outcomes while 15 did not demonstrate a functional relation. While no studies showed AAC resulted in a decrease in speech, it is still unclear if the addition of AAC will benefit a participant's speech production. Six out of 25 articles demonstrated a functional relation between speech production outcomes and AAC (scoring 3–4 using SCARF) across AAC modalities (e.g., PECS, SGD, and sign). Three articles demonstrated a functional relation for only a single participant while the remaining 16 did not demonstrate a functional relation between AAC and speech production outcomes and speech gains did not occur for most participants. In the three identified group design articles, one reported significant increases in speech while the other two reported no gains.

Author, Year	Study Type	Disability	Age Range	Setting	Intervention/ Comparators	Outcomes	Authors Conclusion
							More research with adequate quality evidence should be conducted to further evaluate what could be included in AAC interventions to increase speech production if possible.
Brignell 2018	Systematic review	Children with ASD	Children aged between 32 months to 11 years	School	AAC - PECS vs treatment as usual	Spoken communication Non-verbal communication/AAC Combined spoken and non-verbal communication/AAC Social communication or pragmatic language	**Effectiveness data provided:** The review found that children in the PECS group were significantly more likely to use verbal communicative initiations and PECS symbols more frequently immediately post-intervention. However, this effect was not maintained for either of these two outcomes at the follow-up assessment 10 months later. This study did not find a significant effect of PECS for frequency of speech or for expressive and receptive vocabulary based on standardised tools. Effects of PECS in minimally verbal children with ASD found: • No significant effect on frequency of speech (OR 1.10, 95% CI 0.46 to 2.62, P = 0.83)

Author, Year	Study Type	Disability	Age Range	Setting	Intervention/ Comparators	Outcomes	Authors Conclusion
							• Children with non-verbal communication were 3.9 times more likely to be in a higher PECS-use category (frequency of use of PECS symbols – rate per minute) than children in classes where teachers had not received any active direct, in class training/consultancy with PECS consultants. • Children in the PECS group were 2.73 times (OR 2.73, 95% CI 1.22 to 6.08, P <0.05 (specific P value not reported in paper)) more likely to be in the higher initiation-rate category than the control group. • There was no significant main effect of the PECS intervention on reciprocal social interaction OR 0.55 (95% CI 0.25 to 1.19, P = 0.13)
Karlsson 2018	Systematic review	Cerebral Palsy (with significant physical disability and complex	1-15yrs or adults	Not specified	AAC – eye gaze technology	Communication across different social contexts: • learning to use, or regular use of, eye-gaze control technology	**Effectiveness data provided:** All children achieved one or more goals: 55% of goals were achieved by end of intervention and 60% by follow-up. Six of the seven (68%) goals related to interacting with others

Author, Year	Study Type	Disability	Age Range	Setting	Intervention/ Comparators	Outcomes	Authors Conclusion
		communication needs)				• making choices • interacting with others • Completing school tasks	were achieved, 10 of the 13 (77%) learning to use or regular use of eye-gaze control technology goals, and half of each of the other goal categories were achieved. Approximately 60% of the 37 goals established for implementation in schools and the 21 goals for home were achieved. There is little research to guide assessment for optimal configurations of hardware and software technology, training of users and their communication partners. Likewise, there is no research using direct measures of communication to evaluate outcomes of eye-gaze control technology for people with significant disability. Finally, there is minimal evidence for effectiveness of systems for increasing communication, leisure, creativity, productivity or quality of life across all the user’s environments. The existing research provides weak evidence supporting the positive impact of eye-gaze control technology for children with

Author, Year	Study Type	Disability	Age Range	Setting	Intervention/ Comparators	Outcomes	Authors Conclusion
							cerebral palsy and adults with late-stage amyotrophic lateral sclerosis (ALS).
Chavers 2022	Scoping review	Range of developmental disabilities (other than ASD)	School aged	Not specified	AAC -SGDs and Mobile technology	• Speech output • Acquisition/Production of syntactical structures • Literacy skills	No effectiveness data reported, however the authors concluded that there is evidence that the use of speech output technologies can be used to facilitate acquisition of word identification and simple syntactic structures in individuals with development disabilities. This review showed strong evidence that individuals with developmental disabilities can utilise speech output technologies to request preferred activities and items. The examination of preference as a dependent variable provides valuable insight into the functional relationship between learner preferences and acquisition effectiveness and use of an AAC technique. As such, it represents a critical aspect of self-determination for individuals using AAC.

Author, Year	Study Type	Disability	Age Range	Setting	Intervention/ Comparators	Outcomes	Authors Conclusion
Leonet 2022	Systematic review	Various disabilities and complex communication needs (CCN)	0-6yrs	School, home, clinic, early childhood day care centre.	AAC – varied aided and unaided, low-high tech or combined.	Child communication skills or behavior related to communication via any modality: • number of communicative attempts or turns taken • matching objects of reference (or pictures, photographs) to any AAC system • grammatical aspects of communicative attempts	**No effectiveness data provided.** This analysis revealed that children with different diagnoses show improvements in expressive and receptive communication, functional communication behaviours, communication participation skills, interaction strategies, and symbol and multi-symbol production and comprehension by using various AAC systems.
Langarika-Rocafort 2021	Systematic review	Mixed diagnoses (excluded were participants exclusively diagnosed with ASD or CP).	6-10yrs	School setting, home, day care facility, clinic.	AAC – any system	Communication skills.	**No effectiveness data provided.** Interventions analysed in this review improve communication skills, including phonological awareness, vocabulary, requesting, and developing narrative skills in children aged between 6 and 10 years with mixed diagnoses. The results of one study also indicate that the acquisition of skills using an AAC method is superior when the child prefers the method.
Dada 2021	Scoping review	Children with developmental disabilities and	Not specified	Not specified	AAC – aided and unaided	Receptive language including the comprehension of (a) vocabulary (words), (b) morphology (rule-bound organisation of language),	**No effectiveness data reported.** The authors concluded that the review noted positive

Author, Year	Study Type	Disability	Age Range	Setting	Intervention/ Comparators	Outcomes	Authors Conclusion
		little or no functional speech				(c) discourse (conversation), and (d) symbols (a graphic/form relates to a referent).	associations between aided and unaided AAC, vocabulary acquisition and symbol comprehension. AAC interventions may have merit for the development of receptive language skills in children with developmental disabilities. Specific gaps in relation to unaided AAC, aided augmented input strategies, morphological and syntax development, and discourse comprehension are highlighted.
Barbosa 2018	Systematic review	Children with Down's syndrome	Mixed age range (1-29 years)		AAC interventions – e.g., SGD, PECS, MAKATON, PCS, Core vocabulary, Picture based strategy, interactive digital board prototype, modified ride on car, input techniques, language signals system, COMPIC (Computer-generated pictographs)	Communication, socialisation, quality of life, self-esteem	**No effectiveness data reported.** The authors concluded that 12 instruments significantly aided in the communication and socialisation of children with DS, however no supporting data provided. **SGDs** - improved communication due to speech improvement, cognition, and socialising - improved communication due to speech improvement, cognition, and socialising. **PECs** - improvements in language skills and social communication were reported.

Author, Year	Study Type	Disability	Age Range	Setting	Intervention/ Comparators	Outcomes	Authors Conclusion
							increase interaction among individuals with DS and their peers with a consequent influence on their quality of life. **MAKATON** – Sign language system - Improvements in language development were noted. **PCS** (picture communication symbols) – Grouping symbols and maintaining their original colour increased the speed for target location (food, clothing, activities) in all the participants, including those with DS and those exhibiting typical development, and precision in children with DS. **Core vocabulary:** **Picture based strategy** – study demonstrates that children with DS can benefit from interventions that use images to facilitate the execution of requests **Interactive digital board prototype** **Modified ride on car** – single study improved communication and socialisation **Input techniques:**

Author, Year	Study Type	Disability	Age Range	Setting	Intervention/ Comparators	Outcomes	Authors Conclusion
							Language signals system Web based survey (joystick) – no effectiveness data recorded **COMPIC** – computer generated pictographs - Decision-making and communication development were improved, increase social interaction and language development, and improve their understanding and communication
Logan 2017	Systematic review	ASD	3-17yrs	School, home therapy centre	AAC - Aided SGDs, iPad/iPod, Touch1 configured as SGDs Low-tech aids (e.g., boards or books)	Varied communication functions: • Maintenance • Generalisation • Social validity of goals procedures and outcomes	**No effectiveness data provided.** The authors concluded that the findings of the review demonstrate emerging support for the effectiveness of aided AAC interventions in teaching children with ASD a variety of communication functions beyond requests for objects. Further research is required.
Schlosser 2015	Scoping review	ASD	0-18yrs Mean age 9 yrs 10 mths	Several listed	AAC - SGDs, mobile technology	Requesting: • Reduction of challenging behaviours • Natural speech production	**Effectiveness data not reported.** The authors concluded that "based on a robust body of high-quality studies, interventions with speech output technologies

Author, Year	Study Type	Disability	Age Range	Setting	Intervention/ Comparators	Outcomes	Authors Conclusion
						• Interaction • Labelling	seem to have been used to successfully teach individuals with autism how to request, a critical function for beginning communicators…There are a sufficiently robust number of studies showing that persons with autism can benefit from speech output technologies in intervention packages that address increasing requesting behaviors and challenging behaviors. For requesting in particular, there are not only numerous high-quality studies available, but they also have been conducted by different research teams, contributing another important factor in determining whether an intervention is evidence based. In terms of natural speech production, the evidence base is not clear."
Tanner 2015	Systematic review	ASD	2-57yrs	Several listed, not specified	PECs Others not relevant to AT and	Social communication Other outcomes included but not directly related: Play and leisure,	**Effectiveness data not reported.** The authors concluded that strong evidence was found that social skills

Author, Year	Study Type	Disability	Age Range	Setting	Intervention/ Comparators	Outcomes	Authors Conclusion
				(naturalistic, clinics etc.)	communication and language outcomes	Restricted and repetitive behaviours	groups, the Picture Exchange Communication System, joint attention interventions, and parent-mediated strategies can improve social participation. **Social communication**: PECS (Bondy & Frost, 1998) allows for functional communication through the exchange of pictures or icons. Two Level I systematic reviews of single-participant studies (Flippin, Reszka, & Watson, 2010; Ganz, Davis, Lund, Goodwyn, & Simpson, 2012) showed improvements in social communication and socialisation, with the best effects in younger children and children with comorbid intellectual disability. Three Level I studies noted improvements in rate of initiation of communication and use of PECS (d 5 0.81; Gordon et al., 2011; Howlin, Gordon, Pasco, Wade, & Charman, 2007; Yoder & Lieberman, 2010). However, 1 Level I study reported that effects were not maintained at

Author, Year	Study Type	Disability	Age Range	Setting	Intervention/ Comparators	Outcomes	Authors Conclusion
							10 mo (Howlin et al., 2007). One Level II study indicated that PECS was more effective than conventional language therapy in improving social behaviors, cooperative play, joint attention, requests, and initiations (Lerna, Esposito, Conson, Russo, & Massagli, 2012). The overall strength of evidence for PECS was strong, although it is important to note that the 2 Level I systematic reviews (Flippin et al., 2010; Ganz et al., 2012) included studies with low-level designs.
Baxter 2012	State of the Art Review (Scoping review)	Acquired non-progressive and progressive neurological disorders, autism/ autistic spectrum disorder, and other developmental disorders	Age range not specified.	Everyday settings	High technology communication devices: VOCA/SGDs, voice output computer software, speech recognition technology and brain-computer interfaces	Initiation/response attempts, linguistic analysis, intelligibility of communicative attempts, language test scores, comprehension, behaviour, client satisfaction	**No effectiveness data reported.** The authors suggest that high tech devices may be beneficial to enhance communication across a broad range of diagnoses and age ranges, however there is a lack of high-quality evidence of effect. They concluded that the high level of individual variation in outcome requires a greater understanding of characteristics

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							of clients who may or may not benefit from high tech devices.
Maglione 2012	Guideline	ASD with no or limited language	Children	Not specified	PECS	Communication / Social skills	**PECS:** One previous systematic review reported on 2 randomised controlled trials, non-randomised 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.

Table 7: Summary of mobility reviews

Author, Year	Study Type	Disability	Age Range	Setting	Intervention/ Comparators	Outcomes	Authors Conclusion
Betancourt 2019	Systematic review and meta-analyses	cerebral palsy	0-18yrs	Not stated	Ankle-foot orthoses (rigid or articulated AFOs) vs barefoot or shows only	Functional gait outcomes: • Stride length (meters) • Dorsiflexion angle (degrees)	**Effectiveness data provided:** Children with cerebral palsy using ankle-foot orthoses had improved stride length (mean differences between groups = 0.05m 95% CI - 0.04-0.06) and dorsiflexion angle (mean differences between groups = 8.62 degrees 95% CI 8.05-9.20) when using AFOs compared to barefoot or shoes in a pooled meta-analyses of cohort studies and clinical trials.
Lintanf 2018	Systematic review with meta-analysis	Children with cerebral palsy	0-18yrs	Not specified	Ankle-foot orthoses (AFOs).	Gait, balance, gross motor function and activities of daily living	**Effectiveness data provided:** The review found that for children with spastic cerebral palsy, there is strong evidence that AFOs induce small improvements in gait speed (SMD 0.28 CI 0.14, 0.41 p<0.001) and moderate evidence that AFOs have a small to moderate effect on gross motor function. In children with equinus gait, there is strong evidence that posterior AFOs induce large changes in distal kinematics. Fifty-one studies included children with spastic cerebral palsy. AFOs increased stride length (SMD=0.88, P<0.001) and gait speed (SMD=0.28, P<0.001), and decreased cadence (SMD=–0.72, P<0.001). Gross motor function scores improved (Gross Motor Function Measure (GMFM) D (SMD=0.30,

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							P=0.004), E (SMD=0.28, P=0.02), Pediatric Evaluation of Disability Inventory (PEDI) (SMD=0.57, P<0.001)). Data relating to balance and activities of daily living were insufficient to conclude. Posterior AFOs (solid, hinged, supra-malleolar, dynamic) increased ankle dorsiflexion at initial contact (SMD=1.65, P<0.001) and during swing (SMD=1.34, P<0.001), and decreased ankle power generation in stance (SMD=–0.72, P<0.001) in children with equinus gait.
Fellas 2017	systematic review with meta-analysis	Juvenile idiopathic arthritis (JIA)	0-16 yrs	Any settings (public and community health services, private clinics, preschool and schools)	Lower–limb foot orthoses vs control	Primary outcome – pain. Secondary outcomes – disability, functional ability, health related quality of life.	**Effectiveness data provided:** At 3-month follow-up, no significant differences between customised/custom foot orthosis and a control intervention were found. A number of between group differences were found and although they were not statistically significant but may be clinically important.
Poole 2018	Systematic review	Cerebral palsy	Children aged 2-18 years	All/any settings	Anterior or posterior walkers	Outcomes measured in two or more included studies (velocity, pelvic tilt, hip flexion, knee flexion, step length, stride length, cadence, double stance time,	**No effectiveness data reported.** All studies used cross-over designs. Overall, findings suggest that using a posterior walker instead of an anterior walker may improve some outcomes. The authors noted that most participants and parents preferred the posterior walker.

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						oxygen cost and participant/parental preference.	
Brosseau 2016	Guideline	Juvenile Idiopathic Arthritis	0-18 years	Not stated	• Fitted or custom-made foot orthoses • Multidisciplinary foot care	Pain reduction Gait time Gait velocity Timed walking QoL - Physical functioning	**Effectiveness data provided:** The use of customized foot orthotics and prefabricated shoe inserts seems to be a good choice for managing foot pain and function in JIA. **Custom vs control foot orthoses:** At 3 months (end of intervention), the Ottawa Panel found no clinical benefit (grade C) supporting fitted foot orthoses for pain reduction (100-mm VAS) (fig 1), quality of life and gait velocity (cm/s). Neutral evidence (with no clinical benefit) favouring the control (grade D) was demonstrated for gait time (s) At 6 months (end of intervention), the Ottawa Panel found clinically important benefits without statistical significance (grade Cþ) for fitted foot orthoses in pain reduction (100-mm VAS; box 1). No clinical benefit (grade C) was observed for quality of life, gait time (s), and gait velocity (cm/s). **Recommendation:** The Ottawa Panel suggests the use of custom fitted preformed foot orthotics (versus 1-mm non-customized leather board control) for

Author, Year	Study Type	Disability	Age Range	Setting	Intervention/ Comparators	Outcomes	Authors Conclusion
							at least 6 months to decrease pain (100-mm VAS) after ≥24 weeks. **Custom-made semi-rigid orthotics Vs prefabricated off the shelf shoe inserts** At 3 months (end of intervention), the Ottawa Panel suggests the use of custom-made semi-rigid orthotics that showed clinically important benefits without statistical significance (grade C+) for pain intensity (Pediatric Pain Questionnaire VAS), activity limitation (FFI), foot pain (FFI), and disability. No clinical benefit (grade C) and thus no clinically important benefit was observed for timed walking (s), physical functioning-PedsQL 4.0 Generic Core Scales, child self-report, and physical functioning PedsQL 4.0 Generic Core Scales, parent proxy report. **Recommendation:** The Ottawa Panel suggests the use of custom made semi-rigid orthotics (versus prefabricated off-the-shelf shoe inserts) for at least 3 months to decrease pain (intensity; Pediatric Pain Questionnaire VAS), activity limitation (FFI), foot pain (FFI), and disability (FFI) after ≥12 weeks. **Custom-made semi-rigid orthotics versus new supportive athletic shoes** At 3 months (end of intervention), the Ottawa Panel found stronger evidence for

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							the use of custom-made semi-rigid orthotics that exhibited clinically important benefits with statistical significance (grade A) for pain intensity (Pediatric Pain Questionnaire VAS), activity limitation (FFI), foot pain (FFI), and disability (FFI). No clinical benefit (grade C) was observed for timed walking (s), physical functioning (PedsQL 4.0 Generic Core Scales, child self-report), and physical functioning (PedsQL 4.0 Generic Core Scales, parent proxy-report). **Recommendation:** The Ottawa Panel suggests the use of custom made semi-rigid orthotics (versus new supportive athletic shoes) for at least 3 months to decrease pain (intensity; Pediatric Pain Questionnaire VAS), activity limitation (FFI), foot pain (FFI), and disability (FFI) after ≥12 weeks. **Prefabricated off the shelf shoe inserts versus new supportive athletic shoes** At 3 months (end of intervention), the Ottawa Panel suggests the use of prefabricated off-the-shelf shoe inserts that showed clinically important benefits without statistical significance (grade C+) for pain intensity. No clinical benefit (grade C) was found for timed walking (s) (fig 5), activity limitation (FFI), foot pain (FFI), disability

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							(FFI), physical functioning (PedsQL 4.0 Generic Core Scales, child self-report), and physical functioning (PedsQL 4.0 Generic Core Scales, parent proxy-report). **Recommendation:** The Ottawa Panel suggests the use of pre-fabricated off-the-shelf shoe inserts (versus new supportive athletic shoes) for at least 3 months to reduce pain (intensity; Pediatric Pain Questionnaire VAS) after ≥12 weeks.
Cheung 2020	Systemic review	Not specified	0-6yrs	Hospital, Home, School, Laboratory or Mixed settings	Powered mobility devices (including power wheelchairs and robotic devices)	Social skills outcomes (social functioning, social persistence, social participation, facial expressions, direct peer or adult interaction, initiation of contact with others)	**No effectiveness data reported.** This review showed variable results on the impact of powered mobility devices (PMDs) on the social skills of children with disabilities**.** Six (out of the 12 reviewed) studies reported a significant impact of the PMD interventions on social skills. All 12 studies were of low quality.
Ivanyi 2015	Systematic review	Ambulant children with spina bifida	0-18yrs	Not specified	Walking aids (lower limb orthosis, orthopedic footwear or walking aids)	Gait parameters, walking capacity and walking performance. These were linked to the ICF framework.	**No effectiveness data reported.** Four studies compared ankle-foot orthosis (AFOs) to walking barefoot (cross-over studies). Findings suggested that use of AFOs resulted in positive effect on kinematic and kinetic properties of gait, stride length, walking velocity and oxygen cost of walking. There was more limited research on forearm crutches. Both studies reported positive effects

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							(pelvic and hip kinematics, walking velocity and oxygen cost). Due to nature of included studies limited effectiveness data was reported.
Bray 2020	Health technology assessment	Children with mobility limitations	0-5yrs	Varied	Various powered mobility interventions (powered wheelchair, Ride-on device or toy car, switches)	A key objective of the review was to identify outcomes. Movement and mobility. Additional outcomes included participation, play, social interactions, safety (accidents and pain)	**No effectiveness data available.** No conclusive evidence was found about the effectiveness or cost-effectiveness of powered mobility in children aged either under 5 or over 5 years. The authors note that mixed methods synthesis of all evidence and an assessment of certainty of evidence found strong support that powered mobility interventions have a positive impact on children's movement and mobility, and moderate support for a positive impact on children's participation, play and social interactions, and on the safety outcome of accidents and pain. 'Fit' between the child, the equipment and the environment were found to be important, as were the outcomes related to a child's independence, freedom and self-expression.
Firouzeh 2021	Scoping review	Cerebral palsy	0-6 yrs	Several, including controlled clinical settings, community settings,	Ankle foot orthoses (AFO)	ICF outcomes	**No effectiveness data reported.** Evaluations of effects of AFOs on gross motor skills other than gait were limited. Limited synthesis of findings. Positive effects on independent standing, standing balance and postural control mechanisms were reported.

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				childcare centers, preschool settings.			
Hill 2020	Scoping review	Children under 18 with some form of mobility impairment	0-18 yrs	Not specified	Therapeutic footwear (corrective and functional)	Primary outcome: Biomechanical or skeletal geometry. Secondary outcomes: pain whilst using device, reluctance to use device.	**No effectiveness data reported.** Only a limited number of studies have explored the effects of therapeutic footwear and only in a narrow range of mobility impairments (children with pes planus and cerebral palsy). The review provides descriptive results for the following footwear interventions: Corrective, Functional, Stability, Instability and Lift There is relatively limited research concerning any grouping of therapeutic footwear. Level of evidence ranged from II to IV, but no study exceeded a quality assessment of fair, due to methodology that affected both internal and external validity. This entails a conservative recommendation from the current evidence base concerning clinical usage of therapeutic footwear. There appears to be evidence that corrective footwear is not recommended as an intervention for developmental pes planus since there is no apparent favourable outcome compared to standard footwear in infants and young children. With an unnecessary prescription of corrective footwear

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							leading to potential over-medicalisation of typical development and psychosocial detriment in early adult life. Functional footwear appears to be able to play a role in assisting children with mobility impairment across a broader age range than corrective footwear; however, these studies invariably suffer from a small sample size potentially being underpowered to detect any statistically significant effect. Limited fair quality level II evidence is available that corrective footwear has no statistically significant effect on apparent typical developmental pes planus. Conversely, there is limited fair quality level II evidence that it can offer a corrective effect in mild to moderate cases of CTEV in infancy. Functional therapeutic footwear offers limited fair quality level III evidence on apparent improvement to gait parameters in pre-school and primary school-aged children with pes planus, Down’s syndrome or CP. Included studies explored body structure and functional aspects of the WHO ICF-CY (biomechanical and skeletal geometry outcomes). However, psychosocial aspects of the ICF-CY concerning the quality of life appears largely absent in the research.

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Livingstone 2014a	Systematic review	Children with mobility impairments	Children aged 18 and under	Not specified	Powered mobility	ICF components: body structure and function, activity, participation).	**No effectiveness data reported.** The body of evidence supporting outcomes for children using power mobility is primarily descriptive rather than experimental, so effectiveness data is limited. Authors note that powered mobility device use may have positive effects on overall development, independent mobility and self-initiated movement. The authors noted that powered mobility devices may support a range of ICF outcomes and that environmental factors may influence successful power mobility use and skill development.
Montero 2014	Systematic review	Children with motor disabilities	Children aged 18 and under	Not specified	Technical devices these including ankle foot orthoses, mobility-related support, supports related to the sitting position, orthotic garments, supports related to therapeutic taping, wrist to thumb brace.	Studies reported kinematic and kinetic parameters of gait, gross motor skills, lower limb articulations and body posture range of movement.	**No effectiveness data reported.** The authors suggest that in most cases studies of orthoses, standing frames, adaptive seating devices, orthotic garment and postural treatment suggested a favourable outcome. Studies assessing mobility showed variable effects. They also noted that most of the studies included that the use of technical devices improves the independence of children. Due to nature of studies, synthesis of findings not provided.
Paleg 2015	systematic review	Children with mobility impairments who are unable	Children aged 2-18 years	Not specified	Gait trainers (walkers providing trunk and pelvic support)	ICF components.	**No effectiveness data reported.** Effectiveness is primarily descriptive. Authors note that while the impact is

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		to walk independently					reported to be positive no strong conclusions can be drawn.
Weber 2014	Systematic review	Children with down syndrome or hypotonia	Children aged 1.5 to 10 years old	Not stated	Orthoses (with or without physical therapy)	ICF components.	**No effectiveness data reported. Descriptive data.** The authors suggest that foot orthoses and supramalleolar orthoses may benefit children with hypotonia.
Jackman 2022	Guideline	Cerebral Palsy	2-18 years	Not specified	Range of interventions to improve physical function	Mobility Walking speed and endurance Gross motor function Hand use Self-care Leisure	**Recommendation 10**: • **Mobility**: to improve mobility in children and young people with CP (GMFCS I–IV, all motor subtypes) we recommend mobility training using a goal-directed approach, with a focus of practice within a real-life context, compared with no intervention. • **Walking speed and endurance**: to improve walking speed and endurance in children and young people with CP, we suggest overground training (with or without a walker) (GMFCS I–IV), treadmill training (GMFCS I–III), and HABIT-ILE (GMFCS I–IV), compared with no intervention OR body functions and structure intervention. • **Gross motor function**: to improve functional mobility goals and balance in children and young people with CP, we suggest goal-directed training (GMFCS I–III) and HABIT-ILE

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							(GMFCS I– IV), compared with no intervention OR body functions and structure intervention To improve gross motor function in children and young people with CP (GMFCS I–IV), we suggest either altering environmental factors (e.g. 'context focused') OR child-focused therapy (i.e. treatments that alter child-related factors) We suggest clinicians consider the child's age, ability, and child/family preferences and tolerance of adjunctive interventions when selecting interventions **Recommendation 11:** • Hand use to improve goal achievement in hand use in children and young people with CP (MACS I–IV, all motor subtypes), we recommend a goal-directed or task-specific approach, compared with no intervention OR body functions and structure intervention. • To achieve functional upper-limb goals in children and young people with unilateral CP, we recommend CIMT, bimanual therapy/HABIT (MACS I–III), and we suggest CO-OP and HABIT-ILE (MACS I–IV) compared with no intervention OR body functions and structure intervention.

Author, Year	Study Type	Disability	Age Range	Setting	Intervention/ Comparators	Outcomes	Authors Conclusion
							• To achieve functional hand use goals in children and young people with bilateral CP, we suggest HABIT/HABIT-ILE (MACS I–III) and CO-OP (MACS I–IV) compared with no intervention OR body functions and structure intervention. • To improve hand use in children and young people with CP classified in MACS level IV (unilateral or bilateral), we suggest a goal-directed focus plus environmental adaptations and equipment/assistive technology to maximise independence, compared with no intervention OR no equipment/assistive technology OR body functions and structure intervention. We suggest clinicians consider the child's age, ability, context/resources, and child/family preferences and tolerance of adjunctive interventions when selecting interventions. **Recommendation 12:** • Self-care to improve self-care goal achievement in children and young people with CP (all motor types and severities), we recommend a goal-directed and task-specific approach (for skills development) plus adaptive equipment (for safe, timely

Author, Year	Study Type	Disability	Age Range	Setting	Intervention/ Comparators	Outcomes	Authors Conclusion
							independence), compared with no intervention. • To improve self-care skills in children and young people with CP (GMFCS I–IV, all motor types), we recommend goal-directed training, CO-OP, and HABIT, compared with no intervention or body functions and structure intervention, and we suggest HABIT-ILE (GMFCS I–IV, all motor types) • To improve independence, safety, and decrease caregiver burden during self-care tasks for children and young people with CP (GMFCS IV and V, all motor types), we suggest adaptive equipment. **Recommendation 13: Leisure**: • To improve performance of a leisure activity in children and young people with CP, we suggest clinicians combine goal-directed approaches (CO-OP, goal-direct training, HABIT-ILE for GMFCS I–IV; and goal-directed training for GMFCS V) with a focus on supporting the individual to overcome environmental, personal, and social factors that may limit participation, compared with no intervention or body functions and structure intervention.