National Institute for Health and Care Excellence

Final

Cerebral palsy in adults

[D4] Interventions that improve function and participation: communication

NICE guideline NG119

Evidence reviews

January 2019

Final

These evidence reviews were developed by the National Guideline Alliance hosted by the Royal College of Obstetricians and Gynaecologists

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Interventions that improve function and participation for adults over 25 with cerebral palsy

Review question

D4 Which interventions (for example augmentative and alternative communication systems) are effective in promoting communication for adults with cerebral palsy who have communication difficulties?

Introduction

Adults with cerebral palsy can have communication difficulties due to their underlying motor disorder, learning difficulties and problems with medication and equipment. In current practice speech and language therapy assessment is used to identify interventions including alternative augmentative communication systems that can be used to assist communication. The effectiveness of these interventions is analysed in this review question.

PICO table

Please see Table 1 for a summary of the Population, Intervention, Comparison and Outcome (PICO) characteristics of this review.

Table 1: Summary of the protocol (PICO table)

Population	Adults aged 25 and over with cerebral palsy and communication difficulties

Intervention	• Interventions to improve receptive communication
	  ○ Optimise hearing
	• Interventions to improve expressive communication
	  ○ speech and language therapy
	  ○ assisted augmentative therapy
	• Training for communication partners

Comparison	• Each other • No intervention
Outcome	**Critical** • Participation • Function (expressive and receptive communication) • Independence (communication in different situations) **Important** • Health related quality of life • Patient satisfaction

For full details see the review protocol in appendix A.

Methods and process

This evidence review was developed using the methods and process described in Developing NICE guideline: the manual 2014. Methods specific to this review question are described in the review protocol in appendix A and for a full description of the methods see supplementary document C.

Declaration of interests were recorded according to NICE's 2014 conflicts of interest policy from May 2016 until April 2018. From April 2018 onwards they were recorded according to NICE's 2018 conflicts of interest policy. Those interests declared until April 2018 were reclassified according to NICE's 2018 conflicts of interest policy (see Interests Register).

Clinical evidence

Included studies

Three studies (number of participants, N=28) were included in the review (Hustad 2003, Hustad 2004 and Pennington 2010).

One before-and-after study (Pennington 2010; N=16) evaluated an intensive speech and language therapy intervention. Two cross-sectional studies (Hustad 2003 and Hustad 2004; N=12) compared speech augmented with alphabet or topic cues with habitual speech. No evidence was found for interventions to improve receptive communication or for training of communication partners.

The clinical studies included in this evidence review are summarised in Table 2 and evidence from these is summarised in the clinical evidence profiles below (Table 3 and Table 4).

See also the literature search strategy in appendix B, study selection flow chart in appendix C, forest plots in appendix E and study evidence tables in appendix D.

Excluded studies

Studies excluded from this systematic review, with reasons for their exclusion, are provided in appendix K.

Summary of clinical studies included in the evidence review

Table 2 provides a brief summary of the included studies

Table 2: Summary of included studies

Study	Design	Participants	Comparison(s)	Outcomes
Pennington 2010	Before-and-after study	Older children with cerebral palsy (N=16; mean age 14 years) with moderate to severe dysarthria. United Kingdom	Before versus after intensive speech and language intervention.	Function (intelligibility)
Hustad 2003	Cross-sectional study	Adults with cerebral palsy (N=4) or TBI (N=1) and severe or profound dysarthria.[1] United States of America	Supplemented speech (using topic and alphabet cues) versus habitual (non-cued) speech	Function (intelligibility)
Hustad 2004	Cross-sectional study	Adults with cerebral palsy (N=7) and severe or profound dysarthria. United States of America	Supplemented speech (using topic and alphabet cues) versus habitual (non-cued) speech	Patient satisfaction

N: number of participants in study; TBI, traumatic brain injury.
1. No subgroup analysis reported for those with cerebral palsy.

See appendix D for the full evidence tables.

Quality assessment of clinical studies included in the evidence review

The clinical evidence profiles for this review question are presented in Table 3 and Table 4.

Table 3: Summary clinical evidence profile: comparison 1: before versus after intensive speech and language therapy

Outcomes	Illustrative comparative risks (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)
	Assumed risk before intensive speech and language therapy (SLT)	Corresponding risk after intensive speech and language therapy			
Participation - not reported	-	-	-	-	-
Function: Intelligibility of single words (%) - Familiar listeners Scale from: 0 to 100. Function: Follow-up: mean 6 weeks	The mean intelligibility of single words (%) to familiar listeners before SLT was 42.1 %	The mean intelligibility of single words (%) to familiar listeners after SLT was 14.9 higher (0.21 to 29.59 higher)	-	16 (1 study)	Very low[1,2]
Intelligibility of single words (%) - Unfamiliar listeners Scale from: 0 to 100. Follow-up: mean 6 weeks	The mean intelligibility of single words (%) to unfamiliar listeners before SLT was 34 %	The mean intelligibility of single words (%) to unfamiliar listeners after SLT was 18.4 higher (4.25 to 32.55 higher)	-	16 (1 study)	Very low[1,2]
Function: Intelligibility of connected speech (%) - Familiar listeners Scale from: 0 to 100. Follow-up: mean 6 weeks	The mean intelligibility of connected speech (%) to familiar listeners before SLT was 48 %	The mean intelligibility of connected speech (%) to familiar listeners after SLT was 13 higher (8.45 lower to 34.45 higher)	-	16 (1 study)	Very low[1,2]
Function: Intelligibility of connected speech (%) - Unfamiliar listeners Scale from: 0 to 100. Follow-up: mean 6 weeks	The mean intelligibility of connected speech (%) to unfamiliar listeners before SLT was s 25.9 %	The mean intelligibility of connected speech (%) to unfamiliar listeners after SLT was 14.8 higher (5.23 lower to 34.83 higher)	-	16 (1 study)	Very low[1,2]
Independence - not reported	-	-	-	-	-
Health related quality of life - not reported	-	-	-	-	-
Satisfaction - not reported	-	-	-	-	-

CI: confidence interval; MID: minimally important difference; SLT: speech and language therapy.
1 95% CI of the effect estimate includes one MID threshold
2 Downgraded for indirectness – the participants were older children with mean age 14 years.

Table 4: Summary clinical evidence profile: comparison 2: supplemented versus habitual speech

Outcomes	Illustrative comparative risks (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)
	Assumed risk with habitual speech	Corresponding risk Supplemented versus habitual speech			
Participation - not reported	-	-	-	-	-
Function: Intelligibility (% of words understood) - Topic cues Scale from: 0 to 100.	The mean intelligibility with habitual speech was 39.79 %	The mean intelligibility with topic cues was 2.55 higher (22.48 lower to 27.58 higher)	-	5 (1 study)	Very low[1]
Function: Intelligibility (% of words understood) - Alphabet cues Scale from: 0 to 100.	The mean intelligibility with habitual speech was 39.79 %	The mean intelligibility with alphabet cues was 32.11 higher (7.7 to 56.52 higher)	-	5 (1 study)	Very low[2]
Function: Intelligibility (% of words understood) -	The mean intelligibility with habitual speech was 39.79 %	The mean intelligibility with combined cues was 36.4 higher (13.17 to 59.63 higher)	-	5 (1 study)	Very low[2]

Outcomes	Illustrative comparative risks (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)
	Assumed risk with habitual speech	Corresponding risk Supplemented versus habitual speech			
Combined cues Scale from: 0 to 100.					
Independence - not reported	-	-	-	-	-
Health related quality of life - not reported	-	-	-	-	-
Satisfaction: Listener's attitude - Topic cues Scale from: 1 to 7.	The mean listener's attitude to habitual speech was 2.39	The mean listener's attitude to speech using topic cues 0.42 higher (1.28 lower to 2.12 higher)	-	7 (1 study)	Very low[1]
Satisfaction: Listener's attitude - Alphabet cues Scale from: 1 to 7.	The mean listener's attitude to habitual speech was 2.39	The mean listener's attitude to speech using alphabet cues 1.71 higher (0.08 lower to 3.5 higher)	-	7 (1 study)	Very low[2]
Satisfaction: Listener's attitude - Combined cues Scale from: 1 to 7.	The mean listener's attitude to habitual speech was 2.39	The mean listener's attitude to speech using combined cues was 2.35 higher (0.6 to 4.1 higher)	-	7 (1 study)	Very low[2]

CI: confidence interval; MID: minimally important difference.
1 95% confidence interval of effect estimate includes both MID thresholds
2 95% confidence interval of the effect estimate includes one MID value

See appendix F for the full GRADE tables.

Economic evidence

Included studies

A systematic review of the economic literature was conducted, but no studies were identified which were applicable to this review question.

Excluded studies

No studies were identified which were applicable to this review question.

Summary of studies included in the economic evidence review

No economic evaluations were included for this review.

Economic model

This question was not prioritised for economic modelling as the committee considered that any intervention would be highly personalised to the person receiving it. Given this it would be difficult to consider alternate interventions in the form of an economic model.

Resource impact

No unit costs were presented to the committee as these were not prioritised for decision making purposes.

Evidence statements

Comparison 1: before versus after intensive speech and language therapy

Critical outcomes

Participation

- No evidence was found for this outcome.

Function (expressive and receptive communication)

- Very low quality evidence from 1 before-and-after study including 16 older children (mean age 14 years) with cerebral palsy and moderate to severe dysarthria indicated that an intensive speech and language therapy improved intelligibility (as measured by the familiar listeners scale) by a clinically significant amount.

Independence (communication in different situations)

- No evidence was found for this outcome.

Important outcomes

Health related quality of life

- No evidence was found for this outcome.

Patient satisfaction

- No evidence was found for this outcome.

Comparison 2: supplemented versus habitual speech

Critical outcomes

Participation

- No evidence was found for this outcome.

Function (expressive and receptive communication)

- Very low quality evidence from 1 cross-sectional study including 4 adults with cerebral palsy and 1 with traumatic brain injury and dysarthria indicated supplemented speech (using alphabet cues or combined alphabet and topic cues) improved intelligibility by a clinically significant amount compared to habitual speech.

Independence (communication in different situations)

- No evidence was found for this outcome

Important outcomes

Health related quality of life

- No evidence was found for this outcome

Patient satisfaction

- Very low quality evidence from 1 cross-sectional study including 7 adults with cerebral palsy and dysarthria indicated that listeners had more a positive attitude towards

communication using supplemented speech (using alphabet cues or combined alphabet and topic cues) than to habitual speech.

The committee's discussion of the evidence

Interpreting the evidence

The outcomes that matter most

Participation, function and independence were critical outcomes because effective communication is central to these. The committee thought that lack of ability to communicate would have a significant effect on health related quality of life and satisfaction, these outcomes were considered important.

The quality of the evidence

Evidence was available for function as measured by the intelligibility of communication. The quality of this evidence was very low using GRADE. Evidence was downgraded for non-randomised design and also for applicability – one of the studies included older children and was downgraded for indirectness. There was a lack of evidence about interventions to improve receptive communication (such as optimising hearing) and training of communication partners of people with cerebral palsy. No evidence was found for the outcomes participation, independence or health related quality of life.

Benefits and harms

The committee recognised the changing nature of communication needs in adults with cerebral palsy. People with cerebral palsy and communication difficulties could experience new onset communication difficulties as a result of neurological deterioration. To mitigate this risk, the committee therefore recommended awareness of the possibility of changing communication needs, and that people with cerebral palsy and their families and carers should be asked at each clinical review about any changes in hearing, speech or communication.

To identify communication needs and the support that the adult with cerebral palsy may require the committee decided, based on their experience and good practice,that people should be asked at every review whether they have experienced any changes that could impact on their communication. This would facilitate early recognition of problems and prevent them from becoming an obstacle to, for example, participation and access to services.

Even though no specific evidence was identified for the use of any particular alternative and augmentative communication systems, the committee agreed that communication is a basic human need and that the use of such systems should be considered if problems with communication are highlighted. The committee considered that this recommendation would help meet communication needs, support independence and improve quality of life and the quality of social relationships. Based on their knowledge the committee noted that there is variation in the availability of training in alternative and augmentative communication techniques. To be an effective means of communication the committee agreed that family, carers and people in regular contact with the adult with cerebral palsy need to receive training on how to use such techniques. The evidence suggested moderate benefits of interventions to improve intelligibility and the committee agreed there are effective speech therapy interventions (including augmentative and alternative communication systems), but the optimal choice would depend on the physical, cognitive, language and sensory needs of the individual. For this reason, they recommended referral to speech therapy services for

those with new difficulties with verbal communication for a detailed assessment of each individual's needs.

The committee discussed that people with cerebral palsy and communication difficulties could experience problems in making themselves understood in unfamiliar social situations or when their regular communication partners change – for example when moving out of the family home. They recommended key communication partners should be trained whenever alternative and augmentative communication techniques were required for adults with cerebral palsy, in addition to asking about changes in hearing, speech or communication at each clinical review.

The committee discussed one potential harm is the portability of some augmentative and alternative communication devices which might put-off some potential users. They also discussed that the use of language even if hard to understand is a social interaction that people prefer rather than using technology which to some seems to be one step removed from this. For this, and other reasons the committee highlighted than some people with poor intelligibility may still prefer to rely on their natural speech.

The committee discussed that there was a need for more research in this area. The committee noted that current practice is to offer Alternative and Augmentative Communication (AAC) over intensive speech and language therapy. However, limited evidence has been found to support this treatment. There was very low grade evidence of the use of supplemented speech (augmentative communication) with a combination of alphabet and topic cues to improve the intelligibility of dysarthric speech and also low grade evidence to support the use of intensive speech and language therapy to improve the intelligibility of dysarthric speech. However, this was in children (the mean age for this cohort was 14 years) which is below the age this guideline is concerned with. No evidence was found to support the use of alternative communication with adults with cerebral palsy, therefore further research is necessary to find whether there is support for the use of alternative or augmentative communication aids within this client group.

Cost effectiveness and resource use

The committee noted that no relevant published economic evaluations had been identified for this topic.

The committee referred to the NHS England guidance for commissioning augmentative and alternative communication services and equipment that outlines the role of local and specialised augmentative and alternative communication service and the criteria for referral to these services. However, it was noted that such service specifications by NHS England are not evidence based and did not consider resource impact or cost effectiveness of implementation in areas where it currently is not. The committee made recommendations based on the evidence and their clinical expertise and considered that the extent of change in practice will vary according to current practice.

The committee recognised that speech intelligibility declines with age and if communication difficulties are not identified and managed appropriately, they can negatively affect participation and function. Knowing that speech and communication needs may change with time and social circumstance may lead to better identification and thus more timely management. Therefore, to reduce the high risk of missing emerging problems, the committee agreed healthcare professionals should ask the person with cerebral palsy and their families and carers about any changes in hearing, speech and communication at each review. Asking such questions would not incur any additional training costs according to the committee as healthcare professionals would likely refer adults who have difficulties with verbal communication to a speech. This would likely increase the number of appointments with speech therapists According to NHS Reference Costs 2015/16, the cost per consultant-

led attendance with a speech and language therapist is £87 (Currency Code, WF01B; Non-Admitted Face to Face Attendance; First Attendance; Service Code, 652).

The committee were unable to recommend any specific intervention because this would be individualised to the person's needs, taking into account their skills, aspirations and cognitive ability. However, the committee noted that low-tech and low-cost options would be considered by the local augmentative and alternative communication services, before more costly interventions such as powered communication aids.

Other factors the committee took into account

Under the Mental Capacity Act 2005, individuals should be given adequate opportunity to participate in any decisions about their care. Lack of effective means of communication could lead a person to be deemed to be incapable of making decisions for themselves. Even though there was a lack of evidence for alternative or augmentative communication systems the committee acknowledged that Article 21 in the UN Convention on disability rights relates to freedom of expression and opinion, and access to information. Article 21 states that it should be ensured that people with disabilities can have freedom of expression for example by: '*Accepting and facilitating the use of sign languages, Braille, augmentative and alternative communication, and all other accessible means, modes and formats of communication of their choice by persons with disabilities in official interactions'*.

References

Pennington 2010

Pennington,L., Miller,N., Robson,S., Steen,N., Intensive speech and language therapy for older children with cerebral palsy: a systems approach, Developmental Medicine and Child Neurology, 52, 337-344, 2010

Hustad 2003

Hustad,K.C., Jones,T., Dailey,S., Implementing speech supplementation strategies: effects on intelligibility and speech rate of individuals with chronic severe dysarthria, Journal of Speech Language and Hearing Research, 46, 462-474, 2003

Hustad 2004

Hustad,K.C., Gearhart,K.J., Listener attitudes toward individuals with cerebral palsy who use speech supplementation strategies, American Journal of Speech-Language Pathology, 13, 168-181, 2004

Appendices

Appendix A – Review protocols

Review protocol for review question D4: Which interventions (for example augmentative and alternative communication systems) are effective in promoting communication for adults with cerebral palsy who have communication difficulties?

Table 5: Review protocol for interventions to improve communication

Field (based on PRISMA-P)	Content
Review question	Which interventions (for example augmentative and alternative communication systems) are effective in promoting communication for adults with cerebral palsy who have communication difficulties?
Type of review question	Intervention
Objective of the review	The aim of this review is to determine the relative effectiveness of interventions to improve or promote communication in adults with cerebral palsy and communication difficulties.
Eligibility criteria – population/disease/condition/issue/domain	Adults aged 25 and over with cerebral palsy and communication difficulties.

Eligibility criteria – intervention(s)/exposure(s)/prognostic factor(s)	• Interventions to improve receptive communication
	  ○ Optimise hearing
	• Interventions to improve expressive communication
	  ○ speech and language therapy
	  ○ assisted augmentative therapy
	• Training for communication partners

Eligibility criteria – comparator(s)/control or reference (gold) standard	• Each other • No intervention
Outcomes and prioritisation	**Critical outcomes** • Participation • Function (expressive and receptive communication) • Independence (communication in different situations) **Important outcomes** • Health related quality of life • Patient satisfaction

Field (based on PRISMA-P)	Content
	Minimally important differences • Goal Attainment Scale: 7 units • ICF - Measure of Participation and Activities Screener: 2 units • Canadian Occupational Performance Measure: 2 units • Australian Therapy Outcome Measures for Occupational Therapy: 0.5 units • Assessment of Life Habits: use minimal detectable change for each subdomain reported on rehabmeasures.org • Other dichotomous outcomes will use default MIDs [RR thresholds of 0.80 and 1.2] • Other continuous outcomes will use default MIDs [0.5 times the SD of the control group]
Eligibility criteria – study design	• Systematic reviews of RCTs • RCTs • Comparative cohort studies (only if RCTs unavailable or limited data to inform decision making) • Cross sectional studies
Other inclusion exclusion criteria	Only published full text papers.
Proposed sensitivity/sub-group analysis, or meta-regression	Groups that will be reviewed and analysed separately: • Ambulant vs. non-ambulant • Verbal vs. nonverbal • Learning difficulties In the presence of heterogeneity, the following subgroups will be considered for sensitivity analysis: • Population subgroups (e.g. age groups, presentation, severity): Important confounders (when cohort studies are included): • Ambulant vs non ambulant, verbal vs. nonverbal, learning difficulties
Selection process – duplicate screening/selection/analysis	A random sample of the references identified in the search will be sifted by a second reviewer. This sample size will be 10% of the total, or 100 studies if the search identifies fewer than 1000 studies. All disagreements in study inclusion will be discussed and resolved between the two reviewers. The senior systematic reviewer or guideline lead will be involved if discrepancies cannot be resolved between the two reviewers
Data management (software)	Pairwise meta-analyses were performed using Cochrane Review Manager (RevMan5). 'GRADEpro' was used to assess the quality of evidence for each outcome.
Information sources – databases and dates	See appendix B for the literature search strategy.
Identify if an update	Not an update

Field (based on PRISMA-P)	Content
Author contacts	For details please see the guideline in development web site.
Highlight if amendment to previous protocol	For details please see section 4.5 of Developing NICE guidelines: the manual 2014.
Search strategy – for one database	For details please see appendix B.
Data collection process – forms/duplicate	A standardised evidence table format will be used, and published as appendix D (clinical evidence tables) or H (economic evidence tables).
Data items – define all variables to be collected	For details please see evidence tables in appendix D (clinical evidence tables) or H (economic evidence tables).
Methods for assessing bias at outcome/study level	Standard study checklists were used to critically appraise individual studies. For details please see section 6.2 of Developing NICE guidelines: the manual 2014. The risk of bias across all available evidence was evaluated for each outcome using an adaptation of the 'Grading of Recommendations Assessment, Development and Evaluation (GRADE) toolbox' developed by the international GRADE working group http://www.gradeworkinggroup.org/
Criteria for quantitative synthesis	For details please see section 6.4 of Developing NICE guidelines: the manual 2014.
Methods for quantitative analysis – combining studies and exploring (in)consistency	For details please see the methods and process section of the main file.
Meta-bias assessment – publication bias, selective reporting bias	For details please see section 6.2 of Developing NICE guidelines: the manual 2014.
Confidence in cumulative evidence	For details please see sections 6.4 and 9.1 of Developing NICE guidelines: the manual 2014.
Rationale/context – what is known	For details please see the introduction to the evidence review.
Describe contributions of authors and guarantor	A multidisciplinary committee developed the evidence review. The committee was convened by the National Guideline Alliance (NGA) and chaired by Dr Paul Eunson in line with section 3 of Developing NICE guidelines: the manual 2014. Staff from the NGA undertook systematic literature searches, appraised the evidence, conducted meta-analysis and cost effectiveness analysis where appropriate, and drafted the guideline in collaboration with the committee. For details please see the methods in supplementary document C.
Sources of funding/support	The NGA is funded by NICE and hosted by the Royal College of Obstetricians and Gynaecologists.
Name of sponsor	The NGA is funded by NICE and hosted by the Royal College of Obstetricians and Gynaecologists.
Roles of sponsor	NICE funds NGA to develop guidelines for those working in the NHS, public health and social care in England
PROSPERO registration number	Not applicable

CDSR: Cochrane Database of Systematic Reviews; CENTRAL: Cochrane Central Register of Controlled Trials; DARE: Database of Abstracts of Reviews of Effects; GRADE: Grading of Recommendations Assessment, Development and Evaluation; GMFCS, gross motor function classification system; HTA: Health Technology Assessment; ICF:

International Classification of Functioning, Disability and Health; MID: minimally important difference; NGA: National Guideline Alliance; NHS: National health service; NICE: National Institute for Health and Care Excellence; RCT: randomised controlled trial; RoB: risk of bias; RR: relative risk; SD: standard deviation

Appendix B – Literature search strategies

Literature search strategies for review question D4: Which interventions (for example augmentative and alternative communication systems) are effective in promoting communication for adults with cerebral palsy who have communication difficulties?

This appendix is a combined search strategy and will be the same for all the evidence reviews for the D review questions as listed below:

D1: Which interventions (for example, vocational and independent living skills training) promote participation in adults with cerebral palsy?

D2: Which interventions are effective for maintaining physical function and mobility in adults with cerebral palsy?

- Physical activity
- Strengthening programmes or training
- Orthotics
- Task-oriented upper limb training
- Orthopaedic surgery (including tendon lengthening and orthopaedic bone procedures in adulthood).

D3: What is the effectiveness of electronic assistive technology in promoting independence in adults with cerebral palsy?

D4: Which interventions (for example augmentative and alternative communication systems) are effective in promoting communication for adults with cerebral palsy who have communication difficulties?

Database: Medlife & Embase (Multifile)

Database(s): Embase 1974 to 2018 March 22, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R) 1946 to Present

Table 6: Last searched on 22 March 2018

#	Searches
1	exp Cerebral Palsy/ use prmz
2	exp cerebral palsy/ use oemezd
3	((cerebral or brain or central) adj2 (pal* or paralys#s or pares#s)).tw.
4	cerebral palsy.ti,ab.
5	little? disease.tw.
6	((hemipleg* or dipleg* or tripleg* or quadripleg* or unilateral*) adj5 spastic*).tw.
7	((hemipleg* or dipleg* or tripleg* or quadripleg* or unilateral*) adj3 ataxi*).tw.
8	or/1-7
9	limit 8 to english language
10	limit 9 to (adult <18 to 64 years> or aged <65+ years>) use oemezd [Limit not valid in Ovid MEDLINE(R),Ovid MEDLINE(R) In-Process; records were retained]
11	limit 9 to "all adult (19 plus years)" [Limit not valid in Embase; records were retained]
12	11 use prmz
13	or/10,12
14	exp Community Participation/ or exp Social Participation/ or exp "Activities of Daily Living"/ or exp Independent Living/ or exp Vocational Education/ or exp "Quality of Life"/ or exp Hearing Aids/ or exp Wheelchairs/ or exp Needs Assessment/ or exp Disability Evaluation/ or exp

#	Searches
	Self-Help Devices/ or exp Sickness Impact Profile/ or exp Sensory Aids/ or exp "Prostheses and Implants"/ or exp Orthotic Devices/ or exp Equipment Design/ or exp User-Computer Interface/ or exp communication aids for disabled/ or exp speech disorder/rh or exp Exercise/ or exp Rehabilitation/mt or exp Sports/ or exp Exercise Therapy/ or exp Orthopedic Procedures/ or exp Physical Therapy Modalities/
15	14 use prmz
16	social behavior/ or exp social adaptation/ or exp social participation/ or exp social interaction/ or exp community integration/ or exp community living/ or exp daily life activity/ or exp independent living/ or exp vocational education/ or exp "quality of life"/ or exp hearing aid/ or exp wheelchair/ or exp needs assessment/ or exp disability/ or exp self help device/ or exp Sickness Impact Profile/ or exp sensory aid/ or exp "prostheses and orthoses"/ or exp orthosis/ or exp implant/ or exp equipment design/ or exp computer interface/ or exp exercise/ or exp rehabilitation/ or exp self help/ or exp assistive technology/ or exp vocational guidance/ or exp communication aid/ or exp facilitated communication/ or exp eye tracking/ or exp sport/ or exp kinesiotherapy/ or exp orthopedic surgery/ or exp physiotherapy/
17	16 use oemezd
18	(participat* or (daily adj activit*) or (independen* adj5 liv*) or age* or aging or gender or motivat* or preference* or limitation* or restriction* or capacit* or performance* or (handl* adj5 object*) or assistive technolog* or (social adj5 interaction*) or employ* or vocation* or occupat* or educat* or profession* or isolat* or leisure activit* or mobil* or communicat* or eat* or dining or drink* or dress* or interact* or ((assistive or adaptive) adj5 (technolog* or device* or system*)) or home or school or work* or communit* or play* or eye tracking or sporting activit* or swim* or aqua* or upper limb training or bony procedure* or (neuro-developmental adj (treatment* or therap* or training)) or NDT or (muscle adj (tissue or tone)) or ((strength* or endurance) adj5 (program* or training*)) or ((tendon* or muscle*) adj (length* or stretch*)) or treadmill* or weight*).tw.
19	(augmentative or alternative communication or AAC or voice synthesizer* or accommodation* or sign language or gestur* or manual language board* or high?tech or touch screen* or speech?generating* or electronic keyboard* or phone* or iPad* or laptop* or computer* or modificat* or modify* or adapt* or custom* or tailor* or assist* or ((walking or hearing) adj aid*) or (communication adj (device* or system* or board*))).ti,ab.
20	15 or 17 or 18 or 19
21	13 and 20
22	conference abstract.pt. use oemezd
23	letter.pt. or LETTER/ use oemezd
24	Letter/ use prmz
25	EDITORIAL/ use prmz
26	editorial.pt. use oemezd
27	NEWS/ use prmz
28	exp HISTORICAL ARTICLE/ use prmz
29	note.pt. use oemezd
30	ANECDOTES AS TOPIC/ use prmz
31	COMMENT/ use prmz
32	CASE REPORT/ use prmz
33	CASE REPORT/ use oemezd
34	CASE STUDY/ use oemezd
35	(letter or comment* or abstracts).ti.
36	or/22-35
37	RANDOMIZED CONTROLLED TRIAL/ use prmz
38	RANDOMIZED CONTROLLED TRIAL/ use oemezd
39	random*.ti,ab.

#	Searches
40	or/37-39
41	36 not 40
42	ANIMALS/ not HUMANS/ use prmz
43	ANIMAL/ not HUMAN/ use oemezd
44	exp ANIMALS, LABORATORY/ use prmz
45	exp ANIMAL EXPERIMENTATION/ use prmz
46	exp MODELS, ANIMAL/ use prmz
47	exp RODENTIA/ use prmz
48	NONHUMAN/ use oemezd
49	exp ANIMAL EXPERIMENT/ use oemezd
50	exp EXPERIMENTAL ANIMAL/ use oemezd
51	ANIMAL MODEL/ use oemezd
52	exp RODENT/ use oemezd
53	(rat or rats or mouse or mice).ti.
54	or/41-53
55	21 not 54

Database: Cochrane Library

Table 7: Last searched on 22 March 2018

Hits	Search
#1	MeSH descriptor: [Cerebral Palsy] explode all trees and with qualifier(s): [Physiopathology - PP, Rehabilitation - RH]
#2	((cerebral or brain or central) N2 (pal* or paralys?s or pare?s))
#3	((hemipleg* or dipleg* or tripleg* or quadripleg* or unilateral*) N5 spastic*)
#4	((hemipleg* or dipleg* or tripleg* or quadripleg* or unilateral*) N3 ataxi*)
#5	#1 or #2 or #3 or #4
#6	MeSH descriptor: [Social Behavior] explode all trees
#7	MeSH descriptor: [Social Participation] explode all trees
#8	MeSH descriptor: [Interpersonal Relations] explode all trees
#9	MeSH descriptor: [Community Integration] explode all trees
#10	MeSH descriptor: [Independent Living] explode all trees
#11	MeSH descriptor: [Activities of Daily Living] explode all trees
#12	MeSH descriptor: [Vocational Education] explode all trees
#13	MeSH descriptor: [Quality of Life] explode all trees
#14	MeSH descriptor: [Hearing Aids] explode all trees
#15	MeSH descriptor: [Wheelchairs] explode all trees
#16	MeSH descriptor: [Needs Assessment] explode all trees
#17	MeSH descriptor: [Disability Evaluation] explode all trees
#18	MeSH descriptor: [Self-Help Devices] explode all trees
#19	MeSH descriptor: [Sickness Impact Profile] explode all trees
#20	MeSH descriptor: [Sensory Aids] explode all trees
#21	MeSH descriptor: [Prostheses and Implants] explode all trees
#22	MeSH descriptor: [Orthotic Devices] explode all trees
#23	MeSH descriptor: [Equipment Design] explode all trees
#24	MeSH descriptor: [User-Computer Interface] explode all trees

Hits	Search
#25	MeSH descriptor: [Exercise] explode all trees
#26	MeSH descriptor: [Rehabilitation] explode all trees
#27	MeSH descriptor: [Vocational Guidance] explode all trees
#28	MeSH descriptor: [Communication Aids for Disabled] explode all trees
#29	MeSH descriptor: [Eye Movements] explode all trees
#30	MeSH descriptor: [Sports] explode all trees
#31	MeSH descriptor: [Exercise Therapy] explode all trees
#32	MeSH descriptor: [Orthopedic Procedures] explode all trees
#33	MeSH descriptor: [Physical Therapy Modalities] explode all trees
#34	sporting activit* or swim* or aqua* or upper limb training or bony procedures or Neuro-developmental near (Treatment* or therap* or training) or NDT or muscle tissue or muscle tone or strength* or endurance or length* or stretch* or treadmill* or weight*
#35	participat* or independent liv* or age or aging or limitation* or restriction* or capacit* or performance* or Assistive technolog* or augmentative communication or alternative communication or AAC or employ* or vocation* or occupat* or educat* or profession* or leisure activit* or interaction* or home or school or work* or communit* or play* or accommodation* or sign language or gestur* or manual language board* or high?tech or touch screen* or speech?generating* or electronic keyboard* or phone* or iPad* or laptop* or computer or eye tracking or modif* or adapt* or custom* or tailor* or assist* or walking aid* or hearing aid*
#36	{or #6-#35}
#37	#5 and #36

Database: Cochrane Library

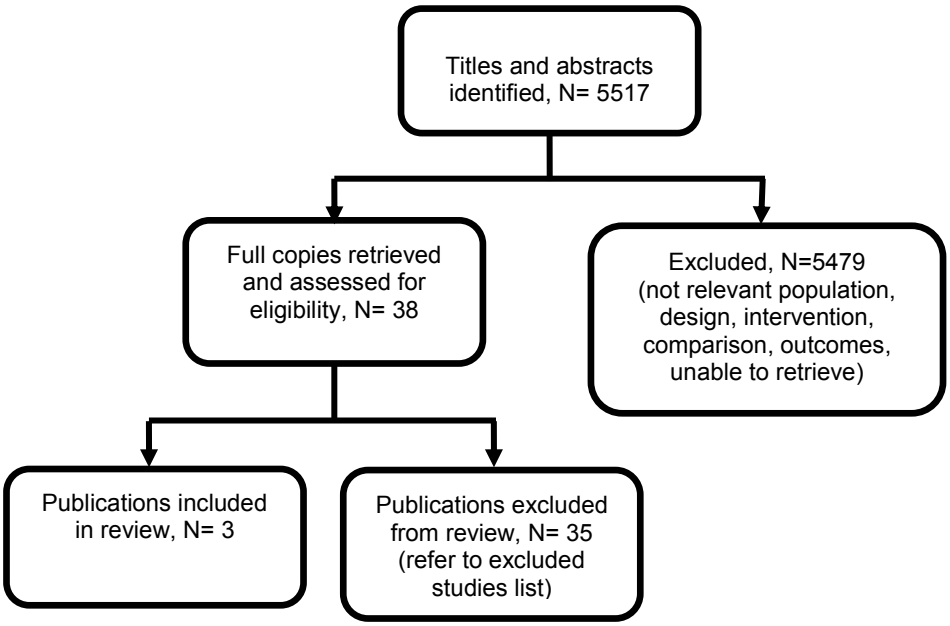
Table 8: Last searched on 22 March 2018

#3	#2 AND #1 AND LANGUAGE: (English)
#2	ts=Social Behavior or ts=Social Participation or ts=Interpersonal Relations or ts=Community Integration or ts=Independent Living or ts=Activities of Daily Living or ts=Vocational Education or ts=Quality of Life or ts=Hearing Aid* or ts=Wheelchair* or ts=Disability Evaluation or ts=Needs Assessment or ts=Self-Help Device* or ts=Sensory Aid* or ts=Prostheses or ts=Implant* or ts=Orthotic Device* or ts=Equipment Design or ts=User-Computer Interface or ts=Exercise* or ts=Rehabilitation or ts=Vocational Guidance or ts=Sport* or ts=Exercise Therap* or ts=Orthopedic Surgery or ts=Physiotherapy OR TS=Assistive technolog* or TS=augmentative communication or TS=alternative communication or TS=AAC OR TS=manual language board* or TS=high?tech or TS=touch screen* or TS=speech?generating* or TS=electronic keyboard* or TS=phone* or TS=iPad* or TS=laptop* or TS=eye tracking
#1	ts=Cerebral Palsy

Appendix C – Clinical evidence study selection

Clinical evidence study selection for review question D4: Which interventions (for example augmentative and alternative communication systems) are effective in promoting communication for adults with cerebral palsy who have communication difficulties?

Figure 1: Flow diagram of clinical article selection for interventions to promote communication



Appendix D – Clinical evidence tables

Clinical evidence tables for review question D4: Which interventions (for example augmentative and alternative communication systems) are effective in promoting communication for adults with cerebral palsy who have communication difficulties?

Table 9: Clinical studies included in the evidence review for communication

<table>
<tr><th>Study details</th><th>Participants</th><th>Interventions</th><th>Methods</th><th>Outcomes and Results</th><th>Comments</th></tr>
<tr>
<td>Full citation

Hustad,K.C., Gearhart,K.J., Listener attitudes toward individuals with cerebral palsy who use speech supplementation strategies, American Journal of Speech-Language Pathology, 13, 168-181, 2004

Ref Id

317647</td>
<td>Sample size

7 speakers with dysarthria

168 listeners without disability

Characteristics

Speakers

Age 24 to 58 years

57% male

All had cerebral palsy.

Four had dysarthria that was considered severe (between 20% and 40% intelligibility</td>
<td>Interventions

Four narrative passages and their associated topic cues, were used as speech stimuli. Speakers produced all four passages using alphabet cues, topic cues, combined cues, and</td>
<td>Details

Video recordings of speakers were made in a quiet environment in each speaker’s home. Listeners viewed the broadcast-quality digital videotapes individually in a quiet, sound-treated room.

Listeners rated their attitude towards each speaker (on a scale 1 to 7 - where 1 is strongly disagree and 7 is</td>
<td>Results

Mean (SD) attitude rating of listeners. Rated on a scale of 1 to 7 (higher is better)
<table>
<tr><th>Cue type</th><th>Mean</th><th>SD</th></tr>
<tr><td>Habitual speech (no cues)</td><td>2.46</td><td>0.75</td></tr>
<tr><td>Difference between habitual speech and topic cues</td><td>+0.42</td><td>0.18</td></tr>
<tr><td>Difference between habitual speech and alphabet cues</td><td>+1.72</td><td>0.56</td></tr>
<tr><td>Difference between habitual speech and combined cues</td><td>+2.38</td><td>0.42</td></tr>
</table>
Measured from figure 1 in Hustad (2004)</td>
<td>Limitations

ROBINS-I checklist

Bias due to confounding: low risk
Bias in selection of participants into the study: unclear risk
Bias in classification of intervention: low risk
Bias due to deviations from</td>
</tr>
</table>

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Country/ies where the study was carried out USA **Study type** Cross-sectional **Aim of the study** To examine the effect of alphabet cues, topic cues, and combined cues on the attitude of listeners relative to non-cued speech in those with severe dysarthria. **Study dates**	on the Sentence Intelligibility Test), and 3 had dysarthria that was considered profound (between 5% and 15% intelligibility on the SIT). **Listeners** Mean age 21 years. All listeners were currently attending college or graduate school. **Inclusion criteria** **Speakers** Each speaker had to (a) have the ability to produce at least eight consecutive words in connected speech, (b) have the ability to produce speech with intelligibility	non-cued (habitual) speech. Each speaker completed the four tasks in a different order to prevent the possibility of an order effect associated with learning the different strategies. In addition, the four passages were presented in a different order within each experimental task and among speakers to prevent a familiarizatio	strongly agree) on 3 questions: I think this person is an effective communicator using this strategy. I would feel comfortable communicating with this person in a class or at work if he/she used this strategy. I would be willing to communicate with this person in a class or at work if he/she used this strategy.		intended interventions: low risk Bias due to missing data: low risk Bias in measurement of outcome: low risk Bias in selection of the reported result: low risk Overall bias: low risk **Other information**

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Not reported **Source of funding** This research was supported, in part, by a New Investigator grant from the American Speech-Language-Hearing Foundation.	between 5% and 40% on the Sentence Intelligibility Test (SIT), (c) choose to use speech as a mode of communication in everyday situations per self-report, (d) speak American English as a first and primary language, (e) be able to read at or above the sixth-grade level, (f) have vision within normal limits (corrected or uncorrected) per self-report, (g) have hearing acuity within normal limits per self-report, and (h) have the ability to direct select letters and orthographically represented	n effect with the narrative passages. Prior to recording the experimental narrative passages, speakers were instructed in the use of each target strategy. Instruction involved a verbal description of the strategy and its purpose, and modelling of the strategy. Speakers practiced using the strategy on a set of rehearsal sentences, which were			

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
	phrases from a communication board. **Listeners** Inclusion criteria required that each listener (a) pass a pure tone hearing screening at 25 dB SPL for 250 Hz, 500 Hz, 1 kHz, 4 kHz, and 6 kHz bilaterally; (b) be between 18 and 35 years of age; (c) have no more than incidental experience listening to or communicating with persons having communication disorders; (d) be native speakers of American English; and (e) have no identified language, learning,	similar to the experimental passages, until they were able to use the strategy comfortably and accurately. Learning time prior to recording experimental passages was less than 15 min per strategy for each speaker. For the topic cues condition, strategy use involved correctly pointing to the predetermined topic of			

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
	or cognitive disabilities per self-report. **Exclusion criteria** Not reported	each utterance on a premade communication board prior to speaking the utterance. For the alphabet cues condition, strategy use involved correctly pointing to the first letter of each word while speaking the word. The timing of letter selection and speech production was controlled in the alphabet cues			

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
		condition so that speakers selected the letter and then either simultaneously produced the target word or subsequently produced the target word immediately afterwards. For the combined cues condition, speakers pointed to the topic of each sentence and then pointed to the first letter of each constituent word, following the same			

<table>
<tr><th>Study details</th><th>Participants</th><th>Interventions</th><th>Methods</th><th>Outcomes and Results</th><th>Comments</th></tr>
<tr><td></td><td></td><td>requirements as those for alphabet cues and topic cues.</td><td></td><td></td><td></td></tr>
<tr><td>Full citation

Hustad,K.C., Jones,T., Dailey,S., Implementing speech supplementation strategies: effects on intelligibility and speech rate of individuals with chronic severe dysarthria, Journal of Speech Language and Hearing Research, 46, 462-474, 2003</td><td>Sample size

5 speakers with dysarthria

120 listeners

Characteristics

Speakers:

Age 33 to 58 years

40% male

80% had cerebral palsy

SIT score 20 to 27%

Listeners:

Age 18 to 35</td><td>Interventions

Four narrative passages and their associated topic cues, were used as speech stimuli. Speakers produced all four passages using alphabet cues, topic cues, combined cues, and non-cued</td><td>Details

Video recordings of speakers were made in a quiet environment in each speaker’s home. Listeners viewed the broadcast-quality digital videotapes individually in a quiet, sound-treated room. Transcriptions from each listener were scored by one of the experimenters, who tallied the number of words identified correctly on the basis of</td><td>Results

Intelligibility (% of words correct; 0 to 100; higher better)
<table><tr><th>Cue type</th><th>Mean</th><th>SD</th></tr><tr><td>Habitual speech (no cues)</td><td>39.79%</td><td>20.15%</td></tr><tr><td>Topic cues</td><td>42.34%</td><td>20.24%</td></tr><tr><td>Alphabet cues</td><td>71.90%</td><td>19.23%</td></tr><tr><td>Combined cues</td><td>76.19%</td><td>17.22%</td></tr></table>
Intelligibility, difference between habitual speech and use of cues (% of words correct; 0 to 100; higher better)
<table><tr><th>Cue type</th><th>Mean</th><th>SE</th></tr><tr><td>Topic cues</td><td>+2.55%</td><td>1.69%</td></tr><tr><td>Alphabet cues</td><td>+29.57%</td><td>1.89%</td></tr></table></td><td>Limitations

ROBINS-I checklist

Bias due to confounding: low risk
Bias in selection of participants into the study: unclear risk
Bias in classification of intervention: low risk
Bias due to deviations from intended</td></tr>
</table>

Study details	Participants	Interventions	Methods	Outcomes and Results			Comments
Ref Id 317659 **Country/ies where the study was carried out** USA **Study type** Cross-sectional **Aim of the study** To examine the effect of alphabet cues, topic cues, and combined cues on intelligibility relative to non-cued speech in those with severe dysarthria.	All listeners were either currently attending college or graduate school or had completed college or graduate school. **Inclusion criteria** **Speakers** Each speaker had to (a) be able to produce connected speech consisting of at least eight consecutive words; (b) have speech intelligibility between 15% and 30%, as measured by the Sentence Intelligibility Test (SIT; Yorkston, Beukelman, & Tice, 1996); (c) use speech as a mode of communication; (d) be a native speaker of	(habitual) speech. Each speaker completed the four tasks in a different order to prevent the possibility of an order effect associated with learning the different strategies. In addition, the four passages were presented in a different order within each experimental task and among speakers to prevent a familiarization effect with	whether they matched the target word phonemically (misspellings and homonyms were accepted as correct). This number was then divided by the number of words possible and multiplied by 100 to yield a percent intelligibility score for each task.	Combined cues	+36.39%	2.00%	interventions: low risk Bias due to missing data: low risk Bias in measurement of outcome: low risk Bias in selection of the reported result: low risk Overall bias: low risk **Other information**

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
Study dates Not reported **Source of funding** This research was supported, in part, by a New Investigator grant from the American Speech-Language-Hearing Foundation.	American English; (e) have functional literacy skills at or above the 6th grade level; (f) have corrected or uncorrected vision within normal limits per self-report; (g) have hearing within normal limits per self-report; and (h) be able to accurately direct select letters and orthographically represented phrases from a communication board. **Listeners** Inclusion criteria required that each listener (a) pass a pure tone hearing screening at 25 dB SPL for 250 Hz, 500 Hz, 1 kHz, 4 kHz, and 6 kHz	the narrative passages. Prior to recording the experimental narrative passages, speakers were instructed in the use of each target strategy. Instruction involved a verbal description of the strategy and its purpose, and modelling of the strategy. Speakers practiced using the strategy on a set of rehearsal sentences, which were similar to the			

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
	bilaterally; (b) be between 18 and 35 years of age; (c) have no more than incidental experience listening to or communicating with persons having communication disorders; (d) be native speakers of American English; and (e) have no identified language, learning, or cognitive disabilities per self-report. **Exclusion criteria** None reported	experimental passages, until they were able to use the strategy comfortably and accurately. Learning time prior to recording experimental passages was less than 15 min per strategy for each speaker. For the **topic cues** condition, strategy use involved correctly pointing to the predetermined topic of each			

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
		utterance on a premade communication board prior to speaking the utterance. For the **alphabet cues** condition, strategy use involved correctly pointing to the first letter of each word while speaking the word. The timing of letter selection and speech production was controlled in the alphabet cues condition so			

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
		that speakers selected the letter and then either simultaneously produced the target word or subsequently produced the target word immediately afterwards. For the **combined cues** condition, speakers pointed to the topic of each sentence and then pointed to the first letter of each constituent word, following the same requirements			

<table>
<tr><th>Study details</th><th>Participants</th><th>Interventions</th><th>Methods</th><th>Outcomes and Results</th><th>Comments</th></tr>
<tr><td></td><td></td><td>as those for alphabet cues and topic cues.</td><td></td><td></td><td></td></tr>
<tr><td>Full citation

Pennington,L., Miller,N., Robson,S., Steen,N., Intensive speech and language therapy for older children with cerebral palsy: a systems approach, Developmental Medicine and Child Neurology, 52, 337-344, 2010

Ref Id

76173</td><td>Sample size

16

Characteristics

Characteristic Value

Sex, males／females n 7／9

Age (y), mean (SD) 14 (2)

Type of cerebral palsy, n

Spastic 9

Dyskinetic 2

Mixed 4</td><td>Interventions

Speech therapy using a speech systems approach to controlling breath support, phonation, and speech rate. Children first practised coordinating the onset of phonation with the beginning of exhalation in sustained vowels. They then moved</td><td>Details

Children received three 30 to 45 minute sessions of individual therapy per week for 6 weeks. Intelligibility in single words and connected speech was compared across four points: 1 week and 6 weeks before therapy, and 1 week and 6 weeks after its completion. Three familiar listeners and three unfamiliar listeners scored each recording. Mean percentage</td><td>Results

Single-word and connected-speech intelligibility percentage scores (0 to 100) by time by occasion for familiar and unfamiliar listeners

<table><tr><td></td><td></td><td></td><td colspan="2">Familiar listeners</td><td colspan="2">Unfamiliar listeners</td></tr><tr><td></td><td></td><td></td><td>Single speech[a]</td><td>Connected speech[a]</td><td>Single speech[a]</td><td>Connected speech[a]</td></tr><tr><td>Time[c]</td><td>Occasion</td><td>n[b]</td><td>Mean (SD)</td><td>Mean (SD)</td><td>Mean (SD)</td><td>Mean (SD)</td></tr><tr><td>1</td><td>1</td><td>7</td><td>44.9 (16.8)</td><td>50.7 (36.8)</td><td>33.8 (16.4)</td><td>24.2 (24.7)</td></tr><tr><td></td><td>2</td><td>9</td><td>45.2 (21.4)</td><td>36.3 (26.5)</td><td>44.9 (19.3)</td><td>25.8 (23.3)</td></tr><tr><td></td><td>Total</td><td>16</td><td>45.1 (19.4)</td><td>42.4 (31.8)</td><td>39.4 (18.7)</td><td>24.9 (23.9)</td></tr></table></td><td>Limitations

ROBINS-I checklist

Bias due to confounding: low risk
Bias in selection of participants into the study: unclear risk
Bias in classification of intervention: low risk
Bias due to deviations from intended intervention</td></tr>
</table>

<table>
<tr><th>Study details</th><th>Participants</th><th>Interventions</th><th>Methods</th><th>Outcomes and Results</th><th>Comments</th></tr>
<tr>
<td>Country/ies where the study was carried out
UK
Study type
Before-and-after study
Aim of the study
To investigate whether speech therapy using a speech systems approach to controlling breath support, phonation, and speech rate can increase the speech intelligibility of</td>
<td>Worster–Drought syndrome 1
GMFCS level, n
I 1
II 4
III 2
IV 5
V 4
Dysarthria severity, n
Moderate 6
Severe 10
Number of sessions completed, mean (SD) 15.5 (1.9)
To calculate children’s speech</td>
<td>on to coordinating exhalation and phonation for the production of spoken language. In the spoken language tasks, children also practised speaking slowly and maintaining breath supply across a phrase, taking a new breath at syntactically appropriate places.</td>
<td>intelligibility was compared using general linear modelling techniques (ANOVA).</td>
<td>
<table>
<tr><td>2</td><td>1</td><td>12</td><td>39.5 (19.2)</td><td>49.2 (30.8)</td><td>32.4 (17.5)</td><td>28.6 (24.6)</td></tr>
<tr><td></td><td>2</td><td>4</td><td>49.8 (30.1)</td><td>40.0 (32.0)</td><td>35.9 (19.8)</td><td>23.3 (22.8)</td></tr>
<tr><td></td><td>Total</td><td>16</td><td>42.1 (22.6)</td><td>46.8 (31.0)</td><td>34.0 (18.6)</td><td>25.9 (23.7)</td></tr>
<tr><td>3</td><td>1</td><td>7</td><td>59.1 (19.9)</td><td>44.6 (29.3)</td><td>47.7 (23.2)</td><td>47.9 (36.1)</td></tr>
<tr><td></td><td>2</td><td>9</td><td>58.0 (24.7)</td><td>61.0 (31.1)</td><td>52.9 (21.4)</td><td>40.2 (26.6)</td></tr>
<tr><td></td><td>Total</td><td>16</td><td>58.4 (22.5)</td><td>54.0 (31.1)</td><td>50.3 (22.3)</td><td>43.9 (31.6)</td></tr>
<tr><td>4</td><td>1</td><td>9</td><td>54.6 (16.2)</td><td>62.3 (29.3)</td><td>50.9 (21.7)</td><td>37.6 (31.1)</td></tr>
<tr><td></td><td>2</td><td>7</td><td>60.3 (23.6)</td><td>56.5 (33.4)</td><td>53.9 (22.7)</td><td>43.8 (35.4)</td></tr>
<tr><td></td><td>Total</td><td>16</td><td>57.0 (19.7)</td><td>59.8 (30.9)</td><td>52.4 (22.1)</td><td>40.7 (33.3)</td></tr>
</table>
[a]Scores are the percentage of words understood.
[b]The number of children rated by familiar listeners: at each time point for each child randomly selected the recording from either occasion 1
</td>
<td>s: low risk
Bias due to missing data: low risk
Bias in measurement of outcome: low risk
Bias in selection of the reported result: low risk

Overall bias: low risk

Other information</td>
</tr>
</table>

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
children with dysarthria and cerebral palsy (CP). **Study dates** Not reported **Source of funding** This study was funded by Cerebra, UK.	intelligibility, adults listened to recordings of children's speech. Three members of school staff who worked with each child were recruited as familiar listeners for the study. One hundred and twenty adults with no experience of people with CP or disordered speech acted as unfamiliar listeners. **Inclusion criteria** Children were eligible for the study if they had a diagnosis of CP, were aged 11 to 19 years, and had dysarthria classed as moderate to			or occasion 2 (all children were rated on both occasions at each time point by unfamiliar listeners). [c] Times 1&2 were 1&6 weeks before intervention, times 3&4 were 1&6 weeks after intervention. After treatment, familiar listeners understood 14.7% more single words and 12.1% more words in connected speech. Unfamiliar listeners understood 15% more single words and 15.9% more words in connected speech after therapy.	

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
	severe by local therapists. **Exclusion criteria** Children were excluded from the study if they had one or more of the following: bilateral hearing impairments greater than 50dB hearing loss, which would affect their ability to hear differences in speech production; severe visual impairments not correctable with spectacles, which would prevent the interpretation of cartoon drawings in the connected speech stimuli; or profound cognitive impairments or difficulties in following simple				

Study details	Participants	Interventions	Methods	Outcomes and Results	Comments
	instructions, which would reduce children's ability to understand and comply with therapy tasks.				

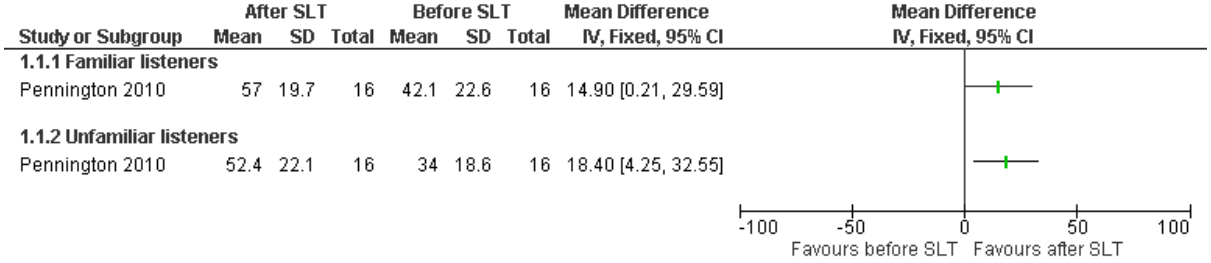
ANOVA: analysis of variance; CP: cerebral palsy; SD: standard deviation

Appendix E – Forest plots

Forest plots for review question D4: Which interventions (for example augmentative and alternative communication systems) are effective in promoting communication for adults with cerebral palsy who have communication difficulties?

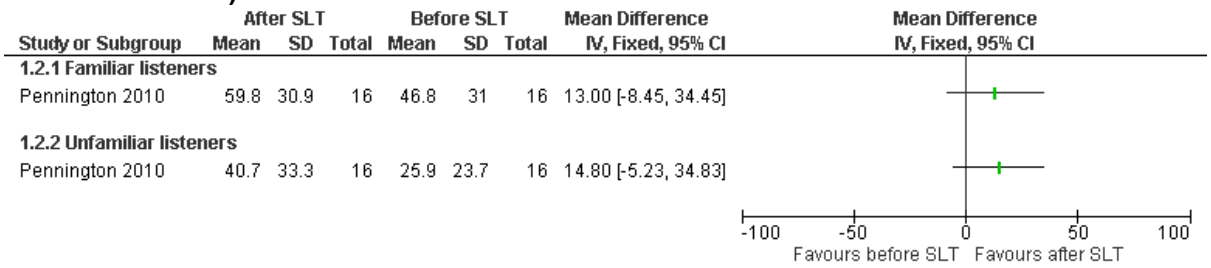
Comparison 1: before versus after intensive speech and language therapy

Figure 2: Before versus after intensive speech and language therapy - intelligibility of single words (range of scores: 0 to 100; better indicated by higher values)



CI: confidence interval; IV: inverse variance; SD: standard deviation; SLT: speech and language therapy

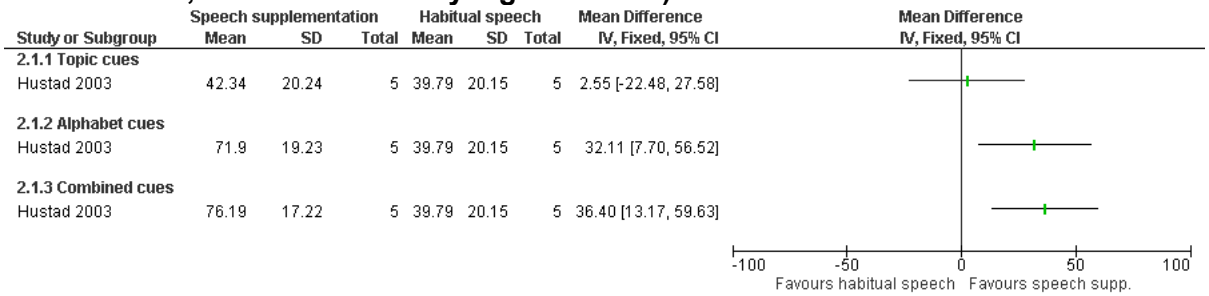
Figure 3: Before versus after intensive speech and language therapy - intelligibility of connected words (range of scores: 0 to 100; better indicated by higher values)



CI: confidence interval; IV: inverse variance; SD: standard deviation; SLT: speech and language therapy

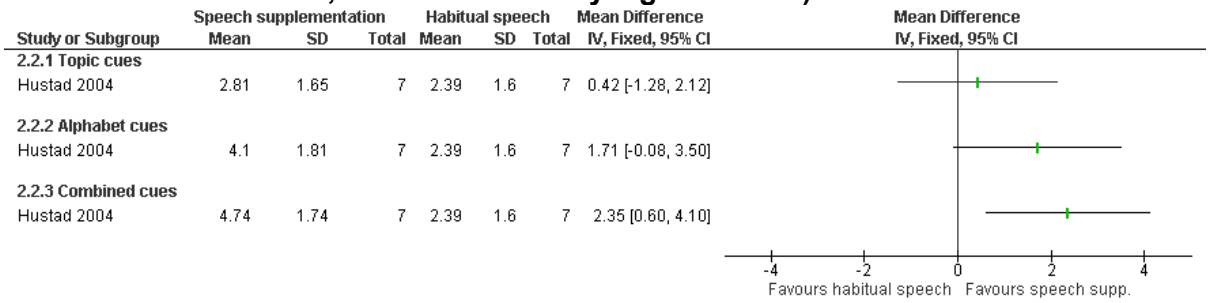
Comparison 2: supplemented versus habitual speech

Figure 4: Supplemented versus habitual speech – intelligibility (range of scores: 0 to 100; better indicated by higher values)



CI: confidence interval; IV: inverse variance; SD: standard deviation

Figure 5: Supplemented versus habitual speech - attitudes of listeners (range of scores: 1 to 7; better indicated by higher values)



CI: confidence interval; IV: inverse variance; SD: standard deviation

Appendix F – GRADE tables

GRADE tables for review question D4: Which interventions (for example augmentative and alternative communication systems) are effective in promoting communication for adults with cerebral palsy who have communication difficulties?

Table 10: Clinical evidence profile: Comparison 1: before versus after intensive speech and language therapy

Quality assessment							No of patients		Effect			
No of studies	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**After intensive speech and language therapy**	**Before intensive speech and language therapy**	**Relative (95% CI)**	**Absolute**	**Quality**	**Importance**
Intelligibility of single words (%) - Familiar listeners (follow-up mean 6 weeks; range of scores: 0-100; Better indicated by higher values)												
1	observational studies	no serious risk of bias	no serious inconsistency	serious[2]	serious[1]	none	16	16	-	MD 14.9 higher (0.21 to 29.59 higher)	VERY LOW	CRITICAL
Intelligibility of single words (%) - Unfamiliar listeners (follow-up mean 6 weeks; range of scores: 0-100; Better indicated by higher values)												
1	observational studies	no serious risk of bias	no serious inconsistency	serious[2]	serious[1]	none	16	16	-	MD 18.4 higher (4.25 to 32.55 higher)	VERY LOW	CRITICAL

Quality assessment							No of patients		Effect			
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	After intensive speech and language therapy	Before intensive speech and language therapy	Relative (95% CI)	Absolute	Quality	Importance
Intelligibility of connected speech (%) - Familiar listeners (follow-up mean 6 weeks; range of scores: 0-100; Better indicated by higher values)												
1	observational studies	no serious risk of bias	no serious inconsistency	serious[2]	serious[1]	none	16	16	-	MD 13 higher (8.45 lower to 34.45 higher)	VERY LOW	CRITICAL
Intelligibility of connected speech (%) - Unfamiliar listeners (follow-up mean 6 weeks; range of scores: 0-100; Better indicated by higher values)												
1	observational studies	no serious risk of bias	no serious inconsistency	serious[2]	serious[1]	none	16	16	-	MD 14.8 higher (5.23 lower to 34.83 higher)	VERY LOW	CRITICAL
Participation - not reported												
-	-	-	-	-	-	-	-	-	-	-		CRITICAL
Independence - not reported												
-	-	-	-	-	-	-	-	-	-	-		CRITICAL
Health related quality of life - not reported												

Quality assessment							No of patients		Effect			
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	After intensive speech and language therapy	Before intensive speech and language therapy	Relative (95% CI)	Absolute	Quality	Importance
-	-	-	-	-	-	-	-	-	-	-		IMPORTANT
Satisfaction - not reported												
-	-	-	-	-	-	-	-	-	-	-		IMPORTANT

MD: mean difference; MID: minimally important difference; CI: confidence interval
1 95% CI of the effect estimate includes one MID threshold
2 Downgraded for indirectness – the participants were older children with mean age 14 years.

Table 11: Clinical evidence profile: Comparison 2: supplemented speech (augmented communication) versus habitual speech

Quality assessment							No of patients		Effect		Quality	Importance
No of studies	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Augmented communication**	**Habitual communication**	**Relative (95% CI)**	**Absolute**		
Intelligibility (% of words understood) - Topic cues (range of scores: 0-100; Better indicated by higher values)												
1	observational studies	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[1]	none	5	5	-	MD 2.55 higher (22.48 lower to 27.58 higher)	VERY LOW	CRITICAL
Intelligibility (% of words understood) - Alphabet cues (range of scores: 0-100; Better indicated by higher values)												
1	observational studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[2]	none	5	5	-	MD 32.11 higher (7.7 to 56.52 higher)	VERY LOW	CRITICAL
Intelligibility (% of words understood) - Combined cues (range of scores: 0-100; Better indicated by higher values)												
1	observational studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[2]	none	5	5	-	MD 36.4 higher (13.17 to 59.63 higher)	VERY LOW	CRITICAL

Quality assessment							No of patients		Effect		Quality	Importance
No of studies	**Design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Augmented communication**	**Habitual communication**	**Relative (95% CI)**	**Absolute**		
Listener's attitude - Topic cues (range of scores: 1-7; Better indicated by higher values)												
1	observational studies	no serious risk of bias	no serious inconsistency	no serious indirectness	very serious[1]	none	7	7	-	MD 0.42 higher (1.28 lower to 2.12 higher)	VERY LOW	CRITICAL
Listener's attitude - Alphabet cues (range of scores: 1-7; Better indicated by higher values)												
1	observational studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[2]	none	7	7	-	MD 1.71 higher (0.08 lower to 3.5 higher)	VERY LOW	CRITICAL
Listener's attitude - Combined cues (range of scores: 1-7; Better indicated by higher values)												
1	observational studies	no serious risk of bias	no serious inconsistency	no serious indirectness	serious[2]	none	7	7	-	MD 2.35 higher (0.6 to 4.1 higher)	VERY LOW	CRITICAL

Quality assessment							No of patients		Effect			
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Augmented communication	Habitual communication	Relative (95% CI)	Absolute	Quality	Importance
Participation - not reported												
-	-	-	-	-	-	-	-	-	-	-		CRITICAL
Independence - not reported												
-	-	-	-	-	-	-	-	-	-	-		CRITICAL
Health related quality of life - not reported												
-	-	-	-	-	-	-	-	-	-	-		IMPORTANT
Satisfaction - not reported												
-	-	-	-	-	-	-	-	-	-	-		IMPORTANT

MD: mean difference; MID: minimally important difference; CI: confidence interval
1 95% confidence interval of effect estimate includes both MID thresholds
2 95% confidence interval of the effect estimate includes one MID value

Appendix G – Economic evidence study selection

Economic evidence study selection for review question D4: Which interventions (for example augmentative and alternative communication systems) are effective in promoting communication for adults with cerebral palsy who have communication difficulties?

No economic evidence was identified for this review.

Appendix H – Economic evidence tables

Economic evidence tables for review question D4: Which interventions (for example augmentative and alternative communication systems) are effective in promoting communication for adults with cerebral palsy who have communication difficulties?

No economic evidence was identified for this review.

Appendix I – Health economic evidence profiles

Health economic evidence profiles for review question D4: Which interventions (for example augmentative and alternative communication systems) are effective in promoting communication for adults with cerebral palsy who have communication difficulties?

No economic evidence was identified for this review.

Appendix J – Health economic analysis

Health economic analysis for review question D4: Which interventions (for example augmentative and alternative communication systems) are effective in promoting communication for adults with cerebral palsy who have communication difficulties?

No economic analysis was included in this review.

Appendix K – Excluded studies

Clinical and economic list of excluded studies for review question D4: Which interventions (for example augmentative and alternative communication systems) are effective in promoting communication for adults with cerebral palsy who have communication difficulties?

Clinical studies

Table 12: Excluded clinical studies for communication

Excluded studies - D4 Which interventions (for example augmentative and alternative communication systems) are effective in promoting communication for adults with cerebral palsy who have communication difficulties?	
Study	**Reason for Exclusion**
Balandin, S., Berg, N., Cooper, L., Trembath, D., Are people with cerebral palsy who use augmentative and alternative communication lonely?, Journal of Policy and Practice in Intellectual Disabilities, 6, 94-94, 2009	Conference abstract
Balandin, S., Hemsley, B., Sigafoos, J., Green, V., Communicating with nurses: The experiences of 10 adults with cerebral palsy and complex communication needs, Applied Nursing Research, 20, 56-62, 2007	Qualitative study
Balandin,S., Berg,N., Waller,A., Assessing the loneliness of older people with cerebral palsy, Disability and Rehabilitation, 28, 469-479, 2006	This study compares loneliness of adults with CP who use augmentative - alternative communication with those who use verbal communication
Bedrosian,J.L., Hoag,L.A., Johnson,D., Calculator,S.N., Communicative competence as perceived by adults with severe speech impairments associated with cerebral palsy, Journal of Speech Language and Hearing Research, 41, 667-675, 1998	Lab study evaluates the effect of message length on effectiveness of communication with AAC
Blackstone, S. W., Pressman, H., Patient Communication in Health Care Settings: new Opportunities for Augmentative and Alternative Communication, Augmentative and Alternative Communication, 32, 69-79, 2016	Expert review
Broberg,M., Ferm,U., Thunberg,G., Measuring responsive style in parents who use AAC with their children: development and evaluation of a new instrument, Aac: Augmentative and Alternative Communication, 28, 243-253, 2012	Children up to 5 years Evaluates method for measuring effectiveness of carer training
Caron, J., Light, J., "Social Media has Opened a World of 'Open communication:'" experiences of Adults with Cerebral Palsy who use Augmentative and Alternative Communication and Social Media, Aac: Augmentative & Alternative Communication, 32, 25-40, 2016	Qualitative study
Collins, S., Markova, I., Murphy, J., Bringing conversations to a close: The management of closings in interactions between AAC users and 'natural' speakers, Clinical Linguistics and Phonetics, 11, 467-493, 1997	Descriptive study about the way conversations are ended by AAC users

Excluded studies - D4 Which interventions (for example augmentative and alternative communication systems) are effective in promoting communication for adults with cerebral palsy who have communication difficulties?	
Study	**Reason for Exclusion**
Cooper,L., Balandin,S., Trembath,D., The loneliness experiences of young adults with cerebral palsy who use alternative and augmentative communication, Aac: Augmentative and Alternative Communication, 25, 154-164, 2009	qualitative study
Dattilo,J., Estrella,G., Estrella,L.J., Light,J., McNaughton,D., Seabury,M., "I have chosen to live life abundantly": perceptions of leisure by adults who use augmentative and alternative communication, Aac: Augmentative and Alternative Communication, 24, 16-28, 2008	Qualitative study
Dew,A., Balandin,S., Llewellyn,G., Using a life course approach to explore how the use of AAC impacts on adult sibling relationships, Aac: Augmentative and Alternative Communication, 27, 245-255, 2011	Qualitative study
Ferm, U. M., Claesson, B. K., Ottesjo, C., Ericsson, S., Participation and Enjoyment in Play with a Robot between Children with Cerebral Palsy who use AAC and their Peers, Aac: Augmentative & Alternative Communication, 31, 108-23, 2015	Children only
Hart, P., Scherz, J., Apel, K., Hodson, B., Analysis of spelling error patterns of individuals with complex communication needs and physical impairments, Aac: Augmentative & Alternative Communication, 23, 16-29, 2007	Does not evaluate communication intervention
Hedvall,P.O., Rydeman,B., An activity systemic approach to augmentative and alternative communication, Aac: Augmentative and Alternative Communication, 26, 230-241, 2010	Qualitative study
Hemsley,B., Balandin,S., Togher,L., 'I've got something to say': interaction in a focus group of adults with cerebral palsy and complex communication needs, Aac: Augmentative and Alternative Communication, 24, 110-122, 2008	Qualitative study
Hidecker, M. J. C., Paneth, N., Rosenbaum, P. L., Kent, R. D., Lillie, J., Eulenberg, J. B., Chester, K., Johnson, B., Michalsen, L., Evatt, M., Taylor, K., Developing and validating the Communication Function Classification System for individuals with cerebral palsy, Developmental Medicine and Child Neurology, 53, 704-710, 2011	Development of a communication measurement scale
Himmelmann, K., Lindh, K., Hidecker, M. J., Communication ability in cerebral palsy: a study from the CP register of western Sweden, European Journal of Paediatric Neurology, 17, 568-74, 2013	Survey of communication methods used by children with CP
Hustad, K. C., Effects of speech supplementation strategies on intelligibility and listener attitudes for a speaker with mild dysarthria, AAC: Augmentative & Alternative Communication, 21, 256-263, 2005	Case report - N=1
Hustad, K. C., Dardis, C. M., Kramper, A. J. (2011). "Use of listening strategies for the speech of individuals with dysarthria and cerebral palsy." AAC: Augmentative & Alternative Communication 27(1): 5-15.	Measures characteristics of strong vs weak listeners
Hynan, A., Goldbart, J., Murray, J., A grounded theory of Internet and social media use by young people who use augmentative and alternative communication (AAC), Disability & Rehabilitation, 37, 1559-75, 2015	Qualitative study
Kim, J. R., Kim, Y. T., Lee, H. J., Park, E. H., Influence of message error type on Korean adults' attitudes toward an individual who uses	Included 1 child with CP

Excluded studies - D4 Which interventions (for example augmentative and alternative communication systems) are effective in promoting communication for adults with cerebral palsy who have communication difficulties?	
Study	**Reason for Exclusion**
augmentative and alternative communication, Augmentative and alternative communication (Baltimore, Md, : 1985). 31, 137-147, 2015	
Light,J., McNaughton,D., Krezman,C., Williams,M., Gulens,M., Galskoy,A., Umpleby,M., The AAC Mentor Project: web-based instruction in sociorelational skills and collaborative problem solving for adults who use augmentative and alternative communication, Aac: Augmentative and Alternative Communication, 23, 56-75, 2007	Social skills training
Lund, S. K., Light, J., The effectiveness of grammar instruction for individuals who use augmentative and alternative communication systems: A preliminary study, Journal of Speech Language and Hearing Research, 46, 1110-1123, 2003	Case report N=2
Lund, S. K., Light, J., Long-term outcomes for individuals who use augmentative and alternative communication: Part III - Contributing factors, Augmentative and Alternative Communication, 23, 323-335, 2007	Observational study - does not compare interventions
Lund,S.K., Light,J., Long-term outcomes for individuals who use augmentative and alternative communication: part I--what is a "good" outcome?, Aac: Augmentative and Alternative Communication, 22, 284-299, 2006	Observational study - does not compare interventions
Lund,S.K., Light,J., Long-term outcomes for individuals who use augmentative and alternative communication: part II--communicative interaction, Aac: Augmentative and Alternative Communication, 23, 1-15, 2007	Observational study - does not compare interventions
McNaughton, D., Rackensperger, T., Dorn, D., Wilson, N., "Home is at work and work is at home": Telework and individuals who use augmentative and alternative communication, Work-a Journal of Prevention Assessment & Rehabilitation, 48, 117-126, 2014	Qualitative study
Rackensperger, T., Krezman, C., McNaughton, D., Williams, M. B., D'Silva, K., When I first got it, I wanted to throw it off a cliff": The challenges and benefits of learning AAC technologies as described by adults who use AAC, Augmentative and Alternative Communication, 21, 165-186, 2005	Qualitative study
Raya,R., Rocon,E., Ceres,R., Harlaar,J., Geytenbeek,J., Characterizing head motor disorders to create novel interfaces for people with cerebral palsy: creating an alternative communication channel by head motion, IEEE International Conference on Rehabilitation Robotics, 2011, 5975409-, 2011	Feasibility study - measuring head movement disorder as a first stage in developing an interface device
Smith,M.M., Connolly,I., Roles of aided communication: perspectives of adults who use AAC, Disability and Rehabilitation Assistive Technology, 3, 260-273, 2008	Qualitative study
Stoner, J. B., Angell, M. E., Bailey, R. L., Implementing Augmentative and Alternative Communication in Inclusive Educational Settings: A Case Study, Augmentative and Alternative Communication, 26, 122-135, 2010	Case study - N=1
Sutherland, D. E., Gillon, G. G., Yoder, D. E., AAC use and service provision: A survey of New Zealand speech-language therapists, Augmentative and Alternative Communication, 21, 295-307, 2005	Survey of AAC use by speech therapists in New Zealand

Excluded studies - D4 Which interventions (for example augmentative and alternative communication systems) are effective in promoting communication for adults with cerebral palsy who have communication difficulties?	
Study	**Reason for Exclusion**
Taibo, M. L. G., Iglesias, P. V., Raposo, M. D. S. G., Mendez, M. S., An exploratory study of phonological awareness and working memory differences and literacy performance of people that use AAC, Spanish Journal of Psychology, 13, 538-556, 2010	Spanish language
Tsukahara,R., Aoki,H., Skin potential response in letter recognition task as an alternative communication channel for individuals with severe motor disability, Clinical Neurophysiology, 113, 1723-1733, 2002	Feasibility study of skin potential response as a communication interface
Yorkston, K. M., Smith, K., Beukelman, D., Extended communication samples of augmented communicators I: A comparison of individualized versus standard single-word vocabularies, Journal of Speech and Hearing Disorders, 55, 217-224, 1990	4/10 had CP Compares individualised versus standard AAC single word vocabularies

AAC: augmentative and alternative communication; CP: cerebral palsy; N: number of participants in study.

Economic studies

No economic evidence was identified for this review.

Appendix L – Research recommendations

Research recommendations for review question D4: Which interventions (for example augmentative and alternative communication systems) are effective in promoting communication for adults with cerebral palsy who have communication difficulties?

Are augmentative and alternative communication systems effective and cost-effective in promoting communication for adults with cerebral palsy who have communication difficulties?

Table 13: Research recommendation rationale

Research question	Are augmentative and alternative communication systems effective and cost-effective in promoting communication for adults with cerebral palsy who have communication difficulties?
Importance to 'patients' or the population	Ensure access to effective approaches Reduce costs of ineffective treatment
Relevance to NICE guidance	Ability to clearly define effective systems in promoting communication for adults with cerebral palsy with communication difficulties
Relevance to the NHS	Reduce costs of therapy Ensure access to services already available
National priorities	Reduce variation in treatment Guidance for commissioning AAC services and equipment, NHS England, 2016 Augmentative and Alternative Communication (AAC) Services Standards, Communication Matters, 2012
Current evidence base	Current evidence found support for two different types of interventions and each were graded as very low quality
Equality	Applies to all adults with cerebral palsy and communication difficulties over the age of 25

AAC: Alternative or Augmentative Communication; NHS: National Health Service.

Table 14: Research recommendation modified PICO table

Criterion	Explanation
Population	Adults aged 18 and over with cerebral palsy and communication difficulties
Intervention	• Interventions to improve expressive communication • Intensive speech and language therapy • Alternative and Augmentative Communication • Alternative Communication
Comparator	• Each other • No intervention
Outcome	**Critical** • Participation • TOMS • Function (expressive and receptive communication) • Independence (communication in different situations) • Important outcomes • Health related quality of life

Criterion	Explanation
	• Patient satisfaction Regular utilisation of AAC in practice
Study design	Multicentre large observational cohort study
Timeframe	5 years
Additional information	Need to stratify by: • Severity of speech impairment • Presence and severity of learning disability

AAC: Alternative or Augmentative Communication; TOMS: Therapy Outcome Measures-Swallowing.