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TABLE OF CONTENTS

[Intervention Review]

Speech therapy for children with dysarthria acquired before three years of age

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ABSTRACT

Background

Children with motor impairments often have the motor speech disorder dysarthria, a condition which effects the tone, strength and co-ordination of any or all of the muscles used for speech. Resulting speech difficulties can range from mild, with slightly slurred articulation and breathy voice, to profound, with an inability to produce any recognisable words. Children with dysarthria are often prescribed communication aids to supplement their natural forms of communication. However, there is variation in practice regarding the provision of therapy focusing on voice and speech production. Descriptive studies have suggested that therapy may improve speech, but its effectiveness has not been evaluated.

Objectives

To assess whether any speech and language therapy intervention aimed at improving the speech of children with dysarthria is more effective in increasing children's speech intelligibility or communicative participation than no intervention at all , and to compare the efficacy of individual types of speech language therapy in improving the speech intelligibility or communicative participation of children with dysarthria.

Search methods

We searched the Cochrane Central Register of Controlled Trials (CENTRAL; 2015 , Issue 7), MEDLINE, EMBASE, CINAHL , LLBA, ERIC, PsychInfo, Web of Science, Scopus, UK National Research Register and Dissertation Abstracts up to July 2015, handsearched relevant journals published between 1980 and July 2015, and searched proceedings of relevant conferences between 1996 to 2015. We placed no restrictions on the language or setting of the studies. A previous version of this review considered studies published up to April 2009. In this update we searched for studies published from April 2009 to July 2015.

Selection criteria

We considered randomised controlled trials and studies using quasi-experimental designs in which children were allocated to groups using non-random methods.

Data collection and analysis

One author (LP) conducted searches of all databases, journals and conference reports. All searches included a reliability check in which a second review author independently checked a random sample comprising 15% of all identified reports. We planned that two review authors would independently assess the quality and extract data from eligible studies.

Main results

No randomised controlled trials or group studies were identified.

Authors' conclusions

This review found no evidence from randomised trials of the effectiveness of speech and language therapy interventions to improve the speech of children with early acquired dysarthria. Rigorous, fully powered randomised controlled trials are needed to investigate if the positive changes in children's speech observed in phase I and phase II studies are generalisable to the population of children with early acquired dysarthria served by speech and language therapy services. Research should examine change in children's speech production and intelligibility. It must also investigate children's participation in social and educational activities, and their quality of life, as well as the cost and acceptability of interventions.

PLAIN LANGUAGE SUMMARY

Speech therapy for children with dysarthria acquired before three years of age

The review question

This review aimed to investigate if therapy is generally effective for children with dysarthria acquired early in life, and if certain types of therapy may be better than others.

Background

Dysarthria is a speech disorder linked to difficulties controlling the muscles needed for speaking. Children with dysarthria often have shallow, irregular breathing which creates difficulties in generating sufficient breath to support speech. They have low pitched, breathy or harsh voices, nasalised speech and very poor pronunciation. Together, these difficulties make the children's speech difficult to understand. Dysarthria is caused by neurological impairment and can arise early in children's lives, from neurological damage sustained before, during or after birth, such as in cerebral palsy, or in early childhood through traumatic brain injury or neurological disease. Communication difficulties have a profound impact on children's development. They reduce the quality of life of children with cerebral palsy and place children at risk of social exclusion, educational failure and later unemployment. Speech and language therapy aims to help children to control the movements for breathing and speech and so become more intelligible.

Study characteristics

We found no randomised controlled trials or controlled group studies which investigate the effects of speech and language therapy to improve the speech of children with dysarthria acquired below three years of age.

Key results

Small, observational studies have suggested that, for some children, therapy might have been associated with positive changes in intelligibility and clarity of voice. Rigorous research, using randomised controlled trials, is needed to evaluate if therapy can help children to increase the intelligibility of their speech and if enhanced intelligibility increases children's participation in social and educational activities and their quality of life.

BACKGROUND

Dysarthria is the term used to describe speech disorders that are caused by neuromuscular impairments. People with dysarthria have difficulties controlling and co-ordinating the speed, range, strength and duration of movements needed for speech and as a result their speech may be difficult to understand. For example, difficulties with lip and tongue movements may cause 'tip' to be heard as 'sip', 'hip' or 'sieve'; 'beach' to be heard as 'eats'; 'decide' as 'sigh' or 'say.' Difficulties affecting the larynx alter the quality of phonation (sound made when air passes through vibrating vocal

folds) and the pitch and loudness of speech. Speech may lack variation in loudness, pitch and rhythm or there may be inappropriate swings in pitch and loudness. Difficulties with speech loudness, pitch and rhythm may also be associated with poor respiratory control. Speakers may have shallow breathing and have difficulty co-ordinating exhalation with phonation, giving them only a small amount of air on which to speak. Involvement of the soft palate typically leads to perceptions of excess nasality in a person's speech. Symptoms of dysarthria can range from mild slurring of speech sounds and slightly low pitch to complete inability to produce any intelligible words.

Dysarthria in childhood is associated with congenital disorders such as cerebral palsy (Lepage 1998; Kennes 2002; Bax 2006; Odding 2006) and with acquired aetiologies such as brain tumours (Van Mourik 1996; Cornwell 2003; Richter 2005) and traumatic brain injury (Chapman 2001; Netsell 2001; Cahill 2002). Approximately 20% of children with cerebral palsy have speech which is affected by dysarthria (Nordberg 2013). We do not know how many additional children have dysarthria arising from other causes, however, cerebral palsy and head injury remain two of the most common medical causes of referral to speech and language therapy (Petheram 2001). As the speech impairments of dysarthria are neurologically based they do not resolve. Intervention seeks to maximise children's speech performance, teaching them how to use different movements and lay down new motor programmes for those movements. The learning of new motor behaviours requires intensive practice (Schmidt 2005) involving considerable therapy input over long time periods. Dysarthria therapy, therefore, potentially carries considerable costs to health services even though the prevalence of the disorder in childhood may be small.

Speech and language therapy to reduce the motor speech impairments experienced by children, and the intelligibility limitations these impairments impose, has been advocated in textbooks on dysarthria (Love 1992; Hayden 1994; Strand 1995; Hodge 1999; Yorkston 1999). An approach that targets all subsystems of the vocal tract, breathing, nasal resonance, articulation and pitch control is commonly described, and is similar to interventions for adults with dysarthria acquired following neurological insults (e.g. a stroke). Treatment focusing on one or more subsystem in speech production may, for example, aim to help children control their breathing and maintain adequate pressure for speech across a phrase. This might involve teaching children how to start to speak at the beginning of exhalation and how to split utterances into smaller phases in which they can maintain adequate volume. Intervention also involves slowing children's speech rate, to allow more precise movement of muscles in the oral tract. Strand 1995 and Yorkston 1999 also advocate increasing respiratory effort and making jaw movements bigger in speech to increase oral cavity volume, plus the use of speech and non-speech exercises to help close the airway to the nose during speech. Treatment for articulation has only been advised when other aspects of speech production have been or are being addressed, as "imprecise production of speech sounds (which is the most common perceptual characteristic of dysarthria) is not simply an oral articulatory problem, and is usually the result of laryngeal, velopharyngeal, respiratory and oral articulatory problems" (Strand 1995, p134). Thus, more precise articulation and improved intelligibility is thought to be achieved through developing control of breathing for speech, increasing background effort and slowing speech rate (Love 1992; Strand 1995; Yorkston 1996; Yorkston 1999). Treatment for prosody (intonational contours of speech) and pitch control has been described (Strand 1995; Yorkston 1999). This comprises exercises to control the rate of words spoken and pauses used, increase volume and possibly the use of pitch change. As treatment of isolated oromotor movements has not been found to affect speech (Weismer 2006), all therapy is functional, being directed at speech production.

Although therapy for dysarthria in childhood has been described in speech and language therapy textbooks, its effects are currently unclear. An earlier version of this review (New Reference) showed that there were a small number of phase I and II studies of therapy for children with early acquired dysarthria but no controlled group studies. Speech and language therapists, therefore, have little evidence on which to base treatment decisions. Some may provide dysarthria intervention as there is no evidence to suggest that the treatment does not work or causes harm. Others may withhold treatment because there is no evidence showing its effectiveness (Watson 2015).

Speech allows us to share complex thoughts and ideas quickly, and is the most highly prized form of human communication. Communication difficulties are associated with lower quality of life and limited participation for children with cerebral palsy (Dickinson 2007; Fauconnier 2009) and children with speech and communication disorders are at risk of educational failure, social exclusion and later unemployment (ICAN 2007). Such problems not only have an obvious individual and family impact but also present considerable societal and economic consequences. To ensure that children have a clear means of communication, augmentative and alternative communication (AAC) systems, such as symbol books and speech synthesisers, are often provided. However, many children still choose to communicate by speech. It is important to investigate if the intelligibility of the speech of children with dysarthria can be improved, as being more immediately understandable will maximise the chances of communication success and may facilitate interaction in all areas of life. We aimed to conduct a systematic review of the studies of speech therapy for children who have acquired dysarthria early in life and to investigate the relative effectiveness of different types of treatment. We focused on children who acquire dysarthria below three years of age as they may differ from children with later-acquired pathologies in terms of their neural development, plasticity and recovery patterns; memories of fluent speech; retrieval of previously developed motor pro-

grammes; self image (seeing themselves as a fluent speaker rather than a person with a speech disorder); and patterns of communication development. Children with early acquired dysarthria may never have developed motor programmes for fluent speech or have memories of non-dysarthric speech and may not see themselves as an intelligible speaker. Furthermore, children with severe speech and motor impairments arising from congenital pathologies or those acquired in early infancy have highly unusual patterns of communication development. They take a mainly responsive role in communication and often fail to develop a full range of conversational skills (Pennington 1999). Interventions for children who acquire dysarthria at three years of age and above are the subjects of a separate review (Morgan 2008).

OBJECTIVES

To assess whether any speech and language therapy intervention aimed at improving the speech of children with dysarthria is more effective in increasing children's speech intelligibility or communicative participation than no intervention at all , and to compare the efficacy of individual types of speech language therapy in improving the speech intelligibility or communicative participation of children with dysarthria.

METHODS

Criteria for considering studies for this review

Types of studies

We looked for randomised controlled trials and studies using quasi-experimental designs in which children were allocated to groups using non-random methods.

Types of participants

Any young person under 19 years of age who acquired dysarthria below three years of age. No exclusions were made on the basis of additional impairments (intellectual or sensory impairments, the presence of epilepsy) or prior receipt of speech and language therapy. We excluded children who did not have a definite diagnosis of dysarthria with underlying neurological/neuromuscular pathology, and those who took part in studies that did not explicitly list dysarthria in their inclusion criteria. Thus, children who had other types of speech disorders, such as articulation problems without dysarthria, were not eligible for inclusion in this review.

Types of interventions

Any speech and language therapy aimed at improving children's speech, whether provided individually or in groups, in the child's home, school or health service settings, except where it is provided as part of a holistic approach (e.g. as in conductive education where there are no specific speech interventions). Therapy can be provided directly by speech and language therapists (also known as speech-language pathologists, speech pathologists) or by other personnel under the direction of a speech and language therapist.

Types of outcome measures

Primary outcomes

Primary outcome measures relate to the extent to which children's speech is understood:

- objective measures of percentage of intelligible words (e.g. Assessment of Intelligibility of Dysarthric Speech (Yorkston 1981) TOCS+ (Wilcox 1999; Hodge 2009);
- subjective intelligibility scales;
- communicative participation scales (e.g. Focus on Communication Outcomes Under Six (FOCUS) (Thomas-Stonnell 2010);
- coding schemes developed for individual research studies that include validity and reliability data.

Secondary outcomes

Measures of speech subsystem function, which could underpin intelligibility, such as respiration, phonation, nasality, articulation, sound pressure level. Measures include:

- voice rating scales (Hirano 1981);
- oromotor skills tests (e.g. Robsertson Dysarthria Assessment (Robertson 1982);
- Verbal Motor Production Assessment for Children (Hayden 1994);
- articulation tests;
- phonology tests (Diagnositic Evaluation of Articulation and Phonology (DEAP) (Dodd 2006);
- acoustic measures of pitch and loudness;
- physiological tests e.g. of respiration and nasal emission.

Impact of intelligibility:

- quality of life (e.g. KIDSCREEN (Ravens-Sieberer 2005);
- generic measures of participation (e.g. CAPE (King 2004)).

Perceptions of treatment:

- satisfaction of participant and family with treatment;
- non-compliance with treatment.

Direct costs of treatment.
Adverse events, including time missed from education.
We planned to consider outcomes at the following time points:

- short term (less than one month following the end of the intervention);
- medium term (one to three months following the end of the intervention);
- and long term (more than four months following the end of the intervention).

Search methods for identification of studies

Electronic searches

We searched for papers written in any language and in any setting in the following databases from 1980 or from inception up until the end of July 2015:

- The Cochrane Central Register of Controlled Trials (CENTRAL; 2015 Issue 7) ;
- MEDLINE (Ovid);
- EMBASE (Ovid);
- CINAHL (EBSCOhost);
- ERIC (EBSCOhost);
- Psych-INFO (Ovid);
- Linguistics and Language Behaviour Abstracts (LLBA) (ProQuest);
- Science Citation Index (Web of Science);
- Scopus;
- Dissertation Abstracts (ProQuest).

We used the search strategy developed from Robinson 2002 to search MEDLINE and modified it to search the other databases (see Appendix 1).

Searching other resources

We handsearched the following journals from their inception or from 1980 until the end of July 2015 (unless otherwise specified): American Journal of Speech-Language Pathology; Applied Psycholinguistics (1996 onwards); Augmentative and Alternative Communication; Child: Care, Health and Development and the Ambulatory Child; Child Language Teaching and Therapy; Developmental Medicine and Child Neurology; European Journal of Special Needs Education; Folia Phoniatrica; International Journal of Disability, Development and Education; International Journal of Language and Communication Disorders; International Journal of Rehabilitation Research; International Journal of Speech Pathology; Journal of Child Psychology and Psychiatry; Journal of Communication Disorders; Journal of Medical Speech-Language Pathology; Journal of Psycholinguistic Research; Journal of Special Education; Journal of Speech, Language and Hearing Research; Speech, Language and Hearing in Schools; Sprache Stimme Gehoer. (The current titles are given for journals whose names have changed since 1980.)

We checked published conference proceedings of the following organisations: European Academy of Child Development (1996 to 2015), International Society for Alternative and Augmentative Communication (1996 to 2015), American Speech and Hearing Association (1999 to 2015), Royal College of Speech and Language Therapists (1998 to 2015).

We checked the reference lists of all studies selected for possible inclusion for other possible eligible studies.

Data collection and analysis

Selection of studies

One of the review authors (LP) independently screened each title and abstract obtained from the database searches for inclusion. One of the four review authors handsearched the journals lis ted above. . Another review author independently selected 15% of the reports found as a result of the searches at random and checked them for inclusion eligibility by a second reviewer. Agreement between the reviewers on the reports included in the reliability check was 100%.

Data extraction and management

We planned that two of the thee review authors (LP, SR, NM) would independently extract data into Review Manager (RevMan) 5.3 (RevMan 2014). The data to be included is listed below.

- Participants:
  - age;
  - gender;
  - age of onset of disorder;
  - diagnosis of underlying disorder;
  - type of dysarthria;
  - severity of dysarthria relating to respiration, phonation, nasality, articulation, sound pressure level, intelligibility
- Co-morbidity
- Intervention:
  - type of intervention;
  - duration;
  - frequency;
  - provider: speech and language therapy (SLT)/other.
- Focus of intervention:
  - respiration;
  - phonation;
  - nasality;
  - articulation;
  - sound pressure level;
  - intelligibility.

- Comparator intervention
  - type of intervention
  - duration
  - frequency
  - provider: SLT/other
  - focus of intervention: respiration, phonation, nasality, articulation, sound pressure level, intelligibility

We planned to develop and pilot data extraction sheets, which would include a methodological assessment table for application of the domains of risk of bias assessment (see below). We planned to enter extracted data into RevMan 5.3 (RevMan 2014) , and to contact authors of studies to request missing data.

Assessment of risk of bias in included studies

We planned that the two review authors who extracted data on an individual study would also independently assess the study's risk of bias. We planned to resolve disagreements with the third review author and to use the Kappa statistic to calculate agreement on methodology assessment(Higgins 2011a).
We planned to rate individual criteria for risk of bias as 'adequate', 'component not reported or unclear' or 'component reported but inadequate', according to the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011b):

- Method of allocation (assignment of participants to group)
  - Low risk: Well described randomised process.
  - High risk: Non-random method (e.g. days of the week, alternate).
  - Unclear risk: Allocation is not described or description leads to uncertainty in quality of allocation and possibility of bias.

- Allocation concealment
  - Low risk: Allocation was to be classed as adequately concealed if allocation was done using a centralised system independent of research team, use of pre-numbered opaque sealed envelopes, generation of allocation by computer by person not in charge of allocation.
  - High risk: Providers of intervention undertake allocation or research team allocate participants and have access to participant characteristics.
  - Unclear risk: Methods of concealment not described or description does not allow bias to be ruled out.

- Blinding of outcome assessors. In the case of speech and language therapy interventions neither participant nor provider can be blind to the type of treatment given. Blinding in studies in this review was to refer to blinding of study research team and treatment provider to allocation process
  - Low risk: Reports state that assessors were blind to allocation.
  - High risk: Reports suggested that assessors were likely to know the group to which the participant had been allocated (e.g. provided treatment, worked with person delivering treatment).
  - Unclear risk: No information on blinding of assessors.

- Loss to follow up
  - Low risk: Attrition is similar in both conditions and no greater than 25% of participants entering the trial.
  - High risk: Loss of participants to follow up is greater than 25% or is distributed unevenly across groups.
  - Unclear risk: Loss of participants to follow up is not reported.
  - We planned to consider studies showing uneven loss to follow up separately in sensitivity analyses.

- Intention to treat analysis
  - Low risk: All trial participants entered into the analysis in the group to which they were originally allocated.
  - High risk: Trial participants who did not complete their originally allocated treatment removed from the analysis.
  - Unclear risk: Intention-to-treat analysis not reported.

Measures of treatment effect

Continuous data

We planned to summarise similar outcome measures with continuous data using standardised mean differences (SMD).

Binary data

Binary data (e.g. reaching normal loudness: yes or no) may be used in early reports. We planned to calculate a standard estimation of the odds ratio (OR) for binary data, with a 95% confidence interval (CI).

Dealing with missing data

Where information was unc l ear or missing we contacted study authors to request clarification and additional data.

Assessment of heterogeneity

We planned to undertake meta-analysis of studies that investigated similar interventions, used similar outcome measures and included groups of participants who were clinically homogeneous. We planned to assess possible inconsistency across studies using the I^2 statistic (Higgins 2003). For heterogeneous studies (Q-statistic = 0.1 and I^2 value of 50% or greater) we planned to conduct subgroup analysis only. We planned to undertake a narrative review of heterogeneous studies.

Assessment of reporting biases

We aimed to investigate associations between effect size and study precision in terms of sample size using funnel plots.

Data synthesis

We planned to assess the overall quality of the body of evidence using Grades of Recommendations, Assessment, Development and Evaluation approach (GRADE) and assign it a rating of 'high', 'moderate', low' or 'very low' quality. We will use GRADE profiler (GRADEPro 2015) to construct a 'Summary of findings' table.

Subgroup analysis and investigation of heterogeneity

We planned to carry out subgroup analyses if studies fitting the criteria for meta-analysis could be grouped further according to participants' type of dysarthria, severity of dysarthria, age.

Sensitivity analysis

We planned to undertake sensitivity analyses to assess the robustness of review findings by investigating the impact of study quality:

- effects of randomisation;
- inadequate concealment;
- blinding of outcome assessors;
- unequal loss to follow up; and
- failure to employ intention-to-treat design.

RESULTS

Description of studies

Results of the search

We found a total of 1644 abstracts. Following removal of duplicates, we considered 48 full texts and 20 papers that initially appeared to meet the inclusion criteria for the review (Fischer-Brandies 1987; Ray 2001; Hartley 2003; Fox 2005; Puyuelo 2005; Pennington 2006; Fox 2008; Marchant 2008; Cleland 2009; Wood 2009; Pennington 2010; Nordberg 2011; Fox 2012; Levy 2012; Miller 2013; Pennington 2013; Ward 2013; Ward 2014; Boliek 2015; Fox 2015). Two papers involved children with Down's Syndrome (Cleland 2009; Wood 2009); one included children with a range of diagnoses (Romski 2010); all others included children with cerebral palsy. Cleland 2009 and Wood 2009 provided additional information to the published paper stating that participants in their studies did not have dysarthria. Romski 2010, was excluded because participants did not have confirmed dysarthria; additional information was requested but not provided. All other studies were excluded on the grounds that they used observational designs. Thus, no papers were identified as fitting the inclusion criteria for this review. Agreement between the reviewers on exclusion was 100%.

Included studies

No controlled studies were identified for this review.

Excluded studies

Excluded observational studies of speech and language therapy intervention aimed at improving the speech of children with dysarthria

Although not the focus of the review, we have summarised the findings of the excluded observational studies of speech and language therapy intervention aimed at improving the speech of children with dysarthria identified by our searches in order show developing evidence for dysarthria intervention for this clinical group. Studies are described in Table 1 and we present a summary of their findings here. Most observational studies investigated interventions designed to control respiratory effort and breath support for speech (Hartley 2003; Fox 2005; Puyuelo 2005; Pennington 2006; Fox 2008; Pennington 2010; Fox 2012; Levy 2012; Miller 2013; Pennington 2013; Boliek 2015; Fox 2015). Those that included motor learning principles of intensive practice, knowledge of results and fading feedback; multiple data collection points pre and post therapy; and blinded outcome assessment provide support for the potential effectiveness of this type of intervention, with increases in speech intelligibility and improvements in acoustic measures associated with voice quality being observed (Pennington 2006; Fox 2008; Fox 2012; Miller 2013 and Pennington 2010; Pennington 2013). Motor learning principles were also used with proprioceptive feedback in the hierarchical treatment PROMPT (Prompts for Restructuring Oral Muscular Phonetic Targets (Hayden 1994)), which was associated with increased oromotor movement and phonetic accuracy and possibly improved intelligibility (Ward 2013; Ward 2014). Three studies involved nonspeech exercises (Fischer-Brandies 1987; Ray 2001; Puyuelo 2005) and indicated no improvement or were unable to do so because of methodological flaws in the study design (e.g. lack of blinding of assessors, indefinite intervention and measurement). Electropalatography increased articulatory precision (Nordberg 2011). However, articulation therapy without biofeedback showed no effect on intelligibility or orofacial spasticity (Marchant 2008).

Risk of bias in included studies

No controlled studies were identified for this review.

Effects of interventions

No controlled studies were identified for this review.

DISCUSSION

Children with early acquired dysarthria often have reduced quality of life and are at risk of social exclusion, failure in education and later unemployment. In addition, there can be psychosocial, family and societal economic consequences. Children with severe dysarthria are often prescribed augmentative and alternative communication (AAC) systems (such as pictures, symbol or word charts or voice output communication aids) to supplement their natural modes of communication but children still prefer to communicate by speech wherever possible.

In this review we aimed to examine the effectiveness of interventions to improve the speech of children with dysarthria acquired below three years of age. We searched for randomised controlled trials and quasi-experimental designs but found no studies of these types. Searches did identify a number of observational studies, however, which have suggested that interventions which follow motor learning principles may be associated with increases in speech intelligibility, precision of articulatory movements and voice quality and clarity for children with moderate and severe dysarthria. Further interventions may have been reported in non-controlled studies, but may not have been identified in this review.

AUTHORS' CONCLUSIONS

Implications for practice

None

Implications for research

Observational studies identified during this review suggest that several interventions which follow motor learning principles may be associated with increases in speech intelligibility, voice quality and clarity. Rigorous research, in the form of randomised controlled trials, is needed to test the general effectiveness of speech and language therapy for children with early acquired dysarthria. Trials should include no therapy and attentional placebo control arms. They should evaluate changes in speech impairment and function, by measuring change in speech intelligibility, voice quality and clarity. And, as intelligible communication allows children to engage with the world around them, trials should also investigate the impact of intervention on children's social participation. This should include the extent and success of children's communication with friends, family, teachers and strangers and their engagement in social and educational activities. The consequent impact of communication change on well-being should also be evaluated using quality of life measures. Such primary and secondary effects may evolve over different periods of time. It is important, therefore, that development and potential decay of effects is evaluated in the short (e.g. one month), medium (e.g. three months) and long (e.g. six to twelve months) term. The costs of intervention and the acceptability of therapy to children and their parents must also be examined.

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* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Akin Senkal 2013	Not nonprogressive dysarthria under three years of age
Boliek 2015	Observational study
Cantarella 2010	Not nonprogressive dysarthria under three years of age
Cleland 2009	Authors confirmed that participants did not have dysarthria
Fischer-Brandies 1987	Observational study
Flipsen 2013	Not nonprogressive dysarthria under three years of age
Forrest 2008	Not nonprogressive dysarthria under three years of age
Fox 2005	Observational study
Fox 2008	Observational study
Fox 2012	Single case experimental design
Fox 2015	Observational study
Gallerano 2012	Not nonprogressive dysarthria under three years of age
Grigos 2010	Not nonprogressive dysarthria under three years of age
Grill 2010	Not nonprogressive dysarthria under three years of age
Hartley 2003	Observational study
King 2013	Not nonprogressive dysarthria under three years of age
Levy 2012	Observational study
Levy 2014	Observational study
Lousada 2013	Not nonprogressive dysarthria under three years of age
Marchant 2008	Observational study
Miccio 2010	Not nonprogressive dysarthria under three years of age

(*Continued*)

Miller 2013	Observational study
Namasivayam 2013	Not nonprogressive dysarthria under three years of age
Nordberg 2011	Observational study
Nordberg 2014	Not intervention study
Pennington 2006	Observational study
Pennington 2008	Observational study. Preliminary report, more detailed information given on same study in Pennington 2009
Pennington 2010	Observational study
Pennington 2013	Observational study
Preston 2013	Not nonprogressive dysarthria under three years of age
Puyuelo 2005	Observational study
Ray 2001	Observational study
Robson 2009	Observational study
Rodriguez-Parra 2011	Not nonprogressive dysarthria under three years of age
Romski 2010	Speech intervention compared with augmented communication in randomised controlled trial. Not clear if participants had dysarthria; no motor speech measures included. Further information was requested from the authors but was not provided
Rong 2012	Not nonprogressive dysarthria under three years of age
Schindler 2008	Not nonprogressive dysarthria under three years of age
Speake 2012	Not nonprogressive dysarthria under three years of age
Stepp 2011	Not nonprogressive dysarthria under three years of age
Van Nuffelen 2009	Not nonprogressive dysarthria under three years of age
Van Lierde 2010	Not nonprogressive dysarthria under three years of age
Van Lierde 2012	Not nonprogressive dysarthria under three years of age
Van Nuffelen 2010	Not nonprogressive dysarthria under three years of age

(*Continued*)

Van Rees 2012	Not nonprogressive dysarthria under three years of age
Ward 2013	Single case experimental design
Ward 2014	Single case experimental design
Wilk 2010	Not speech and language therapy
Wood 2009	Authors confirmed that participants did not have dysarthria

DATA AND ANALYSES

This review has no analyses.

ADDITIONAL TABLES

Table 1. Excluded, observational study findings

Study	Study design	Participants	Intervention type	Intervention duration	Outcome measures	Outcomes	Timing of outcome measures	Methodological problems
Fischer-Brandies 1987	Observational	71 (37 F, 34 M) children with cerebral palsy, age 4-14 years (mean = 10 years); 42 spastic type CP; 9 athetosis, 20 hypotonia; orofacial dysfunction	Oromotor intervention. Orofacial regulation therapy: wearing of removable plates for upper jaw, stimulators on palatal plate for tongue and upper lip plus motor speech therapy. 49 children also received physiotherapy (Vojta or Bobath or Castillo-Morales)	Appliances worn for several hours per day (exact duration not specified) over a mean period of 15 months (range 6 months to 3 years)	***Impairment:*** List of symptoms, rated as better or worse after treatment: abnormal tongue position; limited tongue mobility (single and multiple directions); type of tongue mobility problem (jerky, slow, vermicular); drooling; labial sound production; palatal sound production; dental sound production; feeding (sipping, sucking, chewing, choking)	***Impairment:*** Number of children showing improvement when symptoms rated as better or worse than at start of therapy by neuropaediatrician. Improvements observed (number showing improvement/ number showing difficulties in area measured): abnormal tongue position 20/59; limited tongue mobility 33/56; jerky tongue movements 13/23,	Beginning and end of treatment; timing not specified.	Rater not blind to prior scores; binary scale used in outcome measure (better/worse) with no information on validity or reliability of outcome measures; no control group; before and after treatment measures only.

Table 1. Excluded, observational study findings (*Continued*)

						extremely slow tongue movements 10/21; sucking 15/31; sipping 23/30; chewing 21/37; severe drooling 28/40; labial sounds 24/38; palatal sounds 26/57; dental sounds 24/53. In 17 cases oral functions worsened after therapy		
Ray 2001	Observational	16 children (7 F, 9 M) with cerebral palsy; aged 7 - 10 years (mean = 8 years); mild to moderate spasticity. All children had scores within normal limits on Raven's Coloured Progressive Matrices (Ravens-Sieberer 2005), all had passe d pure tone screening at 25 dB HL bilaterally.	Oromotor intervention. Orofacial myofunctional treatment, focusing on resting position of lips closed and tongue under hard palate, plus strength exercises for jaw, lips and tongue (exercises involving isolated movements not speech) and passive stretching of lips and tongue	Treatment given 5 days per week for 4 months. Treatment sessions = 15 min individual therapy plus 10 min group treatment. Parents were provided with exercises for children to complete at home	***Impairment:*** 4-point rating scale of function of lips, jaw and tongue, by 1 orthodontist and 2 speech language pathologists. Percentage errors on production of phonemes in 20 single words, as transcribed independently by 2 speech language	***Impairment:*** Group difference in pre and post therapy scores for lip and tongue position (mean pretherapy score = 2.21, mean posttherapy score = 1.60; P value = 0.012) and for percentage phonemes correct (mean pretherapy score = 1.00, mean post therapy	Pre and post therapy. Timings not specified.	No blinding of assessors; no maturational or experimental control; no follow-up

Table 1. Excluded, observational study findings (*Continued*)

		Children had mild to moderate language delay but were able to understand simple instructions			pathologists. Percentage errors then converted to 5-point scale	score = 1.62; P value = 0.002)		
Hartley 2003	Observational	4 boys with predominantly athetoid type cerebral palsy aged 10 - 13 years (mean 11 years). Speech described as "borderline intelligible". All children used augmentative and alternative communication systems	Subsystems intervention. 2 blocks of therapy. 1st block concentrated on respiration and phonation. 2nd block focused on articulation deficiencies noted during assessment	Two 4-week blocks of therapy. Duration and frequency of session were not specified	***Impairment:*** Impairment scores on Dysarthria Profile (Robertson 1982) ***Activity:*** Percentage intelligibility of single word speech on Children's Speech Intelligibility Measure (Wilcox 1999) to one familiar and one unfamiliar listener per participant	***Impairment:*** Dysarthria profile showed positive change for one child ***Activity:*** Group comparison of intelligibility data across time. No difference in intelligibility across data collection points	6 weeks prior to therapy, 1 week prior to therapy, in the week between therapy blocks, 1 week after therapy completion, 6 weeks after therapy completion	Results of 4 cases presented as a group for intelligibility investigation; no blinding of outcome assessor; no maturational or experimental control; no follow-up
Marchant 2008	Single case experimental design	One 13 year old girl with spastic type cerebral, and severe spastic dysarthria. Hearing and vision within normal limits. Comprehension	Subsystem and oromotor intervention. 2 blocks of therapy. 1st block: phonetic placement, articulation therapy involving teaching of correct	2 blocks of therapy each comprising 10 sessions of 45 minutes over 2 weeks. Withdrawal of therapy for 2 weeks between therapy blocks	***Impairment:*** Surface EMG amplitude of left and right obicularis oris and submental muscles; vowel formant frequencies; duration of	***Impairment:*** Single word intelligibility improved after articulation therapy and improvement was maintained post EMG therapy	On each of 3 consecutive days before 1st block of therapy, on the day following 1st block of therapy, on the day following the 2nd block of	Therapists rating speech were not blind to aims of the study. No maturational or experimental control; no follow-up

Table 1. Excluded, observational study findings (*Continued*)

		adequate for testing and therapy procedures	movement patterns for target speech sounds. 2nd block: relaxation of muscle groups using bio feedback from surface electromyography (EMG)		alternative motion rates of repeated syllables; perceptual rating of voice characteristics using Duffy scale by 2 therapists blind to time of recording but not to aims of study; self-perception of speech impairment by participant ***Activity:*** percentage intelligibility in single words, sentences and paragraphs Significant difference assumed if post therapy results were +/- 1 SD from pre therapy scores	(pre-therapy = 35%; post articulation therapy = 44.0%; post EMG = 44.45%). Slight change in motor control after EMG therapy: reduction in amplitude of nonspeech movements (approximately 30 microvolts) and gap between syllables (approx 0.1 sec). No change in participants' view of her speech disorder ***Activity:*** No change in intelligibility at sentence or paragraph level	therapy	
Nordberg 2011	Observational	5 children with cerebral palsy (2 F, 3 M) aged 7-13 years (mean = 9 years) with mild to severe	Subsystem intervention. Electropalatography (EPG). Target sounds = /t/, /d/, /n/, /s/	15 minutes per day, 5 days per week for 8 weeks	***Impairment:*** Analysis of place of articulation as shown on EPG pattern. Articulatory du-	Tongue placement for targets in initial and medial word position changed post therapy (P value ≤	1 week before and 1 week after therapy. No further information given	No blinding of assessors; no maturational or experimental control; no follow-up

Table 1. Excluded, observational study findings (*Continued*)

		dysarthria. 3 children had dyskinetic cerebral palsy, 2 spastic cerebral palsy; 4 walked without aids, 1 used a walker			ration. Phonetic transcription of target sound	0.01). Articulation approach and release time reduced after therapy for all participants, with wide variation between participants; all children increased contact between tongue and alveolar ridge; target perceived as /t/ for all children (no statistical testing)		
Ward 2013 and Ward 2014	Single case experimental design	6 children (3 F, 3 M) with cerebral palsy; aged 3-11 years (mean = 5 years); moderate to severe speech impairment; < -1.5 SD on articulation test; 1 dyskinetic, 5 spastic type; IQ ≥ 70; receptive language within 2 SD; hearing within normal limits; correctable vi-	Subsystem intervention. PROMPT (Prompts for Restructuring Oral Musculature Phonetic Targets, Hayden 2006): focuses on timing and co-ordination of movements of speech subsystems; provides tactile-kinaesthetic proprioceptive-	45- minute sessions, once weekly for 20 weeks. 1 lower level goal targeted in first 10 weeks. 1 higher level goal targeted during second 10 weeks. 3rd goal selected as control, no intervention. Fidelity of treatment with protocol checked by indepen-	***Impairment:*** 3D motion analysis of movement accuracy in 11 untrained words repeated 5 times. Visual analysis of perceived movement accuracy and perceived phonetic accuracy (accurate/inaccurate) across 6 trained and	***Impairment:*** Motion analysis: all children changed their lip and/or jaw movements in untrained words following treatment (P value ≤ 0.05). Perceived movement and phonetic accuracy increased during the	Kinematic and intelligibility measures week before therapy, at end of each phase of therapy. Weekly speech probes for measures of perceived movement and phonetic accuracy during 5 baseline therapy and during 20 weeks of	Reliability of 3D motion analysis not tested. Confidence intervals for intelligibility test taken from the test standardisation, which did not include children with speech disorder

Table 1. Excluded, observational study findings (*Continued*)

		sual impairment	tive feedback during speech to train jaw, lip and tongue movements in a hierarchical sequence	dent therapist blind to study phase (77.7%-97%)	untrained words selected from a corpus of 30 ***Activity:*** Percentage intelligibility of single word speech (Children's Speech Intelligibility Measure) to one listener blind to speaker, time of recording and aim of research	treatment phase for all children and was maintained above baseline at follow-up; 4 children increased movement and phonetic accuracy of higher level target; 2 children showed change in control target (no statistical testing) ***Activity:*** All children increased percentage intelligibility after block 2 (mean increase = 24%); increase maintained at follow-up	therapy. Follow-up probe at 12 weeks post therapy	
Fox 2005 and Fox 2012	Multiple baseline single case experimental design with replication across participants	5 children (2 F, 3 M), aged 5; 10-7; 10 years with spastic type cerebral palsy	Lee Silverman Voice Therapy LOUD® - targets respiratory effort and vocal loudness	4 weeks: 16 1-hour sessions (4 times per week for 4 weeks) plus minimum 36 practice sessions between treatment sessions. 4 children received ther-	***Impairment:*** Acoustic measures: dB Sound Pressure Level (SPL) , maximum phonation duration in seconds, harmonics to noise ra-	***Impairment:*** Change (no overlapping data points) noted on all acoustic measures in maximum performance tests post therapy and	2 weeks prior to treatment, 2 weeks post treatment and follow-up at 6 weeks post treatment	

Table 1. Excluded, observational study findings (*Continued*)

				apy, 1 child received no treatment	tios (HNR) in dB, maximum and minimum pitch in Hz, pitch range in Hz, elicited in maximum performance tests, sustained vowels, sentence repetition and cartoon description Perceptual measures: therapists' blinded preferences for recordings made at different times on overall loudness, loudness variability, overall pitch, pitch variability, articulatory precision, overall voice quality; parents' ratings of voice characteristics ***Activity:*** Parent ratings of spoken communicative ac-	at follow-up for 3 of the 4 children who received treatment. Trends noted in sustained phonation and sentence repetition for 3 children. No change or reducing scores for child who did not receive therapy. Therapists preferred overall loudness, loudness variability, pitch variability, articulatory precision, overall voice quality of post-treatment recordings. Parents noted change for 4 children, but changes not consistently maintained at follow-up		

Table 1. Excluded, observational study findings (*Continued*)

					tivity	***Activity:*** 3 children judged to be more communicative after therapy, changes maintained for one child		
Fox 2008	Observational	8 children (6 F, 2 M) aged 6 -12 years with spastic type cerebral palsy	Lee Silverman Voice Therapy LOUD®	4 weeks: 16 1- hour sessions (4 times per week for 4 weeks)	***Impairment:*** Acoustic measures: dB SPL, jitter, HNR and duration of phonation in maximum performance tests and in sentence repetition Perceptual ratings: children's parents rated voice quality using visual analogue scales	***Impairment:*** Increase in vocal SPL in sustained vowels (F (2-12) = 5.14, P value = 0.024) post therapy and follow-up; improvements in jitter (measure of voice quality) post therapy and at follow-up (F (2-12) = 5.27, P value = 0.02); increase in SPL of spoken sentences after therapy (F (2-12) = 5.29, P value = 0.02) Parents perceived their children's voices as "louder", less "nasal" and more "natural" after treatment	2 weeks prior to treatment, 2 weeks post treatment and 12 weeks post treatment	No blind rating of perceptual measures

Table 1. Excluded, observational study findings (*Continued*)

Fox 2015 and Boliek 2015	Observational	8 children (3 F, 6 M) with cerebral palsy aged 8-16 (mean = 10 yrs) years Dysarthria characterised as mild to severe spastic or spastic-flaccid type GMFCS (Palisano 1997) II-V (median = III)	Lee Silverman Voice Therapy LOUD® with daily maintenance sessions (practice without therapist) for 12 weeks	4 weeks: 16 1-hour sessions (4 times per week for 4 weeks), followed by daily maintenance sessions (practice without therapist) for 12 weeks	***Impairment*** : Speech: speech rate in diadochokinetic (DDK) tasks/pataka/; dB SPL in sentence repetition. Neurophysiology: Diffusion Tensor Imaging DTI), functional Magnetic Resonance Imaging (fMRI), intermuscular coherence comparison pre and post intervention and with typically developing controls matched for age and sex ***Activity*** : Percentage Intelligibility in repeated sentences. Subjective ratings of intelligibility and communi-	***Impairment:*** No change in group mean SPL or DDK rate. Mean increase in maximum intermuscular coherence in DDK at follow-up (t (7) = 2.34 P value < 0.02) Change in left corticospinal tract on DTI (fractional anisotropy change > 1 SD of typically developing controls). Change in fMRI activation maps post therapy (t > 3.11, P value < 0.001) ***Activity:*** Group increase in intelligibility post therapy (t (7) = 3.49, P value < 0.01) were maintained	2 weeks prior to treatment, 2 weeks post treatment and follow-up at 12 weeks post treatment	No blind rating of perceptual measures. Fox 2015 states 9 children participated but results provided for 8

Table 1. Excluded, observational study findings (*Continued*)

					cation performance	at follow-up. All parents rated their child's intelligibility as better after therapy		
Levy 2012	Observational	3 girls with spastic type cerebral palsy. P1 age 8 years, mild dysarthria; P2 3 yrs, moderate dysarthria; P3 9 yrs, moderate dysarthria and apraxia, cognitive impairment and language delay	P1 and P2: Lee Silverman Voice Therapy LOUD®, P3: Therapy adapted from Pennington 2010: discussion of posture, speech clarity, monitoring of speech, breathing at start of exhalation, activities focusing on stress, intensity and breathing control	P1 and P2: 4 sessions of 50-60 min per week plus 10 min homework for 4 weeks P3: 2 sessions of 50 minutes per week with homework for 4 weeks	***Impairment*** : dB SPL; articulation (Arizona Articulation Proficiency Scale) . ***Activity*** : Listeners blind to the time of speech recording rated ease of understanding and made rated preference for paired recordings	***Impairment:*** All participants increased articulatory proficiency score by 9-19 points. P1 and P2 increased dB SPL in words or spontaneous speech by > 5 dB SPL; P3 words and spontaneous speech decreased by 6 dB SPL ***Activity:*** Post- therapy speech recordings preferred and judged as easier to understand for all participants	2 weeks prior to intervention; during 1s t week post intervention	No random allocation of participant to treatment. Participants differed in co-occuring difficulties likely to affect response to treatment. Treatment intensity differed between interventions
Pennington 2006	Observational	6 participants (4 F, 2 M), aged 10-18 years) all of whom had cerebral palsy: 4 spastic type,	Whole system approach, targeting control of breath supply for speech pro-	Individual therapy for 20-30 min. 5 sessions per week for 5 weeks	***Activity:*** Percentage of single words (Children's Speech Intelligibility Measure)	***Activity:*** Individual results presented for each participant and group. 4 students	1 week prior to therapy, 1 week after therapy completion, 6 weeks after therapy completion	No control group or maturational control

Table 1. Excluded, observational study findings (*Continued*)

		1 mixed type, 1 ataxic type. Hearing within normal limits. 2 children with language delay, but comprehension adequate for simple verbal instructions; 4 children language comprehension within normal limits. All used speech to communicate. Dysarthria rated as mild to severe by local therapists	duction and prosodic contrasts		and connected speech (elicited in picture description) intelligible to three unfamiliar listeners. Listeners blind to time of recording ***Other:*** Semi-structured interview on acceptability of treatment	increased single word intelligibility immediately after therapy (2%-25%), but gains in intelligibility were not maintained at follow-up. 2 students did not increase intelligibility of single words. Increases in connected speech intelligibility were observed for 3 participants (75-13%), gains were not maintained at follow-up. No group change in intelligibility ***Other:*** 3 participants reported that the duration and intensity of the treatment were acceptable. 3 participants re-		

Table 1. Excluded, observational study findings (*Continued*)

						ported that the therapy was too intensive and that either 4 weeks of therapy 5 times per week or 3 sessions per week for 5 weeks would be preferred		
Pennington 2010; Miller 2013; Robson 2009	Observational	16 participants (9 F, 7 M); aged 12-18 years (mean = 14 years, SD = 2). 15 with cerebral palsy, 1 with Worster-Drought. 9 children had bilateral spastic type cerebral palsy, 2 had dyskinetic type, 4 had mixed (spastic and dyskinetic) and 1 child had Worster Drought. GMFCS ranged from I-V (median = IV). Dysarthria rated moderate to severe by referring speech and	Whole systems approach which focused on stabilising the students' respiratory and phonatory effort and control, speech rate and phrase length/ syllables per breath	3 individual sessions of 30-40 min each per week for 6 weeks	***Impairment:*** Perceived voice quality rating scale (GRBAS: Grade, Roughness, Breathiness, Aesthenia, Strain, Hirano 1981), therapists rated speech recordings blind to time of recording. Acoustic measures: HNR, amplitude, shimmer (regularity of amplitude o f vocal fold vibrations), jitter (r egularity of f requency of vocal fold	***Impairment:*** Slight reduction in fundamental frequency, intensity and jitter of children's voices (all P value < 0. 05). Increase in speaking time between pauses by approx 1 second. Aesthenia reduced post therapy (-0.26 on 4-point GRBAS scale, effect size 0.4). No other differences in voice quality were perceived. Aesthenia	6 weeks and 1 week before therapy, 1 week and 6 weeks after therapy completion	No treatment integrity checks; longer term effects of intervention were not evaluated. Participants acted as own controls, no control group

Table 1. Excluded, observational study findings (*Continued*)

		language therapists. All children were able to comprehend simple instructions			v ibratio n s) , F0 mean (average fundamental frequency) , rate with pauses, rate without pauses, time with pauses and time without pauses ***Activity:*** Mean percentage intelligibility of single words (Children's Speech Intelligibility Measure) and connected speech to 3 familiar and 3 unfamiliar listeners. Listeners blind to time of recording for intelligibility measures ***Other:*** Questionnaire on the acceptability of therapy, using Likert scales	was weakly associated with reduced intelligibility (R -0.11, 95% CI -0.58 to -0.15, with -10.7% reduction in intelligibility with an increase of 1 point on the aesthenia rating scale). No association between change in intelligibility and any other GRBAS ratings ***Activity:*** Statisictially significant gains in intelligibility post therapy: on average familiar listeners understood 14.7% more single words and 12.1% more words in connected speech after the therapy; unfamiliar listeners un-		

Table 1. Excluded, observational study findings (*Continued*)

						derstood 15.0% more single words and 15.9% more words in connected speech after therapy (all P value < 0. 05) ***Other:*** All children reported that the therapy was acceptable and would recommend it to a friend		
Pennington 2013	Observational	15 participants (6 F, 9 M) aged 5-11 years, mean = 8 years, SD = 2). 13 with cerebral palsy, 2 with Worster-Drought. 8 children had spastic type cerebral palsy, 4 had dyskinetic type and 1 ataxia. GMFCS ranged from II-IV (median = II). Dysarthria rated moderate to severe by referring speech and	Whole systems approach which focused on stabilising the students' respiratory and phonatory effort and control, speech rate and phrase length/ syllables per breath	3 individual sessions of 30-40 min each per week for 6 weeks	***Activity:*** Mean percentage intelligibility of single words (Children's Speech Intelligibility Measure) and connected speech to 3 familiar and 3 unfamiliar listeners. Listeners blind to time of recording for intelligibility measures ***Participation:*** FOCUS (Focus	***Activity:*** On average familiar listeners understood 10.8% more single words and 9.4% more words in connected speech after the therapy. Unfamiliar listeners understood 9. 3% more single words and 10.5% more words in connected speech after therapy (all P value < 0. 05)	6 weeks and 1 week before therapy, 1, 6 a nd 12 weeks after therapy completion	No treatment integrity checks. Participants acted as own controls, no control group

Table 1. Excluded, observational study findings (*Continued*)

		language therapists. All children were able to comprehend simple instructions			on Communicaiton Outcomes Under Six, Thomas-Stonnell 2010) measure of perceived communication activity and participation completed by parents ***Other:*** Questionnaires on the effectiveness and acceptability of therapy, using Likert scales	***Participation:*** Mean improvement in FOCUS score = 30. 3 (95% CI 10.2 to 50. 4). No association between change in FOCUS score and percentage intelligibility observed ***Other:*** 12/15 parents rated therapy: 8 rated therapy as having good effects, 4 rated therapy as having moderate effects		
Puyuelo 2005	Observational	10 children (3 F; 7M) with cerebral palsy , aged 3 years at the start of the study. 5 children had athetoid type CP, 4 spastic type and 1 had ataxia. Children had "absence of articulated speech". Hearing and lan-	First block of therapy focused on increasing control of oral movement used in articulation, chewing and expiration. Second block of therapy focused on controlling exhalation for speech and co-or-	2 blocks of treatment. Each block comprised 11 months of twice-weekly therapy, each session lasting 30 min	***Impairment:*** Impairment scores on Spanish adaptation of Robertson Dysarthria Profile . Spectrographic analysis of a repeated sentence	***Impairment:*** Group results presented. Following the first treatment only voice control increased. Following the second treatment scores increased for respiration, voice, artic-	Before intervention, between first and second interventions, after intervention 2. Exact timing of measures not specified	No control group; long duration of treatment; no control of maturational effects; no blinding of assessor

Table 1. Excluded, observational study findings (*Continued*)

		guage comprehension within normal limits	dination of exhalation and phonation; voice training; and prosody (intonation, pausing, rhythm and sound duration). In the second block of therapy advice was given to parents on stimulating communication, and children engaged in story telling and recall to practice their speech skills with their parents. Whilst receiving the above therapies children also received Bobath neurodevelopmental treatment			ulation, intelligibility and prosody (all P value < 0.05). Spectrographic analysis was also possible at the end of the second treatment, as children had developed some spoken output		

GMFCS = Gross Motor Function Classification System (Palisano 1997)

WHAT'S NEW

Last assessed as up-to-date: 15 October 2015.

Date	Event	Description
24 June 2016	New citation required but conclusions have not changed	Review update - conclusions not changed
15 October 2015	New search has been performed	New authors added. New studies added. New funding declared. Conclusions not changed
18 May 2009	Amended	Converted to new review format

HISTORY

Protocol first published: Issue 1, 2008

Review first published: Issue 4, 2009

Date	Event	Description
5 October 2007	New citation required and major changes	Substantive amendment

CONTRIBUTIONS OF AUTHORS

Lindsay Pennington and Nick Miller designed the study. Lindsay Pennington created the first draft of the review. Lindsay Pennington, Helen Kelly and Naomi Parker conducted searches, selected papers for inclusion and extracted data. All authors were involved in the writing of the final draft of the review.

DECLARATIONS OF INTEREST

Lindsay Pennington: none known

Nick Miller: none known

Sheila Robson: none known

Helen Kelly: extracted data from studies conducted by Lindsay Pennington and Nick Miller

Naomi Parker: extracted data from studies conducted by Lindsay Pennington and Nick Miller

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- No sources of support supplied

External sources

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DIFFERENCES BETWEEN PROTOCOL AND REVIEW

An earlier version of this review (New Reference) included measures of speech function (respiration, phonation, resonance, articulation and prosody) as primary outcome measures. These outcomes are secondary outcomes in this review. Primary outcomes in this review comprise speech intelligibility and communicative participation only. Quality of life was not considered in the original version of the review but has been added as secondary outcome in this version.

INDEX TERMS

Medical Subject Headings (MeSH)

*Speech Therapy; Dysarthria [*therapy]; Speech Intelligibility

MeSH check words

Child; Child, Preschool; Humans