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Evidence-Based Intervention Options for Chronic Dysphagia Following Lateral Medullary Stroke

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Structured Abstract

Clinical Question: Are rehabilitation techniques more effective than compensatory strategies in improving swallow function and facilitating oral intake after a medullary stroke?

Method: A review of research comparing treatment outcomes between compensatory strategies and rehabilitative techniques for individuals with chronic dysphagia secondary to brainstem stroke was completed.

Study Sources: Cochrane Database of Systematic Reviews, Evidence-Based Medicine Reviews, PubMed®, MEDLINE®, CINAHL®, Social Sciences Citation Index® (Web of Science®), EMBASE, and speechBITE™

Search Terms: (Dysphagia OR Deglutition Disorders) AND (Lateral Medullary Stroke; OR Lateral Medullary Syndrome; OR Wallenberg Syndrome; OR brainstem stroke) AND (Therapy outcomes; OR treatment efficacy; OR rehabilitation; OR intervention; OR compensatory OR compensation)

Primary Results: Results from a review of the literature yielded only seven articles with enough detail in their descriptions to enable clinical replication. Of these, only one represented an experimental group design of a high standard of evidence; the others comprised case series and case study designs. Results indicate positive outcomes for the use of both compensatory strategies and rehabilitation techniques. Most individuals make improvements in swallow physiology and functional oral intake status.

Conclusions: The majority of studies reviewed in this brief represent lower levels of evidence. However, results do reflect positive clinical outcomes with benefits of both compensation and rehabilitation reported. Regular application of compensatory techniques may produce improvements to swallow physiology over time. The majority of patients appeared able to return to some form of oral intake following therapy.

Evidence-Based Intervention Options for Chronic Dysphagia Following Lateral Medullary Stroke

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Clinical Scenario

Marianne is a 40-year-old female who went to the emergency ward with acute shortness of breath, following a few days of symptoms consistent with an upper respiratory tract infection. On arrival, she presented with inspiratory stridor, a husky voice, coughing episodes, and haemoptysis (coughing up blood). Her oxygen saturation levels worsened and she was transferred to the intensive care unit (ICU).

Initially, Marianne was treated for supraglottitis. Later, an MRI indicated a left-sided (L) lateral medullary infarct (LMI), which was attributed to a vertebral artery dissection with associated thrombosis. While in the ICU, she required intubation to maintain her airway and then a tracheotomy. Her intensive care admission was complicated by an acute episode of aspiration pneumonia and oesophagitis. In the early days following her stroke, Marianne presented with many classical signs of LMI, also known as Wallenberg syndrome. Wallenberg syndrome is a cluster of symptoms that typically involves vestibulo-cerebellar signs and symptoms, sensory alterations, and bulbar muscle weakness.

Marianne's balance was impaired, so she had difficulty sitting upright, with a tendency to fall to the left. She also was unable to stand and limb ataxia was present on the left. She complained of severe vertigo with associated nausea and vomiting. Cranial nerve assessment indicated impaired eye movements (nsytagmus). Her hearing on the right (R) side was impaired. She had significant sensory alterations to temperature and pain ipsilaterally in her L face and contralaterally in her R trunk and limbs. R-sided palatal movement was reduced and her gag reflex was absent bilaterally. Results from an endoscopic examination indicated a (L) vocal cord paralysis and consequent dysphonia. She was severely dysphagic, and relied entirely on a feeding tube (percutaneous endoscopic gastrostomy [PEG]) for nutrition.

When her medical condition stabilised about 6 weeks later, Marianne was transferred to inpatient rehabilitation where she made significant gains. Her ocular and vestibular cranial nerve function improved. She re-established independence with all activities of daily living. Although her gait remained mildly ataxic, she was able to mobilise indoors without assistance and used a walker outdoors and for longer distances. Marianne finally returned home 12 weeks after her stroke.

Prior to her stroke, Marianne worked at a bank and was an active member of her local community. She also has two children. Marianne is unable to participate in school, church, or community events because of her inability to eat and drink normally or swallow her saliva. Likewise, returning to work is not possible. She has had two episodes of pneumonia and several other chest infections since her stroke.

One year later, Marianne was referred to Leah, an experienced neuro-rehabilitation clinician, for ongoing follow up and management of her dysphagia. Marianne's severe dysphagia has persisted. She remains wholly dependent on her feeding tube for nutrition and must cough her saliva to her mouth and then clear it by spitting into a facial tissue. She is eager to know if there is anything more that can be done to improve her swallow function and is very motivated to participate in therapy.

Leah reviewed Marianne's history, noting that she has had therapy several times to help with swallowing, but without success. Dysphagia has significantly affected Marianne's ability to participate in everyday activities and reduced her quality of life. Leah is guarded about Marianne's potential for rehabilitation. She contacted a number of colleagues to discuss her case. The general consensus was that, in light of the severity of the dysphagia, Marianne's previous attempts at therapy and extended period of time since her stroke, her ability to make significant therapeutic gains was limited.

Leah has decided to review the research literature for the best possible options for Marianne's ongoing speech pathology intervention. Specifically, she hopes to ascertain whether swallow rehabilitation is more or less effective than compensatory strategies for individuals following LMI.

Background

The Relationship Between Brainstem Stroke and Dysphagia

Literature examining the relationship between brainstem stroke and dysphagia has generally focused on three topics: the role of the brainstem in swallow function, co-occurrence of brainstem pathology with dysphagia, and the nature of dysphagia following brainstem lesions.

Neural structures of the brainstem play a vital role in the coordination of swallowing networks. Lesions affecting the brainstem, in particular, the lateral medulla, are often associated with a clinical presentation of dysphagia. (For detailed overviews see Amirali, Tsai, Schrader, Weisz, & Sanders, 2001; Bieger & Neuhuber, 2006; Jean, 2001; Lang, 2009; Miller, 2008; Zald & Pardo, 1999.)

Incidence of dysphagia associated with lateral medullary stroke varies. This can be primarily attributed to the range of evaluation techniques of dysphagia and the time-frame of the assessment. For example, Flowers, Skoretz, Streiner, Silver, and Martino (2011) report an incidence of dysphagia of 57% following lateral medullary stroke in the first 3 weeks following stroke, but Meng, Wang, and Lien (2000) report an incidence rate of 22% of individuals with persisting severe dysphagia on hospital discharge (Meng, Wang, & Lien, 2000).

The most clinically relevant focus of the literature has been to ascertain the nature of dysphagia associated with lateral medullary stoke. This has significant implications for clinical intervention. Comparing the characteristics of recurrent cortical or subcortical strokes and first-time brainstem strokes, Han, Chang, Lu, and Wang (2005) found predominantly pharyngeal phase breakdown in the brainstem cohort, while the cortical infarct group displayed more oral preparatory and oral phase difficulties. The brainstem infarct cohorts were significantly more likely to require nasogastric feeding at the time of videofluoroscopy. Interestingly, there were no significant differences between choking, impaired cough ability, aspiration, or pneumonia rates. Han et al. reported that 100% of patients with brainstem infarct demonstrated residue in the pyriform sinuses. Consistent with this, a case series by Bian, Choi, Kim, Han, and Lee (2009) reported that common findings on video-fluoroscopy for patients with medullary infarcts include increased residue in the pyriform sinuses with associated post-swallow aspiration and impaired upper esophageal sphincter (UES) opening.

Using surface electromyography (sEMG), Crary and Baldwin (1997) compared temporal aspects of swallowing and peak sEMG electrical activity in patients with dysphagia following brainstem stroke and healthy age-matched controls. Swallow attempts by the patients with dysphagia showed increased muscle activity and more variable amplitude patterns, occurring during a shorter interval. Three electrode placements sites provided data on the amplitude and temporal aspects of the swallow, enabling interpretation of coordination. Not surprisingly, the patients with dysphagia had significantly worse coordination compared to the controls.

Comparing Compensation Strategies to Rehabilitation

It is important to differentiate between compensation and rehabilitation as therapy options for dysphagia. Huckabee and Cannito (1999) identify compensation as a strategy that temporarily alters the bolus or swallow to facilitate oral intake, but it does not remediate the underlying swallowing impairment. In contrast, rehabilitation aims to improve the disordered swallow physiology in order to promote improved swallow function.

Historically, dysphagia management has relied heavily on compensatory strategies. However, there have been changes in the philosophy of treatment options for dysphagia. Until recently, swallowing was viewed as a reflex and, therefore, not considered suitable for behavioral remediation (Robbins et al., 2008). With advances in understanding the neural substrates underlying dysphagia, the componential nature of the swallowing sequence, and the neuromotor control of each component, swallowing rehabilitation has become theoretically feasible (Chicero, 2006; Robbins et al., 2008). In turn, more support for swallow rehabilitation is now being generated in the literature (Burkhead, Sapienza, & Rosenbek, 2007; Clark, 2003).

A related matter in rehabilitation is indirect versus direct therapy. Indirect therapy is meant to improve aspects of swallowing without introducing a prandial bolus. It can be used with patients who are at high risk of aspiration and used to improve the underlying constructs of swallowing physiology with minimal risk. The goal of direct therapy is to optimize swallow function with a bolus. It may be used with individuals who are able to tolerate even small amounts of oral intake (Logemann, 1991, 1999).

Beneficial effects of both direct and indirect therapy have been reported for the target case in the current scenario. Neumann and colleagues investigated differences in outcomes between direct and indirect therapy for patients with diverse neurological deficits, including brainstem infarct and achieved successful outcomes for both direct and indirect swallowing therapy. They found no differences in outcomes between the groups and no correlations between outcome success and lesion location (Neumann, 1993; Neumann, Bartolome, Buchholz, & Prosiegel, 1995).

Engaging in Evidence-Based Practice

There are various methods available to facilitate the implementation of evidence-based practice (EBP) (e.g., Sackett, Rosenberg, Gray, Haynes, & Richardson, 1996; Worrall & Bennett, 2001). In this scenario, Leah follows the 5-step method suggested by the Oxford Centre for Evidence-Based Medicine (OCEBM, 2011):

1. Ask a focused question
2. Find the evidence
3. Make a critical appraisal of the evidence
4. Make a decision
5. Evaluate the performance

Asking a Focused Question

One strategy employed in EBP paradigms is to focus a literature search by asking a specific and relevant clinical question. The PICO format is followed frequently. This question prototype outlines the patient/problem, the intervention, a comparison intervention, and the outcomes to be measured. By specifying a question this way, a literature search produces a more succinct set of articles for review.

For the purposes of this article, Leah developed the following answerable clinical question in the PICO format to assist her decision making: For people with chronic dysphagia following lateral medullary stroke, is swallow rehabilitation more effective than compensatory strategies to improve swallow function and facilitate oral intake?

Finding the Evidence

Leah employed several search strategies to ensure the most relevant literature was obtained. First she conducted a search for systematic reviews, next a database search, and finally, a search of targeted journals.

First, as systematic reviews are considered the strongest level of evidence, initial searches of the Cochrane Database of Systematic Reviews, Evidence-Based Medicine Reviews, and speechBITE ™ were conducted; this did not yield any systematic reviews related to lateral medullary stroke and dysphagia. There were, however, three systematic reviews of dysphagia rehabilitation in relation to stroke more generally (Bath, Bath, & Smithard, 2000; Foley, Teasell, Salter, Kruger, & Martino, 2008; Geeganage, Beavan, Ellender, & Bath, 2012).

Next, a comprehensive search was undertaken of PubMed; MEDLINE via Ovid, CINAHL via EBSCOhost, Social Sciences Citation Index (Web of Science), mbase; SCOPUS, and speechBITE ™ databases.

Search terms were derived from the PICO question, although slight differences in databases led to small changes in specific search terms. The SLP first searched with patient-related terms, including Dysphagia AND Lateral Medullary Stroke; OR Lateral Medullary Syndrome; OR Wallenberg Syndrome) Because of the limited sample generated, brainstem stroke was added to the list of included etiologies. Following this, Leah combined these searches with intervention and control search terms: Therapy Outcomes; Treatment Efficacy; Rehabilitation; Intervention; and Compensatory or Compensation. This generated a total of 234 articles. Titles and abstracts were screened for articles meeting inclusion criteria and duplicates were removed, leaving 77 articles.

Articles were included if they were peer-reviewed, written in English, published between 1950 and 2013, and reported therapy outcomes for people with dysphagia following lateral medullary stroke.

Articles were excluded if they reported data for participants with dysphagia from any etiology other than brainstem stroke, or if treatments studied were not readily available in speech pathology clinics (i.e., pharmacotherapy, transcranial magnetic stimulation, surgical intervention, acupuncture, and nutritional support as direct therapy).

After closer review, 70 articles were excluded because they did not have a treatment component or did not specify the therapy clearly enough for replication, or because the articles were diagnostic in nature. They aimed to identify dysphagia as a primary impairment after brainstem stroke (Chua & Kong, 1996; Teasell, Foley, Doherty, & Finestone, 2002), characterize the nature of dysphagia associated with brainstem impairment (Bian et al., 2009; Crary & Baldwin, 1997), or correlate neuroanatomical lesions with clinical presentation of dysphagia and/or aspiration on videofluoroscopy (Kim, Chung, Lee, & Robbins, 2000; Kim, 2003; Kim, Lee, Suh, & Lee, 1994; Kumral, Afsar, Kirbas, Balkir, & Ozdemirkiran, 2002; Kwon, Lee, & Kim, 2005).

Several other articles also were excluded. First, one large group study compared outcomes of functional swallowing therapy among 208 patients with neurogenic dysphagia of varied causes, including 27 patients with Wallenberg's Syndrome (Prosiegel, Holing, Heintze, Wagner-Sonntag, & Wiseman, 2005). The authors reported that participants underwent swallowing therapy per published protocols; however, details of the therapy received were not outlined and a wide array of therapy combinations is possible. This study could not be included in the critical appraisal because the contributing factors of each therapy to the outcomes are unclear.

Second, Ozeki et al. (2012) reported outcomes for 34 patients in an inpatient rehabilitation program for dysphagia following brainstem infarct at least 3 months earlier. The therapy undertaken included 40 to 60 minutes of swallowing training by SLPs, 6 days per week, or management of eating style by nursing staff; pulmonary rehabilitation to strengthen cough and occupational therapy to improve performance in activities of daily living also were used. Because of the ambiguous nature of the intervention in this study, it was not included in the critical appraisal.

Finally, there were several case studies that described an unusual presentation (Alstadhaug & Salvesen, 2007; Chen & Huang, 2008) or a more general course of recovery without details of therapeutic intervention following brainstem strokes (Finestone, Teasell, & Heitzner, 1999; Kruger, Teasell, Salter, Foley, & Hellings, 2007). No explicit details of the intervention were provided in these studies, so they were not included.

Figure 1 illustrates the article selection process, including searching, screening, reviewing for eligibility and identifying the final set of articles for inclusion in review.

Critical Appraisal of the Evidence

For the clinical question in this scenario, the evidence was divided into articles reporting outcomes for compensation or rehabilitation of lateral medullary stroke. An overview of participant characteristics, swallowing strategies, and functional outcomes for reviewed articles appears in Table 1.

Compensation

Early research in this area compared swallow physiology with and without a head turn (to the weaker side) in six healthy volunteers and five individuals with LMI (Logemann, Kahrilas, Kobara, & Vakil, 1989). This technique aims to close the weak side of the pharynx and direct the bolus into the stronger side. Outcomes from videofluoroscopy for the individuals who had sustained LMI indicated that all exhibited unilateral pharyngeal residue, pharyngeal residue in the pyriform sinuses on the affected side, a lower apex of the affected pyriform fossa, as well as reduced hyolaryngeal excursion. With a head turn to the weaker side, upper esophageal sphincter (UES) opening diameter and the fraction of bolus entering the esophagus both increased significantly.

Logemann and Kahrilas (1990) followed up that work with a case study of a 45-year-old female with severe and chronic dysphagia following medullary infarct. Over the course of 4 years, the patient was evaluated using videofluoroscopy and progressed through a series of compensatory maneuvers (head-turn 12 months post onset [MPO], then supraglottic swallow 36 MPO, and finally, Mendelsohn maneuver at 45 MPO). At 60 MPO, the patient's swallow function had improved sufficiently to enable return to oral intake and removal of her PEG. She remained free from adverse pulmonary complications for another 2 years. The extent of swallowing therapy she received in the interim periods between evaluations is unclear, and such details would be of interest. Similarly, the necessity of continued use of swallowing maneuvers once the patient returned to oral intake is also not specified. This early study of swallow rehabilitation, however, provides evidence for swallowing being considered as a series of components that may be modified through systematic compensation. The application of these compensatory techniques, if done regularly over extended periods, may lead to rehabilitation of swallow physiology, to some extent.

Tsukamoto (2000) provided a brief case report that confirmed the findings of Logemann et al. (1989). Specifically, two objective imaging techniques, video-fluoroscopy and computed tomography (CT), revealed that a head turn to the weaker side resulted in closure of the hemipharynx. The use of additional CT imaging enabled the exact location of the closure (above the level of the pyriform sinuses) to be established. Although this case report suggested that the head turn technique was potentially beneficial to individuals with dysphagia secondary to LMI, no discussion of aspiration or functional eating outcomes in this case was reported.

Most recently, Kanai et al. (2009) reported the course of recovery of a 54-year-old male with left LMI. Various indirect swallow therapies, including cold stimulation, effortful swallow, Mendelsohn maneuver, Shaker method, and Masako method were initially employed. A cough strengthening exercise consisting of two sets of three voluntary coughs also was introduced. The authors used scintigraphy to monitor the presence of contrast in the lungs after the ingestion of a teaspoon-sized bolus and followed by a voluntary cough (similar to the supraglottic swallow maneuver). They observed the immediate presence of aspirated material in the larynx and pulmonary regions; however, 10 minutes later these areas were clear of aspirate and the voluntary cough appeared effective in expelling aspirated material from the lungs. Seven weeks following his stroke, the participant began daily direct therapy using this technique. The participant started with 1/3 teaspoon of jelly at each practice. The amount was increased during the next 2 weeks, and then he began therapy with all types of pureed (paste-like) foods. Eleven weeks post stroke, his intake had increased to three pureed meals per day. At 6 MPO he resumed 100% oral intake. Due to the reliable use and efficacy of the cough–swallow strategy, despite continuing aspiration on videofluoroscopy at 9 MPO, he was able to continue oral intake without any adverse health outcomes.

Rehabilitation

Two articles describe case series designs in which individuals with chronic dysphagia secondary to brainstem stroke received swallow rehabilitation and were evaluated (Crary, 1995; Huckabee & Cannito, 1999).

First, Crary (1995) administered a direct rehabilitation program with the aim of increasing pharyngeal strength of swallow, duration of hyolaryngeal excursion and UES opening, as well as improving coordination. The protocol included sustained posture swallow, humming to check vocal quality post swallow, and cough to clear residue, if present. An sEMG biofeedback component also was used to provide patients with information on strength and duration of swallow. The proposed therapy schedule began with daily therapy for 3 weeks and then various schedules following this. One of six participants had a variable therapy schedule from the outset and was unable to complete the intensive phase. Outcomes were determined by functional improvements in ability to eat and drink, changes in swallowing physiology as measured by sEMG, and a post treatment questionnaire 18–24 months following completion of the treatment program. Results indicated that all participants improved with swallow physiology measures. Five of the six were able to resume full oral intake without non-oral supplementation, and no adverse health outcomes were identified in 24 months post-treatment.

Second, Huckabee and Cannito (1999) aimed to replicate and extend Crary's (1995) work. Outcomes for ten participants with chronic dysphagia resulting from brainstem injury (either infarct or surgery) were evaluated from a retrospective file audit. All participants undertook an intensive 5-day treatment program that included two 1-hour therapy sessions per day, plus a home-practice program. Rehabilitation exercises comprised regular repetitions of effortful swallow and the Mendelsohn maneuver. The Masako method and head lifting or Shaker method also formed part of rehabilitation programs for some patients. Again, varying therapy schedules occurred after this. Two modes of biofeedback were used with this group of patients. The first used sEMG with submental electrode placement to provide feedback to the patients about electrical activity for the muscles innervated during hyolaryngeal excursion (suprahyoid muscle group). This allowed for both visual and auditory feedback on strength and timing of swallow with various rehabilitative maneuvers having different target patterns. The second mode of feedback involved the use of acoustic feedback of sounds transmitted during cervical auscultation, in particular to monitor breath–swallow coordination. Outcomes were clearly documented for pretreatment after 10 therapy sessions (i.e., the intensive first week), 6 months post therapy, and a final outcome taken 1 to 4 years later. Outcomes were systematically reported for participants and included a scale for functional outcomes related to nutritional intake, swallowing severity scale ratings based on videofluoroscopy, and changes to pulmonary symptomology prior to and following treatment. Significant improvements were found with the means of nutritional route. At the beginning of therapy, all participants were fully dependent on tube feeding. Following the intensive first week of therapy, all participants had begun some form of oral intake. At 6 months post therapy, seven out of 10 participants no longer required supplemental nutrition. All participants improved on a swallowing severity scale. Though six of the 10 had reported previous health complications associated with likely aspiration, no patients reported pulmonary complications following therapy.

Shaker et al. (2002) also reported findings from a randomized controlled trial with 27 patients dependent on enteral nutrition secondary to poor UES opening. Many of the diagnostic studies discussed reported this feature in dysphagia associated with LMI. Seven of the participants in this study had sustained brainstem strokes. The therapy protocol was well specified and involved a home practice program of isometric and isotonic head lifting. The participants were required to complete three head lifts held for 1 minute with 1-minute break in between, followed by 30 repetitions of head lifting. These exercises were completed three times a day for a period of 6 weeks. Overall results were promising for all participants. For the seven participants who had sustained brainstem infarcts, findings were consistent with other studies in terms of outcomes. All seven were at least partially dependent on tube feeding for nutrition at the commencement of therapy and all were able to resume oral intake after completing the program. It should be noted that three of the seven were still in the acute stage of recovery (less than 2 weeks post stroke); the others were all greater than 4 MPO.

Summary of Findings

Of the seven articles included in the review, four focused on compensation and three focused on rehabilitation. There were 31 participants, with sample sizes ranging from one to 10. For one study, seven participants were extracted from a larger cohort based on etiology. Participants from the four studies investigating compensatory strategies all had diagnoses of LMI and participants from the rehabilitation studies had broader diagnoses of brainstem stroke or neurological lesion associated with tumor compression or surgical resection in the brainstem. Of the 31 participants, six had sustained strokes less than 4 weeks prior to entering their respective research programs. The remaining participants ranged from 4 to 84 months post-neurological injury.

Clinical outcomes were extremely positive. Twenty-six of 31 participants demonstrated functional improvements to swallow physiology. It should be noted that results may be skewed as a result of publication bias or the tendency of authors to submit, and journals to publish, articles with positive outcomes rather than those proving null hypotheses or reporting limited clinical outcomes. (For review, see Hopewell, Loudon, Clarke, Oxman, & Dickersin, 2009.)

Evaluation of the Evidence

For many research methodologies, rating scales exist to enable clinicians to verify the methodological quality of research. For example, the PEDro–P scale rates randomized controlled trials and non-randomized group comparison studies (Tate et al., 2004), whereas the single case experimental design (SCED) scale facilitates methodological rating of experimentally controlled single case studies (Tate et al., 2008). Despite the availability of such tools, the majority of research generated by this PICO question is low-level evidence that does not lend itself to rating on published scales. Robey (2004) outlines a five-phase model for clinical outcome research. Within this model, Phase I research includes "case studies, discovery-oriented single-subject studies, small group pre-post studies, and retrospective studies" (p. 404), much of which characterizes the studies reviewed here. Although the level of evidence may be considered low by some standards, it does signify the early stage of research within this specific area of clinical interest.

As an alternative, Logemann (1987) outlines a number of criteria for examining interventions focused on disordered swallowing. These include the use of objective assessment to quantify treatment outcomes; the standardization of assessment and therapy procedures; the homogeneity of patient groups in terms of etiology, nature of dysphagia, and stage of disease progression; and well-defined, detailed treatment protocols. For the purposes of this brief, the articles selected were rated on these indices, as shown in Table 2.

These data clearly highlight the lack of high-level evidence available for the current clinical scenario. They also illustrate the methodological components of this collection of articles by showing that all articles used objective assessment as one of the primary outcomes; four of seven described uniform replicable assessment and treatment procedures; and three of the four group studies had well-defined participant cohorts with homogeneous groups.

Making a Clinical Decision

Having completed her literature search and appraisal, Leah is cautious about generalizing the findings of these results too broadly. However, she has noted that characteristics of one of the case studies overlaps significantly with her patient, the majority of patients mentioned in the literature demonstrated improved swallow function, and many were able to return to oral feeding. Leah also knows it will be important to carefully collect data to ensure that her intervention can be effectively evaluated after completion of the therapy program. It will be important to document frequency of therapy sessions, intensity of treatment during sessions, the exact treatment protocol used and variations as they arise, and to confirm any clinical improvements with objective assessment following therapy. Leah is well prepared for her initial assessment appointment and confident in her plans for Marianne.

Conclusion

The majority of studies reviewed in this brief represent lower levels of evidence. However, results reflect positive clinical outcomes. Positive effects of compensation and rehabilitation are noted. The recurrent implementation of compensatory techniques may produce a rehabilitative effect, producing improvements in functional swallow outcomes. The majority of patients appeared able to return to some form of oral intake following therapy. This review supports the use of an initial intensive therapy schedule and that biofeedback using sEMG may be beneficial.

These findings are consistent with broader principles of neuro-rehabilitation, including those of neuroplasticity (Robbins et al., 2008) and strength-based training (Burkhead et al., 2007; Clark, 2003), as well as principles of motor learning (Schmidt & Lee 2005).

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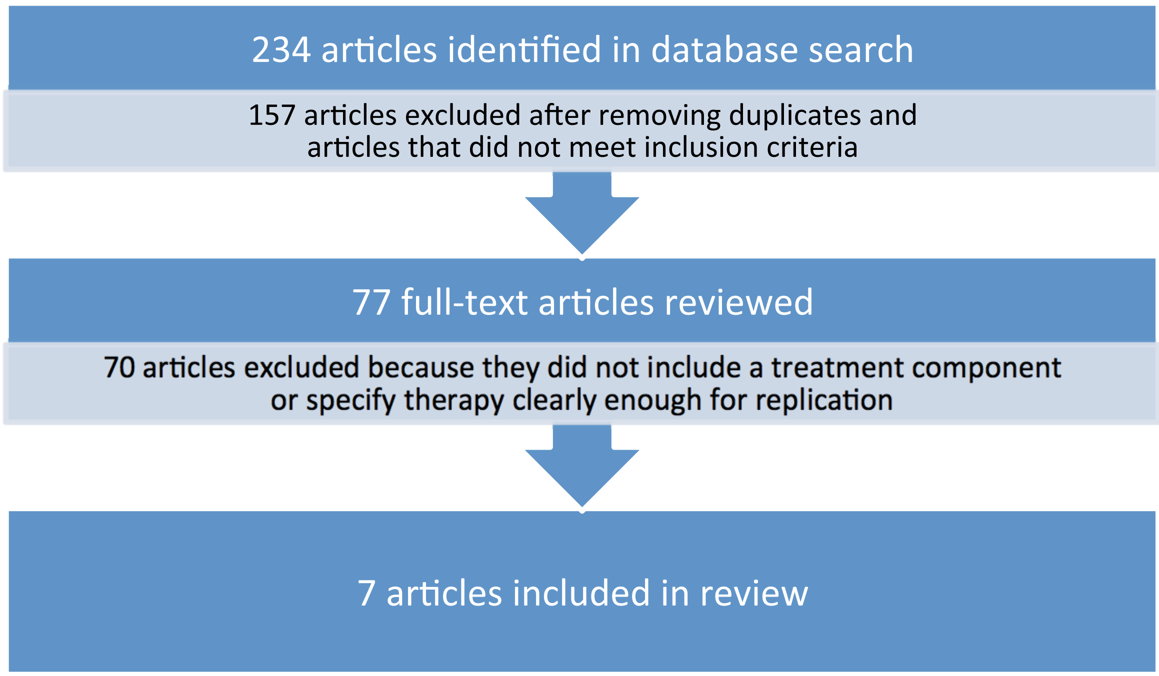

Figure 1. Flow diagram outlining the article selection process

Table 1. Participant characteristics, swallowing strategies, and outcomes reported in reviewed articles

Reference	Strategy Type	Strategy	Number of Participants	Etiology	Months Post Onset (MPO)	Clinical Outcomes
Kanai et al. (2009)	Compensation	After ingestion of bolus 1–2 voluntary coughs to clear aspirated prandial	1	L-LMI	< 1	At 9 months post stroke participant resumed oral intake for all nutrition with voluntary cough following each mouthful and likely texture modification.
Logemann & Kahrilas (1990)	Compensation	Head turn, supraglottic swallow, Mendelsohn maneuver	1	LMI	4–60	At 60 MPO participant resumed oral diet for all nutrition.
Logemann et al. (1989)	Compensation	Single intervention using head-turn strategy on MBS	5	LMI	< 1	Improved UES opening and increased quantity of bolus swallowed.
Tsukamoto (2000)	Compensation	Single intervention using head-turn strategy on CT	1	L-LMI	1	No outcomes regarding oropharyngeal functional or nutritional status reported
Crary (1995)	Rehabilitation	Swallow bolus using sustained posture technique (mouth closed, pharyngeal contraction, following swallow attempt hum to check vocal quality, cough to clear residue if required, re-swallow). SEMG biofeedback was provided to participants following each swallow attempt.	6	Brainstem stroke	5–54	At 18–22 months post therapy, 5/6 resumed oral intake for all nutrition.
Huckabee & Cannito (1999)	Rehabilitation	Regular repetitions of effortful swallow and Mendelsohn maneuver. Masako method, and head lifting or Shaker method also formed part of rehabilitation programs for some patients. sEMG and acoustic feedback were employed.	10	7/10 Brainstem stroke 3/10 tumor compression and/or resection	8–84	4/7 brainstem stroke patients and 3/3 surgical patients resumed oral intake for all nutrition, though most required texture modification at 6 months post therapy.
Shaker et al. (2002)	Rehabilitation	Progressive isotonic head-lifting exercise regime	7 (total of 27)	Brainstem stroke (various etiologies)	3/7 < 1 4/7 > 4	All 7 participants with brainstem stroke were able to resume oral intake following treatment

Table 2. Research design, level of evidence, and methodological evaluation for treatment outcome studies generated

Reference	Design	Level of Evidence	Desirable Features of Treatment Studies in Oral-Pharyngeal Dysphagia2			
			Objective Assessment	Standardized Assessment Procedures	Group Homogeneity	Treatment protocol
Shaker et al. (2002)	3 Randomized Controlled trial PEDro–P scale rating = 6/10	Level 2	YES Videofluoroscopy	YES Assessment procedure well described	NO Chronic and acute patients with various etiologies of dysphagia BUT same disordered aspect of swallow (reduced UES opening)	YES Treatment protocol clearly described
Logemann et al. (1989)	Case Series	Level 4	YES Videofluoroscopy	YES Assessment procedure well described	YES 5 individuals with chronic dysphagia post LMI Also 6 health controls	YES Single intervention of head-turn strategy
Crary (1995)	Case Series	Level 4	YES Videofluoroscopy	NO Post treatment assessment procedures not standardized or systematically reported	YES 6 individuals with chronic post stroke dysphagia resulting from brainstem stroke > 5MPO	YES Treatment protocol clearly described
Huckabee & Cannito (1999)	Case Series	Level 4	YES Videofluoroscopy	YES Assessment procedure well described	YES 10 participants with chronic post stroke dysphagia secondary to brainstem stroke or surgery > 8MPO	YES Treatment protocol clearly described
Tsukamoto (2000)	Case Study	Not rated	YES Videofluoroscopy Computed tomography	NO Not described	NA	NA Assessment only
Kanai et al. (2009)	Case study	Not rated	YES Scinigraphy	NO Assessment procedure well described	NA	YES Treatment protocol clearly described